Development of Green Building Ranking Based on Stakeholders Values Using the AHP

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Abstract. Green buildings conserve precious natural resources and increase our standard of living. Green building, in principle, seeks to reduce the negative impact on our atmosphere and natural environment. This effort is marked by the existence of a green building rating. However, currently, not many construction stakeholders have used this rating system. Therefore, this paper attempts to illustrate the critical points of the green building concept based on stakeholder knowledge and, at the same time, offers new ranking criteria. This paper then chooses a general analytic approach, including literature on green buildings’ ranking and Indonesian religious values. AHP was selected as a method in this study to provide an overview of how much stakeholder confidence for spiritual values in green criteria. This study shows different weight values on the requirements for green buildings based on religious values and Greenship. Most of the stakeholders chose the Water criterion at 27.66% as a substantial point value for realizing a sustainable site, while in Greenship, almost all the criteria have the same weight. Confidently, the criteria and value weights used in realizing a sustainable site align with religious values because the implementation will be more straightforward.

Keywords: Islamic sustainable; Green rating; AHP method; Stakeholders.

1. Introduction

Green building is an approach to environmentally friendly building design that aligns with the philosophy of sustainable growth. The term ‘green building’ is known as constructing structures and buildings throughout the building life cycle using environmentally friendly, resource-efficient methods, from site to design, construction, operation, maintenance, reconstruction, and deconstruction [1]. Green buildings are generally referred to as sustainable buildings and high-performance buildings with health and quality of life improvement mechanism (2)(3)(4). Green buildings are further focused on improving building productivity while simultaneously mitigating the adverse environmental and human health effects (5). Green buildings can also enhance the atmosphere’s quality and the diversity of life and excellent life quality.

The development of green buildings in several countries and Indonesia, in particular, is still constrained by several factors. One of these factors is a lack of awareness of the importance of green buildings, which in turn prefers not to make changes. Another factor is the lack of knowledge and information and an unfavorable atmosphere, including the perceived high costs of implementing green
building principles (6) (7). In Australia, stated that many construction players do not choose to compete in green buildings for many reasons, such as the coordinated team's architecture planning process and the need for innovative technology acceptance, which takes a long time. It then returns to the perception that financial risk rises at a higher initial capital expense and a business climate and not entirely supportive (8). Due to the lack of understanding of green buildings' value, green buildings' implementation would have pros and cons.

Several reports have concluded that driving factors can overcome several challenges to implementing green buildings. The driving variables are grouped into five main categories: external driving variables, driving variables at the business level, property level, project level, and person-level. The driving factors are classified into five main groups: external factors, driving factors at the business level, property level, project level, and driving factors at the individual level (9). At the individual level, spiritual imperatives or social consciousness are the reasons that affect it (10) (11) (12), external engagement (13), perceptions and customs (14) (15) (16) and self-identity (12). It means that the critical thing to establish is person driving factors and external driving factors, such as the value of the project owner's willingness to consent to apply the green building principle in a project (17) (18). In other words, in handling their environments, personal influences play a part in human actions. Personal values play an essential role in determining change, particularly in green building practices or sustainability (19). Superior perception and knowledge of the environment may contribute to improvements in behaviors, culminating in actions (20). In this case, in introducing green buildings, human movement is central and a solution to all problems (21).

Value is a catalyst for environmental behavior changes that can, in turn, form a harmonious mutual relationship between people and their surroundings. Value can bring people to a position to decide if something is good, excellent, valuable, or not. Values then can motivate people to act on things, make their decisions, and contribute to their acts. Cultural or spiritual values, in this case, are found in the values deemed to define a personal promise. Religious principles include the essential values necessary to create personal accountability through human self-development (22) (23). It is possible to create actions, culture, and identification to connect with the person's beliefs and character. The role of human beings in sustainable architecture has a real effect on environmental sustainability (23).

