

UDC 656.1

DOI <https://doi.org/10.32782/2521-6643-2024-2-68.15>

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ANALYSIS OF ORGANIZING THE DELIVERY OF HUMANITARIAN AID IN CRISIS SITUATIONS

The article is devoted to analyzing humanitarian logistics in Ukraine, which has developed significantly since 2014 and increased, in particular, during the full-scale invasion of 2022. Humanitarian logistics have become critical to supporting both the military and civilians affected by the conflict. The authors research the impact of various aspects of humanitarian aid, including economic factors such as reduced exports and a drop in the gross domestic product (GDP), on the volume and efficiency of humanitarian aid delivery. In particular, the impact of the closure of large metallurgical enterprises on the country's economy is analyzed. The activities of such charitable organizations as “Come Back Alive” and “Volunteering and Help Center” were reviewed, which carry out mass transportation of humanitarian goods and provide support to both military and civilian persons. These organizations play a key role in providing the population with necessary resources, such as medicine, food, hygiene products, clothing, etc. They also actively collaborate with international partners and volunteer groups to coordinate aid and improve logistics processes. Data on the amount of support provided by category (hygiene, medicine, food, etc.) are also considered. The article provides an analysis of the logistics routes used for the delivery of goods, taking into account various factors such as the safety of the routes, the efficiency of the transportation process, and the speed of delivery. The importance of flexibility and adaptability of logistics systems in the conditions of continued martial law is highlighted. The research emphasizes the importance of cluster analysis and clustering methodologies for effective decision-making in the field of humanitarian logistics. The article also includes references to legislative acts and portals that regulate and support humanitarian aid in Ukraine. These resources provide a legal basis for the activities of charities and provide important information for donors and volunteers. They contribute to the transparency and accountability of the aid delivery process, which is critical for maintaining trust on the part of the international community and the population of Ukraine.

Key words: humanitarian logistics, cluster analysis, logistics routes, humanitarian goods.

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Нестеренко Г. І., Музикін М. І., Бібік С. І., Стрелко О. Г., Алексєєва А. О. Аналіз організації доставки гуманітарної допомоги в кризових ситуаціях

Статтю присвячено аналізу гуманітарної логістики України, яка значно розвинулася з 2014 року та зростає, зокрема, під час повномасштабного вторгнення 2022 року. Гуманітарна логістика стала критично важливою для підтримки як військових, так і цивільних осіб, які постраждали від конфлікту. Досліджується вплив різних аспектів гуманітарної допомоги, зокрема економічних факторів, таких як скорочення експорту і падіння ВВП, на обсяг і ефективність доставки гуманітарних вантажів. Зокрема, аналізується вплив закриття великих металургійних підприємств на економіку країни. Було розглянуто діяльність таких благодійних організацій, як «Повернись живим» та «Центр волонтерства та захисту», які здійснюють масові перевезення гуманітарних вантажів, які надають підтримку як військовим, так і цивільним особам. Ці організації відіграють ключову роль у забезпеченні населення необхідними ресурсами, такими як медикаменти, харчові продукти, гігієнічні засоби, одяг та інші. Вони активно співпрацюють з міжнародними партнерами та волонтерськими групами для координації допомоги та покращення логістичних процесів. Також розглядається дані про обсяг підтримки, що надається за категоріями (гігієна, медикаменти, продукти харчування і т.д.). В статті надається аналіз логістичних маршрутів, що використовуються для доставки вантажів з урахуванням таких факторів, як безпека маршрутів, ефективність транспортування та швидкість доставки. Висвітлюється важливість гнучкості та адаптивності логістичних систем у відповідь на змінні умови конфлікту та потреби населення. Дослідження підкреслює важливість кластерного аналізу та методологій кластеризації для ефективного прийняття рішень у галузі гуманітарної логістики. Також в статті містяться посилання на законодавчі акти та портали, які регулюють і підтримують гуманітарну допомогу в Україні. Ці ресурси забезпечують правову основу для діяльності благодійних організацій, а також містять важливу інформацію для донорів та волонтерів. Вони сприяють прозорості та підвітності процесу надання допомоги, що є критично важливим для підтримки довіри з боку міжнародної спільноти та населення України.

