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Optimizing Logistics for Higher Sustainability: A Comparative Analysis of Existing Practices

Bachelor Thesis

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Contents

List of abbreviations and symbols

TMS	Transport Management System
WMS	Warehouse Management System
AS/RS	Automated storage / retrieval systems
TBL	Triple Bottom Line
DEI	Diversity, Equality, Inclusion
ESG	Environment, Social, Governance
SDG	Sustainable Development Goal
GRI	Global Reporting Index
SASB	Sustainability Accounting Standards Board
CSRD	Corporate Sustainability Reporting Directive
2PL / 3PL	Second- or Third-party Logistics
UoM	Unit of Measurement
RS	Renewable Source
LTIFR	Lost Time Injury Frequency Rate
EV	Electric Vehicle
AV	Alternative fuel Vehicle
OHS	Operational Health and Safety
POS	Point Of Sale

Introduction

The logistics industry, pivotal to global commerce, is at a critical juncture as it embraces sustainability. Driven by the sector's profound environmental impacts, including high carbon emissions, extensive resource use, and significant waste generation, the urgency for sustainable practices is more pressing than ever amid surging global trade volumes fuelled by globalization and the e-commerce boom.

This thesis explores the effectiveness of sustainability strategies used by the biggest companies the logistics industry, aiming to reveal the most popular practices and see the effect these practices had through a comparative analysis of business' sustainability reports across global regions. In addition, the thesis will explore the existence of gaps in research and reporting to identify areas of improvement.

In writing this thesis, the author expresses his curiosity and concern related to specifically environmental and social issues that were observed during his practical work in the industry. To satisfy this curiosity, following the results of the analysis of best practices, the author will explore how these practices might affect sustainability performance in the context of author's place of work based on own observations.

As a result of the thesis, the author hopes to draw attention to the issues observed both in theoretical research and practical implementation exercise. This will serve as a basement for researchers and potential interested stakeholders in considering further direction of the industry development.

The author has used OpenAI's GPT-4 language model; https://chat.openai.com/ in preparation of the following thesis for the purpose of summarization of literature and case studies relevant to the research. After using the aforementioned tool, the author has reviewed, analyzed, and transformed the content. Author takes full responsibility for the use of the tool.

1 Background on logistics and sustainability

To bring more clarity into the mind of the readers, irrespective of what field they are specialized in, the author deems it important to provide an overview of both areas of the thesis's concern: Logistics and Sustainability. The sub-chapters will explain the definitions used for these concepts, show the difference between Logistics and Supply Chain Management, as well as provide insight into interaction between Logistics and Sustainability. This context will be later used as a basis for research and the analysis of sustainability practices.

1.1 What is logistics?

"Logistics is the process of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and the related information flows) through the organisation and its marketing channels in such a way that current and future profitability are maximised through the cost-effective fulfilment of orders" (Christopher, 2016).

It encompasses a wide range of activities, which can be categorized into key areas such as transportation, warehousing, inventory management, order fulfilment, and packaging.

Each area can be explained as below, following the definitions by InboundLogistics (2023):

- **Transportation:** This area focuses on efficiently moving goods from one location to another within the budget and on time. It involves decisions about transportation modes, route selection, and the management of transportation costs. Transportation management systems (TMS) are pivotal in this area, enabling real-time tracking of shipments, optimizing shipping routes, and ensuring regulatory compliance.

- **Warehousing:** Warehousing involves the strategic placement and organization of goods within a facility to optimize space and accessibility, which is essential for efficient packing, shipping, and inventory management. Modern warehouses integrate technologies like warehouse management

systems (WMS) and automated storage and retrieval systems (AS/RS) to enhance operational efficiency and inventory accuracy.

- **Inventory Management:** This area focuses on maintaining optimal quantities of stock to support production and sales while minimizing excess inventory. It encompasses tasks like forecasting demand, replenishing stock, and using software to provide real-time data to optimize inventory levels.

- **Order Fulfilment:** This process involves receiving, processing, and delivering orders to customers. It is tightly linked with inventory and transportation management to ensure that customer orders are filled accurately and delivered on time. Efficient order fulfilment directly impacts customer satisfaction and retention.

- **Packaging:** In logistics, packaging must protect products during transit and storage, and comply with regulatory requirements. Effective packaging is also crucial for optimizing the handling and stacking of goods in warehouses and during transport. Innovative packaging solutions can provide a competitive edge by enhancing customer experience and meeting sustainability goals.

1.2 Logistics in broader Supply Chain Management

It is important to note that in the news and common talk, logistics and supply chains are often used interchangeably. However, they are two concepts connected to each other, as logistics is only a part of the supply chain management activities. The following definition of supply chain will be used:

"The management of upstream and downstream relationships with suppliers and customers in order to deliver superior customer value at less cost to the supply chain as a whole" (Christopher, 2016).

Differences can be seen in comparing each in their scopes, goals, and strategic roles.

- **Scope**: Based on the definition provided in Chapter 1, managing logistics primarily deals with the planning, execution, and control of transportation and

storage of goods. And if we consider the definition of the Supply chain above, we can see differences in vastness of the scope.

- **Goal**: The primary goal of logistics is to optimize the logistical activities and ensure efficient, cost-effective flow and storage of goods. Supply chain management aims at maximizing the customer value, focusing on speed and efficiency across the entire supply chain thus lessening the costs.

- **Strategic Role**: Logistics is often seen as an operational function that needs to be optimized to reduce costs and improve service levels. On the other hand, supply chain management is considered a strategic function that involves long-term partnerships and collaborations across the entire supply chain to enhance competitiveness and profitability.

1.3 Sustainability basics

In accordance with the Brundtland Comission of 1987, sustainability is often defined as „meeting the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 2023). According to Christopher (2016), the concept is further expanded by an idea of Triple Bottom Line (TBL), encompassing the three core elements: Envorinment, Economy, and Society. Also known as 3P's (people, profit, and planet), these elements express in themselves the areas which businesses should consider their impatc on, to achieve sustainability.

