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Encouraging Thai Real Estate Developers Toward Net Zero: A Case Study on Factors Influencing Decision-Making in Net Zero Building Development

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ABSTRACT

The concept of Net Zero Carbon Buildings, which aims to reduce greenhouse gas emissions, is essential in addressing climate change. However, the development of such buildings in Thailand faces significant challenges, including high construction costs, uncertain returns, and limited investment incentives. This study explores the factors influencing real estate developers' decisions to pursue Net Zero Carbon Buildings in Thailand, with a focus on physical, financial, and policy-related elements. Data collection was done with 388 respondents who are stakeholders, including developers, consultants, designers, and sustainability experts, through an online questionnaire, and analyzed using Multiple Regression Analysis. The independent variables in the analytical model consist of three groups of factors: physical buildings, climate finance, and climate policy. The results indicate that physical building factors, including building age, engineering systems, and design; climate finance factors, such as project cost increases, financial returns, and investment incentives; and climate policy factors, including government policies, international climate agreements, and carbon taxes, significantly influence development decisions. Government policies, building engineering systems, and financial incentives were identified as key positive drivers for investment, while carbon taxes and energy efficiency-focused designs were found to potentially discourage investment due to higher costs. The study concludes that substantial government support such as tax incentives, grants, and low-interest financing is critical to fostering investment in Net Zero Carbon Buildings. Additionally, raising

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awareness among developers and the private sector about the long-term benefits of these projects is essential to strengthening investment incentives.

Keywords: Zero Carbon Emission; Net Zero Carbon Buildings; Climate Finance; Climate Policy; Real Estate Development; Thailand

1. Introduction

The increasing concerns over climate change and environmental degradation have led to significant shifts in the global construction and real estate sectors. With buildings contributing nearly 40% of global energy-related carbon dioxide emissions, transitioning toward sustainable construction practices has become a key focus in mitigating climate impacts [1]. Among the most ambitious strategies in this movement is the concept of Net Zero buildings, which aim to minimize energy consumption while balancing the remaining energy demand with on-site or off-site renewable energy sources [2]. This research investigates the factors influencing the development of Net Zero building projects, particularly in urban environments where energy efficiency and sustainability are essential. Net-zero buildings are crucial not only for environmental reasons but also for market competitiveness, as the construction industry's contribution to global carbon emissions makes it a key player in the fight against climate change.

In the definitions of Net-Zero building or Net-Zero Carbon buildings (NZC), it is defined as a structure that achieves net-zero energy consumption, meaning the total energy used by the building on an annual basis is balanced by the amount of renewable energy generated on-site or, in some cases, through off-site renewable energy sources. This is achieved through technologies such as heat pumps, high-efficiency windows and insulation, and solar panels which is shown in the report of The National Institute of Building Sciences (2015) [3].

The growing focus on Net-Zero buildings has become increasingly significant for real estate developers in Thailand over the past five years, with many initiating projects aimed at reducing carbon emissions and mitigating the impacts of climate change. A primary driver of this shift is the substantial contribution of buildings to overall greenhouse gas emissions, which intensifies the challenges of global climate change. According to the report of TerraBKK (2020), the real estate business placed significant emphasis on environmental trends, incorporating these concepts into the design and development of eco-friendly, energy-efficient homes that enhance the quality of life for their occupants [4]. Homeowners can integrate various technologies to make their homes more environmentally friendly, such as alternative energy homes with solar roof systems to use clean energy instead of electricity. Other innovations include energy-efficient homes that reduce air pollution, with systems like the Active Airflow System to improve air circulation and expel heat from the house and attic, reducing indoor temperatures by 2–5°C and attic temperatures by more than 10°C. Additionally, Well AIR systems can be installed to improve indoor air quality by reducing harmful air pollutants, while heat-insulating materials can block heat from the roof, reflecting up to 95% of heat radiation. Green homes also use construction materials made from recycled or leftover materials, such as floor tiles made from clay and ceramic waste or fiber-cement roofing made from recycled ash and stone dust instead of natural materials. These eco-friendly construction materials not only support environmental sustainability but also maintain high safety standards and are beneficial for residents.

This research examines the factors influencing the development of Net Zero buildings, with a particular focus on urban areas in Bangkok, where energy efficiency is critical. Despite the growing emphasis on sustainability, the adoption of Net Zero strategies faces significant challenges, including high initial costs, regulatory hurdles, and technological barriers [5]. Furthermore, there is a lack of studies addressing the factors that influence decision-making in Net Zero developments, especially in emerging economies. The study aims to identify the key factors that shape Net Zero decisions, evaluate the challenges faced by developers, and offer policy recommendations to encourage broader adoption. By exploring the barriers and opportunities in implementing Net Zero buildings, this research contributes to global efforts toward achieving carbon neutrality in the built environment.

