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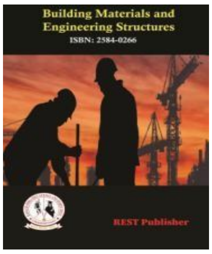

Decision-Making Analysis of Bamboo for Construction Applications Using the MOORA Approach

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Abstract: *Bamboo is gaining recognition as a sustainable building material thanks to its fast growth, strength, and versatility. It provides an environmentally friendly alternative to conventional materials, helping to lower environmental impact. Its inherent durability and adaptability make it ideal for diverse construction uses, enhancing both efficiency and sustainability in building practices. Exploring bamboo as a building material is critical to promoting sustainable construction. With its rapid growth, impressive strength-to-weight ratio and environmental benefits, bamboo stands out as a viable alternative to conventional materials. Exploring its characteristics and applications will foster more environmentally friendly, efficient and innovative building practices. Alternatives taken as Bamboo A, Bamboo B, Bamboo C, Bamboo D, Bamboo E. Evaluation Parameters taken as Cost Effectiveness (Benefit), Environmental Impact (Benefit), Durability (Non-Benefit), Maintenance Requirements (Non-Benefit). The results indicate that Bamboo C achieved the highest rank, while Bamboo D achieved the lowest rank being attained. "The value of the dataset for Bamboo as Building Material, according to the MOORA Method, Bamboo C achieves the highest ranking."*

Key words: *Bamboo, sustainable, building material, eco-friendly, construction, durability, versatility, rapid growth.*

1. INTRODUCTION

Bamboo must undergo a preservation process before being used as a construction material due to its susceptibility to termite and fungal attacks. Commonly, bamboo is treated with borax and boric acid through methods like immersion, gravity or vertical soak diffusion, and injection using solution compression machines. These chemicals have been proven effective in prolonging the lifespan of bamboo. However, concerns and debates have arisen regarding the use of these chemicals and the environmental impact of the resulting wastewater. [1] Bamboo's positive environmental performance is attributed to two factors. First, its hollow structure is more efficient than the solid rectangular mass of wood, allowing bamboo to support loads with less material mass compared to steel, concrete, or wood. Second, bamboo's manufacturing process is straightforward and short, further enhancing its environmental benefits. [2] The characteristics of bamboo culms are key factors influencing its suitability as a construction material. When bamboo is used for products made of strips or thin layers, the internode length becomes important. Bamboo with longer internodes produces strips that result in a smooth, uniform surface. Conversely, for structural applications like columns, pillars, or beams, bamboo species with shorter internodes are preferred. [3] Bamboo degrades easily because it is a natural material. However, industrially manufactured and treated correctly, bamboo components can last thirty to forty years. Depending on the species and kind of treatment, untreated bamboo has varying naturally occurring lifespans. used, along with advancements in building materials and technology. [4] The market for eco-friendly building supplies is huge. There have been reports that buildings with green roofs use less energy than conventionally designed buildings. Including bamboo not only lowers interior air pollution and energy use, but also helps maintain a comfortable indoor temperature. offering benefits beyond what conventional materials alone can provide. [5] Bamboo is adaptable for a range of uses because to a number of noteworthy physical characteristics. Size, color, dimension, grain, texture, density, moisture content, thermal conductivity, and absorption are some of these characteristics. In contrast to wood, bamboo's length and proportions can differ according on the species and its maturity. Bamboo also matures much faster, typically reaching full maturity in just three to four years, whereas wood may take six to twelve years to develop comparable strength. [6] The concentration of strong fibers in the outer layers of the bamboo culm significantly enhances its modulus of elasticity, as well as its Shear, bending, and tensile strength. A higher quality bamboo is indicated by a higher modulus of elasticity. [7] Because bamboo is an anisotropic material, its characteristics change depending on the orientation. In the longitudinal direction, where cellulose fibers are present, bamboo is stronger and tougher. In contrast, the transverse direction contains lignin, making it softer and more brittle. [8] Bamboo with thinner culms exhibits higher compressive strength compared to bamboo with larger culms. This is because thinner culms have better material properties, while larger culms typically have a smaller outer skin area, which is less effective at resisting high pressure.[9] In addition to its use as a building material, bamboo is also proposed as reinforcement for reinforced concrete (RC) columns, beams, and slabs. An example of this application is a silo constructed with bamboo-reinforced concrete, which combines traditional bamboo with modern materials like concrete. This approach represents an innovative integration of ancient and contemporary building techniques. [10] The bamboo samples used in this research were mature, aged 3 to 4 years. Some of these samples were treated with a borax solution, an environmentally friendly method for controlling insects and fungal attacks on bamboo. The treatment was applied over three consecutive days. Both treated and untreated bamboo sections were tested using a Universal Testing Machine (UTM). [11] To address this need, cost-effective technologies are required for building construction using locally available and renewable resources. Despite the creation of relevant information, there remains a significant gap in the actual use of these resources. Therefore, improving access to building materials, technologies, and supply systems for affordable construction is crucial, especially in rural areas. [12] Bamboo has been utilized in the construction industry since ancient times. Despite its lighter mass compared to steel, concrete, and wood, bamboo can support heavy loads and is among the strongest building materials available. Its tensile strength surpasses that of steel. Additionally, producing 1 cubic meter of bamboo construction material uses half as much energy to produce as the same amount of concrete or steel. Because of this, bamboo is a strong substitute for steel in applications requiring load bearing. [13] Additionally, they observed that amorphous lignin is more stressed than amorphous hemicellulose. The primary causes of cellulose failure include the breaking of hydrogen bonds and sliding of linear polymer chains. In cases where normal stress is predominant, failure is mainly due to hemicellulose, while lignin failure is primarily driven by shear stress. [14] Bamboo building construction uses the structural frame approach used in wood frame construction. In this manner, For total stability, the components of the floor, walls, and roof are interdependent and interrelated. In particular, effective lateral restraint is necessary to manage deformations in some conventional building designs. [15] In socially and economically underdeveloped areas, where bamboo resources are available, the use of bamboo can provide more employment opportunities to local workers and increase their income. Since minimal skills are required to process bamboo products, employing less educated workers in the bamboo industry can provide significant social benefits.[16] The continued increase in consumption patterns is placing greater pressure on global resources. This strain is exacerbated by a variety of factors, including food and climate crises around the world, which are driven by human activities. [17] There are currently no manuals or guidelines for bamboo architecture designers. They usually rely on their own experience to design bamboo buildings. When asked about their approach to designing bamboo structures, many will say that they can do it based on their experience, but they have no specific knowledge. Experienced designers in bamboo construction are generally confident in their design skills. [18] The transverse load tests conducted on the columns indicated the steel, hollow, and bamboo reinforced columns' lateral deflection, strain properties, and failure modes. A thorough design technique will be developed with the aid of additional study of these findings. Structural elements made of bamboo-concrete composite can offer affordable options for environmentally friendly homes. [19] Early bamboo splitting technology used a friction-fitting method with braided or multi-stranded ropes from domestic grasses such as jute, rattan and dried bamboo pith. This low-tech approach requires minimal tools and can be implemented without much skilled labor. If the natural fibers are installed while green, the connector will be tightly secured during use. [20].

