



SZÉCHENYI ISTVÁN UNIVERSITY
AUDI HUNGARIA FACULTY OF VEHICLE
ENGINEERING

ASSESSMENT OF LOGISTICALLY PRODUCED CARBON
EMISSIONS PREVENTED BY INITIATIVES OF LOCAL
COMMUNITY

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A fentiekben részletezett adatokkal jellemezhető pályamunkám (dolgozat, alkotás, előadás) nevezését kérem a 37. OTDK-n való részvételre elfogadni. A 37. OTDK központi felhívásának ismeretében kijelentem, hogy pályamunkám önálló munka eredménye, saját szellemi termékem, abban a hivatkozások és idézések standard szabályait következetesen alkalmaztam, mások által írt részeket a megfelelő idézés nélkül nem használtam. A pályamunka összefoglalóját az OTDT online rendszerébe feltöltöttem, és hozzájárulok, hogy azokat (a rezüméket) az OTDT Titkársága és a szekciók rendezői nyilvánosságra hozzák. A közölt adatok a valóságnak megfelelnek, hitelesek. Hozzájárulok ahhoz, hogy az OTDT és a szekciót rendező intézmények az adataimat a 37. OTDK lebonyolításához és az eredményeinek fenntartásához felhasználják, anélkül, hogy beleegyezésem nélkül harmadik fél részére kiadnák. Hozzájárulok továbbá ahhoz, hogy az OTDK részvételemet és az elért eredményemet (1., 2. és 3. helyezés, különdíj), illetve a pályamunkát a szekciót rendező intézmény, illetve az Országos Tudományos Diákköri Tanács jelen nyilatkozatom visszavonásáig szerzőségem feltüntetetésével nyilvánosságra hozza.

Aláírások:

Lillia Snizhkovska

Abstract

This paper looks at a novel method of reducing greenhouse gas emissions through re-assessment of local communities' packaging and delivery systems at a time when concerns about environmental sustainability and combating of climate change intensify. The study acknowledges that these operations are a major source of greenhouse gas emissions and seeks to identify opportunities that may lead to considerable carbon footprint reduction through community initiatives

Over the past few decades, global trade and consumerism led to an exponential growth, with transportation and packaging activities being major sources of environmental pollution. As broader sustainability efforts, local communities begin evaluating their logistics and packaging practices. The objective of this paper is to provide insights into different facets of carbon footprint reduction initiatives such as social, economic, and environmental.

The research is directed towards several objectives such as comprehensive investigation of CO₂ emissions from conventional logistic procedures and packaging methods, listing of essential strategies applied by local communities and examination of impacts resulting from sustainability initiatives. The study offers a comprehensive knowledge on the advantages and challenges arising from community-driven carbon footprint reduction programs based on quantitative data analysis and qualitative assessments.

This paper emphasizes that it is impossible to confront global warming on a global scale without the active participation and engagement of local communities. The study focuses on the communities' efforts toward cutting down carbon emissions through creative means of logistics and packaging. The research will offer guidance and motivation to sustainability initiatives, at regional and global levels.

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Introduction

In an era marked by increasing environmental concerns and a pressing need to combat climate change, the reduction of carbon emissions has become a paramount objective for individuals, communities, and industries worldwide. Acknowledging the pivotal role played by logistical and packaging operations in carbon footprint generation, this scientific paper presents a comprehensive case study that explores a novel approach to mitigate carbon emissions. Specifically, we delve into the potential of local communities to significantly reduce their carbon footprint by reducing logistical and packaging practices.

The past few decades have witnessed exponential growth in global trade and consumerism, leading to a surge in transportation and packaging activities. These essential components of supply chains, often overlooked in discussions of carbon emissions, contribute substantially to greenhouse gas emissions and environmental degradation. Recognizing the need for sustainable alternatives, local communities have begun to reevaluate their logistical and packaging practices as an integral part of their broader sustainability efforts.

This paper seeks to shed light on the potential carbon footprint reductions achievable through community-led initiatives that focus on reducing logistical and packaging operations. By doing so, we aim to contribute valuable insights to the ongoing discourse surrounding carbon footprint reduction and sustainable practices at the grassroots level. Our case study not only examines the environmental implications of these initiatives but also considers the social and economic dimensions of community involvement in carbon emissions' reduction.

The objectives of this research are multifaceted, encompassing a detailed analysis of carbon emissions associated with conventional logistical and packaging processes, the identification of key strategies employed by local communities to minimize their carbon footprint, and an assessment of the environmental, economic, and social impacts of these sustainability efforts. Through a combination of quantitative data analysis and qualitative assessments, we aim to provide a holistic understanding of the potential benefits and challenges associated with community-driven carbon footprint reduction initiatives.

Ultimately, this paper serves as a testament to the importance of local community engagement in the global fight against climate change. By examining how these communities are actively contributing to the reduction of carbon emissions through innovative logistical and packaging solutions, we hope to inspire and inform future sustainability initiatives on both local

and global scales. In doing so, we take a step towards a more sustainable and environmentally conscious future.

