Exploring Sustainable Value Propositions in Logistics Services – How Digitalization and Data Support Greener Services?

Fuad Khan, Taina Eriksson, Marikka Heikkilä, Titiana Ertiö
University of Turku, Turku School of Economics, Turku, Finland
fuad.khan@utu.fi, taina.eriksson@utu.fi, marikka.heikkila@utu.fi, titiana.ertio@utu.fi

Employing a multiple-case study method, this study examines the value propositions in sustainable logistics services. We explored publicly accessible data on the financial, functional, and emotional aspects of the value propositions offered by four companies. We first discovered that digitalization plays a crucial role in value proposition creation supporting low emission logistics ecosystems. Specifically, digital solutions promise cost reduction opportunities across the entire value chain as financial value proposition; route optimization and regulatory compliance as functional value propositions; and transparency, trust, and credibility as emotional value propositions. Second, the reduction of fossil fuels as a functional value proposition is identified as a target for all companies. Third, functional value propositions prelude emotional value propositions, i.e. through sustainability certificates, service providers establish transparency, ensure value chain compliance, and ultimately build trust among customers. By highlighting the differences and similarities in value propositions, this study explores sustainable business model innovation and offers critical perspectives for organizations aiming to shift towards sustainable logistic service provision.

Keywords: sustainability, logistics, value proposition, digitalization, green service

University of Maribor Press
DOI https://doi.org/10.18690/um.fov.4.2024.36
ISBN 978-961-286-871-0

1 Introduction

Holistically, the EU aims to decrease its greenhouse gas emission through initiatives such as the European Green Deal and Fit for 55 legislative packages. Simultaneously, the twining of the green with digital transition (i.e., the transitions mutual reinforcement) provides ample opportunities to achieve EU's climate neutrality goals by 2050. The logistics industry, recognized as a vital component of the global economy, generates a third of global carbon dioxide (CO2) emissions and has come under increasing pressure to minimize its environmental impact (Towards a Net-zero Logistics Sector, 2023). Notably, the European Commission has implemented a series of policies aimed at reducing the industry's carbon emissions (Completion of Key 'Fit for 55' Legislation, 2023). In the face of such pressure towards sustainability, logistics companies have started to rethink and innovate their business models, to both align with environmental goals but also carve out a competitive edge in the changing market/ industry. The exploration of innovative, sustainable business models is not merely an environmental necessity but a strategic choice to stay relevant and appeal to a consumer base which increasingly values sustainability (Bask et al., 2018; Martins et al., 2019). Sustainable business models cover both environmental and social dimensions of sustainability (Mignon & Bankel, (2022); Brenner, 2018). The present study focuses deeply on the environmental sustainability of business models, specifically on carbon dioxide emission reductions. Hence, the concept of sustainable business model is used in this study to refer to environmentally sustainable business model.

Central to sustainable business models is the customer value proposition (De Giacomo & Bleischwitz, 2020). The value proposition reflects the company's commitment to delivering value that goes beyond the traditional economic metrics, encompassing environmental stewardship. However, defining what exactly constitutes a sustainable value proposition remains a challenge. Digital technologies hold immense potential to achieve climate neutrality as exemplified in the European Commission's Twin Transition efforts. However, the extent to which digital technologies are integrated into sustainable value propositions is still under-explored. Hence, our central research question is: **How does digitalisation support value propositions in environmentally sustainable business models in logistics services?** Employing a comparative case study methodology, this paper examines sustainable value propositions of four logistics companies. Our

investigation first delves into the value companies propose, while later illustrating the role of digitalization in providing environmentally sustainable logistics services. The market for sustainable logistics services is still in its infancy, with cases analysed in this paper emerging among the first services offered. The drivers for these services stem from the interplay between market opportunities, increased regulatory demands to lower carbon dioxide emissions and company's desire to contribute to environmental sustainability. Emission data provision contributes to transparency in operations.

This study is organized as follows: Section 2 reviews relevant literature on sustainability in the logistics industry, digital technologies supporting the sustainability transition, and sustainable BMs including their value propositions. Section 3 describes the methodology behind our multiple-case study. Section 4 presents the findings of the cross-case analysis. Section 5 discusses the implications of our findings and concludes the paper, summarizing key insights and proposing directions for future research.

2 Literature review

2.1 Sustainability in the logistics industry

The push towards sustainability is increasingly capturing the interest of international transport and logistics providers, driven by market demands. They view sustainability to gain a competitive edge (Bask et al., 2018; Martins et al., 2019). Incorporating sustainability into logistics requires re-evaluation of conventional operations to reduce environmental impact and improve efficiency. However, researchers found that due to inconsistent measurement method of sustainability indicators across the supply chain, logistics providers fail to share cost and benefits with partners and differentiate themselves from competitors (Bask et al., 2018; Martins et al., 2019).

Like fuel cost, amount of emissions is an indicator of sustainability. Replacing fossil fuels with less emitting alternatives is the major mean to make logistics more environmentally sustainable. While Electrifying freight deliveries has significant prospect to diminish the CO2 emissions of the sector (Gillström, 2023), especially in land logistics, LNG, biofuels, methanol and ammonia are potential renewable

energy sources in sea logistics (Solakivi et al., 2022). Also speed and route optimization has received much attention in past research as it can both save fuel cost and achieve emission reduction. One strategy is to design new vessels with a lower maximum speed. A notable example is Maersk's recent initiative, where they decreased the top speed of their new vessels from the range of 20–26 knots down to 23 knots. This adjustment led to 20% reductions in both fuel consumption and carbon emission (Macguire, 2013). However, there are drawbacks to consider with new constructions, including the emissions generated during the shipbuilding process and the high initial investment required.

