Importance and Performance Ratings Analysis for Implementation of Green Construction on Building Project

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Abstract. Green construction implementation which is part of sustainable construction development has more benefits for building industries, occupants, and public communities. The implementation of green construction is slow and still limited in Indonesia. Frequent opinions about green construction activities are difficult to implement and require different efforts from conventional building processes. Therefore, this study aims to identify the aspects that have prioritized to get improvement for the implementation of green construction in building projects using importance and performance ratings analysis which includes gap analysis, and quadrant analysis. This research identifies 17 criteria success factors approved and has 30 questionnaires received. The questionnaire survey was given based on the perceptions of owner, consultants, and contractors. The questions contain the criteria success factors in implementation of green construction related to the measurement of its importance or significance and extended to evaluate its performance. The results showed there are aspects that are prioritized because low performance. For Quadrant I “Concentrate Here” such as adequate financial resources, optimal cost management, and exactness selection of eco-friendly quality materials and For Quadrant III “Low Priority” such as Existence of green performance evaluation system during the project, changes in labor habits to support green concepts, frequently training/education, procurement related to integrated green concept, and availability of green construction pilots.,

Keyword: Green Construction, Building Project, criteria success factors, Importance and Performance Analysis

1. Introduction

The construction industry is one of the biggest contributors to the greenhouse effect that can cause global warming and climate change. In this industry, it involves many people with various jobs/functions related to engineering. Inaccuracies in the construction process, from initial designing and planning, construction stage, until operational activities that can threaten future lives [1]. Therefore, the green construction concept makes it a solution to minimize environmental damage caused during construction activities.

Green construction is a terminology that focuses on the environmentally friendly building for realizing sustainable construction, which is based on the combination of environmental, economic, and social aspects simultaneously [2]. Ideally, in sustainable construction principles for making decisions related to reduce resource consumption, use recyclable resources, protect nature, eliminate the use of hazardous substance implement life cycle cost, and focus on quality are applied during design process,
construction, and continues throughout the life cycle building [3]. The implementation of green building is in its design, construction, and operational can eliminate negative impacts and create positive impacts on climate and environment, so as to conserves our natural resources and improves the quality of life. Green building refers to the qualities and characteristics whose structures are made using the principles and methodologies of sustainable construction [3]. Therefore, by adopting principles from sustainable development in the entire green construction process, it can ensure an increase in all areas, especially environmental and social impacts. As long-term benefits, implementation of green construction is a form of building professionals’ responsibility to improve environmental performance which will have positive impacts on sustainable company performance. As explained, many benefits derived from the application of green construction can encourage construction companies to invest in green building. However, we need to understand that in the application there are many obstacles and challenges, especially construction which have unexpected risks.

Previous studies explained that green construction practice has an importance rating that is higher than the performance rating. This implies that knowing and realizing the importance of green practice benefits is expected to be able for doing greater things, especially implementation in the construction process. For clients, consider related to higher property prices [2]. In contrast with the owner, more consider construction cost, future marketing, and return investment [4]. For the contractor, financial factors are not burdened, but the contractor’s problem is in unfamiliarity with technologies and methods to be used [5] [6]. So, a balanced consideration is needed between stakeholders involved in the implementation of green buildings, especially in the construction process.

Therefore, this study aims to identify the aspects that have prioritized to get improvement for the implementation of green construction in building projects. using importance and performance ratings analysis which includes gap analysis and quadrant analysis.

2. Research Methodology

2.1 Targeted respondents, type of survey, and Analysis Process

This study begins with reviewing previous studies. This used related to the barrier green practices. Then, brainstormed to obtaining 20 variables research with various assessment criteria (see Table 2). To know the respondent’s assessment of importance and performance ratings of these variables as primary data, the survey method was carried out using paper - based questionnaires with 1-5 Likert type scale (1 representing “not important”, 2 representing “less important”, 3 representing “quite important”, 4 representing “important”, and 5 representing “very important”). Respondents distributed to stakeholders involved in projects that implementing green construction, such as owner, consultant, contractor, and supplier. Respondents were asked to evaluate the importance and performance of 20 criteria success factors related to implementation of green construction. The recapitulated respondent’s answers will be analysed using different techniques including Inter-Rater Reliability Analysis, Importance - Performance Analysis (IPA), Gap Analysis (GA), and Quadrant Analysis.

