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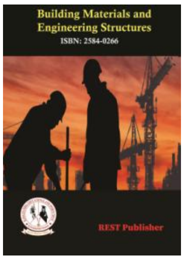

Evaluation of Three Common Green Building Materials Using ELECTRE Method

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Abstract. *This research paper examines various options for replacing halogenated flame retardants with non-halogenated green construction material choices. Cellulosic construction materials like bamboo do not form compounds with conventional flame retardants. Due to a number of circumstances, including the minimal effectiveness of the flame-retardant activity, they may thus be an unnecessary component of the substrate and simply peel off. Utilizing an additive that comes into direct contact with at least one component of the "green building material" will provide long-lasting flame retardancy since the flame retardant will become a structurally integral element of the substrate. The response mechanisms of various treatment approaches are also discussed in this research to ensure that non-halogenated flame retardants effectively protect sustainable building materials like wood and bamboo. This paper demonstrates how various ELECTRE approaches may be used to choose effective tactics that take into account both technical and human behavioral barriers using a typical case study inside an organization. The impact of impedance from each system subsystem is investigated to assure the dependability of the selected method. When employee participation is a deciding element in the multidimensional strategic planning problem, a comparison of a range of compensated and non-compensatory models reveals that the models may produce less. Resistance strategies; However, ELECTRE shows very reasonable sensitivity. The alternatives are Gladstone, Port Augusta, Collie and Tarong. the evaluation parameters are Construction cost, Procurement cost, Waste reduction, GHG emissions, Cement replacement and Self-consolidating. The Final Result of Net superior value and rank the Gladstone is in fourth rank, The Port Augusta is in second rank, The Collie is in third rank, The Tarong is in first rank of the Net Inferior Value and Rank the Tarong is in fourth rank, The Gladstone is in first rank, The Port Augusta is in Second rank, The Collie is in third rank.*
Keywords: *green construction products, Water Sensitive Urban Design, Indoor air quality, MCDM Method.*

1. INTRODUCTION

Fly ash, steel powder, rubber powder, and glass sand are four types of recycled green building construction that are used in this study to create lightweight aggregate concrete. Following a comparison to standard weight concrete, the engineering characteristics of these materials are examined using fresh mix, toughened, and durability testing. The application of "green building materials" in concrete and their contributions to raising the sustainability practices of the construction sector were further evaluated using these findings. In order to choose the optimal action from a given set of actions, the "Elimination Et Choix Traduisant la REalite (ELECTRE)" approach was created in 1965. A popular MCDM method that has proved effective in a number of decision-making circumstances is called ELECTRE. Input for ELECTRE includes preference data, weights, thresholds, alternative criterion cronbach's alpha value as a decision matrix, and other parameters. There are two key steps in all ELECTRE-type methods: modeling preferences using outlier relationships and then performing an exploitation process. One or more smoother or fuzzy outliers' relations can be used with ELECTRE techniques. Linguistic alternatives can be quickly translated into fuzzy numbers using Fuzzy ELECTRE. Because fuzzy AHP is based on pair - wise comparisons and permits the use of linguistic terms, it can be used to establish the relative relevance of evaluation criteria. Pair wise comparisons are used to create a measure.

