



**Karunya INSTITUTE OF TECHNOLOGY AND SCIENCES**

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## **NUTRIZIONE' 26**

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### **Technical Evaluation of Fiber-Based Packaging and Bio-Polymer Barriers for Liquid Food Applications**

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# Problem Statement

Current liquid food packaging (like aseptic cartons) relies on multi-layer laminates of polyethylene (plastic) and aluminum. While these provide an excellent barrier against moisture and oxygen, they are extremely difficult to recycle and are derived from non-renewable resources.

The technical challenge is that fiber-based materials (paper) are inherently porous and hydrophilic (water-attracting), making them unsuitable for liquids unless paired with a barrier that matches the performance of plastic but maintains the recyclability of paper.





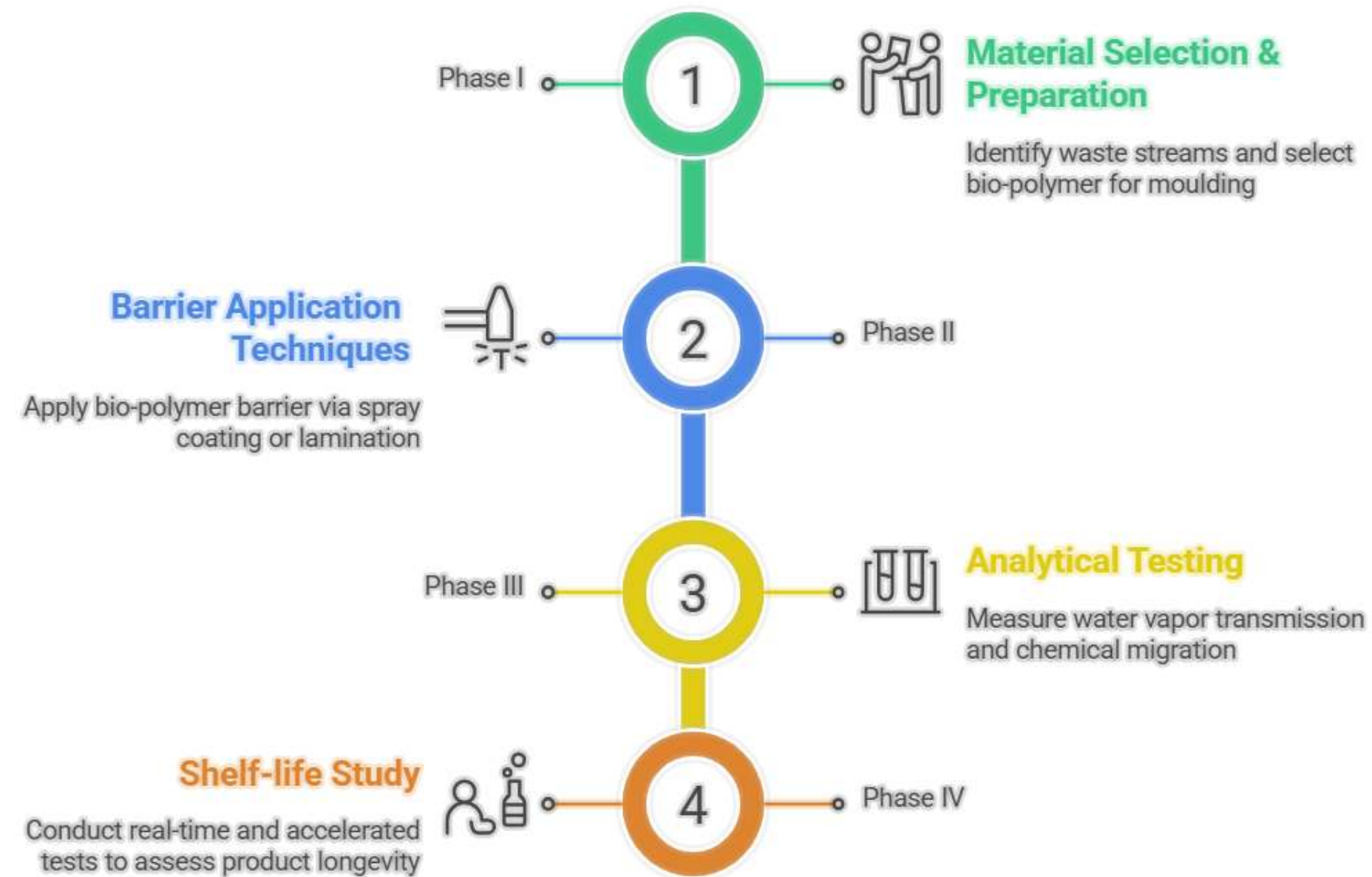
# INTRODUCTION



- The global food industry is under increasing pressure to transition from traditional PET and glass packaging to sustainable alternatives like "**Paper Bottles**". Developed through molded fiber technology, these designs aim to establish a circular packaging model.
- For professionals, the primary technical challenge lies in maintaining necessary **Water Vapor (WVTR)** and **Oxygen Transmission Rates (OTR)** to preserve beverage shelf-life and organoleptic properties. Research highlights plant-based liners, such as **Polyethylene Furanoate (PEF)**, as ultra-thin internal coatings that prevent moisture absorption and structural degradation of the wood-pulp shell.
- While difficulties persist in carbonated pressure management and high-speed aseptic filling, these fiber-based systems can reduce plastic use by 60–80%. Ultimately, integrating bio-barrier engineering provides a viable, recyclable pathway for sustainable liquid food distribution.