Following the definition of the TBL, Christopher (2016) supplements a chart detailing factors of impact considered for each area. Based on these factors, the following definitions of each area were drawn:

Economy: An area focusing on Profit, which dedicates it's attention to effective use and correct allocation of economic resources with the goal of economic growth of the system in question, without damaging the environment and compromising society. It encompasses e.g., GDP, ROI, Tax, Corruption, Employment and Wages.

Environment: With focus on Planet, the area is dedicated to issues of activities altering the environment by altering or breaking natural processes. Factors included are e.g., Air pollution, Energy use, Chemicals and toxins, and Biodiversity.

Society: Focuses on People by considering issues of business activities impacting lives of the people of said society, with the goal of maintaining fair treatment and accessibility of resources. The area covers factors such as Health, Human Rights, Labour rights (incl. DEI-related (Diversity, Equality, Inclusion) rights), Education, and Access to products and services.

1.4 How does Logistics connect to Sustainability?

Sustainability in logistics integrates environmental, social, and economic principles within movement and storage of goods. It approaches all the processes done throughout the movement of the goods from the TBL point of view, trying to improve or redesign these processes or entire models of operation.

Looking through the environmental sustainability prism, logistics is faced with the ecological footprint problem. It is a heavily operational field with usually high level of automation used in order to deal with the flow of incoming orders. However, the data shows that logistics is still responsible for a significant share of GHG emissions. According to an ISO news article (Gould, 2023), „logistics and transport" sector is responsible for around 33% of CO_2 emissions in developing countries. In Europe, in 2020 road transport alone was repsonsible for 21% (European Comission, n.d.). A sustainable approach would attempt to solve this issue by, for example, optimizing transportation routes to reduce fuel consumption and emissions, utilizing energy-efficient warehouses, and shifting towards renewable energy sources and green technologies.

Economic efficiency in sustainable logistics entails maintaining cost-effectiveness part of the logistics activities in the context of TBL. The relationship between sustainable logistics practices and financial performance is further explored by Baah et al. (2021), who demonstrate how these practices can enhance a company's environmental reputation and thereby improve its financial outcomes.

The social aspect of sustainability in logistics involves ensuring that operations enhance the quality of life for all stakeholders (i.e., employees, customers, communities affected, etc.). This includes implementing fair labor practices and minimizing the negative impacts of logistics activities on lives of people that can be affected either directly or indirectly. For example, according to National Safety Council (NSC) of the US (2023), it is shown that in 2021 „Transportation and

warehousing" ranked 1st in Non-fatal injury and sickness (rate), and 5th in the same category (total). This evidence shows that logistics is a source of significant humber of health hazards. An example of an approach to solve the issue would be automatization of warehouse intralogistics with robots, following an example shown by Volkswagen Glass Factory in Dresden, DE.

1.5 ESG and Sustainability concepts in Logistics

Since the context of the thesis is centered around comparing practices that companies use to follow sustainable development path, it is important to note that, based on the 6 companies considered in the thesis, most of the sustainability reporting done by the logistics companies is actually done based on the ESG (Environmental, Social, Governance) principle.

According to an article by HSBC Business Go (n.d.), „[t]he main difference between these two frameworks for business is ESG is a measured assessment of sustainability using benchmarks and metrics", while sustainability itself is „a broader principle that encompasses responsible and ethical business practices in a holistic manner". Essentially, it is appropriate to treat ESG as a way to actually evaluate the progress of companies within sustainability. This is the reason why the concept is so widely used by businesses to report on their sustainability.

However, further examination of the reports has shown that companies are using the two concepts as synonyms. This can be seen in the absense of „Economic" section, which is replaced by the Governance section, with economic factors being represendet in that section only partially. Therefore, when addressing the reporting of sustainability, the thesis will use both „ESG report" and „Sustainability report" as synonyms.

1.6 Standards and regulations used in measuring and reporting sustainability

An overview in global and regional regulations and reporting standards is warranted in the context of this thesis. The most widely used definitions of sustainability as a concept is done by political organizations (e.g., the UN, EU commission). Therefore, the legislation, followed by respective standards, is mostly dependant on the goals in focus of these organizations.

The following regulations and standards were observed to be used the most in the 6 sustainability reports considered in the thesis. For better understanding, they were divided into International and Regional groups, followed by relevant definitions:

International:

- **The United Nations' Sustainable Development Goals (SDGs):** a set of 17 goals for sustainable development to be achieved by 2030, adopted by all UN member states in 2015 (the UN, n.d.). These goals lie at the core of all sustainability initiatives, regulations, and standards across the world. In the context of the thesis, the most focused SDGs are SDG 8, 10, 11, 13, and 17.

- **Global Reporting Initiative (GRI):** a standard developed to "…enable any organization – large or small, private or public – to understand and report on their impacts on the economy, environment and people in a comparable and credible way, thereby increasing transparency on their contribution to sustainable development" (GRI, 2021). The developer also mentions the benefit of the standard showing relevance of the standard to stakeholders (e.g., investors, policymakers, civilians).

- **Sustainability Accounting Standards Board (SASB):** a standard developed to "enable organisations to provide industry-based disclosures about sustainability-related risks and opportunities that could reasonably be expected to affect the entity's cash flows, access to finance or cost of capital over the short, medium or long term" (IFRS, n.d.).

Regional:

- **Corporate Sustainability Reporting Directive (CSRD)** (EU): a regulatory directive developed by the EU that requires large companies, as well as certain SMEs (social- and medium-sized enterprises), to report on sustainability (European Commission, n.d.).

- **Taxonomy Regulation** (EU): "is a classification system that helps companies and investors identify "environmentally sustainable" economic activities to make sustainable investment decisions" (European Commission, n.d.). It is important to note that the regulation does not set mandatory performance requirements or investment options.

It is important to note the **SEC Climate-related Disclosure regulation** a set of rules issued by the US SEC, developed "…to enhance and standardize climate-related disclosures by public companies and in public offerings" (SEC, 2024). It is expected that such regulations will take effect in enhancing the contents of sustainability reporting in the US, which will allow for more precise conclusions to be made based on that data.

