İstanbul Beykent Üniversitesi Fen ve Mühendislik Bilimleri Dergisi, 2023, 16(1), 63-72
Istanbul Beykent University Journal of Science and Engineering, 2023, 16(1), 63-72

Makale Türü: Konferans Bildirisi
Paper Type: Conference Paper

Geliş tarihi/Received: 27/03/2023
Kabul tarihi/Accepted: 04/04/2023

THE EFFECT OF USING NEARSHORING STRATEGY ON CO_2 EMISSIONS FOR SUSTAINABILITY IN GLOBAL TEXTILE SUPPLY LOGISTICS

KÜRESEL TEKSTİL TEDARİK LOJİSTİĞİNDE SÜRDÜRÜLEBİLİRLİK İÇİN YAKIN TEDARİKÇİ (NEARSHORING) STRATEJİSİNİN KULLANIMININ CO_2 EMİSYON ÜZERİNE ETKİSİ

https://doi.org/10.20854/bujse.1272033

D. Özgün Sarıoğlu[1,*]

Abstract

The new world order, in which company interests do not conflict with social interests, and social and environmental issues become the responsibility of companies, has revealed the concept of sustainability. In this context, according to the statements of the European Parliament, sustainability is also important for the textile sector, which is one of the most environmentally harmful sectors according to the amount of production and waste. On the other hand, the textile industry has a complex supply chain in which many distant chain members try to act together under globalization and cost constraints. This situation makes the sustainability studies of the textile sector difficult. However, businesses that create a sustainable supply chain structure and continuously improve this structure are expected to create a competitive advantage. In this study, the nearshore supplier strategy is adopted to improve environmental sustainability. Therefore, old inbound transpostation has been calculated to understand the reduction of CO_2 emissions. The calculation methods used are placed in EN 16258. With nearshoring, the textile company selected suppliers from nearby region. These suppliers, called FM, have reached 30% of total fabric suppliers in the last two years. The reduction of CO_2 emissons rate for inbound transportation became 669 t CO_2e at the end of 2022. The total emission reduction during the next 10-year period is 20,122 tons CO_2e for transportation. It is obvious that this research will be a sustainability study that will create value in terms of the inbound supply process.

Keywords: Calculation of CO_2 Emissions, CO_2 Emissions Based on Transport, Nearshoring, Sustainabile Textile Supply Chain

Özet

Şirket çıkarlarının toplumsal çıkarlarla çatışmadığı, toplumsal ve çevresel konuların şirketlerin sorumluluğu haline geldiği yeni dünya düzeni sürdürülebilirlik kavramını ortaya çıkarmıştır. Bu bağlamda Avrupa Parlamentosu'nun açıklamalarına göre üretim ve atık miktarı göz önünde bulundurulduğunda çevreye en zararlı sektörlerden biri olan tekstil sektörü için de bu kavram oldukça önemlidir. Öte yandan tekstil sektörü, küreselleşme ve maliyet kısıtlamaları altında birbirinden uzak konumdaki birçok zincir üyesinin birlikte hareket etmeye çalıştığı karmaşık bir tedarik zincirine sahiptir. Bu durum tekstil sektörünün sürdürülebilirlik çalışmalarını zorlaştırmaktadır. Ancak sürdürülebilir bir tedarik zinciri yapısı oluşturan ve bu yapıyı sürekli iyileştiren işletmelerin rekabet avantajı yaratması beklenmektedir. Bu çalışmada, çevresel sürdürülebilirliği iyileştirmek için yakın tedarikçi (Near Shore) stratejisi benimsenmiştir. Bu nedenle, nearshoring ile CO_2 emisyonlarının taşıma alanındaki azalma miktarını anlamak için, geçmiş ve planlanan tedarik taşımalarının emisyonları hesaplanmıştır. Tekstil şirketi tedarikçilerinin %30'unu FM (Full Merchandised) adı verdikleri yakın bölge tedarikçilerinden seçerek, taşımadan kaynaklı CO_2 emisyonlarındaki azalış ile, iki yılda 669 t CO_2e azalma sağladığı ortaya konulmuştur. Önümüzdeki 10 yıllık dönemde toplam emisyon azaltımı, nakliye için 20,122 ton CO_2e'dir. Bu araştırmanın tedarik taşımaları süreci açısından değer yaratacak bir sürdürülebilirlik çalışması olacağı açıktır.