The structure of the paper

This research paper adheres to a structured framework designed to comprehensively address the complex issue of carbon footprint reduction in packaging and logistics. The paper begins with an introduction, setting the stage by defining the problem and highlighting its significance. A thorough review of relevant literature follows, elucidating the packaging/logistics footprint theory and showcasing real-world examples of successful carbon footprint reduction initiatives. To provide clarity, key concepts such as the definition of 'locality' are expounded upon. The methodology section outlines our data collection efforts, including a unique insight into our study through the 'WhatsApp group story.' Subsequently, we present the data we gathered and delve into the intricate calculations, elucidating the carbon savings achieved by avoiding specific packaging and logistics processes. This is then extrapolated to broader levels, from the city to the EU, to underscore the potential impact of our findings. Finally, we draw conclusions, summarizing our key insights and offering guidance for future research and practical applications.

The relevance of the problem

The core problem addressed in this paper revolves around the urgent need to mitigate the environmental impact of packaging and logistics practices in the context of carbon emissions. The modern globalized economy heavily relies on these essential processes, which are vital for the efficient movement of goods across various scales, from local to international. However, this convenience comes at a significant environmental cost, as the production, transportation, and disposal of packaging materials, along with the logistical operations, contribute substantially to greenhouse gas emissions. The challenge at hand is to identify effective strategies and interventions that can substantially reduce the carbon footprint associated with packaging and logistics while maintaining their efficiency and functionality. As per our view, the steps for the solution of the problem can be taken by the local communities, bringing into practice a motto "Think Globally - Act Locally".

Addressing this problem is paramount for achieving sustainable and environmentally responsible supply chain practices, aligning with global efforts to combat climate change and reduce the carbon footprint of essential economic activities.

Carbon Footprint in Logistics: Understanding and Mitigating Emissions

Logistics is a multifaceted process that involves the utilization of various resources, making it inherently detrimental to nature and sustainability. As the global economy expands, so do global logistics and supply chains, resulting in increased resource consumption and environmental harm. Different aspects of logistics have distinct effects, which are measured using different metrics [3].

The term "carbon footprint" is a widely recognized concept in today's world, indicative of an individual's or organization's environmental impact in terms of greenhouse gas emissions. In the context of logistics, understanding and managing the carbon footprint is of paramount importance, as transportation and supply chain activities are significant contributors to global emissions.

The carbon footprint in logistics refers to the total amount of greenhouse gas (GHG) emissions generated by the movement of goods and people within the supply chain and transportation operations of a business. Since carbon dioxide (CO₂) is the most abundantly emitted and the most significant anthropogenic GHG (Greenhouse Gas) in terms of overall impact, the word "carbon" is frequently used as a shorthand for GHGs. Methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), nitrogen trifluoride (NF₃), and sulfur hexafluoride are also among the GHGs created by transportation activity. A single standard meter expressed as carbon dioxide equivalent (CO₂e) has been established globally to make it simple to quantify the various GHGs in an aggregated manner [2]. This accepted metric calculates a GHG's relative contribution to global warming using the equivalent CO₂ concentration.

Logistics-related activities encompass a wide range of processes, including the transportation of raw materials, manufacturing, distribution, warehousing, and last-mile delivery. Each of these steps in the supply chain contributes to the overall carbon footprint. Key factors that influence the carbon footprint in logistics include the mode of transportation (e.g., road, rail, air, sea), the distance traveled, fuel efficiency, and the energy sources used.

Logistics is a complex combination of processes that require usage of multiple resources therefore logistics is always a hazard to nature and sustainability. As the global economy grows,

global logistics and supply chains grow proportionally, using more and more resources, which is causing more and more harm to nature.

Different fields of logistics are causing different effects that are measured differently as well.

In the realm of calculating carbon emissions, diverse methodologies and frameworks have been developed to comprehensively assess and address environmental impact. This article delves into the intricacies of carbon footprint measurement, drawing extensively from two pivotal documents that serve as cornerstones in this field.

One crucial reference point is the Global Logistics Emissions Council (GLEC) Framework [22], a document that offers targeted recommendations specifically tailored to the complexities of freight transport. Aligned with the Greenhouse Gas (GHG) Protocol, the GLEC Framework provides a specialized lens through which emissions from the logistics and transportation sector can be accurately quantified and analyzed. This framework not only helps organizations within the freight industry to gauge their carbon footprint but also establishes a foundation for comparison and benchmarking on a global scale.

The GHG Protocol, the second influential document [23], stands as a beacon for standardized carbon accounting practices across various industries. This protocol, developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), has become the bedrock for measuring and managing greenhouse gas emissions worldwide. By outlining consistent and internationally recognized principles, the GHG Protocol ensures a harmonized approach to carbon accounting, fostering transparency and credibility in reporting.

