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SCIENTOMETRIC ANALYSIS ON UTILIZATION OF AGRICULTURAL WASTE FOR BOARD AND PANEL PREPARATION

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ABSTRACT

Agricultural wastes are widely distributed in the environment, creating a health and environmental risk. Because of their environmental and health benefits, natural insulating materials are becoming increasingly popular. The goal of this research is to provide a precise method for measuring science and technology development trends in agricultural waste panel and board production, with sustainability as the most important factor. The papers were gathered using a bibliographic approach based on the Scopus database. Using scientometric analysis, researchers can look at the trends in these articles, including keywords, journals, countries, and authors. The use of waste in energy-efficient architecture is an emerging research topic. The filter is applied based on the paper's keyword of panel and board, and the observed properties are detailed in the study. The research is being carried out to gain a practical understanding of the various materials that have been used in the preparation of boards and panels, as well as the tests that will be carried out, such as modulus of rupture, elasticity, thermal conductivity, energy analysis, small hot box test, and life cycle assessment to assess energy usage and CO_2 emissions. The future scope has also been added in the conclusion.

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Keywords: Agricultural waste, Board, Panel, Insulation, Thermal conductivity.

1.Introduction

Many countries are now debating the use of organic residual biomass from urban, agricultural, and industrial sources. Dumping materials in landfills adds to the production of greenhouse gases, of which paper and cardboard account for a significant portion [1]. Agriculture produces trash, which is currently mismanaged in terms of both environmental and economic considerations [2]. Agricultural waste has the potential to play a key role as a sustainable alternative building material in the construction industry. New alternative sustainable insulating construction products, on the other hand, have been at the forefront of societal concerns [3]. Buildings use a lot of energy and have a lot of severe environmental effects. A structure's facade is a structural component that can help save energy while also mitigating negative environmental effects [4]. Pyrolysis is one of the processes that might be used to transform biomass into higher-value goods [5]. Nonetheless, administrations are passing regulations to prohibit the use of asbestos in a wide range of items due to a variety of health issues. Other advanced technologies are currently searching for more resistant and long-lasting materials [6]. The demand for energy is high, as are the prices of heating and cooling in the winter and summer, respectively. Building insulation, which is becoming increasingly popular, may help save money on these charges. The creation of acceptable materials has become equally important as a result of the rising use [7]. Manufacturing particleboards with agricultural waste as raw materials is a cost-effective and intriguing solution. Natural particleboards with low thermal conductivity might be used in a variety of applications, including ceiling and wall insulation. Furthermore, manufacturers, restaurants, and the food industry create a large number of

agricultural peels each year, which are frequently discarded as trash [8]. Particleboard makers are now obliged to search for new, inexpensive, and readily available raw material sources. At the same time, the construction industry has concentrated on using healthier, safer, and ecologically friendly materials [9]. Particleboard is indeed an engineered wood-based panel made by heating and pressing wood particles with an appropriate adhesive. The major main material in the particleboard business is wood [10]. Vermicomposting, which uses worms to stabilize and modify compost into useable end-products, has been recommended as an alternate treatment strategy for high-moisture-content organic wastes from agricultural, industrial, and municipal sources [11]. A large research community has been paying attention to the ongoing search for better sustainable and cost-effective processing solutions throughout the world. Emissions CO_2 of to the environment, energy, and water usage are just a few of the variables that play a role in this scenario. Some approaches that have shown favorable outcomes in this context include reusing, employing green construction materials (which has to be sustainable, regional, and accessible), retrofitting, and adopting low-tech tools and approaches [12]. Concrete manufacturing has become one of the primary environmental problems in the construction sector because to the related emissions and contributing to natural resource depletion [13].

Using diverse types of agricultural waste for the board can help reduce CO_2 emissions while also being beneficial for soundproofing, insulation, and artificial ceilings [14]. Cork oak are long-lived trees (up to 200 to 250 years), and various life cycle assessments on cork material have highlighted the forest's sustainable environmental benefits, especially in terms of avoiding destruction in dry regions and long-term CO_2 reduction [15]. Buildings' environmental effect has been analyzed not just in terms of the energy used in their usage, but also in terms of the energy materials used in their construction. The prevalence of "sick building syndrome" is

rising. The primary investigation was chemical contaminants from indoor sources such as building materials, poor ventilation, excessive use of heating, ventilation, and air conditioning, and volatile organic compounds [16]. Not only has the utilization of agricultural waste proven beneficial in terms of insulation, but so has bacterial farming, it is 20% stronger and has a larger density, a greensulate panel offers better structural qualities than a foam panel. It is less flammable than foam and can sustain fire for longer. It also creates no hazardous emissions when burned and may be broken down into little pieces and dispersed on the ground to give nutrients [17]. The basic thermophysical characteristics used to describe the thermal behaviour of insulating materials are thermal conductivity, specific heat capacity, and density [18].

Sustainable development asks for lower-impact technology in all aspects of human existence; a circular economy approach attempts to keep a product's value by returning it to the manufacturing process at the end of its lifespan, reducing material intake, waste creation, and energy usage [19]. Waste management is the most essential issue in environmental preservation and natural resource protection. The fundamental causes of the numerous processes of deterioration that have harmed our planet's ecosystem, including the creation of municipal solid waste, are changes in the environment and population increase [20]. The increasing need for high thermal performance and "near-zero-energy" buildings, as well as present rising problems and possibilities in the domains of green manufacturing and low environmental effect, necessitate the use of organic relevant items rather than traditional methods [21]. Thermal insulation is a low-cost, widely available, and well-proven method that saves energy and money while also decreasing emissions as soon as it is implemented. The originality of this research derives from the analysis done, which included a cross-comparative study capable of picking the best article from the scopus data source linked to panel and board preparation, as well as experimental investigations in

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terms of thermal performance and environmental effect. By merging VOS mapping technology with upgraded viewer software, the VOS viewer application was born. The VOS viewer works with almost any hardware and operating system. It may also be launched directly from a web page on the internet [22].

The utilization of agricultural waste will be focused in this study. Agricultural waste is a good building material since it is renewable, inexpensive, lightweight, and has a high specific strength and stiffness.

2. Methodology

While document structure is important in many fields, it is especially important in information inspection. Bibliometrics is the study of document structure via the use of tools, goals, frequency classification, ranking, and reference analysis. The details about the various level done to carry out the review study is represented in the Fig.1 that consisting of six levels.

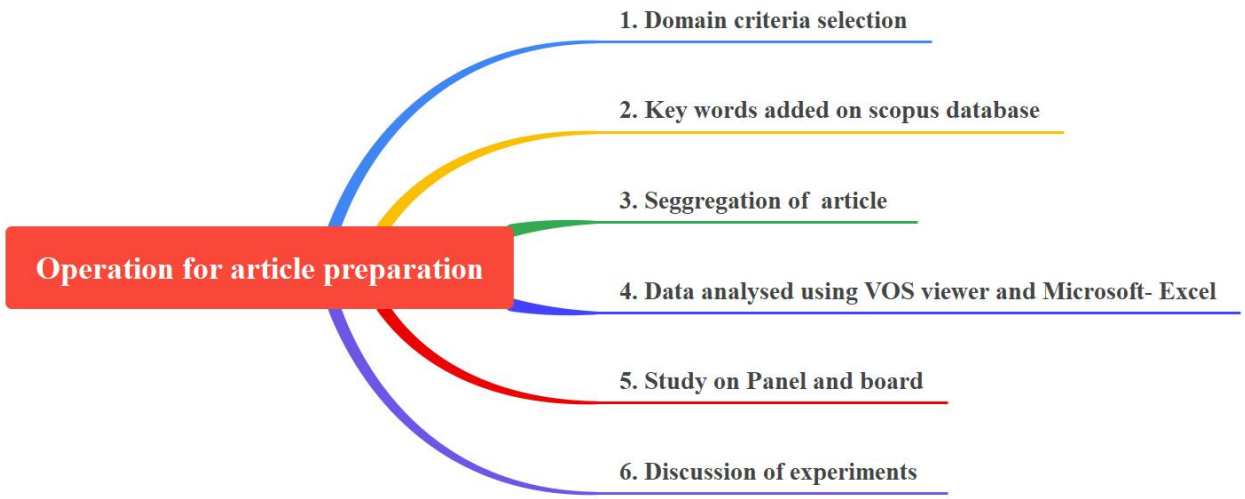

Fig.1. Levels for analytical study

2.1 Data analysis

Bibliometric analysis, a methodology for mapping identified published records, is now widely recognized as a new way to evaluate academically

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complex themes in library and information science [23-24] VOS viewer is a publicly accessible computer software for creating and viewing bibliometric maps. The VOS viewer is used to produce co-citation maps of authors or journals, as well as co-occurrence maps of keywords [25].