Anahtar Kelimeler: CO_2 Emisyonu Hesaplama, Ulaştırma Kaynaklı CO_2 Emisyonu, Nearshoring, Sürdürülebilir Tekstil Tedarik Zinciri

[1,*] Corresponding Author: Adnan Menderes University, Köşk Vocational School, ozgun.sarioglu@adu.edu.tr, orcid.org/0000-0002-6575-6277

1. INTRODUCTION

The fashion industry continues to brutally destroy natural resources. For this reason, calls for sustainability are heard in the European Union and in the world. Various non-governmental organizations apply sustainability measurements and standards that will force textile businesses in this regard. Especially corporate textile companies strive to comply with these standards in order to lead the sector. These textile companies publish their sustainability reports every year, reflecting their transparency to the public. However, studies on this subject in the world are somewhat scattered. Due to the different standards used by businesses, it is difficult to measure sustainability by comparing them. Based on this, businesses have been creating their sustainability reports according to GRI standards since 2016 (Saygılı et al., 2019). Thus, they not only make their own analyses more accurately, but also allow the public and non-governmental organizations to make an understandable assessment.

GRI helps businesses all around the world to understand and communicate their impact on critical sustainability issues such as climate change, human rights, governance, and social welfare. The GRI Sustainability Reporting Standards are developed with multi-stakeholder contributions and are based on the public interest.

In addition, industry-specific performance indicators are also included in the GRI standards. These standards are also guiding for textile companies engaged in sustainability studies. Sustainability has a wide scope from valuing people to production that is harmless to nature. There are different headings in the GRI report covering all areas. This study is under the title of environmental sustainability. Textile enterprises give importance to water consumption, CO_2 emission, use of toxic chemicals, pesticides, and fertilizer control in the environmental sustainability topic. In this study, the nearshoring application of an international textile company, which pioneered the textile industry and adopted GRI standards, was evaluated. The enterprise is located in the "İzmir Free Zone." With the Nearshoring application, the aim is to reduce the CO_2 emissions in the raw material supply process. So, this study includes calculating CO_2 emissions from supply transportation. When the literature is considered, there can be found several studies. In 2012, Klein and his friends calculated the carbon dioxide emissions of Cargill. Based on the results, several carbon dioxide reduction possibilities and European Union regulation scenarios have been evaluated by them. Mock (2016) studied to reduce road-sourced CO_2 emissions in Turkey. Binh and Tuan (2016) presented that nearly 100 tons of CO_2 were emitted from freight movement in the rice industry in 2011, approximately 0.8% of total CO_2 emission borne by freight transport sector of Vietnam with their study. Mubarak and Zainal (2018) developed a CO_2 emissions framework by considering the actual conditions of the region and by calculating the level of emissions with a case study of Indonesia. Xinguang et al. (2022) determined according to the transportation mode and energy type, and the carbon emission factor of each energy source is also determined according to the local energy structure.

As it can be understood from the studies, freight shipments causes high CO_2 emissions. And ıt is also known that heavy truck transportation is increasing throughout the world as a result of globalization and shifting patterns of production and consumption. It is estimated that the global heavy-duty truck that generates a disproportionate share of GHGs fleet will increase by a factor of 2.6 to 64 million by 2050 (Mulholland et al., 2018). 23% of the transport sector is carried out by the trucks (USEPA, 2018). Therefore, a major target is designing nearshoring transportation for the heavy trucks (Giuliano et al., 2021).

In this study, the textile company, which makes nearshoring application by reducing the fabric goods supplied from the Far East, is the subject. A CO_2e emission calculation has been made for the company that wants to estimate the decrease in CO_2 emission level and add it to the 2023 sustainability report prepared in accordance with GRI standards. CO_2 equivalent calculation was made by adhering to the formulas specified in EN 16258 standards.

2. METHODS AND STUDY

The aim of this study is to make a measurable and standards-compliant CO_2e calculation by applying nearshore under the title of Environmental Sustainability study. For this purpose, four steps have been offered, and each step has been defined in Figure 1.