2. Literature Review

The literature review is divided into two main sections. The first section introduces the situation of net-zero buildings in Bangkok, while the second focuses on previous studies examining factors influencing developers' decisions in Net-Zero Building Development.

2.1. The Situation of Net-Zero Buildings in Bangkok, Thailand

Thailand has made significant strides in promoting net-zero buildings, particularly in Bangkok, where sustainability has become an increasing priority for both the public and private sectors. Over the past decade, certification systems such as TREES (Thai Rating of Energy and Environmental Sustainability) and LEED (Leadership in Energy and Environmental Design) have been widely adopted to improve energy efficiency and environmental performance. Since 2007, the growth of green buildings in Thailand has been remarkable, with an average annual increase of approximately 54% in both the number of certified buildings and total floor area. In 2007, only six buildings in the country were green-certified; by 2015, this number had risen to 243, and by 2016, to 294. Between 2020 and 2022, the total certified green building area exceeded 5 million square meters. Most of these buildings are in the commercial sector—including office, retail, and industrial developments—which together account for approximately 40% to 80% of all certified green buildings. The upward trend is particularly evident in Bangkok and other major economic centers. However, the number of fully operational net-zero buildings remains limited, due to persistent challenges such as high upfront costs, limited technical expertise, and a lack of strong policy incentives.

A key factor in achieving net-zero buildings is the assessment of carbon emissions throughout the building's life cycle. The American Institute of Architects (2023) reported that the use of Building Life Cycle Assessment (LCA) methods enables developers to evaluate environmental impacts from material extraction to demolition, thereby reducing carbon footprints and improving energy efficiency [6]. However, LCA implementation in Thailand is still in its early stages, requiring further integration into regulatory frameworks and industry practices. As for the future policy goals toward Net Zero Carbon in Thailand, it has set climate targets, aiming to achieve carbon neutrality by 2050 and net-zero greenhouse gas (GHG) emissions by 2065 [7]. These goals align with global climate commitments and require strategic policies to drive the transition toward sustainable buildings. Key policies such as the Energy Efficiency Plan (EEP) and the Alternative Energy Development Plan (AEDP) support energy-efficient building practices and the increased use of renewable energy [8]. Additionally, financial mechanisms like tax benefits, green bonds, and sustainability-linked financing are being explored to incentivize investment in net-zero developments [9]. In alignment with the United Nations Sustainable Development Goals (SDGs), Thailand has demonstrated active support, particularly for SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action) [10]. The promotion of Net Zero buildings plays a pivotal role in advancing these global objectives by reducing energy consumption, lowering carbon emissions, and supporting sustainable urban development. Government initiatives—such as the Bangkok Master Plan on Climate Change and the incorporation of circular economy principles—further underscore Thailand's commitment to climate action and sustainable development [7].

2.2. Previous Research Related to the Factors Influencing Developers' Decision in Net-Zero Building Development

A review of previous research concludes that three main groups of factors influence real estate developers' decisions in the development of Net Zero buildings: 1) Physical building factors, 2) Climate finance factors, and 3) Climate policy factors.

2.2.1. Physical Building Factors

Moser et al. investigated that the age of a building influences Net Zero Carbon (NZC) feasibility, with older structures benefiting from retrofitting, reducing energy use by up to 50% [11]. However, Weerasinghe et al. found that the regulatory barriers and collaboration issues slow the adoption of such measures [12]. Engineering systems, especially HVAC, lighting, and BMS, are responsible for over 55% of building energy consumption, with AI-driven optimization improving efficiency [13,14]. Yet, integrating smart engineering with renewable energy solutions is still underexplored [15].

As for the building design, Pacheco et al. found that the building design impacts NZC outcomes through passive strategies like natural ventilation and daylighting [16]. A holistic approach involving design, user behaviour, and policy is crucial for energy optimization [17]. However, little research examines the interaction between occupant behaviour and engineering systems for NZC performance. Building type also affects energy consumption, with commercial having higher emissions, though high-density residential NZC solutions remain underexplored [18].

Renewable energy adoption is vital for NZC success but depends on financial feasibility, technical challenges, and policy incentives [12,19]. The role of policy in integrating renewable energy with building systems is critical, though studies rarely investigate the combined impact of design, engineering, and renewable solutions across different building types [17].

2.2.2. Climate Finance Factors

The financial viability of Net Zero Carbon (NZC) adoption is a key concern, with high initial costs balanced by long-term energy savings [20,21]. Despite this, research on cost barriers and financial modeling for NZC is limited. Successful energy-efficient retrofits, like those in the Empire State Building, have shown strong financial returns, cutting energy use by 38% over 15 years [22]. However, comprehensive financial assessments across building types are still needed.

