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The Guidelines of Green Building Operation in Thailand Construction Industry

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Abstract: This research aimed to study the guidelines for green building operations in Thailand's construction industry and develop a structural equation model (SEM). According to global trends in sustainable development goals, issues about energy resources, pollution, and human surroundings are concerning. Each country's green building criteria or discipline topics will be developed and improved for their condition. The research analysis emphasised the green building industry using descriptive, reference, and multiple statistics. The research results show guidelines for green building operation in 4 aspects. Each component aspect's names are (1) Environment Arrangement, (2) Collaborative Creation, (3) Knowledge Management and (4) Technology Development. The hypothesis test showed that the difference in enterprise sizes revealed overall aspects that were not significantly different at 0.05. The analysis of the developed structural equation model showed that it was in accordance and harmony with the empirical data and passed the evaluation criteria. Its Chi-square probability level, relative Chi-square, the goodness of fit index, and root mean square error of approximation was 0.184, 1.084, 0.959, and 0.013, respectively.

Key words: Green building, collaborative creation, knowledge management, technology development and environment arrangement.

Introduction

The current global situation has encountered problems in energy, environment, climate (Zheng et al., 2022) variability, and the global warming crisis (Agbajor et al., 2022); many countries around the world have expressed their intentions by following the United Nations Framework Convention on Cooperation on keeping greenhouse gas concentrations constant in maintaining the global climate (Kucukkaya et al., 2020) (United Nations Framework Convention on Climate Change: UNFCCC). One of the key reasons is the construction of buildings to support many economic investment activities that support economic growth from public and private investment. As a result, vast amounts of resources and energy are consumed (Cao et al., 2022). Without measures or methods to control and inspect would not be suitable for our world in which these energies are used in the construction process. Temperature control, lighting control and control of various systems in the building (Al-Buzz, 2022).; so that people who use the building receive well-being and efficiency in work from such problems. Therefore, the building has been developed to be environmentally friendly. Furthermore, use energy efficiently, known as "Green Building". Building construction, both the

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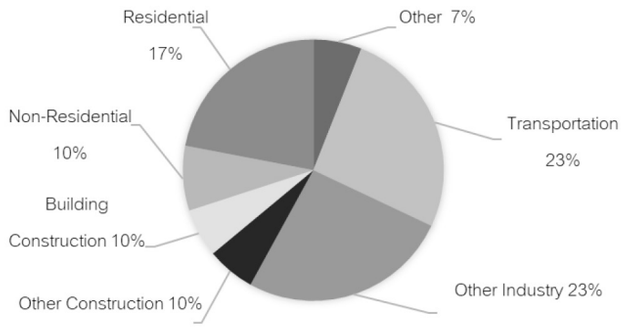
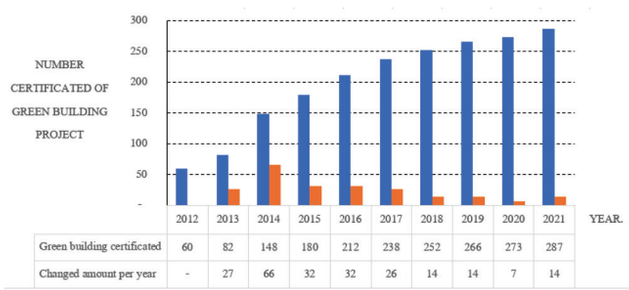
residence from business and industry sectors (Li et al., 2022), are the causes of energy consumption and emissions on a global scale (Aroonsrimorakot et al., 2019); every country must recognize and help each other to solve these problems, as in Figure 1.



Global Construction Status Report, 2021)

Figure 1: Energy consumption and emissions from buildings and construction around the world.

Institutes have been established in each country worldwide to develop green building standards (Hu et al., 2022). Moreover, used to evaluate green buildings in their own countries (Shareena et al., 2022), such as the US LEED & Energy Star standards BREEAM of the United Kingdom, DGNB of Germany, CASBEE of Japan, GOBAS of China, Singapore's Green Mark, and Thailand has several criteria, including TGBI, TEEAM, and PCD. Green building standards used within Thailand Building qualifications will be reviewed by category from the design stage construction and use after construction. The topics for consideration are location and landscape, saving water, saving energy, and saving materials and resources used for power consumption (Thongkong, 2022) the quality of the environment, including the surrounding community and culture, or implementing various innovations. Thai Green Building Institute was founded with the cooperation of the Engineering Institute of Thailand (EIT) and the Association of Siamese Architects under the Royal Patronage of His Majesty the King (ASA). TGBI is a private organization to inspect green building standards coupled with the fact that entrepreneurs are also choosing to use foreign criteria. Building energy-efficient buildings or meeting Green Building standards allows entrepreneurs to respond to trends in building energy standards and customer needs (Olanipekun et al., 2017). Especially the office buildings that want to attract corporate customers who aim to reduce greenhouse gas emissions. However, development of the construction industry in Thailand has been continuously growing, especially in the past 10 years. According to the information obtained from the National Economic and Social Development Council, there will be projects in the next 3-5 years. Generally, the number of green building-certified projects has grown three times, but considering the data of green building-certified projects in Thailand year to year. It can be seen that the growth rate has decreased dramatically for green building projects certified in Thailand from 2012 to 2021, as shown in Figure 2.



