THE ENVIRONMENTAL FOOTPRINT OF E-COMMERCE IN MODERN CONDITIONS

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The article is devoted to studying the ecological impact of e-commerce on the environment and the theoretical aspect of setting and applying sustainable development goals in this sector. As part of the work, an analysis of the growing trend of digital business model research was carried out, considering the three main goals of sustainable development. The relevance of the research is due to the rapid changes in the world, which must be responded to to provide for future generations. Such research methods were used as abstraction, synthesis, empirical research methods, the Scopus information platform's resource base, comparison method, graphic interpretation, and the VosViewer program. The article considered the main opinions of scientists regarding electronic commerce. A bibliographic analysis from the Scopus scientometric database is shown. The relationship between «e-commerce» and «sustainable development» was investigated. The dependence of Internet users over time on social network users from 2012 to 2022 was shown. This dependence was shown in the context of the growth of digital sales, which reflects trends in e-commerce, where the parallel development of Internet users and social networks took place. According to the graph, the equation of direct dependence is given and the coefficient of multiple determination - R^2 is determined. In addition, it is determined to increase sales of goods worldwide with ecological delivery and ecological packaging. The implementation of environmentally friendly packaging and delivery not only contributes to the preservation of the environment, but also positively affects the image of the company, making it more attractive to customers who support sustainability and environmental responsibility. It also showed shoppers' appreciation of green alternatives for e-commerce packaging and found that people are willing to pay more for green shipping. The results of the study allow company managers and buyers to adhere to the goals of sustainable development.
Keywords: e-commerce, sustainable development, online shopping, digitization, digital transformation, ecological packaging and delivery.

ЕКОЛОГІЧНИЙ СЛІД ЕЛЕКТРОННОЇ КОМЕРЦІЇ В СУЧАСНИХ УМОВАХ

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Стаття присвячена вивченню екологічного впливу електронної комерції на навколишнє середовище, а також дослідженню теоретичних аспеків встановлення та застосування цілей сталого розвитку в секторі електронної комерції. В рамках роботи проведено аналіз зростаючої тенденції досліджень цифрових бізнес-моделей з урахуванням трьох основних цілей сталого розвитку. Актуальність проведення дослідження обумовлена швидкими змінами у світі, на які необхідно реагувати для забезпечення майбутнього покоління. Використано такі методи дослідження як абстрагування, синтез, емпіричні методи дослідження, ресурсну базу інформаційної платформи Scopus, метод порівняння, графічної інтерпретації, а також використано програму VosViewer. В статті було розглянуто основні думки науковців стосовно електронної комерції. Показано бібліографічний аналіз з наукометричної бази даних Scopus. Було досліджено взаємозв'язок «e-commerce» and «sustainable development». Було показано залежність користувачів Інтернету в часі від користувачів соціальних мереж у часі з 2012 по 2022 роки. Ця залежність була показана в контексті зростання цифрових продажів, що в свою чергу відображає тенденції в електронній комерції, де відбувався паралельний розвиток користувачів Інтернету та соціальних мереж. Згідно графіку наведено рівняння прямої залежності та визначено коефіцієнт множинної детермінації - R^2. Окрім цього, визначено підвищення продажів товарів по всьому світу, з екологічною доставкою та екологічною упаковкою. Впровадження екологічно чистої упаковки та доставки не лише сприяє збереженню навколишнього середовища, а й позитивно впливає на імідж компанії, роблячи її більш привабливою для клієнтів, які підтримують сталість та екологічну відповідальність. Також, було показано оцінку екологічно чистих альтернатив для упаковки для електронної комерції серед покупців і визначено, що люди готові платити більше за екологічну доставку. Результати дослідження дозволяють керівникам компаній та покупцям дотримуватися цілей сталого розвитку.
Ключові слова: електронна комерція, сталий розвиток, інтернет-магазини, цифровізація, цифрова трансформація, екологічна упаковка та доставка.

Cite as: Prykhodko, A. (2024). The environmental footprint of e-commerce in modern conditions. *Visnyk of Sumy State University. Economy Series*, 1, 52-59. https://doi.org/10.21272/1817-9215.2024.1-05

INTRODUCTION

In today's world, the impact of technology on the environment is becoming more and more obvious and significant. Digital transformation, which transforms all spheres of life, including the economy, education, medicine and others, not only has a significant impact on the way we live and work, but also creates new challenges for the conservation of natural resources and the preservation of ecological balance.

