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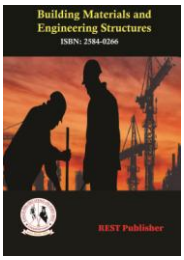

Analysis of Green Building Materials and Technology Development Using Experimental and Evaluation Laboratory Methodology for Decision Making

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Abstract. *This paper focuses more on achieving goals for the development of green building materials and technology than on ensuring long-term and sustainable maintenance. Further research is needed to understand the barriers to sustainable development in India, especially in terms of green building materials and technology adoption. The goal is to decrease carbon emissions and conserve energywhile achieving these goals. DEMATEL is used to analyze green building materials and technology development. A rough fuzzy arithmetic function, employing weak t-norm (Tω) arithmetic functions, is applied to assess sustainable supply chain management through the utilization of the DEMATEL method. In uncertain situations, DEMATEL serves as a crucial decision-making tool. To effectively capture experts' preferences, the method should be enhanced to accommodate linguistic variations.The alternatives considered are Management (D1), Indoor environment (D2), Material (D3), Energy and Water Efficiency (D4), Site ecology (D5), and Innovation (D6). The evaluation parameters are Management system (C1), Indoor air quality (C2), Recycled materials (C3), Energy delivery performance (C4), Cyclist landscaping (C5), and Culture of innovation (C6). The ranking of green building materials and technology is determined using the DEMATEL method. The rank of (Ri+Ci) Energy and Water Efficiency (D4) is first, and Innovation (D6) is ranked last. The rank of (Ri-Ci) Innovation (D6) is first, and Management (D1) is ranked last.*

1. INTRODUCTION

Green building materials focus on using materials that cause little harm to the environment during production and use, while also causing very little harm to human health. In the material life cycle, healthy ingredients, eco-friendly ingredients, high-performance ingredients, and recycled materials can all be classified as "human health-fixed planet" materials, with the aim of creating. A questionnaire survey was conducted and professional opinions were collected from international green design experts. The data with quality information and provide data triangulation to address the limitations of the questionnaire. The intention was to develop an effective green building assessment system based on local standard assessment tools. They used international green building assessment tools to evaluate new assessment items simultaneously, while also meeting local conditions and needs. Various treatment methods were used to ensure the efficiency of non-halogenated functioning as flame retardants. Steel was gradually adopted for construction after the industrial revolution, and in the nineteenth century, Portland cement was invented, leading to the full swing of the age of concrete. In the 1980s, green building materials gradually attracted the world's attention, and building design and urban planning began to prioritize green environmental protection. A green building conserves energy and resources and causes minimal environmental disturbance. Green buildings are mostly represented by standard construction, and sometimes both terms are used interchangeably. Sustainable construction, in the context of its community and a building's environment, focuses on social and economic issues. The strategic window installation, and energy efficiency using low-energy incandescent lighting and natural lighting are integrated with lighting fixtures. Eco-friendly construction materials, such as recyclable bamboo flooring and non-toxic paints, and formaldehyde-free boxes are also used to ensure sustainability in green buildings.