2. GREEN BUILDING MATERIALS

For the study, three frequently used green construction products were chosen: recycled drywall painted with low-VOC paint and primed with low-VOC primer; perlite-based roof tile; and recycled carpet tile. Important information on the behaviour of materials and ozone in a variety of interior environments will be provided by measuring ozone deposition rates and byproduct generation rates at varying amounts and relative humidity conditions. The capacity to decide whether generalisation from small-scale investigations is suitable is further increased by assessments between small rooms and settings typical of full-scale installations. Such efforts are required to create and assist in-situ chemical properties in testing methodologies from "green building materials" due to the accessibility of numerous green building materials. Green building sites serve as locations to preserve urban nature, advance biodiversity through blue-green infrastructure, foster biophilic design, and improve culture and social life through events catered to all ages and social strata. Multiple ecosystem services are provided by green building sites, which also use regenerative and regenerative methods to simultaneously address issues like noise reduction and climate change mitigation. Solutions for Integrated "Water Sensitive Urban Design (WSUD)" can strengthen flood protection, enhance air quality, utilise "permeable and sustainable building materials", decrease construction waste, increase local economic systems, and preserve minimal life cycle impacts. At the scale of green construction sites, NBS seeks to advance sustainability objectives, outdoor attractions, healthy living conditions, and urban well-being. The implementation of green building like LEED, the provision of ongoing education and skills opportunities for staff members linked to green construction, and the inclusion of external stakeholders are among the distinctions, according to Questionnaire will allow and Anandamela. According to Hwang and Tan's analysis, rather than using an integrated delivery system, many green construction activities in Singaporean are still being acquired using the conventional design-bid-build method. Li et al. categories the project management criteria for building performance into five types. The practice of "green building" is being used more frequently as the environmental impact of construction operations becomes increasingly obvious. In order to save resources and lessen pollution over the course of the building's lifespan, green buildings maximize resource conservation, including energy, water, land, and material preservation. In context of sustainable construction and high-performance building, green building is also applied in various industries. Following the advent of green buildings, numerous nations all over the world have established suitable specifications and standards to better standardise the construction of green buildings and enhance the quality of life for people. According to the evaluation techniques, new green energy storage features are incorporated into the design of green buildings. These rating criteria also promote the creation of recyclable and indoor air quality-improving materials. As a result, environmentally friendly building materials ought to be low in emissions and waste, advantageous to people, and good in quality while using little energy. Throughout its entire life cycle (LC), which includes resource consumption, production, use, operation, disposal, and recycling, a "green building material (GBM)" minimises its negative effects on the environment and people's life. It lessens IAQ pollutants and is carefully made from non-toxic, organic, and natural ingredients. In fact, one of the primary methods for managing IAQ in green construction is indoor air measurement. Indoor air quality, or IAQ, is a measurement of contaminants and thermal characteristics that have an impact on occupants' health, comfort, and productivity. GBMs can support IAQ accountability expectations and help to satisfy consumer and regulatory needs.

3. ELECTRE METHOD

The ELECTRE approach, which is founded on the idea of covariance relationships, analyses covariance connections between alternatives using congruence and incongruity indices. This outranking strategy seeks to identify all alternatives that are neither dominated by nor subordinate to any other alternatives. The effectiveness of each alternatives on these criteria and the numerical determination of the relative relevance of the attributes are essential components of the ELECTRE approach. Human judgments are frequently unclear in a variety of situations and scenarios, making it challenging to precisely select the correct data. These uncertainties in the given data can be effectively handled using fuzzy sets and some other non-standard fuzzy sets. Therefore, it makes sense to apply the ELECTRE method to the non-typical uncertain situation. The ELECTRE (Elimination and Choice Relates to Reality) and PROMETHEE (Priority Ranking System Method for Enrichment Evaluations) methods are the two most popular categories of ideal methods. The PROMETHEE approach, which was used in our study, was developed from the ELECTRE method, which served as its model. Finding and eliminating "dominant" alternatives is the fundamental tenet of outranking practice. The ELECTRE system has undergone several versions of evolution. Problem-solving software ELECTRE I, ranking software ELECTRE II, III, and IV, and problem-sorting software ELECTRE TRI are all available. The selection problem is focused on a selection process carried out by comparing between alternatives, in contrast to sorting and ranking problems. Roy created the ELECTRE method, a family of MADM techniques for ranking a set of options. This strategy developed into other varieties not long after the release of the initial version, known as ELECTRE. The most popular versions now in use are ELECTRE II and ELECTRE III. In a set of non-dominated alternatives, the number of choices a DM must choose from is continuously reduced via the electre process. The ELECTRE approach is widely employed in a variety of real-world applications, such as water resource planning, educational establishments, and environmental conservation. In reaction to the flaws in current decision-making techniques, Bernard Roy created "ELECTRE (Election et Choix Traduisant La Realite)". ELECTRE is more than a mechanism for finding solutions; it is the concept of decision support, which Roy has extensively articulated. These node ranking numbers of the foundation nodes in the network are also calculated using the condensed ELECTRE method, whose computation cost is lower than TOPSIS according to an analysis of computational time complexity. To determine node relevance, the authors primarily employed the sum of several measurements of foundation components in a substrate network. They are fundamentally dissimilar since our study employs various metrics of component importance estimate to deliver a reasonably significant value for each substructure node using the streamlined ELECTRE approach.

