Journal of the Civil Engineering Forum, September 2023, 9(3):287-302
DOI 10.22146/jcef.7150
Available Online at https://jurnal.ugm.ac.id/v3/jcef/issue/archive

Incentives and Barriers to Green Building Implementation: The Case of Jakarta

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SUBMITTED 07 March 2023 **REVISED** 01 May 2023 **ACCEPTED** 22 May 2023

ABSTRACT The low implementation of green building through building certification in Jakarta is responsible for the decreased achievement of reducing greenhouse gas emissions in 2020. This is observed in the energy sector through the efficient use of power in commercial buildings, which is only 37,789 tons (0.72 %) of the 5.26 million tons of CO_2e expected in 2030, potentially causing the effects of a climate change-related disaster. In this case, the low prevalence of green buildings is due to the barriers preventing their implementation, with the provision of incentives being a suitable solution regarding its significant influence on rapid development. Therefore, this study aims to determine the influential relationship between barriers, incentives, and the level of green building implementation, to identify the most effective applicable benefits in Jakarta. In this context, path analysis and structural equation modeling (SEM) was used with 101 participants selected from developer/owner institutions, consultants, contractors, and the government experienced in implementing the experimental data of the buildings. These data were subsequently analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results showed that cost-risk and knowledge-information barrier significantly impacted the level of green building implementation in Jakarta. This led to the recommendation of non-financial incentives as an effective regional benefit, which relevantly affected the level of green building implementation, as well as cost-risk and knowledge-information barriers. These results were expected to assist policymakers and practitioners in formulating effective incentive policies for the implementation of green buildings in Jakarta.

KEYWORDS Green Building; Incentive; Barrier; PLS-SEM; Cost Risk.

1 INTRODUCTION

Construction and building activities were responsible for 35% and 38% of total energy consumption and energy-related carbon dioxide (CO_2) emissions in 2019 (UNEP, 2020). This indicated that the increasing trend of energy consumption in the building and construction industry led to a rise in CO_2 gas emissions, contributing to natural disasters such as severe droughts, water scarcity, and floods (United Nations, 2021). In this case, the concept of green building is considered a solution to mitigate the negative impacts of buildings on human health and the environment. This concept aims to optimize energy and resource use, minimize waste and pollution, and reduce environmental degradation (US EPA, 2016). It also provides a viable option for mitigating greenhouse gas emissions (Mozingo and Arens, 2014; Rabani et al., 2021). Furthermore, the implementation of green buildings in Jakarta is low compared to big cities in Asia, such as Hong Kong and Kuala Lumpur. From this context, Jakarta, Hong Kong, and Kuala Lumpur are expected to have 37, 652, and 304 buildings with green certificates in 2022, respectively (Table 1) (GBCI, 2021; GBI, 2022; GBIG, 2022; USGBC, 2022). By using this certification process in Jakarta, the low application of green building led to the decreased achievement of reducing greenhouse gas emissions within the energy sector in 2020, through industrial power use efficiency. This situation only contained 37,789 tons (0.72%) of the 5.26 million tons of CO_2e expected in 2030 (Dinas Lingkungan Hidup Provinsi DKI Jakarta, 2021), causing the vulnerability of the city to climate change-related disaster impacts.

Implementation barriers are often responsible for the low prevalence of green buildings (Darko and

Table 1. Number of green buildings in the City of Asia

City	Year	Number of green buildings
Hongkong	2022	652
Kuala Lumpur	2022	304
Jakarta	2022	37

Chan, 2018; Saha et al., 2021), with the provision of incentives considered an appropriate solution. Since this solution is used to overcome challenges and provide motivation, the implementation of green building practices in the future is expected to be accelerated (Choi, 2009, 2010; Olubunmi et al., 2016; Shazmin et al., 2016; Deng et al., 2018). This has reportedly led to the attempt of the Jakarta regional government to accelerate the implementation of the practices by issuing Governor Regulation 38/2012 concerning green buildings. The results showed that the number of buildings with green certificates was not significantly increased despite the regulation obliging owners to adopt appropriate green principles as a prerequisite for obtaining construction permits. In this case, the provision of incentives was not regulated for implementing green buildings, leading to a low application (Sahid et al., 2020). Based on this description, identifying the barrier factors and recommending various incentives is very necessary for increasing the application of green building and providing input to the Jakarta government as recommendations for improving regional policies.

Several studies had emphasized the green building implementation barriers, with the main problem subsequently identified (Saha et al., 2021). In Ghana, a study was conducted on these barriers by using Structural Equation Modeling (SEM). This was to determine the relationship between barriers, drivers, and promotion strategies for green building adoption, accompanied by suitable implementation recommendations (Darko and Chan, 2018). For the literature related to incentives, various analyses were conducted to identify forms/types of green building benefits (Olubunmi et al., 2016; Shazmin et al., 2016; Saka et al., 2021). Based on the previous explanation, the uniqueness of this study depends on its correlation of barriers and incentives using SEM. This approach enables the identification of effective incentives for implementing green buildings through a case study in Jakarta. Therefore, this study aims to identify the barriers hindering the implementation of green building practices in Jakarta. It also aims to recommend the incentives that should be provided in accelerating the application of the practices. The results obtained are expected to assist policymakers and practitioners in formulating effective incentive policies for the implementation of green buildings in Jakarta.