Therefore, this study seeks to create a system for green building ratings based on values, particularly religious values. This research takes the view that religious values are directly related to fundamental personal standards. Hence, stakeholders were involved in this study to see the extent of their views on green building policies for religious principles. The goal of this research is to expand the perspective and interpretation of green building theory. It may also be used as a benchmark for the principles of sustainability. A value-based approach, particularly in achieving green building performance, would inevitably lead to sustainable practicalities. Until now, green building can be considered as one of the solutions to overcome the environmental crisis in the entire built environment development process. The awareness of various countries marks green buildings' development in issuing different policies and green ratings tailored to each country's conditions. The United States Green Build Council (USGBC) is a world leader in green building, which ultimately produces LEED, a system for designing, construction, and certification for green buildings. Apart from LEED, there are also BREEM (UK), GBCA (Australia).

Meanwhile, Indonesia has issued the DKI Jakarta Governor Regulation No. 38 of 2012 concerning Green Building (24) and Green Rating System by the Green Building Council Indonesia (GBCI) (25). The number of green ratings that appear indicates that the green rating system has become a focal point. For example, BREEAM published and certified about 560,000 buildings at the onset. Simultaneously, LEED has been used with numerous licensed buildings of around 79,100 in 160 countries and territories (26).

The highest weighting focuses on environmental aspects compared to other aspects, with more than 75% of the total sub-categories adopted in any ranking system, such as energy, materials, indoor, and site health quality categories. The eight green ratings have seven main credit criteria for this rating tool, namely (1) Site, (2) Energy, (3) Water, (4) Indoor Environmental Quality (IEQ), (5) Materials, (6) Waste
and pollution, and (7) Management (27). The 'Energy' criterion is the primary credit criterion that is most considered and is then followed by 'IEQ' and 'Water'. This green building ranking system will measure and assess a building's sustainability and provide a degree of how green the building is. The certificate titles will be determined by several categories, criteria, and building benchmarks according to each country's conditions.

This research is developing research carried out previously using the content analysis method (28). The keywords in the greenship are a tool to find religious values in the holy book, especially in the Qur'an and Hadith. In this paper later, it focuses more on reviewing the ASD (Appropriate Site Development) category with one prerequisite criteria, namely Green Basic Area, and seven credit criteria, namely Site Selection, Community Accessibility, Public Transportation, Bicycle User Facilities, Land Landscape, Micro Climate, Water Management Rain runoff with a total value of 17 (weight 16.8%). Overall, the ASD weighting ranks 3rd after the first category EEC with a value of 26 (Energy Efficiency and Conservation) (weight 25.7%) and the second category WAC (weighted water conservation) with a total value of 21 (weight 20.8%). Therefore, the methodology chapter will describe the stages of the research in detail.

2. Research Method

2.1. Data Analysis Method
This study utilizes the Analytical Hierarchical Method (AHP) technique, a matrix and algebra-based analysis method developed by Thomas L. Saaty, a mathematics specialist, in 1977 (29). This approach is still being developed and is commonly used by scholars to make choices or conclusions on different topics arranged according to particular guidelines. Stakeholders then pick these parameters on a scale of 1-9 (figure 2), which corresponds to the AHP system (30). The results are collected in the form of priorities and weights. The general procedures for the AHP are (31) (32): a set of priority or grading criteria. Second, the parameters were evaluated by performing a series of peer-to-peer comparisons. The third step is to assign numerical values to decisions to assess them, then group the resulting values into the decision matrix and determine the priority vector. The last stage is the corresponding vector representing the relative weight of the criterion.

AHP is commonly used in many studies and evaluations in different countries of Green-Matrix production. In general, these studies establish standards by contrasting different standards from countries with an acceptable Green-Matrix, such as LEED, BREAM, and CASBEE. For example, this study compares 4 Green Matrix in other countries, namely LEED, BREAM, IGBC, and CASBEE (32). Some researchers have developed criteria for the Green Matrix in Malaysia and India by assessing other countries (e.g., BREEM, LEED, SB Tool, and CASBEE) (33) (34). These studies evaluate many Green systems; the parameters are then established and weighted using AHP. The criteria must be compared to the AHP method for stakeholder selection when developing and evaluating the Green Matrix. However, in this study, these criteria were not selected through the results of literature studies or comparative studies of the Green Matrix in other countries, with various considerations explained in the introduction chapter. A detailed research stage is needed to describe the relationship between previous research and this research, as shown in the figure 1 below.
Based on the literature, Islam has provided teachings on how to behave in the environment. Through the verses of the Qur'an, Islam promotes the value of environmental care and prevention as part of a sustainable process (35)(36). It is essential to analyze the substance of the Al-Quran verse to create the green matrix on this basis such that prior study is the first step to gather data using the Al-Quran substance analysis process, which then creates parameters.