2. MATERIALS AND METHOD

This method involves calculating congruent and anomalous indices, which can be lengthy. To create an outranking graph that shows preferences, the decision-maker must choose suitable threshold values for coherence and discrepancy indices, relying on human judgment and intervention. [21] However, the proposed methods and approaches are intricate and difficult to put into practice. The construction business requires simple and effective techniques of selecting contractors because of the short bidding times. Choosing a construction contractor necessitates a selection model that takes these and other factors into account. efficiently addresses key aspects of prequalification.[22] Several multi-objective decisions making (MODM) methods exist to address various evaluation and selection challenges. This includes exploring the use of a new MODM approach to optimize various welding parameters. [23] A multi-stakeholder system that includes all stakeholders is stronger than one that involves only one decision- or a group of decision-makers having conflicting agendas. Everybody involved is surrounded by a vested interest in the issue. Therefore, a multi-objective approach should also take consumer sovereignty into account. [24] A decision support system uses the MOORA system to select students for scholarships based on academic achievement. The MOORA technique assists in addressing a range of decision-making difficulties. This college-designed system allows decision makers to efficiently identify scholarship recipients, thereby supporting the academic success of students in need. [25] MOORA offers a multi-dimensional approach to decision-making, providing a robust framework for evaluating options with considerable variety and numerous influential factors. MOORA is a multi-objective optimization technique created by Brauers and Zavadskas (2006) that is intended to address difficult decision-making situations. Its primary objective is to choose, from a set of options, the best option by taking into account opposing criteria, assessing both positive and negative aspects simultaneously. [1,2] MOORA is recognized for its advantages over some traditional decision-making methods. It requires fewer mathematical calculations, has a shorter computational time, is more straightforward, and offers greater stability compared to Multi-Criteria Decision-Making (MCDM) methods like AHP, TOPSIS, ELECTRE, VIKOR, and PROMETHEE. [3] The MOORA method facilitates the simultaneous optimization of multiple conflicting goals within defined constraints. It evaluates each potential decision based on these goals, providing a basis for determining the most suitable choice. [4] In practice, MOORA is well-suited for organizing or selecting one or more alternatives from a range of options, especially when dealing with conflicting attributes. It is known for its simplicity, reliability, and efficiency, requiring minimal mathematical and computational resources. [5] multi-objective optimization often involves balancing conflicting benchmarks, such as maximizing product profitability while minimizing costs, improving vehicle performance while reducing fuel consumption, or achieving a trade-off between weight reduction and strength enhancement. [6,7] In manufacturing contexts, where decision-makers may have varied interests, MOORA helps quantify and address these conflicting criteria, ranking or selecting the best alternatives from available options. [8,9]

