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SUSTAINABLE FOOD PACKAGING IMPACT TO THE REDUCTION OF TRANSPORT COSTS

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Abstract
People dealt with many new issues related to sustainable development goals. Different decisions oriented to sustainable food packing would be very useful, if they could bring significant effect through the reduction of CO2 emission. The paper focuses on sustainable food packing and its effect on reduction of freight transportation costs. This topic has many research gaps and requires theoretical and practical investigations. Integration of sustainability into long term process has clear implications for the environment. Meherishi et al. (2019) highlight that the process of creating sustainable packaging guarantees the optimal use of materials and energy and is efficiently regenerated without wasting of natural resources. The impact of food packaging on transportation is clear and depends on a number of factors, which are shaped by the characteristics of the food packaging. In addition, among benefits of sustainable food packaging are such main functions as product safety and its identification. Modern complex solutions covering sustainable packing and transport costs reduction are important for increasing environmental sustainability. The study aims to analyze the impact of packaging on the reduction of transport costs. The aim was reached by performing sustainable food packaging and its impact on the reduction of transport costs theoretical justification and by conducting biometric analysis. The overview of the literature of sustainable food packaging and its impact on the supply chain was conducted, and it was found that the food packaging described different types of packaging and new packaging technologies which have an impact on the supply chain and are determined by some factors related to the characteristics of food packaging and the nature of the supply chain. Equally the overview of literature on the transport of food dynamics and the role of transport costs reduction on sustainability was also conducted. It was found that there is a need to develop new technologies and methods for food management and CO2 emissions for longer transport routes reduction. Either the research was conducted by biometric analysis for 2022-2023 to identify current trends, and it was found that the number of analyzed articles, included four clusters, which show that topics are oriented to delivery, flow, algorithms, structure, and role. The bibliometry analysis results show that product packing has links with transport and delivery and algorithms. The authors provided investigations under the topic as it requires knowledge to fill the existing gaps.
KEY WORDS: sustainability, food, packaging, transport, cost, supply chain
JEL: Q01

Introduction

As global carbon emissions have reached their highest levels in years, manufacturers and retailers are increasingly aware of the need to provide more sustainable food. According to a 2019 report by the Intergovernmental Panel on Climate Change (IPCC), the transport-related carbon footprint can range from a few percent to more than half of the total carbon footprint associated with the production, distribution and storage of food. Together, transport containers, pallets, trailers, refrigerators, warehouses and other essential components of freight transport cause these greenhouse gas emissions. Larger companies are now moving towards a carbon footprint and trying to take a greener approach to supply chain management.

For most businesses, a sustainable food supply in the supply chain basically means reducing fuel consumption by optimizing existing transport networks. This is achieved by reducing the air in the packed product that is ready to be transported - by reducing the packing of the food products we could transport more products at the same time.

In the paper authors analyze the theoretical links starting from sustainable packing and food packing impact and finalizing by the role of transport costs reduction and transport congestions. The paper consists of several parts. First, the authors highlight the importance of sustainability in the freight transportation process. Second, the authors present sustainable food packing aspects. Third, the authors describe food packaging impact on supply chain. Fourth, there is the presentation of transport of food dynamics. Fifth, the role of transport costs reduction on sustainability as a guiding principle is demonstrated. Sixth, as the main effect is the reduction of road congestion, which is presented in the pre-last section. Finally, the authors provide concluding remarks.

The aim is to perform a analysis of the impact of packaging on the reduction of transport costs.

The main objectives are:

1. To perform a theoretical justification of sustainable food packaging and its impact on reducing transport costs.
2. Conduct a biometric analysis that examines articles focused on analyzing the relationship between food transportation and costs.

Theoretical background

Sustainability importance in processes

Environmental problems such as excessive consumption of land resources, air, water, and soil pollution, and loss of biodiversity are progressively threatening the Earth's systems of life-support. This situation calls for urgent decisions on the transition to sustainable systems in different areas (Geissdoerfer et al., 2017). To address these and other sustainability challenges, the circular economy concept, which entirely is not new, has recently been gaining prominence on the agendas of policymakers (Nikolaou et. al., 2021). Over the last ten years, the circular economy (CE) has not only become a meaningful area of research, but business has also started to realise its value potential and promise (Benachio et al., 2020).

The CE is thus seen as a sustainable economic system in which economic increment is disconnected from the use of resource by reducing and returning natural resources (Schöggl et al., 2020). D'Amato et al. (2017) affermed that the CE concept, based on the ideas of industrial ecology (Belaud et al., 2019; Corvellec et al., 2022; Bruel et al., 2019) and industrial metabolism, does not have any environmental impact, unlike the linear economy. They stressed the achievement of the objective through the redesign of the 'product' life cycle (Peña et al., 2021; Dahiya et al., 2020) and supply chains, minimising costs and reducing waste in the system. The main idea is to turn the by-product of an industry into a resource for another industry, with a focus on cooperation and dynamics between sectors. A sustainable circular economy seeks to achieve economic prosperity by conserving nature and resources and reducing environmental impacts (Nikolaou et al., 2021). It can also stimulate innovation and the creation of new business opportunities, contributing to sustainable and long-term economic development (Schöggl et al., 2020).

