RESEARCH EXPOSE'

Quantifying environmental performance in pharmaceutical supply chains through a composite index

Submitted by:

Student: Ludovica Iannone

Supervisor: Stephane Ganassali, Gustavo Ghory

Academic Year: 2025/2026

Kassel, 28th October 2025

University of Trento - Department of Economics and Management
University Savoie Mont Blanc - IAE Savoie Mont Blanc
University of Kassel – School of Economics and Management
University of León - Faculty of Economics and Business Studies

Abstract

The pharmaceutical industry is facing a continuous increase of detailed exams regarding its environmental footprint, but still a reliable benchmark to evaluate its sustainability performances still does not exist. While sustainability has become a strategic imperative across global supply chains, the measurement of these practices within the pharmaceutical sector remains fragmented and inconsistent. For instance, it is also important to consider that substances toxic for cancer are often equally toxic to the environment, further emphasizing the urgency of developing a robust measurement framework. This thesis addresses this critical gap by developing a composite environmental sustainability index designed to measure and compare through a rank the performances of pharmaceutical supply chains.

Grounded in the Stakeholder Theory and the Resources-Based View (RBV), the following study integrates two complementary dimensions of sustainability: the external accountability pressures, deriving from regulators and investors capabilities such as innovation, environmental efficiency and the operational efficiency. Literature review, conducted in line with PRISMA guidelines, reveals that existing research on Green Supply Chain Management (GSCM) lacks in standardized and sector-specific indicators.

The Index will be consolidated on four environmental pillars in the pharmaceutical field, which are: climate, water, energy and waste, each will be weighted differently according to its material relevance in the pharmaceutical industry, as established by GRI, ISSB and CDP frameworks.

The primary objective of the Index is to translate heterogenous corporate disclosures into comparable benchmarks, offering a transparent tool for both internal and external stakeholders. It aims to facilitate the identification of environmental leaders within the sector and to monitor progress toward a more sustainable and low-carbon pharmaceutical industry.

TABLE OF CONTENTS

Abbreviation	Meaning
CDP	Carbon Disclosure Project
ESI	Environmental Sustainability Index
ESG	Environmental, Social and Governance
EMA	European Medicines Agency
EPR	Extended Producer Responsibility
EU	European Union
FDA	Food and Drug Administration
GHG	Greenhouse Gas
GLEC	Global Logistics Emissions Council
GRI	Global Reporting Initiative
GSCM	Green Supply Chain Management
ISO	International Organization for Standardization
ISSB	International Sustainability Standards Board
LCA	Life Cycle Assessment
OECD	Organisation for Economic Co-operation and Development
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PSCI	Pharmaceutical Supply Chain Initiative
RBV	Resource-Based View
ROI	Return on Investment
SDG	Sustainable Development Goals
TBL	Triple Bottom Line
TCE	Transaction Cost Economics
UN	United Nations
WRI	World Resources Institute
WBCSD	World Business Council for Sustainable Development

List of tables

List of figures

CHAPTER 1. INTRODUCTION

The sustainability has become a central topic across supply chains, transforming what was once a matter of awareness into a question of strategic management. This shift is particularly evident in the industries characterized by high resource intensity and strict regulatory requirements.

In this complex world, the pharmaceutical sector has a unique position. While pharmaceutical products are designed to save lives, their production processes can generate waste and emissions that harm the environment, raising the question: *if life-saving medicines pollute the water people drink, is the trade-off acceptable?* This paradox underscores the need to rigorously analyse the environmental performance of pharmaceutical companies.

These firms generate significant environmental impacts that can be grouped into key dimensions: Scope 1, Scope 2, Scope 3 emissions, waste, water and energy. These indicators were selected because they represent the most material environmental factors for pharmaceutical companies and are recognized by frameworks such as GRI, GHG Protocol and CDP. Moreover, these data are typically available through ESG disclosures and CDP submissions. Like many industries, each stage of the pharmaceutical supply chain, from the raw materials to the distribution, contributes substantially to the overall environmental footprint (Belal, Shukla, Balasubramanian, 2025).

The pharmaceutical sector has made significant progress, which in turn has raised stakeholders' expectation: investors now consider sustainability indicators as a critical element in their decision-making. Existing frameworks, such as GHG Protocol, ESRS, GLEC and GRI, provide indicators, but no standardized or comparable index exists for the sector. Meanwhile, frameworks like ISSB, CDP, and PSCI offer guidance but lack harmonized quantitative metrics.

.

1.2 Problem statement

Research on GSCM has provided substantial theoretical insights but remains largely descriptive. Many studies focus on individual practices, such as waste reduction, water management, or packaging, without offering an integrated or quantitative assessment of overall supply chain performance. Existing measurement frameworks rely heavily on self-reported data, which hinders comparability across firms and over time, creating both internal and external inconsistencies. Moreover, while ESG indices have been developed for general industries, they fail to capture the specific complexity of pharmaceutical production, which is constrained by stringent product safety requirements and the dual challenge of protecting both public health and the environment.

As a result, it is easy to understand that there is a huge methodological gap in the ability to quantify and benchmark environmental sustainability performances among the pharmaceutical supply chains.

1.3 Corporate value-action

To understand the broader context of this research, it is essential to examine the discrepancy between what companies claim about sustainability and what they implement in practice; this phenomenon is often described as the corporate value-action gap. In the selected field of studies, this gap is evident. Many pharmaceutical firms publicly commit to high environmental goals inspired by framework such as the sustainable development goal or the European Green Deal, still their reports on footprint remain fragmented and difficult to compare. This problem could be seen from two different points of view: first, a structural side where companies use different reporting boundaries and measurement methods and those make difficult to evaluate performance among industries. Second, a behavioural side, where sustainability is driven more by reputation than actual engagement, a pattern described as decoupling between what organisations communicate and what they really implement (Meyer and Rowan, 1997). Since this huge issue, for the stakeholders is very challenging to distinguish between genuine environmental improvement and greenwashing, for instance.

1.4 Research gaps

Although research on GSCM in the pharmaceutical sector has expanded in recent years, literature remains uncompleted and theoretically underdeveloped; it reveals four main and interrelated gaps.

(1) Absence of an Integrated Measurement Framework

Most existing works focus on a single stage of the value chain or specific practices rather than providing an overall measurement system. For instance, Belal, Shukla & Balasubramanian (2025) (*study 1*) identify as key environmental hotspots through a qualitative MET framework, while Veleva & Cue Jr. (2019) (*study 5*) benchmark green-chemistry adoption mainly in R&D. Similarly, Sazvar et al. (2022) and Tat & Heydari (2021) (*studies 3 and 8*) model individual cases or conceptual scenarios, without cross-company validation. Compared with other industries, such as the circular-economy models of Kopeinig et al. (2025) (*study 2*), the pharmaceutical sector still lacks an integrated and statistically validated framework for benchmarking environmental performances.

(2) Methodological Heterogeneity

Studies differ in indicators and normalization methods. As shown by Belal et al. (2025) and Becerra et al. (2021) (*studies 1 and 4*), some adopt operational control others financial control and many omit Scope 3 emissions or if published, sometimes they do not split it the different categories. Qorri et al. (2018) (*study 6*) and Greco et al. (2018) (*study 7*) emphasize the lack of standardized weighting and aggregation. These inconsistencies, reinforced by voluntary and patchy corporate disclosures (Leite et al., 2024 – study 9), hinder cross-firm comparability and empirical reliability. Adopting transparent and replicable composite-indicator methods following OECD (2008) guidelines is therefore essential.