Together, the GLEC Framework and the GHG Protocol contribute significantly to the evolution of methodologies for carbon emissions calculations. Their influence extends beyond individual organizations, shaping industry norms and facilitating a collective effort to mitigate the environmental impact of human activities. As we navigate the complex landscape of sustainability, these documents provide a robust foundation for understanding, quantifying, and addressing the carbon footprint associated with freight transport and various other sectors.

Supply chain

Estimating the exact carbon dioxide (CO₂) emissions from the supply chain can be complex and depends on various factors such as the industry, transportation modes, and production processes involved. However, studies and reports provide insights into the significant contribution of supply chains to overall greenhouse gas emissions. It's important to note that specific values can vary, and the numbers provided here are approximate.

According to a report by McKinsey titled "Reducing US Greenhouse Gas Emissions: How Much at What Cost?" from 2016, the supply chain is a major contributor to greenhouse gas emissions [16]. The study estimates that supply chain emissions, including indirect emissions from activities like transportation and production, account for around 40% of total emissions in the United States.

A report by the Carbon Trust suggests that supply chain emissions can be as much as four times higher than a company's direct operational emissions. The study emphasizes the importance of addressing emissions throughout the supply chain to achieve meaningful reductions in a company's overall carbon footprint [12].

The annual CDP Global Supply Chain Report provides insights into the environmental performance of supply chains worldwide. The 2020 report indicates that the supply chain emissions of the companies surveyed are, on average, over 11 times higher than their own operational emissions [13].

Transportation and Freight

Freight transport holds a pivotal position in the global supply chain, wielding significant influence over carbon emissions rates. The environmental impact of various modes of freight transport varies considerably, with air freight standing out as a major contributor to greenhouse gas emissions. To put this into perspective, air freight emissions surpass those of sea freight by over thirty times per kilometer and are nearly ten times higher than emissions from road freight.

According to data from the United States in 2017, the transportation sector accounted for 29% of total greenhouse gas emissions. This statistic underscores the importance of addressing emissions from transportation to achieve broader sustainability goals.

In a study by van den Berg and De Langen (2017) [11], it was highlighted that the transportation sector alone is responsible for a significant share of global carbon dioxide emissions, contributing to 25% of the total. The focus on freight transport is particularly noteworthy, as it accounts for a substantial portion of emissions within the broader transportation sector. Breaking down emissions within the freight transport sector, the study reveals that a notable 29.4% of emissions originate from trucks transporting goods. This finding underscores the need for targeted strategies to address emissions from freight transport, particularly those associated with trucking.

The issue of empty miles in trucking presents a significant challenge to the efficiency and environmental sustainability of freight transportation. In the United States, approximately 36% of heavy-duty trucks operate empty, a figure that is even higher in Asia. This phenomenon contributes to inefficiencies in the transportation industry, leading to increased fuel consumption, emissions, and overall operational costs [24].

Warehousing

Warehousing, a crucial component of the supply chain, plays a significant role in the carbon emissions landscape, second only to transportation. Despite its importance, the environmental impact of warehouses, especially concerning heating, cooling, lighting, and material handling, has often been understated in academic literature. Notable exceptions, such as studies by Dhooma and Baker (2012) and Fichtinger et al. (2015) [5], have shed light on this aspect. Material handling activities in logistics buildings, encompassing warehouses and sortation facilities, contribute substantially to overall supply chain emissions, accounting for a noteworthy 13% [20].

In the United Kingdom, warehouses are estimated to be responsible for approximately 10.2 million tonnes of CO₂ equivalent emissions [18]. Astonishingly, 1.5 million tonnes of these emissions could be mitigated through the implementation of simple changes, as highlighted by the UK Warehousing Association [18]. These findings underscore the untapped potential for reducing the carbon footprint of warehousing operations, making it a ripe area for environmental improvements.

The importance of addressing the carbon intensity of storage and handling operations is emphasized by scholars like Dekker et al. (2012) [4], who argue for a holistic assessment of full life cycle emissions of products and services. Warehouses, being integral to global supply chains,

necessitate a thorough consideration of their carbon impact for a comprehensive understanding of the environmental consequences of goods and services.

Packaging

The role of paperboard in packaging, comprising both primary and recycled fibers, along with printed cartons, has witnessed a substantial increase in European production capacity. In 2008, data collection on environmental factors indicated that paperboard represented 56% of the European production capacity. A subsequent data collection in the same domain in 2010 revealed a notable expansion, accounting for 64% of the European production capacity [25].

Specifically, the environmental impact of cartonboard production and conversion is quantified at 964 kg/tonne of fossil CO₂ equivalents emissions. This figure underscores the carbon footprint associated with the manufacturing and processing stages of cartonboard, highlighting the need for sustainable practices and innovations in the packaging industry.

The significance of this environmental impact becomes even more apparent when considering the broader context of the life cycle of products. Food packaging, for instance, constitutes an integral aspect of product life cycles, accounting for an average of 5% of the energy used in the entire life cycle of a product. This emphasizes the substantial contribution of packaging, particularly cartons, to the overall energy consumption and greenhouse gas emissions associated with consumer goods [25].