The second alternative is to reduce the speed of the vessel; higher fuel prices or lower freight rates encourage slower sailing. Slow sailing impacts the cargo owners most, leading to higher freight costs and delayed deliveries. This may push them to choose faster and potentially more polluting transport modes like rail or air. Interestingly, higher-value cargo tends to sail faster and hence emits more. Port congestion also affects this dynamic; optimizing arrival times can reduce emissions, highlighted by initiatives like "virtual arrival" and financial incentives (Psaraftis and Kontovas, 2015; Bektaş et al., 2019). Adopting green practices in logistics involves navigating through various options, each presenting its unique set of benefits and compromises. For instance, opting for reusable materials can enhance resource efficiency and reduce expenses, but it may inadvertently increase carbon emissions during the return logistics phase. In this context, adopting renewable energy stands out as an effective approach to reduce emissions while also offering economic advantages (Bhattacharya et al., 2016; Khan & Dong, 2017; Trivellas et al., 2020).

Selecting various modes of transport, the average frequency of mode changes, haul duration, incidence of empty runs, energy efficiency per transport mode, and emissions per unit of energy consumption are all critical elements for developing sustainable transport routes. (McKinnon, 2016; Trivellas et al., 2020).

2.2 Digital technologies as means to achieve logistics sustainability

Digitalization, leveraging data, and improved computational capabilities, plays another important role in transforming industries by creating innovative services and business models, enhancing operational efficiency, and enabling cost savings for further digital investments (Tagliapietra et al. 2020; Agarwala et al., 2021; Broccardo

et al., 2023). It encompasses both information and operational technology tools to streamline processes and reduce transactional costs (Felser et al., 2019; Mas et al., 2020; Broccardo et al., 2023). Furthermore, empirical research in European cargo transportation context shows that information and communication technology can be utilised for sustainability promotion (De Andres Gonzalez et al., 2021).

In logistics, technologies such as robotics, AI, and big data offer significant decarbonization potential (Brinken et al., 2023). Various digital solutions, from sensors to blockchain, aim to optimize operations and reduce emissions (Durkin, 2021; Plaza-Hernández, et al. 2021; Lind et al., 2020; Boison & Antwi-Boampong, 2020; Di Silvestre et al., 2018; N. Agarwala & Guduru, 2021; Agarwala et al., 2021). Sustainable business models highlight the role of digital platforms in facilitating resource sharing, co-creation, and operational efficiencies, suggesting that digital tools are instrumental but not sufficient without integrating green technologies for true decarbonization (De Andres Gonzalez et al. 2021; Hiteva & Foxon, 2021; Broccardo et al., 2023).

2.3 Value proposition in sustainable business model

Business models outline how organizations generate, deliver, and capture value, as described by Teece (2010). The business model canvas presented by Osterwalder & Pigneur (2010) includes various elements like the value proposition, customer engagement and segmentation, distribution channels, essential activities and resources, partnerships, and the revenue strategy. Companies can adjust these elements to seize new opportunities for growth or adapt to shifts in the market (Saebi et al., 2017; Eriksson et al., 2022). Sustainable business models can integrate economic, environmental, and social dimensions. As highlighted by researchers such as Lüdeke-Freund (2019), Schaltegger et al. (2012) and Schneide and Spieth (2013), sustainable business model aims to create positive impact and/or reduce negative impact on environment and society, while providing value generation and capture opportunity for all parties involved (Bocken et al., 2014, p. 44; Chevrollier et al., 2023). Sustainable forerunner firms may employ long term partnerships with their stakeholders to share their resources and knowledge. Likewise, rethinking the key partners will include partners who support the creation of sustainable ecosystems (Broccardo et al., 2023).

There are substantial evidences from recent research that especially the value proposition is the most central component of both traditional and Sustainable Business Model (De Giacomo & Bleischwitz, 2020; Eyring et al., 2011; Geissdoerfer et al., 2018; Schaltegger, Hansen, & Lüdeke-Freund, 2016; Bähr & Fliaster, 2022; Baldassarre et al., 2017; Boons & Lu; deke-Freund, 2013; Kristensen and Remmen, 2019; Laukkanen & Tura, 2022). Using value propositions firms can solve environmental problems through their products and services (Awan, 2020; Baldassarre et al., 2017; Chevrollier et al., 2023). New entrants or the biggest players in the market can also disrupt the market's established value propositions and propose a new type of values using non-conventional ways, resources and by revamping processes (Brenner, 2018; Broccardo et al., 2023). Hence, service providers must understand clearly what customers perceive as valuable, because the mismanagement of the expected and realised value will have implications and impacts on stakeholders (Hlady-Rispal and Servantie, 2018; Chevrollier et al., 2023). Customers likely value something that solves their problems or meet their needs, which would help service providers to build a sustainable value proposition (Foss & Saebi, 2016; Schneider & Spieth, 2013; Chevrollier et al., 2023) through which customers gain certain benefits (Patala et al., 2016; Osterwelder & Pigneur, 2010; Laukkanen & Tura, 2022).