(3) Limited Longitudinal and Comparative Evidence

Empirical analyses remain mostly static, focusing on isolated cases or short timeframes. Works such as Sazvar et al. (2022), Tat & Heydari (2021), and Müller et al. (2020) (*studies 3, 8, 11*) show improvements in specific contexts but lack temporal validation. Broader bibliometric reviews like Tseng et al. (2019) (*study 10*) confirm the dominance of qualitative or survey-based evidence and the scarcity of standardized multi-year datasets. Consequently, it is still unclear whether sustainability progress in pharmaceuticals represents temporary compliance or structural transformation.

(4) Limited Theoretical Operationalization

Although theories such as Stakeholder Theory and the Resource-Based View are frequently cited, few studies translate them into measurable constructs. Belal et al. (2025) and Becerra et al. (2021) (*studies 1 and 4*) apply them conceptually, while works on ESG and performance indices (Jain et al., 2019; La Torre et al., 2020) (studies 12–13) demonstrate quantification potential but remain detached from supply-chain sustainability.

1.5 Research aim and questions

The index's development in grounded on the Stakeholder theory and the Resource-based view (RBV) and its focus is to integrate internal and external determinants of corporate sustainability into a unified model. By combining these perspectives, the research aims to capture both external accountability and internal capability within a coherent measurement framework. In line with this objective, the study attempts to address the following research question:

RQ. I) How can a composite index be designed to accurately measure sustainability performance in pharmaceutical supply chains and be standardized to ensure comparability across companies?

CHAPTER 2. THEORETICAL FOUNDATIONS

Literature on GSCM is grounded not only in sustainability science but also at the intersection of environmental economics and operations management. The evolution from a purely compliance-oriented perspective to an integrated framework, one that views sustainability as both a strategic objective and a measurable source of value creation, has emphasized the relevance of two key theories: the Stakeholder Theory and the RBV.

In the specific context of the pharmaceutical industry, where operations are capital-intensive, highly regulated, and globally distributed, these theoretical lenses provide a coherent foundation for understanding the adoption of green supply chain practices and for designing a measurement model capable of capturing performance differences among companies.

2.1 Stakeholder theory

Stakeholder Theory, first articulated by Freeman in 1984, proposes that firms respond not only to the economic interests of shareholders, but also to the expectations of stakeholders who influence or are affected by corporate activity. Those stakeholders include regulators, investors, customers, employees, local communities and non-governmental institutions. Within the field of GSCM, Stakeholder Theory has a central role to explain why firms adopt environmental practices even when they are not mandatory. Companies often pursue sustainability initiatives to maintain legitimacy, reduce reputational risk and comply with the expectation of powerful external actors (Rowley, 1997; Eesley & Lenox, 2006). In this all-encompass industry, in which health and environmental risks are highly salient, stakeholders' influence, as the theory suggests, is particularly strong. Regulators such as the EMA set strict standards, investors rely on ESG metrics and public perception places reputational pressure on companies to reduce their environmental impact. These dynamics explain why pharmaceutical companies adopt green practices, such as solvent recycling, low impact manufacturing and responsible waste management. Stakeholder theory provides a coherent foundation for this study: it clearly connects external pressures with corporate environmental behaviour. The implementation of this theory in a quantitative framework involves identifying indicators that reflect the degree of responsiveness to stakeholder expectations. For instance, the ISO 14001[1] certifications, ESG transparency scores, supplier environmental requirements and third-party assurance of sustainability reports (Balasubramanian & Shukla, 2020).

Finally, by capturing observable outcomes of stakeholders' influence, the theory supports the external dimensions of the Index, which measures how well firms align with environmental and social accountability standards.

2.2 The resource-based view

The resource-based view theory, first developed by Barney in 1991 and later refined by Hart in 1995, focus its attention on the internal capabilities that enable firms to achieve and sustain superior performance. This theory argues that competitive advantages arise from capabilities that are valuable, rare, inimitable and non-substitutable. In the context of the GSCM, this theory highlights how technologies and efficiency can potentially transform green responsibility into a strategic advantage (Rao & Holt, 2005; Teece, 1997).

RBV, applied to the pharmaceutical field, explains why some companies achieve higher levels of environmental performance than others, even when they have the same imposed regulatory conditions. From the studies emerges that firms with advanced R&D capacities in green chemistry matched with a strong internal sustainability cultures can more effectively reduce emissions and generally improve energy efficiency (Soete et al., 2017). However, these capabilities are not easy to replicate, and they often emerge from long-term investments in knowledge, such as technological skills or employee training.

The final choice to integrate this theory in this thesis is based on the recognition that sustainable performances depend not only on responding to external expectations, but also on possessing the internal capacity to do so in an effective way.

Matching those two theories create a dual analytic point of view. The Stakeholder Theory explains the motivation to act, while the RBV explains the means of action.

---

[1] ISO 14001, an international standard developed by the International Organization for Standardization (ISO) that specifies requirements for effective environmental management systems (EMS).

2.3 Identity-based sustainability: corporate environmental as a source of strategic differentiation

In the field of GSCM, the idea of identity-based sustainability helps to explain how pharmaceutical companies transform environmental values and stakeholder expectations into real strategic actions. This identity is directly related to how companies perceive and define themselves in relation to the environment, and how sustainability becomes an integral part of their organizational "self". In fact, they use practices to express who they aspire to be. Having a corporate environmental identity allows to align societal expectations and to show that their green responsibilities are taken seriously. From a theoretical perspective, this concept connects both the chosen theories. Sustainability-oriented organizational identity sits in the middle of the two forces: why companies adopt sustainable practices (Stakeholder Theory) and how they can use their internal capabilities (RBV). In this sense, the environmental indicators disclosed by companies are not only operational measures of performance, but also reflections of how each firm defines itself in relation with its environmental impact. The Index will therefore capture both the quantitative and the symbolic dimensions of corporate behaviour.

2.4 Rejected theories

Several theoretical perspectives have been applied previously to the study of GSCM, but not all of them are suitable for the purpose of this thesis. For this main reason and following the reasoning of earlier studies, two theories have been excluded: Institutional theory and Transaction cost economics (TCE).

First, the Institutional Theory, developed by DiMaggio and Powell in 1983, is focused on the explanation of how organizations adapt to external pressures such as laws and industry regulations. It has been widely applied in sustainability research to illustrate regulatory convergence and the diffusion of environmental standards across industries. However, in the context of this study, the theory's explanatory power is limited. The pharmaceutical industry operates under highly standardized global regulations (e.g., EMA, FDA, REACH), meaning that institutional pressures affect all firms in similar way. However, this thesis, on the opposite side, is focused on the variability, not convergency. This theory is based on compliance rather than performance differences, while the Index aims to evaluate how well companies go beyond compliance. Recent studies cited this theory, but they did not use it: Belal in 2025 and Koenig in 2019 also highlights that the theory is useful to describe regulatory convergence, but not to understand voluntary sustainability efforts. For this reason, it was not chosen as a guiding framework.

TCE, introduced by Williamson in 1979, focuses on minimising the costs of economic exchanges by determining the most efficient governance structures for transactions. This theory has been applied to some recent supply chains studies, but it tends to take in exam sustainability only to save money through reducing inefficiencies. Soete in 2017 and Kusi-Sarpong in 2016 found limited explanatory power of this theory in GSCM contexts, confirming that in pharmaceutical field the sustainability is driven more by stakeholders' expectations and long-term strategic goal than by short term costs savings. Therefore, it has been excluded from this research.