2.2 Data retrieval

The Scopus database was used as it gives users access to journal articles as well as the references in those papers allowing them to go back and forth in time. The database may be used for both research and collection development. [26] A total of 675 articles were used to do research on board made from farm waste.

3. Publications

3.1 Annual publication using agricultural waste

Agricultural waste utilization is one of the important topics to be analyzed as it creating a disturbing impact on the environment. From 1974 to 2021, Fig.2 shows publications published on the subject of "agricultural waste utilized in civil engineering" for construction applications.

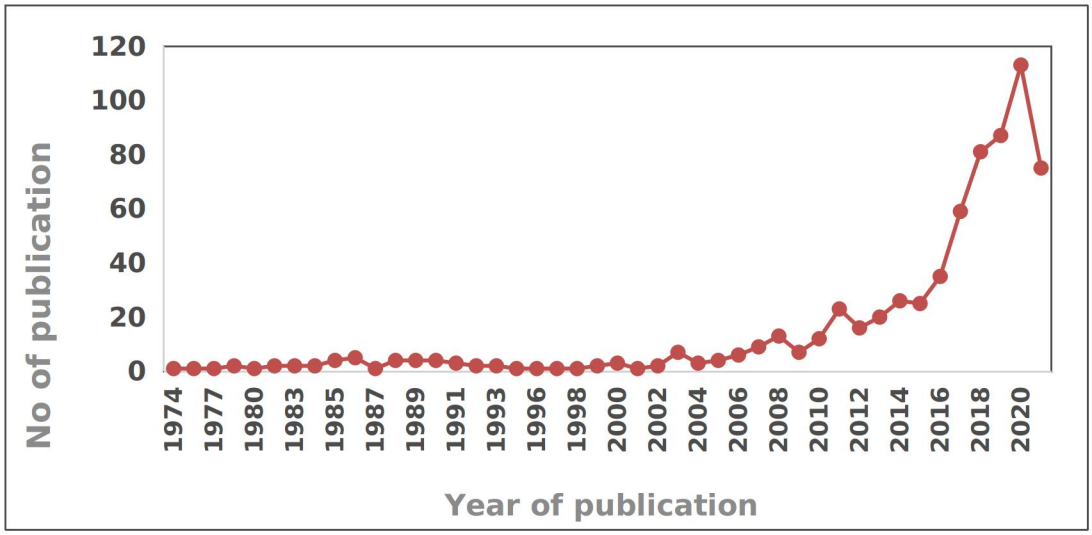

Fig.2. Chronological order of agricultural waste publication

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From the above figure, it is observed that the study on agricultural waste has been done from early years but from 2010, the study has been increased exponentially each year. In 2020 it has reached the highest and it continuous increasing in 2021.

3.2 Types of publication

The publication is divided into three areas, document type, language, and publication access. Fig.3 shows the number of different sorts of publications over the same period (1974 to July 2021). The language in which the publications were published is shown in Fig.4. The graph clearly shows that more than 63% of papers were written in the English language. Fig.5 depicts the paper's publishing access where 75% of the papers are published in the paid journal.

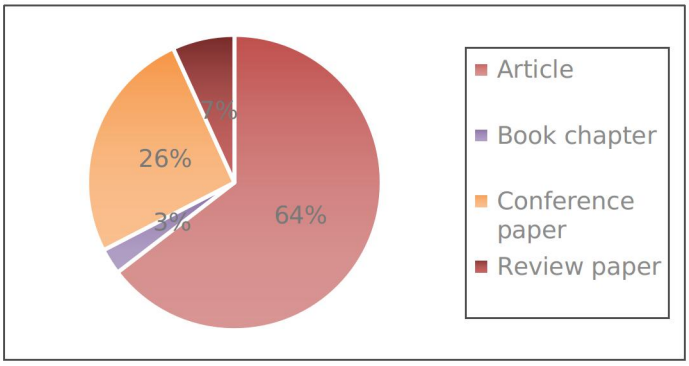

Fig.3. Publication based on document type

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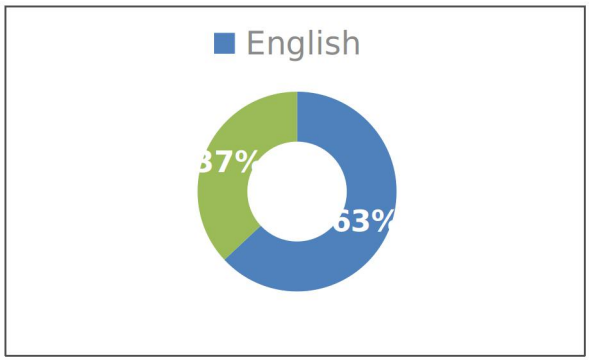

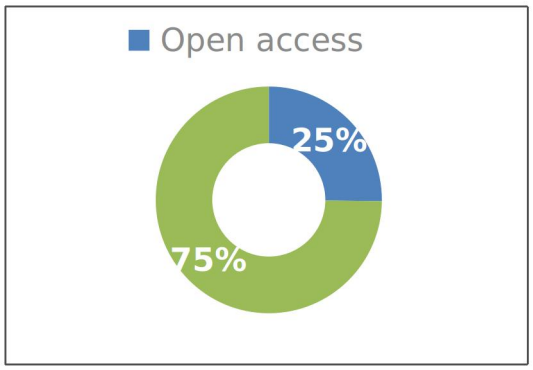

Fig.4. Publication based on language

Fig.5. Publication based on access

3.3 Keyword analysis

The review of the paper is on the area related to agricultural waste and the most prevalent keywords linked with agricultural waste in the building were analyzed. The minimal number of keyword co-occurrences has been kept at five. Using these conditions as a guide, 72 out of 1640 met the requirements. Following that, the mapping was used to document the co-occurrences of terms, total occurrences, and total bond strength. Fig.6 depicts a keyword-based collaborative network. The clusters of the keyword that has been taken in various studies are shown in Table 1.

