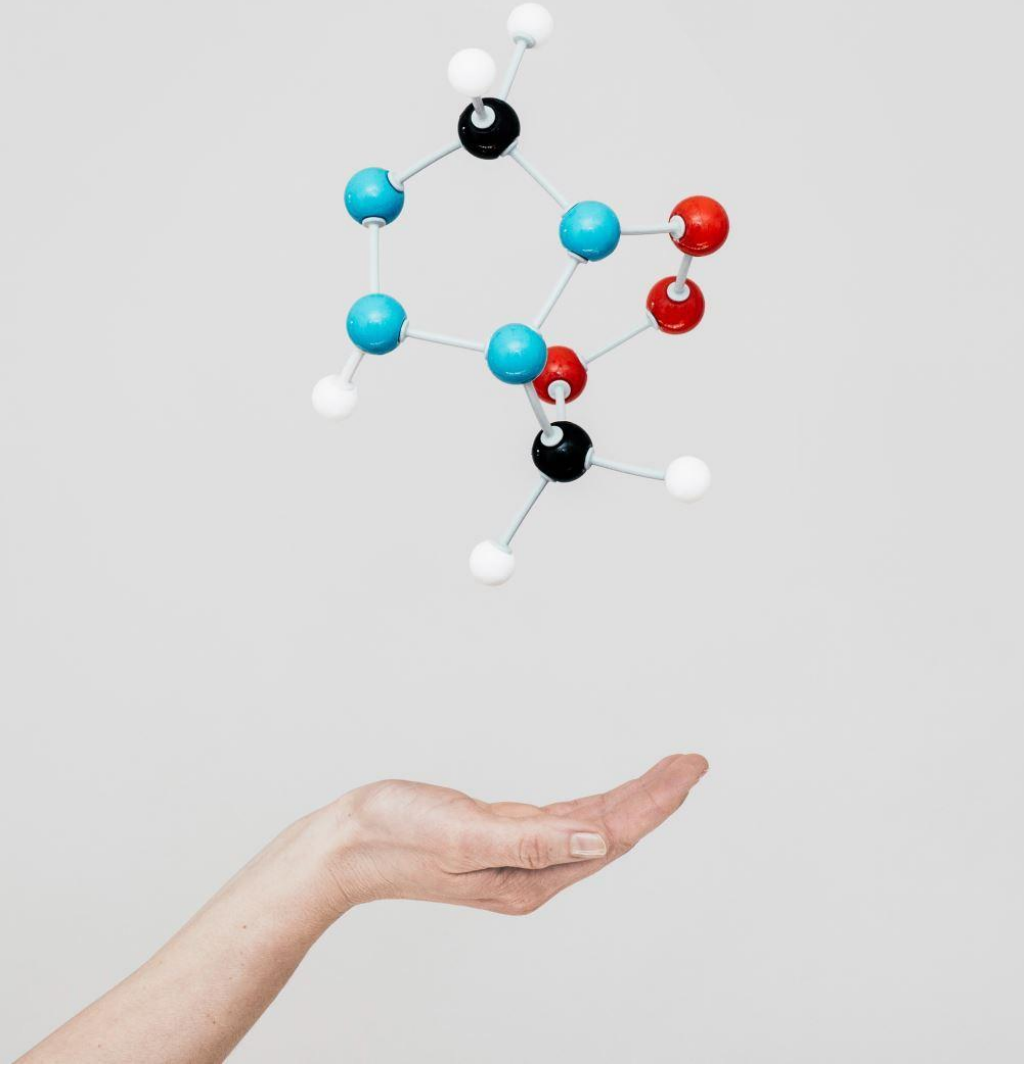


INTEGRATING SUSTAINABILITY IN EU F&B PRODUCT DEVELOPMENT (2020–2025): CHALLENGES, AND BUSINESS IMPACT

INTRODUCTION

2020–2025: EU Food & Beverage firms face growing pressure to prove sustainability drives real product development (PD) decisions, not only corporate messaging (Hoffman and Bazerman, 2007; Stewart, Bey and Boks, 2016).