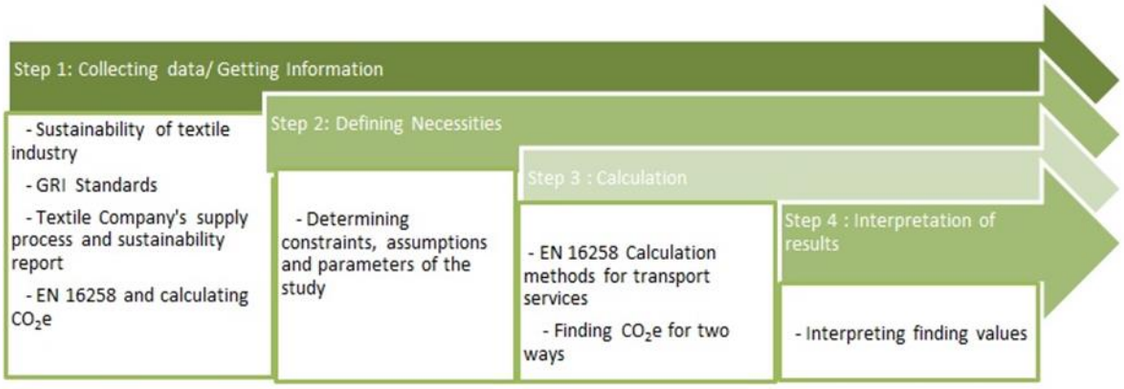

Figure 1: Study steps.

2.1. Collecting Data/Getting Information

A green supply chain is defined as the operational management method and optimization approach to reduce the environmental impact along the life cycle of the green product, from the raw material to the end product.

Fig. 2 illustrates the green supply chain procedure. The green supply chain stimulates chain members to use less harmful and sustainable materials. In producing process, green studies can be applied for decreasing the energy usage or reusing the energy. The logistics has an impressive impact in green supply chain, as it emits significant CO_2 emissions. So, logistics management should be detailed systematically to prevent redundant processes of materials. Also, if the supply chain includes more than one stakeholder, emissions can be reduced (Manavalan et al., 2021). The reverse logistics will help to recover the used products. But it is clear with the Paris climate conferences that the green supply chain cannot be applied sufficiently today. Various factors have been listed as the reason for this in academic studies. Complexity of green process and system design was found to be the most elementary barrier, having the maximum driving power. Lack of consumer support and encouragement, lack of guidance and support from regulatory authorities, and high implementation and maintenance cost are the other elementary barriers of green textile supply chain.

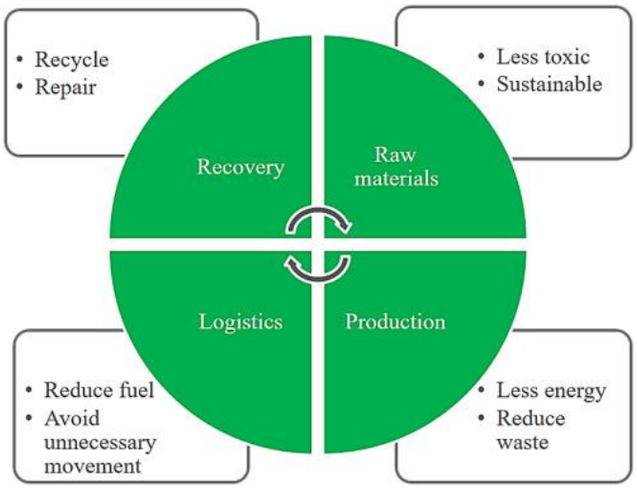

Figure 2: Green supply chain procedures (Manavalan et al., 2021).

As can be seen, there are problems in the wide scope and application of the green supply chain. The subject of this study is to reduce CO_2 emissions by reducing fuel consumption in the product supply process. So, "nearshoring," which can be defined as a geographical relocation of business functions and processes in surrounding or nearby countries, is an optimistic way to solve CO_2 emissions problem caused by transportation (Müller, 2016). Nearshoring strategy is chosen on the basis of the total costs as well as production and personnel costs. In addition, the delivery time and, nowadays, the importance of reducing CO_2 emissions play a basic role for the choice of this strategy.