The keywords used are land, water, and air, and the key terms originating from the Green Matrix parameters are also checked for Green Building Council Indonesia (25), namely Greenship NB Version 1.2. One hundred seventy-two keywords for soil, water, and air, as well as Greenship benchmarks, were derived from the search results and creation of these requirements (28). The search results of the keyword are then used to create a green matrix of religious beliefs. These keywords became the criterion
for stakeholder selection according to the AHP process. However, in this research, the parameters to be contrasted are only ASD-related keywords; since the keywords most frequently used are site development keywords, 66 keywords, in previous studies (28).

The next step is to simplify keywords from 66 to 14 keywords to allow for much clearer responses to the priority questions of AHP, without restricting the criteria or indicators. This procedure seeks to address stakeholders’ concerns in identifying a sustainable site based on religious values. The selected respondents are stakeholders who are known to be aware of the green building concept. Figure 2 shows the AHP process flow as a whole.

![AHP Method Flow](image)

**Figure 2. AHP Method Flow**

2.2. Data Collection Method
The data collection system is electronically spread over the Google Form portal using questionnaires, and the question model is the case for the theory of AHP. Researchers distributed questionnaires to people and communities in about two weeks. In this questionnaire, there were questions related to the respondents' areas of expertise. The respondents' collection was restricted to scholars and architectural and design professionals to determine each stakeholder's views on the Green Criterion. Technically, the query phases are divided into two, the first involves the choice of a keyword by the respondent, and the second concerns the weighting of the keyword selected. This questionnaire includes questions linked to the term "Sustainable Site." The purpose of this process is to make it easy for respondents to complete an AHP questionnaire with a weighted value on a scale of 1-9.

3. Result And Discussion
Based on the findings of the data collection, 194 respondents completed the questionnaire. Of the 194 respondents, 75% worked as an architect, 32% worked in urban planning, 13% worked in the civil and environmental, and 12% worked in the landscape. The AHP weighting findings are then evaluated based on the respondent's fields to determine the Green Criterion's priority pattern for each stakeholder.

The first thing to do at the weighting point is to measure the requirements for appropriate sites. Based on the weighting results, it is found that there are three major patterns of 4 stakeholders. For stakeholders in Urban and Civil and Environmental Planning, respondents tend to choose the Water criterion as an essential criterion in the green criterion. In the field of Architecture, respondents chose Water and Microclimate as the most important criteria. Meanwhile, in the Landscape field, respondents chose Landscape criteria as the most crucial criterion. However, if seen in general, it can be seen that water is the first and second priority for all stakeholders. In terms of weighting criteria (figure 3), water is in the first place (27.66%), then micro-climate (17.91%), vegetation (15.47%), rainwater management
(13.68%), road (13.18%), and the last is landscape (12.10%). The water criterion here becomes a significant point in developing a sustainable site according to stakeholders' views, compared to other criteria. Meanwhile, all stakeholders' other criteria have the same pattern for each criterion, which means that they are weighted closer to the same percentage value.