Step 1: Define the Problem and Criteria: Clearly outline the decision problem and compile a list of all relevant criteria (objectives) to be assessed. These criteria should encompass the various factors you wish to valuate for each alternative.

$$D = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \qquad (1)$$

Step 2: Normalize the Data: Adjust the data for each criterion to ensure consistency in scale. This step is crucial to avoid any single criterion from dominating the decision-making process because of its broader measurement range.

$$n_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \qquad (3)$$

$$where\ i\epsilon[1, m]\ and\ j \in [1, n]$$

Step 3: Determine the Weights (W): Assign proportions to each criterion to indicate its relative importance. The total of these proportions should equal 1. Different methods for weight assignment can be used, such as expert judgment, the analytical hierarchy process (AHP), or pairwise comparisons.

$$w_j = [w_1 \cdots w_n], \text{ where } \sum_{j=1}^{n}(w_1 \cdots w_n) = 1 \qquad (2)$$

Step 4: Create the Weighted Normalized Matrix: Multiply the normalized matrix by the weights assigned to each criterion to produce the weighted normalized matrix.

$$W_{n_{ij}} = w_j n_{ij} \qquad (4)$$

Step 5: Compute the Evaluation Score (yi): Calculate the performance rating for each option by factoring in the normalized values and weights. The performance score (yi) for the alternatives is determined using the following method:

$$y_i = \sum_{j=1}^{g} N_{ij} - \sum_{j=g+1}^{n} N_{ij} \qquad (5)$$

where g is the number of benefit criteria and (n-g) is number of cost criteria.

Step 6: After calculating the performance scores for each option, the next step is to arrange them based on these scores. The option with the highest performance score is given the top rank (usually labeled as 1), and this ranking system continues accordingly. Conversely, the option with the lowest performance score receives the lowest rank. A list of alternatives with their respective ranks should be displayed to visually represent their standings based on performance scores. The option ranked 1 is considered the preferred or optimal choice according to the evaluation criteria. Transactional payments do not add value, but rather refer to transfers of value without collateral, such as gifts or favors. Although exchange payments are widespread in everyday life and various types of insurance, the focus is on geographic exchange payments. These are primarily automated through fiscal or para-fiscal channels such as social security. [26] The MOORA system is one of the most effective decision support systems for evaluating employees based on specific weights and criteria. It is now widely used as a tool in selection and decision-making processes. [27] An effective maintenance system is important because the performance of machinery depends on proper maintenance and keeping the equipment in good condition over time. In daily life we routinely make decisions and manage time automatically, it is best to rely on mathematical decision-making models for industrial processes. [28] Six illustrative examples are presented to demonstrate the applicability and feasibility of the MOORA method for solving multi-objective decision-making problems in real-time manufacturing environments. [29] The results provide a basis for comparison, making the selection process simple and satisfying. Therefore, Mult objective techniques appear to be suitable tools for ranking or selecting one or more alternatives from a set of alternatives, especially when faced with conflicting criteria [30].

3. RESULT AND DISCUSSION

TABLE 1. Bamboo As Building Material

Alternative	Cost Effectiveness	Environmental Impact	Durability	Maintenance Requirements
Bamboo A	8	7	5	6
Bamboo B	6	7	7	5
Bamboo C	8	6	4	4
Bamboo D	4	8	7	7
Bamboo E	6	6	6	6

Bamboo A performs well in both cost efficiency (8) and environmental impact (7), making it a cost-effective and eco-friendly choice. However, it has moderate scores for durability (5) and maintenance requirements (6), indicating that while it excels in cost and durability, it requires a fair amount of maintenance and has average durability. Bamboo B also excels in environmental impact (7) but scores lower in cost efficiency (6) compared to bamboo A. It stands out for its high durability (7), making it a strong choice, and requires minimal maintenance (5), favoring projects where longevity is a priority. Bamboo C is characterized by its high cost-effectiveness (8) but has low ratings for environmental impact (6) and sustainability (4). It requires minimal maintenance (4), which means that although it is economical and low maintenance, it is less durable and has a moderate environmental impact. Bamboo d shines in environmental impact (8) but has low cost (4) and high maintenance requirements (7). Its durability (7) is on par with bamboo B, making it ideal for projects where environmental concerns outweigh cost and maintenance issues. Bamboo E offers balanced performance with moderate scores on all parameters—cost efficiency (6), environmental impact (6), durability (6), and maintenance requirements (6). This makes it a versatile choice, offering a sustainable balance between cost, environmental benefits, durability and maintenance requirements.