The Global Reporting Initiative (GRI) is also known as a non-profit organisation that designs well known standards nowadays for sustainability reporting. These standards are schemed to be used for creating a standard sustainability report for all sectors. The standards guide companies to figure out their impacts economically, environmentally and socially. Protecting nature and human rights are the main topics in that standards. GRI report, which is formed by these standards, raises responsibility and increases clearness on the sustainable development. The textile company has been preparing sustainability report based on GRI standards since 2016. In its sustainability report "environment" is the main topic that has a sub-topic which is called "transportation emissions." Also, the company has three steps for sustainability level (Fig. 3).

Figure 3: Sustainability levels of the textile company.

Production based CO_2 emissions are first level and have been calculated so far. As it can be seen in Figure 3, the second level also includes transportations which are supply and product movements. The company's first aim is to reduce transportation caused CO_2 emissions level.

When the company completes the second sustainability level, as a last step, the whole supply chain based CO_2 emissions level will reduced.

The company recently declared that “Increasing supply bottlenecks have taught us that we need to become more independent and sustainable. For this reason, we are planning to shorten routes. This “nearshoring” will enable us to respond more quickly and with greater flexibility, and also translates into fewer transport-related CO_2 emissions and lower consumption of resources.” So, the aim of shortening routes means nearshoring applications. One of the projects that the company has started is “Reducing Far East Supply.” The company supplies all fabric materials from China. 10 times in a month, the company supplies this raw material via 40’container. Sea and roadways are used.

The company uses sub-contractors for transportation. So, EN 16258 (2012) standards offer a formula that needs information about energy consumption, actual cargo weight, and actual transportation distance.

2.2. Defining Necessities

The company management has estimated uncertain road shipments. For this reason, it is assumed that the supply is carried out by sea 9 times and by road once a month. Only 40’ container is used for transportation.

Assumptions are listed below:

- “Average goods” category is suitable for fabric materials that EN 16258 has defined.
- Uncertain national road transports are assumed to be equal in both countries (Turkey and China)
- Port of Shangai and Xian is start point of tranportations (Fig. 4)

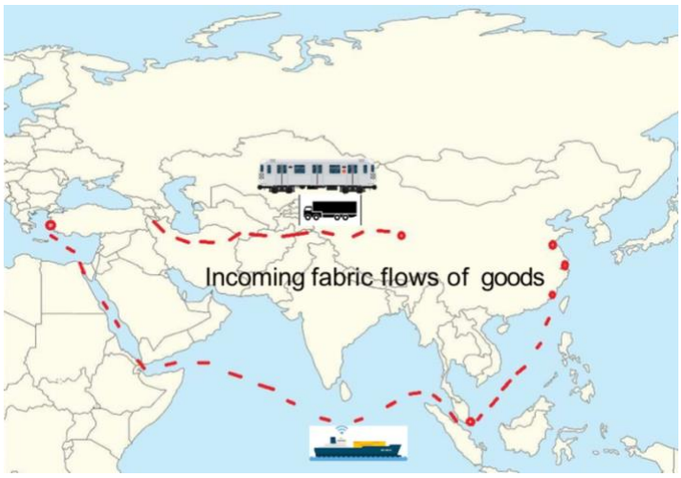

Figure 4: Supply flows of fabric goods.

Parameters are listed below:

- İzmir to China with vessel -->16,500 km
- İzmir to China with truck-->10,000 km
- 9 times with vessel, 1 time with road in a month
- 40’ container is 2 TEU (EN 16258)
- A 40-t articulated lorry transport

- Diesel consumption coefficient: 0.19 --> for road
- Diesel consumption coefficient: 0.1 --> for container ship
- Container ship is articulated tub barge 240 TEU
- 24-40 t load weight
- Greenhouse gas emissions calculating CO_2 equivalent coefficient for diesel: 2.67 (EN 16258, 2012)
- The textile company causes 4,000 t CO_2e emission based on production in a year
- The textile company has reduced 30% Far East Supply until now

2.3. Calculation

$$GT = F * gT \quad (1)$$

Equation 1 variables:

GT = Tank-to-wheels GHG emissions in kg CO_2 equivalents (CO_2e)
F = Measured energy consumption (e.g., l, kg or kWh)
gT = Tank-to-wheels GHG emission factors from measured values in kg CO_2e

F is a variable that can be found in Equation 2.

$$F = W * D * E \quad (2)$$

Equation 2 variables:

F = energy consumption in l, kg, or kWh
W = actual cargo weight in t or TEU
D = actual transportation distance in km
E = specific energy consumption (in l, kg, or kWh) per tkm or TEU-km

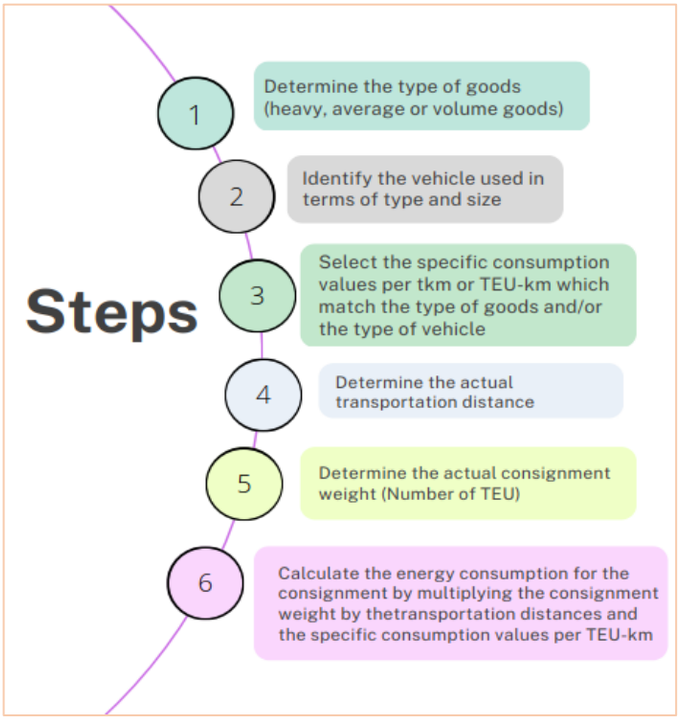

Figure 5: Steps for CO_2e calculation for outsource transportation (CLECAT, 2012).

2.4. Energy Consumption by A Container Transport Service

The company has started nearshoring strategy since the beginning of 2021. It means that the company stepped in after covid times. The calculation of the emission for Far East transports in 2021 is as follows:

A 40-t articulated lorry transports 2 TEU of insulation from China to Turkey.
Determining the parameters for the calculation:
Lorry class: container (articulated lorry) 24 – 40 t
Type of goods: average goods
Transport weight: 25 t (12.4*2)
Transport distance: 10,000 km
Road category: motorway

Energy consumption:
F [liter] = W [t] x D [km] x E [l/tkm]
F = 2 t x 10,000 km x 0.19 l/tkm = 39,800 liter energy consumption of one-way shipment with truck

In general, the same physical rules apply to ships as to road mode of transport in terms of energy consumption: the larger the ship and loading capacity, the smaller the specific energy consumption per unit load (EN 16258, 2012).

Determining the parameters for the calculation:
Type of ship: container ship
Type of goods: average goods
Transported weight: 2 TEU
Distance transported: 16,500 km (determined using EcoTransIT)

Calculating energy consumption:
F [l] = W [TEU] x D [km] x E [l/TEU]
= $2 \text{ x } 16{,}500 \text{ km x } 0.1 \text{ l/Tkm}$
= 3,300 liter energy consumption of one-way shipment with container ship

Total consumption calculation:
Sea way consumption: 3,300 liter (*9 times for a month)
Roadway consumption: 39,800 liter (*1 time for a month)
Supply transportation consumption: $\mathrm{F} = 3{,}300 * 9 + 39{,}800 * 1$
$\mathrm{F} = 29{,}700 + 39{,}800 \;\; \mathrm{F} = 69{,}500$ liter consumption per month

Formula 1 is calculated for CO_2e value:
GT = 69,500 x 2.67
GT= 185,565 CO_2e per month
185,565*12=2,227 tonne CO_2e in a year (2021 value)

