

Addis Ababa Science and Technology University

Graduate Studies

Department of Environmental Engineering

Final Year Presentation

Development and Characterization of plastic-wood
composite boards for sustainable construction

**Natnael Worku, Zekarias Musa, Nahom
Abdeta, Senay Alem, Shalom Tariku**

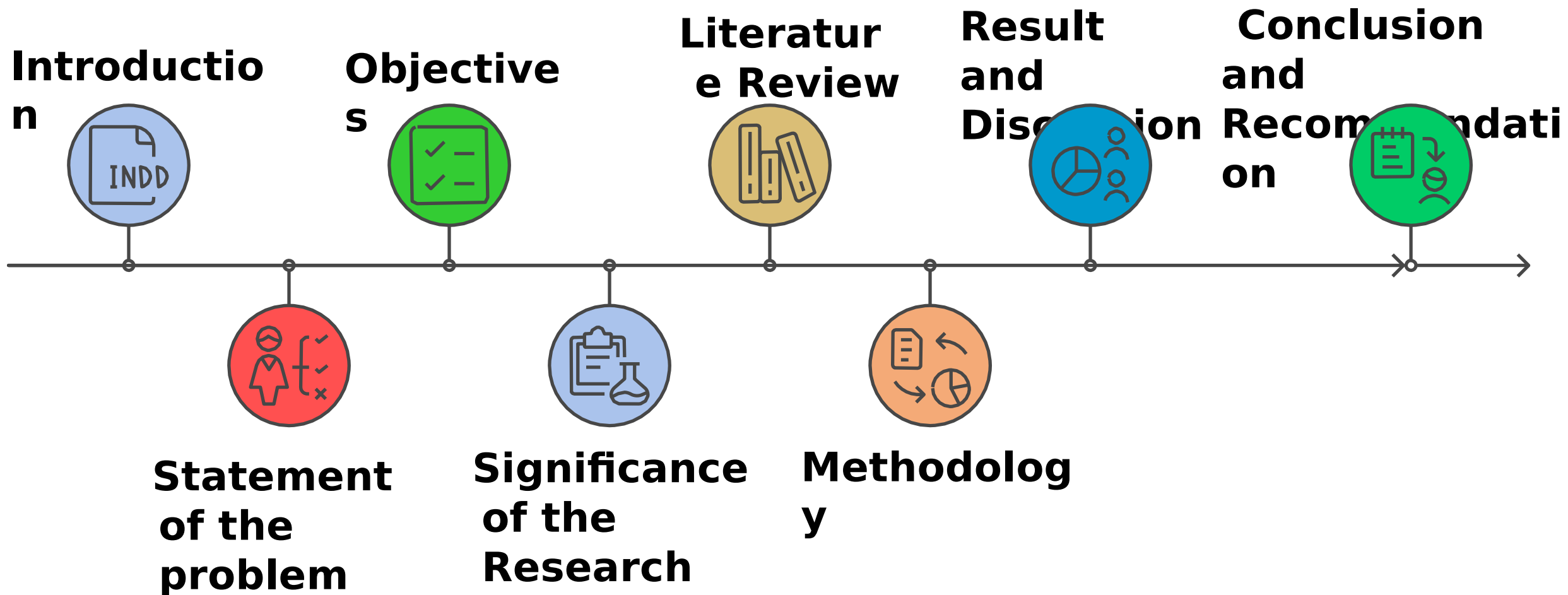


Advisor - Dr. Israel Tessema

May 27, 2025



Presentation Outline





Introduction

- **Plastic waste is a growing global problem.**
- **Over 8,300 million metric tons of plastics have been produced**
- **Only around 9% of plastic is recycled worldwide.**
- **Plastic waste is a major environmental concern, especially in Africa and Ethiopia.**



Introduction...



Ethiopia generates approximately 6.6 million tons of plastic waste annually.



The construction industry contributes ~39% of global carbon emissions.



Wood-Plastic Composites (WPCs) offer a sustainable solution using plastic and wood waste.



This project explores using WPCs for sustainable construction boards.



Statement of the problem



The construction industry heavily depends on non-renewable materials.