Figure 3. Stakeholder Perspective on Sustainable Site Criteria

Following the parameters' measurement, the weighting of the subset criterion known as the indicator is performed. Depending on the weighting of all metrics for each parameter, the same pattern continues for all stakeholders. For the vegetation criteria (figure 4.a), all stakeholders chose the highest indicator in 'green spaces,' then the 'tree' indicator. Furthermore, the other two indicators, ‘greenery’, and ‘shrubs’, were in the third and fourth groups. When weighing landscape criteria (figure 4.b), all stakeholders selected Softscape as the most appropriate indicator, with 46% of the architecture community's stakeholders. With the same pattern, all stakeholders assign a second weight to the 'park' indicator and then 'soil form'. In the last rank, there is the 'hardscape' indicator. In the water and road criteria (Figure 5.ab), clean water was chosen as the primary priority indicator with 87.5%, while 12.5% for groundwater. The same weight also applies to the road criteria, 87.5% for road access and 12.5% for the road infrastructure indicator. In the microclimate parameters (figure 4.c), stakeholders have top-ranked ‘water’, followed by ‘vegetation’ and ‘wind’ indicators. This trend is the same with all stakeholder criteria, only with insignificant weight variations, so that the weighting outcome criteria are the same for the four stakeholders. The results of AHP can then be hierarchically arranged based on weighted results illustrated in figure 6.
After getting weighted results based on religious values by several stakeholder groups above, the next stage, the researcher tries to compare the ranking and criteria of Greenship and Stakeholders. Figure 7 describes the two's ranking values, where all criteria have a value above 10%. For Greenship indicators, 10% are Bicycle, Community Accessibility, Public Transportation, and Site Selection.
Meanwhile, for the weighted results from stakeholders, indicators with a weighting value above 10% are on the criteria for landscape, rainwater management, road, and vegetation. For criteria above 15%, both the Greenship and stakeholder weight are microclimate, site landscaping, and stormwater management criteria. Several criteria cannot be compared with stakeholder results because this criterion is only the Greenship criterion. These criteria are site selection, public transportation, and bicycle. The Community Accessibility (CA) criteria can be juxtaposed with the road criteria in the AHP results, where both have similar weights, namely 11.8% (CA) and 13.18% for the road category. Both emphasize the importance of roads as one of the accesses in land development and are followed by public transport and bicycles as one of the means of transportation that should be available. These criteria do not appear in the AHP results because, in the previous preliminary results, the keywords are only limited to 66 keywords, which all intersect with the aspects of land, water, and air (28).

![Image of Hierarchy Model for Sustainable Category based on Stakeholders Value](image-url)

**Figure 6.** Hierarchy Model for Sustainable Category based on Stakeholders Value

A very striking difference between Greenship and stakeholder weighting is that Greenship does not give percentage weight to indicators only gives percentage values to categories and value points to criteria (figure 8). So that in Greenship, there are prerequisite criteria that must be ensured in every green building assessment. For the ASD category, the prerequisites are written in the Basic Green Area category, while the weighting results are using AHP, both criteria and indicators are weighted in percentage. An important point that can be taken from this comparison is the emergence of a ‘water’ indicator with a very significant weighting value. This indicator only appears in the stakeholder results of 27.66%.

In contrast, the ‘water’ indicator in the category of sustainable site is not found in the ASD Greenship but falls into the Water Conservation (WAC-20.8%) category to be precise in the Water Efficiency Landscaping criteria (WAC 6). The percentage weight of 27.66% can be considered a quite large weight compared to several other green ratings, such as PEARL and GSAS allocate the maximum weight to the water attributes. While the United Arab Emirates launched the PEARL system, allocates 23.9% of its total weight to water aspects, GSAS, developed by Qatar, devotes 19.6% of its total weight to water. It is reasonable because both the United Arab Emirates and Qatar are seriously affected by a shortage of freshwater supplies (37). Water is the essence of sustainable development because water indirectly brings health through improved water and sanitation access. Water is needed by people, for food production and as a power source for development.

With population growth, urbanization, migration, and industrialization, there will automatically be increased production and consumption, including increasing the need for freshwater resources (38). Therefore, the position of water in the site will affect the sustainability of food. Apart from clean water, groundwater availability will affect soil quality because almost all food grows and lives on the ground.
Healthy soil is an essential requirement for sustainable food production. It can be read that there is a chain of life that will last if water can be appropriately maintained. Adequacy of water in a site development plays an essential role in the sustainability of the site itself. So it is necessary to conserve clean water and look for alternative water sources that can be used, such as collecting rainwater. Rainwater harvesting is a perfect complement to a water-wise ecosystem and also reduces potable water demand. The AHP results describe rainwater as the only significant indicator, while in Greenship, rainwater management is not mentioned in the ASD criteria but is included in the Water Conservation (WAC 5 - Rainwater Harvesting) category.