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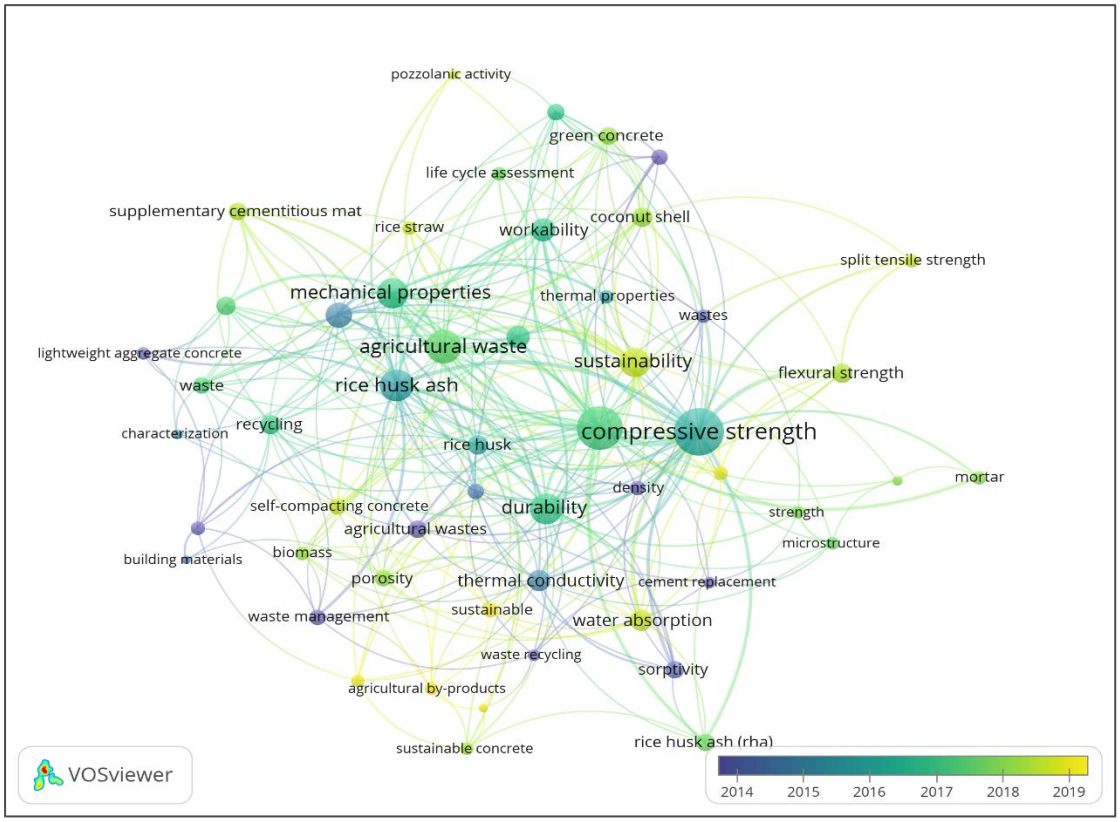

Fig.6 Occurrences map of keywords

Table 1 Clusters of keywords.

Cluster no	Keywords
1	Agricultural by- products, agricultural wastes, biomass, building materials, porosity, recycling, rice husk, self-compacting concrete, sustainable, sustainable concrete, sustainable developer, sustainable materials, thermal conductivity, waste management, Waste material waste recycling.
2	Agriculture waste, agricultural waste materials, environmental impact, green concrete, life cycle assessment, pozzolanic activity, rice husk ash, rice straw, thermal insulation, workability.
3	Characterization, coconut shell, lightweight aggregate, lightweight concrete, mechanical properties solid waste.

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4	Agricultural residues, cement replacement, concrete, durability, microstructure, mortar, strength, sustainability, wastes.
5	Compressive strength, density, flexural strength, foamed concrete, rice husk ash, sorptivity, split tensile strength, water absorption.

3.4 Source Analysis

Readers may receive the finest information available and quickly choose the ideal journal for publishing by assessing the influence of journals in a given subject. Fig.7 shows the source occurrences map using the bibliography as an analysis tool. The minimum number of documents of a source given was 8 and out of 331 sources, 15 meets the threshold. The clusters of the source that has been taken in various studies are shown in Table 2. A cluster is a collection of nodes that are linked in some way. In a network, each node is allocated to a single cluster.

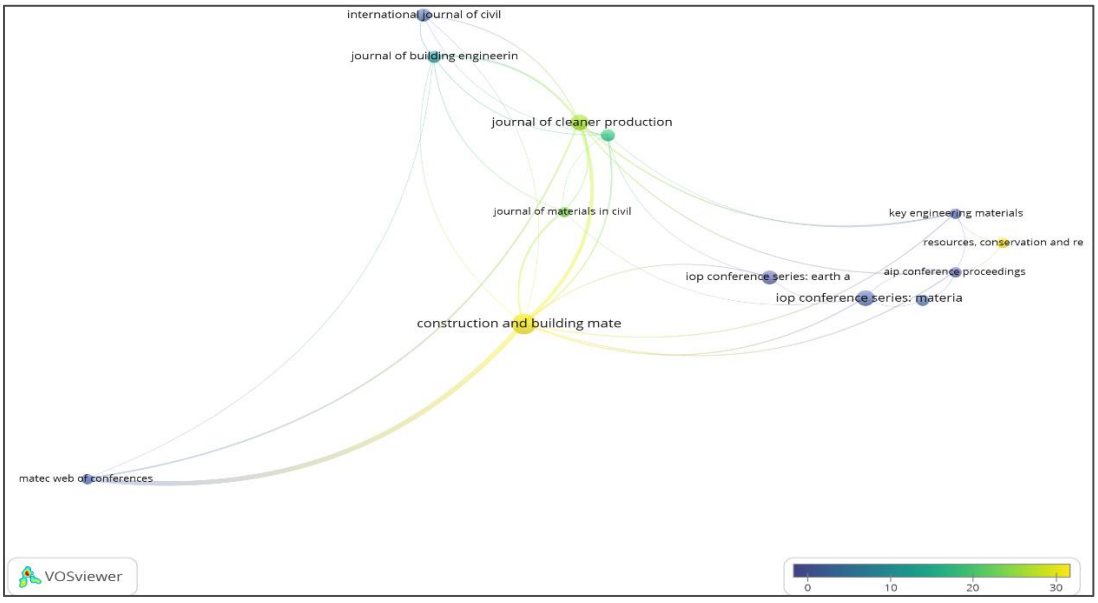

Fig.7. Occurrence's map of source

Table 1 Clusters of Source

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Cluster no	Source
1	AIP conference proceedings, IOP conference series: earth and environmental science, iop conference series: material science and engineering, key engineering materials. Materials today: proceeding, resources, conservation and re.
2	International journal of civil, journal of building engineering, journal of cleaner production, materials.
3	Construction and building, matec web of conference

3.5 Regions analysis

According to the research, the minimum document was 5. Computing the overall strength of co-production groups with other nations and choosing the country with the largest total bandwidth among the 152 countries, 35 meet the threshold that fulfills the criterion. Fig. 8 depicts a network of collaboration based on national cooperation. The highest document was 134 from India and the lowest was 5 from Taiwan. The clusters of the region that has done similar studies are shown in Table 3.