Sustainability - when people responsibly meet their current needs without harming and leaving the possibilities for future generations to explore ways to meet their needs too (dos Santos et al., 2022). This means that we need to take care of the planet's ecosystems, resource use and social well-being in a way that is consistent with the planet's capacities and capabilities, rather than simply a short-term depletion of a resource or degradation of the environment (Ramirez-Corredores et al., 2023; Hoosain et al., 2023). It is a long-term approach that seeks to balance economic, social and environmental considerations to ensure that current activities do not harm future generations and the planet (Hristov et al., 2019).

Sustainability is based on three key areas, as shown in Table 1.

Table 1. Key areas in sustainability

Principles	Description	References
Environmental protection	This includes protecting natural ecosystems, reducing pollution, preserving biodiversity, and conserving the planet's natural resources.	Ramirez-Corredores et al, 2023; Hoosain et al, 2023; Hristov et al, 2019; Velenturf & Purnell, 2021
Social justice	This aims to ensure that all people have access to decent living conditions such as clean water, clean air, adequate food, education, and healthcare. This includes promoting equality, reducing poverty, and reducing inequalities in society.	Hristov et al, 2019; Bennett et al, 2019; Jaeger-Erben et al, 2021
Economy	A sustainable economy aims to use resources efficiently, so that they will be available in the future. In a sustainable economy, companies must also consider the social and environmental impacts of their activities.	Stumpf at al, 2021; dos Santos et al, 2022; Hoosain et al, 2023; Hristov et al, 2019; Jaeger-Erben et al, 2021; Upadhyay et al., 2018

Source: compiled by the authors

Integrating sustainability into long term processes has clear implications for areas such as the environment, the economy and social justice. In today's world, stakeholder relations are increasingly defined as a circularity based on sustainability (Ruggerio, 2021). Due to the global increase in pollution and resource consumption (Brusseau, 2019), environmental protection requires the attention of both government and business, which has increased the need to adopt sustainable environmental practices. One of the essential principles of sustainability is sustainability in environment, which is based on the aim of meeting humanity's needs in a way that respects the environment and its quality, and on maintaining the ecosystem for the benefit of future generations (Daly, 2017). To increase the value of an organization, it is useful to integrate the principle of environmental sustainability into its activities, which would also increase the value of digitisation (Brusseau, 2019; Patlins, 2017).

Thus, sustainable environmental practices are linked to the principle of social justice, which seeks to ensure that all people have decent living conditions, and to the principle of a sustainable economy, where the aim is to use resources efficiently so that they remain for future generations, as well as the adoption of digital technologies and the creation of digital jobs (Harrington, 2016).

A sustainable circular economy is an economic system model that seeks to exploit and optimize natural resources to reduce waste, minimise environmental pollution, and increase long-term economic efficiency (Velenturf & Purnell, 2021). This model differs from the traditional linear economy, where the production process is resource-intensive and waste-intensive.

Sustainable food packaging

Packaging ensures the movement of a product from the point of primary to the point of destination or consumption, with a direct or indirect impact on all industries (Meherishi et al., 2019). An international consortium, the Sustainable Packaging Coalition, identifies the attributes that characterise sustainable packaging. Throughout its life cycle, sustainable packaging is: safe, healthy, and useful, manufactured, recycled from renewable or recycled materials, using clean production technologies, transported using renewable energy. The process of creating sustainable packaging is

based on the optimal use of materials and energy and is efficiently regenerated in both biological and industrial cycles (Meherishi et al., 2019).

Food packaging is directly linked to consumption. Food packaging materials such as plastics, paper, glass, wood, aluminium, steel, and composites pollute the land, air, and water and have negative environmental consequences (Velenturf & Purnell, 2021). This is because food packaging is not always properly sorted after consumption and is discarded as rubbish, and there is a lack of appropriate waste disposal methods (Tassinari et al., 2023). It is therefore important to assess the sustainability of packaging not only in terms of biodegradability, but also to include all the resources that go into the creation of the packaging, such as whether the packaging material is suitable for re-packaging, the energy used in the production of the packaging, the distance over which the packaging will be transported, the way the packaging is stored and the weight of the packaging. Research has shown that food packaging accounts for more than 66% of all packaging in circulation in more economically developed countries (Gallucci et al., 2021). Meanwhile, land, water, and air pollution have been identified as the most significant negative environmental impacts caused by packaging.

The greatest damage to the environment is caused by plastic, which in the European Union alone consumes 50 million tonnes of plastic every year, of which only about 50 percent is collected, and only 30 percent of the collected quantity is properly processed (Fadare et al., 2020). The remaining 70 percent of the waste goes to landfills at best. In the worst case, the waste is thrown directly into the streets, into the water, but where, which leads to pollution. In order to reduce pollution, the European Union, in line with the new Circular Economy Action Plan of the Green Deal, has planned to increase the recycling of litter in the Member States to 10 million tonnes by 2025.