Sustainability-linked bonds (SLBs) help reduce capital costs and incentivize NZC projects through lower borrowing rates [23] but concerns about alignment with science-based targets and transparency limit their growth [24]. Green bonds also finance climate-friendly infrastructure, but risks of "greenwashing" emphasize the need for stricter impact reporting [25].

Other financial mechanisms, such as carbon taxes and green finance incentives, further support NZC adoption [18]. Their effectiveness, however, depends on strong policy frameworks and market transparency.

2.2.3. Climate Policy Factors

Global climate protocols and national commitments are crucial for achieving net-zero emissions by 2050, especially in the building sector [26]. The IEA roadmap emphasizes the need for behavioral changes and policy alignment with climate goals, but substantial energy reductions—up to 83% in buildings—are required to meet these targets [21]. Countries like New Zealand, where construction accounts for 20% of emissions, must accelerate sectoral decarbonization [27].

Government policies drive NZC adoption through asset-level decarbonization and financial incentives, such as tax credits [15]. Stronger regulatory frameworks, including minimum energy standards, are necessary to support the transition [28]. Legislation like the Waxman-Markey Bill and New Zealand's Zero Carbon Act demonstrates the role of policy, but compliance challenges and financial barriers remain.

Carbon taxation and financial incentives encourage NZCB adoption, with tax credits and rebates proving effective [29]. Carbon credits support emissions management by offsetting energy demand, but supply limitations reduce their effectiveness. Expanding carbon credit markets and integrating reduction criteria into project tenders could enhance NZCB feasibility [27,30].

By reviewing the literature and related research, researchers have established a conceptual framework for this study, as depicted in **Figure 1**.

3. Research Methodology

This study adopts a quantitative research approach using a survey design to examine the factors influencing real estate developers' decision-making in the development of Net Zero buildings in Thailand. Data were collected via an online questionnaire distributed through Google Forms, employing stratified random sampling. The survey was conducted over three months (December 2024–February 2025), targeting professionals directly involved in Net Zero project decision-making, including developers, consultants, designers, and sustainability experts in Bangkok and other metropolitan areas. To ensure the relevance of respondents, screening questions assessed their experience in real estate development, project planning, and sustainability. The data relevant to the variables was collected from samples and is divided into three parts: (1) socio-economic information, (2) attitudinal questions related to factors influencing real estate developers' decisions to pursue Net-Zero buildings in Thailand (**Table 1**), and (3) qualitative insights gathered through open-ended questions. The qualitative responses provided additional perspectives on the motivations and barriers to

Net-Zero adoption, offering deeper insights into the decision-making process for Net-Zero building development. After data surveying, 388 respondents were screened and chosen as research sample. This number is sufficient (> 385 samples) as compared to the minimum requirement number of samples recommended by W.G. Cochran [31]. He estimated the proportion of the population when the population size is large or unknown. The sample size to estimate proportions and determine the size of the problem can be analyzed using Equations (1) and (2).

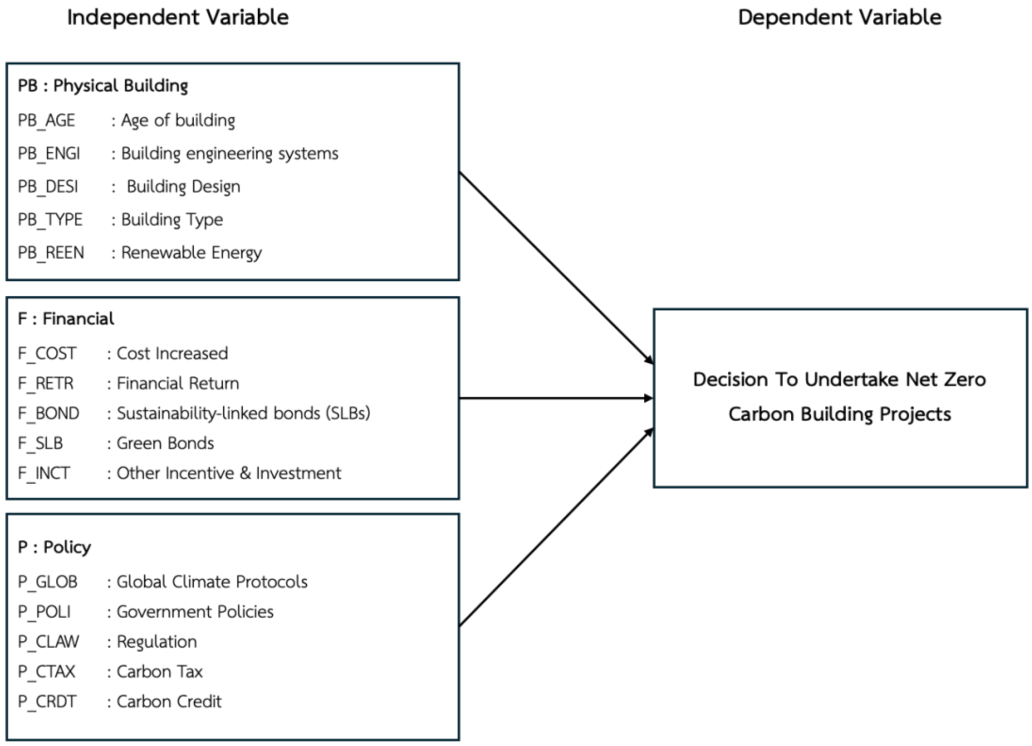

Figure 1. Research framework.

$$n = \frac{Z^2 P(1-P)}{d^2} \tag{1}$$

$$n = \frac{1.96^2 0.5(1-0.5)}{0.05^2} = 384.16 \approx 385 \; samples \tag{2}$$

Where n is the sample size (Sample Size); Z is the selected Z-score (In this case, it's the Z-score for 95% confidence level or 1.96); P is the expected proportion in the population (In this case, 50% or 0.5) and d is the margin of error, 0.05.

Table 1. Attitudinal questions of determinants influencing real estate developers' decision to pursue net-zero buildings in Thailand.

Variable Groups	Variables		Questions
PB (Physical building factors)	PB_AGE1	Age of building	The age of a building has a positive correlation with the development of Net Zero Carbon Building.
	PB_AGE2	Age of building	Retrofitting old buildings to become Net Zero Carbon Buildings is highly feasible.
	PB_ENGI	Building engineering systems	Building engineering systems, like HVAC and electrical are vital to Net Zero Carbon Building development.
	PB_DESI1	Building Design	Knowledge of the carbon number in materials is important to development of Net Zero Carbon Building.
	PB_DESI2	Building Design	Energy-efficient building design significantly contributes to reducing greenhouse gas emissions in Net Zero Carbon Building projects.

Table 1. *Cont.*

Variable Groups	Variables		Questions
PB (Physical building factors)	PB_TYPE	Building Type	The energy demand of different building types affects the development of Net Zero Carbon Building projects.
	PB_REEN	Renewable Energy	The use of renewable energy sources, such as solar and wind power, is essential for the development of Net Zero Carbon Building projects.
F (Climate finance factors)	F_COST	Cost Increased	The higher development cost of Net Zero Carbon Building projects compared to conventional buildings significantly influences investment decisions.
	F_RETR	Financial Return	The payback period of Net Zero Carbon Building is highly attractive compared to conventional building.
	F_BOND	Green Bonds	Green Bonds enhance investor confidence in the development of Net Zero Carbon Building projects.
	F_SLB	Sustainability-linked bonds	Access to Sustainability-Linked Bonds (SLBs) is essential for developing Net Zero Carbon Building.
	F_INCT	Other Incentive & Investment	Government subsidies or organizational support significantly reduce Net Zero Carbon Building development costs.
P (Climate policy factors)	P_GLOB	Global Climate Protocols	The adoption of Sustainable Development Goals (SDGs) strongly promotes the development of Net Zero Carbon Building.
	P_POLI1	Government Policies	Government policies that support greenhouse gas reduction significantly influence the decision to develop Net Zero Carbon Building.
	P_POLI2	Government Policies	Mandatory government policies play a significant role in the decision-making process for developing Net Zero Carbon Building projects.
	P_CLAW	Regulation	The draft Climate Change Act drives demand for Net Zero Carbon Building development.
	P_CTAX	Carbon Tax	The implementation of a carbon tax encourages investment in Net Zero Carbon Building projects.
	P_CRDT1	Carbon Credit	The carbon credit market enhances the attractiveness of investing in Net Zero Carbon Building projects.
	P_CRDT2	Carbon Credit	Rising carbon credit prices will enhance the appeal of Net Zero Carbon Building investments.
Y (Dependent Variable)	Y_PB	Physical Building	The physical building factors significantly impact the development of a Net Zero Carbon Building project.
	Y_F	Financial	Climate financial factors significantly impact the development of a Net Zero Carbon Building project
	Y_P	Policy	Climate policy factors significantly impact the development of a Net Zero Carbon Building project.

Table 1 presents the attitudinal questionnaire items, variable groups, and question codes used to examine the factors influencing real estate developers' decisions to pursue Net Zero Carbon Building projects in Thailand. The variables are categorized into three independent variable groups: physical building factors (PB), climate finance factors (F), and climate policy factors (P) and one dependent variable group (Y). The PB group includes seven questions, the F group includes five questions, and the P group includes seven questions, totaling 19 questions for the independent variables. The dependent variable group comprises three items, each reflecting the perceived influence of the corresponding main factor group on the decisions in pursuing Net Zero Carbon Buildings in Thailand. All attitudinal statements were rated by respondents on a five-point Likert scale ranging from "strongly disagree" (= 1) to "strongly agree" (= 5), as shown in **Table 2**.

Table 2. Scoring range of likert scale of survey.

Evaluation Criterion	Value	Range
Strongly Disagree	1	1.00–1.80
Disagree	2	1.81–2.60
Neither/Nor agree	3	2.61–3.40
Agree	4	3.41–4.20
Strongly Agree	5	4.21–5.00

As for the pilot testing, responses from the first 30 participants were analysed to assess questionnaire reliability via Cronbach's Alpha. Coefficients were 0.76 for Physical Building, 0.72 for Financial, and 0.81 for Policy exceeding the 0.70 threshold [32]. The dependent variable, the decisions in pursuing Net Zero Carbon Buildings in Thailand (Y), had a coefficient of 0.59, indicating moderate reliability. According to Hinton et al., the values between 0.50 and 0.70 are acceptable, especially for constructs with only a few items, as fewer items tend to lower reliability [33]. Multiple Linear Regression Analysis (Enter method) was then applied to identify significant predictors at the 0.05 level [34]. This research uses SPSS for Windows (Statistical Package for Social Science) version 27th to find the statistical results of Multiple Regression Analysis (MRA). The MRA model is established as follows [Equation (3)]:

$$\mathrm{Y} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_{\mathrm{i}} X_i + \varepsilon \tag{3}$$

where Y is dependent variable; I indicates number of independent variables; B_0 is y-intercept (constant); β_1, β_2, β_3,...,β_{i} are slope coefficients for each independent variable; $X_1, X_2, X_3 ... Xi$ are independent variables sequence 1 to i; ε is the model error (residual).

Additionally, the Variance Inflation Factor (VIF) will be checked for excessive correlation among the variables. If the VIF value is no more than acceptable value of 10, it means that the independent variables are not highly correlated with each other.

4. Results and Discussion

4.1. Sample Characteristics

The collected data is summarized and shown in the descriptive data of socio-demographic characteristics and the summary of respondents' awareness, experience, and interest in Net Zero Carbon Building.

4.1.1. Socio-Demographic Characteristic

Table 3 shows that the study examines real estate developers, project consultants, designers, financial professionals, and sustainability developers to assess their perspectives on Net Zero Carbon Building development. Data were analysed using frequency and percentage values. The sample consists of 40.50% male and 59.50% female respondents. The majority are project designers (35.80%) and real estate developers (27.60%), with varying levels of experience: 39.20% have 5–10 years, while 29.90% have less than 5 years. Most respondents have worked on residential (52.10%) or commercial (40.50%) projects. Regarding education, 49.70% hold a bachelor's degree, 45.90% a master's, and 4.40% a doctorate. These insights provide a foundational understanding of industry professionals' expertise and their engagement with sustainable building practices.

Table 3. Summary of characteristics of respondents.

Socio-Demographic Variable	Frequency (Persons)	Percentage (%)
No. of respondents	388	100
Gender		
Male	157	40.50
Female	231	59.50
Occupation		
Real estate developer	107	27.60
Real estate consultant	40	10.30
Designer	139	35.80
Financial careers	9	2.30
Legal career	1	0.30
Sustainability developer	17	4.40
Other	75	19.30

Table 3. *Cont.*

Socio-Demographic Variable	Frequency (Persons)	Percentage (%)
Experience in Real Estate or Architecture		
Less than 5 years	116	29.90
5–10 years	152	39.20
11–14 years	64	16.50
15–19 years	32	8.20
20–30 years	22	5.70
More than 30 years	2	0.50
Types of projects have you developed or involved in developing?		
Residential	202	52.10
Commercial	157	40.50
Other	29	7.50
Education background		
Bachelor's degree	193	49.70
Master's degree	178	45.90
Doctoral degree	17	4.40

4.1.2. Summary of Respondents' Awareness, Experience, and Interest in Net Zero Carbon Building

Table 4 shows that the respondents have varying levels of awareness and understanding of Net Zero Carbon Building development. The majority of respondents are aware but require further study (69.3%), while 26.0% have a strong understanding, and only 4.6% have no prior knowledge. Regarding experience in Low Carbon Building or Net Zero Carbon projects, 55.4% have been involved in such projects, whereas 44.6% have no prior experience. In terms of interest and knowledge about Net Zero Carbon, 27.6% reported having a strong interest and understanding, followed by 32.2% with general interest and knowledge, and 31.2% with moderate interest. Meanwhile, 5.2% expressed no interest but had some knowledge, while 3.9% showed neither interest nor knowledge.

Table 4. Summary of respondents' awareness, experience, and interest in net zero carbon building.

