IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Sustainable Car Body Materials Using Weighted Aggregated Sum Product Assessment (WASPAS)

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Abstract: Sustainable car body materials play a crucial role in the automotive industry's efforts to reduce its environmental impact. With the growing concern about climate change and the need to transition to more sustainable practices, automakers are increasingly focusing on developing and implementing eco-friendly materials for vehicle construction. Traditional car body materials, such as steel and aluminium, have long been used in the industry due to their strength and durability. However, these materials come with several drawbacks, including high energy consumption during production and difficulties in recycling. As a result, there is a pressing need to explore alternative materials that are both lightweight and environmentally friendly. In recent years, significant advancements have been made in sustainable car body materials, offering promising alternatives to conventional options. These materials aim to reduce the carbon footprint of vehicles by utilizing renewable resources, improving energy efficiency, and facilitating recycling at the end of a car's life cycle. This article will explore some of the innovative sustainable car body materials that have emerged in the automotive industry. We will discuss their characteristics, benefits, and potential challenges in their widespread adoption. By embracing these materials, automakers can contribute to a greener future and drive the transition toward more sustainable transportation.

***Index Terms* – WASPAS, WSM, Tensile Strength, Stiffness, Damping capacity, Hardness, Thermal Conductivity.**

I. INTRODUCTION

Regarding the current state of the auto sector, there are many challenging factors to take into account, such as its effect on the spheres of society, economy, and the environment. When the fundamental issues are taken into account, they can be divided into four main issues: durability, massive and substantial resource usage, higher energy use, and contamination of the environment. The term "Sustainable and Renewable Creation" is used to address the aforementioned problems. The following points are tackled in relation to how any of these issues can be resolved or limited by the use of ecologic and renewable methods in the automotive industry [1-2]. In comparison to aluminium, carbon, and other metals, the creation of motor vehicles body components using a polymer biological composite is six times kinder to the environment. Since the supply chain for bio the material automotive components is more environmentally friendly and they are simpler to recycle than metallic automatically body parts, they are therefore strongly advised. Automobiles contribute about 23% of the total worldwide greenhouse gas emissions to the environment while they are in use, and about 80% of the entire pollution is produced over the course of a vehicle's future [3]. Open creating and shut shaping are both types of FRP production methods used in aircraft. During the procedure, a setting is presented for the application of glue and gel coating in accessible moulding. In closed moulding, the mix is processed either inside of a vacuum container or a two-sided mould set [4]. guarantee that the car is an environmentally friendly product. The initial equipment manufacturers (OEMs) are under increased pressure from this trend to not only develop new ways to reduce their impact on the natural environment through the use of resource-saving, improved methods., but also to develop quantitative metrics to, assess such impact and gauges improvement efforts [5]. Creating sustainable products cannot be done in a straightforward manner. Due to the complexities of the scenario and the laws of thermodynamics, it is not possible to create total environmentally friendly goods in general. The various methods and definitions for creating environmentally friendly goods, though, will be examined and studied in this article. The fact that humanity cannot sustain itself on its own is the primary issue that has not yet been resolved [6]. The choice of materials is essential to producing ecologically friendly goods. In the usual design process, choosing materials that will have the desired dimensions after conducting the proper process of manufacture is the goal, Shape and characteristics required for the good or part to financially perform the function that is needed. The emphasis has now changed to choosing materials from the ecological point of view due to environmental regulations and end users' increased awareness of the environment, though [7]. With all the study being done on new substances and manufacturing methods, developers now have options that will lead to even more changes in how they design in the future. The creation of sustainable products will result from interdisciplinary discussions between the research, technological, and design fields, with new kinds of materials playing an increasingly significant role [9]. the EU Contract-funded research project SLC, "Sustainable Manufacturing Technologies of The emission decreased Light weight Car Concepts" [10]. High strength steels have a great potential to reduce weight at a viable cost, but their use in the automotive industry may be constrained by their lack of manufacture. Especially when considering extremely grades: - HSS's formability Care must be taken when designing parts and choosing forming techniques because HSS is less ductile than less durable steels. In order to fully take advantage of the opportunities presented by these materials, spring back grows as well with strength of yield and must be taken into consideration in design of processes with HSS [11]. Machinery, the frame, an engine, and gadgets must all be integrated into systematic portable design concepts. Future design of cars will be heavily influenced by sustainable ideas that gain from secondary portable effects. A portable BIW for mass production is being demonstrated with the Superlight-Car BIW-prototype. To create the best feasible car concepts based on this BIW, more studies and studies are now required [12]. Sustainable concrete, such as in situ sand the plant walling, pushed earth blocks, and chalk structures, can now be easily mass-produced thanks to improvements in manufacturing techniques, making it a competitive alternative to standard masonry [13]. Deciding on one of the available options can have far-reaching consequences for the properties of the future product and its performance with respect to sustainability issues. The persons involved in product development may pursue different targets and their perception of a sustainable product may differ. For these reasons it is essential to use a central guideline and a commonly accepted procedure that helps directing the interactive design process [15]. Numerous solutions are needed to help achieve an environmentally friendly automotive sector and, by extension, help make our communities more sustainable in light of the mounting financial, social, and environmental pressures [16]. The approach used in this paper is based primarily on a standard LCA structure. In general, the LCA was performed throughout the phases of materials development, technology, and each module's layout workflow, serving as effective tools for comparing various design, material, and technology options and for orienting towards environmentally friendly approaches [17]. The interaction between these fields will also give us the means of better comprehending what Mother Nature does and to be mindful of the benefits and restrictions associated with producing green structures. Rich incentives can be found in a variety of created and new technologies, not only by adopting the design principles and paradigms that nature's structures have provided for us, but also by attempting to benefit from some of its self-assemblage processes, self-repair procedures, and best practises for the use of measurements and environmental monitoring. Discovered and adapted from nature's designs are green building supplies that are just waiting to be used [18].