4. RESULT AND DISCUSSION

TABLE 1. Green building material using ELECTRE method

	Construction cost	Procurement cost	Waste reduction	GHG emissions	Cement replacement	Self-consolidating
Gladstone	1450	1850	7.5	6.5	96.3	1.05
Port Augusta	1750	1750	6.9	7.5	95.3	3.08
Collie	1560	1950	8.5	8.6	88.6	6.15
Tarong	1650	1850	9.5	9.15	94.5	4.05

Shows the table 1 Green building materials for analysis using the ELECTRE Method. The alternatives are Gladstone, Port Augusta, Collie and Tarong. the evaluation parameters are Construction cost, Procurement cost, Waste reduction, GHG emissions, Cement replacement and Self-consolidating. it seen also for Data set of the value.

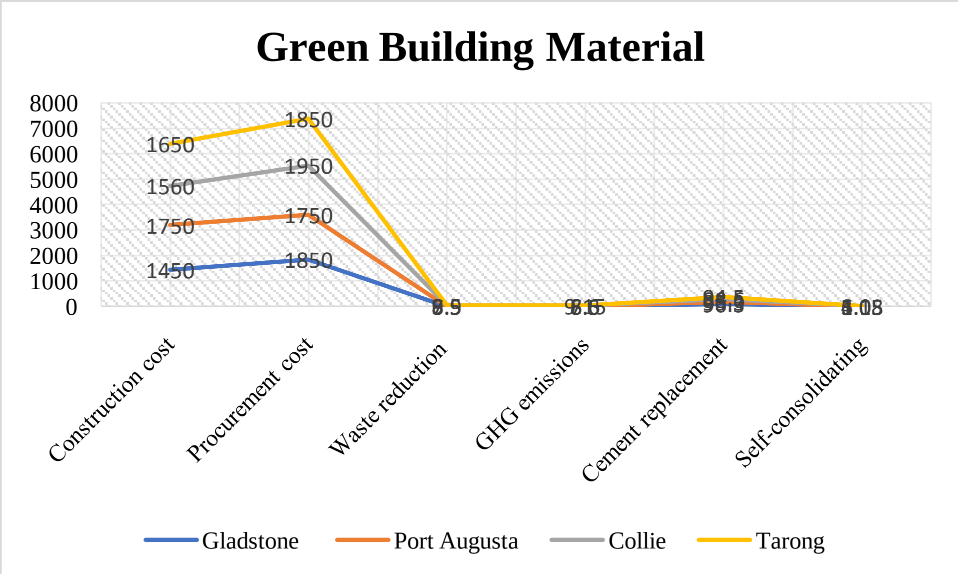

FIGURE 1. Green building material using ELECTRE method

Shows the figure 1 Green building materials for analysis using the ELECTRE Method. The alternatives are Gladstone, Port Augusta, Collie and Tarong. the evaluation parameters are Construction cost, Procurement cost, Waste reduction, GHG emissions, Cement replacement and Self-consolidating. it seen also for Data set of the value.

TABLE 2. Green building materials SUM and SQRT

	Construction cost	Procurement cost	Waste reduction	GHG emissions	Cement replacemen t	Self-consolidatin g
Gladstone	2102500	3422500	56.25	42.25	9273.69	1.1025
Port Augusta	3062500	3062500	47.61	56.25	9082.09	9.4864
Collie	2433600	3802500	72.25	73.96	7849.96	37.8225
Tarong	2722500	3422500	90.25	83.7225	8930.25	16.4025
SUM	10321100	13710000	266.36	256.1825	35135.99	64.8139
SQRT	3212.647	3702.702	16.32054	16.0057	187.446	8.050708

Table 2 shows the soft computing techniques SUM and SQRT value of Gladstone, Port Augusta, Collie and Tarong. Construction cost, Procurement cost, Waste reduction, GHG emissions, Cement replacement and Self-consolidating. This table mentions the SUM and SQRT value in Procurement cost is showing the highest value for GHG emissions is showing the lowest value

