t. LXXVII ▪ nr 1/2025 ▪ DOI 10.33226/1231-2037.2025.1.3

Dr hab. inż. Adam Redmer
Poznan University of Technology (Poland)
ORCID: 0000-0003-2154-232X
e-mail: adam.redmer@put.poznan.pl

Mgr inż. Krzysztof Wyrwicki
Poznan University of Technology (Poland)
https://orcid.org/0000-0001-93851522
e-mail: krzysztof.wyrwicki@doctorate.put.poznan.pl

Potential of post-war Ukraine to handle transport of cargo between countries of the East and the European Union

Potencjał powojennej Ukrainy do obsługi transportu ładunków pomiędzy krajami Wschodu a Unią Europejską

Abstract

The transport potential of Ukraine is discussed in terms of supply and demand, infrastructure and geopolitics considering domestic, import, export, and especially transit one. The demand is analysed as resulting from domestic production and trade links with countries of the European Union (EU), former Soviet bloc countries as well as Asian and Middle Eastern ones, including Transcaucasia. The Ukrainian transport infrastructure, including its condition, is analysed against the background of international transport corridors. The role of the geographical location of Ukraine and the resulting geopolitical situation (including the ongoing war with Russia) are also taken into account. Based on the above, the concept of transit cargo transport East–EU via the territory of Ukraine is proposed. The concept stays in line with development plans of the EU, the Middle East and Ukraine, significantly increasing potential of the latter to handle the transport of cargo between the East and the EU.

Keywords:
Ukraine, Russia, post-war, international transport corridors, transit, transportation system

Streszczenie

Potencjał transportowy Ukrainy omawiany jest w kontekście podaży i popytu, infrastruktury i geopolityki, z uwzględnieniem przewozów krajowych, importowych, eksportowych, a zwłaszcza tranzytowych. Popyt na przewozy analizowany jest w kontekście produkcji krajowej oraz powiązań handlowych z krajami UE, byłego bloku sowieckiego, Azji i Bliskiego Wschodu, w tym Zakaukazia. Infrastruktura transportowa Ukrainy, w tym jej stan, analizowana jest na tle międzynarodowych korytarzy transportowych. Pod uwagę brana jest także rola położenia geograficznego Ukrainy i wynikająca z niej sytuacja geopolityczna (w tym trwająca wojna z Rosją). Na podstawie wyników przeprowadzonych analiz zaproponowano koncepcję tranzytowego transportu ładunków Wschód–UE przez terytorium Ukrainy. Koncepcja ta wpisuje się w plany rozwoju UE, Bliskiego Wschodu i Ukrainy, znacznie zwiększając potencjał tej ostatniej do obsługi transportu ładunków pomiędzy Wschodem a UE.

Słowa kluczowe:
Ukraina, Rosja, wojna, międzynarodowe korytarze transportowe, tranzyt, system transportowy

JEL: F51, L91, R41

Introduction

In the era of globalization, international trade plays a key role. Such trade requires transport of cargo between the world's main areas of supply and demand. They are primarily the most industrialized regions of the world, i.e., countries associated in the OECD, but also a group of developing ones, referred to as the BRICS (Brazil, Russia, India, China, South Africa, also Egypt, Ethiopia, Indo-

nesia, Iran, and UAE). Ukraine, the 58th economy in the world (OEC, 2024), does not belong to any of these groups. However, its economic potential is really high and growing. But, the most important is the geographical location of Ukraine, which is located between the major economies of the West (European Union – EU) and the East (Middle and Far). Thus, Ukraine is located at the intersection of the world transport corridors, both land and sea ones.