Respondents' Awareness, Experience and Interest	Frequency	Percentage (%)
No. of respondents	388	100
Awareness and understanding of Net Zero Carbon Building project development		
Fully aware and understood	101	26.00
Acknowledged but still need time to study.	269	69.30
Never known before	18	4.60
Do you have experience in developing Low Carbon Building/Net-Zero Carbon Building projects?		
Experienced	173	44.60
Never had experience	215	55.40
How interested and knowledgeable are you about Net Zero Carbon?		
Uninterested and extremely knowledgeable	15	3.90
Uninterested and knowledgeable	20	5.20
Moderately interested and knowledgeable	121	31.20
Interested and knowledgeable	125	32.20
Very interested and knowledgeable.	107	27.60

Table 5 shows the summary of the sample's average scores toward factors influencing developers' decision-making on investment of Net-Zero buildings in Thailand. Three groups of factors are evaluated: (1) physical building attributes, (2) financial considerations, and (3) policy regulations.

Table 5. Summary of samples' attitudes toward variables.

Variables	Mean	SD	Level Agree
(PB) Physical building factors			
PB_AGE1	3.85	0.96	Agree
PB_AGE2	3.12	1.04	Neither/Nor agree
PB_ENGI	4.57	0.65	Strongly Agree
PB_DESI1	4.33	0.90	Strongly Agree
PB_DESI2	4.59	0.64	Strongly Agree

Table 5. *Cont.*

PB_TYPE	4.46	0.77	Strongly Agree
PB_REEN	4.36	0.83	Strongly Agree
(F) Climate finance factors			
F_COST	4.44	0.67	Strongly Agree
F_RETR	3.63	1.10	Agree
F_BOND	3.89	0.90	Agree
F_SLB	3.80	0.89	Agree
F_INCT	4.32	0.98	Strongly Agree
(P) Climate policy factors			
P_GLOB	4.13	0.84	Agree
P_POLI1	4.28	0.83	Strongly Agree
P_POLI2	4.41	0.74	Strongly Agree
P_CLAW	4.16	0.87	Agree
P_CTAX	4.19	0.92	Agree
P_CRDT1	4.10	0.86	Agree
P_CRDT2	4.24	0.82	Strongly Agree
(Y) Decision making in the development of net zero buildings Projects			
Y_PB	4.11	0.82	Agree
Y_F	4.61	0.64	Strongly Agree
Y_P	4.34	0.74	Strongly Agree

In the group of physical building attributes, encompasses factors such as building design, engineering systems, incorporation of renewable energy, and building type. Among these, the top three highest satisfaction scores are observed in building design (M = 4.59, SD = 0.64), building engineering systems (M = 4.57, SD = 0.65), and building type (M = 4.46, SD = 0.77). These results highlight the importance of structural and design elements in the decision-making process for developers. Most of them are interpreted as strongly agree. Only PB_AGE2 shows the lowest average score of 3.12, interpreted as neither/nor agree.

The second group consists of financial factors, including cost increase, investment incentives, green bonds, and sustainability-linked bonds. The top three items in this category are cost increase (M = 4.44, SD = 0.67), investment incentives (M = 4.32, SD = 0.98), and green bonds (M = 3.89, SD = 0.90). These factors underscore the significant role that economic considerations play in developers' decisions. Sustainability-linked bonds (M = 3.80, SD = 0.89) also emerged as influential, though their impact appears moderate in comparison.

The third group involves policy factors, which cover aspects such as government policies, global climate protocols, carbon tax, and carbon credit mechanisms. Government policies (M = 4.41, SD = 0.74) and global climate protocols (M = 4.13, SD = 0.84) were ranked the highest, emphasizing the role of regulatory frameworks in supporting Net Zero Carbon adoption. Carbon tax (M = 4.19, SD = 0.92) and carbon credit mechanisms (M = 4.24, SD = 0.82) also contribute significantly to decision-making in this domain.

Overall, the analysis indicates that financial factors (M = 4.61, SD = 0.64) have the most significant influence on developers' decisions, followed by policy factors (M = 4.34, SD = 0.74) and physical building attributes (M = 4.11, SD = 0.82). The average score of dependent variables (Y) is 4.20. These findings suggest that while physical aspects such as design and engineering are important, financial incentives and regulatory support play a critical role in promoting the development of Net Zero Carbon Buildings.

4.2. Multiple Regression Analysis (MRA)

In the result of the multicollinearity test, we found that the highest VIF value was 2.60, which was below 10. Therefore, there is no significant multicollinearity, indicating that all the independent variables analyzed in this study are not excessively correlated and are independent of each other [35]. In other words, there is no complexity in measuring their values, allowing regression analysis to proceed without issues.