TABLE 3. Normalized Data Matrix

	Construction cost	Procurement cost	Waste reduction	GHG emissions	Cement replacement	Self-consolidating
Gladstone	0.451341	0.499635	0.459544	0.406105	0.513748	0.130423
Port Augusta	0.544722	0.472628	0.42278	0.468583	0.508413	0.382575
Collie	0.485581	0.526642	0.520816	0.537309	0.47267	0.763908
Tarong	0.513595	0.499635	0.582089	0.571671	0.504145	0.503061

Table 3.Shows the Normalized Data Matrix of Gladstone, Port Augusta, Collie and Tarong. Construction cost, Procurement cost, Waste reduction, GHG emissions, Cement replacement and Self-consolidating is Normalized Data Matrix value.

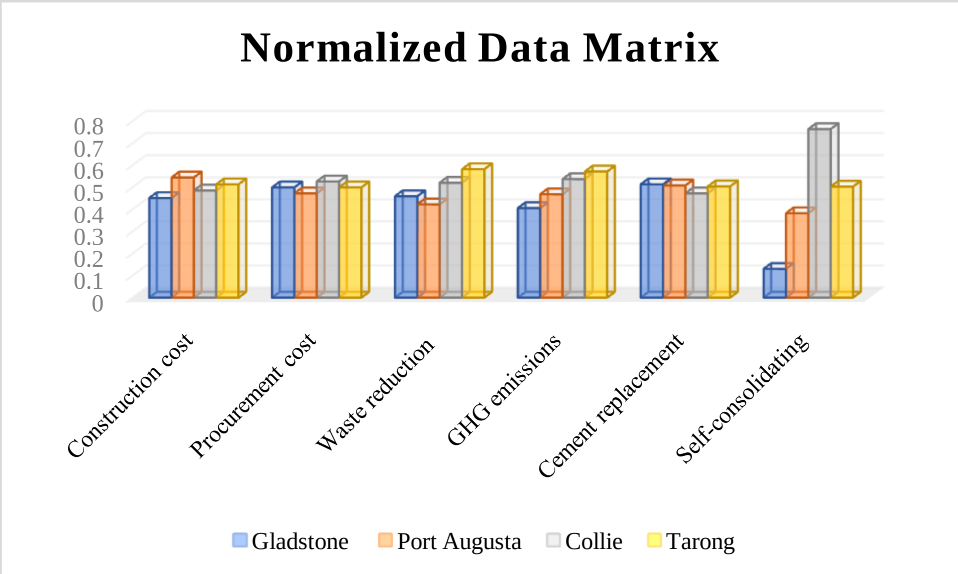

FIGURE 2. Normalized Data Matrix

Figure 2.Shows the Normalized Data Matrix of Gladstone, Port Augusta, Collie and Tarong. Construction cost, Procurement cost, Waste reduction, GHG emissions, Cement replacement and Self-consolidating is Normalized Data Matrix value.

TABLE 4. Weighted Normalized matrix

	0.2336	0.1652	0.3355	0.1021	0.0424	0.1212
	Construction cost	Procurement cost	Waste reduction	GHG emissions	Cement replacement	Self-consolidating
Gladstone	0.105433	0.08254	0.154177	0.041463	0.021783	0.015807
Port Augusta	0.127247	0.078078	0.141843	0.047842	0.021557	0.046368
Collie	0.113432	0.087001	0.174734	0.054859	0.020041	0.092586
Tarong	0.119976	0.08254	0.195291	0.058368	0.021376	0.060971

Table 4 Shows the Weighted Normalized matrix value of the Gladstone, Port Augusta, Collie and Tarong. Construction cost, Procurement cost, Waste reduction, GHG emissions, Cement replacement and Self-consolidating in Normalized Data Matrix multiplication criterion Weights this will be going to multiply again will be constant Weighted Normalized matrix value.