2.4 Conceptual Framework

To provide a value adding solution, firms must understand the utility customers gain from the value. Based on the utility gain, value proposition dimensions are categorised into *financial* (Borg et al., 2020), *functional, emotional,* and *social* (Sheth et al., 1991; Gilly et al., 1992; Sweeney & Soutar, 2001), *epistemic* i.e., utility of gathering new knowledge through products and service and *conditional* i.e., utility obtained in a particular situation (Sánchez-Fernández & Iniesta-Bonillo, 2007; Zeithaml et al., 2020; Laukkanen & Tura, 2022).

We adapt the initial conceptual frameworks developed by Sheth and colleagues (1991), Gilly et al. (1992) for the logistics transportation industry. In this context, the epistemic and conditional dimensions have been excluded as they are linked to the customers, whereas here we focus on service providers' perspectives only and their value proposition for achieving sustainability in logistics. Our working hypothesis is that businesses which provide products and services will prioritize financial,

functional, and emotional value propositions over epistemic and conditional value propositions. Epistemic value (i.e., value accrued through new knowledge) can be beneficial specifically to end consumers rather than service providers. Service providers are continuously pressured by environmental regulations and thus already familiar with sustainability added value than consumers. Similarly, understanding the conditional value of green logistic services would be challenging as such services are new to the market and would require in-depth understanding of the customer context in which logistics services are purchased.

In summary, our framework for sustainable value propositions is broken down into three dimensions:

1. **Financial** (Borg et al., 2020): The financial aspect focuses on cost reduction and avoidance, specifically in the process of fuel consumption, regulatory charges, and material costs. This implies that sustainability efforts can lead to significant savings and more efficient resource utilization from a financial perspective. In addition, by taking sustainability initiatives and abiding by the regulations, firms can avoid regulatory penalties.
2. **Functional** (Sheth et al., 1991; Gilly et al., 1992; Sweeney & Soutar, 2001): Functionality is enhanced through improved performance efficiency, which includes speed, waste reduction, fuel consumption reduction (by decreasing fossil fuel dependency), and optimized routing to reduce idle time at ports. Additionally, the sharing of real-time data and information is highlighted, suggesting that timely and accurate information flow can greatly enhance operational efficiency. Moreover, replacing fossil fuel with renewables also indicates sustainable performance improvement.
3. **Emotional** (Sheth et al., 1991; Gilly et al., 1992; Sweeney & Soutar, 2001): On an emotional level, the goal is to elicit a positive reaction. This suggests that sustainability initiatives should also resonate with customers and other stakeholders on a level beyond mere financial or functional benefits, possibly enhancing the company's reputation.
4. **Digital technologies**: serve to achieve logistics sustainability, suggesting that leveraging technology is central to making these dimensions work together effectively in pursuit of sustainable operations.

A key objective of this framework is the reduction of carbon emissions, aligning business practices with environmental sustainability goals.

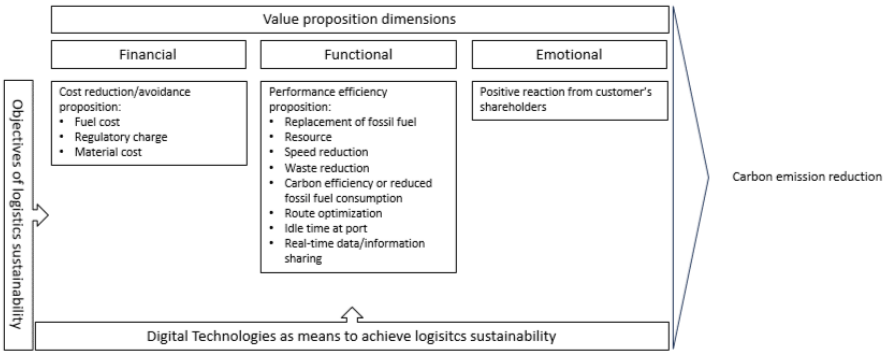

Figure 1: Framework for sustainable value proposition dimensions
Source: adapted from Sheth et al. (1991), Gilly et al. (1992), Sweeney & Soutar (2001)

3 Methodology

This study's aim is to examine sustainable value propositions of logistics services. With tightening emissions regulations and standards, the cases studied here exemplify companies that meet these challenges by providing innovative, environmentally sustainable services to their customers. The primary focus in each case was the value proposition; our secondary focus was to illustrate how digitalisation supports these value propositions.

Case selection criteria: The cases were selected through convenience sampling, because there is a limited number of sustainable logistics services on the market with sufficient public data available to study. The selection aimed to contrast and compare services offered by both large and small businesses, covering global and regional scopes, as well as single and multi-modal transportation options. Consequently, this methodology resulted in the inclusion of *four cases in the final analysis*: two cases represent large, global, and multi-modal logistics services, two cases contrast as small, local, and single-modal transportation services.

Data: The data analysed in this study is secondary data that was collected from public sources, such as companies' web pages, corporate responsibility reports, press releases, articles, or news items. The data was collected through online searches with

the company and service name, Web of Science and Scopus databases for academic publications on sustainable logistics or publications containing the exact service name.

Method and analysis: Following Yin (2012), we used the case study method to investigate each value proposition in each company's service business model. The analysis of each case is *descriptive* in that it provides details on specific dimensions of the value proposition as illustrated in Figure 1. We conducted a *multiple-case study* and cross-case synthesis of the qualitative data (Yin, 2012). All four authors contributed to the analysis to ensure consistency and triangulation.

Cross-case synthesis initiated with a review of key-information on individual case studies. Later, after the authors searched for patterns across the four cases, the interpretation of findings has been organized according to the sustainable value proposition dimensions in the multiple-case study (Figure 1 and Table 1).