Examining the carbon footprints of various packaging materials further illuminates the environmental implications of packaging choices. Drawing from review papers such as Brogaard et al. (2014) [26], the carbon footprints of common packaging materials are outlined based on the material used:

- Cardboard & Paper: Approximately 0.94 kg of carbon emissions per 1 kg of packaging.
- Styrofoam: Roughly 1.16 kg of carbon emissions per 1 kg of packaging.
- Aluminum: About 2.32 kg of carbon emissions per 1 kg of packaging.
- Plastic: Approximately 3.50 kg of carbon emissions per 1 kg of packaging.

These figures provide a comparative insight into the environmental impact of different packaging materials, emphasizing the importance of sustainable choices in the design and production of packaging solutions.

In conclusion, the environmental footprint of cartonboard and packaging materials in general has significant implications for the overall sustainability of products. With the increasing production capacity and prevalence of paperboard in the European market, it becomes imperative for the packaging industry to adopt eco-friendly practices and materials to mitigate the environmental impact associated with packaging throughout its life cycle.

Packaging Tape

The environmental impact of packaging extends beyond the primary materials used, and even seemingly minor components, such as packaging tape, contribute significantly to the overall carbon footprint of shipments. According to a report from Vinted [19], the emissions associated with packaging tape per shipment were calculated at 8.2 grams of CO₂ equivalent, with 2.5 grams of tape being used on average. This figure represented 20% of the total packaging footprint for an average shipment.

However, it is crucial to note that these values come with a degree of uncertainty in the calculations. The emissions could potentially be higher, reaching up to 19 grams of CO₂ equivalent, especially if a larger amount of tape, around 5.71 grams, is used per shipment. In this scenario, packaging tape would constitute the majority of an average shipment's packaging footprint, accounting for a significant 58%.

This variability in emissions underscores the importance of precision in assessing the environmental impact of packaging components, as even seemingly small elements can have a substantial effect on the overall carbon footprint. The average expected packaging footprint per shipment, considering multiple products, was reported to be 40.90 grams of CO₂ equivalent.

To put these findings into context, it is essential to consider the broader landscape of sustainability in packaging. The emphasis on reducing carbon emissions and environmental impact has prompted increased scrutiny of every aspect of the supply chain, including packaging materials and associated components like tape.

Levels on which issue of pollution in logistics is solved

With the wealth of data collected above, it is evident that addressing the consequences of human activities within logistics is imperative. Solutions to these issues need to be identified and

implemented. Efforts to mitigate the environmental impact of logistics are being made on various societal levels.

On the international stage, the Paris Agreement of 2015 stands out as a significant step. In adherence to this accord, the European Union (EU) has committed to substantial reductions in emissions. The EU pledged to decrease emissions by at least 55% by 2030 compared to 1990 levels, submitting its long-term emission reduction strategy and updated climate plans by the end of 2020. This commitment is pivotal in driving robust decarbonization policies, especially in the transportation sector, which represents a major climate challenge for the EU.

At the national level, certain countries have adopted carbon taxation policies to curb CO₂ emissions. Notable examples include Denmark, Finland, Sweden, the Netherlands, and Norway, which were among the early adopters of a tax on CO₂ emissions. Research by Ghazouani et al. (2020) [7] demonstrates that carbon taxation can significantly impact reducing carbon emissions.

In the business realm, the logistics industry is actively engaged in reducing CO₂ emissions. One avenue pursued is the development of frameworks and methodologies for calculating emissions. Such tools enable businesses to measure their carbon footprint and formulate strategies for reduction.. Logistics service providers and freight owners are implementing diverse measures, such as optimizing transportation routes, employing fuel-efficient vehicles, and adopting sustainable practices in warehousing and distribution, all aimed at reducing CO₂ emissions [9].

An additional approach involves local initiatives that address global challenges at a community level. The adage "Think globally, act locally," coined by Patrick Geddes in 1915, resonates strongly among environmentalists. Activists, armed with a global perspective, design localized campaigns within their communities to address specific issues, such as plastic waste. Collaborating with local businesses, schools, and government bodies, these initiatives encompass activities like community cleanup events, educational and advocacy programs, and waste management initiatives. The multifaceted nature of these local efforts contributes to a holistic approach to addressing environmental concerns.

An example of "Think globally, act locally" that has been applied in Győr, Hungary lays in the focus of our research. A group, created by the international students of the Szechenyi Istvan University, functioning in the walls of the dormitory, has shown significance of the local initiatives that are provided by the enthusiastic citizens and in our view should be studied on how such projects can help reduce emissions produced by logistics.

Research

This study is based on the data taken from the WhatsApp Group called “Avoiding Waste”. The group was created on 17th of March 2021 aiming to avoid waste among international students living in the dormitory of the Szechenyi Istvan University.

The items have been shared among the group members for free. The mechanism through which items are shared within the group involves the uploading of photographs accompanied by concise annotations such as "for free" or "to give away," thereby signaling the availability of the item to all members. Concurrently, notifications indicating that a particular item has been claimed by a member are also commonly referred to the group. Communication regarding the claiming of items transpires either within personal messages or within the collective forum of the group.