The role of food packaging is being developed in light of changing market conditions. The authors have examined and described different types of packaging and new packaging technologies that would ensure the desire of consumers to receive high-quality, healthy, and safe food products, as far as possible with extended service life.

Table 2. Types of food packaging

Type of food packaging	Description	References
Active packaging	The technologies for packaging deliberately include components which release or absorb substances into or from packaged food or into or from the environment which surrounds food. In this way, the shelf life of packaged food is extended, and its condition is maintained or improved.	Yildirim et al., 2018; Wyrwa & Barska, 2017; Fang et al., 2017; Sharma et al., 2021; Majid, et al., 2018; Qin et al., 2020
Intelligent/ smart packaging	It is a new technology designed to facilitate better food quality and safety, using the communication function of the packaging for this purpose	Fang et al., 2017; Qin et al., 2020; Chen et al., 2020; Müller & Schmid, 2019; Kalpana et al., 2019; Poyatos-Racionero et al., 2018; Drago et al., 2020; Cheng et al., 2022
Bioactive packaging	With a conceptual approach to the development of functional foods, bioactive packaging technology is being developed, where the food packaging or coating plays a unique role in enhancing the health impact of the food on the consumer.	Jafarzadeh et al., 2020; Torres-Giner et al., 2017; Roy & Rhim, 2020; Primožič et al., 2021
Packaging with nanotechnologies	Nanotechnology in packaging provides environmentally friendly coatings that increase the likelihood of improving food quality, safety, stability, and efficiency in hermetic systems.	Sharma et al., 2017; Nile et al., 2020; Mustafa & Andreescu, 2020; Primožič et al., 2021
Nanocomposites packages	Nanocomposites are fillers with at least one dimension the size of a nanoparticle, with a surface area proportionally larger than that of microparticles, which improves filler-matrix interaction and material properties.	Sharma et al., 2017; Nile et al., 2020; Mustafa & Andreescu, 2020; Primožič et al., 2021
High chemical barrier packaging	High barrier packaging is used to maintain the quality of food products by preventing the passage of oxygen, water vapour, pressurised vapour or liquid molecules, reducing adsorption, desorption and diffusion of gases and liquids.	Brody et al, 2008; Han, 2014; Majid, et al., 2018; Sangronizet al., 2019

Source: compiled by the authors

Table 2 dissects the types of food packaging and briefly describes their application and effects. As a whole, the types of food packaging presented in Table 2 are designed to meet the needs of a changing market and consumers, which are mainly focused on the consumer's desire to receive high-quality, healthy and useful foods and the reduction of the negative impact of food packaging on the environment.

The transition to sustainable food packaging solutions involves all actors in the food chain - regulators, producers, traders, suppliers and consumers. Jurconi et al., (2022) investigated consumers' attitudes towards sustainable food packaging and found that 81% of the study respondents were in favour of the benefits of using sustainable packaging as it is important for them to live in a less polluted environment, and also highlighted the importance of timely information on sustainable product packaging on the market.

Food packaging impact on the supply chain

Changes in global product supply chains and the lengthening of these chains, are also affecting the packaging layers, with corresponding changes in the amounts of directly associated waste throughout the supply chain (Awad et al., 2021). It is clear that packaging presents challenges and opportunities for both the environment and society, touching on economic, environmental, and social issues and influencing supply chain costs (Meherishi et al., 2019; Ramirez-Corredores et al., 2023; Nikolaou et al., 2021). Packaging is a broader concept than cardboard or box, and it is a whole system that allows you to store, handle, transport, and sell goods safely, efficiently, economically throughout the supply chain (Jaeger-Erben et al., 2021).

The impact of food packaging on the supply chain is clear and depends on a number of factors, which are shaped by the characteristics of the food and its packaging and the specificities of the supply chain (Stumpf et al., 2021). As regards the benefits of food packaging, the main functions such as food safety, product identification, logistics and transport, environmental impact, and social implications are identified.

For example, different packaging materials, such as plastic, cardboard, glass or metal (Fadare et al, 2020; Gallucci et al., 2021), have different advantages and disadvantages in the supply chain and therefore have different environmental and economic impacts on the supply chain. Food packaging helps to maintain the safety of products and protects them from physical vulnerability, exposure to weather and microbes. Chen et al., 2020 investigated the rationale and technological application of innovative smart packaging solutions and found that they improve product traceability, reduce food waste and losses, and impact the quality and safety of the food supply. Another important factor is the good quality of food packaging, which helps to maintain product quality for longer, reduce waste and increase product longevity. Majid et al. (2018) wrote that good quality smart packaging is directly linked to product quality and longevity. Product identification ensures the successful movement of the product through the supply chain, as the packaging contains all relevant information about the product: package stamps, brand names, composition, expiry date, and bar codes, which speed up the search for the product for suppliers and consumers, enable them to select the right product, and allow for transport, storage, and tracking. Transport efficiency and safety depend on the food packaging's weight, shape, size and composition. In the supply chain, it is important to design packaging systems appropriately in order to reduce product loss, logistics costs, and environmental impact (Guo et al., 2017).