2 Analysis of the state of research in sustainable logistics. Current focus, gaps, and issues found.

This chapter assesses the current landscape of research in sustainable logistics, aiming to uncover significant foci and issues encountered by other researchers in the field.

2.1 Current focus of sustainable logistics

Increasing regulatory pressures and a shift in consumer expectations towards greener products have compelled companies to prioritize sustainability in their logistics operations. Regulations such as the Corporate Sustainability Reporting Directive (CSRD) in the EU have set new benchmarks for transparency and sustainability in corporate operations, influencing companies across continents (Maersk, 2023). Furthermore, the boom in e-commerce has dramatically transformed how logistics is being managed. Yu et al., (2017), on the example of furniture industry companies, show that such a shift has created the need for companies to adapt to a high volume of small, individualized shipments, as opposed to traditional bulk deliveries, complicating logistics operations significantly.

These changes require investment in various solutions to tackle this issue. According to Umar et al. (2022), technological solutions of Industry 4.0, such as Internet of Things (IoT), Big Data Analytics (BDA), Artificial Intelligence (AI), and blockchain is perspective to be used in logistics through boosting automation of the processes, enhancing accessibility and traceability of data and faster information processing, which in turn improves performance. The research argues that this technology, for logistics specifically, provides significant improvements for environmental and economic indicators (e.g., shorter lead-times due to faster order processing and fulfilment automation, reduced emissions due to optimized routes).

2.2 Roadblocks in research and development of sustainable logistics

According to literature review done by Lambrechts et al. (2019), there are ambiguities in sustainability reporting. The study reports issues with idicating compliance with regulations, showing that some reports only include „...'compliance to all laws and regulations' in general terms" (Lambrechts et al., 2019), without specifying the areas affected. Additionally, the article points out lack of reporting

results of supplier asessment, and sustainability indicators not being reported or developed in their GRI Context Indexes. This presents itself as a risk of misunderstanding the reports due to vaguenes of some of the idicators, caused by missing information on supplier impact, and non-compliance with reporting standard, both resulting in incomplete/questionable information being reported.

2.3 Inequality of research focus

 A detailed review by Jayarathna et al. (2021), points out the issue of imbalance of models concerning sustainability. The review that, while many optimization techniques are used, few models tackle all three sustainability dimensions together. Additionally, authors emphasize a significant gap in addressing uncertainties in operations. Primary focus of the research, according to the authors, is on econimic uncertainties (e.g., costs, demand, capacity), while less focus is given to environmental or socual uncertainties (e.g., environmental regulation changes, labor scarcity, political instability). Such difference shows clear gap and opportunity for further study.

Jayarathna et al. (2021) also conclude that research often deems economic and environmental aspects more important, while neglecting social sustainability. This statement supports the idea previously expressed by Singhry (2015), noting that many companies focus on economic and environmental sustainability but neglect the social implications of their logistics operations, such as worker welfare and community impact. Loske et al. (2021) provides further support to the claim, showing that in retail intralogistics, adverse health effects from workplace practices are frequently ignored or externalized, reflecting a lack of commitment to social sustainability.

Furthermore, Hervani et al. (2017) argue that the degradation of social conditions due to unsustainable practices, such as poor working conditions and community disruption, often goes unnoticed in the pursuit of financial and operational efficiency.

However, it is important to note, that in a further study by Jayarathna et. al (2021), dedicated to logistics-specific sustainability indicators from 64 sustainability reports, shows the same importance distribution as in an earlier study, but displays social factors outnumbering economic (58 to 8 respectively), only prevailed by environmental factors (62 in total).

Another observation from the study would be that a low representation of Economic indicators in the reports. This might be related to the findings of an article by Purvis et al. (2019), who examined the origins of the Three Pillars of Sustainability – a concept like the TBL, as both consider Environmental, Economic, and Social issues as their primary focus. According to the article, the economic pillar of sustainability is often not clearly defined and is misrepresented in sustainability reports due to:

1. Its weak theoretical basis and varying definitions across different documentation by various organizations (e.g., Brundtland report, Agenda 21);

2. The challenge of integrating it with other sustainability goals, as it would usually be treated as secondary goal (shift of focus), or be misinterpreted, resulting in non-alignment with broader sustainability goals;

3. The existence of differences in cultural and institutional contexts, which causes the definition of economic pillar to vary.

2.4 Results of the review and conclusion

The review above highlights significant advancements in sustainable logistics, driven by regulatory pressures and technological innovations such as IoT, AI, and blockchain. These technologies enhance transparency, optimize processes, and address environmental and economic sustainability.

However, gaps remain, particularly in sustainability reporting and the balanced integration of sustainability dimensions. Reports often lack specificity and thoroughness, leading to potentially misleading information. Additionally, there is an issue of inequality in research, particularly of social area of sustainability. The same trend is seen in representation of economic sustainability, which is, although of high importance, usually lacks standardized way and content of reporting it.

Based on these results, the author is concerned with the current inconsistent and, in some cases, confusing state of research and reporting. The lack of agreed definition in the core of the sustainability concept is the issue which the author deems important to solve in the first place. Following that, future studies should focus on developing holistic models that encompass all sustainability areas equally

and improving reporting practices to ensure greater accountability and clarity in sustainable logistics.

Given the theoretical research outcomes, the analysis in the thesis will be conducted in accordance with the reporting standard expressed in the most sustainability reports of the biggest international logistics companies, which is ESG reporting. This decision aims at keeping to a more prevalent way of understanding of sustainability, allowing the analysis to stay consistent and avoid clashing of different schools of thought in relation to sustainability.

3 Methodology of the research

As the thesis aims to identify the most popular practices in the industry, as well as reveal gaps in the research and reporting, a comparative-type analysis was chosen. Given some research gaps and inconsistencies in reporting were already revealed in previous chapters by other researchers, the author followed a case-by-case approach to compare performance of companies in question.

3.1 Sources of data used for the analysis

The data used for the analysis is sourced from 5 ESG reports, provided yearly by 5 of the biggest companies in the logistics industry. Mostly, these companies operate in Transportation or Warehousing areas, each offering various solutions.

The reports were drawn from the companies' official websites, with the latest available editions reporting in periods 2020-2021 and 2022-2023.