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Green building certificated	60	82	148	180	212	238	252	266	273	287
Changed amount per year	-	27	66	32	32	26	14	14	7	14

(TGBI USGBC, 2021)

Figure 2: Number of Green Building Certificated 2012–2021 in Thailand.

Implementing green buildings in Thailand's construction industry faces many problems, including budgets 5-20% higher than conventional construction (Sukhawatthanakun, 2022). There is a lack of interest from private project owners and a lack of interest from private sector owners. Because it is not a law that needs to be followed, and there is no incentive for benefits. The lack of support from government agencies and the shortage of personnel with knowledge and skills in green building, including building designers and workers like contractors. Therefore, the researcher is interested in implementing green buildings in the Thailand construction industry.

Objectives

(1) To study the structure and general operations of small and medium businesses and the large size of the Thailand construction industry.
(2) To study the components of green building operation guidelines in Thailand's construction industry.
(3) To develop a structural equation model for green building operations in Thailand construction industry.

Hypotheses

Following related works of literature, the researcher determined six hypotheses based on the following theories.

- H1: Research hypothesis in the causal influence test between latent variables, the 'Collaborative Creation' component directly influences the 'Knowledge Management' component. (Kamil et al., 2018). Knowledge has a strong relationship with the usage of green buildings (Gupta et al., 2022)
- H2: Research hypothesis in the causal influence test between latent variables, the 'Collaborative Creation' component directly influences the 'Technology Development' component. (Pathak and Kumar, 2019). A green building energy-saving design method based on technology was proposed (Xiao-guang et al., 2022)
- H3: Research hypothesis in the causal influence test between latent variables, the 'Collaborative Creation' component directly influences the 'Environmental Arrangement' component. A good environment is important for human life quality. (Kanchanabhan, 2019).
- H4: Research hypothesis in the causal influence test between latent variables, the 'Environment Arrangement' component directly influences the 'Technology Development' component. Changes in climate cause equipment and program development (Monisha, 2019).
- H5: Research hypothesis in the causal influence test between latent variables, the 'Technology Development' component directly influences the 'Knowledge Management' component. Technology can improve construction method (Darko et al., 2017).
- H6: Research Hypotheses to test the difference in the importance of green building practices in the Thai construction industry as a whole, classified by the size of the business, item. The level of importance of green building practices in the Thai construction industry as a whole classified by business size, the results were not different (Bakar & Ahmed, 2010).

Methodology

This research is creating inductive analysis using mixed-methodology analysis. It consists of 3 parts: qualitative research with in-depth interviews, quantitative research with survey data collection, and qualitative research with focus group techniques to confirm the accuracy of this research model. The research method is presented in steps, including population and sample, data collection, and statistics used in data analysis.

Population and sample qualitative research with in-depth interview techniques. The population used in this research is 9 green building experts using purposive sampling. The research populations are surveyed from the management level in organizations that work in green building businesses that distribute in small, medium and large companies. The population used in quantitative research is a green building executive. The population used in quantitative research is an executive in the construction industrial with 500 samples according to the criteria (Comey & Lee,1992, referred to in Thanin, 2020), 500 cases and qualitative research with a focus group discussion to support the subject from 11 green building experts using purposive sampling.

The characteristics of the tools used in this research can be divided according to the aspects of the research method into two types: qualitative research and in-depth interview techniques. The research tools are structured interviews. quantitative research tools are questionnaires consisting of questionnaires that are characterised by a checklist and rating scale. By setting the weight setting criteria into five levels according to Likert's method, the conformity index between the question and the purpose of this research. It appears that all 100 observational variables have IOC values and then experiment by trying out with population groups similar to the people who want to study. This time, 30 people used the results from trying to analyse by using the scores obtained from the questionnaire to find the discrimination in the question section that looks like a list, with standard deviation and questions that are scaled with correlation coefficients and find the reliability of the questionnaire. The question is characterised by estimating the Cronbach from the ready-made program (SPSS: Statistical Package for the Social Science for Windows) and qualitative research with a focus group discussion; research tools are

For the testing quality of the questionnaire, the results of the discrimination analysis of each item showed that the standard deviation of the items was between 0.93 and 1.42 (standard criteria more than 0.30). In addition, the corrected item-total correlation analysis of the items with the Likert scale was 0.99 (standard criteria more than 0.80), and the Cronbach's Alpha Coefficient of the reliability of the questionnaire was 0.99 (standard criteria more than 0.80).