When assessing the benefits of food packaging for the supply chain, it is also important to consider the negative environmental impacts associated with issues that have become global, such as plastic packaging pollution, increasing waste, and energy use. In many countries, especially in the developed economies, there is a high level of consumerism, which leads to large volumes of food packaging, with consequent increases in waste management costs and challenges in ensuring proper recycling (Rong et al., 2011). As not all waste is properly collected and recycled, plastic or single-use packaging alone is a serious environmental challenge as it is a long-lived waste product, and therefore a shift towards sustainable and environmentally friendly packaging would be an important aspect of the supply chain, which is important to be achieved through the application of green technologies and renewable energy sources that reduce energy costs in production, storage, transport, waste disposal processes (Awad et al., 2021).

Transport of food dynamics

As increasing demand for ecologic food, it is necessary to consider the current approach to the food transport chain. According to global population growth trends it is estimated that the number of the Earth's population will reach 9.8 billion people in 2050 (United Nations, 2015). Life expectancy in Europe will reach 82 years by 2050 (Conrad et al., 2015). This trend is due to the growing demand for food. However, raising awareness of healthy lifestyles in the current food supply chain processes is not effective. A healthier lifestyle has affected the short-term demand for organic food. The supply chain for organic food is long, and the traditional retail channel is not suitable for organic production. Therefore, in order to obtain better package feeding, it is necessary to reduce the preparation time. Another sales channel, in this case, is last-mile delivery. More and more people are shopping online, and this growth has speed up. Euromonitor International's report shows that the actual growth of global retail, including online food retail, is $1.4 trillion between 2020 and 2025 (Euromonitor, 2021). New strategic approaches to the transition of the food sector from physical retail to online need to be developed (Gružauskas et al., 2022).

Changes in online food retail trends require small volumes to be delivered at multiple delivery points, negatively impacting sustainability. The distribution of goods in cities and passenger transport are the essential sources of consumption of energy, air pollution, and noise (Faccio et al., 2015). The development of online food retail in the world's 100 largest cities will grow by 36% by 2030, without affecting the number of trucks (World Economic Forum, 2020). Fossil fuels are estimated to have caused disproportionate greenhouse gas emissions between 2005 and 2018, resulting in global CO2 emissions from transport of 1.2 billion tones (Euromonitor, 2019).

Transport-related emissions are expected to increase by 32% and congestion by more than 21%, meaning that all commuters will go to work every day (World Economic Forum, 2020). Increasing urbanization poses a number of problems for urban areas. Urbanization is growing rapidly: about 70 percent of the inhabitant of the Earth lives in cities, comparing to 49 percent today (United Nations, 2014). This leads to an increasingly negative impact of congestion on the environment. These problems put pressure on companies to adopt environmentally friendly vehicles, but they require more resources to purchasing and maintain these vehicles. Nevertheless, last-mile transportation is the least efficient supply chain part and is expected to account for 28% of total shipping costs (Euromonitor, 2019). There exist a balance between aspects economics and environmental, but social aspects must also be taken into account. Traffic congestion not only increases CO2 emissions but also reduces food package (Jouzdani et al., 2021; Chen et al., 2021). Therefore, in a growing energy supply market, sustainability cannot be achieved through current supply chain management.

The European Union attaches great importance to the SDGs, but it lacks the technological or regulatory mechanisms to achieve them. In 2021, the European Union launched an urban mobility program that aims to reduce pollution from transport by digitising public transport and promoting car-sharing. Rapidly evolving sustainable solutions, that optimize vehicle flows and infrastructure use, and encourage the avoidance of empty and unnecessary journeys are linked to better multimodal transport networks, dynamic routes and distribution

patterns (European Comission, 2021). The European Union adapts United Nations Goals and Key Targets for Sustainable Development for 2030. One of the goals is, among other things, to improve road safety and urban pollution (Humphreys 2017).

The new strategy addressing these issues, called the Green Deal, aimed to reducing emissions of net greenhouse gas by at the least 55% by 2030 (European sustainable development network, 2019). Even according to a report by the European Policy Centre, by 2020 the EU had not achieved almost all the SDGs, including the targets for saving energy, biodiversity, air, water, soil and chemical pollution (E. policy Centre, 2021). It is therefore indispensable to develop new technical and electronic energy management methods in order that achieve sustainable development.

The documents show the need to develop autonomous vehicles and adaptive algorithms for the electronic food industry. As transportation companies work to reduce costs, increase operating capacity, and reduce driver shortages, demand for research is expected to continue to grow. According to DHL, the target is to reduce shipping costs per kilometer by 40%, some of which can be done for shipping customers (E. international Passport, 2021). In the field of logistics analysis, there is a growing interest in optimization of loading volume on trucks.