II. MATERIALS AND METHODS

While addressing five issues from a real-world manufacturing surroundings, the practicality and utility of the weighted aggregated sum product assessment (WASPAS) technique are investigated. The choice of a modular production structure, an instrument in a flexible production cell, a computerized directed vehicle, an automated verification system, and a factory robot are the issues that are taken into consideration. The optimum amounts (control parameter for the WASPAS method) are identified for each issue and their influences on the ranking of potential solutions are investigated [19]. and both introduced WASPAS in 2010 and 2012. However, the surveys that were conducted did not reflect the evolving circumstances in this area. The researchers therefore think that a comprehensive examination of the most significant studies lately done with the subject under consideration [20]. An MCDM method called WASPAS was developed and optimized. Numerous environments and challenges with decision-making have seen this approach applied and expanded. presented a WASPAS-based integrated decision-making with multiple criteria models to determine the ideal building location for a deep-water terminal [21]. Section 'WASPAS Method' presents the WASPAS method. The identification of risks and weights for criteria are covered in section 'Risk Identification and Criteria Weights'. A case study of a project to build roads in Iran is used for the risk analysis in the section titled "Risk Analysis and Numeric Example." A review of the findings and outcomes of the suggested method can be found in section "Discussion," along with a comparison of the proposed techniques with other studies [22]. The WASPAS technique, which combines the Weighted Sum Model as well as the Weighted Product Model, is employed to fully rank all of the options. This paper's primary input to the writing is to show how a novel making choices strategy based on a blend of the CRITIC and WASPAS techniques can be used [23]. to incorporate a recently created WASPAS method (Weighted Aggregated Sum Product Assessment) into the current study. Applying the recommended method for optimising the weighted aggregated function, WASPAS lets the highest calculation reliability [24]. While the initial WASPAS technique includes instructions for calculating the ideal set of parameters, a great deal of researchers simply use 0.5 without referring to any theoretical findings. The reported formulas for determining the optimum arrangement of parameter could produce ambiguous results because it is impossible to calculate the right portion of the derivative [25]. The study's goal is to present an integrated strategy based on the WASPAS technique with data measures to assess MCDM issues with HFSs. HF-aggregation drivers take effect and changes are carried out in the normalisation and weighted goods procedure that expand the WASPAS approach with HFSs. Following that, a GSS problem is used to demonstrate the strategy and demonstrate how the approach created performs in actual MCDM problems [26] the IVIFSs can assess and place the options using the traditional WASPAS technique. The efficacy ratings of the requirements and substitutes in the current decision-making process are assessed in terms of language variables before being converted into IVIFNs. The corresponding significance of every choice expert is calculated in the proposed method based on the suggested similarity measure [27]. In recent times, certain scientists have suggested integrating or combining SWARA and WASPAS strategies and applying them to the resolution of various problems. For instance, Ulutas (2019) used fuzzy SWARA to assess the performance of a university website [28] To solve problems involving multiple criteria for making choices, use the IF-WASPAS method. uses a problem involving calling providers of services to demonstrate how the IF-WASPAS method is applied. It also conducts comparisons and sensitivity study to demonstrate the reliability of the findings [29]. Sect. 3 presents the suggested PF-AHP integrated PF-WASPAS methodology. The actual case use and evaluation of sensitivity of the suggested methodology are presented in Section 4. The final section, which concludes, includes recommendations for the future. The weighted sum model (WSM) and weighed product model (WPM) are two models that make up the foundation of the WASPAS technique. Comparing the aforementioned collecting to other MCGDM means, its accuracy ability is improved [30]. A thorough analysis of alternative energy resources is required. Numerous criteria, some of which may even conflict, should be taken into account during the assessment procedure, in addition to the assessment's fuzziness. In order to evaluate alternative sources of clean energy, this study will employ the IVPF WASPAS method [31]. Their outcomes are contrasted with those of the suggested WASPAS-IVIF. These examples demonstrated that WASPAS-IVIF and other techniques, including TOPSIS-IVIF, COPRAS IVIF, and IFOWA, were very consistent. Therefore, the suggested method's main benefits can be summed up as being computationally simple, having a clear and popular logic, taking into account weighted sum typical and weighed product average, and being consistent with other methods. The suggested technique is the ideal tool for resolving leadership choice or strategy selection issues because it combines the abilities of IVIFS for dealing with incertitude with the enhanced precision of WASPAS [32].