4 Results

4.1 Small, local & single mode case descriptions

Posti Green Freight (Posti, n.d.) is a fossil-free land transportation service offered to business customers. The service is operated based on Book & Claim model (Centre, n.d.), where the customer purchases a share of fossil-free transportation service. Based on the purchase the share of fossil-free transportation is earmarked to the customer. The customer pays a premium for the green transportation service. The Green Freight service is produced with fossil-free energy sources (electricity, biogas or green hydrogen). The customer receives an emissions report four times a year. External verification is in place to ensure the use of fossil-free energy and prevent double-counting.

Viking Line green marine transportation service (Viking Line LNG, 2024) has been available for passengers since the summer of 2023, and it has recently been extended to include the B2B segment. The service is based on biofuel surcharge and available only on routes with appropriate vessels and infrastructure in place for using biofuels. Customers opt to pay the biofuel surcharge when booking the transportation service. Viking Line has calculated the energy it takes to realize the purchased service and orders the equivalent amount of biofuel. The calculation of

the energy required is based on annual averages to even out the impact of severe weather conditions. The logic of this green service is that customer demand defines how much the service provider is purchasing biofuels.

4.2 Large, global & multi-modal case descriptions

Maersk Eco Delivery (Maersk ECO Delivery, n.d.) is a multimodal decarbonization solution to green ocean logistics by replacing fossil fuels with biofuels or methanol. Maersk's Eco Delivery uses "mass balance chain of custody" model to reduce emission with sustainable fuels even in specific shipments across its global network. Customers are not required to invest long-term and have the flexibility to apply Eco Delivery to their specific location and product need. The payment model for this service is based on greenhouse gas emission reduction per trade. In practice, customers ask sales representatives to add Eco Delivery in their contract and Maersk provides yearly CO2 savings certificates to their customers.

DHL Go Green solution (DGF_2017_GoGreen-Solutions_EN, n.d.) is a portfolio of multimodal services to reduce CO2 emissions in the logistics transportation chain. The Go Green solution portfolio consists of three offerings: carbon transparency, carbon footprint optimization, and carbon emission offsetting. *Carbon transparency* is a digital toolkit consisting of a carbon report, carbon dashboard, and DHL quick scan. *Carbon footprint optimization* is a service that helps customers plan their transports more efficiently and sustainably by utilising modal shifts or consolidation of shipments. These services either provide above-industry average carbon efficient freight services or completely replace heavy fuel with biofuel. *Carbon emission offsetting* allows customers to offset their carbon footprint with certified and verified climate protection projects. DHL Go Green solution customers receive annual reports and certified carbon reports. Customers need to pay a premium for the service.

4.3 Findings from the cross-case analysis of value propositions in logistics services

The cases examined differ substantially in service offerings and regarding the availability of public data on their services. For the global cases - Maersk Eco Delivery and DHL Go Green services - there was detailed information available and

hence our analysis was able to capture their services wholistically. As for the local cases - Posti Green Freight and Viking Line Green Transportation Service - only a top-level value proposition was available from public resources. In practice, this means that even though these companies pursue carbon reduction for themselves and their customers, detailed value propositions in different dimensions (Figure 1) were not found at the time of the study. Posti Green Freight and Viking Line Green Transportation Service were only recently launched on the market, which may be one of the reasons for the scarcity of available information. Next, we turn to analyse the cases against the framework developed in Figure 1.

4.3.1 Financial value proposition

Under the financial dimension, we observe that DHL and Maersk services, customers retain the power to govern their cost. For example, customers do not need to commit to the Maersk Eco Delivery service long-term, but they are able to obtain the service whenever needed. Moreover, customers always know the price they must pay and therefore they can circumvent price uncertainty and futureproof their logistics costs. Similarly, while DHL's Go Green solution promises "cost optimization opportunities", the means to secure that promise is different from Maersk. DHL provides a "carbon dashboard", where customers can investigate cost improvement areas by themselves. Paired with their logistics consulting services, DHL offers "transport network optimization" expertise that will ensure cost reduction and profit maximization potential. For Posti and Viking Line, no information on financial value proposition could be found.

4.3.2 Functional value proposition

In the functional dimension, we identified several technology-driven performance improvements, which are likely to increase logistics sustainability (Fig.1). *Waste reduction* is observed in Maersk's and Viking Line's operation. Maersk reuses waste and residues for fuel feedstock, which in turn decreases waste. Likewise, in Viking Line's liquified biogas used in their ships is produced from waste and residues from households, agriculture, and food industries. In addition to sourcing food waste from industries, Viking Line recycle the ship's food waste into biogas production. *Route optimization* is found in DHL's Go Green solution value proposition under the carbon dashboard service. There, customers can model their

entire supply chain, simulate multiple transportation modes, and find the optimal route with the smallest carbon footprint. *Information or data sharing* is another feature in DHL's carbon dashboard report service. DHL offers an "end to end" supply chain visibility which integrates reports from all service providers in the value chain. Next, DHL guarantees *carbon efficient ships* in the marine portfolio with the claim of "5% more carbon efficient than industry average". This also fulfils the performance efficiency value proposition; however, the basis of such efficiency gain is not clear due to limited information. Posti and Viking Line replace fossil fuels with renewables and leverage data to define the amount of energy needed to produce the service bought by the customer.

4.3.3 Emotional value proposition

The cross-case analysis revealed several types of value propositions connected to emotional responses employed by the companies to deliver messages of their environmental solution. These are "creating good feeling and positive image", "convenience and flexibility of the service", "commitment to green transition", "trust and credibility", "taking responsibility and being transparent", "customizable service" and "adaptable service per external changes". The first 4 were mentioned more often than others. *Creating a good feeling* for customers and establishing positive brand image are communicated by two of the cases, Posti's Green Freight and Viking Line's Green Transportation services. Posti and Maersk propose *convenience and flexibility* of their service offering, Viking Line and DHL do not communicate such propositions. For example, to choose Posti's Green Freight service, no separate agreement is needed; with Maersk, customers can choose the Eco Delivery service flexibly according to their location, product preference, and sustainability agenda. *Commitment to the green transition* is found to be another example of value proposition in the case of Maersk's Eco Delivery and DHL's Go Green solution. Maersk's commitment is visible through its promise to go beyond the legislative boundary to reduce emissions. On the other hand, DHL's commitment starts from the top-level discussions on climate impact, which is operationalised through their core businesses. In relation to *ttransparency,* Maersk, for example, wants to be credible by providing certification of traceable feedstock source and proof of sustainability with CO2 certificate. They point out that they partner with trusted certification bodies. Similarly, Viking Line wants to "conduct business in a transparent and proper manner" to gain customers' trust. While there are no explicit

value propositions on transparency in Posti and DHL's case, there is implicit transparency as value proposition in DHL's carbon dashboard solutions. In general, all case companies provide reports, which indicates their attempt in being transparent about their carbon emission data.

Finally, two other value propositions are observed, that stand on their own. First is *customisation:* as part of DHL's Go Green solution, DHL logistics consulting offers customizable environmental performance improvement recommendations. Second, *adaptability* is communicated by DHL as well; they promise to adjust their services as per the regulations changes so that their customers can reach their own environmental targets.

4.3.4 Digital technologies supporting sustainable value propositions

From the customer's perspective, our cross-case analysis reveals that digitalization and data support logistics transportation service provision at key touchpoints:

1. Pre-service purchase, when customers evaluate among and choose transportation alternatives that best meet their needs.
2. Tracking during service delivery
3. Post-transport, by offering visibility into the emission data generated and validated by third parties as well as reporting for the customer.

Based on the publicly available data, it is challenging to paint a complete picture of the *role of data and digitalization* in the service delivery process. Posti Green Freight uses data in allocating the share of fossil-free service to the customers that have paid for it. In a similar vein, Viking Line's Green Transportation service uses yearly ship fuel consumption as a baseline to calculate the energy needed to transport the passenger or the cargo that purchased the green service and then, Viking Line purchases the equivalent amount of renewable fuel.

Although Maersk offers an AI-driven platform called "StarConnect" pooling vessels' big data to forecast and thus improve fuel consumption need, energy efficiency, and reduce carbon emissions (A.P. Møller - Mærsk A/S, 2023, p. 29, 45), the company does not disclose whether StarConnect is related to the solution under investigation in the Eco Delivery case.

Table 1: Summary of the value propositions in the four sustainable logistics service cases

Studied Cases	Value proposition dimensions		
	Financial	Functional	Emotional
Posti Green Freight	n/a*	Replace fossil fuels (with biogas and electric transportation); Aid in achieving sustainability targets & compliance; Verified emission report	Good feeling & positive image; Convenience & flexibility
Viking Line Green Marine Transportation Service	n/a*	Replace fossil fuels (with Bio-LNG); Waste reduction; Aid in achieving sustainability targets & compliance; Certified emission report/ Sustainability certificate	Good feeling & positive image; Responsibility & transparency
Maersk Eco Delivery	Cost reduction	Replace fossil fuels (with biofuel and methanol); Waste reduction; Aid in achieving sustainability targets & compliance; Certified emission report	Convenience & flexibility; Commitment; Trust & credibility
DHL Go Green Solution	Cost reduction (through optimization); Profit maximization	Replace fossil fuel (with biofuel); Carbon efficiency; Route optimization; Information sharing; Aid in achieving sustainability targets & compliance; Certified emission report	Commitment; Customization; Adaptability
Digital technologies: carbon dashboards, data analytics to calculate the share of fossil-free fuel provision, certified emission reporting, digital tools for route simulation and optimisation			

* Refers to the situation when a) when information could not be retrieved from public sources and/or b) at the time of writing, the value proposition does not include this dimension.

There are notable differences between the cases in what kind of data is visible and reported to the customer. DHL is perhaps the most advanced in this respect, offering customers carbon reports, carbon dashboard, and DHL quick scan. customers can simulate and optimise routes with modal shifts or consolidation of shipments. The customers of Posti and Viking Line can opt for the green service when booking their journeys, typically online. Posti offers its Green Freight customers four times a year an emission report that shows the share of fossil-free transportation allocated to the company. Viking Line has been offering biofuel

surcharge to freight customers only recently and, as of now, is not communicating publicly how the emission reductions are reported to the freight customers.

5 Discussion, limitations, and conclusions

While previous research has shown logistics providers' failure to share cost and benefits with partners and differentiate themselves from competitors for sustainable logistics (Bask et al., 2018; Martins et al., 2019), our analysis suggests that digital solutions may help providers deliver both financial and functional value propositions and contribute to sharing costs and benefits of decreased emissions. Company size and scope (local vs global) also link to the value proposition capability: while the local cases do not offer financial value to their customers, the two global cases promise cost reductions through optimization to the customers., at least in the cases of global reach the global cases appear more mature compared to the local ones, also representing the transportation chain more comprehensively, even door-to-door, which means improved possibilities of multi-modal optimization.