It is noteworthy that the turnover of items within the group is subjectively rapid, with the interval between the posting of a photograph and the subsequent announcement of the item's claim averaging 3 minutes and 23 seconds.

At the time of writing this paper the group consists of 206 members. Considering that the number of international students living in the dormitory is varying in the range of 250-350 students, the percentage of international students participating in the activity of the group is between 58% to 80%. This number will be useful for the extrapolation of the analyzed CO₂ emissions not produced in the process of logistics activities to the bigger levels (dormitory-city-county-country).

The total amount of items that have been shared among is 660 items. For the convenience of the analysis all items have been divided into 12 groups: Cosmetics, Electronics, Shoes, Stationery, Bags, Home goods, Books, Sport, Clothes, Accessories, Kitchenware, Food.

A group of items that is a fifth of the total of items posted in the group (162 items) but is not included in the research analysis is a group called “Food”. The decision of not including the items in the research was made on the basis of the impossibility of estimating various values needed for packaging process and later for logistics processes. As the estimation of avoided logistical expenses is the goal of our paper, items in the category “Food” are not taken into consideration.

Therefore the analysis is done over 498 items.

Methodology

The properties of the items taken into considerations for calculations are as following: height (cm), width (cm), length (cm), volume (m^3), dominant material of the item, mass.

The dimensions of the items (height, width and length) were single-handedly estimated by comparing items to the one posted in the group to the similar products that are being sold by the e-commerce seller Amazon. Certain items were estimated visually as it was not possible to find a similar item on the internet. The dimensions are measured in centimeters.

The volume of each item is calculated by multiplying previously estimated height, width and length. The volume is measured in m^3 .

Items under category “Clothes” are calculated in a different approach due to the packaging specifications and due to the purpose of the research. The volume that is to be used in this research is not exactly the real volume of the item but its volume when packed and transported. Items under this category are usually folded when packed. For the sake of this analysis we have accepted, that these items will be folded in half therefore the height of the item when packed is calculated twice as big as its real height, when the length of item for packaging is calculated as twice as small.

The mass of items was estimated similarly to the estimation of the dimensions of the items. The mass of certain items was included in their packaging therefore it was used for the calculation.

The dominant material of the items was chosen based on the category of each item. The approximation was done as following:

Category	Material
Accessoiries	Plastic
Bag	Leather
Books	Paper
Clothes	Fabrics
Cosmetics	Plastic
Electronics	Plastic
Home goods	Plastic
Kitchen ware	Plastic
Shoes	Leather
Sport	Metal
Stationery	Plastic

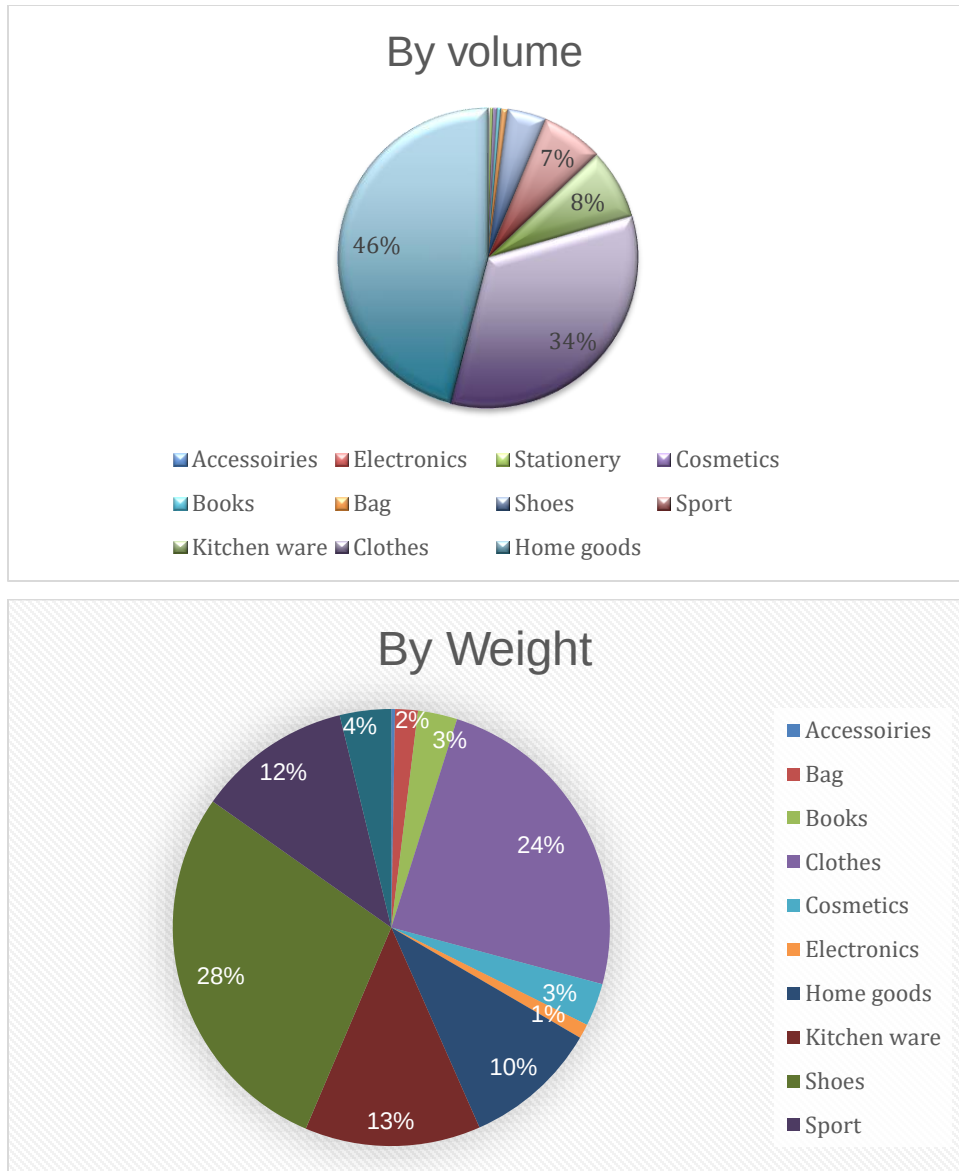
Along with the dominant material of items we have estimated the approximate density of the materials. The estimation is based on open data sources (density for plastic, fabrics and metal is an average of density of similar materials in its category).