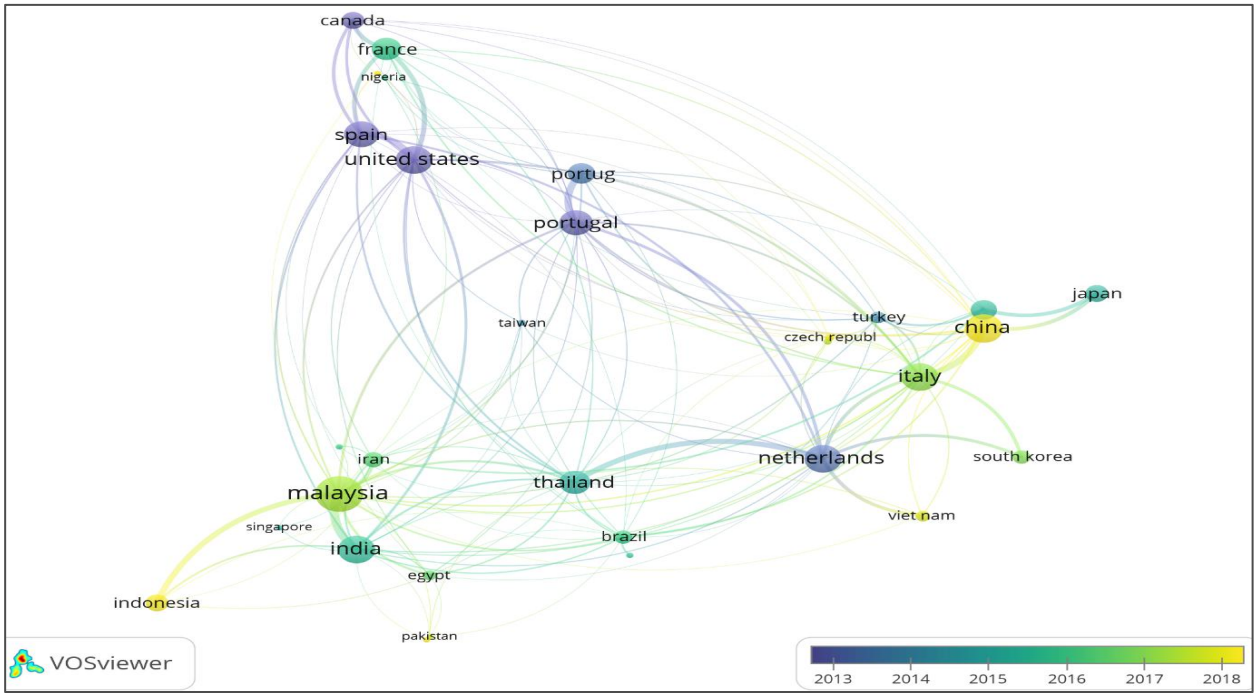

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Fig.8. Occurrence's map of country

Tables 3 Clusters of country

Cluster no	Country
1	Australia, Canada, France, Nigeria, Spain, United States
2	India, Indonesia, Iran, Malaysia, Mexico, Singapore
3	Brazil, Egypt, Germany, Pakistan, South Africa, Thailand
4	Italy, Netherlands, South Korea, Vietnam
5	China, japan, Turkey, United Kingdom
6	Portugal, Taiwan
7	Czech republic

4. Panel Vs Board

A panel is a rectangular portion of a surface covering, wall, fence, and other structure in architecture, a recessed compartment with elevated borders, as in ceilings, wainscotings, etc. While a board is a long, broad, and thin piece of any material, generally wood is similarly used in building or furniture manufacturing. But likely to be used as a word for similar meaning.

4.1 Study on the board preparation using the farm waste

The data collected for the research on agricultural waste was further separated, and then the studies prepared on the board were taken. Corn curbs, agriculture debris, rice husk, and coconut husk, have high insulating properties. The filtering procedure in the title of the article using boards as a search phrase was used to separate the 675 articles. Fig.9 depicts the article about the board that was published each year. It can be

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observed that the study in the area of board preparation for insulation has been increasing from 2020.

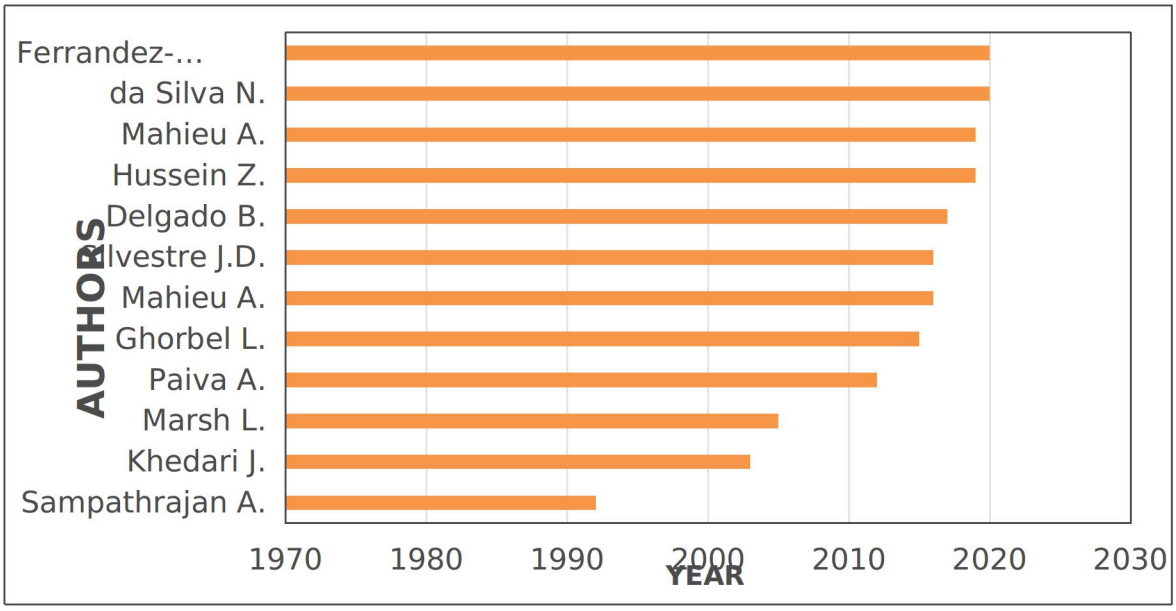

Fig.9. Chronological order of board publication.

4.2 Study on the panel preparation using the farm waste

The data gathered for the agricultural waste study was divided further, and the studies prepared on the panel were then taken. Mostly used waste for the study was cork, granulated tires, rice husk, coffee chaff, wood shavings, straw, and maize stalks Fig.10 depicts the article about the panel that was published each year. It can be observed that the study in the area of panel preparation for insulation has been continuing in 2021.

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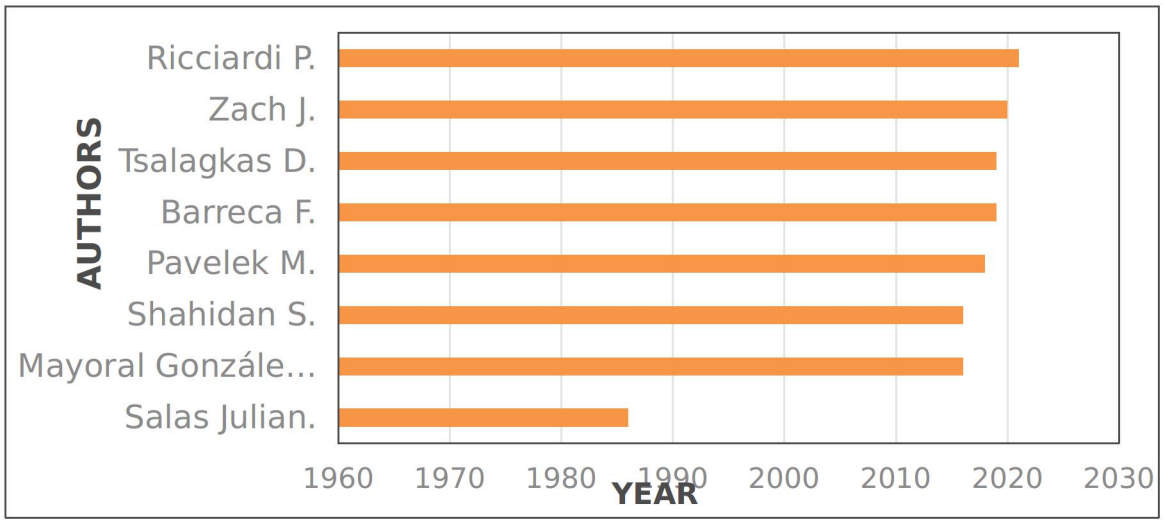

Fig.10. Chronological order of panel publication

5. Test to be done for Board and Panel

The four main parts of this technique include mixing the components, starting with the particles and glue, molding, natural curing, and unmolding. The sample preparation technique is depicted in Figure 11 [7].