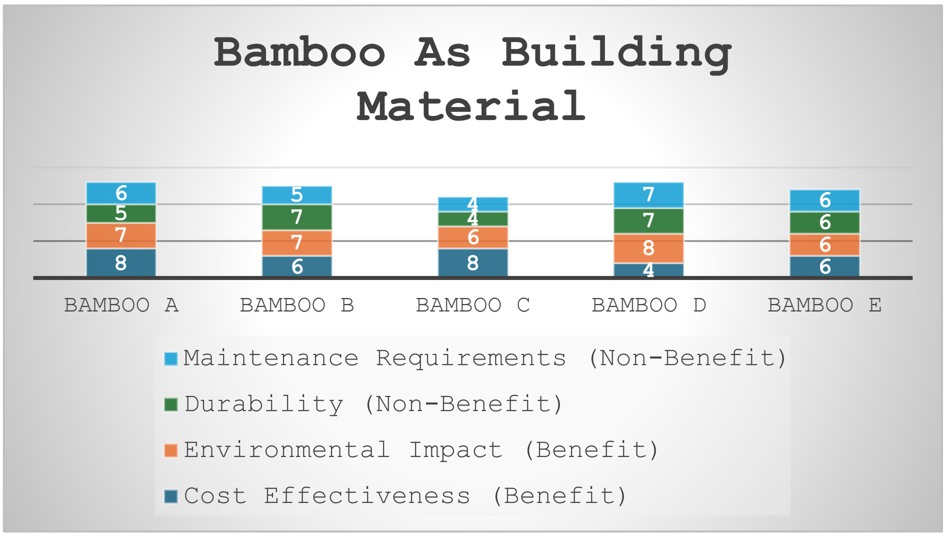

FIGURE 1. Bamboo As Building Material

Bamboo A: Offers excellent cost-effectiveness and environmental benefits, despite moderate durability and maintenance requirements. Bamboo B: Offers solid environmental benefits and durability but has less favorable cost-effectiveness and maintenance requirements. Bamboo C: Offers excellent cost-effectiveness with moderate environmental impact and durability yet requires high maintenance. Bamboo D: Environmentally impactful and durable but less cost-effective and requires more maintenance. Bamboo E: consistently rated for environmental impact, durability and maintenance, but with low cost-effectiveness.

TABLE 2. Normalized Data

Normalized Data			
Cost Effectiveness	Environmental Impact	Durability	Maintenance Requirements
0.5443	0.4576	0.3780	0.4714
0.4082	0.4576	0.5292	0.3928
0.5443	0.3922	0.3024	0.3143
0.2722	0.5230	0.5292	0.5500
0.4082	0.3922	0.4536	0.4714

Alternative 1 shows strong cost efficiency (0.5443) and environmental impact (0.4576), indicating that it is economically and environmentally sound. However, its durability (0.3780) is relatively low and it requires moderate maintenance (0.4714), making it not the most durable option and requiring a fair amount of maintenance despite its cost and environmental benefits. Alternative 2 performs better in environmental impact (0.4576) and has higher durability (0.5292), making it a solid choice for durability and sustainability. Its cost effectiveness (0.4082) is lower than Alternative 1, but it has slightly lower maintenance requirements (0.3928), reflecting a favorable balance between durability and environmental benefits. Alternative 3 excels in cost efficiency (0.5443) but has low scores in environmental impact (0.3922) and durability (0.3024). It also has low maintenance requirements (0.3143), making it economical and low maintenance, but less durable and less environmentally friendly. Alternative 4 stands out for its environmental impact (0.5230) and has the highest maintenance requirements (0.5500), indicating that it is more environmentally friendly, but requires considerable maintenance. Its sustainability factor (0.5292) is high, making it suitable for projects that prioritize environmental benefits and sustainability. Alternative 5 shows balanced scores in all parameters: cost effectiveness (0.4082), environmental impact (0.3922), durability (0.4536), and maintenance requirements (0.4714). This suggests that it is a well-rounded option, providing a sustainable compromise between cost, environmental impact, durability and maintenance requirements.

TABLE 3. Weight

Weight			
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25

The weights for each parameter—cost efficiency, environmental impact, durability, and maintenance requirements—are set equal to 0.25 for all five alternatives. This uniform distribution highlights that all parameters are considered equally important in the evaluation. Such equal weighting indicates a balanced approach in which no parameter is given more importance than others. This ensures that each alternative is consistently evaluated across all criteria, facilitating a fair comparison of their overall performance. By assigning equal weights, the assessment maintains a comprehensive overview of each bamboo option. This approach is most effective when all aspects of performance are considered equally important, preventing any bias towards a particular criterion. Overall, this balanced weighting strategy supports an unbiased evaluation process, facilitating the comparison of alternatives. It ensures that each of the key factors such as cost, environmental impact, durability and maintenance are considered equally in the decision-making process, leading to an objective assessment.