The Ukrainian transport network, including road and in particular railway one, is well developed, although its condition, especially in the context of the ongoing war, should be considered highly problematic. It is due to the Russian invasion of Ukraine which caused major market disruptions (Wysokańska, 2024, p. 80). Anyway, Ukrainian road freight transport focuses mainly on domestic services, while international services, in practice export ones exclusively, accounted for only 5% of the weight of goods transported in 2021 (UkrStat, 2023). In this light, it is transit via Ukraine that is of key importance from the global point of view. Transit is connecting sea routes leading from the East and South via Ukrainian ports and further road and rail routes within the TEN-T Trans-European Transport Network. This is crucial because the maritime transport remains the most important branch of long-distance transport for years, including intercontinental one (80–90% of the total transported weight of cargo, 70% of the total tonne-kilometres (tkm) and 60–70% of the total value of cargo, in 2015 (OECD, 2019)). While international land transport, especially bulk one, is dominated by rail (9% of the total tkm in 2015), and the so-called cross-trade, cabotage and last mile deliveries by road transport (18%) (OECD, 2019), global trade is mainly carried out by sea. Ukraine, what will be discussed in the article, shows a significant import and export potential as well as transit one on the East–EU line within all the above-mentioned transport branches. As for the maritime transport, it is mainly transshipment through Black Sea ports. However, this supply and demand potential is strongly and negatively conditioned politically and infrastructurally.

Assuming that, both, the economic potential and geographical location of Ukraine are of the most importance, the question is, if the post-war inland transport system of Ukraine can be adopted the way to be able to handle cargo transport between countries of the East, Ukraine itself and the EU? Authors formulate an *ex ante* hypothesis that it will be possible under the condition that crucial factors will be taken into account in advance when planning a post-war recovery actions concerning Ukrainian transport system, especially its infrastructure. Thus, the research problem is to identify and characterize factors limiting potential of post-war Ukraine to handle import, export and transit transport via its territory. And, as a result, the aim is to construct a concept of an appropriate Ukrainian cargo transport system taking such factors into account.

To solve the above defined research problem and achieve the set aim a deep and detailed knowledge concerning current and, if possible, future geopolitical and economic situation of Ukraine is necessary. Unfortunately, the situation is very dynamic and access to the data is very limited. The Ukrainian government has introduced significant restrictions on an access to the public data (including this provided by the UkrStat). Thus, the research methodology will be qualitative and based on the desk studies of source materials, especially those in Ukrainian and Russian languages. The quantitative arguments will be given whenever an appropriate data is available. In general, the hypothetico-deductive method will be used. However, it has to be clearly stated that taking into account all the current research obstacles the proposed concept of the transit cargo transport East–EU via the territory of Ukraine is both, preliminary and rough, and can change or at least evaluate in the post-war reality. But it is necessary to prepare at least concepts right now.

Supply and demand potential

Domestic transport in Ukraine, and especially the one from and via its territory, is conditioned by Ukraine's role as an exporter, and to an even greater extent, an importer and transit country. It is estimated that Ukraine possesses approx. 5% of the world's mineral resources, and belongs to the top 10 of the world's largest producers and exporters of, e.g., uranium or metal ores, such as iron, including semi-finished products made of it, or manganese. Similarly, Ukraine is in the top 10 producers of agricultural products as cereals, especially corn, wheat, barley, rye or buckwheat, but also others, e.g., sunflowers, potatoes, raspberries, gooseberries or currants as well as honey and vegetable oils (OEC, 2023). Despite its resources, Ukrainian imports exceed exports (negative trade balance). Ukraine's main import needs include such natural resources as: refined crude oil, petroleum gas and coal briquettes. Apart from them, Ukraine also imports cars, medicaments, machinery and mechanical appliances, electrical equipment and spare parts, in large quantities (OEC, 2023). All this translates into transport, mostly of bulk cargos, from and to Ukraine, although it also includes domestic one.

The scale of transport needs of Ukraine and via its territory is influenced by the location, type and

size of supply and demand markets. As all these factors are highly differentiated inside Ukraine, between its oblasts, the scale of transport needs has been and will remain large. Thus, the industrialization of Ukraine should be analysed at the oblast level, and international exchange in relation to the countries of the Middle East and Asia, and the EU.