2 METHODS

This study was conducted through a quantitative approach, with an extensive literature review used to identify the research variables by analyzing the barriers and types of incentives associated with the adoption of green buildings. The results obtained were then validated through the Delphi method, employing a panel of five experts with 10-15 years of experience in implementing green buildings. Two rounds of discussions were also carried out to ensure content and construct validation from all experts. In this case, the validated variables were subsequently used to develop a survey questionnaire, employing a Likert scale capable of measuring the relationship between barriers, incentives, and the level of green building implementation in Jakarta. To assess the clarity and effectiveness of the questionnaire, a pilot survey was also conducted to acquire feedback from participants, regarding their comprehension of the analyzed issues and questions (Kumar, 2018). This feedback was then used to modify the implemented questionnaire to obtain data, through Google form from institutional developers/owners, consultants, contractors, and government agencies experienced in implementing green construction. Moreover, the correlation between research variables was then determined using Partial Least Squares Structural Equation Modeling (PLS-SEM), through the SmartPLS 4.0 program. Based on literature reviews, the results presented an effective form of incentive to accelerate the implementation of green buildings in Jakarta. Figure 1 depicts the research flowchart.

2.1 Available Literature

2.1.1 Barrier

Several barriers were observed in the implementation of green buildings within various countries.

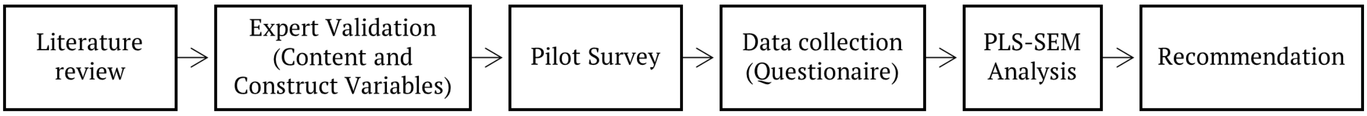

Figure 1 Flow diagram of research method

According to (Saha et al., 2021), a total of fifteen barriers were observed in India, with high investment costs being the main barrier to green building adoption in commercial buildings. In the Malaysian construction sector, low market demand by clients, lack of awareness of existing incentives and the benefits of green building technology, as well as the high cost of implementation were the main barriers (Wong et al., 2021). The following dominant barriers were also found in Vietnam, (1) slow and unwieldy administrative processes in policymaking, (2) lack of a comprehensive code/policy package to guide sustainability actions, (3) inadequate explicit financing mechanisms, and (4) insufficient fiscal incentives (Nguyen et al., 2017). Meanwhile, the main challenges in Ghana were the lack of government incentives, inadequate green building policies and regulations, as well as insufficient administrative promotion.

Several studies had also emphasized and identified the prevalent barriers to green building implementation in Indonesia. According to Wimala et al. (2016), the following main barriers were found in the country, (1) inadequate understanding of the green building concept, (2) the lack of information, (3) the high risk of green building investment due to the high initial cost, and (4) the reluctance of developers to implement green building regarding the unequal distribution of benefits between users and developers (split incentive). Besides this, one of the significant challenges in the country was also the high cost of implementation (Basten, Latief, Berawi, Muliarto et al., 2018). Based on these descriptions, the barrier factors hindered the adoption of green buildings in various countries, including Indonesia, with different challenges observed for each region. This emphasized the need for an analysis to identify relevant barriers in Jakarta, toward providing a clear understanding concerning the formulation of appropriate solutions.

2.1.2 Incentive

The provision of incentives to encourage green building was widely applied and effective in various countries. According to Basten, Berawi, Latief, CrÃ et al. (2018), the application of incentives in Asian countries (Singapore, Hong Kong, Malaysia, and India) showed the development in green building applications. This indicated that 168 and 48 buildings were observed in Singapore and Hong Kong with density bonus incentives yearly, respectively. The application of tax incentives in Malaysia also led to the yearly improvement of 34 buildings. Meanwhile, the mixed incentives (tax and density bonuses) provided in India caused the development of 215 buildings per year. In implementing green buildings, incentives were also categorized into financial and non-financial groups (Olubunmi et al., 2016). From this context, financial incentives were often provided by the government to recompense for differences in costs or produce savings, enhancing the feasibility of selecting green buildings over conventional developments for property owners and developers (Choi, 2009). These incentives encompassed grants, rebates, discounts on development application fees (levies), and tax bonuses. Regarding the research objective to provide recommendations for the Jakarta regional government, the suggested forms of incentives were within the jurisdiction of the local government, including property tax bonuses and levy relief.

Since financial incentives aimed to overcome the additional costs of implementing green buildings, the non-financial category provided more benefits and rights to beneficiaries during the fulfillment of specific conditions (Olubunmi et al., 2016). According to Choi (2009), non-financial incentives saved the time and money of developers and property owners, by reducing risks and process problems. These incentives specifically work adequately when funding options were politically difficult to overcome, or the existing infrastructure/regulatory environment was complex/restrictive. It was also flexible and adjustable to suit local conditions. Most governments commonly preferred this form of incentive due to its non-requirement of direct costs implementation. In addition, non-financial incentives were considered density bonuses, technical assistance, expedited permits, promotions, and awards from the government (Saka et al., 2021). From these descriptions, the provision of tax rewards significantly increased the application of green buildings in Malaysia (Shazmin et al., 2016), with non-financial benefits, such as density bonuses (Adekanye et al., 2020) and expedited permits (Choi, 2010), relevantly influential in the United States. Regarding the different effects of these incentives, the identification of the effective benefits of implementing the buildings was needed in Jakarta. This emphasized the provision of recommendations to local governments in formulating policies to increase the adoption of green construction.