# METHODOLOGY

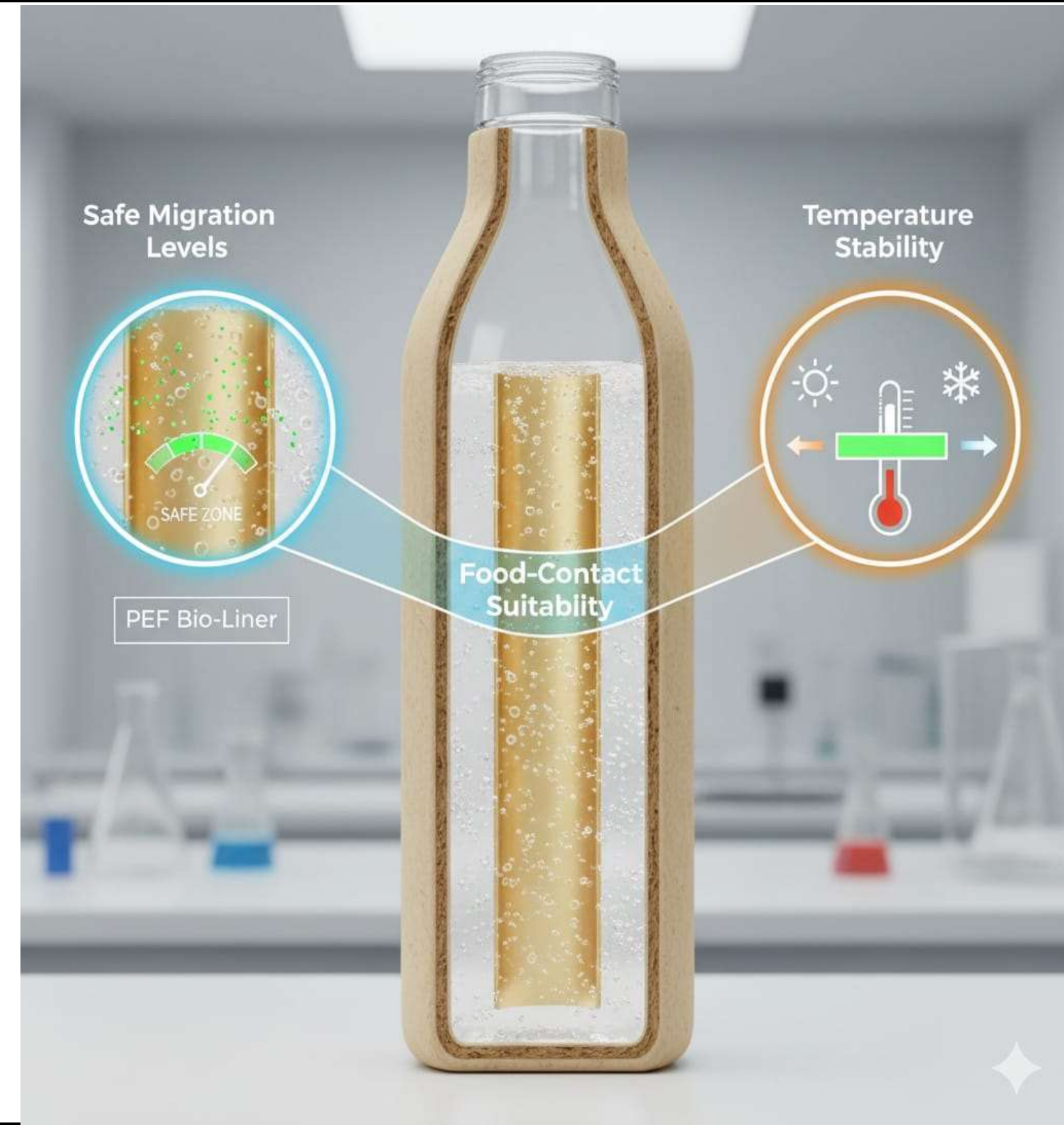
## Methodology: From Idea to Prototype





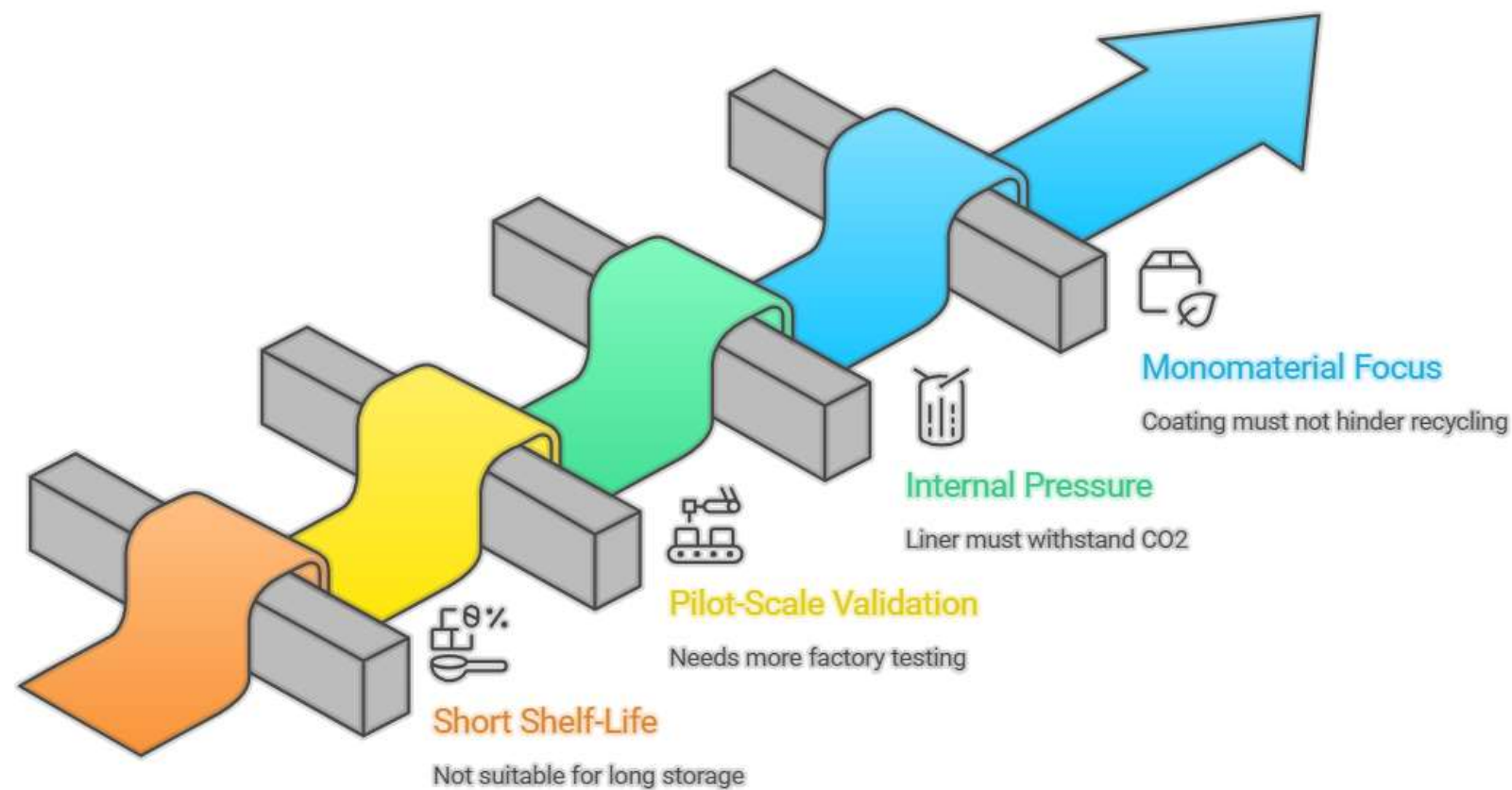
# FOOD SAFETY EVALUATION

- Food safety evaluation addresses the critical health and safety concerns related to switching from traditional plastics to plant-based materials.
- Safe Migration Levels: The research confirms that the amount of bio-polymer material transferring into the food or drink stays within safe, acceptable limits.
- Food-Contact Suitability: The bio-polymers used (like PEF) are technically approved for direct contact with liquids, acting as a safe interface between the wood-pulp and the beverage.
- Temperature Stability: The packaging maintains its structural integrity and safety even when stored at various temperatures, ensuring the bottle doesn't degrade on the shelf.