As for the oblasts there is the overwhelming economic dominance of the eastern ones, i.e., the Dnipropetrovsk Oblast (20% of the value of Ukraine's industrial production), Donetsk Oblast (11%) and Zaporizhzhia Oblast (8%). The capital city of Kyiv (13%) is also important for Ukrainian economy (UkrStat, 2022). If the EU countries are considered as potential sales markets, it is necessary to carry Ukrainian production through a significant part of its territory by road or rail transport, which requires adequate quality of infrastructure and capacity of border crossings.

Ukraine, as mentioned above, has a negative foreign trade balance, however, most of its oblasts (16 out of 25) have a positive one. The leaders of export are the city of Kyiv and the Dnipropetrovsk Oblast, the Donetsk Oblast and the Zaporizhzhia Oblast, which largely coincides with the volume of industrial production. Import is also dominated by the city of Kyiv (43% of the total), and by the Dnipropetrovsk Oblast, Kyiv Oblast and L'viv Oblast as well. In 2021 the western border oblasts of the country had surpluses of imports in relation to exports, which means that they acted as logistics hubs for goods imported to Ukraine. The share of imports, its value, in trade of L'viv Oblast was 62%, Volyn Oblast 69%, and Zaporizhzhia Oblast 50% (UkrStat, 2024).

Considering Ukraine's trade exchange with the EU countries there is an upward trend in both exports and imports, which is stronger in the case of the former. Ukraine's most important trading partners in the EU are Poland (20% of the value of Ukrainian exports and 17% of imports) and Germany (11% and 22%, respectively). However, it should be remembered that, so far, the main partners in Ukraine's international trade have been the countries of the former Soviet bloc, with Belarus, Kazakhstan and Russia at the forefront. More than 60% of the value of Ukrainian exports was sent there (Trading Economics, 2023). The whole is complemented by the leading and growing role of China, both, in terms of imports and exports, and also Egypt and Turkey, here mainly in terms of exports (OEC, 2023).

As for the role of Ukraine as a transit country, infrastructural and logistics projects should take into account cargo flows between Asian and Middle Eastern countries, and EU ones. Particularly noteworthy are the countries of Transcaucasia (Armenia, Azerbaijan, Georgia) and Turkey, as they are located in the immediate vicinity of the Black Sea, which is the shortest trade route between them and the EU. Table 1 shows the value of trade between the EU and the listed countries.

The analysis of the above discussed issues and data presented in Table 1 indicates the following perspective transport directions based on supply and demand (assuming that Ukraine's trade with Belarus and Russia will be very significantly reduced after the war):

- Ukraine's own production – the direction from the east (Kharkiv Oblast, Dnipropetrovsk Oblast, Donetsk Oblast, Poltava Oblast, Zaporizhzhia Oblast – in total more than 50% of the value of Ukraine's industrial production) to the west (EU direction, mainly the border with Poland, and further to the Polish and German markets, as well as Slovakia and then mainly to the Italian one). It means exports carried out by international rail and road transport, of which 40%, in value terms, go to the markets of the

Table 1
EU-27 trade of goods with countries of South Caucasus, Turkey and Ukraine [in EUR billion]

Country	Import from UE	Export to UE	Total (2023/2022)	Balance (2023/2022)
Armenia	2.2	0.8	3.0 (120%)	–1.4 (108%)
Azerbaijan	2.3	19.1	21.4 (65%)	16.7 (58%)
China	223.6	515.9	739.5 (86%)	292.3 (74%)
Egypt	21.2	11.5	32.7 (88%)	–9.6 (209%)
Georgia	3.6	0.8	4.4 (105%)	–2.9 (132%)
Turkey	111.3	95.7	207.0 (104%)	–15.7 (2 343%)
Ukraine	39.1	22.8	61.9 (107%)	–16.2 (775%)

Source: EC (European Commission) Trade Department (2023).

above-mentioned EU countries. And also, to the south (the direction of the Ukrainian Black Sea and river ports on the Danube and further to the countries of the Middle East and Asia, i.e., to Egypt, Turkey and China, respectively). It means exports as well, but carried out by domestic rail, road and inland waterway transport, along the Dnieper River. And finally domestic rail and road transport from the east of the country to Kyiv, the city and the region, which trade balance is negative, so Kyiv is the main destination for domestic production in Ukraine (36% in value terms).