**Figure 7.** Comparison Ranking between Greenship and Stakeholder

**Figure 8.** Comparison Indicator between Greenship and Stakeholder
In addition to searching for alternative water sources, the water conservation measures ensure that the site's proper use of preserves water quality. Land use configurations and topography as a clearly defined parameter to determine water quality were the most critical water quality (39). Furthermore, land use has a strong relationship with water quality during the rainy season, and higher forest land cover contributes to improving water quality (40)(41). Sustainable land use and appropriate landscape planning at multiple scales are used to improve water quality so that the stakeholders put the criteria for landscape 12.10% and vegetation at 15.47%. Softscape indicators have a significant percentage of 40.78%, park 25.46%, 20.45% soil form, and 13.31% hardscape. The softscape criteria will indirectly be supported by vegetation criteria and indicators of 15.47%, with indicators of green spaces of 38.28% followed by trees (26.95%), shrub (18.47%), and greenery (16.29%). Vegetation is the dominant element in green open space to function as a space maker, control air temperature, and improve soil conditions. This description clarifies the relationship between vegetation, landscape, and water criteria. In Greenship, the criteria and indicators identical to the stakeholder outcomes are the Basic Green Area with no percentage weighting but in or in the prerequisites category. The Landscape Category is also 3 points (17.6 %) in addition to the Basic Green Area. Each indicator from both categories contains more or less the same as the AHP result indicator, namely the landscape area of vegetation and 50% covered by trees, shrubs, and bushes.

The second important criterion for the category of sustainable sites (figure 6) is the Micro Climate criterion, with a weight of 17.91%. In Greenship, Micro Climate has 3 points (17.6%), and the specific issues in each of the forming indicators of the microclimate. From Greenship, the microclimate indicator emphasizes more on material selection, pedestrian circulation, and landscape design. The material selection itself is closer to the hardscape than the softscape and its role in forming microclimate and sustainable site development. Whereas for stakeholders, the microclimate criteria have indicators of wind, vegetation, and water. Planting vegetation is one of the critical methods for managing urban microclimate and alleviating the urban heat island. Plant covers, such as trees, shrubs, and grass within parks and other urban green areas, will reduce the effect of rising temperatures by providing shade and protection (42) (43) (44). Tree clusters were also able to reduce the temperature by 1.6~2.5°C and increase relative humidity by 2.9%~5.2% compared to open spaces. Also, the characteristics of the tree canopy structure play an essential role in microclimate regulation; tree communities can reduce the temperature by increasing humidity (45) (46) (47). Moreover, including local vegetation and soil conservation can mitigate temperatures and eventually reduce water use in the gardens (48).

Everything within the vegetation landscape, green spaces, trees, shrubs, greenery, parks, and soils will substantially impact microclimate formation. In the microclimate category, wind (25.99%) and water indicators are also available with a reasonably high percentage weight of 48.54%. These two indicators encourage the development of microclimates on a site by altering the site elements. The condition of the wind speeds provides thermal convenience for the user. The water indicator also has a significant weight so that the water indicator can function as a passive cooling in sustainable sites' development. The air-cooling effect occurs passively without the help of any mechanical. The water area's wind speed impact increases with an increase in the water area, with wind speeds above 400m2 of water rising by 0.08 m/s and wind speeds above 1600 m2 of water rising by 0.13 m/s. The thermal influence of changing the water area is more apparent than changing the water (49).

4. Conclusion
These results indicate that the stakeholders' concern to minimize the environmental footprint. All of the existing criteria are closely related to realizing a sustainable site and emphasize that site planning and architecture plays a vital role in creating a sustainable site. Besides, the development site must have a multifunctional landscape principle, namely a landscape capable of fulfilling a wide variety of purposes without destroying its function as a place of biodiversity. The ranking tool for green buildings should be given good weight for categories, criteria, and indicators so that the degree of achievement is much more measurable. In the literature or other research, specific standards are identified. However, they were not included in each criterion in the green building rating tool despite their essential role. In this
study, the criteria for water in sustainable sites dominate the weighting, meaning that water in this category as water efficiency in sustainable sites has a vital role in achieving SDGs. Therefore, scientifically determining the weighting system following the ecological concept in presenting the green building concept, including rearranging the weighting system to reflect each category's characteristics, criteria, and indicators into a complete assessment, need to be reviewed.

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