- PD is often shaped by stable routines, short timelines, and KPIs that reward speed and cost more than environmental outcomes (Hoffman and Bazerman, 2007; Stewart, Bey and Boks, 2016).
- The challenge is strongest in packaging-intensive categories: teams must meet food-safety rules, material performance needs, supplier capability, and retailer expectations.

As a result, sustainability features can be weakened late in development, causing “last-minute rollbacks” and credibility risks (McGrady and Golicic, 2023).

RELEVANCE OF THE STUDY

2020–2025 is a key period because regulatory pressure, retailer scrutiny, and consumer sensitivity to environmental claims intensified at the same time in EU F&B markets (PwC, 2024; Deloitte, 2025).

- Demand for more sustainable products remains strong: many shoppers consider sustainability, some are willing to pay a premium, and products with sustainability-related claims show meaningful growth (PwC, 2024; Deloitte, 2025; McKinsey and NielsenIQ, 2023).
- However, the literature is often less clear on which PD process mechanisms consistently turn sustainability goals into routine decisions, and how "integration depth" can be assessed using public evidence (Stewart, Bey and Boks, 2016; Montabon, Pagell and Shevchenko, 2016; Dangelico and Pujari, 2010).

RESEARCH QUESTIONS

- **RQ1:** Which sustainability mechanisms are actually integrated into PD by EU F&B firms (2020–2025), and what drives their adoption?
- **RQ2:** What organizational/behavioural and supply-chain barriers are most prevalent, and how are they addressed?
- **RQ3:** How is the depth of PD integration associated with brand metrics (trust/loyalty) and organizational outcomes?
- **RQ4:** How do **organizational readiness** and **external institutional pressure** moderate resistance and shift integration from declarative to effective practice?
- **RQ5:** What trade-offs most frequently shape eco-design decisions in EU F&B (cost, safety, recyclability, shelf-life), and how are these trade-offs resolved in PD?
- **RQ6:** Which governance and verification practices prevent late-stage rollbacks of eco-features and reduce greenwashing risk in EU F&B product development?
- **RQ7:** How can firms reduce the financial burden of sustainability integration while maintaining product performance and compliance in EU Food & Beverage?

THEORETICAL FOUNDATIONS OF SUSTAINABILITY INTEGRATION IN PRODUCT DEVELOPMENT

Sustainability integration in PD means sustainability is built into everyday product development decisions, not added as a final “check”. (Rodrigues, Pigosso and McAloone, 2017; 2018)

It is embedded through rules, tools, and data across the idea funnel, stage-gates, and portfolio governance—shaping formulations, packaging, processes, and supplier engagement, and linked to business + environmental KPIs. (Rodrigues, Pigosso and McAloone, 2017; 2018)

Firms develop eco-capabilities in PD: sustainability criteria in Go/Kill decisions, LCA/LCC at key gates, Design-for-X checklists, traceability/mass-balance, claim governance, and supplier co-development. (Rodrigues, Pigosso and McAloone, 2017; 2018)

These capabilities build over time but can weaken without ongoing investment; maturity models (e.g., EcoM2) help assess progress. (Rodrigues, Pigosso and McAloone, 2017; 2018)

TYPES OF INSTITUTIONAL PRESSURE RELEVANT TO PD IN EU F&B

- Regulation & audits (CSRD/ESRS + retailer audits): push firms to embed traceability, LCA/LCC, and claim governance directly into stage-gate PD; otherwise risk non-conformities and sanctions (Rodrigues, Pigosso and McAloone, 2017; 2018).
- Border / trade frictions increase cost and delay risks, so firms shift toward more local sourcing and more robust (logistically resilient) packaging (FoodNavigator, 2024).
- EPR (Extended Producer Responsibility): recycling/collection targets and mass-balance requirements force end-of-life thinking into packaging/product design and strengthen data capture + supply-chain traceability (Raghupathy et al., 2007).