Material	Density (gm/cm3)
Plastic	1.55
Leather	0.95
Paper	0.85
Fabrics	1.39
Metal	5.25

Analysis

The biggest group of items among analyzed items is group “Clothes” with the count of 208 items of 498 items. On the second place is group “Kitchen ware” with 76 items. The third group is “Cosmetics” with 60 items.





Corrugated paper cardboard emissions calculations

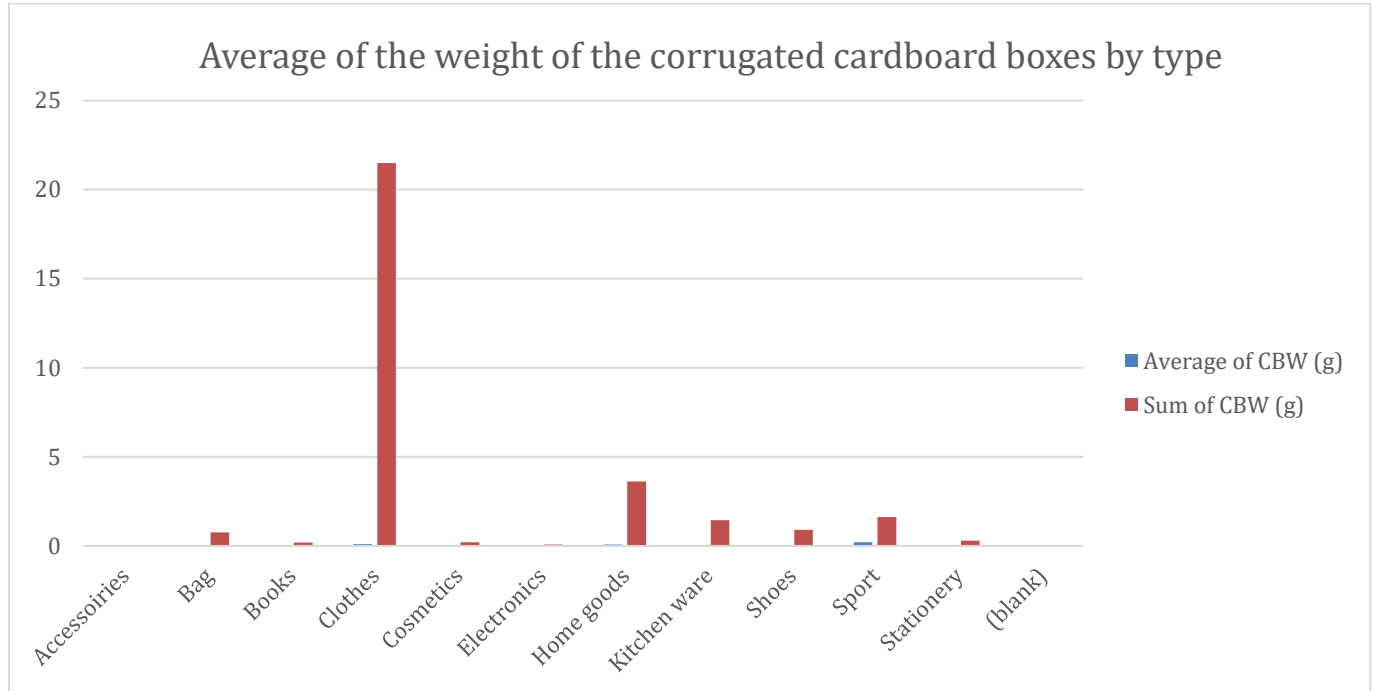
To calculate the weight of a corrugated cardboard box based on the dimensions (height, length, and width) of the item packed inside, we need to consider the thickness of the cardboard material used for the box. The weight of the box itself is the weight of the cardboard material per unit area multiplied by the surface area of the box.