Digitalization was found to be a distinguishing factor among the cases: large global companies leverage more advanced digital technologies compared to smaller, recently established services. By examining how logistics service providers collate data on emissions, utilize and verify the data and deliver reports, the study expands our understanding of the role of data and digitalization in logistics sustainability. Digitalization and data are found to support or enable the green transportation services throughout the entire customer journey.

This study also illustrate that digitally savvy firms can propose multiple value dimensions whereas the scope of new and cross dimensional value proposition for digitally young firms is limited. Digitalization facilitates the collection and calculation of emission data, which *is a backend but central task* for supporting sustainable logistics. For the local companies, providing emission reports to their B2B customers is functional value proposition, however, larger companies have moved further by incorporating digital elements (check table 1) in offerings and therefore both functional and financial value proposition are visible in collection and calculation of emission data.

Furthermore, we observed interconnected relationship between functional and emotional value propositions. All examined case companies communicated reduction of fossil fuel use as their core functional value proposition**.** In addition, all companies verified their carbon emissions reduction calculations through an independent third party. This independent certification process in turn not only adds credibility to the environmental claims of the services but also demonstrates their commitment to sustainability. By doing so, these companies establish trust and goodwill among consumers who prioritize environmental responsibility. Our findings are consistent with previous studies that businesses can address environmental issues through the value propositions in their products and services (Awan, 2020; Baldassarre et al., 2017; Chevrollier et al., 2023).

In this study, we also uncovered various examples of emotional value propositions in the sustainable logistic services. The services analysed connect emotions with their offerings, demonstrating how sustainable logistics services assist customers in reaching their sustainability objectives. This communication builds trust in service providers as reliable partners. The number of emotional value propositions found in the case companies in comparison to their financial value proposition may indicate that companies are aware of the importance of communicating about their sustainability initiatives to their customers. On the other hand, the smaller service providers emphasize emotional value over functional or financial value, whereas the more mature service providers focus on functional and financial ones.

Customers value services that solve their problems or meet their needs, which is an essential consideration for service providers in building a sustainable value proposition (Foss & Saebi, 2016; Schneider & Spieth, 2013; Chevrollier et al., 2023) as well as services through which customers gain certain benefits (Patala et al., 2016; Osterwalder & Pigneur, 2010; Laukkanen & Tura, 2022). In the case of green logistics services, customers increasingly demand reporting and transparency in service providers' operations. Customers greatly benefit from obtaining verified emission data: first in ensuring compliance, second establishing a baseline, and third following up on their own progress in emission reductions. From our cross-case analysis, we observed that all companies provide reports that contain emission reduction data, which becomes a necessary requirement for green logistics services. Differentiation among service providers is based on additional aspects, such as the inclusion of digital elements in offerings as discussed earlier.

This research has focused on exploring value propositions and the role of digital technologies in achieving sustainable transportation solutions from the viewpoint of service providers. This perspective, while valuable, presents certain limitations. First, our analysis is confined to the value propositions as presented by service providers, which does not encompass the customers' perspective, i.e., the value perception. Understanding how customers view and value these sustainable practices could significantly enrich the narrative around sustainable logistics and offer a more rounded perspective on the effectiveness of these services. Another limitation in our study is the reliance on publicly available data. Although we have opted for the service provider's perspective with an assumption that the quality of such data would suffice for customers to evaluate potential partners, this approach limits the scope of our analysis. Finally, our sample of four case companies inhibits the generalizability of our findings.

As the relationship between sustainability and digitalization is expected to become more pronounced and complex, this twin transition provides a fertile ground for future research to delve into the role of digital technologies to help improve sustainability in logistics.

By identifying and elucidating the synergies between sustainability and digitalization, this research contributes to the ongoing dialogue on twin transition and BM innovation, offering actionable insights for logistics companies and stakeholders aiming to advance towards more sustainable operations amidst global environmental challenges.

Acknowledgements

The authors would like to thank two anonymous reviewers for their invaluable feedback in developing this study. This study is supported with funding from Business Finland for the Green Connect project (grant no. 3167/31/2023)

References

A.P. Møller - Mærsk A/S. (2023). *Annual report*. Retrieved March 7, 2024, from https://investor.maersk.com/news-releases/news-release-details/annual-report-2023

Agarwala, N., & Guduru, S. S. (2021). The potential of 5G in commercial shipping. Maritime Technology and Research, 3(3), Manuscript. https://doi.org/10.33175/mtr.2021.248995

Agarwala, P., Chhabra, S., & Agarwala, N. (2021). Using digitalisation to achieve decarbonisation in the shipping industry. Journal of International Maritime Safety, Environmental Affairs, and Shipping, 5(4), 161–174. https://doi.org/10.1080/25725084.2021.2009420

Bähr, K., & Fliaster, A. (2022). The twofold transition: Framing digital innovations and incumbents' value propositions for sustainability. Business Strategy and the Environment, 32(2), 920–935. https://doi.org/10.1002/bse.3082

Bask, A., Rajahonka, M., Laari, S., Solakivi, T., Töyli, J., & Ojala, L. (2018). Environmental sustainability in shipper-LSP relationships. Journal of Cleaner Production, 172, 2986–2998. https://doi.org/10.1016/j.jclepro.2017.11.112

Bektaş, T., Ehmke, J. F., Psaraftis, H. N., & Puchinger, J. (2019). The role of operational research in green freight transportation. European Journal of Operational Research, 274(3), 807–823. https://doi.org/10.1016/j.ejor.2018.06.001

