INNOVATIONS IN SUSTAINABLE LOGISTICS AND TRANSPORTATION

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Summary

With the growing concern of human activities impacting the environment around the globe, sustainability became a slogan common for every business affair. Innovations happening at every passing second slightly changed its mode to include sustainability in its creation. Today, innovations to ensure sustainability is implemented in different sectors of development and profit-making organisations. The calling factors for such innovations in the logistics and transportation sectors with the innovations are systematically studied in this article, utilising the literature review of articles and reports on different logistics organisations. According to studies the pollution expelled out of the vehicles and machinery running in the warehouse of the logistic firms are CO2, nitrous oxide, methane and hydrofluorocarbon in extreme cases. These harmful greenhouse gases emitted from the transport sector alone account for 21% of the overall emissions, which is comprised of vehicles by road, rail, and airways. Innovations in the form of vehicles running on electricity and hydrogen fuel, which is encouraged in the form of recharge stations at appropriate locations and subsistence production of renewable energy, adoption of location tracking techniques like GPS and ITS tools, use of biodegradable plastics are some of them. Several companies have so far adopted these methods to maintain sustainability in their production and transportation. The countries and the customers within are demanding such an innovation in any service offered to them. Hence, the logistics and transportation sectors are impelled to act accordingly which in the long run is the right way to gain profit.

***Keywords**:* innovations, sustainability, logistics, transportation, technology, greenhouse gas, carbon emission, pollution.

Introduction

In an era of self-conscious individuals, the impact of human activities on the environment has become a concern raising demands on the business constructs for change in the existing developmental methods. The logistics industry being inevitable for global trade and commerce is no exception. The call for innovations in the form of sustainability in the logistics and transportation sector is the issue of concern in the article.

Countless supply chain regulations have surfaced after Covid-19. Even though those regulations existed before the pandemic, the stress on those regulations was emphasised after the pandemic situations. The importance of public health and its effect on business enterprises brought the realisation that not just the economy but the society and its environment have to be given equal importance for the success of any firm. Customers are everything for running any business, any negative impact on them or their surrounding can have a negative impact on the business itself. Hence, the stretch on the importance of sustainability of the enterprise became essential.

Sustainability has become the concern of countries that are now assessing all their activities to reduce any impact on their environment. Logistics not being a local process, but with the importance of its international connections they know how important it is to adhere to the eco-friendly productions and distributions. Thus, to survive in the competitive field of logistics going with the trend is as essential as cost efficient management of the operations. Aside from all the above concerns the cost associated with unsustainable practices can also hold a reason for sustainable development. The article explores the responsibility of the logistics firms in establishing sustainable operations and transportation.

Research aim: To identify the innovative trends brought about in the introduction and maintenance of sustainable logistics and transportation.

The following **objectives** have been set to achieve the aim:

1. To discuss and explore different innovative approaches in sustainable logistics and transportation.
2. To study the contribution of innovations in sustainable logistics and transportation to reducing risks and gaining profit
3. To understand the effects of innovations in sustainable logistics and transportation on the economy, society and environment

Research object and methods

Research object: Innovations in sustainable logistics and transportation.

The research applied a mixed-methods approach with both qualitative and quantitative perspectives using secondary data. A systematic review methodology is appropriate for studying the issue, as it can provide an in-depth analysis of available literature, focusing on the established reliable data. An integrated literature review of the theoretical background was conducted to understand the state-of-the-art literature and to form a picture of the body of knowledge on the phenomena. A literature review of articles and reports on studies conducted at different logistics organisation are obtained for modelling a pragmatic article. The research was carried out exploratively with the help of descriptive materials from sources such as company websites, articles and market research reports. The analysis of the article was limited to the innovations in the logistics and transportation sector brought to attain sustainability. Seven articles available online were studied for the article and reports from two reliable website sources were added to the information obtained.

The reports and articles have been obtained from authentic websites like Google Scholar, JSTOR, ELSEVIER and Science Direct. The results of the statistical analyses were used to determine the contribution of innovations in sustainable logistics and transportation in global emissions. The empirical findings were furthermore reflected in the secondary data, namely the academic and managerial literature, which both offered additional information about the phenomena and provided a good reflection point for the findings. The systematic review approach along with content analysis can act as a vital tool for collecting and interpreting data by providing insights into the key challenges, benefits and innovations in the field. The review with its inevitable critical analysis stretches on an expert discussion and conclusion on the study of innovations in sustainable logistics and transportation.