2. MATERIALS AND METHODS

DEMATEL is used to create a structural model that provides a causal diagram, making it a powerful method for visualizing causal relationships. Therefore, to isolate important factors for successful KM initiatives, this study proposes a promising method that connects DEMATEL with Fuzzy set theory. An empirical study is presented to illustrate the proposed method and demonstrate its usefulness and validity in developing an Effective Decision-Making Model for Green Building Materials. This model can be used to design a DEMATEL model for building materials in green building materials and technology systems. The DEMATEL method prioritizes results using different values, and the method proposed in this study is better than the usual fuzzy DEMATEL. In real-world practice, sustainable supply chain management systems use the DEMATEL Method to deal with complex trade-offs using ambiguous numbers or linguistic variables. The initial direct contact (IDR) matrix between each pair of factors refers to subjectivity ratings for comparisons. A fuzzy set is used, and then fuzzy set theory operational rules are carried out in steps of the DEMATEL method. To deal with uncertain linguistic terms, a formula for converting trapezoidal to fuzzy numbers is proposed. Additionally, a novel DEMATEL method is proposed for use in uncertain linguistic contexts. With the classical DEMATEL 2-tuple combined fuzzy linguistic representation model, the DEMATEL method assigns greater influence to factors with greater impact and influence. Selected development initiatives are prioritized based on their impact and influence. The development action plan contains selected development tools that support the preparation of a development action plan. This method is beneficial because it does not require large amounts of information and is easy to use to identify the most important criteria that influence other criteria. DEMATEL can be integrated with other decision-making or mathematical tools. Through an in-depth review of the DEMATEL technique and its applications, it is clear that further development is needed, especially to overcome the shortcomings of the original format.

3. RESULT AND DISCUSSION

TABLE 1. Green building materials and technology

	C1	C2	C3	C4	C5	C6	Sum
D1	0.374	0.242	0.368	0.573	0.404	0.516	2.477
D2	0.468	0.251	0.229	0.596	0.438	0.525	2.507
D3	0.583	0.253	0.403	0.601	0.311	0.542	2.693
D4	0.656	0.254	0.659	0.604	0.544	0.456	3.173
D5	0.284	0.603	0.142	0.319	0.283	0.344	1.975
D6	0.636	0.374	0.221	0.249	0.235	0.421	2.136

Shows the table 1 Green building materials and technology dataset using DEMATEL method. The alternatives are Management (D1), Indoor environment (D2), Material (D3), Energy and Water efficiency (D4), and Site ecology (D5), Innovation (D6). Evaluation parameter is Management system (C1), Indoor air quality (C2), Recycled materials (C3), Energy delivery performance (C4), Cyclist landscaping (C5), Culture of innovation (C6).

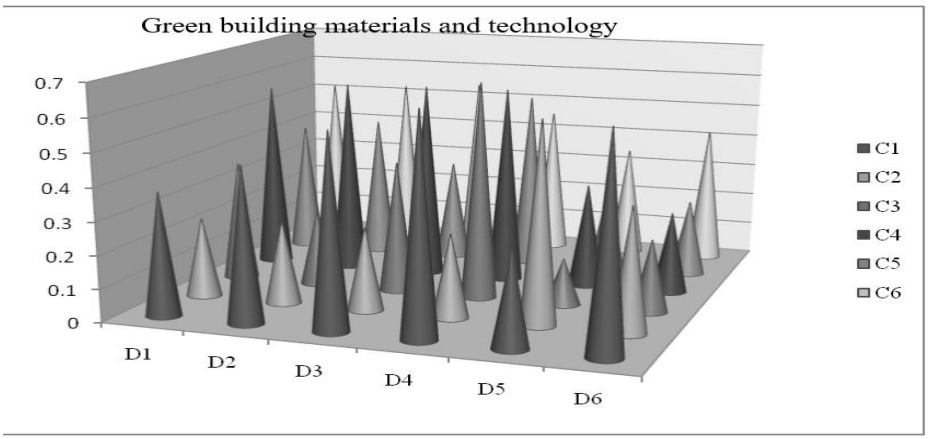

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TABLE 2. Normalizingmatrix

	C1	C2	C3	C4	C5	C6
D1	0.062333	0.040333	0.061333	0.0955	0.067333	0.086
D2	0.078	0.041833	0.038167	0.099333	0.073	0.0875
D3	0.097167	0.042167	0.067167	0.100167	0.051833	0.090333
D4	0.109333	0.042333	0.109833	0.100667	0.090667	0.076
D5	0.047333	0.1005	0.023667	0.053167	0.047167	0.057333
D6	0.106	0.062333	0.036833	0.0415	0.039167	0.070166

Shows the table 2 Green building materials and technology of Normalizing matrix. Management (D1), Indoor environment (D2), Material (D3), Energy and Water efficiency (D4), and Site ecology (D5), Innovation (D6), Management system (C1), Indoor air quality (C2), Recycled materials (C3), Energy delivery performance (C4), Cyclist landscaping (C5), Culture of innovation (C6). The data set's diagonal values are all zero.

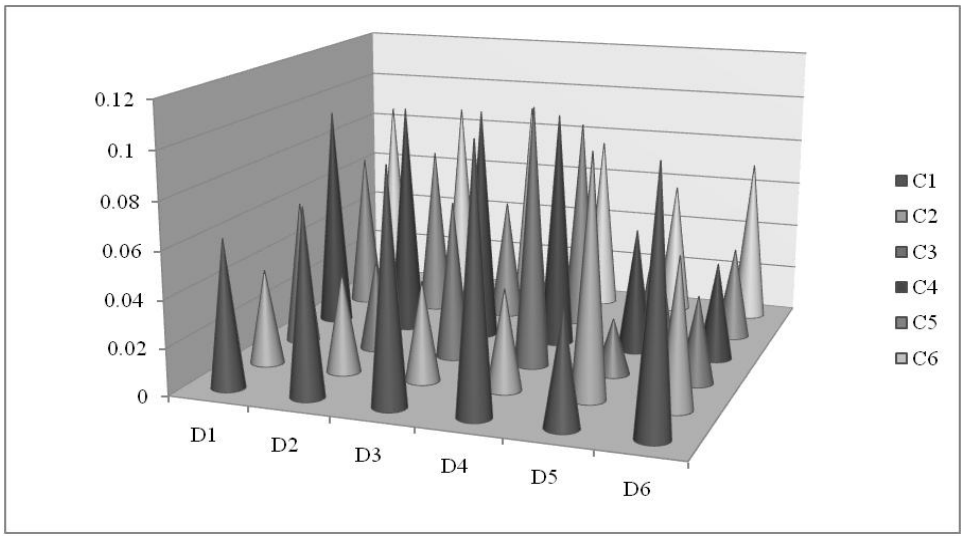

FIGURE 2. Normalizing of direct relation matrix or calculate the total relation matrix

Shows the figure 2 Green building materials and technology of Normalizing of direct relation matrix or calculate the total relation matrix. Management (D1), Indoor environment (D2), Material (D3), Energy and Water efficiency (D4), and Site ecology (D5), Innovation (D6), Management system (C1), Indoor air quality (C2), Recycled materials (C3), Energy delivery performance (C4), Cyclist landscaping (C5), Culture of innovation (C6). The data set's diagonal values are all zero.

TABLE 3. I= Identity matrix

	C1	C2	C3	C4	C5	C6
D1	1	0	0	0	0	0
D2	0	1	0	0	0	0
D3	0	0	1	0	1	0
D4	0	0	0	1	0	1
D5	0	0	0	0	1	0
D6	0	0	0	0	0	1

Table 3 Shows the I= Identity matrix in green building materials and technology. Management (D1), Indoor environment (D2), Material (D3), Energy and Water efficiency (D4), and Site ecology (D5), Innovation (D6), Management system (C1), Indoor air quality (C2), Recycled materials (C3), Energy delivery performance (C4), Cyclist landscaping (C5), Culture of innovation (C6) is the common Value.

TABLE 4. Y – Matrix

	C1	C2	C3	C4	C5	C6
D1	0.062333	0.040333	0.061333	0.0955	0.067333	0.086
D2	0.078	0.041833	0.038167	0.099333	0.073	0.0875
D3	0.097167	0.042167	0.067167	0.100167	0.051833	0.090333
D4	0.109333	0.042333	0.109833	0.100667	0.090667	0.076
D5	0.047333	0.1005	0.023667	0.053167	0.047167	0.057333
D6	0.106	0.062333	0.036833	0.0415	0.039167	0.070167

Table 4 Shows the Y Value in Green building materials and technology. Management (D1), Indoor environment (D2), Material (D3), Energy and Water efficiency (D4), and Site ecology (D5), Innovation (D6) with respect to Management system (C1), Indoor air quality (C2), Recycled materials (C3), Energy delivery performance (C4), Cyclist landscaping (C5), Culture of innovation (C6) is the common Value is the Calculate the total relation matrix Value and Y Value is the differences value.

TABLE 5. I-Y Matrix

	C1	C2	C3	C4	C5	C6
D1	0.937667	-0.04033	-0.06133	-0.0955	-0.06733	-0.086
D2	-0.078	0.958167	-0.03817	-0.09933	-0.073	-0.0875
D3	-0.09717	-0.04217	0.932833	-0.10017	0.948167	-0.09033
D4	-0.10933	-0.04233	-0.10983	0.899333	-0.09067	0.924
D5	-0.04733	-0.1005	-0.02367	-0.05317	0.952833	-0.05733
D6	-0.106	-0.06233	-0.03683	-0.0415	-0.03917	0.929833

Table 5 Shows the I-Y Value in Green building materials and technology. Management (D1), Indoor environment (D2), Material (D3), Energy and Water efficiency (D4), and Site ecology (D5), Innovation (D6) with respect to Management system (C1), Indoor air quality (C2), Recycled materials (C3), Energy delivery performance (C4), Cyclist landscaping (C5), Culture of innovation (C6) table 3 T= Y(I-Y)-1, I= Identity matrix and table 4 Y Value Subtraction Value.

TABLE 6. (I-Y)-1

	C1	C2	C3	C4	C5	C6
D1	1.094159703	0.055282	0.089222	0.131788	0.00467	-0.0156
D2	0.110853962	1.059817	0.067011	0.137514	0.034692	-0.01802
D3	0.055916543	-0.05944	1.052505	0.054157	-1.04347	-0.01633
D4	0.010894181	-0.02007	0.083461	1.069866	-0.02549	-1.0575
D5	0.076351546	0.116688	0.046031	0.086774	1.02627	-0.00044
D6	0.138081695	0.079014	0.06202	0.077793	0.003615	1.024612

Table 6 shows the (I-Y)-1 Value in Green building materials and technology. Management (D1), Indoor environment (D2), Material (D3), Energy and Water efficiency (D4), and Site ecology (D5), Innovation (D6) with respect to Management system (C1), Indoor air quality (C2), Recycled materials (C3), Energy delivery performance (C4), Cyclist landscaping (C5), Culture of innovation (C6) Table 5 shown the Minverse Value.

TABLE 7. Total Relation matrix (T) or T Matrix

	C1	C2	C3	C4	C5	C6
D1	0.094159703	0.055282	0.089222	0.131788	0.00467	-0.0156
D2	0.110853962	0.059817	0.067011	0.137514	0.034692	-0.01802
D3	0.13226809	0.057244	0.098537	0.140931	-0.0172	-0.01676
D4	0.148975876	0.058945	0.145481	0.147658	-0.02187	-0.03289
D5	0.076351546	0.116688	0.046031	0.086774	0.02627	-0.00044
D6	0.138081695	0.079014	0.06202	0.077793	0.003615	0.024612

According to Table 7, the total relation matrix, also known as the T matrix, is obtained by multiplying the direct relation matrix with the inverse of the difference between the direct relation matrix and the identity matrix.

TABLE 8. Ri & Ci

	Ri	Ci
D1	0.480369	0.700691
D2	0.546059	0.42699
D3	0.501979	0.508301
D4	0.539203	0.722458
D5	0.464288	0.030174
D6	0.491153	-0.08371

Table 8 shows the green building materials and technology Ri, Ci Value in Indoor environment (D2) is showing the Highest Value for Ri and Site ecology (D5), is showing the lowest value. Energy and Water efficiency (D4), is showing the Highest Value for Ci and Culture of innovation (C6) is showing the lowest value.

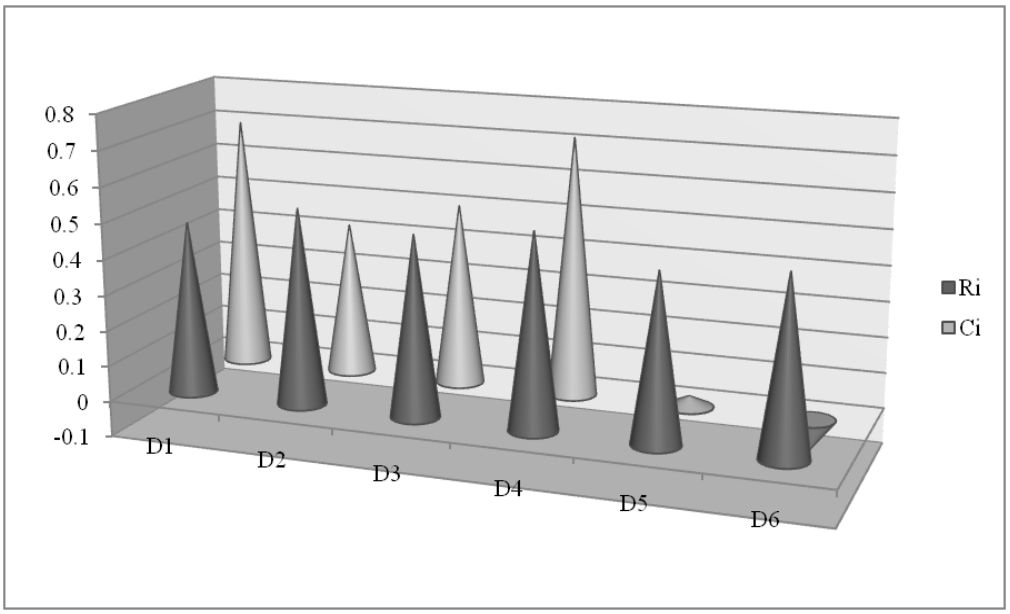

FIGURE 3. Ri & Ci

Figure 3 shows the green building materials and technology Ri, Ci Value in Indoor environment (D2) is showing the Highest Value for Ri and Site ecology (D5), is showing the lowest value. Energy and Water efficiency (D4), is showing the Highest Value for Ci and Culture of innovation (C6) is showing the lowest value.

TABLE 9. (Ri+Ci) & Ri –Ci)

	Ri+Ci	Ri-Ci
D1	1.18106	-0.22032
D2	0.973049	0.11907
D3	1.01028	-0.00632
D4	1.261661	-0.18325
D5	0.494463	0.434114
D6	0.407445	0.574861

Shows the table 9 (Ri+Ci) & (Ri –Ci) values of green building materials and technology. (Ri+Ci) height value of Energy and Water Efficiency 1.261661, Lowest value of Site ecology 0.494463. (Ri-Ci) height value of Innovation (D6) 0.574861, lowest value of Material (D3) -0.00632.

TABLE 10. Rank of (Ri+Ci) & (Ri-Ci)

	Rank (Ri+Ci)	Rank (Ri-Ci)
D1	2	6
D2	4	3
D3	3	4
D4	1	5
D5	5	2
D6	6	1

Shows Figure 4 Green building materials and technology ranking. The rank of (Ri+Ci) Management (D1) is got Second rank, Indoor environment (D2) is got fourth rank, Material (D3) is got third rank, Energy and Water Efficiency (D4) is got first rank, Site ecology (D5) is got fifth rank, Innovation (D6) is got sixth rank. The rank of (Ri-Ci) Management (D1) is got Sixth rank, Indoor environment (D2) is got third rank, Material (D3) is got fourth rank, Energy and Water Efficiency (D4) is got fifth rank, Site ecology (D5) is got second rank, Innovation (D6) is got first rank

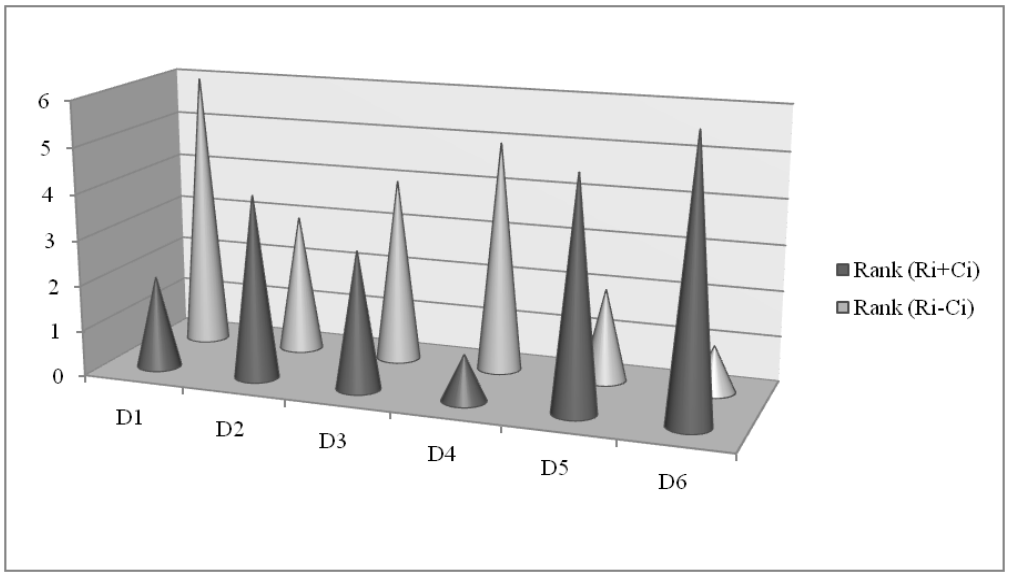

FIGURE 4. Rank of (Ri+Ci) & (Ri-Ci)

Shows Figure 4 Green building materials and technology ranking. The rank of (Ri+Ci) Energy and Water Efficiency (D4) is got the first rank, and Innovation (D6) is got the lowest rank. The rank of (Ri-Ci) Innovation (D6) is got first rank, and Management (D1) is got lowest rank.

4. CONCLUSION

In the future, conventional construction may be replaced with green building construction as the construction industry becomes more interested. The proposed framework will help manage and environmental issues and the benefits of sustainable construction will increase demand for green buildings with public awareness. As a result, research into the benefits of green buildings and green products will be more reliable, and enhanced R&D in technologies will be necessary. Identifying these barriers may be valuable in furthering the reliability of green buildings in Singapore. In comparison to a typical building project management system, a structure for managing green building projects is very detailed, allowing for more communication between everyone involved, including employees. Although such a framework is not yet available in Singapore, it is considered helpful for green building project management. A DEMATEL method for identifying multi-criteria CSFs useful for green building materials and technology development is a hybrid method of linguistic variables and using the fuzzy integration method DEMATEL. When using the DEMATEL method, the reliability of survey results without further probing is assumed by considering the views of all respondents. In this study, survey data is used to assess the stability of the DEMATEL method. In assessing cause and effect relationships, DEMATEL is one of the important methods. The proposed DEMATEL has been successfully applied to green building materials and technology, with effective and reliable results obtained. The Green building materials and technology ranking is determined based on the rank of (Ri+Ci) Energy and Water Efficiency (D4), which received the first rank, and Innovation (D6), which received the lowest rank. The rank of (Ri-Ci) Innovation (D6) is first, and Management (D1) is the lowest rank.

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