While the institutional theory focuses on external compliance and TCE on economic efficiency, this thesis looks at how firms combine internal capabilities and external pressures to achieve better environmental results. So, both these theories have been rejected because they do not fit in the explanation of the performances' differences among companies.

2.5 Conceptual framework

This study integrates several complementary theories to explain how pharmaceutical companies are translating into a measurable environmental performance and the framework. In this sense, the framework combines Stakeholder theory, RBV, TBL and insights from Identity-based sustainability to connect strategic intent with measurable outcomes. This conceptual model assumes that stakeholders' pressures trigger sustainability responses and internal capabilities determine their effectiveness. In this complex context the Index will establish the theoretical foundation for the research model developed this research and it will operationalise these relationships into measurable components of environmental performance.

CHAPTER 3. LITERATURE REVIEW

3.1 Theoretical background: the Triple Bottom Line framework

The studies analysed in this research share a common theoretical foundation the Triple Bottom Line (TBL) framework, which conceptualizes sustainability as the balance among three dimensions: environmental, social and economic. This framework has become one of the most influential approaches in sustainability research because it enables a comprehensive evaluation of corporate performance that goes beyond traditional financial metrics.

In the field of SCM, the TBL framework helps to explain how companies can operate responsibly while maintaining efficiency and competitiveness within global networks. Its relevance is even greater in the pharmaceutical industry, where firms face the dual challenge of protecting human health while minimizing their environmental footprint. This balance embodies the very essence of the TBL approach. Most of the studies reviewed in this research apply TBL framework either directly or indirectly. However, since the main objective of this thesis is to develop a composite index to measure environmental performance, the analysis focuses primarily on the environmental pillar of the TBL framework, which represents the most measurable and comparable component across firms.

3.2 Search process and methodology of the review

The literature search was conducted using a structured methodology to ensure reliability. The process covered a wide range of academic and institutional databases, including Google Scholar, JSTOR, Web of science, Scopus and ScienceDirect. These databases were selected for their comprehensive coverage of peer-reviewed research in supply chain management and sustainability science. In addition, institutional repositories such as the OECD iLibrary, Eurostat, the United Nations Comtrade Database and the European Commission’s Publications Office were analysed to identify methodological guidelines and datasets relevant to the construction of composite indicators and sustainability reporting. The search strategy combined targeted keywords and Boolean operators to capture the intersection between supply chain sustainability, measurement methodologies, and sector-specific applications. Typical search expressions included “green supply chain management” combined with “pharmaceutical industry,” “sustainability index” or “composite environmental indicator,” “ESG performance” combined with “supply chain,” and “stakeholder theory” paired with “resource-based view” and “environmental performance.” Filters were applied to restrict the selection to studies published between 2018 and 2025, ensuring the inclusion of the most recent and relevant contributions. Priority was given to highly cited articles and peer-reviewed papers.

To maintain the academic rigor, the review was limited to English language sources, including academic journals and institutional working papers. Non-scientific commentaries, consultancy briefs, and conference proceedings were excluded to ensure methodological consistency and quality.

The PRISMA flow process guided the selection and screening procedure. Out of all the studies initially identified and reviewed, fourteen were selected for in-depth analysis based on their theoretical alignment and methodological relevance. These studies cover a diverse range of topics, including green manufacturing practices, sustainability reporting, LCA and index-based performance measurement.

Table 1. Stepwise process in accordance with PRISMA 2020 guidelines

STEP	DESCRIPTION	RECORDS
1	Records identified through academic database searches and institutional repositories	320
2	Records after duplicates and non-peer reviewed sources removed	240
3	Records screened by title and abstract for relevance to pharmaceutical supply chain sustainability and composite indicator development	80
4	Full text assessed for eligibility and alignment with theoretical and methodological criteria.	78

5	Final studies included in the corpus for in-depth qualitative and quantitative synthesis	40

Source: Own elaboration

The inclusion criteria were guided by three main considerations. First, all selected studies had to focus on environmental or green supply chain practices with measurable outcomes. Second, they were required to contain explicit references to sustainability measurement frameworks or performance indicators. Third, they needed to be relevant either to pharmaceutical sector or to comparable high-impact manufacturing industries, such as chemicals, biomedical, biotechnological and healthcare logistics.

The studies meeting these conditions were then assessed for their theoretical grounding and their contribution to the broader research agenda of developing standardized tools for sustainability benchmarking. This systematic search strategy ensured a comprehensive evidence base: combining theoretical insight with methodological depth and sectoral specificity. This foundation established the empirical and conceptual basis upon which the remainder of this literature review is built and serves as the starting point for the development of the composite Index proposed in this research.

A structured overview of the reviewed studies, covering authors, methods, findings, and gaps, is presented in here to guarantee transparency and replicability of the review process.

Table 2. Summary of key literature on GSCM and sustainability measurement in the pharmaceutical sector

N.	Authors and year of publication	Title	Source	Methodology	Sample	Key findings	Gaps
1	Belal, M.M., Shukla, V., & Balasubramanian, S. , 2024/2025	Greening the Pharmaceutical Supply Chain.	Business Strategy and the Environment	Systematic review (PRISMA) + exploratory single-case study (UK) with an interpretivist approach and abductive logic; thematic analysis (NVivo).	47 interviews across the UK pharmaceutical supply chain + 112 environmental/ CSR reports and corporate documents.	The MET-based GSCM framework shows higher adoption in Biopharma than Generics, driven by regulation, cost savings, and leadership. Barriers include costly approvals, high investments, and low standardization,	GSCM research in pharma is fragmented, UK-centered, and mostly descriptive, lacking quantitative data, standardized metrics, and integrated supply chain

						though GSCP delivers emission cuts and ROI via solvent recovery.	perspectives, with limited focus on existing drug redesign weak regulatory and technological frameworks.
2	Jacob Kopeiniga, Kevin Anton Kriechbauma, Julia K¨oberla, Helmut Zsifkovits, 2025	*Supply Chain Circularity Composite Index: Measuring the Closed-Loopedness of Material Flows*	Sustainable Production and Consuption	Systematic Literature Review; development of SC3I framework using Material Flow Analysis (MFA); composite index construction with geometric mean; validated via multiple manufacturing case studies (Companies A & B).	49 academic articles reviewed; 59 circularity metrics analysed and clustered; two anonymized manufacturing companies tested (plastic sheets/films and gas engines).	Developed SC3I: a mass-based composite index integrating three dimensions, Material Efficiency (ME), Secondary Material Usage (SM), and Effectiveness of Recovery (ER). SC3I = geometric mean of ME, SM, ER, ensuring systemic perspective and penalizing weak areas. ER is the bottleneck across cases, despite strong ME and SM. Proposed improvements: take-back/buy-back programs, digital traceability (RFID, blockchain, DPP), reverse logistics partnerships, modular product design, regulatory incentives. SC3I aligns with SDG 12 and offers actionable, scalable, and non-subjective performance measurement.	Circularity assessment methods are fragmented, qualitative, and lack scalability or comparability across supply chains. Current indicators rarely capture multi-tier interdependencies, and recovery processes such as traceability, remain weak. SMEs are underrepresented, facing higher costs and lower benefits. Empirical validation is limited to few cases, with minimal integration of carbon, cost, or financial metrics. Advancing circularity requires supportive policies and further research to refine weighting methods, create benchmarks, and incorporate

							socio-economic dimensions.
3	Sazvar, Z. et al., 2022	Designing a Sustainable Closed-Loop Pharmaceutical Supply Chain	Annals of operations research	Scenario-based Multi-Objective Mixed-Integer Linear Programming (MOMILP) model; Game theory; Integration of CLPSC design with Vehicle Routing Problem; LP-metrics method for multi-objective optimization; two-phase hybrid heuristic solution approach.	Real-world case study: pharmaceutical supply chain in Noor (Iran) with 7 pharmacies, 1 distribution center, multiple manufacturers, 2 disposal centers, 3 remanufacturers; 3 pharmaceutical products. Demand analyzed across 24 periods (4 years), with optimistic, likely, and pessimistic scenarios.	A multi-period CLPSC model links direct and reverse flows, improving cost and environmental performance via recycling and remanufacturing. Game theory shows that price - quality competition and inventory strategy reduce waste and boost resilience.	Few quantitative CLPSC models integrate waste management or competition factors, with weak empirical validation and limited scope. Future research should improve scalability, coordination, resilience, and computational efficiency.
4	Becerra, P., Mula, J., & Sanchis, R. , 2021	*Green Supply Chain Quantitative Models for Sustainable Inventory Management: A Review*	Journal of Cleaner Production, 328, 129544	A systematic literature review of 91 studies (2004–2021) on sustainable inventory management analysed purposes, contexts, decision levels, and modeling methods, highlighting quantitative approaches within green and circular supply chains.	N = 91 peer-reviewed works. Outlets: IJPE, J. Cleaner Production, EJOR, Sustainability and others. Application contexts (when present): consumer goods, energy/fuel/biofuel, plus waste/spares/warehousing/hazardous. SC structures: divergent most common. Time: published in the last 10 years; ~60% in the last 5.	Sustainable inventory models mainly target cost reduction with limited social focus. Research is mostly tactical, using MILP and EOQ approaches, with scarce integration of all sustainability pillars. Reverse logistics is increasingly considered, but inventory policies and data sharing remain underdeveloped.	Sustainable inventory management research is mostly theoretical, lacks social and circular economy integration, shows weak validation, coordination, modeling of remanufacturing or recycling flows.

5	Vesela R. Veleva 1 and Berkeley W. Cue Jr. , 2019	The role of drivers, barriers, and opportunities of green chemistry adoption in the major world markets	Current Opinion in Green and Sustainable Chemistry	A global benchmarking survey (2016–2017) assessed green chemistry adoption in the pharmaceutical supply chain using a 22-question framework on governance, goals, metrics, training, and collaboration. Conducted among senior R&D, manufacturing, and EHS managers, it compared Big Pharma with smaller firms and analysed responses quantitatively.	A survey pharma firms across five regions (34 responses) found high Big Pharma participation and strong engagement in green chemistry, enhancing data reliability.	Big Pharma leads green chemistry adoption with strong metrics and governance, while smaller firms lag due to cost, regulation, and weak supplier engagement	Green chemistry progress in pharma is uneven: Big Pharma leads, while generics and API firms lag due to weak governance, metrics, and training. Regulatory barriers and poor supplier accountability persist, calling for global regulation, stronger standards, and broader education.
6	Ardian Qorria,Zlatan Mujkica,Andrzej Kraslawski, 2018	*A conceptual framework for measuring sustainability performance of supply chains*	Journal of cleaner Production	A systematic review of 104 studies analysed sustainability performance measurement in supply chains using the Content–Context–Process framework, identifying key metrics, tools, and methodological trends in GSCM and SSCM research.	The reviewed studies span multiple industries and cover both internal and cross-organizational contexts, emphasizing that sustainability performance must be assessed across whole supply chains using diverse qualitative and quantitative methods.	The study found that most research focuses on environmental and economic dimensions, while multi-criteria decision-making methods are increasing. It highlights that sustainability assessment remains fragmented, with inconsistent metrics and limited data sharing among firms.	Sustainability measurement remains fragmented—social factors are underrepresented, and data sharing is limited. The study urges standardized metrics, stronger collaboration, and integrated frameworks connecting sustainability assessment to supply chain strategy.

7	Greco, S., Ishizaka, A., Tasiou, M. et al. , 2019	On the Methodological Framework of Composite Indices: A Review of Weighting, Aggregation, and Robustness Issues	Social Indicators Research	The review analyses composite index methodologies, emphasizing weighting, aggregation, and robustness. It integrates participatory and data-driven approaches across disciplines, offering a comprehensive synthesis of theoretical and empirical developments.	The review covers an extensive body of literature published since the early 2000s, updating and expanding beyond classic works. The sample encompasses hundreds of studies that employ or critique composite indices.	Composite indices lack consensus on weighting and aggregation; most use arbitrary equal weights and compensatory linear models. Robustness testing is often missing, while hybrid and non-compensatory methods offer more balanced but underused alternatives.	Composite index methodologies face issues of arbitrary weighting, poor transparency, weak robustness testing, and excessive reliance on linear aggregation. Non-compensatory methods are underused, and interdisciplinary integration remains limited.
8	Roya Tat , Jafar Heydari , 2021	*Avoiding medicine wastes: Introducing a sustainable approach in the pharmaceutical supply chain*	Journal of Cleaner Production	A bi-level optimization model for a supplier–retailer pharmaceutical chain integrates economic, environmental, and social goals via donation and take-back strategies	The study is conceptual and model-based rather than empirical. The "sample" consists of simulated supply chain scenarios based on a two-echelon PSC. Six demand scenarios with varying mean and standard deviation values were tested to evaluate model robustness.	The bi-level collaborative model boosts supplier and retailer profits, reduces medicine waste through take-back and donations, and balances economic, social, and environmental goals-achieving win–win sustainability outcomes.	The model's scope is narrow with simplified assumptions on returns, shelf life, and timing. Future studies should address multi-product systems, pricing contracts, behavioral CSR factors, and validate results with real-world data.
9	Emilene Leite, Nikolina Koporcic, Stefan Markovic , 2024	Corporate Sustainability Reporting: Shifting From Optional Due Diligence to	Business Ethics, the Environment & Responsibility (Wiley)	This paper synthesizes policy analysis, legal perspectives, and theoretical frameworks. The authors analyze the directive	Rather than empirical cases, the "sample" consists of 104 documents. The study uses illustrative cases to contextualize how poor governance in	The CSDDD makes CSR a binding legal duty across value chains, promoting sustainability and human rights, but risking procedural compliance. It emphasizes shared responsibility	The CSDDD lacks clarity in enforcement and investor duties, risking superficial compliance. Power imbalances and high costs may

		Mandatory Duty		through different point of view, using secondary sources. The methodology is thus narrative review and normative analysis, focusing on implications for firms, supply chains, and policymakers.	global value chains can create human rights risks. The scope is global, but the regulatory focus is the EU and its value chain partners, with emphasis on industries most affected: textiles, agriculture, mining/extraction, and financial services.	contracts and digital tools for improved traceability and efficiency.	affect fairness and competitiveness. Future studies should assess global effects, shared-responsibility frameworks, and EU policy integration.
10	Ming-Lang Tseng, Md Shamimul Islamb,c,N oorliza Kariab, Firdaus Ahmad Fauzib, Samina Afrin , 2019	*A literature review on green supply chain management: Trends and future challenges*	Journal of cleaner Production	The study uses a systematic literature review and bibliometric/meta-data analysis. Data was collected from Scopus and ISI Web of Science databases between 1994 and December 2017. The authors applied keyword-based search strategies to retrieve studies. After screening, they conducted content analysis and classified the literature into thematic categories and performance assessment	The review analysed 880 papers. The sample covers publications across multiple disciplines and identifies top authors, journals, institutions, and countries active in GSCM. The time span of the data captures the development of GSCM literature from the early 1990s through 2017	The study identifies China and the USA as leaders in GSCM research, with Sarkis and Zhu as key contributors. It defines an integrated GSCM framework, notes growing collaboration and modelling efforts and highlights that most performance assessments still rely on survey rather than operational data.	GSCM studies rely on limited databases and perceptual data, lack theoretical depth, and focus mainly on large firms. Cross-industry, international, and SME analyses are scarce, while emerging areas like big data and digitalization remain underexplored.
11	Leonard Jan Mu ¨ller, aArne Ka ¨telho	The carbon footprint of the carbon	Energy & Environmental Science	The study uses Life Cycle Assessment to evaluate CO_2	European CO_2 sources from industrial processes (e.g.,	System expansion and substitution are the most reliable LCA methods for	LCA methods for CO_2 use lack consistency, often stop at

	¨n, abStefan Bringezu, Sangwon Suh,e Robert Edwards, Volker Sick, Sean McCoy, Simon Kaiser,Rosa Cue ´llar-Franca,h Aı ¨cha El Khamlichi,i -Jay H. Lee, Niklas von der Assena and Andre ´ Bardow, 2020	feedstock CO2		footprints in Carbon Capture and Utilization, comparing system expansion, substitution, and allocation methods, supported by case studies and future low-carbon scenarios.	ammonia, fermentation, biogas, and direct air capture). Modelled datasets integrate process-specific and energy-mix assumptions.	CO_2 foot printing. Current European sources show negative footprints, improving further in low-carbon scenarios. Ammonia, fermentation, and biogas plants perform best, while Direct Air Capture remains most energy intensive. CO_2 availability could drop by 80% in a decarbonized Europe.	cradle-to-gate boundaries, and risk misinterpreting "negative emissions." CCU remains energy-intensive and reliant on renewables, with limited socio-economic analysis and uncertain future CO_2 availability in low-carbon scenarios
12	Mansi Jain , Gagan Deep Sharma and Mrinalini Srivastava, 2019	*Can Sustainable Investment Yield Better Financial Returns: A Comparative Study of ESG Indices and MSCI Indices*	Risks	The study compares ESG and MSCI index performance using econometric models to analyse returns, volatility, and long- and short-term relationships.	The study analyses ten indices (four ESG, six MSCI) from 2013–2017 to compare ESG and traditional market performance, assessing differences in returns, risks, and market co-movements.	ESG indices match or exceed traditional benchmarks in returns, with mixed volatility results. They show persistent volatility, long-term integration with conventional indices, and bidirectional spillovers, confirming ESG investments as viable, diversified alternatives	The study's five-year scope and focus on developed markets limit insights into ESG performance during crises or in emerging economies.
13	Mario La Torre, Fabiomassimo Mango , Arturo Cafaro and Sabrina Leo, 2020	Does the ESG Index Affect Stock Return? Evidence from the Eurostoxx50	Sustainability, Volume 12, Issue 16, Article 6387	The study adopts a two-step empirical approach. First, a panel data analysis, second, multiple linear regressions are performed separately for each firm to explore how	The dataset covers 46 firms listed on the Eurostoxx50 index. Monthly data spanning May 2010 to December 2018 (105 observations per firm) were used for the panel analysis. ESG	ESG scores show a weak, but positive link to stock returns, significant in few firms, mainly energy and utilities. Governance and social factors drive most effects, though overall explanatory power and predictive ability remain limited.	The authors note several limitations. The weak explanatory power of ESG indices; the analysis is restricted to Eurostoxx50 firms; ESG effects were significant only

				ESG sub-factors impact stock returns. The analysis draws on ESG scores aggregated by CSRHub from multiple data providers, normalized into a single “Overall ESG” index.	indicators were taken from CSRHub and opinions from a wide range of providers covering more than 17,000 firms across industries and countries.		in a minority of firms and sectors; the reliability of ESG indices remains an issue due to methodological divergences among providers.
14	Andrej Srakar, Vesna C ˇopicˇ, Miroslav Verbic, 2018	*European cultural statistics in a comparative perspective : index of economic and social condition of culture for the EU countries*	Journal of Cultural Economics, volume 42	A cultural index for EU countries was built using factor analysis with advanced corrections, PCA for aggregation, and cluster analysis for classification, validated through correlations with socio-economic indicators.	The study uses Eurostat and national-level cultural statistics for EU countries in two benchmark years. Indicators span areas such as employment in cultural sectors, education in humanities and arts, cultural industries, and public financing of culture.	The study finds interconnected cultural dimensions in the EU, with participation linked to other indicators rather than independent. The cultural index aligns with economic and social metrics and reveals four regional clusters, showing cultural resilience during economic crises.	Cultural data are fragmented and limited to two periods, hindering long-term analysis. The study calls for richer, micro-level, and longitudinal datasets, testing alternative models, and linking cultural indices more directly to EU policy and social outcomes.

Source: Own elaboration based on the reviewed literature (2018-2025)

3.3 Key findings

Three main insights emerge from the reviewed studies. First, the adoption of green practices is highly uneven: larger and more innovative firms are leading the transition toward sustainability, while smaller companies remain primarily compliance oriented. Second, external pressures, both regulatory and stakeholders driven, represent the main drivers of sustainability initiatives and progress. Third, these improvements can only be sustained when they are supported by strong internal capabilities and resource investments. Overall, literature suggests that environmental performance in the pharmaceutical sector results from the interaction between external accountability and internal capability. This insight provides the theoretical foundation for the development of the composite Index.

3.4 Scholarly discussion

Sustainability within the pharmaceutical field has evolved over the years, as have the approaches used to measure and operationalize its integration into corporate strategy. This topic represents the main focus of several existing studies and is situated within a broader academic debate on how to advance both the theoretical and methodological understanding of GSCM in this industry. Existing contributions have mapped the drivers, barriers and practices associated with green transformation, yet they have not developed an integrated measurement system. *Belal, Shukla & Balasubramanian (2025)* conceptualize environmental performance through the MET framework, highlighting regulation and cost reduction as key drivers, yet their analysis remains qualitative and context specific. *Veleva & Cue Jr. (2019)* and *Sazvar et al. (2022)* extend the discussion to green chemistry and closed-loop supply chains, but these efforts remain fragmented and focus primarily on individual case studies. Other research, such as *Becerra, Mula & Sanchis (2021)* and *Kopeinig et al. (2024)*, demonstrates the increasing use of quantitative models and composite indicators in sustainable operations, suggesting a methodological transition toward more data-driven approaches. The Index proposed in this thesis aims to address these deficiencies. By structuring environmental data into pillars weighted according to sectoral materiality, the Index transforms heterogenous corporate disclosures into a standardized metric. It not only operationalizes the theoretical propositions of Stakeholder Theory and RBV but also aligns with the key international disclosure frameworks such as GRI, ISSB, and CDP, whether mandatory or voluntary depending on jurisdiction. Thus, this research advances the academic conversation toward a more quantitative, standardized, and transparent form of sustainability assessment for the pharmaceutical industry. By combining theoretical rigor with methodological precision, it contributes to the scholarly debate on GSCM by proposing a replicable and statistically grounded model capable of informing future research, enhancing managerial decision-making, and supporting evidence-based policymaking.