2.2 Research Framework

This study was responsible for establishing the relationship between barriers and incentives in the implementation of green buildings. Table 2 presents the literature reviews and an expert validation of variables. Green building barriers were capable of causing low levels of implementation (Nguyen et al., 2017; Darko et al., 2018; Chegut et al., 2019; Mustaffa et al., 2021; Saha et al., 2021; Guribie et al., 2022). These barriers were categorized as knowledge and information, social and cognitive (Nguyen et al., 2017), as well as cost and risk challenges (Darko et al., 2018). In sustainable development, incentives were also used to boost stakeholder motivation. These bonuses were capable of increasing the enthusiasm and motivation of owners to implement green construction practices (Olubunmi et al., 2016; Onuoha et al., 2018; Adekanye et al., 2020). Furthermore, incentives were widely adopted and effective in numerous countries, to promote the implementation of green building (Basten, Berawi, Latief, CrÃ et al., 2018). From this context, financial and non-financial incentives were used as schemes (Olubunmi et al., 2016). This indicated that the financial group included tax incentives (Shazmin et al., 2016; Rana et al., 2021) and user fee exemption (Bond and Devine, 2016), with the non-financial category emphasizing density bonuses (Adekanye et al., 2020), technical assistance, administrative awards and promotions, as well as expedited permit issuance (Choi, 2010; Saka et al., 2021).

The barriers to implementing green buildings were also interrelated, with high failure risk often exhibited due to a lack of expertise according to Saha et al. (2021). The absence of information related to green building practices also led to poor quality of the planning process, causing the non-achievement of targets from relevant construction features. This led to additional scheduling and project implementation expenses (Orsi et al., 2020). However, the absence of knowledge and data enabled the difficulty for the construction industry to invest their money, causing a lack of investment interest in implementing green building practices (Agyekum et al., 2022).

In influencing the implementation of green construction, incentives also directly affected barriers. This demonstrated that financial incentives were capable of reducing the difference in prices and providing cost savings (Choi, 2009). The reduction of investment costs also expedited the return on investment and decreased risks in green building implementation (Shazmin et al., 2016). According to Rana et al. (2021), the provision of financial incentives encouraged and overcame the reluctance to adopt green buildings, increased interest in relevant construction, and used energy-saving technologies. By increasing the area of buildings being sold or leased, non-financial incentives, such as density bonuses, subsequently engulfed a portion or all of the costs associated with implementing green construction (Olubunmi et al., 2016). The acceleration of licensing and technical assistance also reduced the need for time and provided certainty for the issuance of permits. This led to the mitigation of the risks associated with implementing green buildings (Choi, 2010). In addition, publishing, such as government prizes and promotions, educated the public about the concepts and advantages of applying green building practices (Deng et al., 2018). This was in line with Gou et al. (2013), where publication through awards and promotions enhanced public awareness.

Based on this theoretical relationship between variables, several hypotheses were constructed

Table 2. Barriers and Incentives for Implementing Green Building

Code	Variable	Code	Indicator	Reference
X1.1	Barriers related to cost and risk	X1.1.1	High initial costs	[2]; [7]; [8]; [9]; [10]; [11]; [12]; [14]; [16]; [18]; [20]; [21]
		X1.1.2	Long payback period	[8]; [9]; [10]; [12]; [18]
		X1.1.3	Lack of financing schemes	[2]; [8]; [9]; [10]; [11]; [14]; [18]
		X1.1.4	Inadequate government incentives	[2]; [7]; [8]; [9]; [10]; [11]; [12]; [14]; [15]; [21]
		X1.1.5	Split incentives	[7]; [8]; [14]
X1.2	Barriers related to Knowledge and information	X1.2.1	Lack of professional education and training	[8]; [9]; [10]; [11]; [12]
		X1.2.2	Inadequate professional knowledge and expertise	[2]; [8]; [9]; [10]; [11]; [12]; [15]; [16]; [18]; [20]; [21];
		X1.2.3	Insufficient cost-benefit data	[8]; [14]; [16]; [21]
		X1.2.4	Lack of information on the options/practices related to green building	[2]; [7]; [8]; [9]; [10]; [11]; [14]; [16]; [20]; [21]
		X1.2.5	Inadequate demonstration projects	[8]; [9]; [10]; [11]; [21]
		X1.2.6	Insufficient promotion platform	[9]; [10]; [11]; [15]; [21]
X1.3	Barriers related to social and cognitive	X1.3.1	Lack of public awareness about green building	[2]; [7]; [8]; [9]; [10]; [11]; [15]; [16]
		X1.3.2	Misconception about green building	[8]
		X1.3.3	Inadequate expressed interest and demand from clients/investors	[8]; [9]; [10]; [11]; [12]; [16]
		X1.3.4	Reluctant to adopt changes, for example, new concepts and construction technologies about green building	[8]; [11]; [18]; [21]
X2.1	Financial incentives	X2.1.1	Property tax incentives	[1]; [4]; [6]; [17]; [18]
		X2.1.2	Acquisition Duty of Right on Land and Building tax incentive	[1]; [4]; [6]; [17]; [18]
		X2.1.3	Reduction of building permit fees	[3]; [4]
X2.2	Non-financial incentives	X2.2.1	Density bonus	[3]; [4]; [13]; [19]
		X2.2.2	Technical assistance	[1]; [3]; [19]
		X2.2.3	Government award	[3]; [19]
		X2.2.4	Government promotion and publication	[3]; [19]
		X2.2.5	Expedited permit processing	[1]; [3]; [4]; [19]
Y1	Green Building application level	Y1.1	Number of buildings with green building certificates	[1]; [2]; [3]; [8]; [13]; [18]
		Y1.2	Private sector participation in green building markets	[2]; [3]; [5]; [8]