Assuming a cardboard material density of 150 g/m², the surface area (SA) is computed as follows:

$$\text{Surface Area} = 2 \times (\text{Length} \times \text{Width} + \text{Length} \times \text{Height} + \text{Width} \times \text{Height})$$

The weight of the box (WB) can be expressed as:

$$\text{Weight of Box} = \text{Surface Area} \times \text{Weight per Unit Area}$$



Upon computation, the mean weight of the corrugated cardboard box is found to be 0.016 kg, with the highest value in the Sport category at 0.2 kg. Individual calculations for each item indicate a cumulative weight of 30.66 kg, assuming discrete packaging.

Considering a carbon footprint of approximately 0.94 kg of carbon emissions per kilogram of corrugated cardboard packaging, the estimated carbon emissions for the investigated items' packaging amount to 28.82 kg.

Transportation emissions calculations:

Local level

The majority of shipments made to city Győr is transferred from the logistics hubs in Budapest. We can model the situation by choosing a logistics hub in Budapest as a point of calculation of a distance between Budapest and Győr as a delivery point.

The calculation details are as follows:

Delivery point: Hungary, Győr, 9026, Egyetem tér 1.

Starting point: Budapest, DPD Pickup Csomágy, Városház u. 14, 1152 Hungary

Transportation method: Truck

Distance: 137 km.

Weight: $267\text{kg} + 30.66\text{kg} = 297.66\text{kg}$.

Calculated CO_2 for the given distance and weight - 3.9 kg.

Therefore we can state that 206 people have save approximately 3.9 kg of CO_2 that has not been emitted into the atmosphere on the transportation of the calculated goods.

Intercountry level

Most of items that are sold in Hungary are produced in Asia and then delivered to one of the main transport hubs in West Europe. These hubs are strategically located at the economic heart of Europe, which spans the conurbation of cities stretching from the Netherlands, Belgium, Western and Southern Germany down to Switzerland and Northern Italy. Antwerp tops the list, followed closely by Rotterdam, Brussels, Dusseldorf and Hamburg. Only after being processed in relatively big hub items are distributed to different points in other parts of Europe.

We can model the situation by choosing a logistics hub in West Europe to determine distance between it and Budapest as a delivery point and as a result we will be able to determine CO_2 emission for this part of the logistics process.

The calculation details are as follows:

Delivery point: Budapest, DPD Pickup Csomagpont, Városkapu u. 14, 1152 Hungary

Starting point: HUB010, Bijlstraat 2, 3087 AA Rotterdam, Netherlands

Transportation method: Truck

Distance: 1430 km

Weight: $267\text{kg} + 30.66\text{kg} = 297.66\text{kg}$.

Calculated CO_2 for the given distance and weight: 42 kg.

Due to the fact that the distance is over 600 km these items could also be delivered by combination of air transportation and road transportation. In this case the amount of emitted CO_2 will be equal to 1.3 kg of truck emissions and 583, kg of air emissions, in total 584,6 kg.

Intercontinental level:

Last leg that we can model is the leg between European logistics hub and the global goods manufacturer in Asia.

The calculation details are as follows:

Delivery point: HUB010, Bijlstraat 2, 3087 AA Rotterdam, Netherlands

Starting point: HW2F+M38 Shenzhen Airport Logistics Distribution Center, 北环南山立交南头 Nanshan, Shenzhen, Guangdong Province, China, 518051

Transportation method: Sea

Distance:

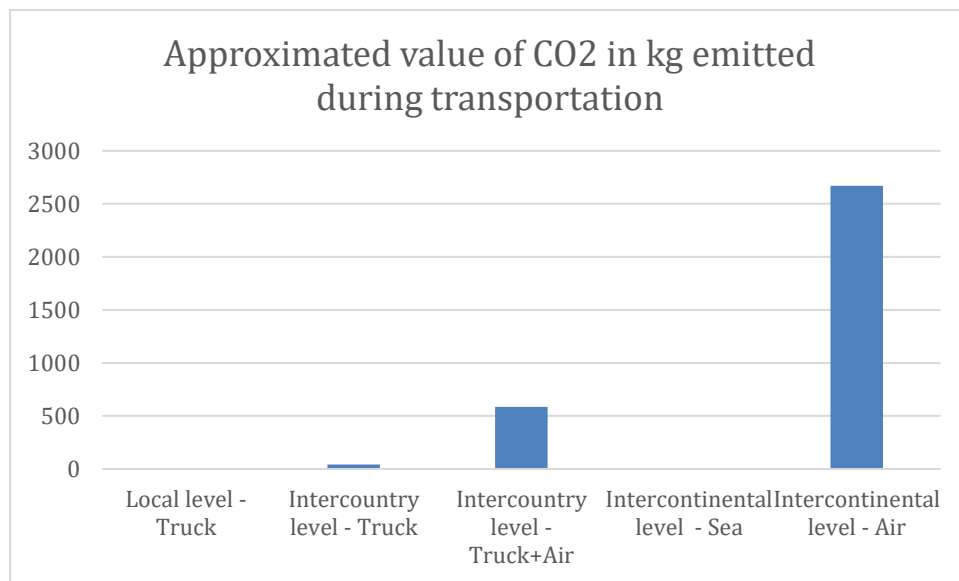
Weight: 267kg+30.66kg=297.66kg.