CO-DESIGN PRACTICES DOMINATE EU F&B

1) Packaging optimisation

- Material reduction (light-weighting: thinner plastic, lighter glass, less cardboard)
- Shift to recyclable / mono-material packaging ("design for recycling")
- Recycled content in plastics where targets and supply allow (European Commission, 2025; ecosistant, 2025)
- Bio-based / biodegradable options when compatible with product & local waste systems (Dri et al., 2018; Schumann, 2019)

2) Shelf-life & food waste reduction

- Modified-atmosphere packs, re-sealable formats, and portion-size optimisation (Dri et al., 2018; Wijaya, Setiawan and Kartaatmadja, 2021)

3) Labels & claims (consumer-facing)

- Clear eco-labels/claims (recyclable icons, organic, low-carbon, less plastic)
- Evidence shows packaging sustainability can influence brand choice and willingness to pay (Acee-Eke and Nwokah, 2019; Estrada, 2024)

4) Factory resource & waste management

- Waste segregation/recycling + energy and water efficiency projects (Barón et al., 2020; João, Alves and Silva, 2025)

TRADE-OFFS IN ECO-DESIGN DECISION-MAKING IN EU F&B

Eco-design in EU F&B is difficult not because firms lack ambition, but because **packaging must deliver many functions at once**: protection & safety, portioning, convenience, marketing/communi

Six common trade-offs in sustainable packaging redesign:

- perceived vs achieved sustainability
- food waste vs sustainability
- branding vs sustainability
- product visibility vs sustainability
- cost vs sustainability
- convenience vs sustainability

Trade-offs often overlap higher visibility can increase disposal complexity. (Sumter et al., 2023)

cation, and transport quality. (Monforti-Ferrario et al., 2015)

SUPPLY CHAIN AND SUSTAINABILITY INNOVATION

Sustainability innovation in supply chains means embedding environmental, social, and economic priorities into day-to-day operations and strategy—so the supply chain becomes not only efficient, but also resilient and value-creating long term.

A circular supply chain keeps products, components, and materials in use for longer, guided by the 6R principles: reduce, reuse, repair, refurbish, remanufacture, recycle (Pathan and Kesavaraj, 2024).

Circularity can also make business sense: it can reduce material and disposal costs and sometimes create new revenue from secondary materials or services (Pathan and Kesavaraj, 2024).

In Food & Beverage, this is especially relevant because agricultural volatility, strict food-safety rules, and packaging regulation make resilient and circular flows critical for compliance and continuity.

