FibrilX

Material Combination Intelligence for Paper and Paperboard Packaging

An evidence-led, AI-assisted approach to fibre, substrate and coating selection

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About this edition. This is the first public edition of the FibrilX white paper, published in October 2026. FibrilX Limited was founded in 2021, and the concepts, methodology and platform direction described here are the product of development carried out by the company since then. This edition describes the platform at a conceptual level; proprietary data, model architectures, parameters, formulations and customer information are deliberately excluded.

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1. Executive Summary

Paper and paperboard are at the centre of the shift away from fossil-based packaging. Brand owners, converters and mills are being asked to deliver packaging that is stronger, lighter, more recyclable, richer in recycled fibre and lower in cost, all at the same time. These goals interact in complex ways, and today most material decisions are still made through experience and sequential physical trials.

FibrilX is building Material Combination Intelligence: a decision-support platform that combines materials science, structured evidence and artificial intelligence to help packaging teams identify, compare and justify combinations of virgin and recycled fibres, substrates and functional coatings for a defined application.

> *Our proposition: start from the packaging requirement, not a predetermined material; evaluate feasible combinations against performance, process, cost and sustainability objectives; and make every trade-off and every piece of supporting evidence visible.*

The platform is designed to shorten the path from specification to a validated shortlist, focus laboratory and mill trials on the candidates and uncertainties that matter most, and give technical, procurement and sustainability teams a shared, auditable basis for decisions.

Highlights

- **Large, regulation-driven market:** independent estimates place the global paper packaging market at roughly USD 380-450 billion in 2025, with continued growth forecast [3][4][5].
- **Clear timing:** the EU Packaging and Packaging Waste Regulation (EU) 2025/40 has applied since 12 August 2026 and requires all packaging on the EU market to be recyclable by 2030 [1][2].
- **Working product:** the FibrilX application already implements requirement planning, evidence and knowledge-graph concepts, candidate-space visualisation, Pareto trade-off analysis and recommended combinations.
- **Defensible approach:** traceable evidence, explainable recommendations and a structured validation loop that improves with every trial.
- **Scalable model:** a subscription-based software offering, complemented by pilot engagements with industry partners.

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2. The Market Opportunity

Paper and paperboard form the second-largest packaging material segment worldwide. Published market estimates vary by scope and method, but consistently describe a market in the hundreds of billions of US dollars with steady growth:

Source	2025 market size	Forecast
Grand View Research [3]	USD 416.1 bn	USD 611.7 bn by 2033 (5.0% CAGR)
IMARC Group [4]	USD 448.9 bn	USD 552.0 bn by 2034 (2.25% CAGR)
InsightAce Analytic [5]	USD 378.6 bn	USD 619.7 bn by 2035 (5.3% CAGR)

Why now

- **Regulation.** The EU PPWR sets mandatory eco-design, recyclability, recycled-content and waste-prevention rules across the packaging life cycle [1], raising the cost of getting material choices wrong.
- **Substitution from plastic.** Brand owners are moving formats into fibre-based packaging, creating new and demanding performance requirements, particularly for barrier and moisture resistance.
- **Recycled fibre variability.** Higher recycled content supports circularity goals, but recovered fibre quality varies by source and processing history, making formulation harder, not easier.
- **Cost and energy pressure.** Mills and converters need to reduce trial costs, rejects and downtime while maintaining quality.
- **Maturity of AI and data tooling.** Knowledge graphs, machine learning and multi-objective optimisation are now practical to deploy in industrial decision workflows.

Target customers

- Paper and board mills and their technical and product development teams
- Packaging converters and manufacturers
- Brand owners and their packaging, procurement and sustainability functions
- Coating, additive and fibre suppliers seeking application-specific positioning

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3. The Challenge: A Multi-Variable Material Decision

Packaging performance emerges from interactions among furnish composition, fibre condition, refining and forming conditions, basis weight, additives, coatings, converting processes and the environment in which the package is stored and used. Relevant outcomes include tensile and compression strength, stiffness, tear resistance, surface properties, moisture response, barrier performance, runnability and product-specific requirements.