TABLE 4. Weighted normalized DM

Weighted normalized DM			
0.1361	0.1144	0.0945	0.1179
0.1021	0.1144	0.1323	0.0982
0.1361	0.0981	0.0756	0.0786
0.0680	0.1307	0.1323	0.1375
0.1021	0.0981	0.1134	0.1179

Alternative 1 excels in cost effectiveness (0.1361) and environmental impact (0.1144), highlighting its strengths in these areas. However, its durability (0.0945) and maintenance requirements (0.1179) are very moderate, indicating that it performs well in terms of cost and environmental benefits, but is less robust in durability and requires a fair amount of maintenance. Alternative 2 shows balanced results with significant improvement in durability (0.1323) compared to other options. Although its cost efficiency (0.1021) and maintenance requirements (0.0982) are relatively low, its environmental impact remains stable (0.1144). This makes it a strong candidate for projects where sustainability is a key consideration. Alternative 3 mirrors the performance of Alternative 1 in cost-effectiveness (0.1361) but has lower scores in environmental impact (0.0981) and durability (0.0756). It stands out with very low maintenance requirements (0.0786), suggesting it is cost-effective and low maintenance, although it may be less durable and less eco-friendly. Alternative 4 performs better in terms of environmental impact

(0.1307) and maintenance requirements (0.1375), which is environmentally friendly but requires more maintenance. Its low scores on cost effectiveness (0.0680) and durability (0.1323) suggest a focus on environmental friendliness and durability at the expense of cost and ease of maintenance. Alternative 5 shows a balanced approach with moderate scores in all criteria—cost effectiveness (0.1021), environmental impact (0.0981), durability (0.1134) and maintenance requirements (0.1179). Providing a sustainable compromise between cost, environmental impact, durability and maintenance, this provides a well-rounded option.

TABLE 5. Assesment value

	Assesment value
Bamboo A	0.0381
Bamboo B	-0.0140
Bamboo C	0.0800
Bamboo D	-0.0710
Bamboo E	-0.0311

Bamboo C emerges with the highest evaluation value of 0.0800, indicating that it performs best among the alternatives overall. Bamboo C excels in key evaluation criteria—cost efficiency, environmental impact, durability, and maintenance requirements—or is well balanced in these factors. Bamboo A has a positive evaluation value of 0.0381, which shows strong performance but not as exceptional as Bamboo C. It performs well, especially in terms of cost efficiency and environmental impact, but may lack strength in other aspects. Bamboo E, with a slightly negative evaluation value of -0.0311, shows very mixed performance with some limitations. It may be a reasonable option but does not excel in any particular area and has some drawbacks. Bamboo B and Bamboo D show negative evaluation values of -0.0140 and -0.0710, respectively, indicating that they are less favorable overall. The performance of bamboo B is slightly below the average, while the low value of bamboo D indicates more significant deficiencies that affect several evaluation criteria.

TABLE 6. Rank

	Rank
Bamboo A	2
Bamboo B	3
Bamboo C	1
Bamboo D	5
Bamboo E	4

Bamboo C achieves a top rank of 1, indicating that it performs well in all evaluated criteria. This high ranking means that bamboo C excels in essential areas such as cost-effectiveness, environmental impact, durability and maintenance requirements, making it a very favorable choice. Bamboo A is in second place, showing strong performance but not as exceptional as Bamboo C. Its high ratings in cost effectiveness and environmental impact contribute to its solid status, although it may score moderately in other areas. Bamboo B ranks third, exhibiting a balanced performance overall. However, it does not perform as well as Bamboo A and Bamboo C in various criteria, offering positive characteristics but lacking distinctive features. Bamboo E ranks fourth, indicating a more mixed performance profile. While it has some strengths, it doesn't excel in any particular category and has significant drawbacks compared to high-end options. Bamboo T is fifth last, reflecting low overall performance. This condition highlights significant weaknesses in several assessment factors, making Bamboo D a more suitable alternative compared to others.

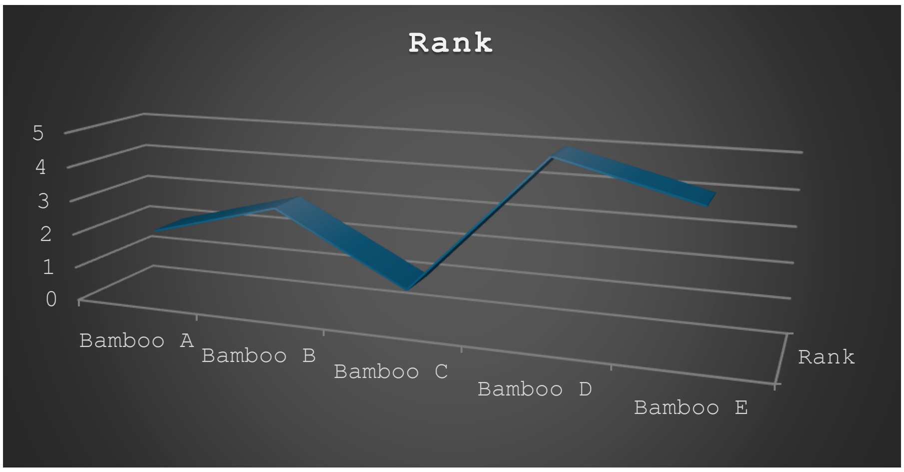

FIGURE 2. Rank

Bamboo C ranks highest overall, excelling across key criteria. Bamboo A follows, performing well but not as strongly. Bamboo B is balanced but less standout. Bamboo E shows mixed performance with notable drawbacks. Bamboo D ranks lowest, reflecting significant weaknesses.