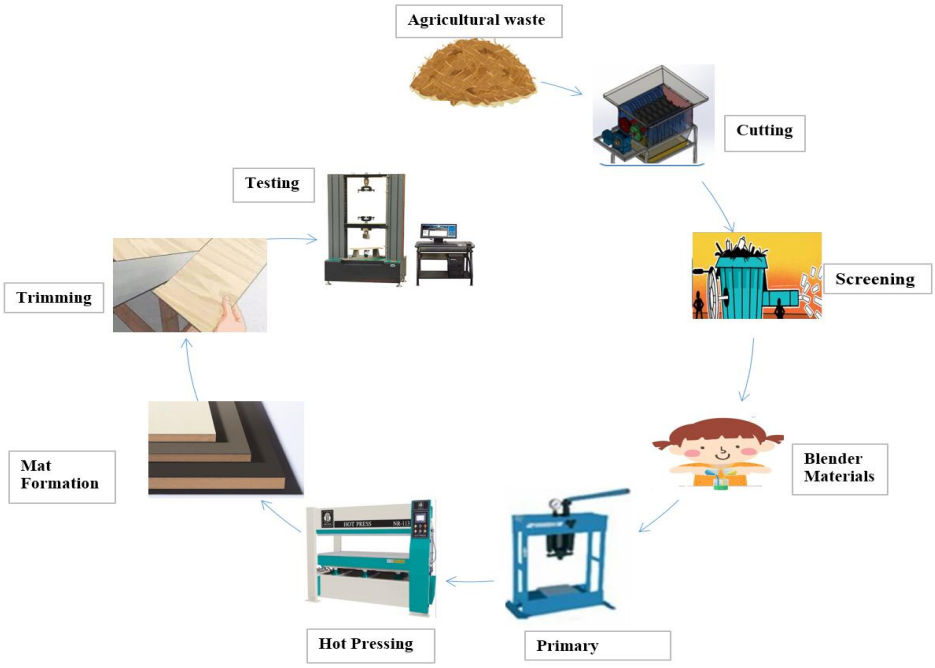

Fig.11. Particleboard production process.

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5.1 Classification of board

Particleboards are divided into seven categories based on their characteristics. The SFS-EN 312 [27] standard is used to define the characteristics of particle board classes across Europe. Particleboard classes are denoted by the letter 'P' followed by a number from 1 to 7 [28]. Table 4 shows the classification of board grades.

Table 4 Board grade and its uses

GRADE	USES
P1	Boards for interior construction
P2	Interior usage furniture boards
P3	Non-load-bearing usage
P4	Interior-use boards that can endure stress
P5	board that withstands moisture better, that must tolerate tension.
P6	For internal usage, floor boards that can resist a lot of pressure.
P7	For applications that must bear a lot of pressure.

5.2 Flexural strength

Flexural parameters such as modulus of rupture (MOR) and modulus of elasticity will be evaluated using static bending tests (MOE) section 9 of ASTM D1037-06 [20] is used for the samples that are subjected to static bending testing [7]. The results are shown in Table 5 for various materials.

Table 5 MOR and MOE of board from various farm waste materials [2,7,9,10,14]

Material	**MOR (MPa)**	**MOE (MPa)**

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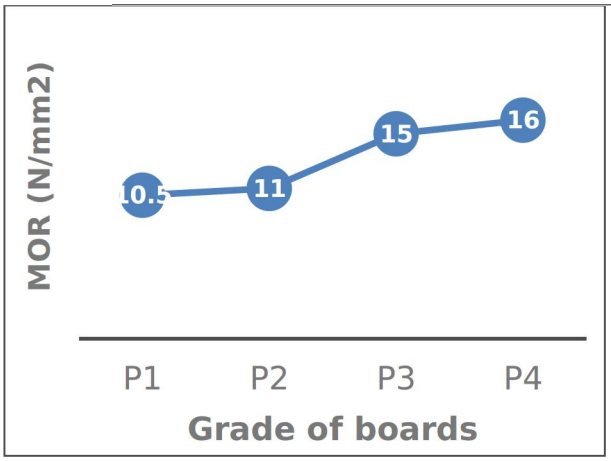
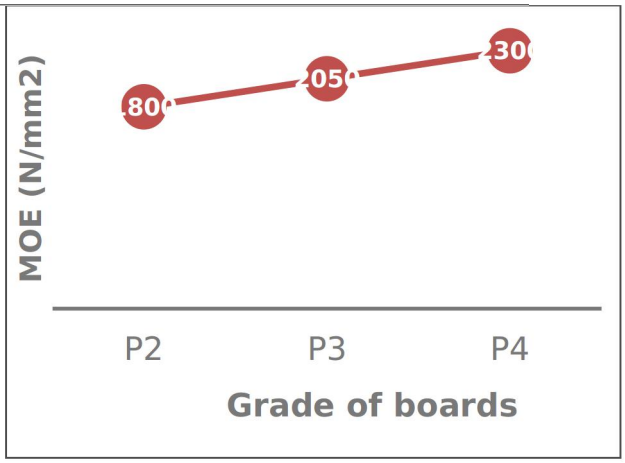
Vine pruning	6.58- 16.5.	743 – 1810
Flax	13.85	1722
Durian particleboards	25.177	28.407
Rubber wood Medium Density	3776.100	2947.234
Tea oil camellia shell	13.4	1840
Maize husk	427	5.2
Paddy straw	193	4.9
Coconut Pith	282	5.8
Groundnut shell	523	6.3



a) Modulus of rupture for grade P1-P4



b) Modulus of elasticity for grade P1-P4

Fig.12. MOR and MOE of Grade P1-P2

5.3 Thickness swelling and water absorption

According to European rules, particleboards certified as Grade P3 must have a maximum thickness swelling value of 17% after 24 hours in water. The findings of the thickness swelling values and water absorption values using natural fiber are shown in Fig.13. [2].

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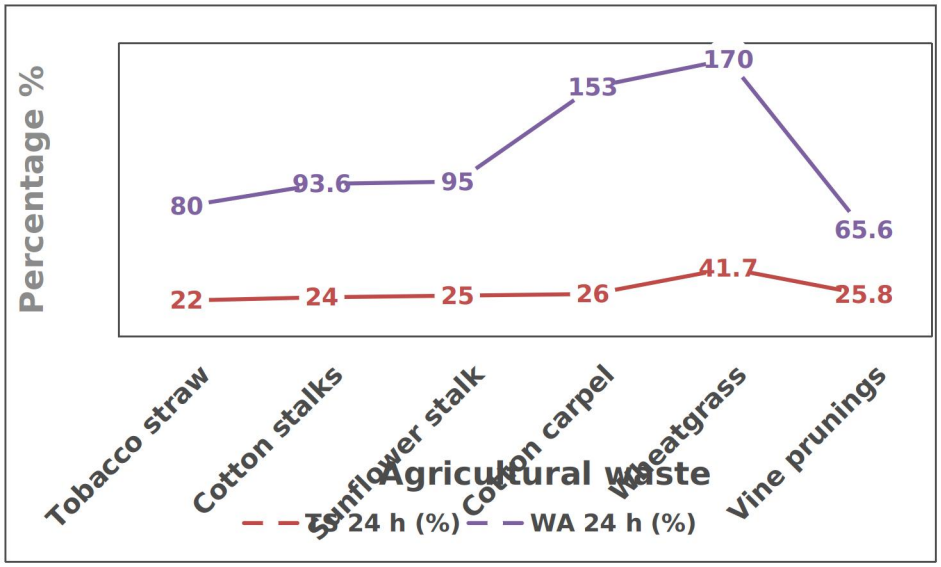

Fig.13. Thickness swelling (TS) and water absorption (WA).