References : [1] (Choi, 2010); [2] (Gou et al., 2013); [3] (Samari et al., 2013); [4] (Bond and Devine, 2016); [5] (Olubunmi et al., 2016); [6] (Shazmin et al., 2016); [7] (Wimala et al., 2016); [8] (Nguyen et al., 2017); [9] (Chan et al., 2018); [10] (Darko and Chan, 2018); [11] (Darko et al., 2018); [12] (Shen et al., 2018); [13] (Adekanye et al., 2020); [14] (Agyekum et al., 2022); [15] (Liu et al., 2020); [16] (Mustaffa et al., 2021); [17] (Rana et al., 2021); [18] (Saha et al., 2021); [19] (Saka et al., 2021); [20] (Wong et al., 2021);[21] (Guribie et al., 2022)

and used to develop a research model. This model was implemented to understand the relationship between barriers, incentives, and the level of green building application. The provision of appropriate incentives also recommended the promotion of green building adoption in Jakarta.

2.3 Research Hypothesis

Based on the described literature review and research framework, the following hypothesis is formulated, H1: Financial incentives significantly impact green building implementation. H2: Non-financial incentives significantly affect green building implementation. H3: Cost and risk barriers significantly influence green building implementation. H4: Knowledge and information barriers significantly impact green building implementation. H5: Social and cognitive barriers significantly affect green building implementation. H6: Financial incentives significantly influence cost and risk barriers. H7: Financial incentives significantly impact social and cognitive barriers. H8: Non-financial incentives significantly affect cost and risk barriers. H9: Non-financial incentives significantly influence knowledge and information

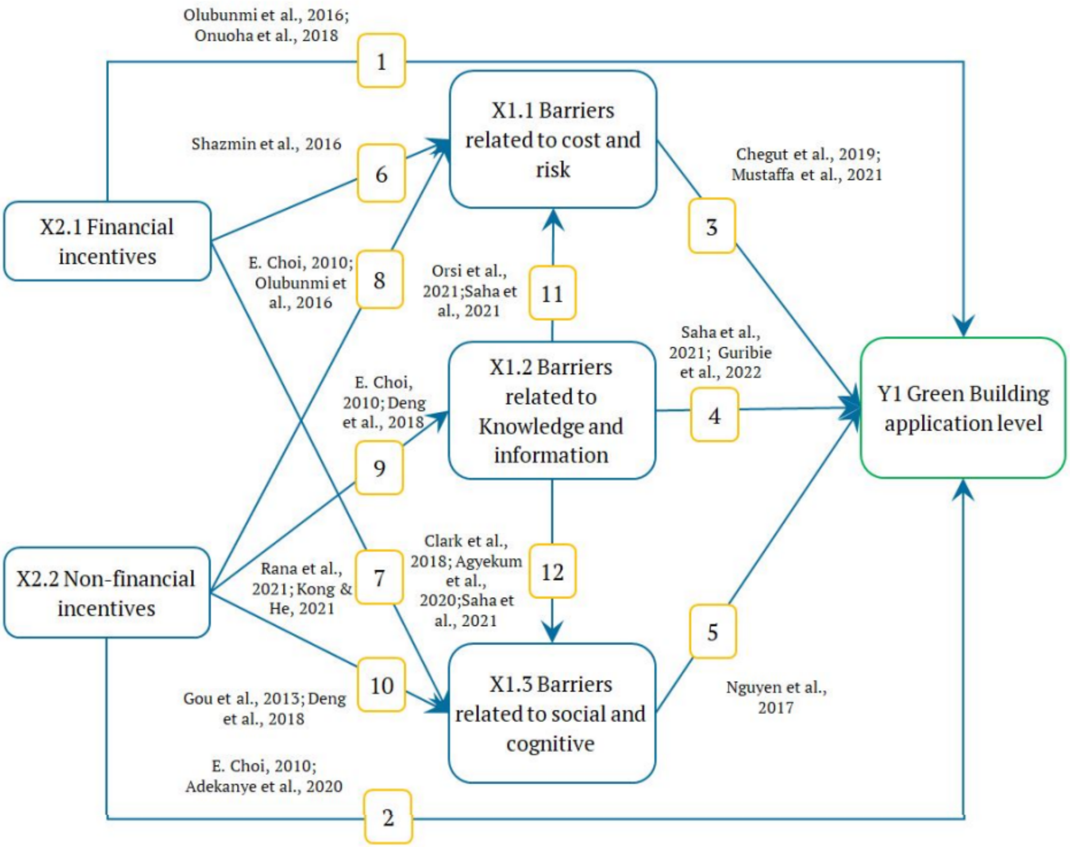

Figure 2 Hypothetical research model

barriers. H10: Non-financial incentives significantly impact social and cognitive barriers. H11: Knowledge and information barriers significantly affect cost and risk barriers. H12: Knowledge and information barriers significantly influence social and cognitive barriers. Figure 2 shows the structural equation modeling describing the research hypotheses.

2.4 Data Collection

A professional/academic population from agencies/companies involved in applying green building in building construction was considered for data collection, including developers, consultants (planners and supervisors), contractors, and government organizations. In this case, a non-probability sampling technique (purposive sampling) was used to select the required participants. This technique was selected for use due to the unknown number of population elements and ensured that data were adequately obtained from participants with the required information (Kumar, 2018). From this context, the data collector used a Likert scale questionnaire, to measure the attitudes, opinions, and perceptions of a person or group regarding social phenomena (Sugiyono, 2013). This subsequently emphasized the measurements of the barriers and incentives influences on the implementation of green buildings in Jakarta. A total of 101 samples were also obtained, meeting the data adequacy requirement of at least 70 samples for SEM-PLS analysis according to the employed model (Hair et al., 2013). Based on the institution, 16%, 15%, 32%, and 38% of the participants were obtained from developers, consultants, contractors, and government agencies, respectively. Regarding experience in implementing a green building, those with < 2 years dominated the analysis (45%), accompanied by the participants having 2-7 (30%) and > 7 (28%) years.