4. CONCLUSION

Using bamboo as a modern material improves construction efficiency, but also increases the technical requirements for completing projects. This change may limit its presence in rural or relief settings. Therefore, adopting safe and sustainable construction methods using existing resources is highly beneficial. Bamboo's moisture content varies with terrain and climate, and that directly affects its strength. According to global research, steel production is expected to decline over the next 60 years, leading to increased use of natural and eco-friendly materials such as bamboo. Because bamboo bonds weaken under pressure, it must be treated with epoxy, tar, or similar coatings. However, bamboo exhibits tensile strength comparable to that of steel, making it suitable for use as an alternative to steel in tension and compression members of RCC structures. Expanding access to bamboo in our country indicates its potential for large-scale use in development projects. Its high value improves financial opportunities and helps conserve natural resources by providing an alternative to wood, contributing to the preservation of our environment. Bamboo is lighter and more cost-effective, while offering burst resistance comparable to steel. However, more research is needed to fully explore its use in security structures. Selecting the appropriate bamboo for a particular construction task requires a thorough understanding of structural unit functions and load ratios. In order to make an informed decision about the most suitable bamboo, it is necessary to have detailed information about the load size and duration.

REFERENCES

[1]. Nurdiah, Esti Asih. "The potential of bamboo as building material in organic shaped buildings." Procedia-Social and Behavioral Sciences 216 (2016): 30-38.

[2]. Van der Lugt, P., A. A. J. F. Van den Dobbelsteen, and J. J. A. Janssen. "An environmental, economic and practical assessment of bamboo as a building material for supporting structures." Construction and building materials 20, no. 9 (2006): 648-656.

[3]. Gurubasannavar, S. D. "Predictive Analysis of User Satisfaction in Omni-Channel Retailing a Comparative Analysis of Linear Regression and Random Forest Models." *J Comp Sci Appl Inform Technol* 8, no. 2 (2023): 1-8.

[4]. Chaowana, Kitti, Supanit Wisadsatorn, and Pannipa Chaowana. "Bamboo as a sustainable building material—culm characteristics and properties." Sustainability 13, no. 13 (2021): 7376.

[5]. Manandhar, Rashmi, Jin-Hee Kim, and Jun-Tae Kim. "Environmental, social and economic sustainability of bamboo and bamboo-based construction materials in buildings." Journal of Asian Architecture and Building Engineering 18, no. 2 (2019): 49-59.

[6]. Kaur, P. Jit. "Bamboo availability and utilization potential as a building material." Forestry Research and Engineering: International Journal 2, no. 5 (2018): 240-242.

[7]. Adier, Maria Fe V., Maria Emilia P. Sevilla, Daniel Nichol R. Valerio, and Jason Maximino C. Ongpeng. "Bamboo as sustainable building materials: a systematic review of properties, treatment methods, and standards." Buildings 13, no. 10 (2023): 2449.

[8]. Das, Arghya, and Saikat Sarkar. "Importance of bamboo in building construction." Int Res J Eng Technol 5, no. 6 (2018): 389-392.

[9]. Raj, Ar Dhenesh, and B. Agarwal. "Bamboo as a building material." Journal of Civil Engineering and Environmental Technology 1, no. 3 (2014): 56-61.

[10]. Sunku, Raghavendra. "Enterprise Sales Compensation Optimization: A Machine Learning Framework for Accurate Payout Forecasting." *International International Journal of Robotics and Machine Learning Technologies* 1, no. 2 (2025): 240.

[11]. George, Diana, and Sam G. Benjamin. "Survey Paper On Different Types Of Prediction Algorithm For Air Quality Index And Comparative Study On Types Of algorithms Used." *INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS* 9, no. 6 (2021): b557-b562.

[12]. Auwalu, Faisal Koko, and Panshak Dakur Dickson. "Bamboo as a sustainable material for building construction in Nigeria." Civil and Environmental Research 11, no. 8 (2019): 30-36.

[13]. Syeda, Ayesha, Barvaliya Shrujal, and Jayesh Kumar. "A case study on bamboo as green building material." International Journal of Engineering and Advanced Technology 4, no. 2 (2014): 78-82.

[14]. Boity, Antony Kumar, Harveen Bhandari, and Saurabh Shukla. "Bamboo as a sustainable building construction material." Materials Today: Proceedings 71 (2022): 306-311.

[15]. Patil, Shweta, and Shruti Mutkekar. "Bamboo as a cost effective building material for rural construction." Journal of Civil Engineering and Environmental Technology 1, no. 6 (2014): 35-40.