- Foreign production – from the EU to Ukraine (mainly from Poland, Germany and Italy, which account for almost 50% of Ukrainian imports in value terms) and from China; such flows of goods end mainly in the city of Kyiv (almost 43% of the total), and the Dnipropetrovsk Oblast (east) and L'viv Oblast (west).
- Transit – from Asian countries (mainly China, but also Azerbaijan, Armenia and Georgia), as well as Middle Eastern countries (mainly Turkey) via Ukrainian Black Sea ports and then by road and rail, possibly also river transport on the Danube, to EU countries, i.e., from south of Ukraine to the west).

Infrastructural potential

Ukrainian transportation infrastructure covers practically all branches of transport. Their network densities are characterized in Table 2.

Ukraine ranks 35th in the world in terms of the length of road transport network. Therefore, it's network is not very extensive, especially in the view of the relatively large Ukrainian territory and population. For comparison, in Europe the density of the road network is 4 and almost 3 times higher per 1K km^2 and per 1M inhabitants, respectively (WorldData.info 2023a). The technical condition of the Ukraine's road network is very poor. According to the Ukrainian government 97% of roads require general renovation or ongoing repairs, as well as 2K bridges (Закон України, 2018). And these are pre-war figures. The railway network of Ukraine looks much better. Its total length gives Ukraine the 15th place in the world, just after Poland. Its density per 1K km^2 in comparison with the European countries is 0.8 times lower, whereas per 1M inhabitants, is 1.2 times higher (WorldData.info, 2023b). And finally, inland waterway and maritime transport. Here the data are divergent according to various sources. The length of Ukraine's inland waterways ranks 42nd place in the world. Its density in comparison with the European countries is 3 and 2 times higher per 1K km^2 and 1M inhabitants, respectively (WorldData.info, 2023b). The length of Ukraine's coastline is almost 2.8K km (41st place in the world). On the other hand, there are 18 Ukrainian seaports serving, according to various sources, approx. 1.0–1.3M TEU per year, which results in 61–58 place in the world only. However, in the Black and Azov Sea basins, this potential is very significant.

Transit through the territory of Ukraine depends much on the functioning of its seaports. The 5 largest Ukrainian ports, i.e., Pivdennyi, Mykolaiivskyi, Chornomorskyi, Odessa and Mariupol (characterized in Table 3), had in 2021 a total share of 25% of the weight of cargo handled in the Black and Azov Sea basins, and 28% of the weight of cargo that passed through all Ukrainian ports (Риженкова, 2022). But, these ports, excluding Chornomorskyi, recorded negative dynamics of cargo handled YoY. The largest group of goods handled by Ukrainian seaports were metal ores and agricultural products (60% in weight terms).

Table 2
Network length and density (2023)

Parameter	Ukraine	EU-27 [on average per 1 country]
Road network length [K km]	170	4467
Road network density [km/1K km^2]	280	1286
Road network density [km/1M inhabitants]	4	12
Railway network length [K km]	21	203
Railway network density [km/1K km^2]	35	58
Railway network density [km/1M inhabitants]	500	451
Inland waterways length [K km]	2	31
Inland waterways density [km/1K km^2]	3	9
Inland waterways density [km/1M inhabitants]	45	90

Source: WorldData.info (2023a, 2023b).

Table 3
Seaports of Ukraine (in M metric tons in 2021)

Seaport	Export	Import	Transit/cabotage	2021/2020
Pivdennyi	14	2	0.7	74%
Mykolaiivskyi	6	22	1.0	97%
Chornomorskyi	21	4	1.0	107%
Odessa	15	6	1.0	97%

Source: Південний морський торговельний порт (2023), Морхоз (2023).

The Pivdennyi/Yuzhnyi port was in the year 2021 the largest and deepest one in Ukraine, focused on handling bulk cargo, i.e., aggregates and metal ores (Південний морський торговельний порт, 2023). In the same year, the port of Mykolaiv was the leader in transshipment of vegetable oils, almost 3M t (36% share in the Ukrainian market). The largest groups of cargo handled in this port were also: metal ores, rolled steel, cast iron, chemical/mineral fertilizers, and petroleum products (Landlord, 2022). The port in Chornomorsk was the only one among the 5 largest ports, which in the year 2021 recorded an increase in throughput. The largest groups of cargo handled in this port were: agricultural products, motor vehicles, containerized cargo, steel, and vegetable oils (Морхоз, 2023). The largest groups of cargo handled by the port of Odessa in 2021 were: containerized ones, agricultural products, steel, and petroleum products (Морхоз, 2023). In 2021, the largest Ukrainian seaports were used primarily for the export of agricultural produce, bulk cargo and low-processed industrial products. The share of imports was much lower than that of exports, while transit was of negligible importance.

Goods handled by (unloaded in) seaports are further transported through the territory of Ukraine using road and/or rail modes. In the 2020, therefore before the ongoing war, the condition of Ukrainian road infrastructure, as mentioned above, was assessed as critical (Стасюк et al., 2020), and Ukraine was ranked 119 out of 141 countries in The Global Economy ranking "Roads quality by country" dated 2019 (TheGlobalEconomy.com, 2023). Some attempts were made to implement the GO-Highway infrastructural project, which was very relevant to the National Transport Strategy Priorities of Ukraine. The project aimed at connecting, via expressways, the Ukrainian ports on the Black Sea, Odessa and Mykolaiv, with the Polish ports on the Baltic Sea, Gdansk, Gdynia and Szczecin. The construction of an expressway from the border crossing with Poland Korczowa-Krakovets and further through L'viv–Tarnopol –Chmielnicki–Uman to Odessa and Mykolaiv, was assumed. Selected sections of the routes E95 (Uman–Odessa), E50 (Tarnopol–Uman), and E40 (border crossing Korczowa–Krakovets–L'viv) were to be brought up to the standard of European expressways. Unfortunately, it has not been completed due to the need to constantly focus on servicing and repairing the existing infrastructure on the Ukrainian side (Zasiadko, 2020). However, in the post-war period, the project has a significant chance of being completed. It is because in November 2022 the Ukrainian State Agency of Automobile Roads (Ukravtodor) became a part of the Conference of European Directors of Roads (CEDR). It may not be a guarantee, but it creates credible conditions for improving the quality of Ukraine's road infrastructure.

The development of the railway infrastructure leading to and from Ukrainian seaports (especially the one in Odessa) would significantly improve Ukraine's competitiveness in relation to the seaports of the EU countries (especially the Romanian port in Constanta, whose connection with the railway infrastructure is insufficient, which significantly extends duration of transport processes) (ЦТС, 2023). At the same time, the use of the Odessa port would be highly desirable from the countries through which the Trans-Caspian International Transport Route (TITR) passes. This would make it possible to bypass Russia and Belarus and avoid congestion in the port of Constanta. The main problem standing in the way of the competitiveness of Ukrainian railways in relation to road transport in terms of the use of both in the intermodal supply chains is the track gauge of 1,520 mm (the so-called "wide gauge"), and not 1,435 mm, as in the EU countries.

River transport in Ukraine is insufficiently regulated by law, which causes little interest in it on the part of potential investors. In addition,

significant sections of the rivers are unregulated and the infrastructure is outdated. Despite this, the Ukrainian Ministry of Infrastructure estimates that by 2030, over 30M t of cargo will be transported annually by inland waterways. The Ukrainian Independent Transport Strategy Center has even more ambitious forecasts: from 60 to 80M t of cargo per year. Transport on the Dnieper is expected to exceed 45M t per year, of which 30M t will cover exports and 15M t imports (Molchanov, 2022). These assumptions are based on the new law on inland waterway transport signed in 2020 by President Volodymyr Zelensky (Закон України, 2020). This legal act is intended to facilitate the organization of water transport in Ukraine and is largely consistent with the EU directives (Netrebenko, 2021).