# OUTCOMES

## Sustainable Packaging: Challenges and Opportunities



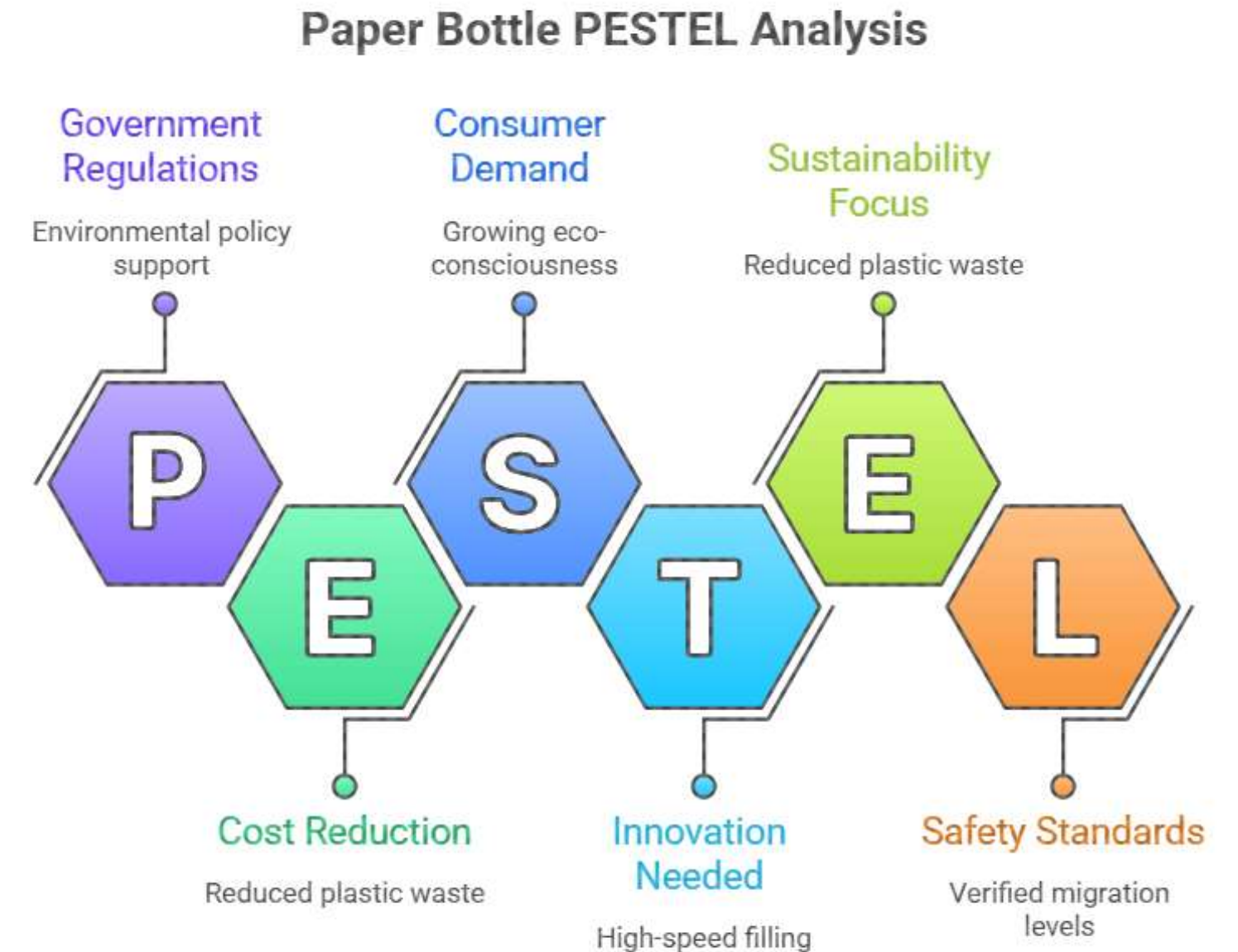
This technology can be used in the real world and what the current limitations are.

- **Short-Shelf-Life Applications:** Currently, this packaging is most suitable for liquid foods that don't need to sit on a shelf for years.
- **Massive Plastic Reduction:** Implementing this technology can reduce the industry's plastic use by 60–80%.
- **Pilot-Scale Validation:** While the theory works, the slide notes that more testing is needed to see how these bottles perform in high-speed factory filling lines.
- **Experimental Validation:** We need more real-world tests on how these bottles hold up in fast-moving factory environments.
- **Internal Pressure Management:** For carbonated drinks, the liner must be strong enough to handle the internal pressure of CO<sub>2</sub> without the fiber shell losing its shape.
- **Monomaterial Focus:** The ultimate goal is a "monomaterial fiber system" where the coating is so thin it doesn't interfere with standard paper recycling.



# CONCLUSION

- **Eco-Friendly Packaging:** The industry is replacing PET and glass with "Paper Bottles" made via Moulded Fiber Technology.
- **Bio-Barriers:** Plant-based liners like PEF prevent liquid absorption and maintain the bottle's structure.
- **Protection:** These coatings manage WVTR and OTR to preserve drink taste and shelf-life.
- **Verified Safety:** Testing confirms safe migration levels and stability across various temperatures.
- **Impact:** This design reduces plastic usage by 60–80% while staying recyclable.
- **Next Steps:** Challenges remain in high-speed aseptic filling, requiring more industrial-scale testing.



# KEY REFERENCES

- Avantium. (2024).  
*PEF and FDCA: Pioneering sustainable chemistry solutions.*
- Paboco. (2022).  
*Paboco reveals a prototype of the next generation paper bottle.*
- Burgess, S. K., et al. (2014).  
"Oxygen sorption and transport in amorphous poly(ethylene furanoate).*Macromolecules*, 47(4).







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# THANK YOU