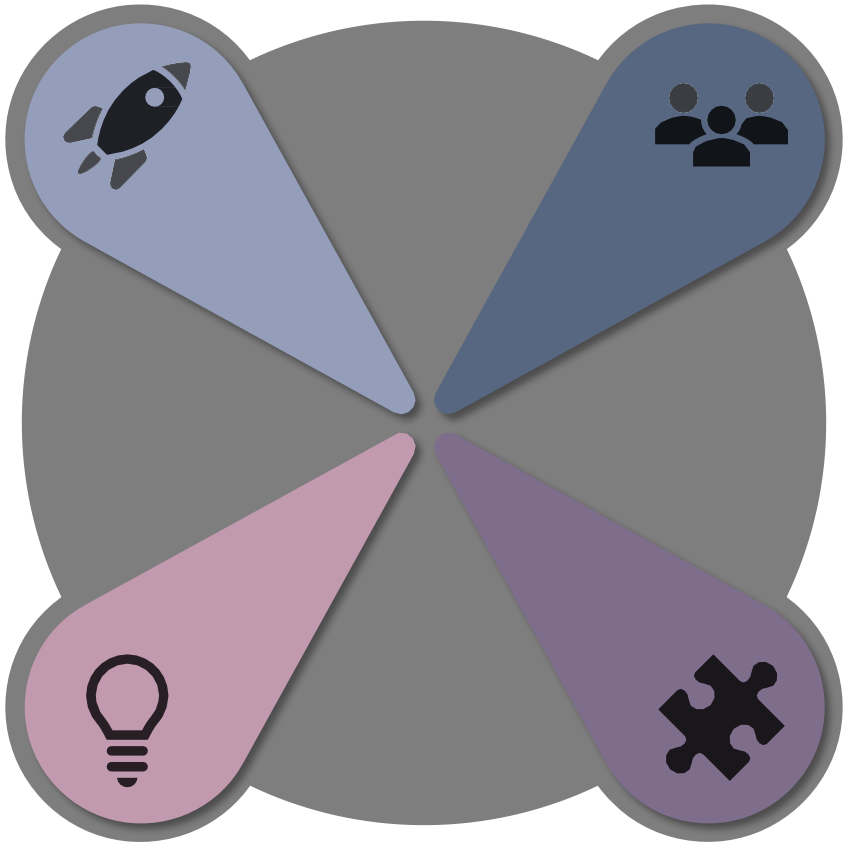
FOUR RADIATING BLADES – SLIDE TEMPLATE

04 - GREEN PRODUCT INNOVATION

designing products/packaging to lower life-cycle impact (e.g., lighter or mono-material packs, higher recycled content, recipes that reduce waste) and support differentiation (Dangelico, 2016; Xie, Huo and Zou, 2019; Dev et al., 2021).

03 - GREEN PROCESS INNOVATION

cleaner production that cuts energy, water, chemicals, and waste (e.g., heat recovery, closed-loop water, by-product valorisation), often reducing operating costs and emissions.



01 - GREEN LOGISTICS INNOVATION

route and load optimisation, modal shifts (rail/sea where possible), low-emission vehicles, and reusable/lighter secondary packaging—improving circular performance by lowering cost, risk, and emissions (Pathan and Kesavaraj, 2024).

GREEN SERVICE INNOVATION

take-back/refill/reuse systems, eco-labelling support, and digital tools to reduce food waste; this can have the strongest impact because it connects technical improvements with customer behaviour and long-term relationships (Pathan and Kesavaraj, 2024).

EXAMPLES OF CORPORATE SUSTAINABILITY AND SALES RELEVANCE

- Many global brands now **openly** share supply-chain and packaging sustainability actions to build trust and reduce greenwashing risk.
- Red Bull explains the aluminium can lifecycle and recycling on its website, showing how packaging circularity fits its sustainability strategy (Red Bull, 2024).In 2024, Red Bull reported strong growth: 12.67bn cans sold and +6.4% turnover to €11.227bn (Red Bull, 2024).
- This does not prove causality but shows transparency can coexist with growth in a packaging-intensive category.
- **Unilever** reported that its "Sustainable Living" brands grew **50% faster** than the rest of the business and delivered **>60% of company growth** (Unilever, 2017).
- This suggests sustainability can support growth **when embedded into products and value-chain decisions**, not only marketing (Unilever, 2017).

ORGANISATIONAL & BEHAVIOURAL BARRIERS

- Sustainability is recognized, but hard to translate into routine PD decisions.

Barriers come from two levels:

- Organizational: processes, KPIs, governance, resources
- Behavioral: habits, fear of risk, resistance to change
- Result: eco-features are often weakened when time/cost pressure increases (Boks, 2006; Rodrigues, Pigosso and McAloone, 2017).