The multiple regression analysis using the Enter model identifies 19 significant predictors of decisions in pursuing Net Zero Carbon Buildings. The regression results reveal that the value of the multiple correlation coefficient (R) is 0.66, indicating a positive correlation between the dependent variable and the independent variables. The results, as shown in **Table 6**, indicate that the model has an Adjusted R-squared of 0.40, meaning that the model can explain 40% of the variability in the dependent variable. The value of R-square is 0.43, which reveals that 43% of the variability observed in the target variable is explained by the regression model. It is an acceptable value in the social science research as recommended by Hair et al. and Ozili that R-square between 0.10 and 0.50 is acceptable when some or most of the explanatory variables are statistically significant[36,37]. Additionally, the significant value (Sig.) is less than 0.001, indicating that at least one independent variable is significantly related to the dependent variable, which is the decision-making in pursuing the Net-Zero building in Thailand.

Table 6. Results of multiple regression analysis.

Variables	Unstandardized Coefficients		t	*p*-value
	B	Std. Error		
(Constant)	1.98	0.24	8.21	0.00**
PB_AGE1	0.08	0.02	3.36	0.00**
PB_AGE2	−0.02	0.02	−1.03	0.3
PB_ENGI	0.17	0.03	4.74	0.00**
PB_DESI1	0.04	0.02	1.78	0.07
PB_DESI2	−0.09	0.03	−2.65	0.01*
PB_TYPE	0.01	0.03	0.44	0.65
PB_REEN	0.01	0.02	0.60	0.54
F_COST	0.10	0.03	3.04	0.01*
F_RETR	0.07	0.02	3.40	0.00**
F_BOND	−0.01	0.03	−0.30	0.76
F_SLB	0.01	0.03	0.31	0.75
F_INCT	0.06	0.02	2.86	0.01*
P_GLOB	0.07	0.03	2.21	0.02*
P_POLI1	0.10	0.03	3.34	0.00**
P_POLI2	0.04	0.03	1.14	0.25
P_CLAW	0.07	0.02	2.50	0.01*
P_CTAX	−0.20	0.02	−7.06	0.00**
P_CRDT1	−0.01	0.03	−0.06	0.95
P_CRDT2	0.02	0.03	0.61	0.54
F = 14.81, p = < 0.001, Adj. R^2 = 0.40, R^2 = 0.43				

Notes: * Significant at $p < 0.05$, ** Significant at $p < 0.01$

The regression analysis reveals that Physical Building significantly influences decision making in the development of net zero building projects. Among these, Building Age (PB_AGE 1) emerges as the strongest predictor (β = 0.08, $p < 0.01$), aligning with findings from similar studies that emphasize the importance of building condition and age in sustainability decisions. Additionally, Building Engineering Systems (PB_ENGI) is a key factor (β = 0.17, $p < 0.01$), reflecting the critical role of advanced building technologies in enabling Net Zero performance. Other building-related factors, such as Building Design (PB_DES2), also exhibit a moderate impact (β = -0.09, $p = 0.01$), supporting the assumption and the respondents' comments that the design of energy-efficient buildings is increasingly recognized; however, concerns regarding higher project costs and extended timelines have emerged as significant obstacles, influencing decisions to pursue Net Zero building development.

In the financial attributes, the Expected Cost Increased (F_COST) (β = 0.10, $p = 0.01$), Financial Return (F_RETR) (β = 0.07, $p < 0.01$), and Other Incentive & Investment (F_INCT) (β = 0.132, $p = 0.01$) show a significant influence on decision-making. The positive coefficient of F_COST suggests that while cost increases are a concern, developers still proceed if long-term financial benefits are evident. Additionally, F_RETR highlights the importance of expected returns, while F_INCT underscores the role of external financial support in encouraging Net Zero Carbon Building Projects.

From a policy perspective, Global Climate Protocols (P_GLOB) (β = 0.07, $p = 0.02$) influence developers' decisions, reflecting the impact of international commitments. Government Policy Support (P_POLI1) (β = 0.10, $p < 0.01$) plays a major role in adopting Net Zero practices, while Regulations (P_CLAW) (β = 0.07, $p = 0.05$) show moderate significance in shaping decisions. However, Carbon Tax (P_CTAX) (β = -0.20, $p < 0.01$). It implied that carbon taxation represents a major barrier that negatively impacts decision-making regarding the development of Net Zero projects. The higher taxation may deter developers. A summary of the model is provided in Equation (4).

$$
\begin{aligned}
Y = 1.98 + 0.08(PB\_AGE1) + 0.17(PB\_ENGI) - 0.09(PB\_DESI) + 0.10(F\_COST) \\
+0.07(F\_RETR) + 0.06(F\_INCT) + 0.07(P\_GLOB) \\
+0.10(P\_POLI1) + 0.07(P\_CLAW) - 0.20(P\_CTAX)
\end{aligned} \tag{4}
$$

However, the qualitative insights gathered from open-ended questionnaire responses reveal several key concerns. The majority of respondents expressed apprehension regarding the high cost associated with Net Zero building projects and noted that the perceived returns may not be sufficiently attractive to incentivize investment. Although there is some level of government policy support, financial incentive mechanisms such as carbon taxes or carbon credits have not yet been effectively implemented in a concrete and practical manner. As a result, investors feel that such mechanisms remain distant from real-world business operations. In addition, some respondents voiced concerns about potentially complex legal and regulatory requirements, which could further increase development costs. On a more positive note, a number of respondents indicated that investment in advanced building technologies and high-performance design could lead to long-term energy cost savings and offer opportunities to enhance the overall value of development projects.