Water absorption can be assessed with a precision of 0.1 mg by weighing the samples before and after immersion. To get an accurate average, the measurements must be repeated five times for each particleboard[9].

5.4 Sound insulation

Boards with thicknesses of 3, 2, and 4 cm are utilized for sound insulation boards made from natural waste. Impact sound insulation tests must be carried out following NP EN ISO 140 [30], and impact sound insulation ratings were determined following ISO 717-2 [31]. The equipment to measure sound insulation is shown in Fig.14. The basic tools for testing sound insulation are a sonometer and a percussion machine [3]. Table 6 shows the values of the various average sound absorption coefficients for agricultural materials.

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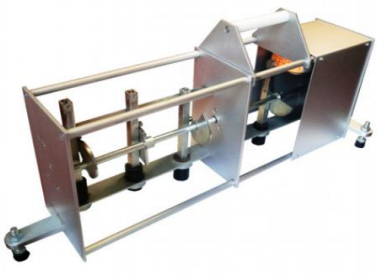
(a) I - Rion NC74, II - Sonometer (01dB/Solo Blue) and III - standard tripod



(b) Percussion machine (Retec RI 069)

Fig.14. Sound insulation test equipment.

Table 6 Sound absorption coefficient of materials.

Product	Average sound absorption coefficient	References	Product	Average sound absorption coefficient	References
Flax	0.5–0.85	[34]	**Rice**	0.02–0.8	[38]
Hemp	0.45–0.95	[35]	**Oak**	0.9	[36]
Reed	0.25–0.6	[36]	**Coconut**	0.5–0.9	[39]
Bagasse	0.15–0.9	[37]	**Palm**	0.38	[40]
Sunflower	0.86–0.99	[35]			

5.5 Thermal conductivity

A Netzsch Heat Flow Meter (HFM) 436 Lamda was used to measure the thermal conductivity () of the bulk plant particles and particleboards [9]. As the porosity of the boards grew, the thermal conductivity decreased as the particle size rise [2]. The HFM is a calibrated device that is used for testing thermal conductivity. A specimen is placed between two plates, one hot and the other cold, and the heat flow induced by the temperature

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differential is measured using a heat flux sensor [32]. The schematic diagram is shown in Fig.15 and the thermal conductivity (**λ**) value for various materials is shown in table 7.

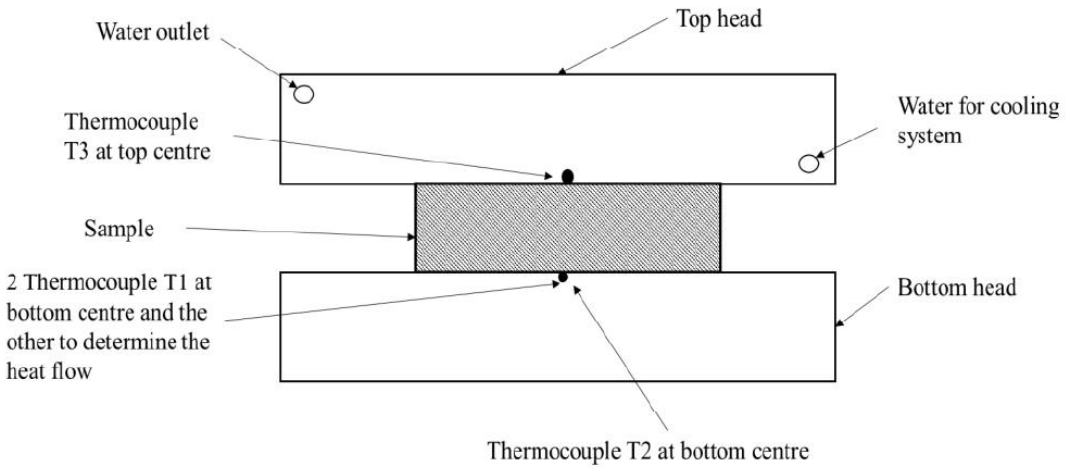

Fig.15. Schematic of thermal conductivity test [6]

Table 7 Thermal conductivity coefficients of different organic fibers [2].

Material	Thermal Conductivity λ (W/m K)
	0.111
Hemp	0.040 to 0.094
	0.038 to 0.075
Flax	0.042
Cotton	0.040 to 0.069
Date palm rachis	0.083
Rice straw	0.076 to 0.091
Sisal	0.070
Sugarcane bagasse	0.079 to 0.098
Wood particleboards	0.070 to 0.180
Wood	0.050 to 0.140

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fiberboards	
Vine prunings	0.064 to 0.068

The hot box design is the method that was used by Milos Pavelek and Paola Ricciardi to measure the thermal conductivities. Fig.16 shows the apparatus of the small hot-box [19].

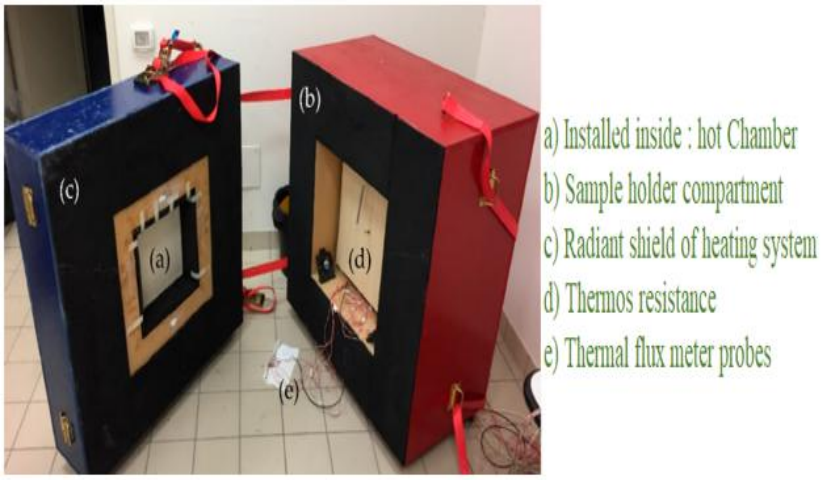

Fig.16. The small hot box apparatus

The specimen is sandwiched between two compartments, one for metering and the other for environmental conditions [42]. The climatic chamber represents the outside climate (cold side), whereas the metering chamber represents the inside environment (hot side). The panel thermal resistance is estimated using the observed heat flow from the metering chamber side to the climatic chamber side passing through the specimen, as well as the recorded temperature differential between the hot and cold sides [41].

5.6 Energy analysis

The software mostly used is “energy plus”. This activity includes the physical or chemical processing of materials, as well as the transfer and conversion of energy. The innovative panels in giant reed for buildings with

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the “chimney effect” and the cork were used to make the panel in the wall the panel was compared with the normal brick wall for the energy analysis of heating and cooling. For heating and cooling, the predicted CO_2 emissions for brick walls were 2517 kg, 623 kg for agglomerated cork walls, and 1905 kg for giant reed walls [16].

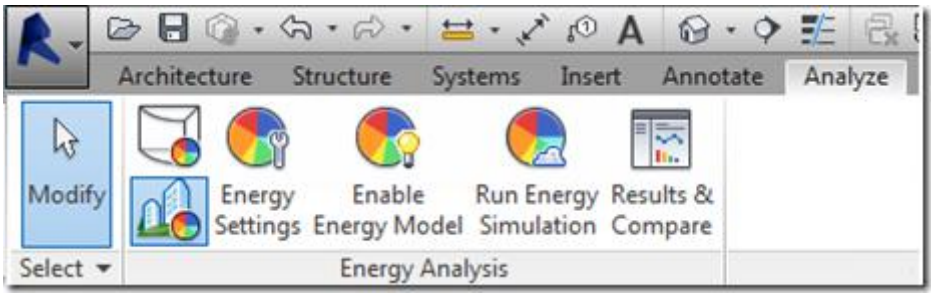

Fig.17. Energy Analysis for Autodesk Revit

As shown in Fig.17, Energy Analysis for Revit is a tool that allows users to execute a cloud-based whole-building evaluation using Autodesk® Green Building Studio® (GBS) directly from Revit. Revit now provides an integrated Energy Analysis workflow that incorporates both Architectural Building elements such as walls, roofs, floors, and windows, as well as Conceptual Massing components formerly known as Conceptual Energy Analysis.

5.8 Life Cycle Assessment (LCA)

The analysis and valuation of a given item's natural impacts is known as a life cycle assessment [1]. An LCA investigation of a building material or collection can be classified as cradle-to-grave (the extraction and handling of raw materials and creation), cradle-to-cradle (vehicle cost, appropriation, and assembly, use, upkeep, and final removal), or cradle-to-cradle (reuse, recovery, and recycling).The details of 4 stages (A,B,C and D) considered in LCA are discussed in figure 18.

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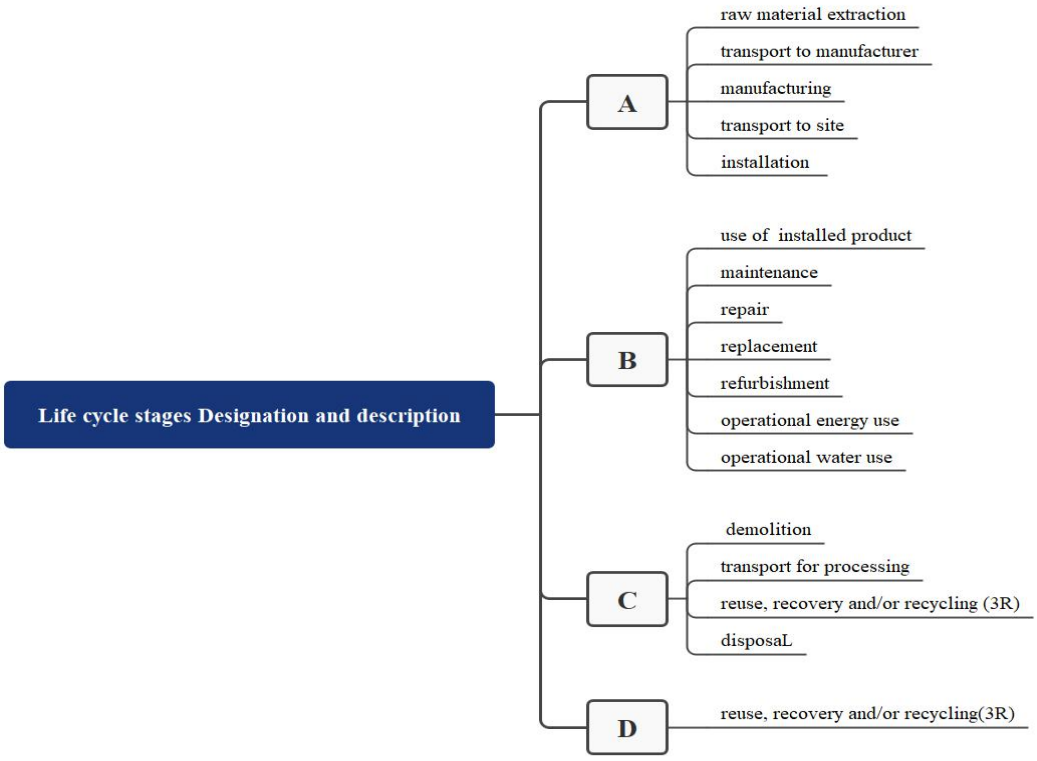

Fig.18. Detailed life cycle stages of building materials [15]

The importance of conducting a life cycle assessment of particleboard production is that it provides information on critical parameters such as fossil fuel based primary energy consumption, renewable primary energy consumption, Eutrophication potential, climate impact over a period of 100 years, depletion of the ozone layer.

6. Conclusion

- The monetization of these agricultural byproducts could thus give farmers with a new source of income. It contributes to the removal of agricultural waste from the environment in such a way that even waste is turned into a commodity.

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- Applying water repellent chemicals during the board's manufacture would improve these metrics significantly if the thickness swelling and water absorption values were very high.

- When compared to cork and granulated tyres, rice husk and coffee chaff have the lowest global warming potential and cumulative energy requirement, especially when considering thermal studies.
- Coconut shells can withstand temperatures of up to 800°C while losing just a small percentage of compressive strength. Less than 10% was the ideal proportion to use as an admixture or replacement. The thermal characterization can be done using the small hot box apparatus.
- Cork, rice husk, and coffee chaff were some of the finest sustainable panels discovered, with similar thermal conductivities of 0.063–0.068 W/mK and reduced environmental effects.
- As the agricultural waste is used on the panel and board preparation the binding agent must be used and binder types urea-formaldehyde, phenol-formaldehyde resins, isocyanate.
- Consequently, particleboards manufactured from agricultural waste are feasible choices to employ in building insulation walls and ceilings, even for the improved aesthetic features making it affordable and also decrease in CO_2 emission and the problem of waste disposal.
- The greater the value of the average sound insulation capacity, the better the sound insulating capability.
- This review paper would help in understanding the different test values of agricultural waste as well as the experimental procedure for the thermal conductivity test. Making it useful for the researcher.
- The study of life cycle assessment aids in analyzing the environmental consequences of practical boards and panels' manufacture, usage, and end-of-life processing. This aids in the reduction of toxic waste utilization as well as pollution in the environment.

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Future scope

Future studies on the impact of various binding material ratios for thermal and mechanical characteristics can be done. Furthermore, most of the studies are done using the hot-pressing process, and fewer binders are used, further research on the binder and alternative agricultural waste for the sustainable solution can be an intriguing and better approach in the construction of sustainable solutions.

Declaration of Competing Interest

There are no conflicts of interest declared by the authors.

References

1. B. Delgado, D. Lopez Gonzalez, S.Godbout, R. Lagace, A. Giroir-Fendler, A. Avalos Ramirez, A study of torrefied cardboard characterization and applications: Composition, oxidation kinetics and methane adsorption, Science of the Total Environment 10 (2017) 593–594.
2. Manuel Ferrandez-Villena, Clara Eugenia Ferrandez-Garcia, Teresa Garcia-Ortuno, Antonio
Ferrandez-Garcia, Maria Teresa Ferrandez-Garcia, Analysis of the Thermal Insulation and Fire- Resistance Capacity of Particleboards Made from Vine (Vitis vinifera L.) Pruning, Polymers 12 (2020) 2-11.
3. Jorge Faustino, Luos Pereira, Salviano Soares, Daniel Cruz, Anabela Paiva, Humberto Varum, Joso Ferreira, Jorge Pinto, Impact sound insulation technique using corn cob particleboard, Construction and Building Materials 37 (2012) 153-159.
4. Amirhossein Balali, Alireza Valipour, Identification and selection of building façade's smart materials according to sustainable development goals, Sustainable Materials and Technologies 26 (2020) 1-20.

5. L. Ghorbel, T. Rouissi, S.K. Brar, D. Lopez-Gonzlebz, A.A. Ramirez, S. Godbout, Value-added performance of processed cardboard and farm breeding compost by pyrolysis, Waste management (2015) 1-10.
6. Daniel Fernando Hincapi Rojas, Posidia Pineda-Gomez, John Fredy Guapacha-Flores, Effect of silica nanoparticles on the mechanical and physical properties of fibercement boards, Journal of Building Engineering 31 (2020) 1-7.
7. Zakia Hussein, Taha Ashour, Mervat Khalil, Adel Bahnasawy, Samir Ali, Jutta Hollands, Azra Korjenic, Rice straw and flax fiber particleboards as a product of agricultural waste: An evaluation of technical properties, Applied science 9 (2019) 1-20.
8. Joseph Khedari, Sarocha Charoenvai, Jongjit Hirunlabh, New insulating particleboards from durian peel and coconut coir, Building and Environment 38 (2003) 435 – 441.
9. A. Mahieua, S. Alixb, N. Leblanca, Properties of particleboards made of agricultural by-products with a classical binder or self-bound, Industrial Crops & Products 130 (2019) 371-379.
10. Kamran Choupani Chaydarreh, Xiuyi Lin, Litao Guan, Hong Yun, Jin Gu, Chuanshuang Hu, Utilization of tea oil camellia (Camellia oleifera Abel.) shells as alternative raw materials for manufacturing particleboard, Industrial Crops & Products 161 (2021) 1-9.
11. Lori Marsh, Scott Subler, Sudanshu Mishra, Michele Marini, Suitability of aquaculture effluent solids mixed with cardboard as a feedstock for vermicomposting, Bio resource Technology 96 (2005) 413–418.
12. Anabela Paiva, Sandra Pereira, Ana Sa, Daniel Cruz, Humberto Varum, Jorge Pinto, A contribution to the thermal insulation performance characterization of corn cob particleboards, Energy and Buildings 45 (2012) 274–279.
13. Malindu Sandanayake , Chamila Gunasekara, David Law, Guomin Zhang, Sujeeva Setunge, Dennis Wanijuru, Sustainable criterion selection framework for green building materials – An optimization based study of fly-ash

Geopolymer concrete, Sustainable Materials and Technologies 25 (2020) 1-10.
14. A.Sampathrajan, N.C. Vijayaraghavan, K.R. Swaminathan, Mechanical and thermal properties of particle boards made from farm residues, Bioresource Technology 40 (1992) 249-251.
15. Jose D. Silvestre, Nuno Pargana, Jorge de Brito, Manuel D. Pinheiro, Vera Durao, Insulation Cork Boards—Environmental Life Cycle Assessment of an Organic Construction Material, Material (2016) 91-16.
16. Francesco Barreca, Antonio Martinez Gabarron, Jose A. Flores Yepes, Joaquin J. Pastor Perezb, Innovative use of giant reed and cork residues for panels of buildings in Mediterranean area, Resources Conservation & Recycling 140 (2019) 259–266.
17. Mayoral Gonzalez, Eduardo, Gonzalez Diez, Isabel, Bacterial induced cementation processes and mycelium panel growth from agricultural waste, Key Engineering Materials 663 (2015) 42-49.
18. Milos Pavelek, Marek Prajer, Kamil Trgala, Static and dynamic thermal characterization of timber frame/wheat (triticum aestivum) chaff thermal insulation panel for sustainable building construction, Sustainability 10 (2018) 1-19.
19. Paola Ricciardi, Elisa Belloni, Francesca Merli, Cinzia Buratti, Sustainable Panels Made with Industrial and Agricultural Waste: Thermal and Environmental Critical Analysis of the Experimental Results, Applied science 11 (2021) 1-14.
20. Shahiron Shahidan, Alif Syazani Leman, Mohamad Syamir Senin, Nurul Izzati Raihan Ramzi Hannan, Suitability of Coconut Shell Concrete for Precast Cool Wall Panel-A Review, MATEC Web of Conferences 87 (2016) 1-10.
21. Dimitrios Tsalagkas, Zoltan Borcsok, Zoltan Pasztory, Thermal, physical and mechanical properties of surface overlaid bark-based insulation panels, European Journal of Wood and Wood Products 77 (2019) 721–730
22. https://www.vosviewer.com

23. Zhang Ying, Pu Shengyan, Lv Xue, Gao Ya, Ge Long, Global trends and prospects in microplastics research: A bibliometric Analysi, Journal of Hazardous Materials (2020) 1-18.
24. Antonino Marvuglia, Lisanne Havinga, Oliver Heidrich, Jimeno Fonseca, Niki Gaitani, Diana Reckien, Advances and challenges in assessing urban sustainability: an advanced bibliometric review, Renewable and Sustainable Energy Reviews 124 (2020)1-12.
25. Nees Jan van Eck, Ludo Waltman, VOSviewer: A computer program for bibliometric mapping, ERIM report series research in management Erasmus Research Institute of Management 84 (2009) 1-22.
26. Judy F Burnham “Scopus database: a review" Biomedical Digital Libraries. 2006,1-8
27. https://www.scribd.com/doc/262489054/BS-EN-312
28. https://www.woodproducts.fi/content/particle-board
29. American Society of Testing and Materials. Standard Test Methods for Evaluating Properties of Wood-Base Fiberand Particle Panel Materials; D1037-06 Section 9, 11, 12; American Society of Testing and Materials: WestConshohocken, PA, USA, 2006.
30. NP EN ISO 140-7. do isolamento sonoro de e de elementos de – Parte 7: in situ, do isolamento sonoro de pavimentos a sons de (in Portuguese), Instituto da Qualidade (IPQ); 2008.
31. ISO 717-2. Acoustics: rating of sound insulation in buildings and of building elements – Part 2: impact sound insulation. International Organization for Standardization (ISO); 1996.
32.https://autodesk.typepad.com/bpa/2013/03/revit-2014-release-news-new-building performance-analysis-features.html
33. HFM_436_Lambda_brochure.pdf
34. Nemr El Hajja,*, Brice Mboumba-Mamboundoua, Rose-Marie Dheillya, Zoheir Abourab,Malek Benzeggaghb, MichΦle Queneudeca "Development of

thermal insulating and sound absorbing agro-sourced materials from auto linked flax-tows" Industrial Crops and Products 34 (2011) 921– 928.

35. P.A. Chabriac, E. Gourdon, P. Gle b, A. Fabbri a, H. Lenormand "Agricultural by-products for building insulation: Acoustical characterization and modeling to predict micro-structural parameters" Construction and Building Materials 112 (2016) 158–167.
36. Berardi U and Iannace G "Acoustic characterization of natural fibers for sound absorption applications" Building and Environment (2015) 1-42.
37. Kazem Doost-hoseini a, Hamid Reza Taghiyari, Abdollah Elyasi "Correlation between sound absorption coefficients with physical and mechanical properties of insulation boards made from sugar cane bagasse" Composites: Part B 58 (2014) 10–15.
38. DT Liu1, KF Xia1, RD Yang1, J Li1, KF Chen1 and MM Nazhad "Manufacturing of a bio composite with both thermal and acoustic properties" Journal of Composite Materials
46(9) 1011–1020
39. Zahra Balador, Morten Gjerde, Nigel Isaacs, and Marzieh Imani "Thermal and Acoustic Building Insulations from Agricultural Wastes" Springer International Publishing AG 2018.
40. Changjie Chen,a,b You Zhang,a,b Guangxiang Sun,a,b Jiayi Wang,c,* and Guohe Wang "Windmill Palm Fiber/Polyvinyl Alcohol Coated Nonwoven Mats with Sound Absorption Characteristics" *BioResources* 11,(2016) 4212-4225.
41. American Society for Testing and Materials. ASTM C 518-85 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission by Means of the Heat Flow Meter Apparatus; American Society for Testing and Materials: West Conshohocken, PA, USA, 1989.
42. Xinrui Lu, Ali M. Memari, Comparative study of Hot Box Test Method using laboratory evaluation of thermal properties of a given building envelope system type, Energy & Buildings, 178 (2018) 130–139.

https://doi.org/10.36375/prepare_u.iei.a197