The business expects its suppliers to fulfill certain commitments through the Supplier Code of Conduct it has published. With the three modules of the Supplier Code of Conduct - 'Social Compliance Management', 'Environmental Management', and 'Governance' - it combines environmental and social topics. This currently covers all fabric and trimming suppliers that are Far East.
In this way, the company wants to establish a binding framework for fair working conditions and human rights in its supply chain for sustainability. For example, the company denies the

suppliers that have child and forced labor, and it has a Child Labor Policy for this. The company focuses on measures to create constraints for climate change, save water and soil, and avoid air pollution thanks to the Environmental Management module. Also, the objective of the Governance module is to ensure suppliers with responsibility tools. These tools make possible suppliers to get on growing responsibility for their own supply chain accordingly the "Supplier Code of Conduct". They also reduce their own environmental and social risks in supply chain. In short, all these constraints are incorporated by the company into its global textile supply chain management for sustainability works.

The company works with many suppliers for the supply of raw materials. It needs a close supply policy without compromising on raw material quality, cost, technological production, and expectations specified in Code of Conduct. Evaluation of the suppliers in the regions close to the business, whose current location is in Izmir, is an ongoing process. This process includes requesting a new product from the supplier, converting the supplier's product to the quality requested by the company, and fulfilling the supplier code of conduct requirements. Besides, the company has business relationships with its strategic partners that go back eleven years and more. Suppliers are also the one of the most important partners of them. The company's supply chain management strategy includes long-term partnerships that are essential to finding answers to social and environmental challenges together. As the manager said, nearshoring needs time for this transformation. And the company's estimation for nearshoring rates and supply rates year by year is shown Table 1.

Table 1: Estimated nearshoring rates and increase of supply rates.

Year	Estimation in Supply Plan (nearshoring rate)	Estimated rate of increase in supply (raw material)	Units of Truck year by year
2021	10%	8%	10
2022	30%	7%	11
2023	55%	7%	12
2024	65%	6%	12
2025	75%	6%	13
2026	80%	5%	14
2027	88%	4%	14
2028	94%	4%	15
2029	97%	3%	15
2030	99-100%	3%	16

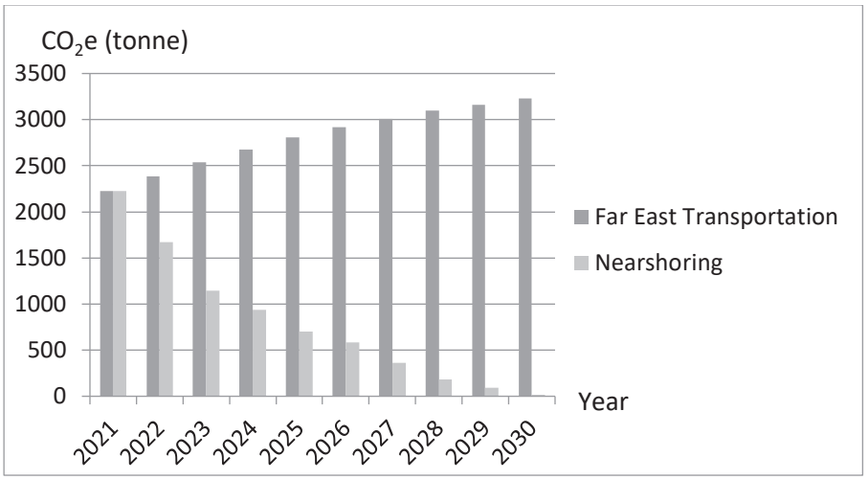

Figure 6: Comparision of CO_2e values between Far East and Nearshore Regions for the next ten years.

3. RESULTS

The company has declared in its sustainability reports that it releases 4,000 tons of CO_2 per year as a result of only its production at its İzmir facility. With this study, it is found that the company emitted 2,227 tons of CO_2 during transportation for fabric products in a year. When the data is analyzed, it is seen that the transportation process corresponds to 55% of the CO_2e emission emitted in production. In the past 2 years, the business has brought 30% of its fabric product supply closer to the business with its nearshoring strategy. This means that as of this year, the CO_2e value of the transportation made from the Far East has been decreased and become approximately 1,558 tons. This means that two years reduction of emissons rate for inbound transportation has become 669 t CO_2e.