2.5 Data Analysis

SEM-PLS, a research methodology with advantages in exploratory studies aimed at theory development, was employed to test the hypothesis (Hair et al., 2013). In this case, two sub-models were emphasized, (1) the inner model examining the relationship between independent and dependent latent variables, and (2) the outer model exploring the relationship between latent and observed indicators. Before conducting PLS-SEM analysis, ensuring the non-occurrence of cyclical relationships was essential among the constructs (Hair et al., 2014). When designing the outer model, the use of a formative or reflective measurement model should also be determined. Furthermore, the reflective measurement approach was adopted, with the implemented indicators manifested from the latent variables. Reflective indicators were also considered representative samples of all potential items within the conceptual domain of the construct (Hair et al., 2013). To validate the model and assess the hypothesis during the analysis, SmartPLS 4.0 software was applied.

The analysis was initiated with modeling based on the variables and indicators presented in Table 1. After the development of the model, the validity and reliability of the outer model were evaluated to verify the function of the construct regarding an appropriate assessment of its relationship to the inner system. Composite reliability was also used to evaluate dependability, with convergent and discriminant validities emphasizing the evaluation of viability (Hair et al., 2014). In evaluating the dependability requirements, the composite reliability (Wong, 2013; Hair et al., 2014) and Cronbach alpha (Daud et al., 2018) values were > 0.70 and > 0.60, respectively. After meeting the requirements of this evaluation process, the convergent and discriminant validities of the model were then used to assess its viability. In this case, the viability of the outer model was evaluated using a convergent validity test, which required external loading and Average Variance Extracted (AVE) values of > 0.70 and > 0.5, respectively. The discriminant validity test was also carried out using Cross loadings, requiring the loading value of each item on the construct to be more than the cross-loading coefficient. Regarding the Fornell-Larcker criteria analysis, the requirement stated that the AVE value of each construct (variable) should be greater than the R2 with other constructs (variables) (Wong, 2013; Hair et al., 2014).

The inner model was also used to evaluate the research hypotheses after the outer system passed the initial test for reliability and validity. According to (Henseler et al., 2014), model fit was evaluated by calculating the SRMR, which was considered the average square root of the difference between the observed and model-implied correlations. This indicated that the SRMR value of 0.08 was the threshold for satisfactory fit, with 0.1 deemed acceptable (Schermelleh-Engel et al., 2003). The study hypotheses were also assessed by examining the T-statistic obtained through bootstrapping, using SmartPLS 4.0. When the T-statistic value exceeded 1.96 (at a 5% significance level), a substantial impact of the independent variable was exhibited on the dependent factor. Meanwhile, the independent variable did not significantly affect the dependent factor when the T-statistic was less than 1.96 (Hair et al., 2013).

3 RESULTS

3.1 Evaluation of the Measurement Model (Outer Model Evaluation)

In evaluating the outer model, a convergent validity test was conducted by adhering to the requirement of external loading values, where the X2.2.1 indicator exhibited a coefficient of 0.688, which was < 0.7. This indicator was gradually eliminated, and the SmartPLS 4.0 application was rerun until achieving outer loading values above 0.7. In this case, two indicators, X2.2.1 and X 1.1.3, were discarded due to their insufficient values. The outputs generated by SmartPLS 4.0 were presented in Tables 3 to 5. Based on Table 3, the dependability (reliability) test of the model demonstrated that all indicators surpassed a Cronbach Alpha value of 0.6, with the composite reliability coefficient exceeding 0.7. From these results, the model successfully met the requirements for reliability. Furthermore, the Average Variance Extracted (AVE) value exceeding 0.5 signified that the concept was responsible for over 50% of the variance in the measurement model. The outer loading value surpassing 0.7 also validated the fulfillment of the conditions for convergent validity testing.

According to Table 4, the AVE value of each construct (variable) was greater than the coefficients of other variables. Meanwhile, Table 5 showed that the loading coefficient of each indicator on the variable was greater than the cross-loading value. From these results, the model satisfied the requirements for reliability and validity, enabling subsequent hypothetical analysis through boot-

Table 3. Measurement model evaluation

Variable Code	Indicator Code	Outer Loading	Cronbach alpha	Composite reliability	AVE
X1.1	X1.1.1	0.780	0.771	0.777	0.593
	X1.1.2	0.816			
	X1.1.4	0.734			
	X1.1.5	0.746			
X1.2	X1.2.1	0.777	0.877	0.879	0.620
	X1.2.2	0.815			
	X1.2.3	0.746			
	X1.2.4	0.826			
	X1.2.5	0.732			
	X1.2.6	0.824			
X1.3	X1.3.1	0.834	0.820	0.832	0.649
	X1.3.2	0.835			
	X1.3.3	0.821			
	X1.3.4	0.728			
X2.1	X2.1.1	0.937	0.925	0.926	0.869
	X2.1.2	0.940			
	X2.1.3	0.920			
X2.2	X2.2.2	0.813	0.891	0.897	0.755
	X2.2.3	0.908			
	X2.2.4	0.912			
	X2.2.5	0.839			
Y1	Y1.1	0.884	0.746	0.749	0.797
	Y1.2	0.902			

Table 4. Fornell-Larcker of the Measurement model

Variable Code	X1.1	X1.2	X1.3	X2.1	X2.2	Y1
X1.1	**0.770**					
X1.2	0.529	**0.788**				
X1.3	0.606	0.767	**0.806**			
X2.1	0.394	0.382	0.450	**0.932**		
X2.2	0.486	0.414	0.474	0.561	**0.869**	
Y1	0.588	0.513	0.509	0.741	0.780	**0.893**

strapping in the SmartPLS 4.0 application. The bold diagonal values were the square root of the average variance extracted from each construct, with the other coefficients emphasizing the correlations among constructs. The bold values showed that each measurement item had the highest loading on its respective construct.