The term «ecological footprint of e-commerce and digital transformation» reflects the impact of digital technologies on the environment, including both positive and negative aspects. On the one hand, digital innovation can contribute to optimizing the use of resources, reducing emissions, and improving the efficiency of production and consumption. On the other hand, they can lead to increased energy consumption, waste production and other negative consequences for the environment.

Understanding and studying the ecological footprint of e-commerce is essential to the development of a sustainable society that balances technological progress and environmental protection. This paper will explore various aspects of this issue, including the impact of digital transformation on resource use, waste management, and other environmental challenges of today. This topic is relevant and not fully researched.

LITERATURE REVIEW

In the 1950s and 1960s, the term «electronic commerce» appeared, when programs on the «Mainframe» began to be developed. In 1960, the first transport ticket sales system appeared - SABER. In those years, they began to create prototypes of e-commerce systems to automate business processes. The terms «e-business» and «e-commerce» appeared in the United States in the 1980s due to the development of the global information economy. The emergence of the Internet contributed to the rapid development of electronic commodity-money relations.

Ukraine did not have a definition of «e-commerce» until 2015. Law No. 675-VIII of 2015 introduced the definition and general principles of the functioning of electronic commerce, the rights and obligations of participants, the procedure for conducting electronic transactions and resolving disputes [1].

The question of the functioning of e-commerce is being actively studied by scientists all over the world, including in Ukraine. Various aspects of the use of Internet technologies in Ukraine were studied by several authors.

Schieferdecker, I. studied the legal aspect, while Shlapak A., Yatsenko O., Ivashchenko O., Zarytska N., Osadchuk V., Dagli A., Dogan S.Ö. focused on legal principles and measures to improve e-commerce [2, 3, 4]. Problems and prospects of the development of international electronic trade in Ukraine were considered by Tovkun L., Perepelytsia M., Maryniv N., Ovcharenko A. [5].

While studying various aspects of the theory and practice of e-commerce application, it is important to note that businesses and enterprises pay a lot of attention to this issue. In particular, in the work of foreign author such as Dyma, O., it is emphasized that "electronic commerce" is any form of business process that takes place electronically using Internet technologies [6].

Among Ukrainian researchers Kushnirenko O., Gakhovich N. considered a special mechanism for recovery, reconstruction and modernization of Ukraine, aimed at the transition to a "green", digital and inclusive economy that meets EU standards [7]. S. Vorobyov and Yu. Zaitsev studied the peculiarities of legal protection of the honor, dignity and business reputation of environmentalists in the context of the digital development of society [8]. V. Moroz and O. Kozhuhar described the processes and methods of decision-making in digital organizations and institutions, as well as ways of coordinating and controlling the activities of personnel and the use of resources in order to achieve certain goals [9]. S. Vorobyov analyzed the theoretical, methodological and organizational foundations of the functioning of digital information and communication infrastructures in the field of ecology, nature protection and nature management, as well as considered the experience of functioning of digital enterprises in this field [10].

The origins of the scientific study of the reproduction of the goals of sustainable development in electronic commerce are embodied in a few scientific works. By analyzing the Scopus database, modern scholars who have entered the era of rapid development of digital technologies and shown their views to the world have been highlighted, such as Chen Mo, Bashir Rabia [11], who research the evolution process of multi-channel retailing, as well as the performance of the connection channels of physical stores and caused changes in the urban areas and retail sector. Di Yuna, Zhi Ruixin, Song Huaixi, Zhang Lu [12] show that human capital and NTI potential are more sensitive to the digital trade of middle-income countries than to the effects of high-income countries, and the contribution of the population in middle-income countries is more pronounced. Pradap Aneesh, Alisherova Zokhidabonu [13] show various factors associated with the use of green logistics for the e-commerce industry, which provides home delivery across the country in the shortest possible time.

Despite the multitude of the above-mentioned works, and scientific works and international reports, we note that although the issue of electronic commerce is widely covered in modern literature, the issue of sustainable development goals remains insufficiently researched in global practice, so further research is needed.

Modern bibliometric analysis methods from the Scopus scientometric database were used for a clearer analysis of the used terms and determination of the intersection of research fields. The relationship between «e-commerce» and «sustainable development» was investigated. Figure 1 shows the number of articles, which is small but is only increasing every year, indicating that the research field is at an early stage of development, although the first article was registered

in 2000. The total number of articles in the Scopus database that mention the relationship between «e-commerce» and «sustainable development» was 632 (118 for 2022, 50 publications for 2024).

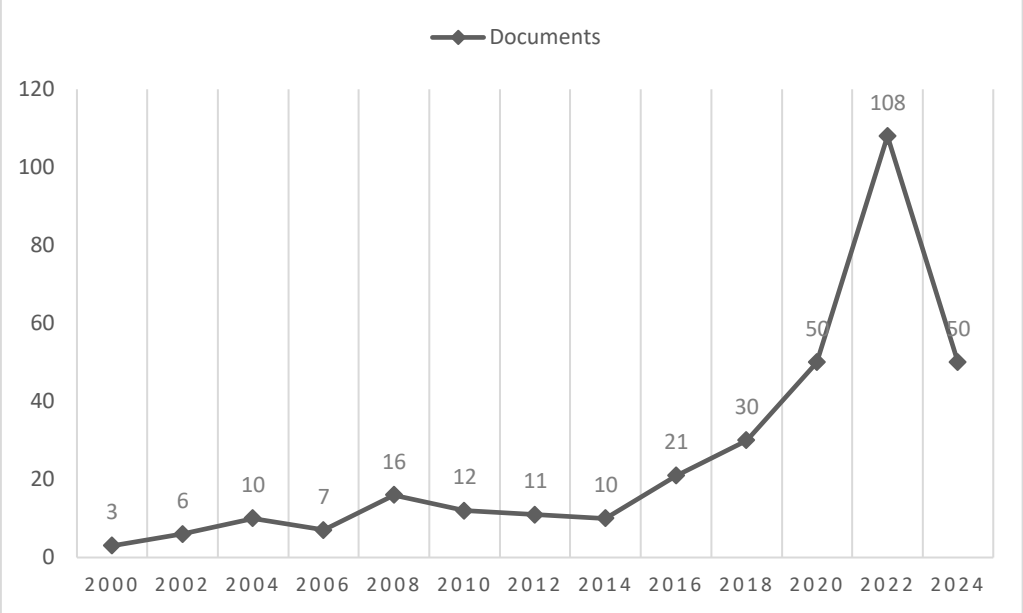

Fig.1. The trend of academic publications in the field of e-commerce with sustainable development goals
Source: compiled by author formed on the Scopus database

The number of publications fluctuated over the course of 20 years, even from zero papers to an incredible 10 papers in 2014. This topic has not been popular among academics, but since 2016 there has certainly been an increase in attention. Based on the results, it is possible to predict the appearance of a series of new publications in periodicals.

The distribution of documents by subject areas (Fig. 2) varies significantly according to all major areas, such as Engineering, Business, Management and Accounting, Computer Science, Mathematics, Economics, Economics and Finance, Energy, etc.

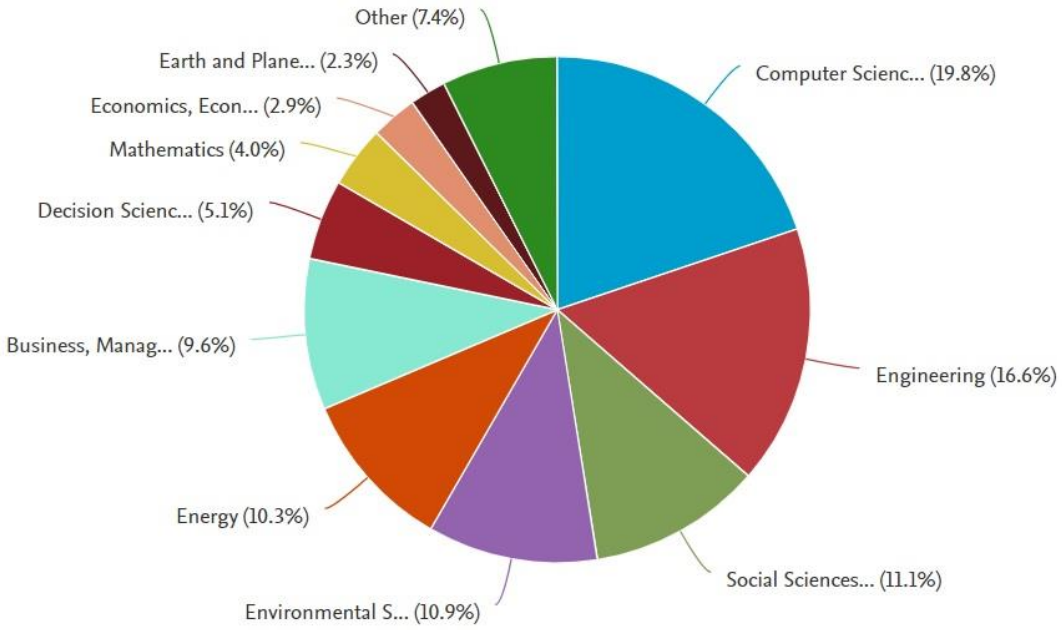

Fig. 2. Separation of documents on e-commerce with sustainable development goals by areas
Source: complied by the author formed on the Scopus database

Figure 3 shows the results of data processing in the VOSviewer software.

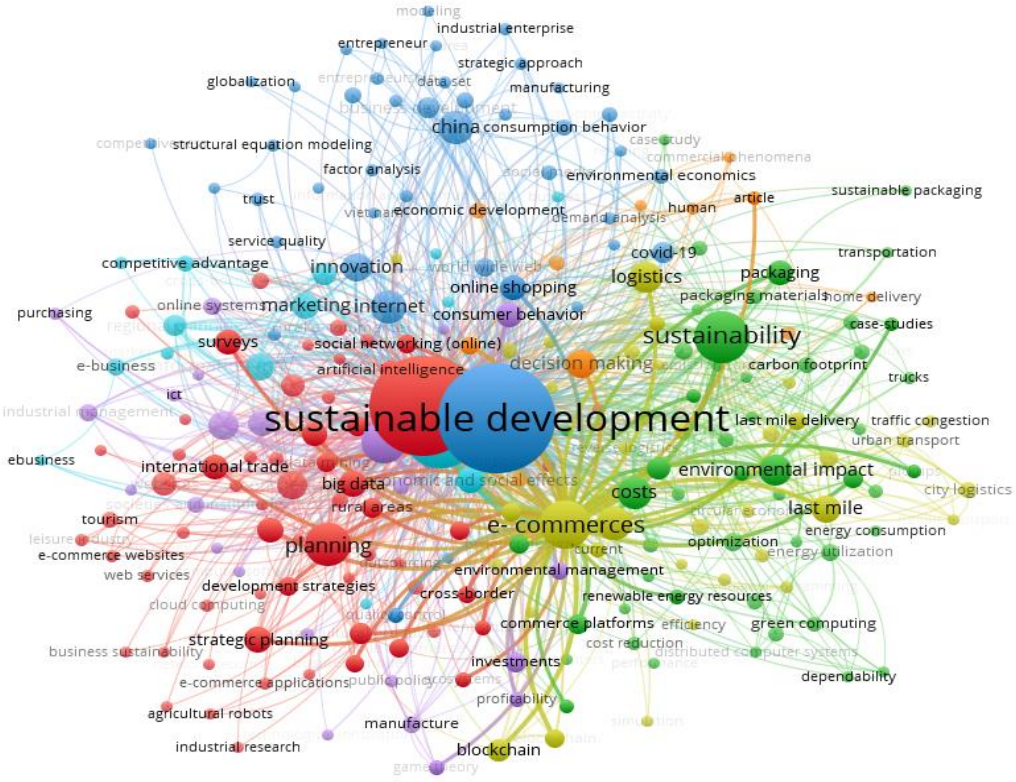

Fig. 3. Network visualization of the most used terms articles of e-commerce with sustainable development goals
Source: complied by the author formed on VOSViewer v.1.6.16 using a sample of 74 articles from Scopus Database

The size of the circles reflects the density of the terms used. An overlay visualization, network visualization, and density visualization were done for all terms using VOSviewer. Related terms are «e-commerce», «sustainability», «international trade», «logistics packaging», «environmental impact», «online shopping».

METHODOLOGY AND RESEARCH METHODS

The article is based on the works of domestic and foreign scientists, entrepreneurs, speakers and businessmen who deal with e-commerce issues. For a detailed study of the existing theoretical base, theoretical methods were used: abstraction and synthesis. Empirical methods were used to process the received information: description and observation. The resource base of the Scopus information platform was used to collect information and analyze it. A comparison method was used to highlight the goals of sustainable development. With the help of graphs, charts, as well as VosViewer, data was presented.

The purpose of the research is:

- conducting a bibliometric analysis of sustainable development in electronic commerce;
- consideration of the combination of sustainable development and digital transformation;
- identification of problems and proposed measures to solve them in electronic commerce from a social and environmental point of view;
- formulation of conclusions in accordance with the research topic.

RESULTS

Implementation of the concept of sustainable development involves solving the complex challenges of the modern world, in particular, ensuring economic growth, social justice and environmental sustainability.

Digital transformation, in turn, reflects a modern development paradigm aimed at using digital technologies to change and improve all aspects of life and activity.

The combination of sustainable development and digital transformation creates a powerful innovative synergistic effect that can accelerate the achievement of sustainable development goals and contribute to the creation of a fairer, more efficient and environmentally sustainable society.

Like other UN member countries, Ukraine has also joined the process of ensuring sustainable development, but it is still at an initial stage. Today, the country is in an economic crisis, therefore, during the formation of economic policy, the principles of sustainable development should be implemented at all levels.

Among the 17 Sustainable Development Goals (SDGs), 3 SDGs were focused on, which most correspond to the problem of studying the ecological footprint of e-commerce (Fig. 4).

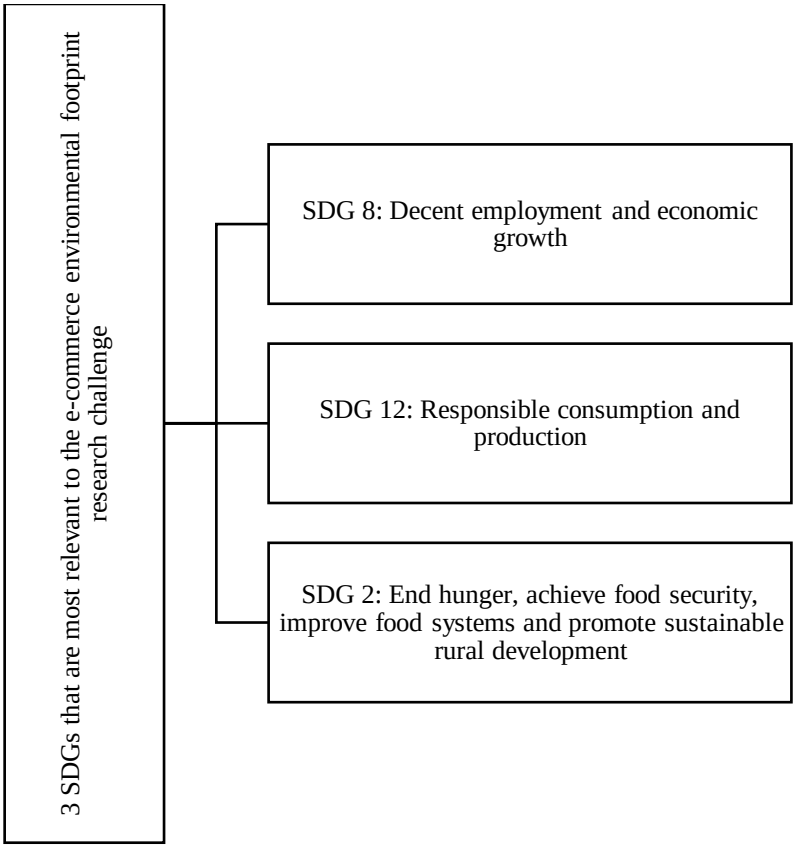

Fig. 4. SDGs that are most relevant to the e-commerce environmental footprint research challenge
Source: developed by the author

According to SDG 8, digital technologies create new opportunities for the creation of quality jobs and the development of innovative sectors of the economy.

According to SDG 12, digital innovations contribute to the creation of more efficient and sustainable processes of production and consumption, reducing waste and negative impact on the environment, using eco-packaging.

In SDG 2, digital market platforms can provide villagers with access to a wide range of buyers and improve their ability to sell their products, contributing to their income and improving their lives.

9 companies from the Opendatabot rating reduced the number of employees in 2023. Among them are «Ukrposhta», which cut 35% of the staff, «Silpo» (-18.1%). The companies explained the reduction by optimization of business processes, digitization and automation of manual operations. Digital technologies also helped to create remote digital places, reducing the cost of renting premises, minimizing the paper circulation of documents, switching to electronic programs [14].

The latest e-commerce patterns, exacerbated by the COVID-19 pandemic, are showing significant changes in the behavior of online customers.

The number of Internet users has more than doubled over the past 10 years — from 2,18 billion at the beginning of 2012 to 4,95 billion at the beginning of 2022. Namely, in 2022, the number of Internet users increased by 192 million people, and the annual growth in 2021 was only 4%.

Also, the audience of social networks grew by 10.1%. Growth rates between 2021 and 2022 remain higher than pre-pandemic levels. A large number of online sales are made through social networks, which either sell goods/services on their pages or through advertising in them from online stores [15].

Figure 5 shows the dependence of Internet users over time on Social media users over time. The R^2 coefficient shows the reliability and is within the permissible limits.

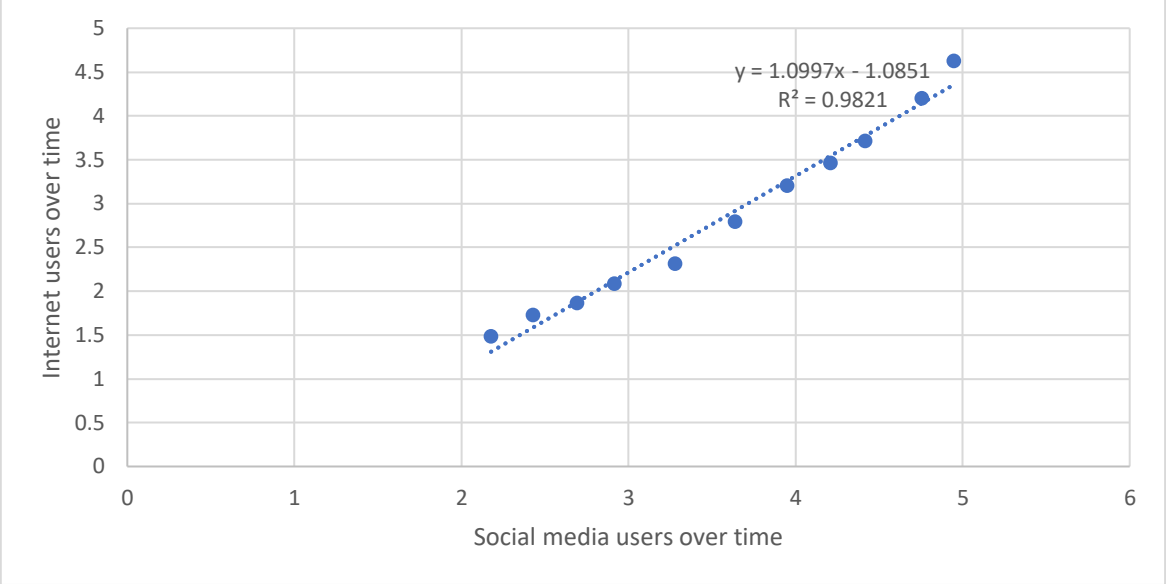

Fig. 5. The dependence of Internet users over time on Social media users over time for the period 2012-2022
Source: developed by the author

As seen from Graph 6, there is a direct linear relationship between the level of Internet use and the number of users of social networks. According to this equation, each one-unit increase in the level of Internet use leads to an increase in the number of social media users by 1,0997 units. The coefficient of multiple determination (R^2) shows the proportion of variation in the studied performance characteristic due to the influence of factors. Also, there are a large number of factors that influence the increase in this number of users.

Many experts suggest the emergence of a new consumption paradigm and the future evolution towards sustainable consumption. The impact of digital business models on the environment is becoming increasingly relevant.

With e-commerce spreading so fast, the environmental footprint of shipping has become a pressing issue. As a result, companies choose environmentally friendly supplies that can give them a competitive advantage and strengthen their brand image in the market. So, for example, the restaurant «La Spezia» uses electric scooters to deliver ready-made food. Companies should strive to provide the best infrastructure for e-commerce delivery and be responsible for social and environmental impacts.

Also, the production and use of e-commerce packaging has a large impact on the environment. More than 20 billion packages were shipped worldwide in 2018, and packaging has a direct impact on the environment in the form of increased CO_2 emissions and energy consumption [16].