Considering the supply increase and nearshore rates between 2021 and 2030, the sustainability gain of 2030 is 3229 tons CO_2e (Figure 6). The total emission reduction during this 10-year period is 20122 tons CO_2e. It is obvious that this research will be a sustainability study that will create value in terms of the inbound supply process.

It can be said that this analysis is a start for the company's second part of the sustainability efforts that include distribution transportations between the company and customers. Also, the textile company will be able to use this calculation at the end of this year in its sustainability report which is to be prepared in accordance with GRI standards. This research will be a shiny guide for other calculations of the company’s logistics functions (handling, warehousing, etc.) which cause CO_2 emissions.

REFERENCES

Binh, N., & Tuan, V. (2016). Greenhouse gas emission from freight transport-accounting for the rice supply chain in Vietnam. *Procedia CIRP*, *40*, 46–49. https://doi.org/10.1016/j.procir.2016.01.051

CLECAT (European Association for Forwarding, Transport, Logistics and Customs Services). (2023, March 20). *Calculating GHG emissions for freight forwarding and logistics services*.

https://www.clecat.org/media/CLECAT_Guide_on_Calculating_GHG_emissions_for_freight_forwarding_and_logistics_services.pdf

Jovanović, B., Ghodsi, M., van Zijverden, O., Kluge, S., Gaber, M., Mima, R., & Mandić, M. (2021). *Getting stronger after COVID-19: Nearshoring potential in the Western Balkans (No. 453).* WIIW Research Report. https://wiiw.ac.at/getting-stronger-after-covid-19-nearshoring-potential-in-the-western-balkans-dlp-5814.pdf

Klein, J., Geilenkirchen, G., & Hulskotte, J. (2012). *Methods for calculating the emissions of transport in the Netherlands.* Statistics Netherlands Report.

Li, X., Lv, T., Zhan, J., Wang, S., & Pan, F. (2022). Carbon Emission Measurement of Urban Green Passenger Transport: A Case Study of Qingdao. *Sustainability*, *14*(15), 9588. https://doi.org/10.3390/su14159588

Majumdar, A., & Sinha, S. (2018). Analyzing the barriers of green textile supply chain management in South-east Asia using interpretive structural modeling. *Sustainable Production and Consumption*, *17*, 176-187. https://doi.org/10.1016/j.spc.2018.10.005

Manavalan, E., Thanigai M.A., & Kandasamy, J. (2021). Chapter 14 - Sustainable supply chain management in manufacturing industries, In K. Gupta & K. Salonitis (Eds.), *In Handbooks in Advanced Manufacturing, Sustainable Manufacturing,* (pp. 367-389). Elsevier.

Mock, P. (2016). *Policy options to reduce emissions from the road transport sector in Turkey*. IPM-Mercator Policy Brief, 1-13. https://ipc.sabanciuniv.edu/Content/Images/Document/policy-options-to-reduce-emissions-from-the-road-transport-sector-in-turkey-31c3c2/policy-options-to-reduce-emissions-from-the-road-transport-sector-in-turkey-31c3c2.pdf

Mubarak, A., & Zainal, F., (2018). Development of a framework for the calculation of co2 emissions in transport and logistics in southeast asia. *International Journal of Technology*, *9*(4), 787–796. https://doi.org/10.14716/ijtech.v9i4.1432

Müller-Dauppert, B. (2016). Production nearshoring in Europe and their consequences to the supply chain. *Gazdaság és Társadalom*, *8*(2), 5-25. https://doi.org/10.21637/GT.2016.2.01.

Saygılı, E., Saygılı, A. T., & Gören Yargı, S. (2019). An analysis of sustainability disclosures of textile and apparel companies in Turkey. *Textile and Apparel*, *29*(3), 189-196. https://doi.org/10.32710/tekstilvekonfeksiyon.471049

Standard EN 16258. (2012). *Methodology for calculation and declaration of energy consumption and greenhouse gas emissions of transport services*. German from Beuth Verlag. https://www.beuth.de/de

USEPA. (2018). *Fast facts on transportation greenhouse gas emissions.* https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions