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Marchenko V.S. Postgraduate student, State University «Kyiv Aviation Institute» (Ukraine)

ORCID – 0009-0000-8959-8720
Researcher ID –
Scopus author id: –
E-Mail: vsmarch@ukr.net

MAIN CHALLENGES ON THE WAY OF IMPLEMENTING «GREEN» TECHNOLOGIES IN THE LOGISTICS SPHERE

Vladyslav Marchenko. «Main challenges on the way of implementing «green» technologies in the logistics sphere». *At present, the escalation of such serious global challenges as environmental pollution, climate change and depletion of natural resources is pushing humanity to find modern technologies, decisions and practices that can minimize the ecological burden on the planet. Sustainable development, as an innovative, balanced concept that counters these problems, could not ignore the logistics sphere, which, despite its invaluable role as a global transport network, unfortunately still has a significant negative impact on the environment. In such conditions, the implementation of «green» technologies in the logistics sphere is not just an important, but a critically needed task. The ecological transformation of logistics has a strategic importance for countries, business representatives and ordinary citizens. The purpose of this article is to study and analyze the main challenges that stand on the way of implementing «green» technologies in the logistics sphere. In this research, the main barriers were identified and explained, starting from economic, technological, regulatory and legislative difficulties and ending with cultural, infrastructural and complex problems. An essential emphasis in the work was made on their relevance in the context of the current Ukrainian realities of wartime, when the «green» modernization of the logistics sphere is greatly complicated. The results of this conducted research can be used by different scientists, developers of «green» policy, managers of logistics companies, business representatives, and simply all other people who are interested in spreading the concept of sustainable development in the logistics sphere.*

Keywords*:* sustainability, development, technologies, ecology, effectiveness, prospects, transport, logistics, management

Владислав Марченко. «Головні виклики на шляху впровадження «зелених» технологій у логістичну сферу». *В наш час, ескалація таких серйозних глобальних викликів, як забруднення навколишнього середовища, зміна клімату та вичерпання природних ресурсів, плекає людство до знаходження сучасних технологій, рішень та практик, що можуть мінімізувати екологічне навантаження на планету. Сталий розвиток, як інноваційна, збалансована концепція, що протистоїть даним проблемам, не могла оминути стороною логістичну сферу, яка крім своєї безцінної ролі світової транспортної мережі, на жаль все ще має значний негативний вплив на навколишнє середовище. В таких умовах імплементація «зелених» технологій в логістичну сферу є не просто важливою, а критично необхідною задачею. Екологічна трансформація логістики має*

стратегічне значення для країн, представників бізнесу та звичайних громадян. Метою цієї статті є вивчення та аналіз головних викликів, які стоять на шляху імплементації «зелених» технологій у логістичній сфері. В цьому дослідженні було визначено та пояснено головні бар'єри, починаючи з економічних, технологічних, нормативно-правових складностей і закінчуючи культурними, інфраструктурними та комплексними проблемами. Важливий акцент в роботі було зроблено на їх актуальності, в контексті нинішніх українських реалій воєнного часу, коли «зелена» модернізація логістичної сфери є суттєво ускладненою. Результати цього проведеного дослідження можуть бути використані різними науковцями, розробниками «зеленої» політики, менеджерами логістичних компаній, представниками бізнесу та просто всіма іншими людьми, які є зацікавленими у поширенні концепції сталого розвитку в логістичній сфері.

Ключові слова: сталість, розвиток, технології, екологія, ефективність, перспективи, транспорт, логістика, менеджмент.

Introduction. At present, humanity faces a wide range of serious global challenges. This undoubtedly includes problems related to climate change, the gradual depletion of various natural resources and environmental pollution. The last questions are being talked about a lot lately, since minimising the negative impact of human activity on the environment is one of the top priority tasks of our time. It is not surprising at all that the search for new approaches to global development has not bypassed the logistics sector. Today, logistics is not just about transport and warehousing operations, but about one of the largest existing sources of environmental pollution. It is enough just to remember its enormous volumes of carbon dioxide emissions and annual packaging waste, and everything immediately becomes clear.

The realisation of the need to reduce its enormous impact on the environment has led humanity to seek new, modern, safe and effective ways for its development. Such a promising option became the idea of integrating the concept of sustainable development into the logistics sphere. The implementation of elements of this concept has had a positive impact on the development of a new, promising direction of «green» logistics. «Green» logistics has focused on the idea of minimizing the ecological impact of logistics on the environment by balancing social, environmental, and economic aspects.

Nowadays, «green» logistics is a set of effective practices, highly productive approaches, innovative technologies and solutions aimed at reducing the environmental footprint of logistics operations. This direction is a global, strategic vector for the development of the logistics sphere designed for a long-term perspective. It includes the use of a wide array of tools, starting with electric transport and eco-friendly packaging and ending with hydrogen and digital technologies. Many experts agree that «green» logistics can achieve serious success, since not only ordinary society but also modern business is interested in its development. This concept contributes not only to the preservation of ecosystems, but also to increasing the competitiveness of the business itself, improving its reputation and global responsibility.

The logistics sector continues to adapt quickly to all possible changes, globalisation processes and modern trends, but despite this, it must be acknowledged that there are currently a huge number of obstacles that prevent and, in the coming years, will continue to prevent the full-fledged development of this direction. Despite growing environmental awareness and international efforts towards a «green» transition, the development of this direction in most countries, including Ukraine, has

encountered extremely significant difficulties on its way. These problems are very complex and require well-thought-out decisions at both the macro and micro levels. This includes not only the obvious serious initial costs and strategies of logistics companies, but also such global challenges as reforms in the economy, the formation of a modern regulatory framework, and infrastructure development. In the context of the current full-scale hostilities in our country, this question is particularly important, as logistics companies must not only thoroughly plan their economic and resource capabilities, but also carefully consider options for «green» modernization.

Thus, the task of studying the main challenges that stand on the way of implementing «green» technologies in the logistics sphere and searching for possible ways to overcome them is more relevant than ever

The purpose of the article is to study and analyse the main challenges that stand out the way of implementing «green» technologies in the logistics sphere. The article not only explains examples of modern issues, but also puts an emphasis on the current situation in Ukraine.

Presentation of the main results. Today, humanity is fighting a wide variety of serious threats, and inadequate attention to their resolution in our time could lead to a real catastrophe for all our future generations. Currently, the issues related to environmental pollution, the gradual depletion of natural resources and climate change are especially sharp.

In the context of climate changes, increasing carbon dioxide emissions into the atmosphere, growing waste volumes, declining natural resources, and growing number of all possible environmental demands from society, the idea of introducing the concept of sustainable development into the logistics sphere has become not just a matter of simple importance, but rather a matter of urgent necessity. Sustainable development is critical for our planet and future generations [1].

Even if we take into account only a few of the above-mentioned aspects, it can be confidently stated that the logistics sphere is currently one of the largest sources of environmental pollution, not only in terms of greenhouse gas emissions, but also in terms of the enormous volumes of waste, which is clearly demonstrated in Fig. 1.

The integration of sustainable development aspects into the logistics sphere has allowed humanity to look at it in a completely new way, from a more ecological, «green» point of view. Over many years, society has managed to form a modern vision of logistics as an effective tool that is not only concerned with economic results, but also takes responsibility for preserving the environment.

«Green» logistics aims to minimise the negative impact of logistics on the economy through the massive introduction and use of both «green» technologies and different sustainable practices. Among the most popular examples are energy-efficient warehouses, electric transport, various types of biofuels, wind turbines, solar panels, regenerative energy systems, hydrogen technologies, eco-friendly packaging, modern systems for calculating the most efficient routes, automated resource distribution systems, greenhouse gas emission monitoring systems, and many other options.

For a long time, «green» technologies in logistics were not taken seriously by business representatives, but now there are countless examples of their successful implementation by all kinds of companies. The development and deployment of new green technologies is key to mitigate and adapt to climate change, reduce negative impacts of economic activity on nature and reduce pollution [2].

Figure 1 – Example of huge amounts of packaging waste
Source: https://thesustainabilist.ae/sustainable-packaging-in-the-uae-e-commerce-industry/

Despite numerous achievements in this area, it must be acknowledged that successful, truly large-scale cases usually occur in developed states, while in other countries, including Ukraine, the issue of «green» transformation faces significant challenges. These difficulties exist at both the macro and micro levels, and a country's success usually depends on the development of its infrastructure, economic stability, environmental reforms and investments.

Today, there is a greater need than ever in researching the challenges that stand in the way of implementing «green» technologies in the logistics sector. Knowing what to expect helps us adapt and prepare for a more resilient future [3]. A deep understanding of these complexities and the reasons for their emergence can help identify the most effective ways for their potential resolution. That is why this article aims to study and analyse the main challenges that currently stand on the way of implementing «green» technologies in the logistics sphere. At present, they are quite numerous. The «green» transformation of the logistics sphere is a truly complex process, and although the idea of implementing the concept of sustainable development in logistics has gained support from society and business, the introduction of «green» technologies in logistics companies is still proceeding at a fairly slow pace.

Of course, today, the most obvious challenge is the high initial costs and the need in significant investments. This factor is quite critical for many operators, as reducing the negative impact of logistics activities on the environment is directly linked to the use of modern technical and advanced technological solutions. The need in significant financial investments is a very painful question for small and medium-sized companies, which often simply cannot allow themselves to take such steps. This is not about trivialities, but about large-scale decisions such as purchasing electric transport, charging station equipment, installing energy-efficient lighting, modernising work spaces and warehouses, switching to eco-friendly packaging, starting to use renewable energy sources, and many, many other examples.

In order to achieve success in this area, logistics companies must carefully calculate everything for the long-term perspective, find sources of investment, or at least take advantage of favourable credit offers. In

developed countries, this problem is well understood and attempts are being made to solve it through state funding, sponsorship of ecological programs, grants, «green» crediting and even tax reductions. In developing countries, including Ukraine, despite the existence of certain such initiatives, it should be noted that support for logistics companies in this regard is quite limited. The lack of such assistance is a critical barrier for business on the path to a «green» future, and that is why high initial costs are still considered a significant challenge on the way of implementing «green» technologies in logistics.

Another, but no less large-scale problem is the lack of a detailed regulatory and legislative basis that would regulate the introduction and development of «green» technologies in the logistics sphere. This moment represents the key reason why their implementation in logistics is still at such a low level. The absence of relevant legislation that addresses aspects of «green» logistics deprives business representatives of a clear vision of their direct obligations in terms of complying with modern sustainable norms. This, in its turn, does not give logistics companies confidence in their «green» initiatives, nullifies the very concept of stability and the need to plan such projects, especially large-scale ones. Today, each country has its own approach to this question. Many developed countries already have specific achievements in this direction, but in Ukraine, it still has not received enough attention. At present, there is no comprehensive law in our country that would be responsible for the general, effective regulation of the «green» logistics sphere. In practice, we have separate laws and state strategies, which usually do not indicate specific requirements for logistics operations related to the «green» course, as well as clear, step-by-step time frames for their realization in life. For Ukraine, as a modern developing country, it is important to pay more attention to creating a strong regulatory and legislative framework that will not only turn «green» logistics into an integral part of our national environmental policy, but will also have clear requirements, obligations, timelines, control methods and enforcement mechanisms.

It is also impossible not to mention such a challenge as the lack of unified, legislatively defined environmental standards for logistics operations, or at least criteria for their assessment. Current legislation lacks a large number of requirements for sustainable supply chains, greenhouse gas emissions accounting in logistics processes, «green» packaging, ecological transport, etc. This leads to a situation where each market player decides for himself what are the frames of acceptable environmental friendliness, which is a completely wrong decision. Currently, logistics companies can only take into account certain aspects of their impact on the environment, ignoring such important factors as the amount of waste, noise pollution, the efficiency of resources use, etc. The result of this is a picture that does not show the real, complex impact of business on the environment. This not only makes this sphere less transparent and honest, but also makes it harder to compare results, and not just between Ukrainian companies, but also with foreign ones. Right now, they cannot prepare accurate, standardised reports that are created according to unified, modern norms and which fully reflect the true picture of their ecological friendliness, which is a very important factor in the question of attracting new investments, obtaining grants, receiving favourable credit offers and even the simple opportunity to participate in various government programmes.

In the absence of unified environmental standards for logistics operations, it is simply impossible to seriously discuss the concepts of «obligation», «control» and «implementation» of sustainable solutions. On this basis, an unpleasant situation arises when companies do not have any relevant guidelines to follow, and regulatory authorities, in their turn, are unable to conduct proper monitoring and enforcement. Such a long-term, irresponsible policy leads to

the result, where companies still do not see much sense in the ecological transition, postpone promising «green» initiatives to the distant future, or banally implement them in a limited form more for PR and marketing purposes than with the aim of conscious reduction of the negative impact of logistics on the environment. A way out of this situation could be the development and popularisation of common international standards that would serve as tools for achieving the set goal. Currently, such modern examples include ISO 14001 environmental certificates, Life Cycle Assessment (LCA) methodologies, GHG Protocol carbon reports, and others. That is why the creation and application of standardised mechanisms for measuring the «green» efficiency of logistics operations is such an important question in our time.

One of the most acute problems today is the lack of government support for logistics companies and a poorly thought-out incentive system for their environmental transition. Governments have a key role to play in supporting green technology dissemination and can influence the flow of technology to their own countries [4]. The introduction of «green» technologies in logistics companies is a very complex task. In developed countries, this issue is regularly brought to the agenda, as people there understand that the state should not stand aside of these processes and silently watch, but rather should perform the role of a reliable regulator, supervisor and responsible investor. In the same European Union countries, the practice of stimulating logistics companies through all possible grants, various subsidies and tax incentives is quite widespread. Talking about our country, it should be noted that such a system is just beginning its formation.

The logistics sphere is often not included in state programmes on sustainable development. This represents a very serious drawback, as today many logistics companies want to conduct «green» modernization but do not do so due to a lack of access to appropriate long-term financing of their projects or at least favourable credit offers. Ignoring the issue of tax incentives for companies that implement «green» technologies does not add optimism either. Lack of attention to this question from the side of the state leads to the result when companies have no motivation to switch to ecological solutions, as they do not see enough benefits in it. The «green» course looks for them not as an opportunity to gain competitive advantages, but on the contrary, as an additional and very risky burden on business. To overcome the above-mentioned challenge, each country must ensure the formation of an appropriate system of incentives and limitations for logistics companies, which will gradually and quantitatively stimulate the adoption of sustainable solutions in their activities. It is necessary not only to create a complex policy of supporting the development of «green» logistics, but also to include it in the overall strategy of the state's sustainable development.

It is worth mentioning the significant value of the challenge of building modern infrastructure for alternative, «green» solutions. The issue of creating reliable, high-quality and safe infrastructure has always been relevant, and today, at a time of urgent need for the development of «green» logistics, it is regularly discussed around the world, as it represents one of the most critical problems on the path to its widespread use. The fully-fledged functioning of «green» decisions in the logistics sphere directly depends on the availability of modern transport, technical and energy infrastructure. The operation of all electric transport, «green» logistics hubs, hydrogen technologies, automated ecological warehouses and power stations is simply impossible without the creation of appropriate, high-quality infrastructure.

In developed countries, especially in the EU member states, much more attention has been paid to this question in recent years. Ukraine is also well aware of this problem, but

here its solution is proceeding at a rather slow pace. Even without mentioning advanced «green» technologies, but taking into account the banal charging stations for electric transport, it is possible to understand how serious this challenge is for our state. Currently, their number is quite limited, and their distribution across the territory is very unequal. By region, they are usually installed in small quantities and are unable to meet the demand of large logistics operators, which reduces the attractiveness of choosing electric transport for long routes.

On the other hand, despite the complexity of the process of their distribution, the trend in the development of this direction remains positive and is gradually improving with each new year. Large fuel retail chains have a great influence on this issue today, as they practically set the trend for the entire market in terms of installing the relevant electrical infrastructure, which can be seen in Fig. 2.

Figure 2 – OKKO has launched a network of fast electric charging stations
Source: https://www.okko.ua/okko-masshtabuye-servis-dlya-elektrokariv-na-osnovnih-avtoshlyahah-vpershe-rozgornuto-merezhu-ultra-fast-chargers

Even more complex is the situation with infrastructure for hydrogen logistics. Many scientists and experts see hydrogen as a promising fuel of the future, which has a wide range of advantages over traditional fuels. Despite our country's enormous potential in this area and the interest of foreign investors, it must be acknowledged that this sector is currently practically unexplored in Ukraine, not only in terms of full-fledged hydrogen filling stations, but also in terms of hydrogen production, distribution and storage systems. It is possible to realise our potential in this area with the help of European Union countries, which are directly interested in the development of this sector and are ready not only to share their experience and technologies with us, but also to invest significant financial resources in relevant projects. Such a successful example of cooperation is the signing by Ukraine in 2023 of an agreement to join the European Union's Single Market Programme. On this day, a very promising Memorandum of understanding between the European Union and Ukraine on a Strategic Partnership on Biomethane, Hydrogen and other Synthetic Gases was signed at this meeting.

Similarly, regular warehouses are also poorly developed in terms of ecological standards. In fact, in most cases, they are not equipped with solar panels, modern energy-

saving systems or recuperation systems, and zero-emission construction is currently very rare. Success in overcoming this challenge can only be achieved through private investments and government support. If the question of improving logistics infrastructure is not included in the ecological strategy for regional development, any discussion about potential solutions to this problem will remain only theoretical, and will not be implemented in practice.

A unique challenge on the path to implementing «green» technologies is also the need to renew the transport fleet and warehouse facilities of logistics companies. Today, their complex modernisation is a key requirement for the development of «green» logistics. This process is not quick, but rather step-by-step and long-term. In order to achieve success in this area, a clear ecological policy must be formulated, both at the state and industry programmes level, as well as on a corporate scale. Nowadays, a significant percentage of logistics vehicles are simply outdated and do not meet modern «green» standards. This primarily concerns the issue of their low energy efficiency, high noise levels and harmful emissions. Such companies as Amazon clearly understand this challenge and, having significant resources and financial support, are already working on renewing their logistics fleet of vehicles with more environmentally friendly models, which is perfectly illustrated in Fig. 3.

Figure 3 – Amazon's growing lineup of electric vehicles
Source: https://www.aboutamazon.com/news/sustainability/amazon-electric-vehicles-vans-trucks-bikes

The situation is no better when it comes to current warehouse facilities. A large share of them are outdated, poorly equipped, energy inefficient, and unable to perform transportation, sorting, processing, and storage operations in accordance with modern standards. A total replacement of such a logistics fleet of vehicles or a high-quality modernisation of warehouses requires enormous financial contributions and investments. In most cases, such large-scale initiatives can be brought to life only by the largest market players, such as UPS, DHL or FedEx, which can be seen in Fig. 4.

Figure 4 – FedEx Ship Center in Washington, D.C.
Source: https://newsroom.fedex.com/newsroom/global-english/communitysolarinstallation

For small and medium-sized businesses, which are quite limited in terms of economic opportunities and available resources, such large-scale changes are simply an extremely difficult task. The high cost of modern «green» technologies, weak government support, and economic instability leave logistics companies with no choice but to continue using outdated equipment and solutions until the end of their service life, which undoubtedly has a negative impact on the environment. The need for regular maintenance of modern eco-friendly equipment and the search for highly professional personnel to work with «green» technologies does not add optimism either. For this reason, the question of renewing the transport fleet and warehouses still remains so relevant.

An additional challenge to the previously outlined problem is the integration of «green» technologies into the established logistics activities of companies. The process of improving traditional procedures is quite complex. The very fact that logistics companies purchase «green» technologies is not enough to reduce their environmental impact. The final result always depends on the quality of implementation of «green» technologies into the system of established business processes and the effective use of these technologies in the future. More simple solutions in the sphere of «green» logistics really require replacement of only some separate elements, such as packaging or transport, but more complex «green» modernisation may demand change of the entire operational model of a logistics company. First and foremost, this concerns changes to the system of developed routes, training and preparation of environmentally conscious employees, the use of new software, modernisation of warehouses, and changes to business relationships with customers, partners and even suppliers. In a world of global competition, for many companies, conducting such modernisation represents considerable stress and risk, as this process may be accompanied by a temporary loss of productivity, disruption of logistics processes and a decline in service quality. In our time, this question is quite delicate, since even small declines in efficiency can lead to the loss of clients and a negative impact on the company's image in the market. Based on the above-mentioned moments, it can be emphasised that the complexity of implementing «green» technologies in logistics systems scares even those companies that well understand the importance of a «green» course. This challenge can be resolved through well-

planned, step-by-step introduction of innovations, using flexible methods of adaptation.

An important challenge that is often left unspoken is the poor ecological awareness of logistics companies. This problem cannot be equated with the technical difficulties mentioned above, but it is still worth paying attention to, as it has a key role in the process of «green» logistics development. Currently, the level of environmental awareness among employees of logistics companies around the world is really low. Their unwillingness to accept new, sustainable approaches and lack of eco-thinking leads to inaction, which is a huge barrier on the way to «green» modernisation in logistics. A great number of people still refuse to understand sustainable development as a strategic step into the future that can provide them with enormous number of advantages in the market. They are guided by clear commercial concepts and understand environmental friendliness as an empty bottomless pit, investing in which their time, funds and resources will not bring them adequate feedback. If a person with such a worldview is a manager in a company, this poses a serious threat to the sustainable development of the business, as this individual will simply look for quick ways to make a profit and refuse to consider practical cases where «green» technologies can lead to cost savings through improved routing systems, energy efficiency, waste reduction, etc. This is a negative moment, as logistics companies will in fact focus on operational response to emerging challenges and will not give any priority to «green» projects.

Similarly, this problem is equally challenging in the case of a workforce that is simply inexperienced in this regard. Unfortunately, today, the educational sphere does not pay enough attention to explaining the importance of preserving the environment. This leads to a situation where, without having undergone appropriate training and gained invaluable knowledge in this area, employees may neglect the goals and objectives of sustainable initiatives when logistics companies begin to implement them. This complex problem can be solved through the gradual improvement of people's environmental awareness. The best way to achieve this is to implement a «green» logistics course in professional education, conduct all possible awareness-raising activities, and create corporate courses for employees. Thus, improving environmental awareness and culture remains a critical task necessary for the development of «green» technologies in logistics.

No less significant difficulty, which today is closely linked to the previous challenge, is weak pressure from clients. This problem is quite complex and practically stems from a combination of several previously explained challenges that stand on the way to the implementation of «green» technologies in the logistics sphere. We live in an era of globalization, and although the level of citizens' environmental awareness continues to grow, it must be acknowledged that this is still happening at a slow pace. In this case, for many people, the priority criteria when choosing products or relevant services are still their price, quality, and speed of delivery, with environmental friendliness coming only after that.

In the context of slowly growing demand for «green» services, logistics companies are in no hurry to enter a completely new area for themselves by implementing environmental initiatives, as they believe that this entails additional costs and risks for them. The lack of noticeable pressure from clients turns the goal of «green» modernization of logistics into a voluntary process. This leads to logistics companies continuing to use familiar technologies and operating models, which in their opinion are simpler, cheaper, and more understandable, even if they have a greater ecological impact on the environment. Not all citizens are aware of the advantages of «green» logistics, and certainly not all are willing to pay for it. This collective behavior does not provide many companies with additional motivation for sustainable development and the introduction of relevant

«green» innovations. To solve this problem, it is necessary to combine the efforts of the state, all possible business associations, and public organizations with the aim of improving citizens' environmental awareness and supporting a culture of ecological responsibility.

The last but not least important challenge that should be mentioned in this article is global instability, geopolitical conflicts, and crises. This factor is especially relevant and painful for our country. Our world is super interconnected, and sometimes even the smallest changes, which at first glance may seem irrelevant, can ultimately cause serious consequences. Today, there is a wide range of instabilities that can affect the development of the entire «green» logistics sector. Disruptions in supply chains, economic crises, fluctuations in demand, wars, and dramatic changes in fuel prices are examples of serious problems, faced with which logistics companies prioritize the survival of their business and its uninterrupted functionality. In such cases, they first and foremost think about the present, high-quality adaptation to difficulties, how to ensure the safety of employees, and how to optimize the route network, while strategic sustainable development remains in the background, as a long-term plan. Even during such crisis periods, it is very important to find a successful balance between countering short-term changes and executing long-term environmental policies, as constant postponement or even complete avoidance of this issue may result in businesses falling behind their competitors and incurring serious losses in the future.

Since 2022, Ukraine has been living in the new reality of full-scale military actions. Working in conditions of martial law, constant shelling, and when part of the infrastructure is simply destroyed or temporarily non-functional, talks about «green» prospects and projects are in most cases left out of focus and postponed for later. And this is not surprising, since national safety must remain a top priority for the country during such difficult times. Currently, all Ukrainian enterprises and companies, including logistics ones, are concerned with questions of personal survival during this tough crisis period, maintaining their own operational functionality, resolving existing difficulties, and adapting to wartime threats, which is clearly demonstrated in Fig. 5.

At present, war is inextricably linked to the economy. Implementation of various measures to reduce risks requires sufficient costs [5]. The start of active combat actions led to major market shocks, which resulted in rising prices, declining production, inflation, reduced demand, higher fuel prices, and the mobilization of state and community resources for defense. All these reasonable points stand as a wall in the way of implementing «green» technologies and environmental solutions. The «green» transition is usually carried out in stable conditions, when companies not only have the appropriate resources and financial support, but can also clearly predict their future condition for the coming years. This complicates the current situation in this direction in our country. The development of the transport complex under martial law is a very important task for supporting the country's economy [6].

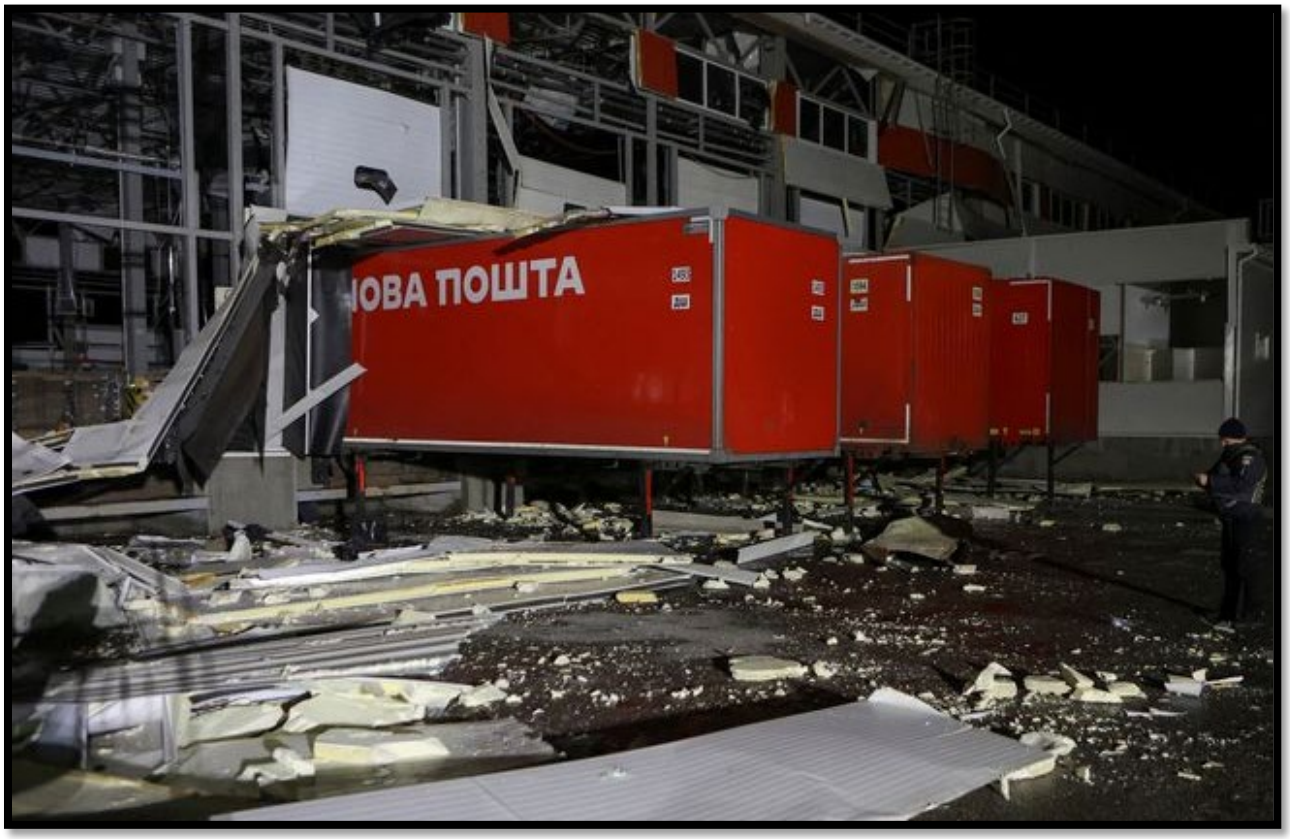

Figure 5 – Russian missile attack on postal centre in Kharkiv
Source: https://news.sky.com/story/six-killed-in-russian-missile-attack-on-postal-distribution-centre-in-kharkiv-says-ukraine-12989826

Taking all of the above into account, it can be emphasized that today, more than ever before, it is important to continue studying the challenges that stand on the way of implementing «green» technologies in the logistics sphere, creating modern conditions for the development of «green» logistics, and seeking new possible sources of support for its improvement.

Conclusions. Having conducted an in-depth analysis of the key challenges that stand on the way of implementing «green» technologies in the logistics sphere in this article, it can be highlighted that this process is quite complex in our time. Having studied this question in full, it is important to note that the development of «green» logistics requires not only the renewal of the technical and technological components of companies, but also the introduction of modern reforms and systemic changes in traditional practices of strategic forecasting, state regulation, financing, investment, and the development of environmental awareness of citizens. Having studied a wide range of difficulties that hinder the implementation of «green» technologies in logistics, it is possible to highlight a list of the main challenges, among which are high initial costs and the need for significant investments, the lack of a detailed regulatory and legislative framework, the lack of unified, legally defined standards for the environmental friendliness of logistics operations, the lack of state support for logistics companies and a poorly thought-out system of incentives for them in terms of ecological transition, the need to build modern infrastructure for alternative, «green» solutions, the complexity of integrating «green» technologies into the established logistics activities of companies, the need to renew the transport fleet and warehouse facilities of logistics companies, poor environmental awareness of logistics companies, weak pressure from clients, as well as global instability, geopolitical

conflicts, and crises. Research has shown that all of the above-mentioned challenges are relevant to our country and are currently greatly complicated by wartime conditions. In order to solve them step by step, it is necessary to achieve active cooperation between the state, business, and society. The development of «green» logistics is undoubtedly a complex but already inevitable process. The survival of humanity and the preservation of our planet depend on the success of this sustainable transformation. Even in such a difficult situation, we must not forget about «green» logistics and realize its potential, at least in the long term. The gradual resolution of the difficulties mentioned in the article will lead to the formation of a productive, environmentally friendly, energy-efficient, competitive, and safe logistics sphere that meets «green» standards. That is why it is so important to continue to research, analyze, and study this fateful question.

References

1. Consortium for Sustainable Development. The Importance of Sustainable Development for Our Planet and Future Generations. [Electronic resource]. – URL: https://consortium4sd.org/blog/the-importance-of-sustainable-development-for-our-planet-and-future-generations

2. OECD. Green technology and innovation. [Electronic resource]. – URL: https://www.oecd.org/en/topics/green-technology-and-innovation.html

3. IPCC. Climate change in data. [Electronic resource]. – URL: https://www.ipcc.ch/report/ar6/wg1/resources/climate-change-in-data

4. WIPO. Green Technology Diffusion: Insights from Industry. [Electronic resource]. – URL: https://www.wipo.int/web/wipo-magazine/articles/green-technology-diffusion-insights-from-industry-38710

5. Dmytro Bugayko, Volodymyr Reznik, New challenges for logistics in the conditions of military operations. Intellectualization of Logistics and Supply Chain Management: The electronic scientifically and practical journal v.21 (2023).

6. Volodymyr Reznik, Dmytro Bugayko, Comparative analysis of the legislation of Ukraine and international norms that regulate the implementation and formation of aviation logistics system. Intellectualization of Logistics and Supply Chain Management: The electronic scientifically and practical journal v.20 (2023).