2.2 Inter-Rater Reliability Analysis

Before analysing overall data, the reliability of data obtained was tested. This data analysis aims to analyse the extent of consensus (agreement) and internal consistency of scores/ratings given among respondents under certain conditions of observation regarding green construction. Reliability can be searched using inter-rater agreement index $\alpha_{WG(I)}$ and Cronbach’s alpha

2.2.1 Inter-Rater Agreement Analysis

Inter-Rater Agreement Analysis (IRA) is used to estimate whether the absolute value in terms has an equivalent agreement given by one or more judges [7] [8]. This approach was perfectly reasonable used for estimating rater similarity in many kinds of research. [8]. If the equivalent agreement levels by multiple judges are higher, it is preferred regardless of total respondents varied locations observed, and other conditions [7] [9]. Formula for IRA index is as follows:

$$\text{IRA} = \frac{1}{n} \sum_{i=1}^{n} \frac{r_{ij}}{n}$$

where $r_{ij}$ is the correlation coefficient between judges $i$ and $j$, and $n$ is the total number of judges.
Where $α_{WG(i)}$ is index IRA for a single item; $S_x^2$ is the obtained variance of items; $H$ is the maximum value of the scale; $L$ is the minimum possible value of the scale; $M$ is the observed mean ratings; $k$ = number of judges

2.2.2 Cronbach’s Alpha

The measurement of reliability as internal consistency are Cronbach's Alpha and Corrected Item-Total Correlation. Cronbach's alpha test provides a value / inter-item correlation coefficient, which is the correlation of each item with the sum of all other relevant items for measuring a construct [10]. In Table 1 the Coefficient Alpha which can be used as a reference for interpreting a construct. Then, for the provisions of the resulting value on the Corrected Item-Total Correlation, it can be considered good enough if it exceeds 0.3. If the correlation value is below 0.3 this indicates that the item is not well correlated with the overall score, so it is advisable to remove the item [11].

| Alpha Levels | Interpreted               |
|--------------|---------------------------|
| > 0.90       | Very highly realiable     |
| 0.80 - 0.90  | Highly realiable          |
| 0.70 - 0.79  | Realiable                 |
| 0.60 - 0.69  | Minimally realiable       |
| < 0.60       | Low realiable (unacceptably) |

2.3 Importance and Performance Analysis

We used the Importance – Performance Analysis (IPA) are based on two purposes: 1) To identify the importance and performance ratings of implementing green construction and 2) To prioritize key aspects in the area that need to be improved based on the mean score. IPA is a simple technique that has the benefit of identifying attributes of a product or service which prioritizes the candidates’ need improvement without causing significant disadvantage [7] [12]. To evaluate overall mean ratings of performance using the following formula [7]:

$$P_w = \frac{\sum_{i=1}^{N} P I_i}{\sum_{i=1}^{N} I_i}$$

(2)

Where $P_w$ is the overall performance score, $P$ is the mean rating of performance i, and $I$ is the mean rating of importance i

Then, to infer priorities and identify variables that need improvement, using Gap Analysis and Quadrant Analysis [7]. Wilcoxon signed-rank test is based on ranking the differences in both importance and performance ratings and on whether have statistically significant [11]. We will get different ranks assigned in positive or negative [11].
Table 2. Identification of Research Variables

| Criteria Assessment | Research Variables                                                                 | Literature |
|---------------------|------------------------------------------------------------------------------------|------------|
|                     | Achieved understanding of the goals and objectives of green-certified development | ✓ ✓ ✓ ✓    |
|                     | Obvious and consistent specifications of green building contract                   | ✓ ✓ ✓ -    |
|                     | Owner involvement during the project                                               | - ✓ ✓ -    |
|                     | Communication and cooperation between stakeholders                                 | ✓ ✓ ✓ ✓ ✓  |
|                     | Existence of green performance evaluation system during the project (certification) | ✓ ✓ ✓ -    |
| Project Management  | Adequate financial resources                                                       | ✓ - - - ✓  |
| Performance         | Optimal cost management                                                            | ✓ ✓ ✓ ✓ ✓  |
|                     | Effectiveness of project planning and controlling (scheduling)                    | - ✓ ✓ ✓    |
|                     | Has an integrated design planning and building structure                            | ✓ ✓ ✓ -    |
|                     | Availability of green building pilots                                              | ✓ - - ✓ ✓  |
|                     | Exactness selection of eco-friendly quality materials                               | - ✓ ✓ ✓ -  |
|                     | Utilization of Innovative technologies                                            | ✓ ✓ ✓ ✓ ✓  |
| Technologies and    | Changes in labor habits to support green concepts                                  | ✓ - - ✓ -  |
| Resources Performance| Competency and professionalism of participants project                              | ✓ ✓ ✓ ✓ ✓  |
|                     | Frequently training/education                                                      | ✓ - - ✓ -  |
|                     | Procurement related to integrated green concept                                    | - ✓ ✓ ✓ -  |
|                     | Availability of expressed interest from clients and market demand                   | ✓ - - ✓ -  |
| External Performance | Cooperative client                                                                 | ✓ - - - -  |
|                     | Enforcement of green building policies/regulations                                  | ✓ - - ✓ ✓  |
|                     | Effectiveness of external conditions and the environment                            | ✓ - - ✓ ✓  |
3. Results and Analysis

There were 40 questionnaires distributed by the survey to projects where a total of 30 responses were completed and 17 variables approved. This survey encompasses the diverse background of respondents involved in construction who are all relevant stakeholders. Table 3. summarizes demographic respondents who spread with different backgrounds.

| Characteristics | Number of Responses |
|-----------------|---------------------|
| n  | %  |
| Stakeholders    |                     |
| Owner           | 2   | 7%   |
| Consultant      | 9   | 30%  |
| Contractor      | 19  | 63%  |
| Length of Experiences |       |
| <5 years        | 18  | 60%  |
| 5 - 10 years    | 10  | 33%  |
| 10 - 15 years   | 1   | 3%   |
| >15 years       | 1   | 3%   |

3.1 Inter-Rater Reliability Analysis

Table 4. exhibits the inter-rater agreement index $\alpha_{WG(0)}$, by using equation (1). The index ranges of importance attributes are from 1,009 (M4 = existence of green performance evaluation system during the project (certification) to 1,022 (TR5 = Frequently training/education) with average value 1,014, and also for importance attributes which between 1,007 (TR2 = Utilization of innovative technologies) and 1,026 (M6 = Optimal cost management) with an average of 1,012.

Under the guidelines for inter-rater agreement index, values between 0.00 to 0.30 represent “lack of agreement”, 0.31 to 0.50 represent “weak agreement”, 0.51 to 0.70 represent “moderate agreement”, 0.71 to 0.90 represent “strong agreement”, 0.91 to 1.00 represent “very strong agreement”. Following this result with agreement indices, 1.0 indicates perfect agreement among judges which have equivalent in terms of absolute value [8].