A survey was conducted on the willingness of customers to pay more for delivery if the company uses ecological delivery and 70,25% of respondents answered that they are willing. An evaluation was also conducted regarding the packaging of e-commerce products. The results are shown in Figure 6 [16].

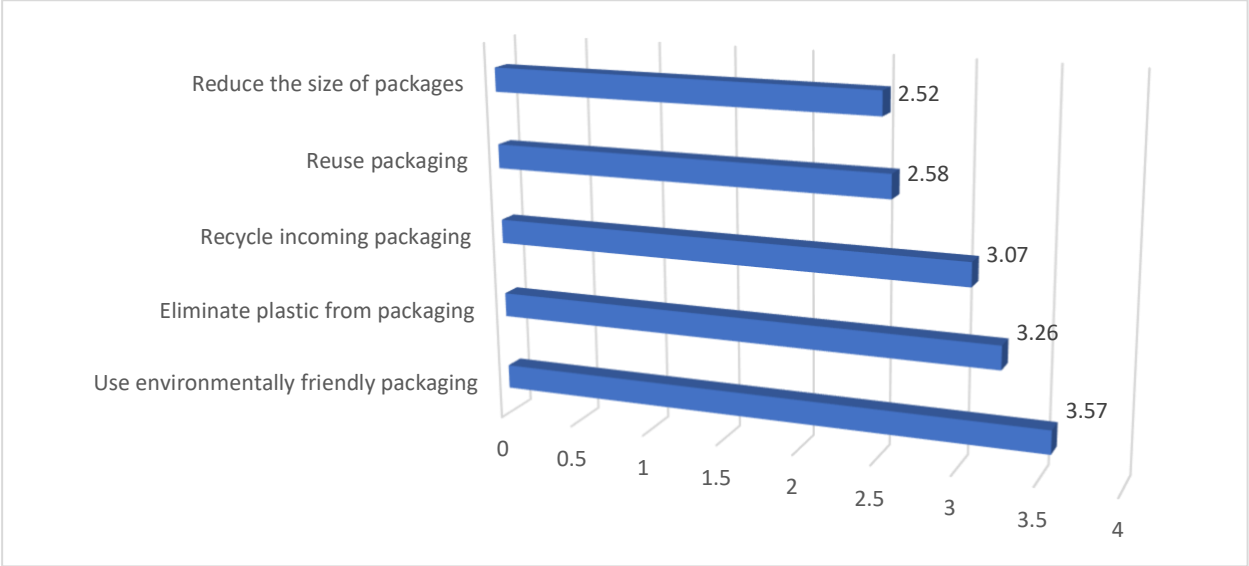

Fig. 6**.** Evaluation of eco-friendly alternatives for e-commerce packaging
Source: developed by the author based on [16]

Due to the popularization of e-commerce among consumers who buy products online, the question of compliance with the goals of sustainable development has arisen. Since the period of Covid-19, the delivery of goods has gained popularity all over the world, including in Ukraine. Ukrainian companies want to follow and act according to the goals of sustainable development, but the level is not high in the conditions of war. To improve the situation, companies need to pay attention to green logistics of products, use delivery without harming anyone, use ecological packaging for online delivery.

CONCLUSIONS

In today's world, e-commerce plays a key role in shaping the ecological footprint. The increasing use of digital technologies and the Internet leads to a significant reduction in the need for physical stores and transportation costs for the delivery of goods. However, along with these benefits come serious challenges, such as the production and disposal of electronic devices, the energy consumption to support the digital infrastructure, and the challenges of processing and disposing of electronic waste.

To reduce the negative environmental impact of e-commerce, it is necessary to implement strategies for sustainable production and consumption, as well as to strengthen efforts in the field of ecological disposal of e-waste. In addition, it is important to focus on the development of environmentally responsible technologies and initiatives that will help reduce the carbon footprint of e-commerce. Only through the joint efforts of governments, businesses and consumers can we achieve an ecologically balanced e-commerce that will contribute to the conservation of natural resources and the preservation of the ecosystem of our planet.

Based on the conducted research, the essence of the concept of sustainable development in e-commerce and its use in companies was analyzed. Delivery of goods, both from shops, warehouses, supermarkets and from restaurants and cafes, is popular among people. And based on the research, a large number of respondents are willing to pay more for green shipping and green packaging for the sake of humanity.

We conclude that a detailed study of methods of increasing social and environmental responsibility among sellers, intermediaries and buyers is promising for further scientific research.

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