Research results and discussion

Logistics in simple terms is the management of material flow and distribution to customers. The activities involved are transportation, distribution planning, inventory, warehousing and order processing. Beginning with transportation every phase of logistics management is a warehouse of greenhouse gas (GHG) emissions. Transportation of the materials takes place by road, rail, and air. Vehicles running on fuels are emitting carbon every second. The machineries involved in running operations within the warehouse are also emitting pollution in different forms. The air pollution caused by vehicles is by the emission of carbon dioxide (CO2), nitrous oxide (N2O), particulate matter (PO) and volatile organic compounds (VOC). Electric vehicles do not emit greenhouse gases (GHG) and those running on hydrogen fuel will only emit water vapour. Vehicles running on gasoline sometimes produces methane (CH4), accompanied by the emission of hydrofluorocarbon (HFC) during air conditioner leakage. Even though the emission of HFC is small compared to the emission of CO2 from vehicles running on fuel, the global warming potential (GWP) of HFC is higher than CO2. Electric vehicles also as a potential for greenhouse gas (GHG) emission during air conditioner leakage. These emissions can cause air pollution in the form of smog and physical illnesses like heart and lung diseases and cancer (Fulton et al.,2015).

Global CO2 emission from transport, according to International Energy Agency is as follows:

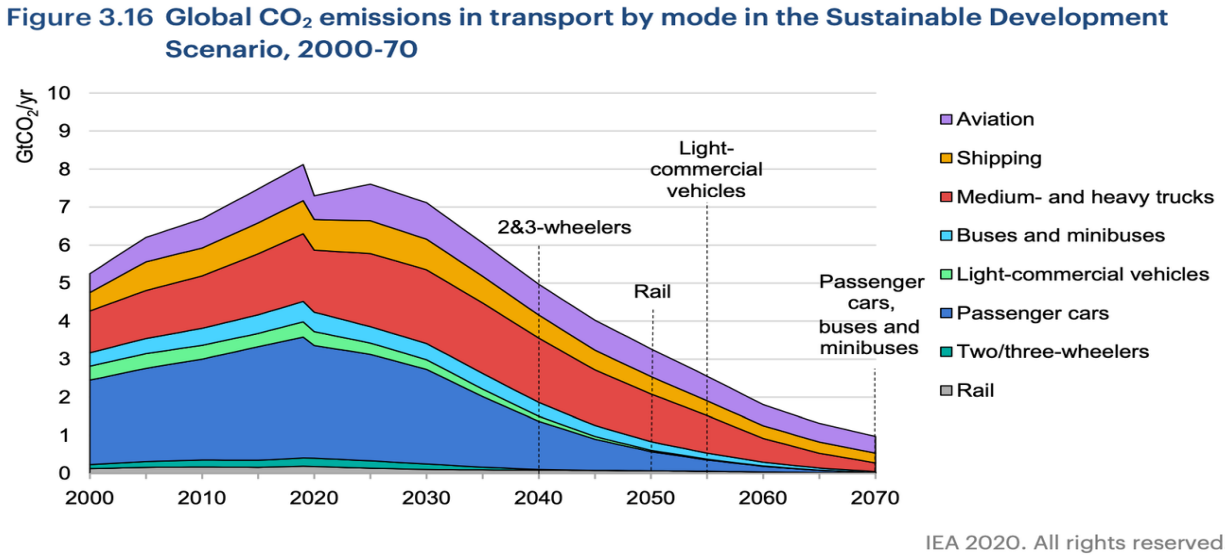

Fig. 1. Global CO2 emissions in transport by mode in the Sustainable Development Scenario, 2000-70 (Energy Technology Perspectives, 2020)

1 pav. *Pasaulinis CO2 išmetimas transporto srityje pagal tvaraus vystymosi scenarijų, 2000–2070 m. (Energijos technologijų perspektyvos, 2020 m.)*

The chart shows that it is expected for the 2-3 wheelers to stop their consumption of fossil fuels by 2040, hence reducing their contribution to direct emission of CO2. Similarly, railway transport to have a substantial reduction in the consumption or the complete stoppage of its use by 2050. Light-duty vehicles by 2055 and passenger cars, buses and minibuses by 2070. Thus, it is expected to have a massive reduction in the emission of greenhouse gas (GHG) by the transport sector by 2070. The total greenhouse gas (GHG) from the transport sector accounts for 21% of the overall emissions. Road transport is responsible for almost three-quarters of the transport emission, covering 15% of the total CO2 emission. Passenger vehicles like cars and buses contribute 45.1% and 29.4% from trucks carrying freights. Aviation accounts for 11.6% of transport emissions, which is under one billion tonnes of CO2 every year covering around 2.5% of total global emissions. 10.6% is covered by international shipping transport, while the rest 1% is the only emission from rail transport. The transport of materials such as water, oil and gas through pipelines is responsible for more carbon emissions than rail transport, covering 2.2% of the total emission (Ritchie, 2020). With the present rate the climate initiative to achieve net-zero emissions by 2050 seems to be far. But the innovations and their adaption by the logistic firms are working towards achieving them within the targeted time period.