3.2 Inner Model Evaluation

During model testing, the SRMR value was 0.093 (<0.1) and still below the 0.1 threshold (Table 6). This indicated that the size of the model was appropriate for the provided data (Schermelleh-Engel et al., 2003). Since the Coefficient of Determination (R^2) represented the combined effect of exogenous latent variables on endogenous factors, its 0.788 value measured model accuracy (Figure 3). In this case, the models with R^2 values of 0.75, 0.50, and 0.25 for endogenous constructs were robust, moderate, and weak, respectively (Hair et al., 2013). Based on the results, the R^2 score belonged to the substantial (robust) model. According to Table 7, the T statistic for H1, H2, H3, H4, H8, H9, H11, and H12 was more than 1.96, indicating their acceptance. Meanwhile, the T statistic for H5, H6, H7, and H10 was less than 1.96, demonstrating their rejection.

Table 5. Cross loadings of Measurement model items

Variable Code	X1.1	X1.2	X1.3	X2.1	X2.2	Y1
X1.1.1	**0.780**	0.390	0.440	0.251	0.316	0.430
X1.1.2	**0.816**	0.401	0.462	0.306	0.489	0.529
X1.1.4	**0.734**	0.282	0.350	0.368	0.345	0.462
X1.1.5	**0.746**	0.548	0.607	0.291	0.325	0.382
X1.2.1	0.401	**0.777**	0.565	0.236	0.311	0.379
X1.2.2	0.405	**0.815**	0.517	0.200	0.382	0.392
X1.2.3	0.530	**0.746**	0.538	0.388	0.370	0.479
X1.2.4	0.425	**0.826**	0.609	0.412	0.323	0.443
X1.2.5	0.383	**0.732**	0.643	0.247	0.206	0.321
X1.2.6	0.349	**0.824**	0.741	0.299	0.352	0.398
X1.3.1	0.465	0.611	**0.834**	0.507	0.485	0.518
X1.3.2	0.480	0.698	**0.835**	0.337	0.438	0.421
X1.3.3	0.501	0.601	**0.821**	0.353	0.285	0.356
X1.3.4	0.528	0.553	**0.728**	0.219	0.286	0.319
X2.1.1	0.396	0.341	0.404	**0.937**	0.518	0.684
X2.1.2	0.343	0.401	0.457	**0.940**	0.467	0.641
X2.1.3	0.362	0.328	0.399	**0.920**	0.581	0.744
X2.2.2	0.391	0.312	0.410	0.411	**0.813**	0.583
X2.2.3	0.483	0.395	0.390	0.460	**0.908**	0.700
X2.2.4	0.441	0.429	0.474	0.460	**0.912**	0.689
X2.2.5	0.367	0.293	0.371	0.622	**0.839**	0.736
Y1.1	0.517	0.538	0.468	0.619	**0.651**	0.884
Y1.2	0.534	0.385	0.442	0.701	0.739	**0.902**

Table 6. Model fit output

Parameter	Saturated model	Estimated model
SRMR	0.084	0.093
$d_U LS$	1.929	2.385
d_G	1.084	1.117
Chi-square	565.729	567.260
NFI	0.691	0.690

Based on these results, financial and non-financial incentives significantly and directly impacted the level of green building implementation (H1; H2). Cost & risk and knowledge & information barriers also significantly affected the building adoption level (H3; H4). Regarding path analysis, social and cognitive barriers insignificantly influenced green construction implementation (H5). Furthermore, knowledge & information barriers relevantly and directly impacted cost/risk and, as well as social/cognitive challenges (H11; H12). From these results, non-financial incentives had a direct