These outcomes rarely move together. Improving barrier performance may affect repulpability. Raising recycled content supports circularity but introduces variability. A lower-cost formulation is no improvement if it causes breaks, rejects or functional failure.

Data needed for good decisions is typically fragmented across laboratory records, supplier specifications, production systems, technical literature and individual expertise. The result is slow, costly iteration and decisions that are difficult to explain or reuse.

4. The FibrilX Solution

FibrilX connects a clearly stated packaging requirement with the evidence needed to evaluate possible material solutions. The workflow begins with the application: the user defines the packaging format and use case, target properties, environmental conditions, process constraints and non-negotiable requirements. This specification is translated into a structured representation that can be reviewed before any candidate is evaluated, so recommendations are never optimised against an incomplete brief.

Core capabilities

- **Requirement planning:** structured capture of application, constraints and target performance.
- **Evidence and knowledge graph:** linked records of materials, properties, processes, conditions and sources.
- **Candidate-space exploration:** visual comparison of feasible combinations across multiple dimensions.
- **Pareto trade-off analysis:** identification of combinations where no objective can be improved without worsening another.
- **Recommendation workbench:** ranked candidate combinations with supporting rationale and the most informative next validation step.

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5. Evidence Architecture and Traceability

A useful recommendation must be explainable. The FibrilX evidence model preserves the relationship between a material or combination, a property, the relevant process and environment, and the source that supports it. Evidence can include supplier technical data, peer-reviewed literature, laboratory measurements, production observations and expert-reviewed assumptions, each weighted according to its scope and reliability.

Each record captures, where available, provenance, date, test method, units, material identity, conditions and limitations. Conflicting results remain visible rather than being silently averaged, and missing information is flagged rather than filled in. Model outputs are always distinguished from measured results.

> *Evidence quality is a product requirement, not an interface feature. This is what allows FibrilX recommendations to be inspected, challenged and trusted.*

6. Computational Approach

FibrilX applies the analytical method appropriate to the question and the data: descriptive analytics to reveal patterns and gaps, statistical and machine-learning models to estimate properties where representative data exist [7], and constrained multi-objective optimisation to search the space of feasible combinations.

Conceptually, the platform selects material combinations that satisfy every mandatory requirement while balancing objectives such as cost, strength, barrier performance, recycled content, processability and environmental impact. Objectives are defined per application, and a weighted score never conceals a failure to meet a hard threshold.

Predictions are labelled as predictions and accompanied by uncertainty and applicability information. Models are validated with appropriate procedures and monitored as materials, suppliers and production conditions change. Specific model architectures, features and training data are proprietary to FibrilX and are not disclosed in this paper.

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7. Responsible Sustainability

FibrilX supports sustainability through better-informed material decisions: using fibre resources efficiently, increasing recycled content where technically suitable, reducing avoidable material use and waste, and assessing the wider consequences of each combination.

Environmental claims require comparable data and a transparent method. FibrilX is designed to work alongside life-cycle assessment conducted in line with ISO 14040 [6], and to flag recyclability, compostability, food-contact and regulatory questions for specialist assessment rather than inferring them. This disciplined approach helps customers make sustainability claims they can substantiate, an increasingly important requirement under packaging and consumer-protection regulation.

8. Validation Framework

FibrilX moves customers from digital screening to controlled validation through a seven-step operating model:

Step	Activity
1. Define	Record format, contents, storage and transport conditions, converting route, targets and mandatory constraints.
2. Baseline	Document the incumbent formulation, measurements, variability, cost and production indicators.
3. Qualify evidence	Identify source, age, comparability and gaps; separate measurements from literature, assumptions and estimates.
4. Screen	Exclude options that violate hard constraints; compare the rest across objectives, with reasons recorded.
5. Plan trials	Prioritise experiments that resolve the most consequential uncertainties; agree acceptance criteria in advance.
6. Validate	Test under representative laboratory, pilot or mill conditions; record successes and failures.
7. Learn	Compare predicted with observed outcomes and update the evidence base under change control.