Bhattacharya, M., Paramati, S. R., Öztürk, İ., & Bhattacharya, S. (2016). The effect of renewable energy consumption on economic growth: Evidence from top 38 countries. Applied Energy, 162, 733–741. https://doi.org/10.1016/j.apenergy.2015.10.104

Bocken, N., Rana, P., & Short, S. W. (2015). Value mapping for sustainable business thinking. Journal of Industrial and Production Engineering, 32(1), 67–81. https://doi.org/10.1080/21681015.2014.1000399

Boison, D. K., & Antwi-Boampong, A. (2020). Blockchain ready port supply chain using distributed ledger. Nordic and Baltic Journal of Information and Communications Technologies. https://doi.org/10.13052/nbjict1902-097x.2020.001

Borg, D. R., Mont, O., & Schoonover, H. A. (2020). Consumer Acceptance and Value in Use-Oriented Product-Service Systems: Lessons from Swedish Consumer Goods Companies. Sustainability, 12(19), 8079. https://doi.org/10.3390/su12198079

Brenner, B. (2018). Transformative Sustainable Business Models In the Light of the Digital Imperative—A Global Business Economics Perspective. Sustainability, 10(12), 4428. https://doi.org/10.3390/su10124428

Brinken, J., Behrendt, F., & Trojahn, S. (2023). Comparing decarbonization potential of digital and green technologies. Sustainable Futures, 6, 100125. https://doi.org/10.1016/j.sftr.2023.100125

Broccardo, L., Zicari, A., Jabeen, F., & Bhatti, Z. A. (2023). How digitalization supports a sustainable business model: A literature review. Technological Forecasting and Social Change, 187, 122146. https://doi.org/10.1016/j.techfore.2022.122146

Centre, S. F. (n.d.). *Smart Freight Centre*. https://smartfreightcentre.org/en/about-sfc/news/new-accounting-framework-to-address-barriers-to-transport-decarbonization/

Chevrollier, N., Argyrou, A., Ainiwaer, N., & Nijhof, A. H. (2023). On the encroachment of sustainable value propositions: Business model innovation for impact. *Journal of Cleaner Production*, *382*, 135341. https://doi.org/10.1016/j.jclepro.2022.135341

Completion of key 'Fit for 55' legislation. (2023, October 9). European Commission - European Commission. https://ec.europa.eu/commission/presscorner/detail/en/IP_23_4754

De Andres Gonzalez, O., Koivisto, H., Mustonen, J. M., & Keinänen-Toivola, M. M. (2021). Digitalization in Just-In-Time approach as a sustainable solution for maritime logistics in the Baltic Sea Region. Sustainability, 13(3), 1173. https://doi.org/10.3390/su13031173

De Giacomo, M. R., & Bleischwitz, R. (2020). Business models for environmental sustainability: Contemporary shortcomings and some perspectives. *Business Strategy and the Environment*, *29*(8), 3352–3369. https://doi.org/10.1002/bse.2576

DGF_2017_GoGreen-Solutions_EN. (n.d.). [Video]. DHL. https://www.dhl.com/global-en/home/our-divisions/global-forwarding/special-expertise/gogreen-solutions.html

Di Silvestre, M. L., Favuzza, S., Sanseverino, E. R., & Zizzo, G. (2018). How Decarbonization, Digitalization and Decentralization are changing key power infrastructures. Renewable & Sustainable Energy Reviews, 93, 483–498. https://doi.org/10.1016/j.rser.2018.05.068

Eriksson, T., Heikkilä, M., & Nummela, N. (2022). Business model innovation for resilient international growth. *Small Enterprise Research*, *29*(3), 205–226. https://doi.org/10.1080/13215906.2022.2092890

Felser, M., Rentschler, M., & Kleineberg, O. (2019). Coexistence standardization of operation technology and information technology. Proceedings of the IEEE, 107(6), 962–976. https://doi.org/10.1109/jproc.2019.2901314

Foss, N. J., & Saebi, T. (2016). Fifteen years of research on business model innovation. Journal of Management, 43(1), 200–227. https://doi.org/10.1177/0149206316675927

Gillström, H. (2023). *Regional Electrified Logistics: Review of research projects, academic publications, and perspective of the industry*. https://doi.org/10.3384/9789180750943

Gilly, M. C., Sheth, J. N., Newman, B. I., & Gross, B. L. (1992). Consumption Values and Market Choices: Theory and Applications. Journal of Marketing Research, 29(4), 487. https://doi.org/10.2307/3172719

Hiteva, R., & Foxon, T. J. (2021). Beware the value gap: Creating value for users and for the system through innovation in digital energy services business models. Technological Forecasting and Social Change, 166, 120525. https://doi.org/10.1016/j.techfore.2020.120525

Khan, S. a. R., & Dong, Q. (2017). Impact of green supply chain management practices on firms' performance: an empirical study from the perspective of Pakistan. Environmental Science and Pollution Research, 24(20), 16829–16844. https://doi.org/10.1007/s11356-017-9172-5

Laukkanen, M., & Tura, N. (2022). Sustainable value propositions and customer perceived value: Clothing library case. Journal of Cleaner Production, 378, 134321. https://doi.org/10.1016/j.jclepro.2022.134321

Lüdeke-Freund, F. (2019). Sustainable entrepreneurship, innovation, and business models: Integrative framework and propositions for future research. *Business Strategy and the Environment*, *29*(2), 665–681. https://doi.org/10.1002/bse.2396