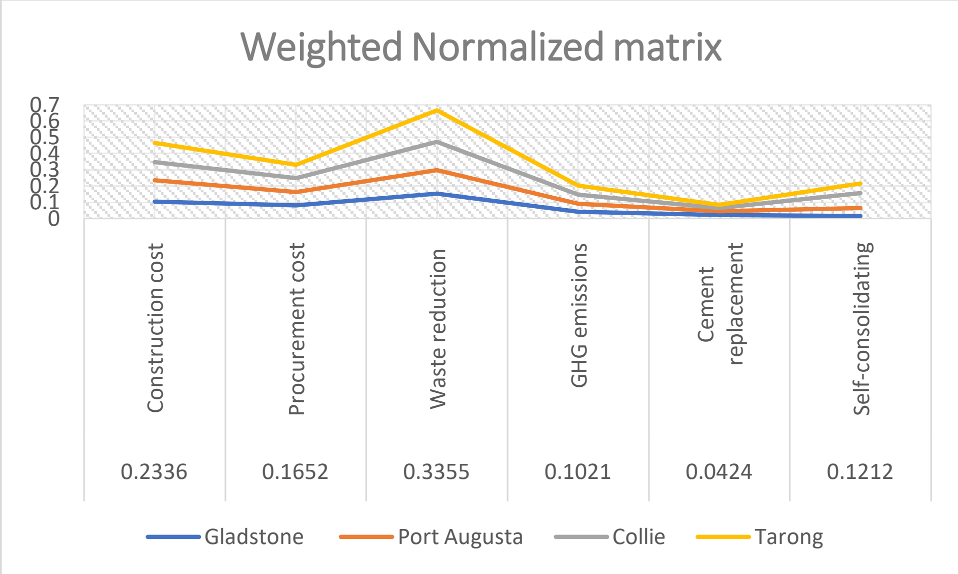

FIGURE 3. Weighted Normalized matrix

Shows the Figure 3.Weighted Normalized matrix value of the Gladstone, Port Augusta, Collie and Tarong. Construction cost, Procurement cost, Waste reduction, GHG emissions, Cement replacement and Self-consolidating in Normalized Data Matrix multiplication criterion Weights this will be going to multiply again will be constant Weighted Normalized matrix value.

TABLE 5. Concordance Interval Matrix & Discordance Interval Matrix

C12={2}	D12 = {1,3,4,5,6}
C13 = {3,5}	D13={1,2,4,6}
C14={2}	D14={1,3,4,5,6}
C21={1,3,4,5,6}	D21={2}
C23={1,3,5}	D23={2,4,6}
C24={1,4}	D24={2,3,5,6}
C31={1,2,4,6}	D31={3,5}
C32={2,4,6}	D32={1,3,5}
C34={1,2,4,6}	D34={3,5}
C41={1,3,4,5,6}	D41={2}
C42={2,3,5,6}	D42={1,4}
C43={3,5}	D43={1,2,4,6}

Table 5 shows the Concordance Interval Matrix and Discordance Interval Matrix is showing the Common Value.

TABLE 6. Concordance Value

0	1	1	0	1	0
0	0	0	0	1	0
0	1	0	0	1	0
1	0	0	1	0	1
1	0	0	0	1	0
1	0	0	0	1	0
1	1	1	1	0	1
0	1	1	1	0	1
0	1	0	0	0	1

Table 6 Shows the Concordance Value for Water technology using the ELECTRE Method =IF(I12>=I13,1,0) to =IF(N14>=N15,1,0) is the Common Value.

TABLE 7. Concordance Interval Matrix

	M1	M2	M3	M4		
M1	0	0.1652	0.3779	0.1652	0.7083	
M2	0.8348	0	0.6115	0.3357	1.782	
M3	0.6221	0.3885	0	0.6221	1.6327	
M4	0.8348	0.6643	0.3779	0	1.877	
	2.2917	1.218	1.3673	1.123	6	0.5

Table 7 Shows the Concordance Interval Matrix in shown the value Table 4 addition of I10 to N10.

TABLE 8. Concordance Index Matrix

	M1	M2	M3	M4
M1	0	0	0	0
M2	1	0	1	0
M3	1	0	0	1
M4	1	1	0	0

Table 8 Shows the Concordance Interval Matrix in shown the value of Green Building Materials using the ELECTRE Method =IF(J29>=0.5,1,0) to =IF(M32>=0.5,1,0) is the Concordance Interval Matrix.