Large volumes of plastic waste are disposed of improperly, harming the environment.



Existing WPCs often suffer from moisture absorption and mechanical weakness.



Plastic waste causes pollution and needs innovative solutions for reuse.



There's a lack of local research into optimized WPCs using Ethiopian waste materials.



Objective

General Objectives

- **Develop a durable and eco-friendly board from recycled plastic and wood residues**

Specific Objectives

- **Study the impact of varying plastic-to-wood ratios on physical and mechanical properties.**
- **Compare the new composite boards with conventional MDF.**

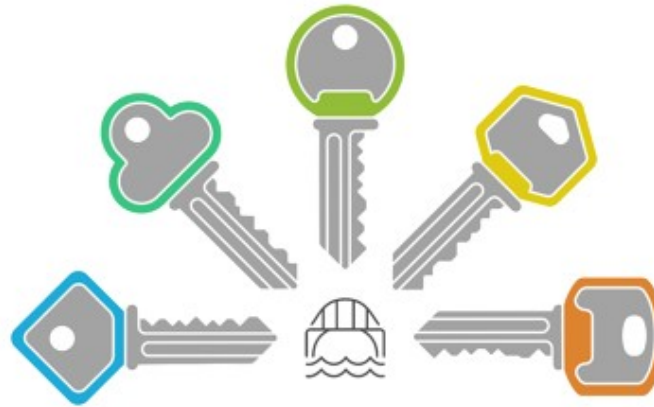


Significance of the Research

Encourages recycling of plastic and sawdust waste

Promotes sustainable and green construction practices.

Offers an affordable alternative to imported or conventional MDF



Supports Ethiopia's goal to transition to a circular economy

PWC



Significance of the Research

1

Academic:
Expands
knowledge in
environmental
and materials
engineering.

2

Industrial:
Offers cost-
effective,
sustainable
construction
alternatives.

3

Environmental:
Reduces landfill
waste and
carbon
emissions.

4

Social:
Supports
public
awareness,
economic
opportunity,
and green
practices.



Literature Review

Effect Category	Authors	Findings
Durability & Moisture	Ashori (2008)	WPCs are durable and moisture resistant, suitable for construction.
	Adhikary et al. (2008)	More wood increases stiffness but also raises water absorption.
	Zhou et al. (2013)	WPCs with proper mixing show low creep deformation and long service life.
Mechanical Strength	Najafi et al. (2007)	Plastic type and wood ratio affect mechanical strength significantly.
	Stark & Rowlands (2003)	Strong bonding between plastic and fiber improves strength.
	Rahman et al. (2013)	PET-based WPCs offer good strength and are recyclable.



Literature Review...

Long-term Performance	Klyosov (2007)	WPCs are stable and suitable for outdoor use over time.
Environmental Impact	Beg & Pickering (2008) Migneault et al. (2015) Lehmann et al. (2014)	Recycling plastics in WPCs reduces environmental burden. Lifecycle analysis confirms WPCs as eco-friendly alternatives to MDF and PVC. WPCs contribute to circular economy by closing material loops in construction.
Material Properties	Alves et al. (2010)	Particle size and moisture level influence composite performance.



Methodology

Methodological Approach for plastic-wood composite board

Materials:

- HDPE,
- PET plastics (bottles, packaging) and
- sawdust.

Preparation Steps:

- Plastics: cleaned, shredded, and sometimes pyrolyzed.
- Sawdust: sun-dried and sieved.

Ratios Tested:

- 50:50, 60:40, 70:30, and 80:20 (plastic:sawdust).

Tools:

- Steel mold, universal testing machine, oven.