Calculated CO² for the given distance and weight: 5,12 kg

If this delivery is performed by air transportation then the calculated CO² for the given distance and weight is 2.67 t.

Therefore the total emissions are:

Level of delivery	CO2 in kg
Local level - Truck	3.9
Intercountry level - Truck	42
Intercountry level - Truck+Air	584.6
Intercontinental level - Sea	5.12
Intercontinental level - Air	2670



We can see four different ways of delivery on the three levels and therefore we can calculate 4 different emission amounts.

1. Local level – Truck + Intercountry level – Truck + Intercontinental level - Sea = $3.9 + 42 + 5.12 = 51.02$ kg
2. Local level – Truck + Intercountry level – Truck + Intercontinental level – Air = $3.9 + 42 + 2670 = 2715.9$ kg
3. Local level – Truck + Intercountry level - Truck+Air + Intercontinental level - Sea = $3.9 + 584.6 + 5.12 = 593.62$ kg
4. Local level – Truck + Intercountry level - Truck+Air + Intercontinental level – Air = $3.9 + 584.6 + 2670 = 3258.5$ kg

The last transportation combination is the most damaging to the environment due to the emission amount. Therefore the local initiative helped to save CO₂ emissions from 51.02 kg to 3258.5 kg (in average 1654.76 kg). It can be called effective as only the minimal effort of 200 people helped to save the CO₂ the equivalent of the CO₂ emissions generated by one person in a year in some countries (Guardian).

We performing these simple we have found the impact made by the local initiative where only 200 people take part in. We can as well estimate the analogue impact made by the coefficient population of chosen areas (for the CO₂ calculation we will use average value of 1654.76 kg divided by three as the value was calculated on the three years data):

- Gyor – population ~ 130,000 people $\rightarrow (130.000 * 1654.76/3) / 200 = 358.531$ kg
- Budapest - population ~ 1,778,052 people $\rightarrow (1,778,052 * 1654.76/3) / 200 = 4,903,748$ kg
- Vienna - population ~ 1,691,468 people $\rightarrow (1,691,468 * 1654.76/3) / 200 = 4,664,955$ kg

The population number was used on the basis of the World Population Review Database [27].

Even a half of this estimations if they were made into reality would made a big difference to the global emissions strategies. Moreover, as we have estimated the saved emissions of only logistics processes, we cannot assume the amount of the saved emissions due to not produced items and as well of the emissions that could be cause by their utilization and decomposition.

Guidance

- Promote following initiative withing dormitories, offices, blocks of flats with high density of dwellers.
- Include marketing tactics for popularization of similar initiatives.
- Create a digital application that could promote sustainable consumption.
- On the academic level – search for new ways of possible simple solutions of the global emissions issues and calculating their contribution.

Conclusion

This comprehensive assessment underscores the environmental impact associated with the entire lifecycle of goods, from packaging to transportation across various geographical scales. As the world grapples with the challenges of sustainability, such analyses become instrumental in identifying areas for improvement and guiding efforts toward more eco-friendly practices in the logistics and consumption of goods.

Studies processed in the literature review suggest that supply chain emissions, including indirect activities, make up approximately 40% of total emissions. Freight transport, particularly air freight, stands out as a major contributor, surpassing sea and road freight emissions by significant margins. Warehousing, often underestimated, follows transportation as a key emitter, with material handling activities alone contributing 13% to overall supply chain emissions. Additionally, the production and use of packaging materials, including tape, further amplify the carbon footprint, highlighting the need for comprehensive strategies to address emissions across diverse logistics processes for long-term sustainability.

The study of the "Avoiding Waste" WhatsApp group, focusing on international students, revealed significant environmental benefits. Analyzing 498 items exchanged within the group, an estimated 28.82 kg of carbon emissions were saved through shared corrugated cardboard packaging.

Transportation emissions were examined at local, intercountry, and intercontinental levels. Local transport from Budapest to Gyor saved approximately 3.9 kg of CO₂. Intercountry transport from Rotterdam to Budapest resulted in 42 kg of emissions, while a combination of air and road transport emitted 584.6 kg. Intercontinental sea transport from Rotterdam to Shenzhen produced 5.12 kg of emissions, while air transport for the same route yielded 2.67 t.

In conclusion it could be said, the "Avoiding Waste" initiative not only promotes sustainability but also significantly reduces carbon emissions in packaging and transportation. This study offers valuable insights for understanding the global environmental impact of community-driven waste reduction efforts.

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