3.2 Goals of the analysis

As stated in the aims of the thesis, the analysis tries to achieve the two goals set out by the topic:

1. Find most popular practices and evaluate their effects

2. Reveal gaps in research and reporting to suggest further areas of improvement or topics of further research.

3.3 Methods and analysis tools

It was discovered during the analysis that the ESG reports in scope of the thesis suffer from an issue of lack of standardized factors across all the reports. This is crucial when considering the methods used in the thesis, as more data that is standardized, the more extensive and detailed the analysis can be.

Therefore, the author has developed his own approach to the analysis, involving side-by-side analysis of annual results of reporting years to identify companys' own progress, as well as ranking by % YoY change for factor in question to establish companies performance in reaching ultimate goals of sustainability. Such approach allows for, if not retrieval of the absolute results regarding particular practice

effectiveness, an approximated view on the way various approaches can take their effect.

The required data was gathered through manual reading with support of ChatGPT software to help with summarizing select chapters of the reports or identifying key ranges of pages to be focused on.

For analysing the data available, Microsoft Excel and its' natural functions were used to assemble the data into tables with information in various forms. Using the data gathered, findings of the analysis are shown based on the custom approach discussed above. Through logic and questioning of the data, the discussion of the results was performed to identify general trends and possible gaps.

3.4 Analysis procedure

The analysis was conducted following the procedure described below:

1. Analysis of the ESG reports to identify sustainability practices used.

2. Selection of practices based on number of companies implementing said practice. Only practices implemented by no less than 4 companies (80%) are selected.

3. Extraction and selection of relevant factors depending on availability across reports and relevance to a specific practice discussed.

4. Structuring of relevant factors depending on:

   a. Number of reported factors per area per company.

   b. Most reported sustainability practice categories.

   c. Connection between selected factors and sustainability practices.

5. Overview of combined results and analysis of performance of companies based on these results.

   a. During analysis, important notes are added to support the numbers displayed (or lack thereof) based on the qualitative data reported by the companies.

6. Findings of the analysis drawn based on the data provided in steps above.

The analysis was concluded by discussing the findings and conducting a thought experiment, suggesting how these practices might affect sustainability of the logistics department at the authors' place of work.

3.5 Issues encountered during analysis

Analysing the reports, the author experienced complications with appropriately identifying the data. Even though each company followed general ESG reporting framework, it was noted that in some cases, companies were either not disclosing relevant ESG data, or missing any related numbers, instead only providing descriptive information of sustainability practices and their effects.

This led to the need of restriction of the factors used to analyse the data, which both shown areas in which data is missing, as well as constrained the factors to

Another one of such issues lies in the way companies report their actios. As the reports did not contain sufficient data to describe the cost and effect of each action the company took to get closer to their ESG targets, the author refrained from trying to analyse and compare the practices in such a form. This issue partly connects to the issue stated before, requiring grouping of practices to assess their joint effect rather than effect of a singular action.as

3.6 Methods justification

The author acknowledges the risks in building claims based on incomlpete data. Such an approach is quite subjective due to factors possibly related not being taken into account or only suggested, which is caused by the very issue of lack of standardized data. Therefore, the analysis was conducted with the following assumptions for the cases of missing data:

1. If data is missing, but there is general trend, same trend is assumed for that company;

2. If data is missing, and there is no general trend, it is derived based on reasonable outcome of practices affecting the data.

4 Analysis performance

Following the methodology explained in Chapter 3, the information gathered and structured is presented in a form of various tables, describing issues identified in the process of gathering data, as well as relationships between ESG areas, selected sustainability practices, and factors displaying the company development while applying these practices.

4.1 Introduction of the companies evaluated

To conduct the analysis, 5 companies were considered: DHL Group, DSV A/S, A.P. Møller - Mærsk A/S, FedEx Corporation, and Kuehne+Nagel International AG.

Each one, although in a similar industry, operates for different audiences and offers different services. However, the reason for choosing these companies lies in similarities between them, which mostly lie in the type of operations they can support. These include:

- Warehousing solutions

- Multiple modes of transport

- Offer 2PL or 3PL services

- Operate globally

These similarities allow for better analysis, providing more possibility for availability of similar data in the reports.

4.2 Analytics on data availability based on reports and their annexes

Table 1 shows the number of quantitative data entries found in company reports based on data appendices to each of the reports. It shows prevalence of Social and Environment related data being measured, with strong underrepresentation of Governance factors. Additionally, a more detailed look into the factors reported shows some factors not being reported in most cases or being exclusive to one of the reports.

Table 1 ESG areas number of quantitative data entries (totals and detailed breakdown included as separate entries) reported for each company.

Name of the company	ESG area		
	Environment	Social	Governance
DHL	145	180	17
DSV	34	37	8
K+N	37	61	0
Maersk	31	12	8
FedEx	99	64	14

Both results confirm previously discovered issues of lack of balanced approach to reporting of ESG, and a more fundamental issue of specificity in the factors used in the standards. However, being outside of this thesis' scope, the author hopes the issue will be addressed, and solutions will be proposed, in further research.

4.3 Descriptive data

Table 2.1 shows the environmental practices that companies have applied in their operations. Only the practices appearing for more than 4 companies are shown:

Table 2.1 Environmental practices

Practice	P_Code	FedEx	DSV	K+N	Maersk	DHL	Total
Use of Renewable Energy	E1	x	x	x	x	x	**5**
Use of Sustainable Fuels	E2	x	x	x	x	x	**5**
Fleet Electrification	E3	x		x	x	x	**4**
Waste Management & Recycling	E5	x	x	x	x		**4**

The table indicates companies adopting all these practices, with exceptions for DSV adopting fleet electrification and DHL investing into waste management & recycling.

Table 2.2 below shows similar information, but for social practices implemented by the companies.

Table 2.2 Social practices

Practice	P_Code	FedEx	DSV	K+N	Maersk	DHL	Total
Health and Safety Initiatives	S1	x	x	x	x	x	**5**
Employee Development and Education	S2	x	x	x	x	x	**5**
Community Engagement Programs	S3	x	x	x	x	x	**5**
Diversity and Inclusion Initiatives	S4	x	x	x	x	x	**5**

In this case, all companies adopted all 4 social practices,

Lastly, Table 2.3 shows the information about Governance practices, which shows only 1 exception of DHL not reporting on ESG risk assessment.