Every completed cycle strengthens the evidence base, so the platform becomes more accurate and more valuable with use.

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9. Value for Stakeholders

Stakeholder	Value
Packaging developers	Faster, comparable and well-documented formulation choices
Mills and converters	Focus on options relevant to real operating conditions; fewer, better-targeted trials
Procurement	Cost and material availability assessed alongside performance
Sustainability teams	Recycled content and environmental questions in the same decision, with substantiation
Suppliers	Clear evidence of where their materials fit specific applications

Value is demonstrated through defined pilot studies with agreed baselines. Key indicators include time to shortlist, number and cost of trials, first-pass success rate, material cost per functional unit, rejects and downtime, performance variability and recycled-fibre utilisation. Results will be published as case studies with the application, baseline, method and limitations needed to interpret them.

10. Business Model and Competitive Advantage

Business model

- **Subscription software** for technical and product development teams, tiered by users, applications and data integration.
- **Pilot engagements** with selected partners to configure use cases, establish baselines and demonstrate measurable value.
- **Enterprise deployment** with secure handling of confidential formulations and production data.

Why FibrilX

- **Domain focus:** purpose-built for fibre-based packaging rather than generic materials informatics.
- **Explainability:** every recommendation is traceable to its evidence, a prerequisite for adoption in quality-critical industries.
- **Compounding data advantage:** the validation loop turns each trial into structured, reusable knowledge.
- **Trade-off transparency:** Pareto-based comparison replaces single-score rankings that hide compromises.
- **Engineering fit:** designed to sit inside existing laboratory, mill and converting workflows, not to replace them.

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11. Governance and Data Security

Material identifiers, units, test methods and property definitions are standardised; sources are versioned; and changes to records and models are traceable. Hard constraints are separated from preferences, measured values from estimates, and evidence-backed findings from hypotheses. Access to confidential customer formulations and production data is controlled according to each customer's requirements, and customer data is never used to benefit another customer without permission.

Integration is incremental: initial deployments use structured uploads and curated records, with deeper system integrations introduced where data quality, security and operational benefit justify them.

12. Company and Development Roadmap

FibrilX Limited was founded in 2021 and is based in Manchester, United Kingdom. The company brings together expertise in fibre physics, materials science, paper and packaging technology, data science and software engineering. Since its founding, FibrilX has developed its methodology and built a working application that implements the core decision-support workflow described in this paper.

Stage	Focus	Status
Foundation (2021-2023)	Company formed; problem definition, methodology, evidence taxonomy and input schema	Completed
Platform build (2024-2026)	Requirement planning, knowledge graph, candidate comparison, Pareto analysis, recommendations	Working application
Experimental feedback	Capture lab and production outcomes; model-validation protocols	In progress
Industry pilots	Representative pilots with selected partners to measure value	Partner discussions open
Controlled scaling	Additional applications and integrations as evidence coverage grows	Planned

Specific milestones and release dates are shared directly with partners and investors.

13. Partnering and Investment

FibrilX is seeking investors and industry partners who share its view that the transition to fibre-based packaging will be won with better material decisions. Investment will accelerate experimental validation, industry pilots, the expansion of the evidence base and the growth of the commercial team.

> *To discuss investment, pilot partnerships or a platform demonstration, contact FibrilX at info@fibrilx.com or visit fibrilx.com. Further information is available under a non-disclosure agreement.*

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14. References

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Important Notices

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Forward-looking statements. This paper describes the platform's design, capabilities and intended development. Statements about future development, market conditions and benefits are forward-looking and subject to change. Market figures are third-party estimates. Performance, savings and environmental outcomes depend on the application and are established through validation with customers. This document is for information only and does not constitute an offer of securities or investment advice.