Macguire, E. (2013, June 26). Maersk 'Triple E': Introducing the world's biggest ship. CNN. https://edition.cnn.com/2013/06/26/business/maersk-triple-e-biggest-ship/index.html

Maersk ECO Delivery. (n.d.). Low-emissions Shipping | Maersk. https://www.maersk.com/transportation-services/eco-delivery?exit=Eco+Delivery+Air

Martins, V. W. B., Anholon, R., Quelhas, O. L. G., & Filho, W. L. (2019). Sustainable practices in logistics Systems: An overview of companies in Brazil. Sustainability, 11(15), 4140. https://doi.org/10.3390/su11154140

Mas, F. D., Dicuonzo, G., Massaro, M., & Dell'Atti, V. (2020). Smart contracts to enable sustainable business models. A case study. Management Decision, 58(8), 1601–1619. https://doi.org/10.1108/md-09-2019-1266

McKinnon, A. C. (2016). Freight Transport deceleration: Its possible contribution to the decarbonisation of logistics. Transport Reviews, 36(4), 418–436. https://doi.org/10.1080/01441647.2015.1137992

Mignon, I., & Bankel, A. (2022). Sustainable business models and innovation strategies to realize them: A review of 87 empirical cases. Business Strategy and the Environment, 32(4), 1357–1372. https://doi.org/10.1002/bse.3192

Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation : a handbook for visionaries, game changers, and challengers. https://academicjournals.org/journal/AJBM/article-full-text-pdf/BA71B6427744.pdf

Patala, S., Jalkala, A., Keränen, J., Väisänen, S., Tuominen, V., & Soukka, R. (2016). Sustainable value propositions: Framework and implications for technology suppliers. Industrial Marketing Management, 59, 144–156. https://doi.org/10.1016/j.indmarman.2016.03.001

Plaza-Hernández, M., González, A. B. G., González, S. R., Prieto, J., & Corchado-Rodríguez, J. M. (2020). Integration of IoT technologies in the maritime industry. In Advances in intelligent systems and computing (pp. 107–115). https://doi.org/10.1007/978-3-030-53829-3_10

Posti. (n.d.). *Green freight - For businesses - Posti*. https://www.posti.fi/en/delivering-with-care/success-of-companies/freightservices/green-freight

Psaraftis, H. N., & Kontovas, C. A. (2009). CO2 emission statistics for the world commercial fleet. WMU Journal of Maritime Affairs, 8(1), 1–25. https://doi.org/10.1007/bf03195150

Psaraftis, H. N., & Kontovas, C. A. (2014). Slow steaming in maritime transportation: fundamentals, trade-offs, and decision models. In International series in management science/operations research (pp. 315–358). https://doi.org/10.1007/978-3-319-11891-8_11

Reduced emissions | Viking Line Group. (n.d.). Viking Line. https://www.vikingline.com/sustainable-travel/lng/

Sánchez-Fernández, R., & Iniesta-Bonillo, M. Á. (2007). The concept of perceived value: a systematic review of the research. Marketing Theory, 7(4), 427–451. https://doi.org/10.1177/1470593107083165

Schaltegger, S., Lüdeke-Freund, F., & Hansen, E. G. (2012). Business cases for sustainability: the role of business model innovation for corporate sustainability. International Journal of Innovation and Sustainable Development, 6(2), 95. https://doi.org/10.1504/ijisd.2012.046944

Schneider, S., & Spieth, P. (2013). BUSINESS MODEL INNOVATION: TOWARDS AN INTEGRATED FUTURE RESEARCH AGENDA. International Journal of Innovation Management, 17(01), 1340001. https://doi.org/10.1142/s136391961340001x

Sheth, J. N., Newman, B. I., & Gross, B. L. (1991). Why we buy what we buy: A theory of consumption values. Journal of Business Research, 22(2), 159–170. https://doi.org/10.1016/0148-2963(91)90050-8

Solakivi, T., Paimander, A., & Ojala, L. (2022). Cost competitiveness of alternative maritime fuels in the new regulatory framework. Transportation Research. Part D, Transport and Environment, 113, 103500. https://doi.org/10.1016/j.trd.2022.103500

Sweeney, J., & Soutar, G. N. (2001). Consumer perceived value: The development of a multiple item scale. Journal of Retailing, 77(2), 203–220. https://doi.org/10.1016/s0022-4359(01)00041-0

Tagliapietra, S., Häfner, M., & Noussan, M. (2020). The future of transport between digitalization and decarbonization. In SpringerBriefs in energy. https://doi.org/10.1007/978-3-030-37966-7

Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, *43*(2–3), 172–194. https://doi.org/10.1016/j.lrp.2009.07.003

Towards a net-zero logistics sector. (2023, January 20). ISO. https://www.iso.org/contents/news/2023/01/a-net-zero-logistics-sector.html

Trivellas, P., Μαλινδρέτος, Γ., & Reklitis, P. (2020). Implications of Green Logistics Management on Sustainable Business and Supply Chain Performance: Evidence from a Survey in the Greek Agri-Food Sector. Sustainability, 12(24), 10515. https://doi.org/10.3390/su122410515

Yin, R. K. (2012). *Applications of case study research* (3rd ed.). SAGE Publications, Inc.

Zeithaml, V. A., Verleye, K., Hatak, I., Koller, M., & Zauner, A. (2020). Three Decades of Customer Value Research: Paradigmatic roots and future research avenues. Journal of Service Research, 23(4), 409–432. https://doi.org/10.1177/1094670520948134