Table 4. contains consistency levels between evaluator from corrected item–total correlations and Cronbach’s alpha constructs. The value of all constructs generated more than 0.60 (except for external indicators in performance levels) however, because the value is 0.597 close to 0.60, it’s assumed that all indicators gave correlation coefficients in reliability test. Responses to the variables in a construct, the correlation can be measured using the corrected item–total correlation. It can be seen in Table 4 that all the values contained in the column labelled the corrected item total correlation in importance and performance get values that exceed 0.3, can be considered satisfactory and quite good.
| Research Variables                                                                 | Inter-rater Agreement Index | Corrected Item–Total Correlation | Cronbach’s alpha constructs |
|----------------------------------------------------------------------------------|-----------------------------|---------------------------------|----------------------------|
| M1 Obvious and consistent specifications of green building contract               | 1.016 1.011                 | 0.484 0.715                     |                            |
| M2 Owner involvement during the project                                          | 1.014 1.018                 | 0.662 0.687                     |                            |
| M3 Communication and cooperation between stakeholders                            | 1.010 1.015                 | 0.729 0.754                     |                            |
| M4 Existence of green performance evaluation system during the project (certification) | 1.009 1.010                 | 0.525 0.403                     | 0.871 0.873                |
| M5 Adequate financial resources                                                  | 1.015 1.020                 | 0.507 0.517                     |                            |
| M6 Optimal cost management                                                       | 1.015 1.026                 | 0.638 0.697                     |                            |
| M7 Effectiveness of project planning and controlling (scheduling)                | 1.012 1.014                 | 0.782 0.712                     |                            |
| M8 Has an integrated design planning and building structure                       | 1.013 1.014                 | 0.775 0.805                     |                            |
| M9 Availability of green building pilots                                          | 1.015 1.023                 | 0.424 0.306                     |                            |
| TR1 Exactness selection of eco-friendly quality materials                          | 1.011 1.010                 | 0.61 0.346                      |                            |
| TR2 Utilization of Innovative technology                                          | 1.012 1.007                 | 0.755 0.587                     |                            |
| TR3 Changes in labor habits to support green concepts                             | 1.018 1.016                 | 0.885 0.669                     |                            |
| TR4 Competency and professionalism of participants project                        | 1.013 1.011                 | 0.709 0.357                     | 0.915 0.797                |
| TR5 Frequently training/education                                                 | 1.022 1.012                 | 0.815 0.688                     |                            |
| TR6 Procurement related to integrated green concept                                | 1.016 1.016                 | 0.805 0.703                     |                            |
| E1 Enforcement of green building policies/regulations                              | 1.010 1.009                 | 0.628 0.449                     | 0.770 0.597                |
| E2 Effectiveness of external conditions and the environment                       | 1.014 1.017                 | 0.628 0.449                     |                            |
3.2 Importance - Performance Analysis (IPA)
Table 5 contains mean and standard deviation ratings for both importance and performance. The mean ratings of every variables were used to calculate for next analysis stages. Then, evaluate overall mean ratings of performance using equation (2) was founded 3.613, denoting fair performance, which means the evaluation score doesn’t exceed the range of the highest and lowest overall performance ratings.

3.3 Gap Analysis
Gap analysis is part of the IPA method which functions to measure importance and performance ratings at the difference significant level on data simultaneously. The results of gap analysis which computed from Wilcoxon signed-rank test using IBM SPSS statistic. This showed that the resulting whole differences are negative (shown in Table 6) and have statistically significant p-value < 0.05 (exclude obvious and consistent specifications of green building contract (M1), owner involvement during the project (M2), communication and cooperation between stakeholders (M3), competency and professionalism of participants project (TR4), effectiveness of external conditions and the environment (E4)). Thus, there are 12 variables with statistically significant differences between the importance and performance ratings from the implementation of green construction. For the highest value on the gap (ignoring the minus sign) are has an integrated design planning and building structure (M8) and procurement related to integrated green concept (TR6) with a score of 3.051 and the lowest is the effectiveness of external conditions and the environment (E4) with a score of 0.486. Focussing on negative gaps that indicate performance score is potentially problematic. Prioritizing aspects that need improved which will be explained in quadrant analysis. The gap between importance and performance ratings is also interpreted on a radar chart. As shown in Figure 1.