[16]. Kaur, Perminder Jit, K. K. Pant, Santosh Satya, and S. N. Naik. "Bamboo: The material of future." International Journal Series in Multidisciplinary Research 2, no. 2 (2016): 27-34.

[17]. Shu, Biqing, Zhongping Xiao, Lu Hong, Sujun Zhang, Chen Li, Naiqiang Fu, and Xiaoning Lu. "Review on the application of bamboo-based materials in construction engineering." Journal of Renewable Materials 8, no. 10 (2020): 1215-1242.

[18]. Abhinav, E. Meher, Sai Naveen Kavuri, Thota Sandeep Kumar, Maragani Thirupathi, M. Chandra Mohan, and A. Suresh Reddy. "Analysis of molecular single-electron transistors using silicene, graphene and germanene." In *Proceedings of the Second International Conference on Computer and Communication Technologies: IC3T 2015, Volume 1*, pp. 77-84. New Delhi: Springer India, 2015.

[19]. Janssen, Jules JA. "Bamboo in building structures." (1981).

[20]. Diana George, R. Navya, Vinitha V, "Next-Gen Air Quality Index Forecasting with Hybrid Machine Learning Models and Cloud Synergy", International Journal of Engineering Trends and Technology, 73(8), 2025, 129-136.

[21]. Aka, V. P. K. "Strategic Framework for SAP S/4HANA Transformation Planning: Support Vector Regression Analysis of Migration Parameters and Implementation Paths." *International Journal of Computer Science and Data Engineering* 1, no. 2 (2024): 1-7.

[22]. Jayanetti, D. L., and P. R. Follett. "Bamboo in construction." In Modern bamboo structures, pp. 35-44. CRC Press, 2008.

[23]. Shen, Liyin, Junsi Yang, Rong Zhang, Changzhuan Shao, and Xiangnan Song. "The benefits and barriers for promoting bamboo as a green building material in China—An integrative analysis." Sustainability 11, no. 9 (2019): 2493.

[24]. Prajapati, Gouri, and Sumedha Dua. "A critical review of bamboo as a building material for sustainable development." Journal of Sustainable Construction Engineering and Project Management 4, no. 3 (2022).

[25]. Mardjono, Fitri. "A bamboo building design decision support tool." (2002).

[26]. Peram, S. R. "Advanced Network Traffic Visualization and Anomaly Detection Using PCA-MDS Integration and Histogram Gradient Boosting Regression." Journal of Artificial Intelligence and Machine Learning 1, no. 3 (2023): 281.

[27]. Aka, V. P. K. "Improving the Performance of Artificial Intelligence and Robotics Systems Through Comprehensive Sensor-Based Data Analysis and Predictive Model." *International Journal of Artificial intelligence and Machine Learning* 1, no. 3 (2023): 1-7.

[28]. Thota, Sandeep Kumar, Kumari Gubbala, Ashok Polavarapu, Vikram Narayandas, Hari Suresh Babu Gummadi, Narendra Chennupati, Sreedhar Babu Seshagani, Shivakrishna Deepak Veeravalli, and Manisha Guduri. "Adversarial Training with Attention-Guided DCGAN for Robust Lung Segmentation in Medical Imaging." In *2025 IEEE Region 10 Symposium (TENSYMP)*, pp. 1-6. IEEE, 2025.

[29]. Nayeemuddina Umme Salma, Green Fabrication of Nio Nano Particles Doped PS-PVDF Nanocomposite Films: Structural, Morphology and Electrical Studies, Journal of Information Systems Engineering and Management, 10(23), 2025, 794-800.

[30]. Sunku, Raghavendra. "AI-Powered Forecasting and Insights in Big Data Environments." *Journal of Business Intelligence and Data Analytics* 1, no. 2 (2024): 254.

[31]. Kaware, Ajinkya, U. R. Awari, and M. R. Wakchaure. "Review of bamboo as reinforcement material in concrete structure." International Journal of Innovative Research in Science, Engineering and Technology 2, no. 6 (2013): 2461-2464.

[32]. Kanumarlapudi, P. K. "Improving Data Market Implementation Using Gray Relational Analysis in Decentralized Environments." Journal of Artificial intelligence and Machine Learning 2, no. 1 (2024): 1-7.

[33]. Karande, Prasad, and Shankar Chakraborty. "Application of multi-objective optimization on the basis of ratio analysis (MOORA) method for materials selection." Materials & Design 37 (2012): 317-324.

[34]. Brauers, Willem Karel M. "Multi-objective contractor's ranking by applying the MOORA method." Journal of Business Economics and management 4 (2008): 245-255.

[35]. Gadakh, V. S., Vilas Baburao Shinde, and N. S. Khemnar. "Optimization of welding process parameters using MOORA method." The International Journal of Advanced Manufacturing Technology 69 (2013): 2031-2039.