Table 2.3 Governance practices

Practice	P_Code	FedEx	DSV	K+N	Maersk	DHL	Total
Compliance training	G1	x	x	x	x	x	**4**
ESG risk management / assessment	G2	x	x	x	x	x	**4**
External audits for compliance in data security, human rights, and other policies	G3	x	x	x	x	x	**4**

All three tables display consistent application of practices across each company's ESG reports, which DHL being the company with the least number of adopted practices chosen for analysis, totalling 9 out of 11.

4.4 Factors of comparison

To measure the effectiveness of practices to be evaluated, 4 factors applicable to measure particular sustainability practices in each area of ESG (impact factors). These factors are supplemented by main indicators of company impact to see if sustainability practices either brought positive results or helped negate downward development in the respective area (effect factors).

Each section below describes the impact and effect factors in detail, providing definitions to these factors with Units of Measurement (UoM).

4.5 Environment factors

To express the impact of the companies on the environment, the following impact factors were used. For all three factors a positive development is considered in reduction of YoY numbers.

- **Total GHG Emissions:** measures the total greenhouse gas emissions (CO_2, N_2O, and CH_4 primarily) produced by logistics activities, measured in tonnes of CO_2 equivalents (t CO_2e). Conversion for equivalents can be seen in Table 3 below:

Table 3 Conversion rates of 1 kg emissions of GHGs to kg CO2e

Mass of GHGs	Mass in CO_2e
1 kg CO_2	1 kg
1 kg N_2O	298 kg
1 kg CH_4	25 kg

Source: (CBS, n.d.)

- **Total Electricity Consumption:** Tracks the amount of electricity used in logistics operations, reported in terajoules (TJ).

- **Total Waste Generated:** Describes the mass of waste generated by operations. Expressed in tonnes (t).

The effect factors used to evaluate the effectiveness of a particular environmental sustainability practice are described below. For each factor shown, YoY increase is considered a positive development, as they translate to reduction in impact factors.

- **% of sustainable fuel usage:** expressed as % of total fuel replaced by sustainable alternatices. Includes fuels for all modes of transport (SAFs, SMFs, HVOs, electricity)

- **% of energy used from RS (renewable sources)**: constitutes the % of total energy used, that was obtained from renewable sources (e.g., wind, solar, water, geothermal).

- **% of waste recycled**: displays the % of total waste that was sent for recycling either at own facilities or at partners.

- **% of fleet using alternative fuels**: depicts a share (%) of vehicles (total across all modes of transport), that use alternative ways of gaining energy (i.e., sustainable fuels for air, sea, road, and rail transport).

4.6 Social factors

For Social sustainability measurement the only one impact factor in common was the number of employees. As it defines the amount of people involved in the operations, it might serve as a good indicator of company's treatment of its employees.

In the case of effect factors, more factors were identified:

- **LTIFR (Lost time injury frequency rate):** shows the number of work-related accidents in day-to-day operations per 200.000 working hours.

- **Has employee dev. programs?:** indicates whether the company has any employee development programs in place (e.g., education, leadership courses, development plans, etc.).

- **Engaged in community dev./aid?:** indicates if a company engages in community development or air programs to support people or local environment and infrastructure.

- **% women in management:** displays % of women occupying positions of middle- or higher-management based on total number of employees. An important metric to measure efforts in DEI (Diversity, Equality, Inclusion).

4.7 Governance factors

Upon review of the reports, it was noted that companies either do not report on Governance, or only mention alleged improvements in cybersecurity, compliance, or tax-related matters, without disclosing much quantitative information. Further research of various professional blogs and platforms, it was concluded that governance is an area, understanding of which is the weakest and out of focus for a substantial number of companies.

To not get carried away with creating or realizing own impact metrics, the author decided to avoid the use of impact factors to measure governance, and instead focused on identifying effect metrics from the ESG reports, which could be used to piece together an approximated image of Governance situation within the companies. The most represented effect metrics are:

- **% trained in compliance:** displays a share of employees that have undergone training in compliance (e.g., with cybersecutiry, anti-corruption regulations, Codes of Conduct, etc.)

- **ESG risk M/A is performed?:** inticates if a company performs ESG risk Management or Assessment reviews, and has a person or multiple people assigned to this task.

- **External audits for compliance control?:** shows if companies perform external audits of their suppliers and partners, aiming at identifying compliance with all relevant regulations and agreements (e.g., Human Rights, Code of Conduct, sustainable sourcing, etc.).

4.8 Data on ESG factors and relationship to sustainability practices

The sustainability practices shown above can be linked to the respective descriptive factors using the "P_Code" column values from tables 3, 4, and 5. Using the table below, the connection is established between the supplementary factors and sustainability practices.

Table 4 Link between effect factors and sustainability practices

ESG area	Factor	Which practice?	UoM
E	Total GHG emissions		tonnes
E	Total Electricity Consumption		TJ
E	Total waste generated		tonnes
E	% of energy used from RS	E1	%
E	% of sustainable fuel usage	E2	%
E	% of fleet using alternative fuels	E3	% or number

E	% of waste recycled	E4	%
S	Number of employees		number
S	LTIFR	S1	number/200.000 wh
S	Has employee dev. programs?	S2	Yes/No
S	Engaged in community dev./aid?	S3	Yes/No
S	% women in management	S4	%
G	% trained in compliance	G1	%
G	ESG risk M/A is performed?	G2	Yes/No
G	External audits for compliance control?	G3	Yes/No

In the table, readers might note the 4 factors that are missing an assignment to a particular practice. This is because they are showing company impact, and therefore cannot be used to partially represent the effects of a particular practice.

4.9 Compound data per company analysis and interpretation

To further evaluate the companies' individual performance in each of these dimensions, as well as overall performance in each respective area of ESG, following information is provided in the reports.