3.4 Quadrant Analysis
Each variable with its mean is plotted in quadrant models divided into four quadrants (2x2). Consisting of quadrant, I (“concentrate here” indicates high importance and low performance), quadrant II (“keep up the good work” indicates high importance and high performance), quadrant III (“low priority” indicates low importance and high performance), and quadrant IV (“possible overkill” indicates low important and low performance).

The intersection of the quadrant on the x-axis (performance) and y-axis (importance) is at 3.614 and 3.930 points. Most variables were plotted in lower left-hand quadrant (section 3 “low priority”). Several variables as well as the existence of green performance evaluation system during the project (certification) (M4), availability of green building pilots (M9), changes in labour habits to support green concepts (TR3), frequently training/education (TR5), and procurement related to the integrated green concept (TR6). Furthermore, there were 3 variables included in Quadrant I “concentrate here” such as adequate financial resources (M6), optimal cost management (M7), exactness selection of eco-friendly quality materials (TR1). Other factors and their quadrants are summarized in Table 6. This implies that the performance stakeholders rated relatively lower than their importance and also these performances on implementation of green construction will be prioritized improvement.
Table 5. Mean and Standard Deviation Ratings and Inter-rater Agreement Index of Each Variable

| Code | Research Variables                                                                 | Mean and Standard Deviation Ratings |
|------|-------------------------------------------------------------------------------------|------------------------------------|
|      |                                                                                     | I   | P    |
| M1   | Obvious and consistent specifications of green building contract                     | 3,800 | 0,847 | 3,633 | 0,669 |
| M2   | Owner involvement during the project                                                  | 4,100 | 0,845 | 3,967 | 0,928 |
| M3   | Communication and cooperation between stakeholders                                   | 4,000 | 0,695 | 3,833 | 0,834 |
| M4   | Existence of green performance evaluation system during the project (certification)   | 3,767 | 0,626 | 3,467 | 0,629 |
| M5   | Adequate financial resources                                                          | 4,000 | 0,871 | 3,533 | 0,900 |
| M6   | Optimal cost management                                                              | 3,967 | 0,850 | 3,433 | 1,006 |
| M7   | Effectiveness of project planning and controlling (scheduling)                       | 4,167 | 0,791 | 3,900 | 0,803 |
| M8   | Has an integrated design planning and building structure                              | 4,267 | 0,785 | 3,900 | 0,803 |
| M9   | Availability of green building pilots                                               | 3,767 | 0,817 | 3,433 | 0,935 |
| TR1  | Exactness selection of eco-friendly quality materials                                 | 4,000 | 0,743 | 3,533 | 0,629 |
| TR2  | Utilization of Innovative technology                                                 | 4,067 | 0,785 | 3,633 | 0,556 |
| TR3  | Changes in labor habits to support green concepts                                    | 3,767 | 0,898 | 3,400 | 0,770 |
| TR4  | Competency and professionalism of participants project                               | 3,867 | 0,776 | 3,700 | 0,702 |
| TR5  | Frequently training/education                                                        | 3,700 | 0,988 | 3,367 | 0,669 |
| TR6  | Procurement related to integrated green concept                                      | 3,733 | 0,828 | 3,367 | 0,765 |
| E1   | Enforcement of green building policies/regulations                                    | 4,033 | 0,718 | 3,667 | 0,606 |
| E2   | Effectiveness of external conditions and the environment                             | 3,733 | 0,785 | 3,667 | 0,844 |

Figure 1. Radar Chart on Importance and Performance Ratings
### Table 6. Gap Analysis of Each Variable