TABLE 9. Discordance value

	C1	C2	C3	C4	C5	C6
D12	0.021814	0.004462	0.012334	0.006379	0.000226	0.030561
	1					
D13	0.007998	0.004462	0.020557	0.013396	0.001742	0.076778
	1					
D14	0.014543	0	0.041114	0.016904	0.000407	0.045164
	1					
D21	0.021814	0.004462	0.012334	0.006379	0.000226	0.030561
	0.145991					
D23	0.013815	0.008923	0.032891	0.007017	0.001516	0.046218
	1					
D24	0.007271	0.004462	0.053448	0.010525	0.000181	0.014603
	1					
D31	0.007998	0.004462	0.020557	0.013396	0.001742	0.076778
	0.267744					
D32	0.013815	0.008923	0.032891	0.007017	0.001516	0.046218
	0.711658					
D34	0.006544	0.004462	0.020557	0.003508	0.001335	0.031615
	0.650235					
D41	0.014543	0	0.041114	0.016904	0.000407	0.045164
	0					
D42	0.007271	0.004462	0.053448	0.010525	0.000181	0.014603
	0.196926					
D43	0.006544	0.004462	0.020557	0.003508	0.001335	0.031615
	1					

Table 9 Shows the Discordance value of soft computing techniques Table 4 Weighted Normalized matrix and table 5 Concordance Interval Matrix and Discordance Interval Matrix or using the Formula =ABS(B43-B44) and Maximum is shown the Manufacturing Companies Value.

TABLE 10. Discordance Interval Matrix

	M1	M2	M3	M4	
M1	0	1	1	1	3
M2	0.145991	0	1	1	2.145991
M3	0.267744	0.711658	0	0.650235	1.629637
M4	0	0.192926	1	0	1.192926
	0.413735	1.904584	3	2.650235	7.968554
				d bar	0.664046

Table 10 show the Discordance Interval Matrix for Green Building Materials is using the Table 9 Discordance value.

TABLE 11. Discordance Index matrix

	M1	M2	M3	M4
M1	1	0	0	0
M2	1	1	0	0
M3	1	1	1	1
M4	1	1	0	1

Table 11 show the Discordance Index matrix for Green Building Materials is using the Table 8 Discordance value.

TABLE 12. Net superior value, Net Inferior Value and rank

	Net superior value	Rank	Net Inferior Value	Rank
Gladstone	-1.5834	4	2.586265	1
Port Augusta	0.564	2	0.241407	2
Collie	0.2654	3	-1.37036	3
Tarong	0.754	1	-1.45731	4

Table 12 Shows the Final Result of Net superior value and Rank the Gladstone is in fourth rank, The Port Augusta is in second rank, The Collie is in third rank, The Tarong is in first rank of the Net Inferior Value and Rank The Tarong is in fourth rank, The Gladstone is in first rank, The Port Augusta is in Second rank, The Collie is in third rank

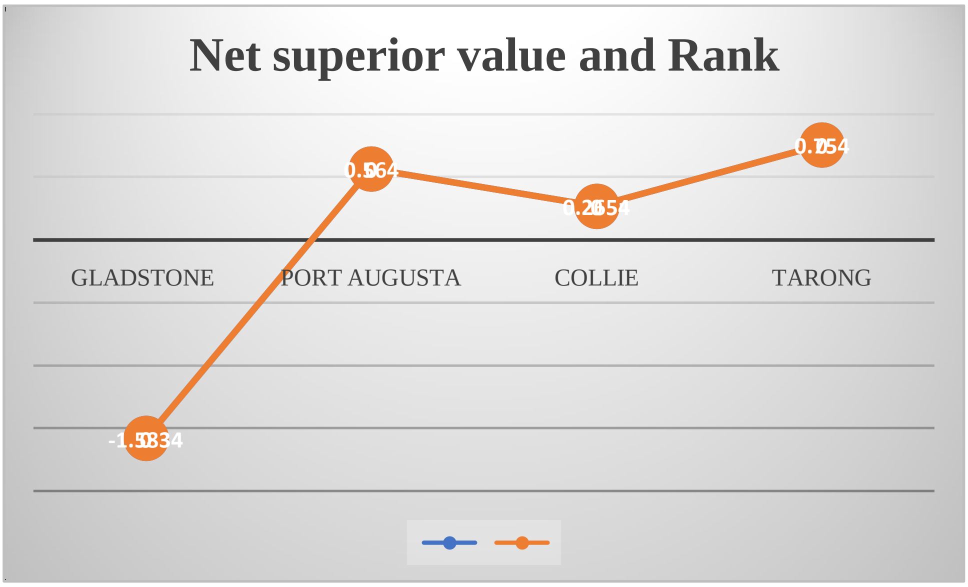

FIGURE 4. Net superior value and Rank

Shows the figure 4 Final Result of Net superior value and rank the Gladstone is in fourth rank, The Port Augusta is in second rank, The Collie is in third rank, The Tarong is in first rank