Ключові слова: гуманітарна логістика, кластерний аналіз, логістичні маршрути, гуманітарні вантажі.

Formulation of the problem. Natural disasters, the COVID-19 pandemic, and the full-scale military invasion of the Russian Federation, all these phenomena are catalysts and factors in the development of the transport and logistics system for the transportation of humanitarian goods in special conditions. This article is particularly topical even today during the full-scale invasion of Russia on the territory of Ukraine. The experts noted that “the scale of humanitarian aid in Ukraine remains enormous.” Therefore, this article is relevant.

Analysis of recent research and publications.

There are the following factors that have influenced changes in logistics services in Ukraine: a mass movement of the population abroad, the unstable psychological state of the population, mobilization of the male population, the appearance of “new” types of goods (humanitarian aid and military supplies); mass internal motion of enterprises. Also, there are problems related to the transport infrastructure damage, due to which established logistics chains were destroyed [1, p. 161]. But, regardless of all these obstacles, companies carrying out the transportation of humanitarian goods use the following principle – in a heavy lorry, the freight that does not take up all the space in the freight compartment, it becomes possible to fill this space with additional freight. In this way, the fuel shortage is compensated and savings are achieved in the time during which the freight must arrive at the final destination.

As for the delivery of humanitarian goods in international traffic, these features are disclosed in the article [2]. In this article, the authors considered the main problems that may arise during the organization of international transportation and found that to increase the efficiency of this process, it is sufficient to define a rational scheme for the delivery of goods.

In turn, the article [3] presents examples usage of intelligent route modeling for the transportation of humanitarian goods. Also, it provides the scheme of the transport network of delivery, which is used to determine the basic plan of transportation. Also, we can see the scheme of operational management of cargo delivery when applying the concept of situational route selection (Fig. 1), which may arise during an “unpredictable situation” on a pre-planned route.

When an unpredictable situation occurs, it is necessary not only to determine the situation itself and several relevant management decisions but also to determine a reasonable way to achieve the goals in planning and operational management for the choice of delivery routes. For this, one needs to consider the possible consequences of several steps preceding the adoption of management decisions.

The genetic algorithm as an approach for global optimization is presented in the article [4]. The following advantages are given as an argument, such as:

1. Learning optimization: genetic algorithms can solve complex optimization problems of transportation systems by finding the best solution among different alternatives.
2. Ability to consider many factors: genetic algorithms can consider many parameters and restrictions of the transportation system, such as cost, travel time, and safety.
3. Adaptability to changes: genetic algorithms can adapt to changes, such as changes in traffic volumes, resource restrictions or changes in demand for transport services.
4. Ability to optimize complex functions: genetic algorithms can be used to optimize complex functions that are nonlinear, continuous, or contain multiple local optimum.

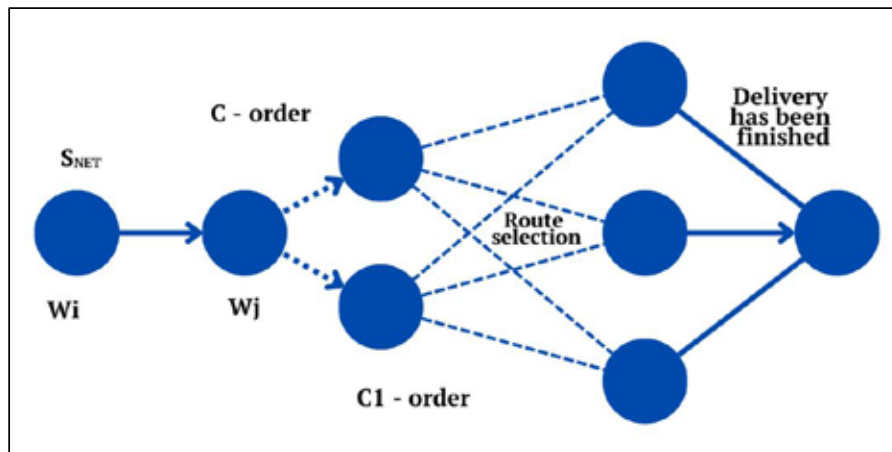


Figure 1. Operational management of freight delivery when applying the concept of situational route selection [3]

In the article [5] the authors emphasize the efficiency of integration processes when the Ukrainian transport system enters the European transport network. They note that this factor is an important one affecting the development of the country's economy.

In [6] it is underlined that within the framework of the transport market it is possible to separate two main interacting subjects: the transport system and consumers of transport products – consignors and consignees.

In paper [7] the results showed that the use of cluster analysis facilitates decision-making at the stage of intervention in humanitarian logistics. The authors propose a clustering methodology that works on processing historical data on natural disasters, creating models and clusters of the most characteristic types of emergencies in the region. As a result, communities can improve the standardization of disaster prevention procedures.

The purpose of the article is to analyze statistical data on the volume of humanitarian goods on the territory of Ukraine, to identify ways to improve the main stages in the transportation process and to study the phenomenon of humanitarian logistics itself.

Presenting main material. In Ukraine, we heard firstly about humanitarian logistics in 2014, and this type of logistics received its second wave and flourished in 2022, during a full-scale invasion. [8, 9] These historical events have greatly influenced our lives, so let us consider several aspects and areas in which we can see changes.

Many experts estimate that the GDP of Ukraine will decrease by 112 billion US dollars in 2022. This is due to a significant reduction in exports. [10] The main reason for the drop-in exports is the closure of the metallurgical plants PJSC “Ilyich Iron And Steel Works of Mariupol”, PJSC «Azovstal Iron & Steel Works», PJSC “Zaporozhstal”, partly “ArcelorMittal Kryvyi Rih” and some other enterprises. Available data attests to the scale of problems in the country's economy. [11]. In October, the export of ore abroad reached 1.1 million tons, which is the lowest monthly figure until 2022. In December 2021, ore exports reached the lowest figure this year, amounting to 3.7 million tons worth US\$270 million, while the highest figure in dollar equivalent for December was 4.3 million tons worth US\$788.4 million in the fifth month of 2021. [10]

From the beginning of the full-scale war against Ukraine, all infrastructure and its spheres have been damaged or destroyed. Based on the data collected by the Kyiv School of Economics (KSE) [10], we can understand that the direct damage caused to the infrastructure of Ukraine amounts to 157 billion dollars. Figure 2 presents the dynamics of the overall assessment of direct costs in Ukraine's economy, \$ billion [11].

The largest part of the total amount of direct damage falls on housing 37.5% (\$58.9 billion) and infrastructure – 23.4% (\$36.8 billion). It is also noted that the total number of destroyed residential buildings is 250,000 units. Figure 3 shows the overall estimate of direct damage to infrastructure in the first quarter of 2024.

Transport infrastructure facilities such as roads, railways, airports and ports are vital for the organization of military communications and transport, as well as for the evacuation of the population. [12] This infrastructure is also important for the country's economy. As of April 2024, according to preliminary estimates, 19 airports, 110 railway stations, 344 bridges, and 25,400 km of roads were destroyed. This aspect both complicates the work of transport enterprises and is also critical for the logistics sector of Ukraine, that is, there is no possibility of returning the work of transport enterprises to pre-war conditions [13]. As you know, before the start of the full-scale invasion, there were four main sectors of the transport market in Ukraine, namely: aviation, sea, railway, and automobile [14]. After the start of hostilities, most seaports and airspace had to suspend their activities due to the introduction of martial law. Analytical data on trends in the freight transport market in 2022 [11] show that the war led to a 22% drop in road transport, 48% in rail transport, 85% in sea transport, and almost 100% in air transport. The drop in freight transportation by each market segment is shown in Figure 4.

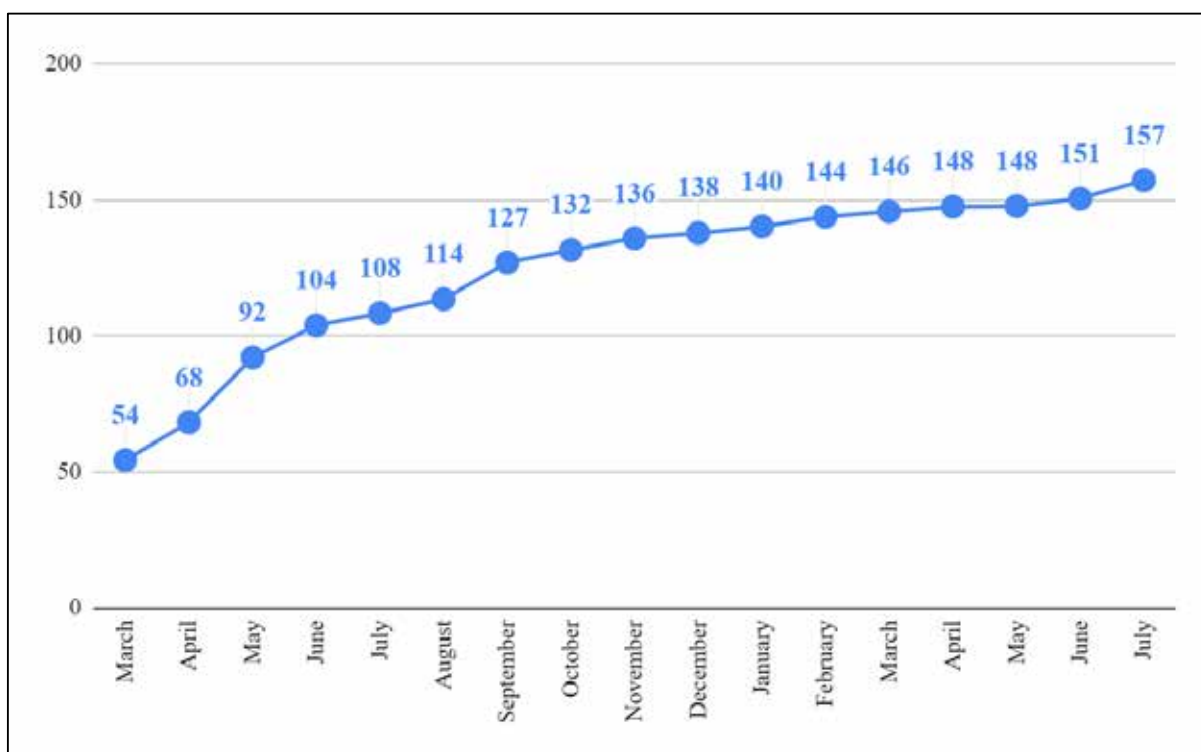


Figure 2. Dynamics of the overall assessment of direct costs in Ukraine's economy, \$ billion

Source: built according to the data [10]

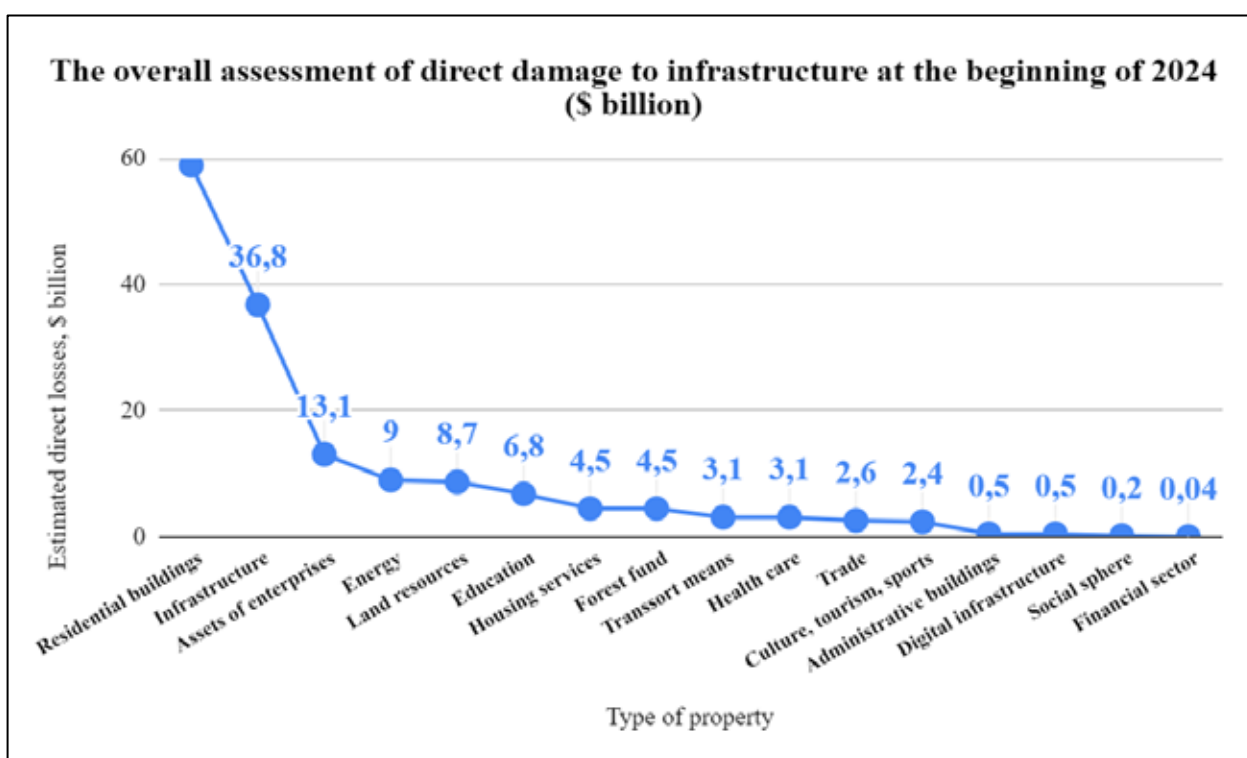


Figure 3. Assessment of direct damage to infrastructure in the first quarter of 2024 (it is compiled according to [10])

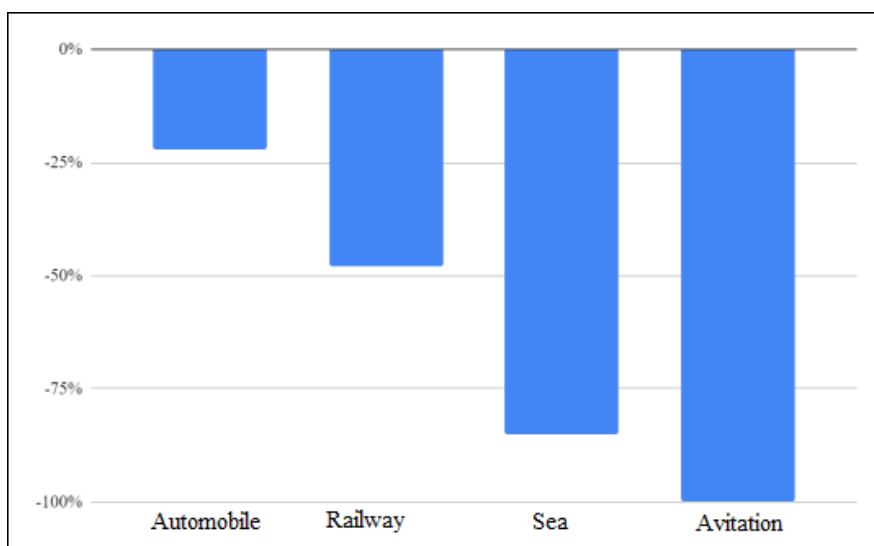


Figure 4. Decrease in freight traffic in Ukraine after the start of a full-scale Russian invasion (%)

Source: built according to the data [11]

Therefore, based on Figure 4, it is possible to understand why choosing freight transportation exactly by motor vehicles is optimal. However, it should not be forgotten that at the beginning of a full-scale invasion, the acute shortage of cars, drivers, and fuel was critical [15]. This was because the drivers left the territory of Ukraine to save their lives and those of their loved ones [16, 17]. All these factors impacted the migration of the population to the affected/temporarily occupied territories within the country. More than 14 million Ukrainians were left without their native homes and needed help.

Based on Art. 1 of the Law of Ukraine “On Humanitarian Aid” No. 1192 dated 10/22/1999: “humanitarian aid is designed-purpose addressed free aid in money or in kind as nonrepayable financial aid or voluntary donations, or aid in the form of fulfilling work or services provided by foreign and compatriot donors out of humane motives to recipients of humanitarian aid in Ukraine or abroad who need it due to social insecurity, poverty, difficult financial situation, state of emergency.” [18, 19]. The main needs demanded by Ukrainian society are medicines; fuel; sanitary and hygienic means; food; technical means and others.

The activities of foreign donors (about 40 of them) who provide military, humanitarian, and financial aid to Ukraine [20] are shown in Figure 5.

Having analyzed the Table, one can see that Poland and the Baltic countries are the leaders in helping Ukraine as a percentage of the country’s GDP. Estonia spent 1.26% of its GDP on aid, Latvia – 1.09%, Lithuania – 0.95%, and Poland – 0.68%. Slovakia and Denmark spend more than 0.5% of GDP to support Ukraine. Since the beginning of the full-scale war, the United States has provided Ukraine with the largest amount of aid – 76.84 billion US dollars. However, this is only 0.33% of US gross domestic product. The second place is occupied by Germany with 19.58 billion US dollars of aid. This is 0.27% of the country’s GDP. The United Kingdom ranks third, having provided \$11.67 billion, or 0.37% of GDP, in bilateral aid. Also, the aid was provided by France – 8.11 billion US dollars; Italy – 6.28 billion US dollars; The Netherlands – 7.24 billion US dollars; Spain – 5.21 billion US dollars.

Voluntary and charitable foundations perform active work as domestic donors. Before and during the full-scale invasion, dozens of volunteer funds and platforms were created, which are aimed at collecting and implementing humanitarian goods/aid for various segments of the population. In modern conditions, the issue of volunteering is becoming increasingly important and influential in society. Volunteers have become one of the most influential organizations in modern Ukraine. The level of trust of Ukrainians in the volunteer movement can be compared with the level of trust in the Armed Forces of Ukraine (AFU), which already says a lot about the influence and reputation in society [21]. Since the beginning of the full-scale invasion, dozens of charitable foundations (CF) and organizations have been established in our country. “Come Back Alive” is one of the largest funds supporting the Armed Forces of Ukraine, founded in 2014, and has a high reputation. The day before the invasion on February 23, 48 million hryvnias were collected. Since then, the scale of support has only grown, and at the end of July “Come Back Alive” reported 4 billion hryvnias in donations from 866,000 donors.

We can also consider the activities of the charitable organization (CO) “Volunteering and Help Center” (VHC) [22, 23]. Since the CF “Come Back Alive” is aimed at helping the army, the CO “VHC” directs its forces to support the civilian population of Ukraine. Having one main logistics center in Lviv and four regional ones in Zaporizhzhia, Kharkiv, Zhovti Vody, and Kherson, the fund carries out logistical transportation of humanitarian goods. The logistics route of the charitable organization is shown in Figure 6.