Tensile Strength:

Tensile strength is a mechanical property that measures the maximum amount of tensile (pulling) stress a material can withstand before breaking or undergoing permanent deformation. It is a critical property for materials used in various applications, including car body materials. When a tensile force is applied to a material, it experiences internal forces that attempt to pull the material apart. Tensile strength is the maximum stress that the material can withstand without fracturing. It is usually expressed in units of force per unit area, such as pounds per square inch (psi) or megapascals (MPa).

Stiffness:

Stiffness is a mechanical property that measures the resistance of a material to deformation under an applied load. It characterizes how much a material resists bending, stretching, or compressing when subjected to external forces. Stiffness is an important property in car body materials as it determines the structural integrity, handling, and overall performance of the vehicle. When a material is subjected to an external force, it undergoes deformation. Stiffness measures the material's ability to resist this deformation and return to its original shape when the force is removed. It is commonly quantified by the material's elastic modulus or Young's modulus.

Damping capacity:

Damping capacity refers to a material's ability to dissipate or absorb energy when subjected to vibrations, shocks, or oscillations. It is an important property in car body materials as it impacts the vehicle's ride comfort, noise reduction, and overall dynamic performance. When a material undergoes vibrations or impacts, energy is generated and transmitted throughout the structure. Damping capacity is the material's ability to absorb and dissipate this energy, thereby reducing the amplitude and duration of vibrations.

Hardness:

Hardness is a mechanical property that measures a material's resistance to indentation, scratching, or abrasion. It is an important characteristic for car body materials as it determines their ability to withstand wear, impact, and surface damage. The hardness of a material is typically measured using standardized tests such as the Rockwell or Vickers hardness tests. These tests involve applying a known force to the material's surface using a specific indenter and measuring the depth or area of the resulting indentation.

Thermal Conductivity:

Thermal conductivity is a property that measures the ability of a material to conduct heat. It quantifies how efficiently a material can transfer thermal energy through conduction. In the context of car body materials, thermal conductivity is a significant consideration for managing heat transfer within the vehicle. When a temperature difference exists between two regions of a material, thermal conductivity determines how quickly heat will flow from the hotter region to the colder one. Materials with high thermal conductivity are effective at conducting heat, meaning they can transfer thermal energy more rapidly.

Recycling rate:

Recycling rate refers to the percentage of waste or discarded materials that are recycled rather than being sent to landfill or incinerated. In the context of car body materials, recycling rate is an important factor in assessing the sustainability and environmental impact of vehicles. The recycling rate of car body materials is significant because it determines the extent to which valuable resources can be recovered and reused at the end of a vehicle's life cycle. Higher recycling rates contribute to reducing the demand for virgin raw materials, minimizing energy consumption, and decreasing waste generation.

Cost:

Cost is a critical factor to consider when it comes to car body materials. The cost of materials can significantly impact the overall production cost of vehicles and, in turn, affect their market price and profitability for automakers. The cost of car body materials encompasses various aspects, including the cost of raw materials, manufacturing processes, and any additional treatments or finishes required. Different materials have different cost profiles, and their availability and production processes can influence their market prices.

CO2 Emission:

CO2 emissions refer to the release of carbon dioxide gas into the atmosphere as a result of human activities, including the burning of fossil fuels. In the context of car body materials, the choice of materials can impact the amount of CO2 emissions associated with vehicle manufacturing and use. The production of car body materials often involves energy-intensive processes that contribute to CO2 emissions. Materials like steel and aluminium, which have been traditionally used in automotive manufacturing, require significant amounts of energy during extraction, refining, and fabrication, resulting in CO2 emissions.