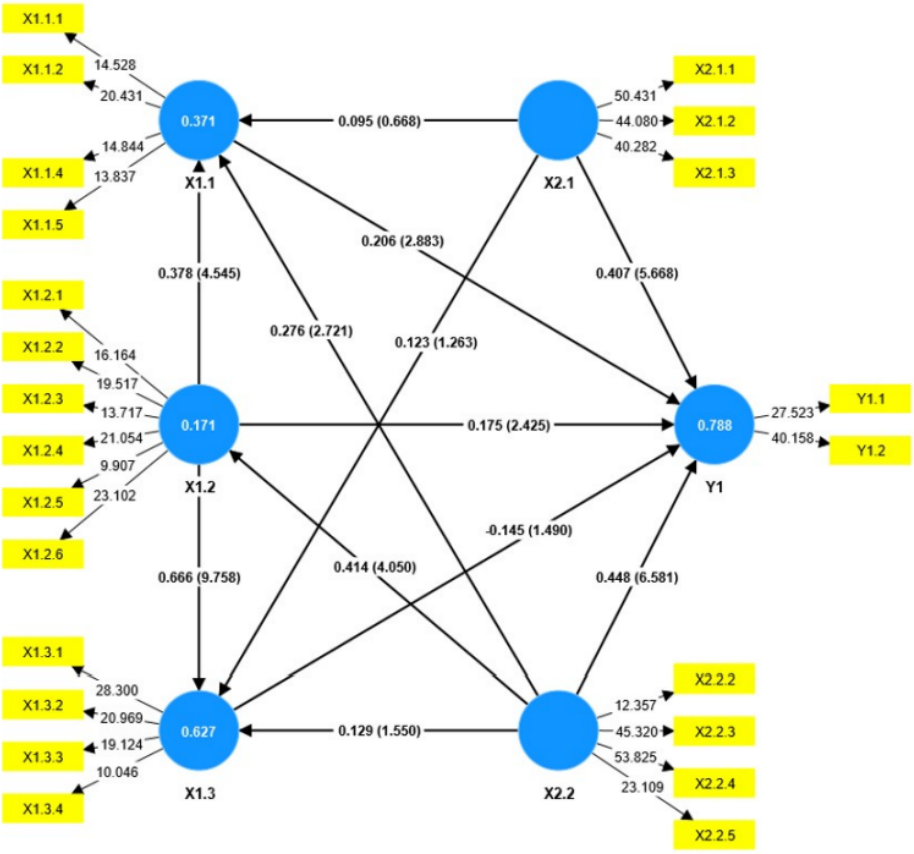

Figure 3 Final structural equation model

and significant relationship with cost & risk and knowledge & information barriers (H8; H9). This variable did not affect social and cognitive barriers (H10), with financial incentives having no significant relationship with the challenges of implementing green building (H6; H7).

4 DISCUSSION

4.1 Barrier

Cost and risk, as well as information and knowledge barriers significantly impacted the implementation of green buildings in Jakarta. Since cost and risk barriers had a significant relationship with the building implementation (T-value 2.883), the results were supported by Durdyev et al. (2018), where cost-related challenges relevantly affected sustainable construction (T-value 14.236). These barriers included a long payback period, high initial costs, split incentives, and a lack of government bonuses. According to Chegut et al. (2019), the longer period used to finish a green construction project led to a waste of time for the developer/owner to obtain a return on investment. The high initial cost of implementation in Jakarta also affected the long return period for the investment. This indicated that the investment expenses for green buildings were 6.5% and 20-25% higher than those for conventional structures in Europe Chegut et al. (2019) and Jordan (Nasereddin and Price, 2021), respectively. Meanwhile, the additional investment cost reached 7.85% in Indonesia (Latief et al., 2017). This additional investment caused the unpopular application of green buildings in the country regardless of the value being lower and slightly higher than those in Jordan and Europe, respectively Basten, Latief, Berawi, Muliarto et al. (2018). The high initial investment cost was also identified as a significant barrier to building adoption in the Malaysian construction industry. This was due to the great cost of design and construction, the need for additional investment in environmentally friendly materials and technologies, as well as the supplementary expenditures required to acquire certification (Mustaffa et al., 2021). In Chegut et al. (2019), green buildings required a higher design fee that should be paid before construction,

Table 7. Relationship between variables based on PLS-SEM

Hypothesis	Hypothetical path	Original sample (O)	T statistics (|O/STDEV|)	Influence path	Interpreters
H1	X2.1 →Y1	0.407	5.668	Significant	Supported
H2	X2.2 →Y1	0.448	6.581	Significant	Supported
H3	X1.1 →Y1	0.206	2.883	Significant	Supported
H4	X1.2 →Y1	0.175	2.425	Significant	Supported
H5	X1.3 →Y1	-0.145	1.490	Insignificant	Not supported
H6	X2.1 →X1.1	0.095	0.668	Insignificant	Not supported
H7	X2.1 →X1.3	0.123	1.263	Insignificant	Not supported
H8	X2.2 →X1.1	0.276	2.721	Significant	Supported
H9	X2.2 →X1.2	0.414	4.050	Significant	Supported
H10	X2.2 →X1.3	0.129	1.550	Insignificant	Not supported
H11	X1.2 →X1.1	0.378	4.545	Significant	Supported
H12	X1.2 →X1.3	0.666	9.758	Significant	Supported

posing a great investment risk for the developer when more certainty was still needed about the success of the project.

According to Wimala et al. (2016), the unequal allocation of incentives between developers and occupants/tenants caused profit delays. This indicated that the developers encountered difficulty in setting high rental prices to accelerate investment returns, with occupants/tenants enjoying the savings obtained from green building features and increasing capital risk. In this case, the unwillingness of the developers was exhibited in deploying green buildings, as observed in Australia (MacAskill et al., 2021) and Ghana (Agyekum et al., 2022). Moreover, the absence of government incentives was the final hindrance to cost and risk-related barriers. This was supported by the occurrences in China (Hwang et al., 2017) and Ghana (Darko and Chan, 2018; Agyekum et al., 2022), where the lack of government bonuses was a critical barrier to the implementation of green building.

The significant influence of knowledge and information barriers on the level of green building implementation contained the following, (1) a lack of information on the options/practices related to green building, (2) inadequate promotion platforms, (3) insufficient professional knowledge and expertise, (4) a lack of professional education and training, (5) insufficient cost-benefit data, and (6) inadequate demonstration projects. From this barrier, the lack of information about the options/practices related to the green building was the main challenge in Jakarta. This caused inadequate knowledge in applying more complex construction, leading to an increased risk of failure (Saha et al., 2021). The lack of a platform also led to difficulty in facilities for exchanging information and knowledge toward applying green building (Zhang et al., 2018). According to Shen et al. (2018), a lack of professional understanding and expertise in implementing and meeting certification requirements and energy systems was a barrier to green building adoption in Thailand. The need for pilot projects was also a challenge in Jakarta, considering the low number of green constructions. This was supported by similar occurrences in Vietnam, causing difficulties in obtaining and investigating data on the costs and benefits of implementing green buildings (Nguyen et al., 2017).