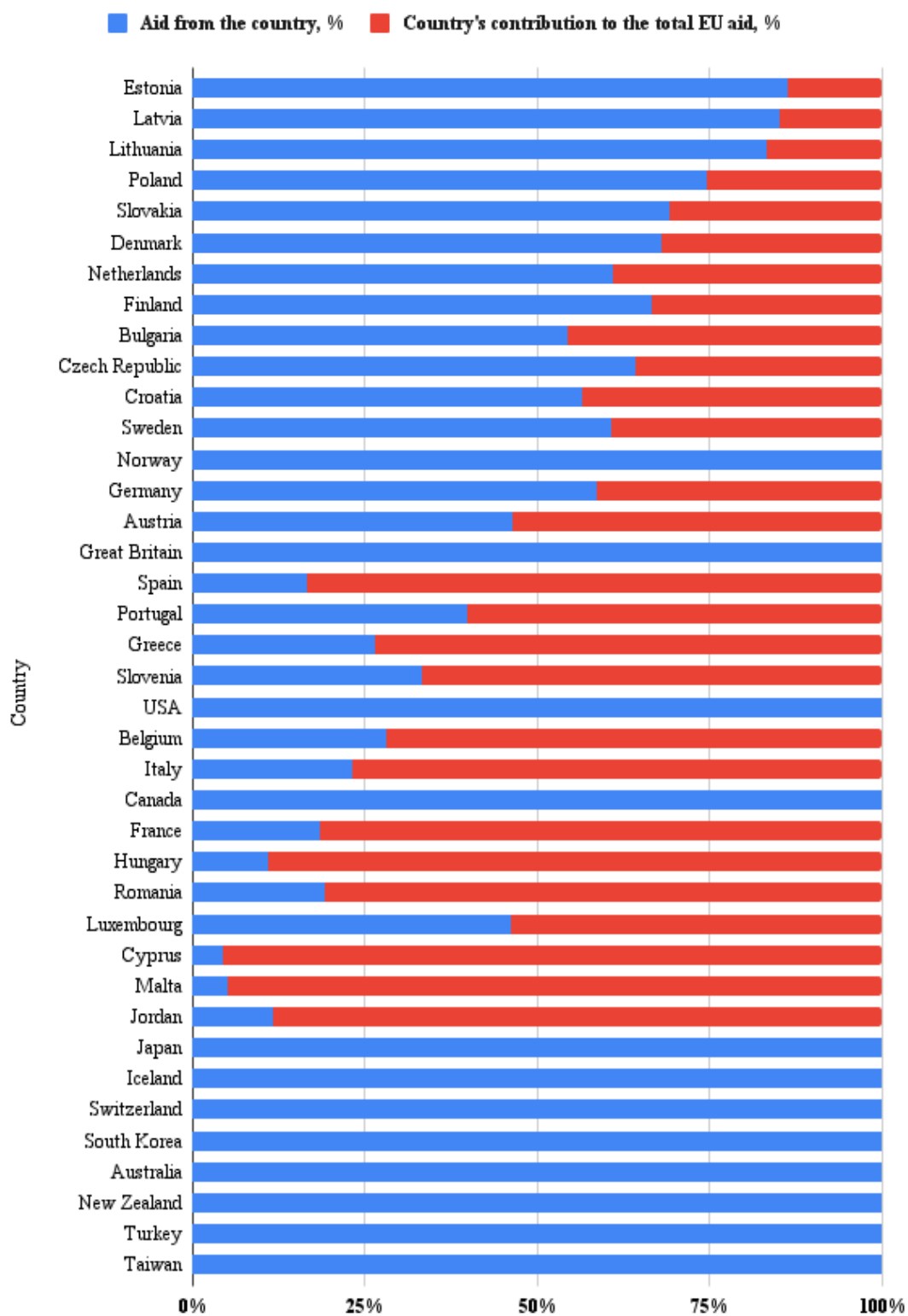


Figure 5. Analytics of the investment of monetary assistance from different countries in the world in % of GDP
 Source: compiled according to the data [20]

The article considered the main aspects of humanitarian logistics in Ukraine, which have been developing since 2014 and significantly intensified during the martial law, which was implemented in 2022. The authors analyzed various factors affecting the volume and effectiveness of humanitarian aid supplies, including economic ones. In particular, the closure of large metallurgical enterprises, which had a significant impact on the country's economy, is being discussed.

The role of charitable organizations such as "Come back Alive" and "Volunteering and Help Center" in providing large-scale transportation of humanitarian goods and supporting both military personnel and the civilian population is highly appreciated. These organizations actively cooperate with international partners to improve logistics processes and aid coordination. Data on the amount of aid provided by category, including medicine, food and hygiene products, were also analysed.

The article highlights the importance of flexibility and adaptability of logistics systems, which must respond to changing conflict situations and the needs of the population. The article also emphasizes the need to use cluster analysis and other methods for effective decision-making in humanitarian logistics.

In this research we also analyzed the activities of foreign donors who provide humanitarian and financial aid to Ukraine. Poland and the Baltic States are the largest donors in terms of the share of GDP spent on aid to Ukraine, while the United States provides the largest financial assistance.

It is important to note that volunteer organizations play a decisive role in meeting the humanitarian needs of the Ukrainian population. The research analyzed in detail the volumes and types of assistance provided by various organizations, and also emphasized the importance of coordinated logistics processes and effective organization.

Overall, the article demonstrates the importance of an integrated approach to organizing humanitarian aid in crisis situations and emphasizes the need for continuous monitoring and analysis to optimize logistics processes.

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