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Investigation of Barriers and Improvement Methods for Net Zero Energy Buildings: Stakeholders' Viewpoints

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Abstract: - Construction and buildings used 37% of the total energy, the world's largest gross energy consumption. So, net zero energy building (NZEBs) to mitigate carbon dioxide (CO2) has become a hot trend worldwide. The NZEBs concept can be defined as the balance between generation and load or imported and exported energy. The target population for this research was the stakeholders in implementing NZEBs. Stakeholders are individuals or groups interested in and influencing an organization. Cochran's Sample Size Formula was used to determine the sampling number, and a quantitative approach was used to collect data in this research. A total of 105 respondents answered the questionnaire. The questionnaire consists of three main sections—The first section questions about the respondents' demographic. The entire data of respondent background includes gender, age, highest academic qualification, stakeholder position, and years of experience in NZEBs construction. The second section investigated the barriers to implementing NZEBs in Malaysia from the Stakeholders' viewpoint. The highest mean of the barriers to implementing NZEBs was "Requires high initial costs for installation NZEBS technologies" within 105 respondents. The third section investigates the improvement ways of implementing NZEBs in Malaysia from the Stakeholders' viewpoint. The highest mean was item 7, "Education enhancement at university and training institution level", with 4.28. In conclusion, the NZEB concept can aid in decreasing energy use through energy efficiency. However, the findings of this research demonstrated that there are barriers to the development of NZEBs in Malaysia and have also pointed out some of the improvement ways to solve the barriers.

Keywords: Net Zero Energy Building; Sustainability; Stakeholders; Construction; Barriers of Implementation.

I. INTRODUCTION

Buildings of various forms have always been a part of humanity. Buildings had been sheltered, providing comfort and protecting humans from surrounding environment danger. The main purpose of the building has not changed over time, but in the last century, the method and influence of construction have changed significantly. Therefore, the impact of buildings and the construction industry on the economy, society, and environment has changed significantly. Due to population growth, the demand for buildings worldwide is increasing. This has led to increased demand for energy use by residents worldwide. The building sector is the main contributor to energy consumption. Due to the increase in housing demand, building energy consumption has recently become a significant concern for carbon dioxide and greenhouse gas emissions. Most of the current media reported that traffic and industry are the main energy users, which can easily cause the misconception. But overall, construction and buildings use 37% of the total energy, the world's largest gross energy consumption [1]. Therefore, a critical step to significantly reduce carbon dioxide (CO2) emissions and energy consumption in OECD countries is to improve energy efficiency and building sustainability over their entire life cycle.

Consequently, in the building and construction industry, high-performance building design has become an overriding priority, and also the commonly used performance index endorsed by multiple fields is the performance of energy efficiency. So, the concept of net zero energy building (NZEBs) to mitigate carbon dioxide (CO2) has become a hot trend worldwide. Many of the researchers and other prominent industry community leaders have dedicated themselves to addressing the rising energy consumption in commercial and residential buildings by pushing the limits of building efficiency to generate net zero energy building (NZEBs). As a developing country, Malaysia has introduced the net zero energy building (NZEBs) concept to achieve better energy-efficient buildings. Concerning the Malaysian construction industry, the government has recognized that energy use is a major concern and that the ineffective use of energy in the developing country has a negative impact. The Construction Industry Transformation Program (CITP) 2016-2020 clearly indicates that environmental protection is one of the strategic

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forces aiming to change the industry [2]. Moreover, the statement on the budget speech 2016 from our prime minister of Malaysia mentioned that the government aims to reduce up to 40% gross domestic product (GDP) of the greenhouse gas emissions in 2020 [3].

Therefore, this research was focused on diagnosing the barriers of implementing Net Zero Energy Buildings (NZEBs) and determining the improvement ways of implementing NZEBs in Malaysia from the Stakeholders' viewpoint. Any group or person who can influence the company project's goals is called stakeholder [4]. There are two types of stakeholders: the internal stakeholders, owners and employees, and the external stakeholders, customers, investors, suppliers and government agencies [5].

II. MATERIALS AND METHODS

2.1 Research Procedure

This research consists of 5 phases, illustrating the whole process from the start of the activity until the end. Phase 1 is to study and discuss the title of the problem statement. The process of phase 1 includes the research background, problem statement, research questions, research objectives, scope of research, significance of research, expected findings and, research methodology and thesis outline. Phase 2 is the process of literature review, where locating the research article that related to the research title. This research objective can be achieved by obtaining information through the various published material such as books, journals, thesis and proceeding papers.

Moreover, Phase 3 is data collection. The data collection can be divided into two categories, which is primary data and secondary data. Primary data is using quantitative approach, which is collected via questionnaires. Secondary data is a method to collect information through books, journals, internet articles, and proceeding papers. This phase can lead us more understanding regarding the challenges and improvement ways of NZEBs in Malaysia. Phase 4 explains the analysis techniques and the result collected using questionnaires. Data collected will be analyzed using the descriptive analysis method by using SPSS software and MS Excel. All descriptive statistics will be presented in frequency, percentage, mean, standard variation in various types such as charts, graphs and tables. Phase 5 is the final phase in this research, consisting of a conclusion and recommendation. In this phase, the analysis's results will be summarised and concluded. Recommendations and suggestions also will be provided.

2.2 Research Population and Sampling

A research sampling is a subgroup of the target population that the researcher plans to study to make generalizations about the target population. Sampling enables researchers to collect smaller quantity of the data that represents the whole population [6]. Cochran's Sample Size Formula was used to determine the sampling number. The Cochran formula can be used to find an optimum sample size, given a desired level of precision, desired confidence level, and the expected fraction of the attribute present in the population. In the cases involving huge populations, Cochran's formula is particularly useful. Because a sample of any size provides more information about a smaller population than a bigger one, there is a 'correction' that may be used to reduce the number supplied by Cochran's formula if the entire population is tiny [7]. Assume there is a large population but that we do not know the variability in the proportion that will adopt the practice; therefore, assume p=0.5 (maximum variability). Furthermore, suppose we desire a 95% confidence level and ±10% precision. Where e is the desired level of precision (i.e. the margin of error), p is the (estimated) proportion of the population which has the attribute in question, q is 1 – p. Therefore, a total of 97 or more responses were collected through self-administered survey method by online survey to citizens in this research.

2.3 Data Collection Methods

Primary data are those that are obtained a new and for the first time, and therefore happen to be original. In this research, the methods used for collecting the primary data is through questionnaire served as a tool to collect and analyze the data. Primary data is collected with the aim to obtain the solution for the problem statement. Primary data collection is also very involved, which means it is very time-consuming and expensive compared to secondary data rapid and easy [8]. The primary data collection uses a quantitative approach through questionnaire to obtain data related with the barriers and improvement ways to implement the NZEBs. The respondent who participate in this research are stakeholders in Malaysia. Secondary data is the information data which have been obtained before by someone else and which have already been conducted in the statistical process. For example, journals, reports,

censuses and information extracted for the specific purpose of the research. The secondary data used must be conservative. The secondary data used must be conservative. This is because the secondary data might not be acceptable or appropriate in the sense of the problem the researcher wants to analyze, so a minute review is required. In this research, journals, articles, books and online databases are the core secondary data sources to get the relevant information [8].

2.4 Research Approach

This quantitative research approach is more suitable for identifying the extent of an issue, problem or phenomenon. In the situation of how many persons have a particular viewpoint, have a particular issue, or hold a particular opinion need to be found, then quantitative research approach will be needed. Therefore, the quantitative method has been used in this research. Quantitative data collection methods are based on random sampling and structured data collection method. Quantitative research findings are easy to summarize, present, compare and generalize [9]. This method covers the use of questionnaires whereby the data collected and analyzed. The quantitative method was carried out in this research to achieve the research objectives. For quantitative method, the questionnaire is used to be the research instrument. There are two types of questionnaires: soft copy (online form) and hard copy. Hard copy form is print out the questionnaire on the paper can let other respondents to fill it. While soft copy form is but using the online form. Therefore, it is suitable to use the soft copy online to obtain and gather the results from the respondent during this pandemic Covid-19 and save the paper. The questionnaire consists of three main sections. First section questions about demographic of respondents. Second section investigated the barriers of implementing NZEBs in Malaysia from the Stakeholders' viewpoint. Third section investigation about the improvement ways of implement NZEBs in Malaysia from the Stakeholders' viewpoint. Questionnaires are very useful in collecting data required with less consuming time.

Section A question the respondents about demographic which consist gender, race, age, working experience (years) and level education. In this section, selection scale is used. Section B covered the barriers to implementing NZEBs in Malaysia from the Stakeholders' viewpoint. This section used five-point Likert Scale to achieve the first research objective. Section C will question respondents regarding the improvement ways of implement NZEBs in Malaysia from the Stakeholders' viewpoint. This section will also involve the five-point Likert Scale and open ended question. 5 point Likert-scale were used, ranging from '1' Strongly disagree to '5' strongly agree. The Likert-scale was chosen to let respondents take less time to answer and easy to answer [10]. Therefore, the rating can predict easily.

III. RESULTS AND DISCUSSION

3.1 Reliability analysis for an actual study

Reliability is to test how consistently a measuring instrument measures for any concept it is measuring. A Cronbach's alpha coefficient is used to test the consistency of inter-item for each measurement items in the questionnaire [11, 15, 16]. The higher the Cronbach's alpha values, the greater the scale's reliability. It is help researcher to check whether data reliable or vice versa. Each variable shows moderate reliability with it Cronbach's alpha value showed were above 0.600 in the table below. Based on Table 1, the barriers of implementing NZEBs achieved 0.886 Cronbach's alpha which show very good reliability while the improvement ways of implement NZEBs achieved eexcellent reliability with scores 0.970.

Table 1: Strength of association of Cronbach's Alpha value for an actual study

Variables	Cronbach's Alpha Value	Number of items	Strength of association
The barriers of implementing NZEBs	0.886	10	Very good
The improvement ways of implement NZEBs	0.970	10	Excellent

The total Cronbach's Alpha value of actual study was recorded for the reliability test was with the total number of 20 items with 105 respondents. Table 2 showed the overall Cronbach's Alpha value for actual study. Therefore, the questionnaire instrument is reliable for measuring all variables consistently and free from random error.

Table 2: Overall Cronbach's Alpha value for actual study

Number of respondents	Cronbach's Alpha Value	Number of items	Strength of association
105	0.937	20	Excellent

The entire data of respondent background includes gender, age, highest academic qualification, stakeholder position and years in experience on NZEBs construction as below Table 3. The data in the table below include the frequency and the percentage of the respondent. According to the table shown below, most of the gender are male (60.0%) and most of them also holding Bachelor Degree (60.0%). The respondents involved are mostly between 20-30 years old (56.2%) and most of them were clients (37.1%), second were contractors (20.0%). Most of the respondents have no experience in NZEBs.

Table 3: Respondent Background

Item		Frequency	Percentage (%)
Gender	**Male**	**63**	**60.0**
	Female	42	**40.0**
Age	**20-30 years old**	**59**	**56.2**
	31-40 years old	28	**26.7**
	41-50 years old	12	**11.4**
	51 years old and above	6	**5.7**
Highest Academic Qualification	Diploma	29	**27.6**
	Bachelor Degree	**63**	**60.0**
	Master	8	**7.6**
	PhD	5	**4.8**
Position Held (Stakeholder)	Architects (AR)	9	**8.6**
	Contractors (C)	21	**20.0**
	Clients (CL)	**39**	**37.1**
	Consultants (CS)	19	**18.1**
	Project Engineer (PE)	13	**12.4**
	Property development and procurement (O)	4	**3.8**
Having Experience in NZEBs construction	**None**	**40**	**38.1**
	1-3 years	33	**31.4**
	3-5 years	19	**18.1**
	5-9 years	6	**5.7**
	10 years and above	7	**6.7**

3.2 Summary the barriers of implementing NZEBs

According to the Table 4 below, it consists of the barriers of implementing NZEBs. The highest mean of the barriers of implementing NZEBs in Malaysia from the Stakeholders' viewpoint was 4.14 which is "Requires high initial costs for installation NZEBS technologies" within 105 respondents, which having standard deviation 0.945. One of the most serious obstacles to the deployment of NZEB in Malaysia is the cost. For renewable energy technology, NZEB requires high investments. It also necessitates a longer payback period. As a result, stakeholder interest in investing will decrease. For the lowest mean of the barriers of implementing NZEBs in Malaysia was "Government policies and regulatory framework do not encourage the sustainable housing development" which is 3.83, at the same time highest standard deviation 1.130 in ranking 10. The average mean of this summary was 3.992.

Table 4: highest cases of the barriers for implementing NZEBs

Item	N	Mean	Standard Deviation	Ranking
Requires high initial costs for installation NZEBS technologies	**105**	**4.14**	**0.945**	**1**

Low availability of renewable energy technologies supply in Malaysia	105	4.11	0.964	2
Malaysians are lack of awareness of sustainable ideas and NZEBs concept	105	4.10	1.018	3
Unwilling to approve design when authorities are unfamiliar with the NZEBS concept	105	4.06	0.998	4
Lack of expert professional and consultant in NZEBs design	105	4.05	0.924	5
Resist the change from the use of traditional technologies	105	3.96	1.073	6
Lack of timely information sharing/ communication between the stakeholders	105	3.93	0.953	7
Lack demand of NZEBS market in Malaysia	105	3.90	0.980	8
Current tax exemptions and financial incentives are insufficient to induce the construction of NZEBs	105	3.84	1.075	9
Government policies and regulatory framework do not encourage the sustainable housing development	105	3.83	1.130	10
Average Mean		**3.992**		

3.3 Improvement ways of implement Net Zero Energy Buildings

Based on the Table 5, the improvement ways of implement NZEBs in Malaysia from the Stakeholders' viewpoint with the highest mean is the item 7 "Education enhancement at university and training institution level" with 4.28 and first in the ranking. Academicians, administrators, and students must incorporate environmental awareness and adoption into the learning process. The importance of conservation culture in the classroom must be emphasized. In the teaching-learning process, eco-friendly building, equipment, tools, and strategies must be employed. Future generations should be able to comprehend and conserve natural resources, as well as human health, by acting as environmental leaders [12, 13,14]. Meanwhile, the lowest mean value is item 4 "Revise existing regulations, guidelines and building standards" which is 4.01 and ranking 10. The average mean for this part is 4.150.

Table 5: improvement methods for implement NZEBs

Item	**N**	**Mean**	**Standard Deviation**	**Ranking**
Education enhancement at university and training institution level	**105**	**4.28**	**0.985**	**1**
Provide training development for employee technology skills enhancement	105	4.23	0.963	2
Development of a project management system that includes both project owners and citizens and ensures the coordination of all stakeholders from the start.	105	4.23	0.973	3
Research & Development (R&D) enhancement	105	4.23	1.031	4
Joint professional bodies and academia to conduct seminars, conferences and forums	105	4.15	1.017	5
Technology implementation subsidies by government	105	4.13	0.991	6
Reduce the maintenance cost of NZEB technology by extending the warranty period	105	4.09	1.030	7
Tax exemption initiative by government	105	4.08	0.906	8
Joint public or private institution to initiate project	105	4.07	1.049	9
Revise existing regulations, guidelines and building standards	105	4.01	0.925	10
Average Mean		**4.150**		

IV. DISCUSSIONS

In short, the result of data analysis has achieved the research objective from 105 respondents. With the data collected from respondents, researchers analyzed the variety of the barriers of implementing NZEBs and improvement ways of implement NZEBs in Malaysia from the Stakeholders' viewpoint by using SPSS software. The data was analyzed using the reliability test to determine the level of reliability whether the research can be continued access. All the reliability and variables are satisfied since the Cronbach Alpha value is 0.937 which is considered excellent. On the other hand, the descriptive analysis has determined that the most significant average mean is between the range of 3.67 to 5.0, so it is considered high. The first objective of this research is to identify the barriers of implementing NZEBs in Malaysia from the Stakeholders' viewpoint. The research objective has been achieved by distributing questionnaire form to respondents who are the stakeholders in Malaysia by using online questionnaire form. Based on the analysis performed, the highest mean of the barriers of implementing NZEBs in Malaysia from the Stakeholders' viewpoint was 4.14 which is "Requires high initial costs for installation NZEBS technologies" within 105 respondents, which having standard deviation 0.945. Most of the respondents agreed on The high cost of implementing NZEBS technologies. Meanwhile, for the lowest mean of the barriers of implementing NZEBs in Malaysia was "Government policies and regulatory framework do not encourage the sustainable housing development" which is 3.83, at the same time highest standard deviation 1.130.

The next objective of this research is to determine the improvement ways of implement NZEBs in Malaysia from the Stakeholders' viewpoint. The research objective has been achieved by using a quantitative approach to distribute questionnaires to the stakeholders in Malaysia by using online questionnaire form. The highest mean is the item 7 "Education enhancement at university and training institution level" with 4.28 and first in ranking. Academicians, administrators, and students must incorporate environmental awareness and adoption into the learning process. Meanwhile, the lowest mean value is item 4, "Revise existing regulations, guidelines and building standards" which is 4.01 and ranking 10.

V. CONCLUSION

In conclusion, the Net Zero Energy Buildings concept can aid in reducing energy use through energy efficiency. The NZEB concept can supply a building's energy requirements by utilizing renewable energy technologies to produce as much energy as it consumes annually. However, the findings of this research demonstrated that there are just a few barriers to the development of Net Zero Energy Buildings in Malaysia. The most intensive barrier is Net Zero Energy Buildings, which requires high initial costs for installation technologies. Furthermore, the respondents in this research have also pointed out some improvement ways to solve the barriers, such as Education enhancement at university and training institution levels. There are some recommendations suggested for improving the future study. In a nutshell, this research reached its goal objectives with positive outcomes. The result of all the research questions shows that the Malaysian people still need to work harder on Net Zero Energy Buildings implementation in Malaysia. Therefore, the crucial element for achieving Net Zero Energy Buildings is the enhancement of education at both the university and training institution levels.

REFERENCES

[1] R. Wen, S. Qi, and A. Jrade, "Simulation and assessment of whole life-cycle carbon emission flows from different residential structures," Sustain., vol. 8, no. 8, 2016, doi: 10.3390/su8080807.

[2] R. H. Abdellah and M. A. N. Masrom, "Exploring the barriers of net zero energy buildings (NZEBS) implementation in Malaysia: Perception of Malaysian construction practitioners," Int. J. Integr. Eng., vol. 10, no. 9, pp. 110–115, 2018, doi: 10.30880/ijie.2018.10.09.003.

[3] R. H. Abdellah, M. A. Nasid Masrom, G. K. Chen, S. Moham, and R. Omar, "The potential of net zero energy buildings (NZEBs) concept at design stage for healthcare buildings towards sustainable development," IOP Conf. Ser. Mater. Sci. Eng., vol. 271, no. 1, 2017, doi: 10.1088/1757-899X/271/1/012021.

[4] M. Ferreira, M. Almeida, and A. Rodrigues, "Cost-optimal energy efficiency levels are the first step in achieving cost effective renovation in residential buildings with a nearly-zero energy target," Energy Build., vol. 133, no. November 2014, pp. 724–737, 2016, doi: 10.1016/j.enbuild.2016.10.017.

[5] Q. S. and M. H. Jing Yang, "Article information :An overview of previous studies in stakeholder management and its implications for the construction industry," www.emeraldinsight.com/1472-5967.htm, vol. 7, pp. 159–175, 2009.

[6] D. R. Cooper and P. S. Schindler, "Business research methods," Business, no. 2000. p. 38, 2003, [Online]. Available: http://130.209.236.149/headocs/31businessresearch.pdf.

[7] G. D.Israel, "Using Published Tables Using Formulas To Calculate A Sample Size Using A Census For Small Populations."

[8] V. O. Ajayi, "Primary Sources of Data and Secondary Sources of Data," no. September, pp. 1–6, 2017, doi: 10.13140/RG.2.2.24292.68481.

[9] C. Williams, "Research methods," Cambridge Handb. Soc. Probl., vol. 1, no. 3, pp. 23–37, 2018, doi: 10.1017/9781108656184.003.

[10] D. R. Edmondson, "Likert scales: A history," Charm. pp. 127–133, 2005, [Online]. Available: http://www.orion2020.org/archivo/investigacion/Likert_History.pdf.

[11] D. B. Lomet, "Bulletin of the Technical Committee on Data Engineering," Bull. Tech. Comm. Data Eng., vol. 24, no. 4, pp. 1–56, 2001, [Online]. Available: papers2://publication/uuid/30073F7F-1B7C-4496-ADA4-94FF4E6EE8F7.

[12] P. Rao and P. S. Aithal, "Green Education Concepts & Strategies in Higher Education Model," Int. J. Sci. Res. Mod. Educ. ISSN, vol. I, no. I, pp. 2455–5630, 2016, [Online]. Available: www.rdmodernresearch.com.

[13] Tighnavard, B. Willy, S. David, Y. Mohd, and N. Yasin, “Economic and environmental life cycle perspectives on two engineered wood products : comparison of LVL and GLT construction materials,” Environ. Sci. Pollut. Res., no. Lcc, 2022, doi: 10.1007/s11356-022-24079-1.

[14] Balasbaneh and W. Sher, “Economic and environmental life cycle assessment of alternative mass timber walls to evaluate circular economy in building: MCDM method,” Environ. Dev. Sustain., no. 0123456789, 2022, doi: 10.1007/s10668-022-02707-7.

[15] Tighnavard, B. Willy, and S. David, “Recommending a new building structure to alleviate environmental impact in tropical climates : increasing the use of wood in construction,” no. 0123456789, 2022.

[16] Tighnavard Balasbaneh, W. Sher, D. Yeoh, and K. Koushfar, “LCA & LCC analysis of hybrid glued laminated Timber–Concrete composite floor slab system,” J. Build. Eng., vol. 49, no. January, 2022, doi: 10.1016/j.jobe.2022.104005.