An influential relationship was also observed between the barriers regardless of the direct impacts on the level of green building implementation. This proved that the barriers related to knowledge and information significantly and directly affected costs and risk challenges. In this case, the lack of knowledge and expertise emphasizing green building design, materials, and technology from professionals in Vietnam caused an increase in costs and time from the planning and implementation stages (Nguyen et al., 2017). Based on Orsi et al. (2020), inadequate information and knowledge led to poor planning, which failed to achieve the expected performance of environmentally friendly features. Moreover, the barriers related to knowledge and information significantly and directly impacted social and cognitive challenges. This demonstrated that insufficient infor mation and knowledge caused the construction industry in Ghana to experience difficulties in green building investment (Agyekum et al., 2022). It also developed an information gap, leading to weak private-sector investment in sustainable development (Clark et al., 2018).

4.2 Incentives

In testing the hypothesis emphasizing the influence between the form of incentives and the level of green building implementation in Jakarta, a significant direct effect was observed on financial and non-financial benefits. This result aligned with Olubunmi et al. (2016), where the provision of financial and non-financial incentives increased the application of green buildings. From these contexts, the financial incentives significantly affecting green building implementation included the Acquisition of Duty of Right on Land Building tax and property incentives, as well as the reduction of building permit fees. According to Shazmin et al. (2016), tax incentives significantly increased the application of green buildings in Malaysia. These financial incentives encouraged higher adoption of energy-saving technologies in Canada (Rana et al., 2021). This form of incentive was often provided to the building application in America regardless of the construction permit fee reduction (Bond and Devine, 2016). Furthermore, the non-financial incentives significantly affecting the level of green building implementation in Jakarta included government promotion and publication, administrative awards, expedited permit processing, and technical assistance. In this case, government promotions and awards increased publication, one of the main strategies in enhancing the application of green building (Darko et al., 2018). The acceleration of permits and technical assistance was also the incentives widely applied to cities in America, relevantly influencing the development of green building implementation (Choi, 2010).

Based on the hypothetical analysis, a significant direct effect was found between non-financial incentives with cost-risk and knowledge-information barriers. This indicated that the provision of incentives through expedited permits and technical assistance reduced the need for time and risks, as well as the certainty of obtaining permits (Choi, 2010; Olubunmi et al., 2016). In this case, the reduction in time subsequently decreased investment costs and risk. During the planning stage, the provision of technical assistance also greatly assisted the developer and strategizing team in determining and identifying certification requirements and permit processes (Saka et al., 2021). From this context, the higher planning costs (design fees) and great investment risk (Chegut et al., 2019) were mitigated through technical assistance. Meanwhile, non-financial incentives, such as government promotions and awards, played a crucial role in enhancing public knowledge about green building practices. These incentives facilitated the provision of relevant and easily accessible data and information through dedicated platforms (Liu et al., 2020).

Considering the significant influence on the level of implementation of green building and barriers to implementation, non-financial incentives were recommended and considered effective to improve relevant construction adoption in Jakarta. The provision of these incentives was capable of increasing green building implementation and reducing significant barriers in Jakarta. This result was supported by Olubunmi et al. (2016), where non-financial benefits were more effective for relevant construction adoption than financial incentives. These incentives were provided through promotions and awards from the government, expedited permits, and technical assistance. Incentives can be given by providing requirements to meet specific levels of green building implementation to become beneficiaries.

5 CONCLUSION

Based on the results, the low implementation of green building through building certification in Jakarta led to the decreased achievement of reducing greenhouse gas emissions within the energy sector in 2020. This was carried out through the efficiency of energy use in commercial buildings, potentially causing Jakarta to experience the effects of a climate change-related disaster. In this case, the low prevalence of the buildings was due to barriers preventing their implementation. This led to the provision of incentives as a solution to overcoming the barriers, significantly affecting the rapid development of green buildings. In this study, path analysis and structural equation modeling (SEM) was used to determine the influence relationship between barriers, incentives, and the level of green building implementation.

This experimental process was carried out to identify the most effective incentives for relevant construction adoption in Jakarta. Data were also obtained through the Google Form questionnaires distributed to 101 participants from skilled institutional developers/owners, consultants, contractors, and government agencies. Furthermore, PLS-SEM was employed to analyze data, where cost-risk and knowledge-information barriers, as well as financial and non-financial incentives significantly affected the implementation of green buildings in Jakarta. Considering the significant influence on the level of green building implementation and barriers, non-financial incentives were recommended and considered effective in the region. This showed that the provision of the incentives increased building adoption and reduced significant barriers in Jakarta.

From these results, appropriate assistance was provided to policymakers and practitioners in formulating policies. This emphasized the provision of adequate incentives for improving the implementation of green buildings in Jakarta. Although the study yielded positive outcomes, its scope was still limited to the Jakarta region only. The review of barrier factors also encompassed cost-risk, knowledge-information, and social-cognitive challenges, with government-regulated incentives highly prioritized. Since the specific mechanisms by which incentive arrangements expedited the adoption of green buildings were not analyzed, subsequent analyses should be performed. This future analysis should explore the intricate workings of incentives and supplement previous recommendations, to enhance the understanding of benefits arrangements and provide valuable insights for policymakers, specifically in Jakarta.

DISCLAIMER

The authors declare no conflict of interest.

ACKNOWLEDGMENTS

The authors are grateful to the editors and reviewers, whose invaluable comments and suggestions helped improve the quality of this paper.

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