Several academic studies have shown the need to develop new technologies and methods for electronic food management. Authors conducted an in-depth literature review of refrigeration chains, citing 40 publications with similar evidence on food package, shelf life, or comfort (Awad et al., 2021; Paciarotti et al., 2021). The review revealed a number of flaws in the study. First, the analysis concluded that sound route designs and vehicle models that take into account product package and environmental impact will remain an open area of research. Second, the researchers disagreed with the lesions models used to apply the cold foods freshness.

Therefore, it is necessary to study important variables and qualitative models. Thirdly, the complexity of the problem requires the development of heuristic and metaheuristic methods to solve such patterns (Awad et al., 2021). The authors found that published publications and found that researchers did not pay much attention to time-related issues. The need depends on the time it takes to consider a broader understanding of how to solve the transport problems (Koç et al., 2020). These strategies should therefore include sustainable development and the SDGs.

The role of transport costs reduction on sustainability as a guiding principle

Several White Papers provide answers to frequently asked questions about vehicle loading planning (Tan et al., 2021; Awad et al., 2021; Vidal et al., 2020; Koç et al., 2020; Guo et al., 2017; Malladi et al., 2018; Gunawan et al., 2021). Driving algorithms often draws attention on distance or the shortest possible time of delivery, but the food industry needs to take into account the package of food. Sovald and Stirn (2008) understood the problem of vehicle mobility against the background of package of products, their research was applyed on time-dependent optimization and integrated the cost of transport into the target function (Osvald, 2008).

Another study, Rong et al. (2011) described how to increase efficiency in supply chain processes from manufacturing to retail and tangibly contribute to measuring food packaging failure due to product flow and volume (Rong, 2011). A current study investigated the impact of reduced food package on urban transport, focusing on warehouse management methods and delivery times (Fikar, 2018; Waitz, 2018). One of the research projects of this method was carried out Portuguese restaurants (2015). Instead of cargo, the focus is on the availability of sea bananas (Haass et al., 2021). Their method measures the initial package of food and determines the route adjustment and optimization. Fikar and Braeker (2022) developed a two-pronged approach to optimizing food transportation to identify compromise solutions between distance and food package deterioration (Fikar et al., 2022).

According to the publication, the general direction and collection shorten the distance to the store, but necessary in certain cases to extend the distance and combine several products if there are no refrigeration units in the store. They also point out that larger fleets and direct shipments can further reduce food losses. In the above articles, the simulations checked the package of food but did not take into account excessive loads.

CO2 emissions was revied in other motorway-related studies. In view of the increasing direct supply of organic food to final consumers, CO2 emissions from longer transport routes are also problematic, and new modes of transport need to be developed (Nabot et al., 2016). Authors analyzed retail channels and concluded that the overuse of cars of the last displacement significantly increases overall carbon emissions (Seebauer et al., 2016). Authors found that consumers on average, reduced the carbon footprint of their shipments by 84 % as a result of the transition from full truck delivery to last mile delivery (Carling et al., 2015). Naboth et al. (2016), who performed a comparative analysis on interactive food retail, show that on-line food retail is very important in reducing CO2 emissions in the last kilometer of stocks, and recommend investing in more efficient transport processes. Kellner (2016) analyzes the impact of congestion on CO2 emissions, but omits its impact on food package. Authors developed algorithms for planning pollution processes for last-mile deliveries to reduce environmental impact (Tan et al., 2019).

Another study of Velazquez-Martinez et al. (2016) shows that when optimizing the CO2 route, consider the height, weight, and efficiency of the truck. It is therefore important to take into account not only the package of food, but also environmental impacts, such as CO2 emissions.

The reduction of road congestion

Sustainable development goal SDG 11 promotes safety in cities and road congestion reduction. Reduction of the size of food package could help to achieve that. By now, most of researchers focus on reduction of traffic congestions methods and believe that traffic congestion is less problematic than on motorways, but even small

bottlenecks in transport and transport systems can play an important role in reducing efficiency (Calvert et al., 2018). The study focused on increasing traffic congestion, some of which focused on controlling traffic flows rather than delivering products (Jabbarpour et al., 2018; Isa et al., 2015). Authors conducted a study on computational methods for detecting blockages, and one of the most important observations was the assertion that tools need to be developed to evaluate and evaluate real cases (Jabbarpour et al., 2018). His research focuses more on the overall diagnosis of stenosis. Authors analyzed blockchain and proposed a method to generate a flow data block that allows analyzing relationships with space and time (Xu et al., 2013).

Tang et al. (2018) analyzed congestion in terms of strength and proposed a method for measuring node tolerances. The latest research not only analyzes historical or current traffic conditions, but also tries to assess future trends. Authors proposed neural networks to predict the flow of traffic (Peng, 2020). Traffic and congestion assessment or analysis can provide driving information, but this information needs to be integrated into the driving process to improve decision-making (Gružauskas et al., 2021).