ORGANISATIONAL BARRIERS

- “Add-on” mindset: eco-design treated as a late checklist → eco-features compete with cost/speed and get removed under pressure (Boks, 2006; Rodrigues, Pigosso and McAloone, 2017).
- KPIs & incentives misaligned: teams rewarded for launch date, budget, short-term sales—not carbon, recyclability, packaging weight, or food waste (Lozano, 2013; Dangelico, 2016).
- Silo working: R&D, packaging, marketing, procurement, supply chain, quality have different goals → conflicts slow or block implementation without clear governance (Tukker et al., 2008; Rodrigues, Pigosso and McAloone, 2018).
- Lack of tools/data/skills: missing LCA tools, recyclability guidelines, internal experts → decisions based on judgement, higher perceived risk (Pigosso, Rozenfeld and McAloone, 2013; Bocken et al., 2014).
- Supplier/co-packer misalignment: sustainability options fail if specs, contracts, or supplier capability are not aligned (Pullman, Maloni and Carter, 2009).

BEHAVIOURAL BARRIERS

- Resistance to change sustainability feels like “extra work”; teams prefer familiar routines and avoid new eco-design steps (Lozano, 2013; Boks, 2006).
- Fear of risk & responsibility: concerns about quality issues, complaints, or line failures; without clear ownership, teams choose the “safe” conventional option (Tukker, 2015).
- Limited awareness & skills: weak understanding of life-cycle impacts, recyclability, and claim rules; sustainability is seen as marketing, not a design task (Dangelico, 2016; Bocken et al., 2014).
- Short-term pressure / firefighting culture: urgent launches and operational issues push teams to optimise for speed, not long-term environmental performance (Rodrigues, Pigosso and McAloone, 2017).
- Scepticism about impact: some employees doubt small improvements matter or view sustainability as PR, reducing motivation without clear evidence and management support (Lozano, 2013).

COST-EFFICIENT INTEGRATION OF SUSTAINABILITY INTO BUSINESS PROCESSES

- In EU Food & Beverage, a common concern is that sustainability integration is expensive.
- However, many costs come from tight deadlines, inefficiencies, and weak integration processes, not from sustainability itself.
- A cost-saving approach is to embed sustainability into standard PD decision-making alongside cost, quality, and time-to-market—rather than treating it as an extra layer (Govindan and Sivakumar, 2016; Büyüközkan and Çifçi, 2012).

MAKE DECISIONS UPSTREAM (DESIGN-TO-COST + ECO-DESIGN).

Cost-efficient sustainability: "avoid the late check"

- A practical way to reduce sustainability cost is to **prevent "late checks"** by building sustainability into **early design**, because early choices lock in most future impacts and costs.
- Evidence suggests that around **80% of environmental impact** (for food packaging) and **~80% of total cost** can be determined at the design stage (CNTA, 2022).

How to apply this in EU F&B PD

- **Set cost + sustainability targets together** (e.g., pack cost/unit, recyclability grade, recycled content %, transport efficiency).
- Use **early "light" screening** before full LCA (e.g., a simple MET matrix to identify hotspots) (CNTA, 2022).
- Embed sustainability checks into **stage-gates**, so failing a simple cost/packaging/sustainability filter early is cheaper than changing after artwork, suppliers, and logistics are fixed.
- This also fits **design-to-cost**: define cost targets upfront and manage trade-offs throughout the design cycle (4Cost, 2024).

COST-EFFECTIVE SUSTAINABILITY: START WITH "WIN–WIN" MOVES

Cost-effective sustainability: start with "win–win" moves

- If firms start with the hardest changes (new materials, new suppliers, major process shifts), sustainability can become **too costly**.
- A better approach is to begin with **"win–win" actions** where environmental gains also **reduce costs**—most often in **packaging and distribution**.

Why eco-design can save money (F&B)

- Direct savings from **less material**, **lower component complexity**, and **higher packaging efficiency**.
- CNTA reports **40–60% cost savings** in some packaging system redesign cases while improving environmental indicators (CNTA, 2022).
- Packaging changes are also **highly visible to consumers**, supporting credibility and reducing internal disputes about what sustainability means (Monforti-Ferrario et al., 2015).