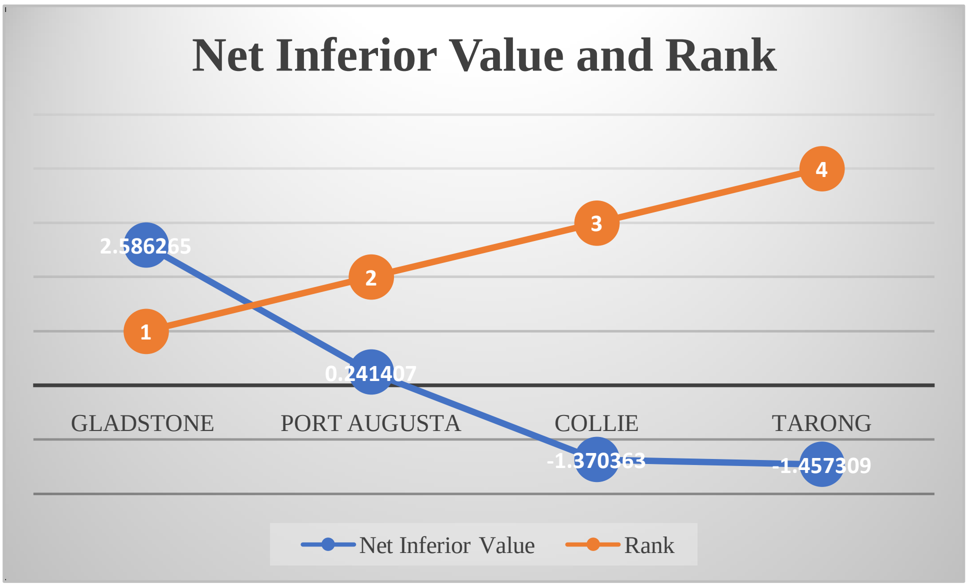

FIGURE 5. Net Inferior Value and Rank

Shows the figure 5 Final Result of Net Inferior Value and Rank the Tarong is in fourth rank, The Gladstone is in first rank, The Port Augusta is in Second rank, The Collie is in third rank

5. CONCLUSION

It is inevitable that construction materials will have an effect on people's health. However, efforts have been made to lessen the overall effects on health either indoors and outside by switching from conventional construction materials to greener alternatives. " Green building materials (GBMs)" with non-toxic, organic, and natural chemicals have the ability to lessen negative effects on human health overall and deterioration of indoor air quality (IAQ). Green composites, also known as bio composites or GBMs, are bio-based, healthy, and recyclable, which raises people's standard of living in general. The green construction industry is thriving in India right now, and the numbers of India Building Construction Labels has skyrocketed. Green building, however, requires evaluation criteria as technical assistance for its deployment and promotion because it is a very complicated system engineering. In this study, we examined the most recent evaluation criteria for green architecture in India, Uk, and the U.s from 5 perspectives, including site selection, outdoor and internal environmental stewardship, energy and water conservation, and material conservation. The three standard settings' assessment procedures and assessment indicators are compared the most. We have showed how to accommodate for these kinds of engagement inside the coherence code utilised within the ELECTRE techniques framework. In all ELECTRE approaches, equation (2) can be changed to formula (6) for this reason. We described the practical applications of the expansion of the synchronisation index that we propose. This addition, however, is only useful when there are few correlation criterion pairs. We offer top of the power with two different types of metrics in comparison to the conventional ELECTRE approach, which is based on BWM: The worst from the other is about the comparison outcomes of the other options instead of just the worse one; best for others is about the comparable outcomes of alternative that are superior than others. It adjusts to the real-world circumstances and strengthens the final ranking decision's logical reasoning.

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