This research was designed as an Inductive Research with a mixed methodology (Siljaru, 2020). The qualitative research with an in-depth interview and the quantitative research chooses a population in a group of management level with 500 enterprises with green building operations in the construction industrial business with a total population of 6,695 (Thailand

Green Building Institute, 2021). Dividing into two groups, they were between small and medium (SME) and large enterprises. And the qualitative research with Focus group discussion.

Data analysis uses descriptive statistics. Reference statistics and multi-statistics to develop a structural equation model (SEM) using ready-made programs SPSS and AMOS. Determine the criteria for evaluating the data-model fit (Evaluating the Data-model Fit) used to consider four values: (1) The probability of chi-square is more significant than 0.05, (2) The relative chi-square value must be less than 2, (3) The Consistency Index is more significantly more significant than 0.90, and (4). The root index of the squared mean error estimate (RMSEA) is less than 0.08.

Result

The statistical analysis results of the guidelines for effective industrial waste management of the industrial business sectors are as in Table 1.

Table 1 shows the analysis results of the importance of green building implementation guidelines in the Thai construction industry, classified by the size of the industrial business. The results were as follows:

Small and medium businesses found that the guidelines for green building operations in the Thailand construction industry overall are important at a high level. The mean was 3.98, and when analysing the level of importance by size found that all aspects were at a high level. After ranked in order of importance from most to least as follows: (1) Collaborative Creation component has an average value of 4.00, S.D. = 0.45, (2) Knowledge Management component has an average value of 4.00, S.D. = 0.46, (3) Environment Arrangement component has an average value of 4.00, S.D. = 0.57 and (4) Technology Development component with an average of 3.91, S.D. = 0.60, respectively.

Large businesses found that the guidelines for green building operations in the Thailand construction industry overall are important at a high level. The mean was 4.01, and when analyzing the level of significance by each side found that all aspects were at a high level. The order of importance from the most to the least is as follows: (1) Environment Arrangement component has an average value of 4.06. (2) Collaborative Creation component had an average of 4.01. (3) Technology Development had an average of 3.98, S.D. = 0.46, and (4) Knowledge Management had an average of 3.98, S.D. = 0.53, respectively.

The structural equation model analysis results of green building operation guidelines in Thailand's construction industry in mode standard after modification, is shown in Figure 3.

Table 2 presents the assessment results of the harmoniousness of the structural equation model for green building operation guidelines in Thailand's construction industry before model improvement and after modifying the model.

The statistical values evaluate the consistency of the comparative structural equation model before model modification. The root mean squared error approximation (RMSEA) was found to be 0.067, passing the criteria for concordance assessment with empirical data. However, for other values, there were chi-square probability level (CMIN-p) equal to 0.000, the chi-square relative (CMIN/DF) equal to 3.241, and the goodness of fit index (GFI) equal to 0.709 did not pass the assessment criteria for concordance with empirical data.

Therefore, the researcher then proceeds to improve the model by considering the modification indices suggested by Arbuckle's manual guide (2016). The considering value of the result obtained from the packaged program with the theory principles is to eliminate some unsuitable observed variables one by one and then reprocess the model. The process is repeated until the model has all parameters passing statistical values. Therefore, the structural equation model is consistent with the empirical data.

Table 1: The mean and standard deviation of the guidelines of green building operation in Thailand construction industry

Guidelines of green building operation in Thailand construction industry	*Small and medium enterprise*			*Large enterprise*		
		SD.	*Sig. level*		*SD.*	*Sig. level*
Overall	3.98	0.46	High	4.01	0.43	High
1. Collaborative Creation	4.00	0.45	High	4.01	0.44	High
2. Knowledge Management	4.00	0.46	High	4.01	0.46	High
3. Technology Development	3.91	0.60	High	3.98	0.53	High
4. Environment Arrangement	4.00	0.57	High	4.06	0.49	High

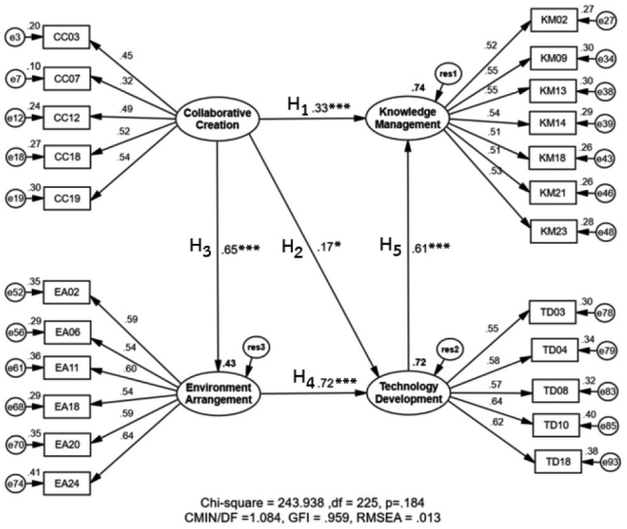


Figure 3: The structural equation model (SEM) of the guidelines of green building operation in Thailand construction industry after modification.