III. RESULT AND DISCUSSION

TABLE 1. Sustainable automotive car body material

Sustainable automotive car body material								
Materials	Tensile Strength (Mpa)	Stiffness (Gpa)	Damping capacity	Hardness (MPa)	Thermal Conductivity (W/mK)	Recycling Rate (%)	Cost (Rs)	CO2 Emission (Ton/Ton)
Steel Alloy (AHSS)	1000	193	0.05	197	42.6	86	145	1.9
Aluminum Alloy (A7075 T6)	572	72	0.002	87	196	52	486	4.8
Carbon Fiber/ epoxy laminate (CL)	3500	70	0.048	160	2.98	10	2000	20
Titanium Alloy (Ti6Al4 V)	862	110	0.015	3730	7.2	80	1600	7.2

Table 1 provides information on various sustainable materials used in automotive car bodies, along with their respective properties and characteristics. Let's go through each material:

1. Steel Alloy (AHSS):
   - Tensile Strength: 1000 MPa
   - Stiffness: 193 GPa
   - Damping capacity: 0.05
   - Hardness: 197 MPa
   - Thermal Conductivity: 42.6 W/mK
   - Recycling Rate: 86%
   - Cost: Rs 145
   - CO2 Emission: 1.9 Ton/Ton
2. Aluminum Alloy (A7075 T6):
   - Tensile Strength: 572 MPa
   - Stiffness: 72 GPa
   - Damping capacity: 0.002
   - Hardness: 87 MPa
   - Thermal Conductivity: 196 W/mK
   - Recycling Rate: 52%
   - Cost: Rs 486
   - CO2 Emission: 4.8 Ton/Ton
3. Carbon Fiber/epoxy laminate (CL):
   - Tensile Strength: 3500 MPa
   - Stiffness: 70 GPa
   - Damping capacity: 0.048
   - Hardness: 160 MPa
   - Thermal Conductivity: 2.98 W/mK
   - Recycling Rate: 10%
   - Cost: Rs 2000
   - CO2 Emission: 20 Ton/Ton
4. Titanium Alloy (Ti6Al4 V):
   - Tensile Strength: 862 MPa
   - Stiffness: 110 GPa
   - Damping capacity: 0.015
   - Hardness: 3730 MPa
   - Thermal Conductivity: 7.2 W/mK
   - Recycling Rate: 80%
   - Cost: Rs 1600

- CO_2 Emission: 7.2 Ton/Ton

The table presents key properties of each material, including tensile strength (a measure of its resistance to breaking under tension), stiffness (a measure of its rigidity), damping capacity (ability to absorb vibrations), hardness (resistance to deformation or indentation), thermal conductivity (ability to conduct heat), recycling rate (percentage of material that can be recycled), cost (in Rupees), and CO_2 emissions (amount of carbon dioxide emitted per ton of material produced). These materials offer different trade-offs in terms of their properties, costs, and environmental impact. Steel alloy provides high strength and stiffness with a relatively low cost, but its CO_2 emissions are higher compared to other materials. Aluminum alloy is lighter than steel and has good thermal conductivity but lower strength. Carbon fiber/epoxy laminate offers high strength, low weight, and low CO_2 emissions but has a higher cost. Titanium alloy provides excellent strength-to-weight ratio but is more expensive than steel or aluminum. Manufacturers must consider these factors when selecting a suitable material for automotive car bodies, balancing performance, cost, environmental impact, and sustainability.