Logistics "win–wins"

- Better pack/pallet design can increase pallet loads, reduce shipments, shorten handling time, and lower damage—translating into cost savings (CNTA, 2022).
- Packaging decisions involve multiple trade-offs (cost, sustainability, convenience, visibility), so sequencing matters (Sumter et al., 2023).

INTEGRATE SUSTAINABILITY INTO WORKFLOWS USING DIGITAL PROCESS INTEGRATION

Keeping sustainability costs low: "evidence by default"

- Treating sustainability as a separate activity ("extra reporting") makes it expensive because teams **recreate the same data repeatedly** and make decisions with incomplete information.
- A lower-cost approach is to embed **sustainability evidence** into existing workflows: product requirements, procurement approvals, packaging BoMs, and supplier onboarding.

Role of digital integration

- Evidence from manufacturing suggests that digital integration can improve sustainability and economic performance through **operational efficiency** (faster processes, better resource allocation, fewer errors) (Bindeeba et al., 2025).

Implication for EU F&B PD

- **Standardise data capture inside PD/quality/procurement** (e.g., weights, supplier info, recycled content proof, compliance documents).
- When evidence is standardised, sustainability proof **"happens by default"**, enabling comparisons, stronger governance, and fewer last-minute surprises.

COST-EFFICIENT SUSTAINABILITY INTEGRATION ROADMAP

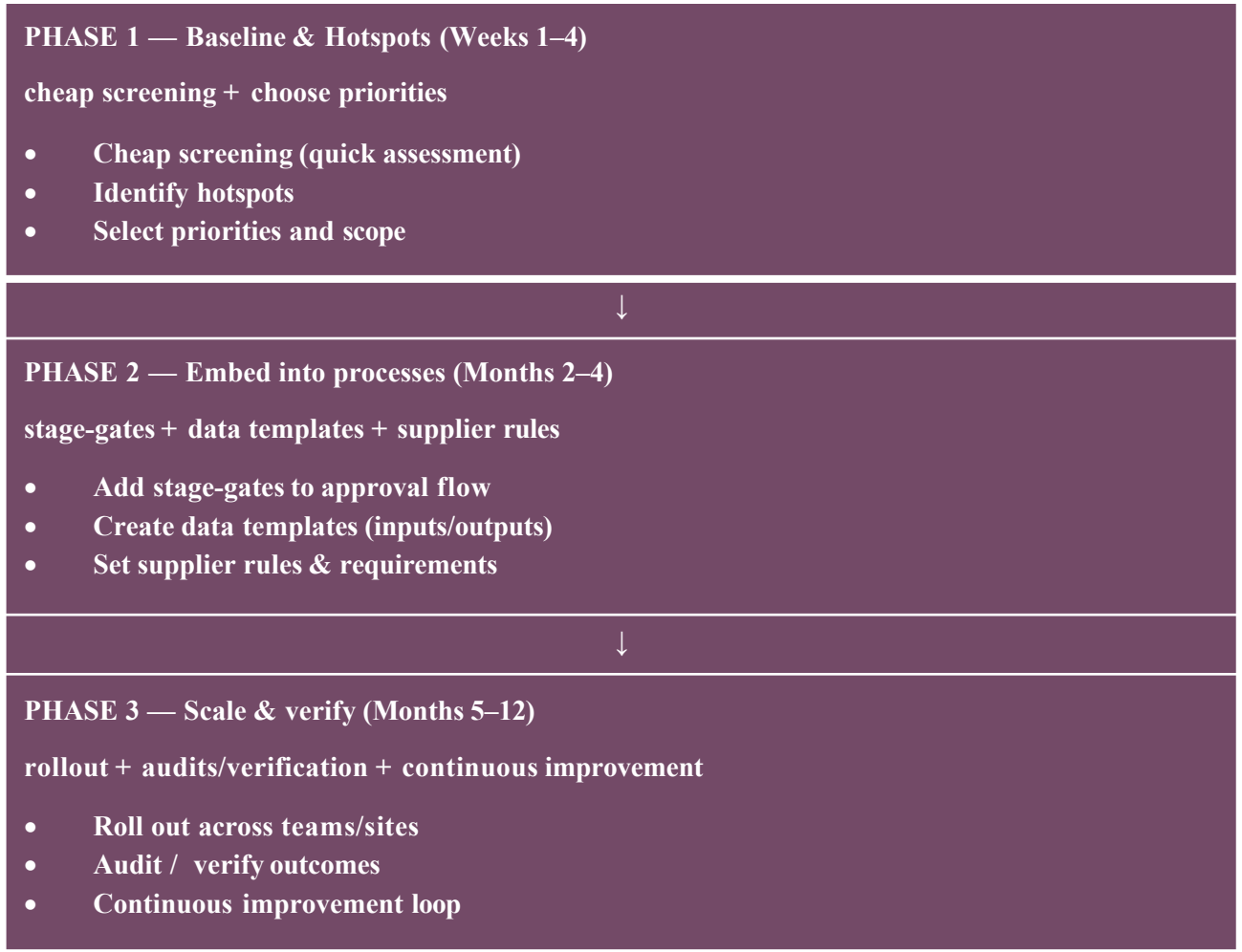


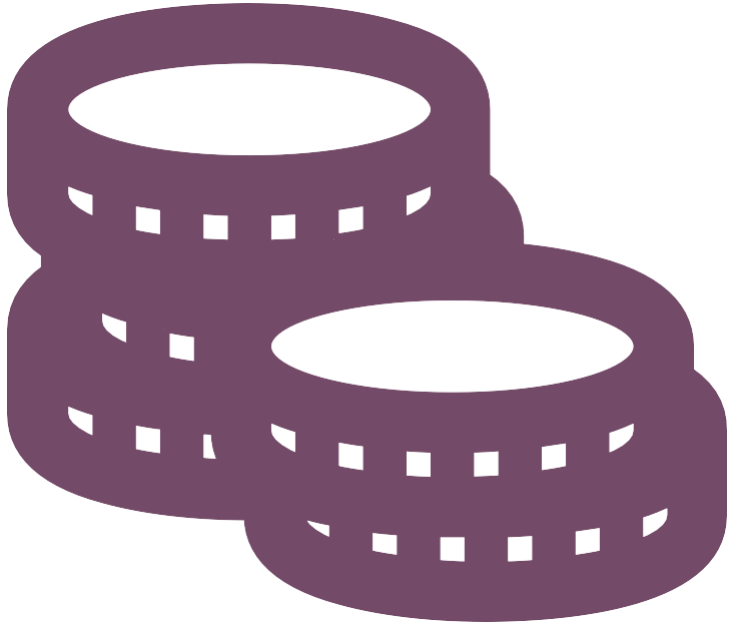
Figure 1. Process Phases Diagram

BUDGET PLANNING FRAMEWORK

Workstream	Typical cost items	Low-cost approach	KPI (to track savings)	Owner
Packaging redesign	prototypes, testing, tooling changes	start with lightweighting + standard formats	packaging weight/unit, cost/unit	R&D + Packaging
Logistics optimisation	pallet trials, reconfiguration	redesign case/pallet dimensions first	units/pallet, shipments/month	Supply Chain
Data & reporting	software, data cleaning	integrate into existing templates/ERP	% SKUs with complete data	IT + QA
Supplier alignment	audits, certifications	risk-based focus on top suppliers	% Spend covered by criteria	Procurement
Training & change	workshops, playbooks	role-based short training	adoption rate	HR + PD lead

PREVENTING LATE-STAGE ECO-FEATURE ROLLBACKS AND GREENWASHING IN EU F&B PRODUCT DEVELOPMENT

- Rollbacks of eco-features in EU F&B often occur because time and cost pressures make sustainability the first thing cut when it is not formally protected, while greenwashing risk rises when marketing claims move faster than evidence. A simple solution is **"lock + prove"**: lock eco-features as eco-critical specifications with change control and clear approval ownership, and prove them through standardised stage-gates and an auditable launch evidence pack so claims cannot outrun implementation (Ma and Ahmad, 2024; Zhu, Song and Zhang, 2024; MacLennan and De Catelle, 2025).



METHODOLOGY

Design choice

- This study uses a mainly **qualitative multi-case design** based on **secondary data** (corporate disclosures and other public materials). Where possible, a small number of **semi-structured expert interviews** may be added to enrich interpretation. This design supports both **in-depth case understanding** and **cross-case pattern comparison** of practice-level PD dynamics.

Unit of analysis

- The unit of analysis is the **company-level PD system**, focusing on PD processes and related product/packaging initiatives. Evidence will be synthesised across **4–6 EU-based F&B brands** to enable cross-case comparison.

Sampling frame and selection criteria

- Firms are selected **purposively** based on four criteria:
- active in EU markets and subject to relevant disclosure expectations;
- provide **sufficient detail** on PD-related sustainability actions in reports/communications (e.g., CSRD/ESRS, GRI, annual reports, packaging disclosures);
- introduced or reformulated packaged products during **2020–2025**;
- show **variation in PD integration depth** (e.g., use of LCA, stage-gate controls) and in contextual pressures (e.g., organisational readiness, external scrutiny).
  Where possible, cases will be broadly comparable in **scale and product category mix** to strengthen comparisons.

ANALYSIS STRATEGY

- Create a case database (doc type/year/product relevance) + evidence matrix with key excerpts
- Code evidence using a codebook: integration mechanisms, barriers, moderators, governance/verification, outcomes
- Within-case analysis: build a 2020–2025 PD "process story" across gates (concept, feasibility, design freeze, launch), highlighting trade-offs, rework and rollback signals
- Cross-case comparison: identify recurring bundles via pattern matching and co-occurrence mapping (which barriers cluster with which practices)
- Descriptive quantification only: counts of mechanisms, LCA/LCC requirements at gates, assurance presence, claim-governance completeness, rollback indicators
- Robustness checks: triangulate corporate claims with external sources (retailers/ratings) + include negative/weak-evidence cases

EXPECTED RESULTS

- Empirical insights: where sustainability enters PD (concept → launch), most used eco-design mechanisms, and common rollback drivers (cost, shelf-life, supplier gaps, KPI conflicts, time pressure).
- Integration depth typology: classify firms by how deeply sustainability is embedded (gate criteria, documented trade-offs, supplier/traceability requirements, change-control visibility).
- Governance & verification: practices that reduce rollbacks/greenwashing (claim owner, claims approval, evidence pack before launch, internal controls/external assurance).
- Practical toolkit: PD gate checklist + evidence matrix template + rollback-prevention playbook (early warning signals + actions).
- Contribution: links sustainability reporting + eco-design to observable PD routines; positions governance/verification as stabilisers of eco-features.

CONCLUSION

- Sustainability integration in EU Food & Beverage is most feasible when treated as “business as usual” inside product development—rather than an add-on or a communication project. Evidence from the cases suggests that success depends on how sustainability data is embedded into PD decision-making, and that governance and verification mechanisms (clear ownership, evidence packs before launch, and change-control rules) stabilise eco-features, reduce late-stage rollbacks, and lower greenwashing risk by shifting attention from claims to traceable proof. The study also highlights organisational constraints—time, budget, incentives, and change management—and shows that earlier, transparent trade-off management (cost, shelf-life, recyclability) makes implementation smoother. Overall, the dissertation contributes a practical framework to assess “depth of integration” from public sources and a set of repeatable practices for PD routines, helping firms integrate sustainability credibly and efficiently while protecting innovation cycles and long-term business value.

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