5. Conclusion and Recommendations

This study on the determinants of real estate developers' decision to develop Net Zero Buildings in Thailand analyzed responses from 388 participants, identifying statistically significant factors at both the 99% and 95% confidence levels. All respondents are stakeholders in developing the projects. The majority of respondents are designers (35.80%), who play a key role in influencing real estate investors to pursue Net Zero building projects in Thailand, followed by real estate developers, who accounted for 27.60% of the sample. Most of them are female and work on the residential project (52.10%) and commercial project (40.50%).

This research examines three groups of independent variables that influence the decision-making in Net Zero building development: (1) Physical building attributes, (2) Climate finance attributes, and (3) Climate policy attributes. The dependent variable is the decision-making to pursue on Net-Zero building project in Thailand. Based on the descriptive analysis, respondents placed the highest importance on the physical building factors in relation to their decision-making. The variables with the highest mean scores are PB_DES2, PB_ENG1 and PB_TYPE, that is, 4.59, 4.57 and 4.46, respectively. The multiple regression analysis results indicate that physical building factors particularly the building's engineering systems (PB_ENGI), followed by building design (PB_DESI2) play an important role, with the latter exerting a negative influence. It implies that while the importance of energy-efficient building design is increasingly acknowledged, concerns about higher project costs and extended timelines remain significant barriers that influence decisions to pursue Net Zero development.

In the domain of financial considerations, increased costs (F_COST) and expected financial returns (F_RETR) emerged as key determinants. Policy-related factors, including carbon taxation (P_CTAX), government policies (P_POLI1), and regulatory frameworks (P_CLAW), also significantly impacted decision-making processes. However, the carbon credit program shows the negative impact to developers. An inappropriate increase in carbon taxation may lead to resistance from developers, as the resulting rise in construction and operation costs (driven by the need to adapt and reduce carbon emissions) can pose a significant financial burden. Overall, the findings suggest that financial factors especially cost increases are the most influential, while building engineering systems and policy mechanisms also exert substantial influence. These insights offer practical guidance for real estate developers in Thailand, helping them to align development strategies with physical, financial, and policy-related considerations in the implementation of Net Zero Carbon Building projects.

The study also highlights several challenges, such as the financial implications of carbon taxes and the need for energy-efficient building designs. These factors can inform more strategic and informed decision-making among developers. In addition, the findings provide a foundation for government policy development, including the formulation of tax incentives and financial support mechanisms to accelerate the transition toward Net Zero greenhouse gas emissions by 2065.

Recommendations to alleviate concerns about participating in Net Zero building development include the following:

1) Providing education and awareness regarding the initial increased investment costs of Net Zero buildings compared to the long-term energy cost savings, thereby highlighting the potential returns over time. This should also emphasize the environmental benefits of such projects, as well as the positive image and reputational value they can bring to both the development and the company and 2) Government support through incentives, such as tax benefits or subsidies for environmentally friendly projects, can help mitigate the impact of carbon taxation. However, such measures should avoid overly stringent enforcement, particularly in the short term, to minimize resistance from real estate developers.

Nevertheless, the study has limitations. Data were collected exclusively through an online survey distributed via Google Forms, which may have introduced misunderstandings or inconsistencies in question interpretation. To improve data quality, future research should incorporate a mixed-methods approach and target a more diverse sample, including face-to-face interviews to enhance accuracy. Furthermore, the limited timeframe of this study may not fully reflect evolving policies or sustainability trends. Longitudinal research could address this gap. Future research should incorporate in-depth interviews with developers, investors, and policymakers to gain a more comprehensive understanding of their motivations, perceived barriers, and the types of support systems required to facilitate Net Zero development. Additionally, future studies could focus specifically on examining the underlying reasons why certain barriers—such as resistance to carbon taxation—are particularly pronounced in Thailand, with the aim of identifying strategies to mitigate these obstacles and promote progress toward Net Zero objectives.

Author Contributions

Conceptualization, P.P. and S.K.; methodology, P.P. and S.K.; software, S.K.; validation P.P.; formal analysis, S.K.; investigation, P.P. and S.K.; writing – original draft preparation, S.K.; writing – review and editing, P.P.; supervision, P.P.; project administration, S.K. All authors have read and agreed to the publication version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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