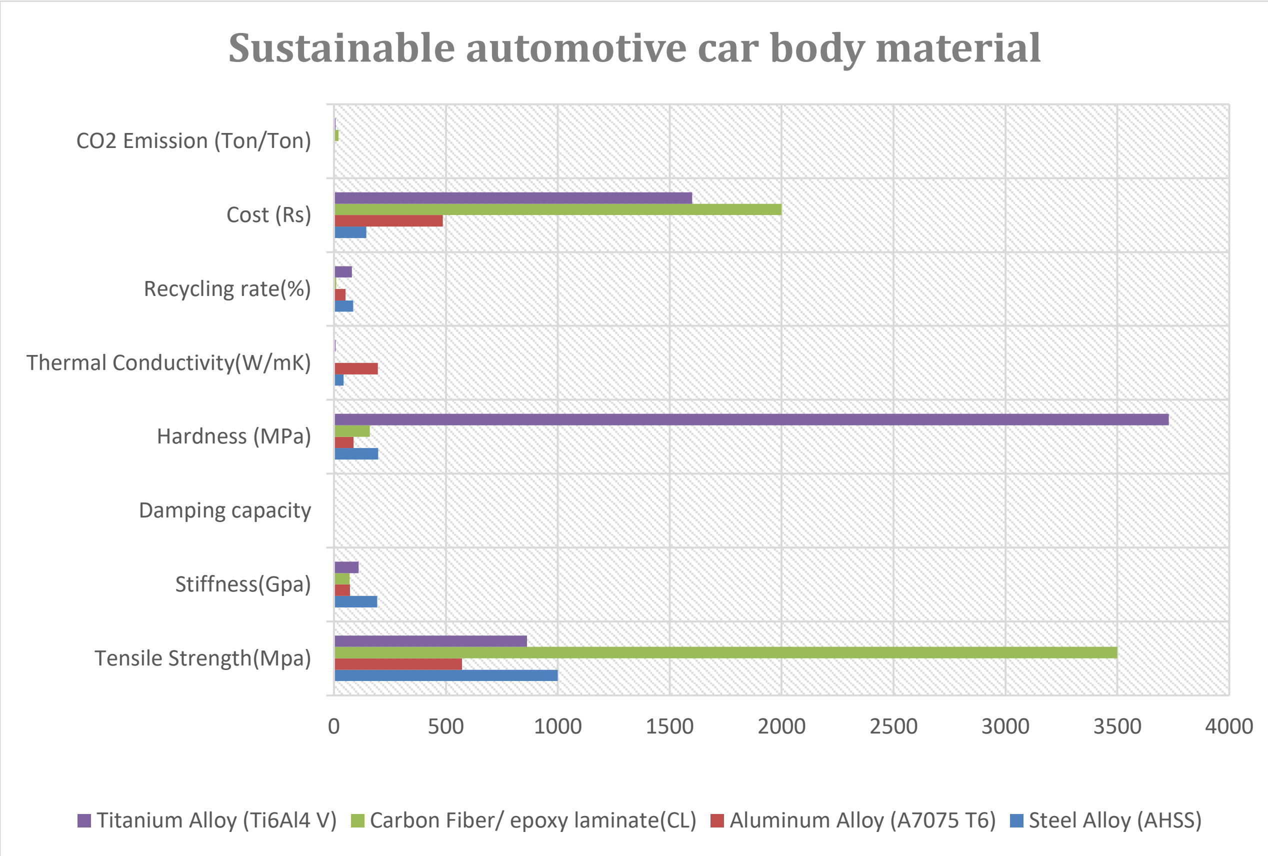

FIGURE 1. Sustainable automotive car body material

Figure 1. Sustainable automotive car body material Shows the Tensile Strength (Mpa) it is seen that Carbon Fiber/ epoxy laminate (CL) is showing the highest value for Aluminum Alloy (A7075 T6) is showing the lowest value. Stiffness (Gpa) it is seen that Steel Alloy (AHSS) is showing the highest value for Carbon Fiber/ epoxy laminate (CL) is showing the lowest value. Damping capacity it is seen that Steel Alloy (AHSS) is showing the highest value for Aluminum Alloy (A7075 T6) is showing the lowest value. Hardness (MPa) it is seen that Titanium Alloy (Ti6Al4 V) is showing the highest value for Aluminum Alloy (A7075 T6) is showing the lowest value. Thermal Conductivity (W/mK) it is seen that Aluminum Alloy (A7075 T6) is showing the highest value for Titanium Alloy (Ti6Al4 V) is showing the lowest value. Recycling Rate (%) it is seen that Steel Alloy (AHSS) is showing the highest value for Carbon Fiber/ epoxy laminate (CL) is showing the lowest value. Cost (Rs) it is seen that Carbon Fiber/ epoxy laminate (CL) is showing the highest value for Steel Alloy (AHSS) is showing the lowest value. CO_2 Emission (Ton/Ton) it is seen that Carbon Fiber/ epoxy laminate (CL) is showing the highest value for Steel Alloy (AHSS) is showing the lowest value.

TABLE 2. Performance value

Performance value								
	Tensile Strength (Mpa)	Stiffness (Gpa)	Damping capacity	Hardness (MPa)	Thermal Conductivity (W/mK)	Recycling Rate (%)	Cost (Rs)	CO2 Emission (Ton/Ton)
Steel Alloy (AHSS)	0.28571	1.00000	1.00000	0.05282	0.21735	1.00000	0.07250	0.09500
Aluminum Alloy (A7075 T6)	0.16343	0.37306	0.04000	0.02332	1.00000	0.60465	0.24300	0.24000
Carbon Fiber/ epoxy laminate(CL)	1.00000	0.36269	0.96000	0.04290	0.01520	0.11628	1.00000	1.00000
Titanium Alloy (Ti6Al4 V)	0.24629	0.56995	0.30000	1.00000	0.03673	0.93023	0.80000	0.36000

Table 2 presents a comparison of performance values for different materials based on various properties. Let's examine each material:

1. Steel Alloy (AHSS):
    - Tensile Strength: 0.28571 (relative value)
    - Stiffness: 1.00000 (relative value)
    - Damping capacity: 1.00000 (relative value)
    - Hardness: 0.05282 (relative value)
    - Thermal Conductivity: 0.21735 (relative value)
    - Recycling Rate: 1.00000 (relative value)
    - Cost: 0.07250 (relative value)
    - CO2 Emission: 0.09500 (relative value)
2. Aluminum Alloy (A7075 T6):
    - Tensile Strength: 0.16343 (relative value)
    - Stiffness: 0.37306 (relative value)
    - Damping capacity: 0.04000 (relative value)
    - Hardness: 0.02332 (relative value)
    - Thermal Conductivity: 1.00000 (relative value)
    - Recycling Rate: 0.60465 (relative value)
    - Cost: 0.24300 (relative value)
    - CO2 Emission: 0.24000 (relative value)
3. Carbon Fiber/epoxy laminate (CL):
    - Tensile Strength: 1.00000 (relative value)
    - Stiffness: 0.36269 (relative value)
    - Damping capacity: 0.96000 (relative value)
    - Hardness: 0.04290 (relative value)
    - Thermal Conductivity: 0.01520 (relative value)
    - Recycling Rate: 0.11628 (relative value)
    - Cost: 1.00000 (relative value)
    - CO2 Emission: 1.00000 (relative value)
4. Titanium Alloy (Ti6Al4 V):
    - Tensile Strength: 0.24629 (relative value)
    - Stiffness: 0.56995 (relative value)
    - Damping capacity: 0.30000 (relative value)
    - Hardness: 1.00000 (relative value)
    - Thermal Conductivity: 0.03673 (relative value)
    - Recycling Rate: 0.93023 (relative value)
    - Cost: 0.80000 (relative value)

- CO_2 Emission: 0.36000 (relative value)

In Table 2, the performance values for each property are presented as relative values, where 1.00000 represents the highest value within each column. The other values are scaled accordingly. This table allows for a comparative analysis of the materials based on their performance in different properties. For example, when comparing the tensile strength, carbon fiber/epoxy laminate (CL) has the highest relative value of 1.00000, indicating its superior strength compared to the other materials. Steel alloy (AHSS) and titanium alloy (Ti6Al4 V) also have relatively high tensile strengths but lower than that of carbon fiber/epoxy laminate. Aluminum alloy (A7075 T6) has the lowest relative value for tensile strength among the materials listed. Similarly, other properties such as stiffness, damping capacity, hardness, thermal conductivity, recycling rate, cost, and CO_2 emissions can be compared between the materials using their respective relative values. This table provides a comprehensive overview of the materials' performance values, allowing for easy comparison and analysis of their suitability for various applications based on specific requirements and priorities.

Weight							
Tensile Strength (Mpa)	Stiffness (Gpa)	Damping capacity	Hardness (MPa)	Thermal Conductivity (W/mK)	Recycling rate (%)	Cost (Rs)	CO2 Emission (Ton/Ton)
0.12500	0.12500	0.12500	0.12500	0.12500	0.12500	0.12500	0.12500
0.12500	0.12500	0.12500	0.12500	0.12500	0.12500	0.12500	0.12500
0.12500	0.12500	0.12500	0.12500	0.12500	0.12500	0.12500	0.12500
0.12500	0.12500	0.12500	0.12500	0.12500	0.12500	0.12500	0.12500

TABLE 3. Weight

Table 3 shows the weight of the Sustainable automotive car body material the weight is equal for all the value in the set of data in the table 1. The weight is multiplied with the previous table to get the next value.

TABLE 4. Weighted normalized decision matrix

Weighted normalized decision matrix							
Tensile Strength (Mpa)	Stiffness (Gpa)	Damping capacity	Hardness (MPa)	Thermal Conductivity (W/mK)	Recycling rate (%)	Cost (Rs)	CO2 Emission (Ton/Ton)
0.03571	0.12500	0.12500	0.00660	0.02717	0.12500	0.00906	0.01188
0.02043	0.04663	0.00500	0.00292	0.12500	0.07558	0.03038	0.03000
0.12500	0.04534	0.12000	0.00536	0.00190	0.01453	0.12500	0.12500
0.03079	0.07124	0.03750	0.12500	0.00459	0.11628	0.10000	0.04500

Table 4. Weighted normalized decision matrix shows the Alternative Parameters: Steel Alloy (AHSS), Aluminium Alloy (A7075 T6), Carbon Fiber/ epoxy laminate (CL), Titanium Alloy (Ti6Al4 V). Evaluation Parameters: Tensile Strength, Stiffness, Damping capacity, Hardness, Thermal Conductivity, Recycling rate, Cost, CO_2 Emission.