| Code | Research Variables                                                                 | Gap   | p-value | Quadrant                      |
|------|-------------------------------------------------------------------------------------|-------|---------|------------------------------|
| M1   | Obvious and consistent specifications of green building contract                     | -1.249| 0.212   | Quadrant 4 (Possible overkill) |
|      |                                                                                     |       |         | Quadrant 2 (Keep up the good work) |
| M2   | Owner involvement during the project                                                 | -1.633| 0.102   | Quadrant 2 (Keep up the good work) |
| M3   | Communication and cooperation between stakeholders                                   | -1.508| 0.132   | Quadrant 2 (Keep up the good work) |
|      | Existence of green performance evaluation system during the project (certification)  | -2.179| 0.029   | Quadrant 3 (Low priority)     |
| M4   | Adequate financial resources                                                         | -2.565| 0.01    | Quadrant 1 (Concentrate here)  |
| M5   | Optimal cost management                                                             | -2.976| 0.003   | Quadrant 1 (Concentrate here)  |
| M6   | Effectiveness of project planning and controlling (scheduling)                      | -2.530| 0.011   | Quadrant 2 (Keep up the good work) |
| M8   | Has an integrated design planning and building structure                             | -3.051| 0.002   | Quadrant 2 (Keep up the good work) |
| M9   | Availability of green building pilots                                               | -2.673| 0.008   | Quadrant 3 (Low priority)     |
| TR1  | Exactness selection of eco-friendly quality materials                               | -2.967| 0.003   | Quadrant 1 (Concentrate here)  |
| TR2  | Utilization of Innovative technology                                                | -2.829| 0.005   | Quadrant 2 (Keep up the good work) |
| TR3  | Changes in labor habits to support green concepts                                    | -2.653| 0.008   | Quadrant 3 (Low Priority)     |
| TR4  | Competency and professionalism of participants project                              | -1.667| 0.096   | Quadrant 4 (Possible overkill) |
| TR5  | Frequently training/education                                                        | -2.233| 0.026   | Quadrant 3 (Low priority)     |
| TR6  | Procurement related to integrated green concept                                      | -3.051| 0.002   | Quadrant 3 (Low priority)     |
| E1   | Enforcement of green building policies/regulations                                   | -2.653| 0.008   | Quadrant 2 (Keep up the good work) |
| E2   | Effectiveness of external conditions and the environment                             | -0.486| 0.627   | Quadrant 4 (Possible overkill) |
Figure 2. Quadrant Analysis on Importance and Performance Ratings

Note. [1] Obvious and consistent specifications of green building contract (M1), [2] owner involvement during the project (M2), [3] communication and cooperation between stakeholders (M3), [4] existence of green performance evaluation system during the project (certification) (M4), [5] adequate financial resources (M5), [6] optimal cost management (M6), [7] effectiveness of project planning and controlling (scheduling) (M7), [8] has an integrated design planning and building structure (M8), [9] availability of green building pilots (M9), [10] Exactness selection of eco-friendly quality materials (TR1), [11] utilization of Innovative technologies (TR2), [12] changes in labour habits to support green concepts (TR3), [13] competency and professionalism of participants project (TR4), [14] frequently training/education (TR5), [15] procurement related to integrated green concept (TR6), [16] enforcement of green building policies/regulations (E1), and [17] effectiveness of external conditions and the environment (E2).

4. Conclusion
The research aims to identify the aspects that have been prioritized to get improvement. The literature review provides knowledge about the criteria success factors and barriers of implementation green construction with various opinions resulted to decide 20 research variables. The questionnaire of this study was distributed to stakeholders involved in the implementation of green construction and we got 17 variables approved. We collected the assessment data related to identifying conditions of success criteria for implementing green construction which might be based on their experiences.

As a result, this study can illustrate differences in both importance and performance ratings that lead to negative signs, it indicates that, although given the importance of an item, its performance is still potentially problematic. We defined two quadrants will prioritized because low performance. For quadrant I “Concentrate Here” such as adequate financial resources, optimal cost management, and exactness selection of eco-friendly quality materials. Then, for quadrant III “Low Priority” such as existence of green performance evaluation system during the project, changes in labour habits to support green concepts, frequently training/education, procurement related to integrated green
concept, and availability of green construction pilot. Further research could close other research gaps by formulating strategies improvement, especially for area in a quadrant was main concentrated. So, it can refer and motivate stakeholders to invest green construction in overcoming some relevant project problems in certain areas.

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