Very little research focuses on traffic congestion in traffic problems. For example, Xiao et al. (2016) recommend managing green actions in case of traffic jams (Xiao et al., 2016). Authors proposed self-adaptive algorithms for traffic congestion management (Sabar et al., 2018). Authors proposed methods to support deep learning in overload-related vehicle navigation (Koh et al., 2020). Nguyen et al. (2021) proposed a green algorithm to optimize route planning based on floating intelligence. However, the calculation of congestion in online stores is less analyzed. Authors proposed a method to optimize cold chain transportation routes in front warehouse in terms of congestion (Chen et al., 2021). Jouzdani et al. (2021) analyzed the food chain in terms of sensitivity in light of traffic congestion. Their analysis shows that congestion affects all aspects of sustainability, not just social ones. Therefore, it is necessary to develop doctoral algorithms, taking into account the density of turnover, the package of food and the impact on the environment.

The practical application of disaster recovery algorithms can be carried out using tokens. Studies have been carried out on autonomous vehicles, taking into account the risk of congestion. Authors analyzed the problem of load balancing and balancing and developed a routing algorithm that shows good network load and customer service performance (Rossi et al., 2018). Boson (2020) conducted a comprehensive review of last-mile transit documents. One of the main consequences is that from a management point of view, it is important to develop last-mile logistics and optimization methods, as well as real-time data, disaster recovery algorithms, fleet management and management algorithms (Bosona, 2020). Author argues that it is important to consider storage for foreign transportation, not just methods of distribution and automation of warehouses (Zennaro et al., 2022). Authors documented the use of the Internet of Things in intelligent traffic and highlighted that this technology is essential for real-time planning and deployment (Ding et al., 2021). Shladover (2018) explores connected and automated vehicle systems that are essential for urban transportation, where real-time decision-making can be overwhelming. Authors modeled micromaterials and liquids on food routes, their research showed that this method reduced distance by 15% and weight by 22% (Aktas et al., 2021).

Table 3. Template for designing the transport of food with reduces package size

Method	Evaluation
Goal function	Size of food package, size of vehicle and its fleet, loading composition, stability, height of freight, etc.
Optimization	Considering all aspects of the packing and loading problem. Mathematical optimization method consider actual package dimensions and multiple physical, legal and business-specific rules.

Source: compiled by the authors

Table 3 presented above provides a documented overview of food transport and traffic congestion reduction patterns. Most simulations involve distribution centers and a special type of supply chain network that can represent the home. Some studies take into account not only the birth of the last mile, but also the processing steps. The deadline set for orders usually has a random demand pattern for food delivery. Almost all simulations limit truck, warehouse or production capacity. But only a small part of the models are ecologically dynamic, that is, overloaded. The garage usually focuses on delivery time, distance or cost, while the latest versions focus more on CO2 emissions or food package.

Only a few channels determine the characteristics of transport destinations seeking to reduce traffic congestions. Food transport models often focus on the model itself rather than optimization technologies, so most people use contactless search, simulated defrosting. Some studies use complex optimization methods based on colonies of ants, bees, swarm seeds or other types of evolutionary or genetic algorithms. However, in the field of electronic energy, disaster recovery methods are not tested, which focus not only on ordinary time, but also on real time, but often analyze congestion problems.

Methodology

The authors conducted a biometric analysis for 2022-2023 to identify current trends. After the introduction of the keywords „packing“, basically the results of the publications of the authors of „VOSviewer“, which were used to create bibliographic maps, were included in the figures below. After searching for literature, a bibliographic map was created to reconstruct the most common authors of articles, which are repeatedly used by the authors of articles. As a rule, circles on bibliometric maps can have different colors, distinguishing sets that indicate which keywords are closest to each other, as well as circles that are also reflected in different sizes indicating the meaning of the word, the clearer the meaning of the word. The lines indicate the relationship between the elements, and their clarity indicates the strength of the connection, and the distances between the keywords determine the strength of the interface. The closer they are to each other, the greater their connection.

The paper's authors established clusters during bibliometric analysis.

The methodology applied for the identification of clusters included three steps:

• VOSviewer software is applied for the analysis of publications appeared during period of 2022-2023;

• Bibliographic coupling analysis is used for the clusters' construction;

• Keywords important for the papers written on packing topic are groupped based on their co-occurancies in the titles of the publications.

Results

The figure below (Fig. 1) shows the prevalence of the most frequently repeated words of authors after publications in the „VOSviewer" audience database.

When analysing related keywords, it was found that the number of analysed articles included four clusters (see Fig. 1). These clusters show that topics are oriented to delivery, flow, algorithms, structure, and role.

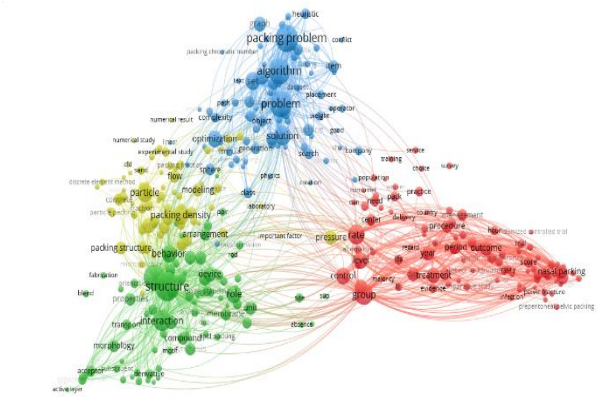

Fig. 1. Results of bibliometry analysis: four clusters. Keywords according to the results of the search packing in the „VOSviewer" database

Source: Compiled by the authors based on the results of the „VOSviewer" database

The results of this study are provided below. The first cluster consists of words: management, control, efficiency, delivery, duration, food, etc. The word „management" has 170 links, 60 occurrancies, and total link strength – 515. The other words: „delivery" has 112 links, 27 occurrancies, total link strength – 208, and „food" has 96 links, 24 occurancies, total link strength – 150. The fourth word „duration" has 107 links, 27 occurrancies, and total link strength – 280. The fifth and sixth words „efficiency" has 145 links, 35 occurancies, total link strength – 340, and „control" has 239 links, 113 occurancies, and total link strength – 747.

The second cluster consists of words: packing mode, shelf-life, preparation, engineering, metal, flexibility, transport, plane, etc. The word „packing mode" has 71 links, 22 occurrancies, and total link strength – 141. The second word „shelf-life" has 42 links, 15 occurrancies and total link strength – 58. The third word „preparation" has 104 links, 25 occurrancies, and total link strength – 169. The fourth and the fifth words: the word „engineering" has 125 links, 34 occurancies, total link strength – 227, and the word „metal" has 79 links, 24 occurrancies, and total strength links – 151. The seventh word „flexibility" has 78 links, 15 occurrancies, and total link strength – 105. The words „transport"have 108 links, 47 occurancies, and total link strength – 265; the word „plane" has 66 links, 20 occurancies, and a total link strength – 97.

The third cluster (see Fig. 2) consists of problem, solution, algorithm, optimization, optimization problem, genetic algorithms, packing problem, energy consumption, raw material, and computational experiments. The word „problem" has 283 links, 296 occurrancies, and total link strength – 2001 and is the most popular. The second word „solution" has 265 links, 165 occurrancies, and total link strength – 1212. The third word „algorithm" has 230 links, 277 occurancies, and total link strength – 1527.

The fourth and the fifth words: the word „optimization" has 206 links, 115 occurrancies, and total link strength – 665, and the word „optimization problem" has 94 links, 30 occurancies, and total strength links – 285. The seventh word „genetic algorithm" has 85 links, 35 occurancies and total link strength – 209. The words „packing problem" has 165 links, 306 occurancies, and total link strength – 1263 and word „energy consumption" has 52 links, 14 occurancies, and total link strength – 82. This shows that the search of solutions which solve packing problems gets high attention from researchers. The words „raw material" has 53 links, 11 occurancies, and a total link strength – 74 and word „computational experiments" has 76 links, 13 occurancies, and a total link strength – 145.

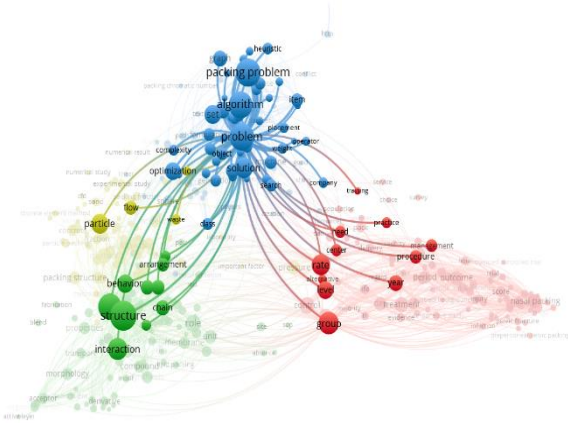

Fig. 2. The third cluster

Source: Compiled by the authors based on the results of the „VOSviewer" database

The fourth cluster consists of words (according Fig. 3): packing structure, packing model, packing density, liquid, modeling, flow, particle packing, experimental study, mathematical model, etc. The word „packing structure" has 127 links, 72 occurancies and total link strength – 310. It shows low attention on packing. The second word „packing model" has 102 links, 48 occurancies and total link strength – 212.

The third and fourth words: word „packing density" has 184 links, 152 occurancies, and total link strength – 571 and word „liquid" has 96 links, 31 occurancies, total link strength – 171. The fifth word „modeling" has 152 links, 69 occurancies and total strength links – 350. The seventh word „flow" has 150 links, 73 occurancies and total link strength – 362. The eight word „particle packing" has 76 links, 39 occurancies, and total link strength – 156.

The ninth word „experimental study“ has 78 links, 37 occurancies, and total link strength – 119. And the tenth word „mathematical model“ has 127 links, 33 occurancies, and total link strength – 246.