CHAPTER 4. HYPOTHESES

The formulation of the hypothesis derived from the theoretical framework and the central research aim of this study: how can environmental sustainability performance in pharmaceutical supply chains be explained and measured in a consistent and comparable way? To capture both external and internal dimensions of corporate sustainability behaviour, the framework integrates Stakeholder Theory and RBV. The first theory explains the influence of external forces on corporate environmental behaviour. It provides the foundation for H1, which predicts that stronger stakeholder pressures led to higher levels of sustainability performance. The RBV complements this perspective by focusing on internal resources and capabilities, forming the rationale for H2, which associates stronger green capabilities with improved environmental outcomes. The integration of these two hypotheses leads to H3, which proposes that firms combining external accountability with internal capability achieve superior sustainability results. H4 reflects the methodological objective of this research: to validate the proposed Index as a reliable and statistically robust tool for measuring green performance.

In accordance with the Stakeholder Theory, the RBV and the theoretical perspectives identified in the current literature, this thesis is based on the following hypotheses:

H1. Firms facing stronger stakeholder and regulatory pressures are expected to exhibit higher levels of environmental sustainability performance within their supply chains. *(Stakeholder-driven accountability hypothesis)*

H2. Firms with stronger internal green capabilities, such as advanced technologies, skilled human resources, and structured programs achieve higher levels of environmental performances.
(Capability-based performance hypothesis)

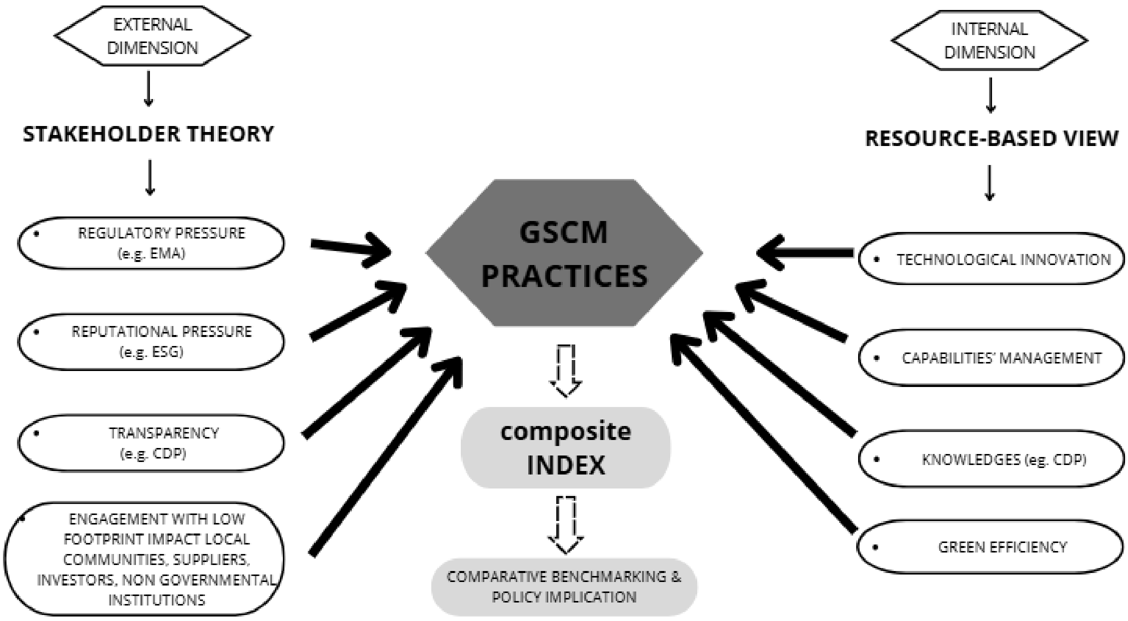
H3. The interaction between external stakeholder pressures and internal capabilities expected to have a strong positive effect on environmental performance, indicating that companies combining external accountability with internal strength outperform others. *(Integrated sustainability hypothesis)*

H4. The proposed Index constitutes a valid and comparable statistical instrument for measuring and benchmarking sustainability performance among pharmaceutical companies. *(Measurement validity hypothesis)*

CHAPTER 5. RESEARCH MODEL

This diagram represents the conceptual research model developed for this thesis, in particular, this model integrates the Stakeholder Theory and the RBV to explain environmental performance differences among pharmaceutical supply chains.

Figure 1. Theoretical-Conceptual Model of Green Supply Chain Sustainability



Source: Own elaboration based on Freeman (1984), Barney (1991), Hart (1995), Elkington (1997), Bansal (2005), DiMaggio & Powell (1983).

This model shows how external stakeholders' pressure and internal firm capabilities jointly influence GSCM practices, which will be then operationalised through the composite Index. It provides the structural basis for the empirical validation of the hypothesis discuss in the previous chapter, serving as the theoretical foundation for the Index that will be developed in this thesis.

CHAPTER 6. METHODOLOGICAL FRAMEWORK

6.1 Research design

The methodological framework of this study adopts a quantitative approach to compare sustainability's indicators within pharmaceutical supply chains. Given the need to overcome the limitations of previous incomplete studies, qualitative methods such as interviews, while fundamental for exploring conceptual relationships and managerial perceptions, cannot provide comparable measurements among those firms. Therefore, a qualitative approach is considered inadequate for benchmarking purposes (Clark, Breeden and Summerton, 2010; Watson 2012).

A quantitative approach allows the integration of the data into a statistical model that enables in-depth understanding of the research's results through cross-company comparison and interpretation. This decision aligns with the methodological principle defined by the OECD and the United Nations, which emphasizing robustness in the construction of the composite Index.

6.2 Target sample

The study will be focus on a sample of 8 to 10 multinational pharmaceutical companies, a number considered sufficient to enable cross-company comparison while ensuring analytical consistency. The analysis will cover two years (2024 and 2025) to allow both current and short-term performance assessment. Companies' selection is based on data accessibility and transparency, particularly whether firms are publicly listed. This distinction is important because with international frameworks, ensuring greater data reliability and comparability.

6.3 Data collection and analysis procedure

The methodological process develops on four main steps: data selection, indicators' harmonization, index construction and weighting. Each of those steps will be designed to ensure a consistent and coherent final framework grounded on available and statistical data. The index will rely on publicly available environmental data disclosed by leading pharmaceutical companies, including sustainability reports, CDP submissions and ESG disclosures. To ensure methodological consistency, all data will be harmonized according to the market-based, location-based and the operational control approaches defined by the GHG protocol (WRI and WBCSD, 2015). This boundary definition allocates environmental impacts to the operations over which a company has the authority to implement management decisions and sustainability practices. The harmonization process will involve standardising units of measurement: tonnes of CO_2 equivalent for emissions, cubic meters for water, MWh for energy and tonnes for waste and normalizing the indicators by operational output such as revenue (Euro) or production volume to correct for size effects. Qualitative data are excluded since their inclusion would compromise statistical validity (OECD, 2008; Saisana and Saltelli, 2011).

The Index will be structured on four pillars of footprint: climate, energy, water and waste, since those areas are considered the most impactful in the pharma sector (GRI, 2021; SASB, 2023; CDP, 2024). Where climate includes emissions among Scope 1, Scope 2 and Scope 3 (categories 1 and 4), corresponding respectively to direct emissions, indirect emission, upstream packaging goods and logistics. Water means the total withdrawal from all the sources: this kind of companies, more than others, are depending on water's usage to clean, disinfect, production and cooling. Energy represents the total energy used, while waste is accounting both the toxic and not toxic substances generated by the firms. As mentioned, because of the numerical comparability, a quantitative indicator-based was preferred. Each of the variables analysed will be normalized through a min-max transformation and rescale between zero and one (OECD, 2008). This standardization transforms heterogeneous sustainability data into a dataset that can support the development of the composite Index.