[36]. Brauers, Willem K., and Edmundas K. Zavadskas. "Robustness of the multi-objective MOORA method with a test for the facilities sector." Technological and economic development of economy 15, no. 2 (2009): 352-375.

[37]. Siregar, Victor Marudut Mulia, Mega Romauly Tampubolon, Eka Pratiwi Septania Parapat, Eve Ida Malau, and Debora Silvia Hutagalung. "Decision support system for selection technique using MOORA method." In IOP Conference Series: Materials Science and Engineering, vol. 1088, no. 1, p. 012022. IOP Publishing, 2021.

[38]. Brauers, Willem Karel M., Romualdas Ginevičius, and Valentinas Podvezko. "Regional development in Lithuania considering multiple objectives by the MOORA method." Technological and economic development of economy 16, no. 4 (2010): 613-640.

[39]. Aka, Venkata Pavan Kumar, and Kiran Kumar Mandula Samuel. "Adoption of SAP FSCM–Enhancing Collections and Dispute Processes in Spain, Portugal, and UK Operations." *International Journal of Information Technology and Management Information Systems (IJITMIS)* 15, no. 2 (2024): 148-161.

[40]. Gurubasannavar, S. D. "A Predictive and Scalable Framework for B2b Commerce Platforms Using Micro Services, Micro Frontends." *And Machine Learning Models. International Journal of Artificial intelligence and Machine Learning* 1, no. 3 (2023): 1-9.

[41]. Kurinjimalar Ramu, M. Ramachandran, Ramya sharma, Prabakaran Nanjundan, "Urban Agriculture Overview of Sustainability Using GRA Methodology", Building Materials and Engineering Structures, 2(3), September 2023, 7-14.

[42]. Sinaga, Novendra Adisaputra, Heru Sugara, Ewin Johan Sembiring, Melva Epy Mardiana Manurung, Harsudianto Silaen, Pipin Sumantrie, and Victor Marudut Mulia Siregar. "Decision support system with MOORA method in selection of the best teachers." In AIP Conference Proceedings, vol. 2453, no. 1. AIP Publishing, 2022.

[43]. Pérez-Domínguez, Luis, KY Sánchez Mojica, LC Ovalles Pabón, and MC Cordero Diáz. "Application of the MOORA method for the evaluation of the industrial maintenance system." In Journal of Physics: Conference Series, vol. 1126, no. 1, p. 012018. IOP Publishing, 2018.
[44]. Gadakh, Vijay S. "Application of MOORA method for parametric optimization of milling process." International Journal of Applied Engineering Research, Dindigul 1, no. 4 (2011): 743-758.
[45]. Brauers, Willem Karel M., Edmundas Kazimieras Zavadskas, Friedel Peldschus, and Zenonas Turskis. "Multi-objective optimization of road design alternatives with an application of the MOORA method." (2008).
[46]. Kanumarlapudi, Praveen Kumar, and S. Ballamudi. "Enhancing Generative AI Shopping Assistants through Advanced Multi-Attribute Decision Making Technique." Journal of Artificial Intelligence and Machine Learning 3, no. 2 (2025): 1-7.
[47]. Peram, S. R. "Automated Label Detection and Recommendation System Using Deep Convolution Neural Networks and SPSS-Based Evaluation." *International Journal of Computer Science and Data Engineering* 1, no. 2 (2024): 258.
[48]. Kathad, S. K., and D. J. Pandya. "Virtual Inertia Evaluation for Frequency Instability in Renewable Energy Integration." Indonesian Journal of Electrical Engineering and Computer Science 37, no. 1 (2024): 380.
[49]. Gurubasannavar, S. D. "Evaluating Enterprise Data Accuracy Using Batch Migration Algorithm Analysis." *International Journal of Computer Science and Data Engineering* 1, no. 2 (2024): 1-6.
[50]. Chandrasekar Raja, Devipriya Mani, M. Ramachandran, Nathiya Murali, "Evaluating Multimedia Technologies an EDAS-Based Analysis of Quality, Accessibility, Cost, and Energy Efficiency", REST Journal on Data Analytics and Artificial Intelligence, 4(3), September 2025, 24-34.
[51]. Shilpa K kathad, “Virtual Inertia Based Inverters for Frequency Mitigation By Incorporating VIC and Multi-Power Level Controller In Grid Connected Renewable Energy”, Semiconductor Optoelectronics, 42(2), 2023, 1216-1237.
[52]. Nayeemuddin, . and Salma, Umme, Analysis of a Drilling Hybrid Aluminum Metal Matrix Composites by Using SPSS (May 7, 2023). Int. J. Adv. Res. 11(01), 82-91, 2023, Available at SSRN: https://ssrn.com/abstract=4440349
[53]. Sunku, Raghavendra. "AI-Powered Data Warehouse: Revolutionizing Cloud Storage Performance through Machine Learning Optimization." *International Journal of Artificial intelligence and Machine Learning* 1, no. 3 (2023): 278.