For each of the tables, two statistics were reported: for the year of the report (RY) and year before the report (RY-1) in columns, and for each company analysed in the rows. Tables were sorted by the YoY change (%) to see the leaders in effectiveness. In addition to that, the absolute leaders (e.g., the lowest absolute impact or the strongest absolute effect) for each metric in the RY were highlighted.

First, the data for impact factors is shown in the tables below. Each table from 5.1 to 5.4 show Year-on-Year development across each impact factor for every company, according to data that was disclosed or available for calculation:

Table 5.1 Total GHG emissions

	RY-1	RY
DSV	20.117.000	15.489.000
K+N	16.191.000	14.422.000
DHL	36.590.000	33.270.000
Maersk	82.877.000	79.462.000
FedEx	21.448.385	22.247.331

Table 5.2 Total waste generated

	RY-1	RY
K+N	92.000,00	79.000,00
Maersk	553.000,00	553.000,00
FedEx	519.859,00	617.452,00
DSV	57.339,00	70.349,00
DHL		

Table 5.3 Total Electricity Consumption

	RY-1	RY
Maersk	447.202,80	419.493,60
K+N	1.332,00	1.263,60
DHL	124.174,80	126.201,60
FedEx	308.181,00	315.227,00
DSV	5.091,00	5.343,00

Table 5.4 Number of employees

	RY-1	RY
Maersk	95.966,00	108.934,00
FedEx	508.650,00	518.249,00
K+N	80.334,00	80.983,00
DHL	600.278,00	594.396,00
DSV	76.283,00	73.577,00

For Total GHG emissions, the main factor considered, when evaluating environmental sustainability, a general positive trend can be seen. The only outlier identified is FedEx, consistently showing an increase in emissions by around 700.000 tonnes of CO_2e.

The other factors, however, do not show promising results. There is an increase in total waste generated in 3 out of 4 cases, with exceptions of K+N reporting reduction, and DHL not having data in the report. Like waste is the situation with Total electricity consumption, with 3 out of 5 companies reporting increase, although not as drastic as decrease for Maersk.

Continuing with the same ratio, 3 out of 5 companies reported an increase in the Number of employees, which is an item to be investigated further.

To compliment the impact factors and allow for the further analysis by providing reasons either for or against the results shown for the impact metrics, the following tables are used to display values for each effect factor, separated by ESG dimensions.

4.9.1 Environment: Tables 6.1 – 6.4.

Table 6.1 % of energy used from RS

	RY-1	RY
DSV	9,0%	11,0%
Maersk	0,05%	0,06%
DHL	94,0%	97,0%
K+N	98,0%	99,0%
FedEx	#N/A	30,0%

Table 6.2 % of sustainable fuel usage

	RY-1	RY
DHL	1,7%	2,8%
K+N	2,0%	2,0%
DSV	3%	2%
FedEx	#N/A	#N/A
Maersk	#N/A	#N/A

Table 6.3 % of waste recycled

	RY-1	RY
K+N	59,8%	64,6%
DSV	49,7%	49,9%
FedEx	67,0%	61,0%
Maersk	#N/A	#N/A
DHL	#N/A	#N/A

Table 6.4 % of fleet using alternative fuels

	RY-1	RY
FedEx	4156	6213
DHL	26,4%	30,4%
K+N	#N/A	1,5%
DSV	#N/A	#N/A
Maersk	#N/A	#N/A

In most cases, an upward trend is visible across the factors. All the companies reported either new initiatives or continuing effort in obtaining energy from RSs, setting an example in the industry.

For waste recycling, only 2 out of 3 companies reported growth of the share recycled, with FedEx showing decrease of 6%. In the case of DSV, only 0,2% growth YoY was recorded – an insignificant grown compared to K+N, who displayed a 4,8% increase in their report.

For the items of missing data, information was either not reported or only mentioned, without clear display of the effectiveness. For example, FedEx did not report on the usage of sustainable fuels, but instead displayed growth in vehicle fleet running on these fuels. As the growth in overall fleet size was not reported, it is impossible to objectively conclude whether the change is significant.

However, after searching for 3rd party sources, a report by Statista (2024) revealed an overview of the total vehicle fleet size of FedEx, showing a drop in 2023 against 2022, showing 82.000 against 86.100 vehicles respectively. Assuming the real numbers are in the realm of the ones provided above, it is indeed possible to conclude FedEx displayed significant growth.

4.9.2 Social: Tables 7.1 – 7.3

Table 7.1 LTIFR

	RY-1	RY
FedEx	3,99	2,87
Maersk	0,104	0,084
K+N	1,76	1,60
DHL	3,4	3,1
DSV	2,87	3,3

Table 7.2 % women in management

	RY-1	RY
DHL	30,2%	33,3%
DSV	32,0%	34,0%
Maersk	33,0%	35,0%
FedEx	27,0%	27,0%
K+N	28,5%	27,8%

Table 7.3 Engaged in community dev./aid?

	RY-1	RY
FedEx	Yes	Yes
DSV	Yes	Yes
K+N	Yes	Yes
Maersk	Yes	Yes
DHL	Yes	Yes

Table 7.4 Has employee dev. programs?

	RY-1	RY
FedEx	Yes	Yes
DSV	Yes	Yes
K+N	Yes	Yes
Maersk	Yes	Yes
DHL	Yes	Yes

For social effect factors, companies again report positive results in general. All 5 companies are engaged in developing local communities and infrastructure, with most of them either participating in either volunteering activities or investing in climate action projects. In the case of Maersk, they also contribute to humanitarian aid both financially and in-kind, as well as provide support for emergency response efforts requiring expertise in logistics.

Companies also show an upward trend in improving their OHS situation. The only outlier is DSV, which saw an increase in LTIFR of 0,43 points YoY. However, in the report they state their belief in actual decrease of LTIFR, which cannot be reflected because of an increase in accuracy in the reported year, thanks to an improved knowledge and professionalism of their health and safety specialists.

Similar situation is visible for diversification efforts of the companies, displaying an upward trend with exceptions of K+N, reporting 0,7% decrease. The negative development is not commented on in the report, but the company provides enough data to attribute the overall decrease to reduction in senior management headcount being greater than overall increase in the headcount for top management.