The present scenario of fuel running vehicles, airplanes and ships has to go a long way for adopting electric or gasoline mechanism. The potential for using hydrogen as fuel, or electric batteries for running planes, ships and large

trucks is limited by the range and power requires, the size and weight of batteries or hydrogen fuel tanks would be much larger and heavier than current combustion engines (J. Davis, 2023). Starting from the light-duty vehicles, which is the primary mode of transport covers 80 percent of all journeys. For this reason, technologies have been invented to reduce the carbon emission from light vehicles. Ultra-efficient internal combustion engines capable of reducing fuel combustion, biofuels produced from plants and similar renewable resources, hydrogen used in fuel cells for generating electricity and vehicles running on electric charged batteries are some of them (Davis et al.,2018). Producing electric vehicles requires a stable electricity infrastructure, which can produce electricity with low or zero carbon emissions. If not, producing electric vehicles to reduce carbon emissions from vehicles whose electric source is emitting carbon brings no change to the earth. For the optimum realisation of its aim, efficient electricity transmission system, grid connections and fast charging stations are necessary. Solar and wind energy generation are carbon-neutral energy production, smart grids can handle electricity demand and supply efficiently, and the availability of fast charging stations at strategic locations like that of the fuel stations can promote electric vehicles and their usage to a great extent.

Maritime transport is the first option for international transport of cargo for most of the logistics and transport companies. About 80 percent of the cargo handled through the shipping mode. The same source is recorded to have emitted nearly 3% of the global greenhouse gas emissions. Even though remarkable technology inventions are not made to this extent improving efficiency can cut down fuel consumption and the following carbon emissions to some extent. The use of digital technologies like real-time tracking systems provides efficient GPS routing, thereby unnecessary fuel consumption can be reduced, and automated systems for loading and unloading can speed up the process on board, reducing port idle time. Aviation being the second option for every international transportation accounted for nearly 2% of carbon emissions. This rate has been increasing annually. Innovations for reducing carbon emission in the form of electrification of short-haul flights, usage of mixed-fuels in flights by blending kerosene with biofuels and producing synthetic fuels from CO2 and hydrogen or ammonia (Cecere et al., 2014). Rail transport has been the primary source of transport for earlier times. With the adoption of railways running on electricity its effect on the environment is also minimised. Several innovations have been introduced in rail transport, from digital tools like mobile apps with updates on schedules to Automatic Train Operations for AI operated railways, reducing inefficiency due to human error.

Sustainability introduced in the transportation sector ensures that the logistics firms have undertaken the motto of establishing sustainable development to 70 percent. Transportation being the soul of logistics, a green-sustainable logistics movement can be an addition to those businesses trying to establish carbon neutrality in their development. Sustainable transport is said to be a new era in mobility. Reducing the impacts of enterprise activities on the environment is the prime motive. Alternately, the safety, accessibility and efficiency of the system is ensured with the introduction of new technologies. A new field for the development of technologies to this extent is working out, so that the effort for these enterprises to find eco-friendly technologies are minimised. With the combined effort of every field of development, sustainability has become a realistic goal working towards cutting down the harmful impression on the environment and society. Tier IV of Japan with the commercialization of autonomous vehicles, Hevo of USA provides a wireless charging network for electric vehicles, Get My Parking of India aims to simplify parking by digitizing the entire process and Carmetry of Spain offers apps that use AI, Big Data technologies, and GPS devices for the management of fleet operations. These are some of the innovative enterprises around the world to working towards reducing carbon emissions with efficient technology utilisation. Smart cities are playing a crucial role in improving the travel experience through technologies like Intelligent Transport Systems (ITS). ITS is a collection of wireless, electronic and automated technologies with the potential to integrate vehicles, infrastructure, and users. This can provide information on traffic conditions, data on public transport occupancy rates, and suggesting best routes and modes for freight transport. This can reduce traffic and mob congestion, improving efficiency, saving time and reducing unnecessary fuel consumption, thereby working towards the creation of sustainable cities (C. Brears, 2024).

Many logistics companies around the world have begun the revolution by adopting green technology, which is made available in a more accessible, affordable and efficient manner. Electric trucks, vans and bikes with reduced emissions of carbon and noise pollution are being used for delivery operations by logistics companies these days. Hence, logistic companies are focusing on exploring alternative fuels such as hydrogen, natural gas and biofuels to power their transport and machinery within the warehouse. Carbon emissions out of the activities run for the warehouses and distribution centre are minimized with the optimization of routes and implementation of energy-efficient practices with the use of technologies like GPS maps. With people becoming more conscious about the impact of human-activities on the environment, there is a demand for transparency in the supply chain. This is to ensure that the source, collection, manufacturing and packing of the product are in an eco-friendly manner. The development of blockchain technology and other digital tools for tracking and verifying the sustainability of products and their utilisation by logistic companies are measures for ensuring transparency in the supply chain (Malisic et al., 2023). The product is tracked from its initial phase to its delivery to the customers. Waste hierarchy management through the R policies are also adopted by the logistic companies through the recycling, reduce, repurpose, repair and reuse schemes. This can minimize waste and improve the life cycle of goods. Such a reverse logistic approach or circular logistics is a step towards sustainability by reducing the need for new production and transportation. Plastic packaging is ceased by most of the logistic companies. Innovations by way of using eco-friendly, reusable materials and lightweight packaging like biodegradable plastics and recyclable cardboard (Innovations in logistics, 2023). The location of the manufacturing unit and warehouse also plays an important role in saving energy and reducing emissions. The closer they are to the customers, the less fuel consumption and carbon emission. Similarly, companies have started to produce renewable energy on their own for running their operations. Solar energy farms and windmills are built on top of the warehouse or alongside to power the equipment and utilities required

for their operations. Proper tracking of the services and health of the vehicles can reduce additional emissions coming out of the spoiled material along with increasing its longevity.

As the world started to promote those eco-friendly businesses, the practice of documenting and publicising the sustainable practices of the company has become an inevitable practice in every business. Sustainability reporting fosters trust and accountability within the industry, and in attracting customers. Thus, the companies prefer eco-friendly options even for their material handling equipment. Pharma giant GlaxoSmithKline is an eco-friendly supply chain initiative, focusing on boosting its green supply chain outside of the company. This drug company with its climate initiatives is aiming to achieve an 80% reduction in carbon emissions from outside suppliers and service providers. Nike, the athletic apparel company through their reuse and recycle policies has become a greener supply chain along with its sustainable sourcing and manufacturing methods. The US based nutrition company, Shaklee has achieved carbon-neutral certification by reducing carbon emissions. These companies stand as proof of the achievement of the carbon-neutral, eco-friendly and sustainable logistic firms. Countries are now adhering to strict rules and regulations to ensure that their products and the products they accept from other countries are eco-friendly. Eco-design regulations of the European Union are one such. Hence, with their profit at stake, there is an enormous increase in the number of logistics firms focusing on improving their operations to ensure sustainability.

The future of sustainable logistics is not just a promise, it has become a reality. With the advancement of technologies, people started to address the environmental issues, making it an emergency to turn all human activities to be environment friendly. With the digital world portraying every activity of a firm, the promotion and existence of any enterprise is in the hands of the customers. The customers are not just the acceptors, they themselves have become the decision makers. This impact is visible in the logistic companies who are now committed to finding innovative solutions to reduce the impact on the planet. Electric vehicles, alternative fuels, supply chain transparency and circular logistics are approaches for reshaping enterprises to a greener, sustainable future. By embracing the facts and the ways to move forward accepting those facts is how the logistic companies are meeting the demands of its customers. Sustainable logistics is not only a movement towards a healthy planet, but also towards a healthier customer.

Conclusions

1. The article has introduced the current innovations in the logistics and transportation sectors to ensure sustainability. Innovations in the form of Electric vehicles with reduced noise pollution, vehicles and machinery running on hydrogen, natural gas and biofuels, blockchain technology and the use of digital tools for tracking and verifying their operations like GPS systems and Intelligent transport systems (ITS), use of biodegradable plastics and renewable energy sources for power. Investments in green fuels and technology, responsible recycling mechanisms and more efficient resource consumption are the much-needed initiatives towards building an eco-friendly logistics and transportation system.
2. The article has tried to bring to focus the long-term profit gained from the less harmful way of running operations. The customers being the soul of every enterprise, the importance that must be given to their customer's health and well-being is addressed in the present scenario. With the current trend in promoting sustainability, most countries have started to accept products following the same motive. This, in way, is standing as a hindrance to the profitability of enterprises that relied on raising their profit over a healthy environment and residents. The misconception that turning the processes to be eco-friendly adds to the expenses is now slowly fading away with the experiments that took place in different logistic companies becoming a success. Thus, today reducing risk in a way is part of stabilising their profit from falling out.
3. The article has addressed the environmental issues arising out of the operations of a logistics firms and the subsequent innovations brought about in rectifying the limitations and inefficiency of the firm. The importance given to sustainability is evident in the rules and regulations of most of the countries. With the advancement of the digital world and the adding support on sustainability gained from different parts of the world, any actions acting against those sustainable initiatives are brought to light affecting the goodwill of the company. Thus, valuing the environment is equally important to maintaining a strong economy, and focusing on society.

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