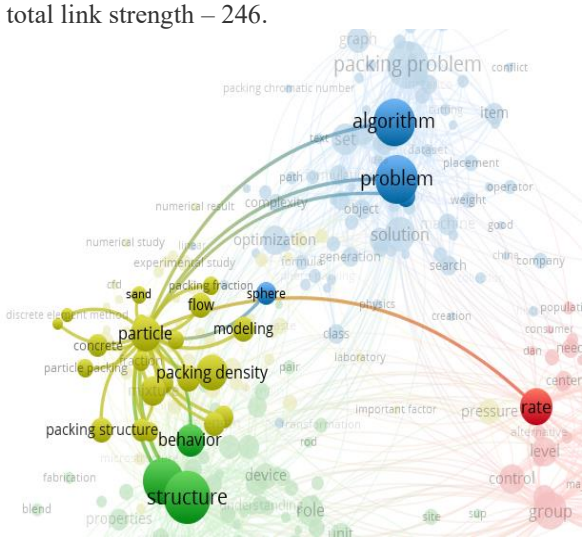

Fig. 3. The fourth cluster
Source: Compiled by the authors based on the results of the „VOSviewer” database

The results of bibliometry analysis shows that the topic of products packing has links with transport and delivery and algorithms. Such link also highlighted in the theory.

Discussions

People are involved in many new topics related to the SDGs. Many of the options focused on sustainable food packaging would be very useful if they could significantly reduce CO2 emissions. The report focuses on sustainable food packaging and its impact on reducing transport costs. This topic has many research gaps and requires theoretical and practical research. Incorporating sustainability into the long-term process has a clear impact on the environment. The authors point out that a sustainable packaging production process ensures optimal use of materials and energy and is effectively regenerated without wasting natural resources. The impact of food packaging on transportation is obvious and depends on many factors, which are determined by the nature of the food packaging. The benefits of sustainable food packaging also include key features such as product safety and traceability. Modern comprehensive solutions, including reducing sustainable packaging and transportation costs, are important for increasing environmental sustainability. The study aims to analyze the impact of packaging on reducing transport costs. The goal was achieved by introducing sustainable food packaging and its impact on reducing transport costs, theoretical foundations, and biometric analysis. A review of the literature on sustainable food packaging and its impact on the supply chain was carried out, which found that food packaging describes different types of packaging and new packaging technologies that affect the supply chain and are identified taking into account specific factors related to the characteristics of food packaging and the type of supply chain.

In addition, a literature study was conducted on the dynamics of food transport and the impact of reduced transport costs on sustainability. It concluded that new technologies and methods for food processing and CO2 emissions need to be developed to reduce transport distances. The study was conducted in the course of biometric analysis from 2022 to 2023 to identify current trends, and it was found that the number of analyzed units included four groups, which indicates that the topics were focused on presentation, flow, algorithms, structure, and role. The results of bibliometric analysis show that the product's packaging is associated with transportation and delivery, as well as algorithms. The authors studied this topic because knowledge is needed to fill the existing gaps.

Conclusions

The authors investigated how food packaging affects the reduction of transport costs. The authors identified the print functions and different optimization methods that are commonly used to analyse the impact on cost reduction, in this case, transport cost reduction. Among the optimization methods, the most popular methods used in other authors' studies are different types of evolutionary and genetic algorithms.

Theoretical analysis has shown the need to develop food reduction package approaches, taking into account traffic congestion and sustainability factors. In order to achieve that objective, new targets should be set for a number of criteria relating to food package, carbon dioxide emissions, and operating costs. The food transport should identify past congestion and create new patterns. To test the effectiveness of the food package size, you need to analyse the usage weekly, daily, and in real time. The authors looked at the environmental impact of different types of food packaging and the need for sustainable packaging.

The authors also looked at the impact of food packaging on the supply chain, which clearly depends on a number of factors determined by the characteristics of the food packaging and the characteristics of the supply chain, and, after a review of food transport and congestion reduction, found that a small proportion of the models are eco-dynamic.

The models considered focus mainly on delivery time, distance, or cost, but recent work has focused more on CO2 emissions or food packaging. Inevitably, in order to reduce carbon emissions, both wholesalers and retailers need to move towards more sustainable food products, including more sustainable food packaging, which research shows has implications for cost reduction in the supply chain.

A cluster analysis based on keyword associations identified four distinct clusters of terms, each representing a group of related concepts and keywords.

Furthermore, it's important to note that the link between packing and transport is visuable in publications between 2022 and 2023. We restricted our analysis to publications from 2022 to 2023 due to the overwhelming volume of available publications, potentially overlooking relevant earlier research on the subject. However, during the bibliometric analysis, a connection between packing and transport field topics was identified in the publications. The analysis of recent literature and keyword associations indicates the significant interrelationship between products packing and transportation problems. While the

concept is theoretically highlighted, there are very few papers on this specific subject written.

In conclusion, the results of this analysis emphasize the need for further research in the field of packing in logistics, particularly with a focus on its practical implications on efficiency and CO2 reduction. Understanding the challenges and opportunities that packing presents in transport management is crucial for businesses seeking to adapt to the changing landscape of the global economy.

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