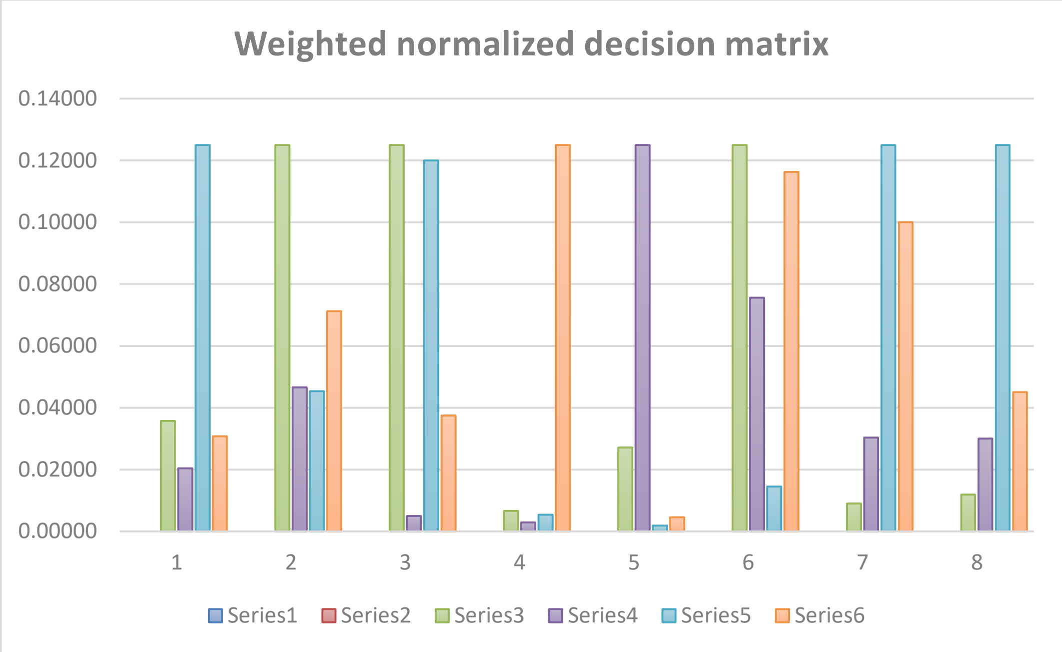

FIGURE 2. Weighted normalized decision matrix

TABLE 5. Preference Score & WASPAS Coefficient & Rank

	Preference Score	WASPAS Coefficient	Rank
Steel Alloy (AHSS)	0.46542	0.23293	4
Aluminium Alloy (A7075 T6)	4.66492	2.33433	1
Carbon Fiber/ epoxy laminate (CL)	3.64999	1.82504	2
Titanium Alloy (Ti6Al4 V)	3.29926	1.64970	3

Table 5 presents the preference scores, WASPAS coefficients, and ranks for different materials. Let's examine each entry:

1. Steel Alloy (AHSS):
    - Preference Score: 0.46542
    - WASPAS Coefficient: 0.23293
    - Rank: 4
2. Aluminum Alloy (A7075 T6):
    - Preference Score: 4.66492
    - WASPAS Coefficient: 2.33433
    - Rank: 1
3. Carbon Fiber/epoxy laminate (CL):
    - Preference Score: 3.64999
    - WASPAS Coefficient: 1.82504
    - Rank: 2
4. Titanium Alloy (Ti6Al4 V):
    - Preference Score: 3.29926
    - WASPAS Coefficient: 1.64970
    - Rank: 3

In Table 5, the preference score represents the relative preference or desirability of each material, with higher values indicating a higher preference. The WASPAS (Weighted Aggregated Sum Product Assessment) coefficient measures the relative weight or importance assigned to each material. The rank represents the position or order of each material based on its preference score. According to the table, Aluminium Alloy (A7075 T6) has the highest preference score of 4.66492, indicating it is the most preferred material among the listed options. It also holds the rank 1. Carbon Fiber/epoxy laminate (CL) has the second-highest preference score (3.64999) and is ranked 2. Titanium Alloy (Ti6Al4 V) has a preference score of 3.29926 and holds the rank 3. Steel Alloy (AHSS) has the lowest preference score (0.46542) and is ranked 4. These rankings and preference scores are determined based on the assigned WASPAS coefficients, which represent the relative importance or weight of each material's properties or criteria in the decision-making process. The specific criteria or factors considered for assigning these scores and coefficients are not provided in the table. The table helps in comparing and ranking the materials based on their overall preference scores, allowing for a quick understanding of the relative desirability of each material according to the given criteria and weights.