Figure 3 and Table 2 show that after the model improvement was completed, it was found that the Chi-Squared Probability Level (CMIN-p) was 0.184 greater than 0.05. The Chi-Squared Relative (CMIN/DF) was 1.084, which was less. 2.00, the Goodness of Fit Index GFI was 0.959, was greater than 0.90, and the Root Mean Squared Error Approximation (RMSEA) was 0.013, was less than 0.08, so it was concluded that all four statistics passed the assessment criteria. Therefore, after improvement, the structural equation model for green building implementation in Thailand's construction industry is consistent with the empirical data.

Table 2: Statistical values that assessed the consistency of the comparative structural equation model before and after modifying the model

Statistics	*Standard criteria*	*Before modification*	*After modification*
CMIN-ρ (Chi-Square Probability Level)	> 0.05	0.000	0.184
CMIN/DF (Relative Chi-Square value)	< 2.00	3.241	1.084
GFI (Goodness of Fit Index)	> 0.90	0.709	0.959
RMSEA (Root Mean Squared Error of Approximation)	< 0.08	0.067	0.013

Discussion

Discussion to summarize the solutions with relevant research papers cited as follows.

Key issues found from the research of the guidelines of green building operation in Thailand's construction industry focus on factors that create the ability to operate more efficiently. To study the principles and factors influencing management to achieve success to promote the organisation's green building operations (Tekka et al., 2019). They are supporting continuous driving and development in the environment of the construction industry in a sustainable manner. As a result, Sukhawatthanakun (in press) pointed out that construction industry businesses can efficiently manage the process, resources, and operations of green buildings for organizations (Liu et al., 2022). Moreover, to upgrade the innovation ecosystem (Feng, 2022) to be strong in the country to connect with the international competitive environment of the industrial business sector in the age of Industry 4.0. The researcher has been brought to a discussion to conclude a solution by referring to relevant research papers to support or contradict.

From the research results, in the category of small and medium-sized industrial businesses with large industrial businesses as a whole and in each aspect. There was no statistically significant difference at the 0.05 level, namely in the small and medium business sectors with large businesses. That has a clear working structure that supports green building implementation in Thailand's construction industry. Informal communication is used to foster collaboration and rapport among members or alliances. Openly exchange information and knowledge between entrepreneurs to develop and learn together (Bungau et al., 2022). In order to set a campaign for building users to work together to save energy; therefore, the organisation must set a practical training course to enhance knowledge of green building for personnel within the organisation as a guideline for work to create a learning system for green building construction to promote a learning organisation (Girum, 2022). A standard personnel assessment system exists, such as an individual development plan for developing green building skills and knowledge.

Conclusion

The Importance components of green building guidelines in Thailand's construction industry were found overall at a high level, with a mean of 3.99.

According to the green building operation guidelines in Thailand's construction industry by aspects ranked as follows: (1) Environment Arrangement had an average of 4.03, (2) Collaborative Creation had an average of 4.00, (3) Knowledge Management had an average of 3.99, and (4) Technology Development had an average of 3.94, respectively.

The guidelines for green building operations in Thailand's construction industry – it is a guideline that represents principles of management within an industrial business organization. The structured nature of green building operations includes Collaborative Creation, Knowledge Management, Technology Development and Environmental Management (Selvendran, 2017). At the policy level, there should be support from the government and related organizations, namely: the Thai Green Building Institute (TGBI), Thai Green Building Foundation, the Council of Engineers, The Engineering Institute of Thailand Under the Royal Patronage (EIT), and Association of Siamese Architects Under the Royal Patronage (ASA).

At the operational level, the industrial sector should focus on managing relationships with business partners and building knowledge for organizational personnel (Elgadi et al., 2019). The firm should find modern technology and innovations to adapt as appropriate to the paradigm shift in line with the uncertain change in the era of globalization. Companies should have research and development studies with partners in the government sector (Nguyen et al., 2017), academy or business partners (Collaborative Research). There should be enough green building experts to give more information, comments and advice that are correct and helpful.

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