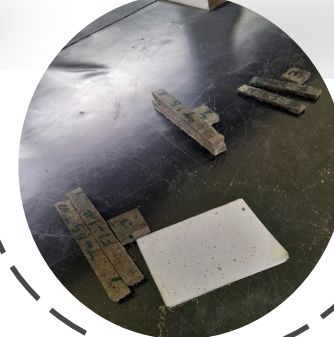


Methodology- Experimental Program

**Material Collection
and
Preparation**

Mixing with Sawdust

**Sample Preparation
for Testing**



Plastic Processing

**Molding and
Compression**

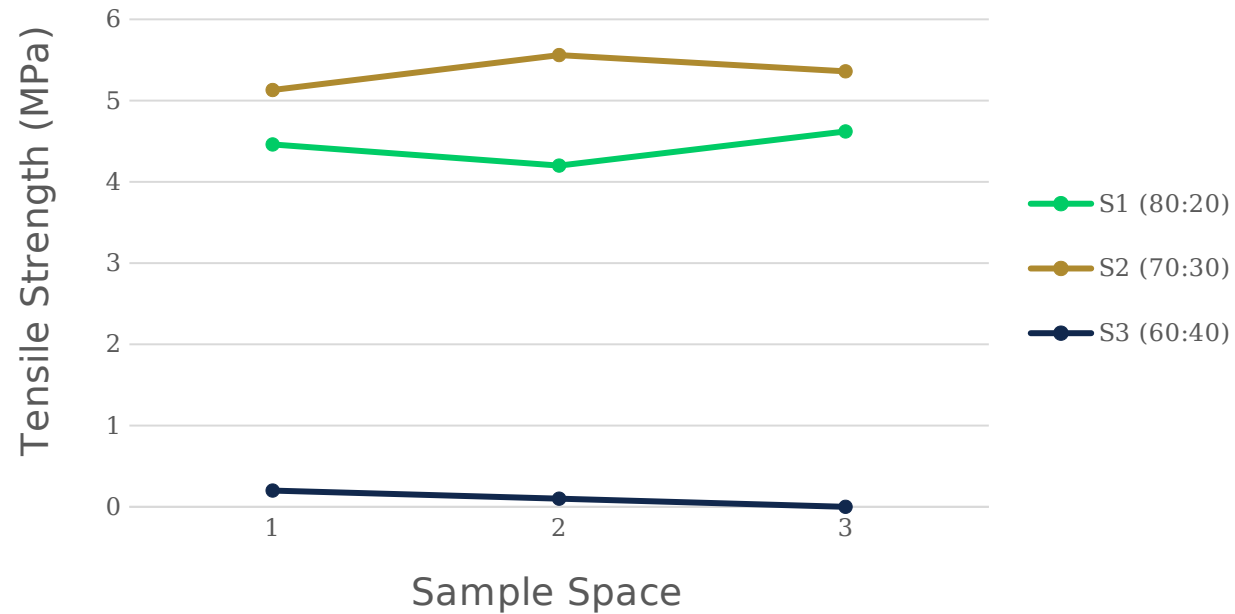
**Testing and
Analysis**

Production of Specimens



Result And Discussion

Tensile Strength of PWCs

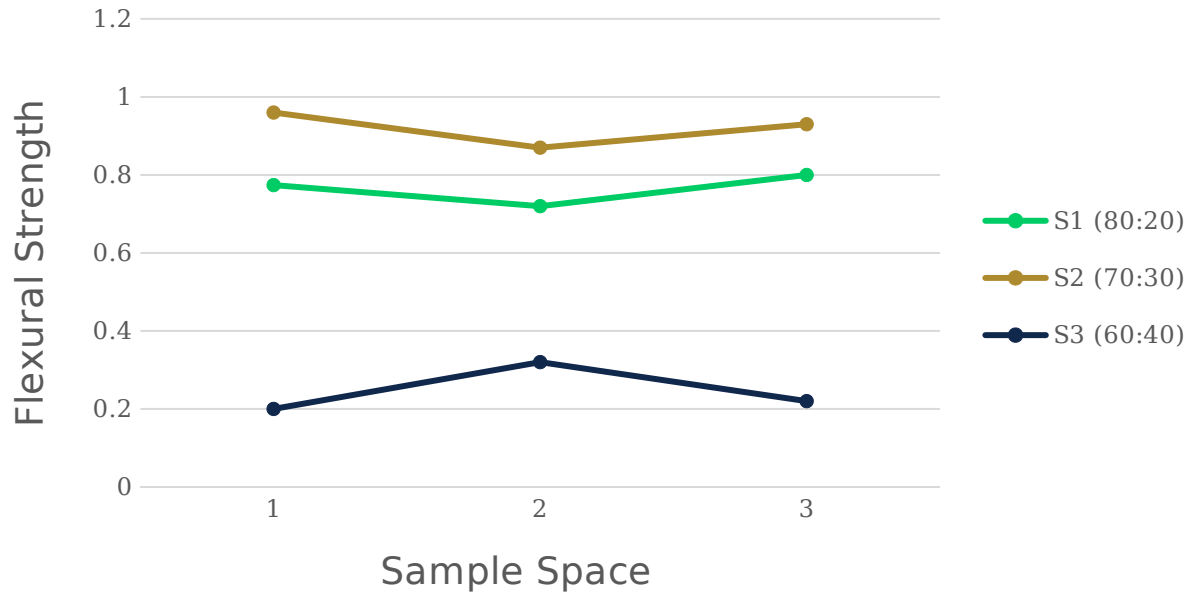


- **The 70:30 plastic-to-wood ratio showed the highest tensile strength among all samples.**
- **This indicates strong interfacial bonding and suitability for structural applications.**



Result And Discussion

Flexural Strength of PWCs

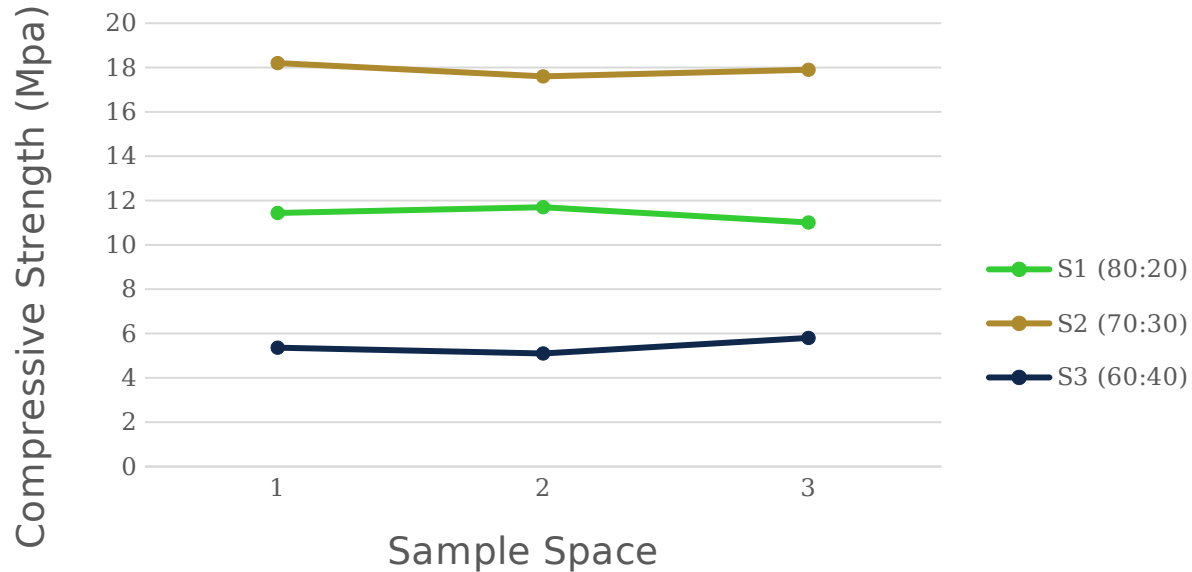


- **The 70:30 plastic-to-wood ratio exhibited the highest flexural strength.**
- **This suggests improved load-bearing capacity and bending resistance of the composite.**



Result And Discussion -

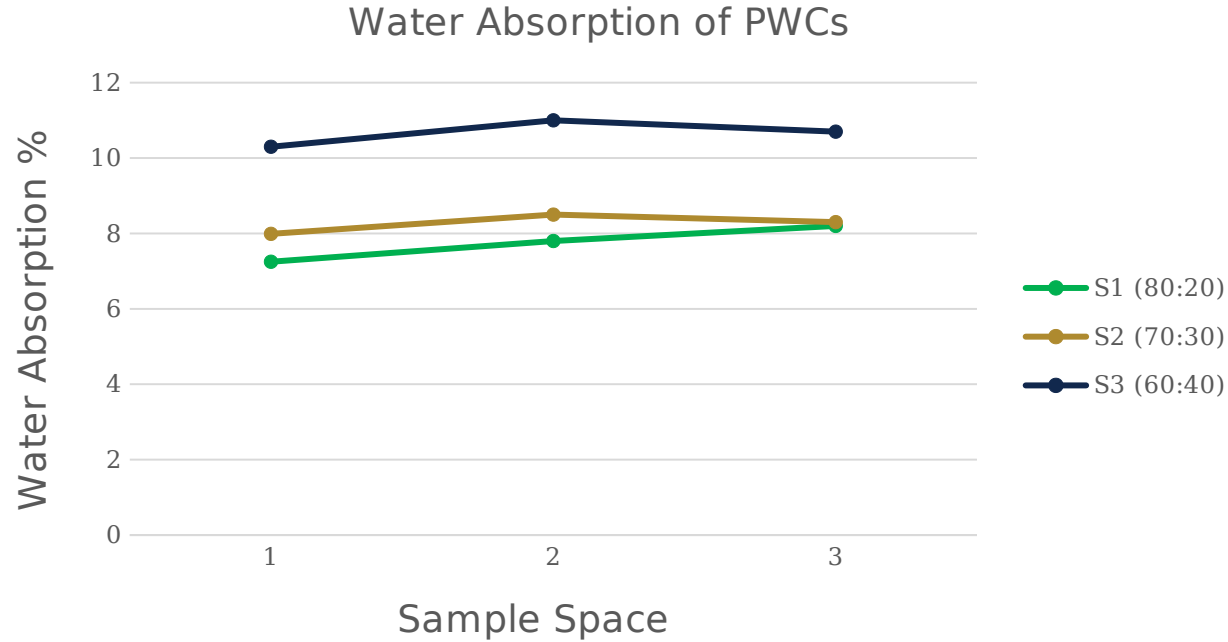
Compressive Strength of PWCs



- **The 70:30 composite achieved a compressive strength of approximately 18.2 MPa.**
- **This value aligns with standard MDF ranges, indicating its suitability for load-bearing use.**



Result And Discussion



- **The 80:20 plastic-to-wood ratio showed the lowest water absorption among all samples.**
- **This indicates superior moisture resistance, making it ideal for outdoor applications.**



Result And Discussion

Mechanical Properties Comparison – PWC vs MDF

Tensile Strength:

- PWC (70:30) > 10 MPa
- MDF standard ~0.6 MPa (internal bond)
- **PWC significantly outperforms MDF in tensile strength**, indicating better internal bonding.

Flexural Strength:

- PWC (70:30) ~25.8 MPa
- MDF range: 20–25 MPa
- **PWC slightly exceeds MDF**, suggesting better bending resistance.

Compressive Strength:

- PWC (70:30) ~18.2 MPa
- MDF: 10–15 MPa
- **PWC shows higher load-bearing capacity** under compression.



Result And Discussion

Physical Properties and Application Potential

Water Absorption:

- PWC (80:20) = **7.25%**
- MDF = Up to **20%** (in 24 hours)
- **PWC is more water-resistant**, ideal for humid or outdoor environments.



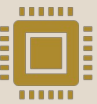
Conclusions



A plastic-to-wood ratio of 70:30 is optimal.



Boards made with this ratio show strong mechanical properties and low water absorption.



The developed WPCs can replace MDF in certain applications.



Demonstrates the potential of turning local plastic and wood waste into valuable construction materials.



Recommendations



Further optimization of material composition is recommended to enhance mechanical strength and moisture resistance.



Use of coupling agents or additives should be explored to improve the bonding between plastic and wood particles.



Scale up the fabrication process using industrial extrusion or molding techniques for consistent quality and commercial viability.



Thank You