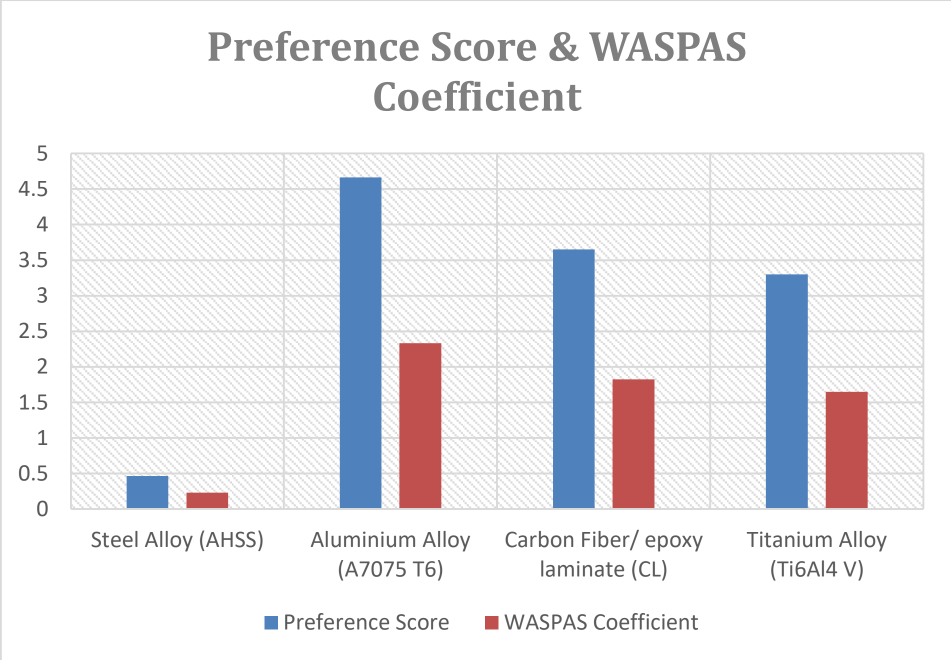

FIGURE 3. Preference Score& WASPAS Coefficient

Figure 3. Preference Score& WASPAS Coefficient Shows the Steel Alloy (AHSS) Preference Score (0.46542) WASPAS Coefficient (0.23293), Aluminium Alloy (A7075 T6) Preference Score (4.66492) WASPAS Coefficient (2.33433), Carbon Fiber/ epoxy laminate (CL) Preference Score (3.64999) WASPAS Coefficient (1.82504), Titanium Alloy (Ti6Al4 V) Preference Score (3.29926), WASPAS Coefficient (1.64970).

FIGURE 4. Rank

Figure 4. Rank shows the Sustainable Car Body Materials the final result of this paper Steel Alloy (AHSS) is in 4th rank, Aluminium Alloy (A7075 T6) is in 1st rank, Carbon Fiber/ epoxy laminate (CL) is in 2nd rank, Titanium Alloy (Ti6Al4 V) is in 3rd rank the final result is done by using the WASPAS method.

IV. CONCLUSION

The development and utilization of sustainable car body materials are of paramount importance in the automotive industry's pursuit of sustainability and environmental responsibility. With the increasing global concern about climate change and the need for sustainable practices, automakers are compelled to explore and adopt alternative materials that minimize their environmental impact. Sustainable car body materials offer several advantages over conventional options. They are designed to be lightweight, improving energy efficiency and reducing fuel consumption during vehicle operation. Additionally, these materials are often made from renewable resources, reducing reliance on non-renewable raw materials and minimizing carbon emissions during production. Furthermore, sustainable car body materials promote the principles of a circular economy. By incorporating recyclability and end-of-life considerations into material design, automakers can minimize waste generation, facilitate resource recovery, and reduce the demand for virgin materials. However, there are challenges to overcome in the widespread adoption of sustainable car body materials. These include cost considerations, scalability of production, and ensuring adequate performance and safety standards. Research and development efforts need to address these challenges, finding ways to make sustainable materials more economically viable and meeting or exceeding the performance requirements of the automotive industry. In conclusion, sustainable car body materials represent a significant opportunity for the automotive industry to make strides towards a greener and more sustainable future. By investing in research and development, collaborating with material scientists and manufacturers, and prioritizing environmental responsibility, automakers can accelerate the adoption of sustainable car body materials and contribute to the global transition to a low-carbon transportation sector. Ultimately, the use of these materials will not only benefit the environment but also cater to consumer demands for eco-friendly vehicles and drive positive change in the industry as a whole.

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