One of the main decisions in the methodological field concerns how indicators are weighted and aggregated. This thesis adopts a pillar-weighting approach, assigning different levels of importance to each environmental dimension based on its material relevance. The equal-weighting method has been rejected, as it assumes identical importance among variables, which is inconsistent with both regulatory evidence and sectorial materiality (Saisana and Saltelli 2011; OECD 2008). This weighting scheme was developed in alignment with official frameworks, such as GRI, ISSB and CDP, and previous studies, such as Belal, Shukla and Balasubramanian (2025) and Clark, Breeden and Summerton (2010).

Accordingly, to climate was given a weight of 50 percent because these emissions represent the most impactful challenge to manage in this sector, while to water was given a weight of 20 percent, because as mentioned above this firms are highly involved in the usages of water during the manufacturing processes and the frequent location plants in water-stressed areas. To waste and energy were each assigned a weight of 15 percent, because, even if they are relevant, their impact is relatively lower in comparison to climate and water. Thus, there are sub weights established for the climate sector, such as scope 1 a weight of 0.15, scope 2 a weight of 0.15, scope 3 category 1 a weight of 0.012 and scope 3 category 4 a weight of 0.08, this subdivision is aligned to the logic of GHG protocol. Those selected weights ensure that the Index will capture the real impacts in the pharmaceutical industry.

To sum up in a better vision approach:

Table 3. Weighting Scheme of the Composite Index

PILLAR		BASE WEIGHT
Climate total		**0.50**
- Scope 1-direct emissions	0.15	
- Scope 2-indirect emissions	0.15	
- Scope 3 cat 1-purchase goods	0.12	
- Scope 3 cat4-logistics	0.08	
Water		**0.20**
Energy		**0.15**
Waste		**0.15**

Source: Own elaboration based on GRI (2021), ISSB (2023), CDP (2024); Belal, Shukla & Balasubramanian (2025)

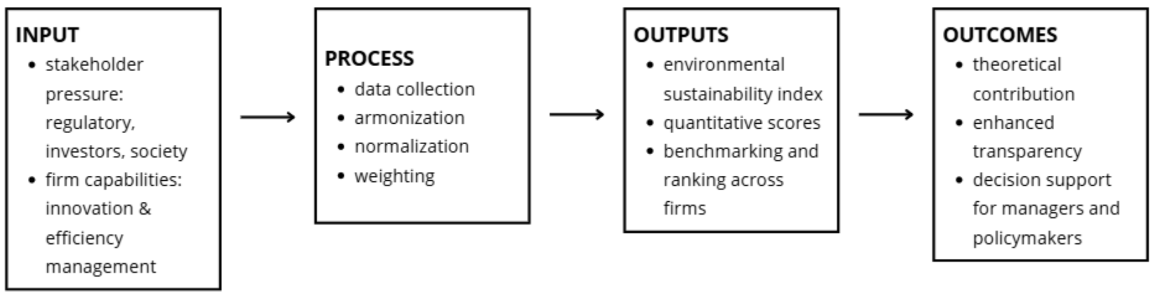
This figure represents the weighting structure applied to the four pillars, defined according to their material relevance for the pharmaceutical industry.

The data were aggregated using a linear additive model, which provides a transparent interpretation of the results, while preserving balance and proportionality among variables. Alternatives methods, such as geometric or non-linear aggregation, were rejected because they can distort proportionality and introduce bias into the results (Saltelli et al., 2020). The linear additive model is widely recommended in the construction of composite indicators when transparency and interpretability are prioritized over complex weighting optimization (OECD, 2008).

To ensure the robustness of the Index, a series of comparative analyses will be conducted. Correlation and Principal Component Analyses (PCA) will be used to verify that the selected indicators capture distinct yet complementary dimensions of environmental performance. Sensitivity analysis will then be performed by varying pillar weights and normalization methods by ±10% to test the stability of company rankings. In addition, a qualitative cross-check of company disclosures will complement the statistical validation to ensure that the quantitative results remain consistent with actual sustainability strategies and are not influenced by greenwashing practices.

The adoption of a quantitative, indicators-based approach is therefore justified by the goal of developing a framework capable of transforming fragmented environmental disclosures into a comparable Index. However, pharmaceutical firms differ significantly in how they define organizational boundaries, with some adopting operational control, others financial control, and a few using hybrid systems. This inconsistency generates potential measurement bias, as the same environmental outcome may be reported differently depending on the chosen consolidation method.

Figure 2. Conceptual Framework for the Index



Source: Own elaboration based on Freeman (1984), Barney (1991), Hart (1995), Elkington (1997), Bansal (2005), Belal, Shukla & Balasubramanian (2025) & OECD (2008)

The figure illustrates the logical flow underpinning the development of the composite Index, integrating theoretical inputs, methodological processes and practical outcomes.

CHAPTER 7. CONTRIBUTIONS

7.1 Contributions to theory building

While previous research has often focused on conceptual models or isolated practices, this study introduces the first statistically validated composite index specifically designed to measure green supply chain performance in the pharmaceutical sector. Its novelty lies in three key innovations.

First, the creation of a harmonized data framework that standardised sustainability information among pharmaceutical companies. This structure addresses the significant inconsistency in reporting practices highlighted by earlier studies, particularly regarding the treatment of Scope 3 emissions. The use of verified data sources ensures methodological consistency and enhances replicability.

Second, the weighting and aggregation process. Instead of applying equal weights, the Index adopts a structured system based on an in- depth analysis of environmental materiality. This approach is supported by both the GRI and ISSB, which identify greenhouse gas emissions and water use as the most material aspects within this sector. The weighting reflects the environmental dimensions of highest stakeholder relevance, assigning proportionally greater importance to those areas over which managerial influence is strongest.

Third, translation of theoretical concepts into quantifiable variables. Stakeholder responsiveness is operationalized through external indicators, such as the proportion of suppliers evaluated for environmental performance. Resource-based capabilities are represented by internal investment and operational efficiency metrics, including energy intensity, solvent recovery rates and process mass intensity improvements. These indicators are not arbitrarily selected: they are derived from the theoretical mapping of how external stakeholder pressures and internal firm resources interact to shape environmental outcomes.

7.2 Implications for business and society

The Index has a hybrid purpose: on one hand it will provide companies with a tool to measure their environmental footprint based on transparent data; on the other hand, it will offer investors a reliable means of comparing firms across the pharmaceutical sector through standardized rankings. The implementation of the Index is expected to be straightforward for companies already aligned with the compulsory ISSB framework. In fact, while the ISSB establishes sector-specific ESG disclosure requirements relevant to investors, the Index will complement these standards by transforming disclosed data into measurable performance outcomes.

The findings provide actionable insights for managers, policymakers and investors. For corporate decision-makers, the Index will be use as a diagnostic tool not only to benchmark performances, but also to identify areas for improvement and integrate sustainability targets into strategic planning. For policymakers and regulatory authorities, it will offer a data-driven mechanism to monitor sectorial progress in line with the European Green Deal and the United Nations Sustainable Development Goals. Lastly, for investors, the Index will deliver a standardized measure of environmental accountability, enabling more informed decision-making in ESG financial evaluations.

The proposed Index bridges academic research and practical application, offering a robust framework for evaluating and advancing environmental sustainability across the pharmaceutical industry.

CHAPTER 8. CHAPTER OVERVIEW

CHAPTER 9. WORK PLAN

Time period	Activity	Stage
1st September-28th October	Research and writing the Exposé	Done
28th October	Exposé Submission	Done
28th October-20th November	Data Collection	
20th November-10th December	Data Analysis	
10th December-15th January	Final developing, conclusions and reviewing the Thesis	
29th January-30th January	Thesis defence	

REFERENCES

Balasubramanian, Sreejith & Vinaya Shukla. «Green Supply Chain Management: An Empirical Investigation on the Construction Sector». *Supply Chain Management: An International Journal* 22, fasc. 1 (2017): 58–81.

Bansal, Pratima. «Evolving Sustainably: A Longitudinal Study of Corporate Sustainable Development». *Strategic Management Journal* 26, fasc. 3 (2005): 197–218.

Becerra, Pablo, Josefa Mula & Raquel Sanchis. «Green Supply Chain Quantitative Models for Sustainable Inventory Management: A Review». *Journal of Cleaner Production* 328 (December 2021): 129544.

Belal, Md Mostain, Vinaya Shukla & Sreejith Balasubramanian. «Greening the Pharmaceutical Supply Chain». *Business Strategy and the Environment* 34, fasc. 2 (2025): 1917–48.

Birasnav, M., Richa Chaudhary, James Henry Dunne, Joshua Bienstock & Cristina Seaman. «Green Supply Chain Management: A Theoretical Framework and Research Directions». *Computers & Industrial Engineering* 172 (October 2022): 108441.

Brandenburg, Marcus, Kannan Govindan, Joseph Sarkis & Stefan Seuring. «Quantitative Models for Sustainable Supply Chain Management: Developments and Directions». *European Journal of Operational Research* 233, fasc. 2 (2014): 299–312.

Carter, Craig R. & Dale S. Rogers. «A Framework of Sustainable Supply Chain Management: Moving toward New Theory». *International Journal of Physical Distribution & Logistics Management* 38, fasc. 5 (2008): 360–87.

CDP. (2024). *CDP climate change and water security questionnaires.* London: CDP Worldwide

De Soete, Wouter, Concepción Jiménez-González, Phil Dahlin & Jo Dewulf. «Challenges and Recommendations for Environmental Sustainability Assessments of Pharmaceutical Products in the Healthcare Sector». *Green Chemistry* 19, fasc. 15 (2017): 3493–509.

DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review, 48*(2), 147–160. https://doi.org/10.2307/2095101

Eesley, Charles & Michael J. Lenox. «Firm Responses to Secondary Stakeholder Action». *Strategic Management Journal* 27, fasc. 8 (2006): 765–81.

Elkington, J. (1997). *Cannibals with forks: The triple bottom line of 21st-century business.* Oxford: Capstone Publishing.

European Commission. Statistical Office of the European Union. *Guide on Multilateral Methods in the Harmonised Index on Consumer Prices: 2022 Edition.* Publications Office, 2022.

Freeman, R. E. (1984). *Strategic management: A stakeholder approach.* Boston, MA: Pitman.

Global Reporting Initiative (GRI). (2021). *GRI standards 2021 update.* Amsterdam: GRI.

Greco, Salvatore, Alessio Ishizaka, Menelaos Tasiou & Gianpiero Torrisi. «On the Methodological Framework of Composite Indices: A Review of the Issues of Weighting, Aggregation, and Robustness». *Social Indicators Research* 141, fasc. 1 (2019): 61–94.

Hart, S. L. (1995). A natural-resource-based view of the firm. *Academy of Management Review, 20*(4), 986–1014. https://doi.org/10.5465/amr.1995.9512280033

Jain, Mansi, Gagan Deep Sharma & Mrinalini Srivastava. «Can Sustainable Investment Yield Better Financial Returns: A Comparative Study of ESG Indices and MSCI Indices». *Risks* 7, fasc. 1 (2019): 15.

Kopeinig, Jacob, Kevin Anton Kriechbaum, Julia Köberl & Helmut Zsifkovits. «Supply Chain Circularity Composite Index: Measuring the Closed-Loopedness of Material Flows». *Sustainable Production and Consumption* 58 (September 2025): 351–63.

La Torre, Mario, Fabiomassimo Mango, Arturo Cafaro & Sabrina Leo. «Does the ESG Index Affect Stock Return? Evidence from the Eurostoxx50». *Sustainability* 12, fasc. 16 (2020): 6387.

Leite, Emilene, Nikolina Koporcic & Stefan Markovic. «Corporate Sustainability Reporting: Shifting From Optional Due Diligence to Mandatory Duty». *Business Ethics, the Environment & Responsibility* 34, fasc. 4 (2025): 2048–55.

Mahajan, Ritika, Weng Marc Lim, Monica Sareen, Satish Kumar & Rajat Panwar. «Stakeholder Theory». *Journal of Business Research* 166 (November 2023): 114104.

Müller, Leonard Jan, Arne Kätelhön, Stefan Bringezu, et al. «The Carbon Footprint of the Carbon Feedstock CO_2». *Energy & Environmental Science* 13, fasc. 9 (2020): 2979–92.

OECD, European Union, e Joint Research Centre - European Commission. *Handbook on Constructing Composite Indicators: Methodology and User Guide*. OECD, 2008.

Oelze, Nelly, Marcus Brandenburg, Christoph Jansen & Ronak Warasthe. «Applying Sustainable Supply Chain Management Frameworks to Two German Case Studies». *IFAC-PapersOnLine* 51, fasc. 30 (2018): 293–96.

Qorri, Ardian, Zlatan Mujkić & Andrzej Kraslawski. «A Conceptual Framework for Measuring Sustainability Performance of Supply Chains». *Journal of Cleaner Production* 189 (July 2018): 570–84.

Rao, Purba & Diane Holt. «Do Green Supply Chains Lead to Competitiveness and Economic Performance?» *International Journal of Operations & Production Management* 25, fasc. 9 (2005): 898–916.

Rowley, T. J. (1997). Moving beyond dyadic ties: A network theory of stakeholder influences. *Academy of Management Review, 22*(4), 887–910. https://doi.org/10.5465/amr.1997.9711022107

Sazvar, Zeinab, Mahsa Zokaee, Reza Tavakkoli-Moghaddam, Samira Al-sadat Salari & Sina Nayeri. «Designing a Sustainable Closed-Loop Pharmaceutical Supply Chain in a Competitive Market Considering Demand Uncertainty, Manufacturer's Brand and Waste Management». *Annals of Operations Research* 315, fasc. 2 (2022): 2057–88.

Srakar, Andrej, Vesna Čopič & Miroslav Verbič. «European Cultural Statistics in a Comparative Perspective: Index of Economic and Social Condition of Culture for the EU Countries». *Journal of Cultural Economics* 42, fasc. 2 (2018): 163–99.

Tat, Roya & Jafar Heydari. «Avoiding Medicine Wastes: Introducing a Sustainable Approach in the Pharmaceutical Supply Chain». *Journal of Cleaner Production* 320 (October 2021): 128698.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7 <509::AID-SMJ882>3.0.CO;2-Z

Tseng, M.-L., Islam, M. S., Karia, N., Fauzi, F. A., & Afrin, S. «A Literature Review on Green Supply Chain Management: Trends and Future Challenges». *Journal of Cleaner Production* 141 (February 2019): 145–62.

Veleva, V. R., & Cue, B. W. Jr. (2019). The role of drivers, barriers and opportunities of green chemistry adoption in major world markets. *Current Opinion in Green and Sustainable Chemistry, 15*, 97–104. https://doi.org/10.1016/j.cogsc.2018.11.003

Yi, Ming, Yiqian Wang, Modan Yan, Lina Fu & Yao Zhang. «Government R&D Subsidies, Environmental Regulations, and Their Effect on Green Innovation Efficiency of Manufacturing Industry: Evidence from the Yangtze River Economic Belt of China». *International Journal of Environmental Research and Public Health* 17, fasc. 4 (2020): 1330.