4.9.3 Governance: Tables 8.1 – 8.3

Table 8.1 % trained in compliance

	RY-1	RY
Maersk	83,0%	92,0%
DHL	98,1%	98,6%
FedEx	98,0%	98,0%
DSV	100,0%	100,0%
K+N	85,6%	81,8%

Table 8.2 ESG risk M/A is performed?

	RY-1	RY
FedEx	Yes	Yes
DSV	Yes	Yes
K+N	Yes	Yes
Maersk	Yes	Yes
DHL	Yes	Yes

Data displayed for governance, although mostly qualitative, does provide insight into the overall state of corporate governance. As most of the companies reported an

Table 8.3 External audits for compliance?

	RY-1	RY
FedEx	Yes	Yes
DSV	Yes	Yes
K+N	Yes	Yes
Maersk	Yes	Yes
DHL	Yes	Yes

increase of share of employees trained in compliance, it is only natural for the companies to also implement similar external audits, which is in line with SDGs 3, 8, 10, 13 and 17.

Additionally, companies reported implementing systems for managing and assessing ESG-related risks. Each company expressed the existence of contingency and avoidance measures connected to these risks.

5 Findings and discussion

Data described and interpreted in the chapter so far displays certain relevance to the topic. Although far from completeness, both the impact and effect factors were reported consistently. To reiterate one of the main issues encountered during research, the data displayed in the chapter mostly consisted of factors reported in a majority of ESG reports.

However, an attempt was made to identify the absolute leader across all three ESG areas. Therefore, any findings and observations made by the author cannot be treated as the most objective result, but rather as relative overview of the ESG situation for the 5 companies altogether.

The following sub-chapters depict findings and observations by the authors, divided into 3 sets in accordance with ESG areas. These observations were used as inputs when considering the effect, the described sustainability practices can have on the authors' place of work:

5.1 Effect on Environment

Overall reported performance of companies, according to the effect factors, correlates with the development of the impact factors. In most cases, when reporting on impact practices, companies already displayed fluctuations allowing for a positive evaluation of environmental impact generation.

As shown by Kuehne+Nagel, reporting an overall decrease in all three environmental impact factors, has also shown either no change or an increase in the effect factors, which allows for drawing a conclusion that the considered environmental factors can be accredited for partial contribution to improvement of E in Kuehne+Nagel' s ESG standing.

Another interesting case is Maersk, who reported net-zero change in total waste, and reduction in carbon emissions and electricity consumption, it is quite simple to credit environmental sustainability practices for this achievement. However, after exploring the reports deeper, it is noted that the company shipment volume, and therefore fuel and energy consumption, has also decreased.

For FedEx, overall picture reported shows an overall increase in negative impact on the environment, when the effect factors, strangely, are showing improvements.

Such a dilemma can be addressed based on additional information provided by the company in the report. FedEx states that increased package volumes and operational expansion, together with transition to a fleet of EVs, which together might explain the inconclusive result obtained.

Based on the above, it is possible to conclude that listed environmental sustainability practices can be used to explain most of the impact of the companies. Absolute leaders in the field, based on the effectiveness showed in YoY change in each environmental metric are Kuehne+Nagel, DSV, and DHL.

Based on the examples of these companies, the practices listed have shown a positive effect. However, a deeper analysis is warranted to investigate the extent to which each practice had its' effect. To support this, more factors are needed to be reported in a standardized manner, as more data correlates with the accuracy of results.

5.2 Social standing

All the companies concerned reported their efforts in improving their social standing. And this effort is visible based on the results of the analysis. The 5 companies in question have demonstrated their focus on OHS, Development and Education, Community engagement, and DEI.

Based on the data reported, companies report stable improvements across all factors considered, with exception of women representation diversify for K+N and LTIFR for DSV seeing a decrease. However, this decrease was explained in the previous chapters, and cannot be considered harmful.

Therefore, it is possible to safely conclude the listed social sustainability practices affect social standing of the companies positively, either preventing significant outflow of workforce, or attracting new employees, and showing that these companies care about the societies they operate in.

An absolute leader in effectiveness for social sustainability is then FedEx and DHL, followed by Maesrk, all three displaying significant improvements and interest in further increasing their positive impact in the social domain.

5.3 State of governance

Governance remains a mysterious area, based on the ESG reports. Among the selected practices to consider, as well as factors used to measure their effect, no agreement was identified in terms of definitions.

Analysis shows clear interest in ensuring compliance with standards and regulations, both internally and externally, as the companies have reported the related factors and explained their efforts in this regard.

In line with compliance stands an initiative to continuously manage and assess ESG-related risks and develop response or prevention strategies. However, no details on the risks or strategies were expressed, which is why the analysis could only be conducted based on existence or absence of such efforts.

Based on the above, it is impossible to appropriately track the effect of the listed practices. Indeed, some show effectiveness in achieving solid legal ground, based on additional information provided only in singular reports (e.g., number of legal cases, number of ISO certificates, etc.). However, as long as governance stays under-represented and not reported in a standardized way, no conclusions can be drawn.

6 Practical application of the analysis results

As was stated in the goals of the thesis, it is author's personal motivation to try and see how the sustainability practices in scope of the analysis would show their effect in the current layout of logistics operations within the authors' place of work.

To conduct said experiment, a company profile with a description of the logistics and supply chain setup is given below. For the purposes of staying in line with the legal obligation for non-disclosure of operational details and trade secrets, the company name was replaced with "Company A GmbH", while names of the suppliers and partners are not mentioned. Any financial or operational information, such as revenue, costs, lead times, volumes, was not disclosed as well.

6.1 Company A GmbH profile

The Company A GmbH is an e-commerce company specializing in sale of furniture. Owning offices across regions of presence, the company consists of >1000 employees globally. Originating and operating mostly in Europe, the company is quite competitive on the market. In the recent years, however, the company increased its' reach to the regions of Americas and Asia-Pacific.

The supply chain of the company is entirely outsourced and is set up as a chain of external suppliers and 3PL providers, managed by the respective team's manager. The main sales are happening on the interned through company webstore, or alternatively, through partner retailers, as no company-owned points of sale (POS) are yet functioning.

The main flows of goods are separated into two legs: Replenishment and Delivery, with more than 90% of the items are flowing through centralized warehouses rented by the company, and the rest being delivered directly from production to the POS. Each leg is managed by separate teams and coordinated through people responsible for planning and information flow management.

Due to the nature of flows and main ways a sale can occur, the two dominant ways of transport are 1. Using vans through parcel shipment providers (for small quantity shipments to retailers or direct clients), and 2. Using trucks through 3PL FTL service providers (for batch shipping to own warehouses or retailers). The other modes of

transports used are primarily Sea shipping for slow-moving products, and Air shipment for delivery of samples.

Logistics management of the company is confined within the department of operations, limited to less that 10 teams dedicated to managing transport and warehouses.

6.2 Potential improvements or risks brought by implementing the reviewed sustainability practices

As the company operates mostly using 2PL or 3PL services, implementing the practices in scope of the thesis might prove to be challenging or ineffective.

6.2.1 Environmental practices

Among the environmental practices, the company itself cannot feasibly implement any, except on company resource level (e.g., use of EVs or AVs as company cars, preferred avoidance of commercial flights, office waste recycling). However, as these are not related to company logistics, it is safe to say that all the practices will be translated into the requirements to Company A's partners.

Assuming the partners can adapt to the required practices, Company A will see a number of risks related to implementing the results of these practices. A change to the use of renewable energy and sustainable fuels will not affect the logistics setup and system used as much, and instead will trigger service cost negotiations, as the prices of services would expectedly go up. Requesting our carriers of choice to provide us with EVs will not cause many issues either, as the company's biggest supplier of EV transport capacity happens to be a provider specialized in conducting such operations.

For AVs, the issues will mostly appear for truck shipping, as the already scarce shipping capacity will have to be restricted even further through limiting use of trucks running on fossil fuels. Such an issue with capacity will cause considerable damage in the first year of operations, during one of the busy seasons, when sales of that period are multiplied many times over the usual quarterly sales.

Overall, the implementation of environmental sustainability in the company logistics will prove to be quite challenging, risky, and expensive, without much benefit.

6.2.2 Social practices

Out of the 4 listed practices, the only practice not yet implemented at a bigger scale, is participation in Community Engagement Programs. Potential benefit of integrating such a practice lies in the possibility of attracting more sales and increasing company presence. Given not the highest possible public score, the Company A would significantly benefit from activities that are able to bring feasible and impactful developments to society or people in need will undoubtedly affect the public image of the company, which will attract higher interest.

However, a potential risk to this initiative is the current financial state of the company, as a set of operational and corporate expansions have been performed recently. As financial support or investments in infrastructure of local cities where the company operates is risky, the only feasible option might be providing aid and donations in a form of products, which is currently in scope of research, and the logistics department is well involved in it.

6.2.3 Governance practices

The same way as with social practices, governance strategies related to compliance and partner audits are already in place and performing in expected manner. Considering the practice of ESG risk management or assessment is the only option left.

As was stated before, the entire supply chain of the company is outsourced. This, in case the company adopts ESG risk management requirements, might be already partially or fully be handled by the partners or suppliers. In both cases, the company would have to gather and analyse the risks evaluated by the partners/suppliers, which will require a separate task force to be created to support the partners/suppliers. However, the party responsible for managing those risks will still stay with the partner.

At the current stage of company development, however, investing in this area might prove to be not financially sustainable, adding a stable source of expense for the company balance sheets, without much benefit provided in a form of crises avoided. However, the fact that the partner is mostly responsible for managing the ESG risks, the company might use this as an opportunity to strengthen the partnership.

6.3 Experiment conclusion

In conclusion, the practices in scope of this thesis, which are not already implemented, might not be a reasonable investment, due to the amount of expense and complexity it brings. In some cases, both can be offset by potential gain in reputation or clientele, but it is more likely than not for these practices to turn out as failed investments.

Author suggests that with time and development, as the company gains more ground, volume, and responsibility, the negative impacts of implementing these practices might be outweighed by the benefits.

Conclusion

This thesis assesses the integration and impact of sustainability practices in the logistics sector, focusing on environmental, social, and governance (ESG) aspects. The goals were to evaluate existing sustainability strategies, identify research, and practice gaps for future improvements. The analysis showed substantial efforts by logistics companies to adopt ESG principles, especially in environmental practices like renewable energy and fleet electrification, reflecting a commitment to reducing carbon footprints. Social initiatives aimed at employee welfare and community engagement were also notable, signalling a shift towards more responsible business operations.

However, governance and sustainability reporting gaps were evident, underscoring the urgent need for standardized reporting frameworks. These frameworks are crucial to ensure consistent and precise measurement of sustainability efforts. The current lack of consistency complicates accurate impact assessments and may undermine sustainability claims, highlighting the necessity of this action.

The thesis highlights the need for a unified reporting standard and suggests that companies enhance their governance structures to integrate sustainability more deeply into their core operations. Additionally, it recommends leveraging AI and big data to optimize logistics routes and reduce emissions, which could significantly boost sustainability initiatives' effectiveness. In conclusion, while progress has been made in integrating sustainability into logistics, ongoing improvements in governance and reporting are essential for the sector to fully contribute to sustainable development goals and develop a resilient, responsible business model.

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ANNOTATION

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SUMMARY	**This thesis provides a comprehensive analysis of sustainability practices within the logistics sector, with a focus on environmental, social, and governance (ESG) aspects. It evaluates the effectiveness of these practices and identifies gaps in current research and reporting. The analysis reveals that while logistics companies have made notable strides in adopting sustainability practices, significant inconsistencies in governance and reporting standards remain. The thesis recommends the development of unified reporting standards and further integration of sustainability into core business strategies. It also suggests leveraging advanced technologies like AI and big data for optimizing sustainability efforts. Overall, the thesis underscores the need for enhanced governance and clearer reporting to truly advance sustainability in logistics.**
KEY WORDS	**Sustainability, logistics, analysis**