Geopolitical potential

Ukraine is located between the East (Asia, including mainly the Transcaucasian countries, the former Soviet republics, and China plus India) and the West (Europe, including mainly the eastern EU countries, such as Hungary, Poland, Romania, Slovakia, and Moldova, which is not a member of the EU). Eastern Europe, from the point of view of so called "land power" (the concept of Sir Halford Mackinder), is most important to control Eurasia under the ongoing process of disturbance of the current (old) balance of power (Doński-Lesiuk, 2022, pp. 20–28). Moreover, Ukraine is located on the shores of the Black and Azov Seas, which open the southern direction (the Middle Eastern countries, especially EU candidate Turkey, and Iran). Such a location makes Ukraine an important transit country.

An international transit potential is mainly related to the so-called World Transport Corridors, where the two major global transport initiatives, the east-west and north-south, are located. The east-west one is the Belt and Road Initiative – BRI, which theoretically is mainly infrastructural initiative of China, launched in 2013 and bringing together 147 countries. The BRI covers both land (rail) and sea connections. There are 6 land corridors of which 4 include sea connections constituting the 7th corridor, called the 21st Century Maritime Silk Road. Both Ukraine (formally, from 2020) and Russia (not formally) are participants of the BRI. But at the moment, not a single BRI connection covers the territory of Ukraine or the Black and Azov Seas. However, since 2020 the Sino-Ukrainian Bilateral Cooperation Program, signed for the period of 5 years, is in force. It assumes the joint development of the "Economic Belt of the Silk Road" and the "Maritime Silk Road of the 21st century" (Poita, 2023, pp. 313–327).

An initiative, informally considered to be a part of the BRI, the so-called Middle corridor or the Kazakh Silk Route, is the Trans-Caspian International Transport Route (TITR). It was initiated in the 1993, i.e., after the collapse of the USSR, as an EU-supported program for the creation of the Transport Corridor Europe–Caucasus –Asia (TRACECA). The TITR is the shortest, rail-sea transport route connecting China with Europe, and offering an alternative to the New Eurasia Land Bridge (part of the BRI) omitting Russia. It may be an opportunity for countries such as Azerbaijan, Georgia, Turkey or Iran, through which logistic corridors lead not endangered. However, it should be remembered that the capacity of the Caspian–Black Sea corridors is incomparably lower than that of those still handling the exchange of goods through the infrastructure of Belarus and Russia, i.e., the New Eurasia Land Bridge (Doński-Lesiuk, 2022, pp. 20–28). This corridor leads to Poland via railway terminal in Malaszewicze accessed by the Terespol–Brest border crossing. Moreover, one of the TITR's branches also leads, via the Black Sea and then the territory of Ukraine, to Poland reaching the railway terminal in Slawkow by the Korczowa–Krakovets border crossing. Thus, an alternative solution may therefore be the post-war transport via Ukraine to Poland, which is part of both the BRI and TITR.

The north–south transport initiative is the International North–South Transport Corridor (INSTC). The corridor initiated in 2000 (formally 2002) by Russia, Iran and India constitutes a multimodal water-rail-road connection linking the above-mentioned countries, and Azerbaijan, Central Asia and Europe as well. And although neither of the two legs of the INSTC (sea or land) runs through Ukraine, Ukraine is still a member state of this project. This is despite the fact that the INSTC is based on the Eurasian Economic Union – EEU/EAEU, to which Ukraine does not belong. However, the majority of the Central Asian population (especially the inhabitants of Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan) is currently sceptical about the political goals of the EEU. They do not want to repeat the experience of the Soviet past, especially in the light of the so-called "special operation" in Ukraine. In this sense, the Shanghai Cooperation Organization – SCO, headed by China, is claimed to be more appropriate for the countries of this region (Yuldasheva, 2022, pp. 107–117). And although the INSTC primarily connects India with Russia, for the former and the other countries on the route (e.g., Iran), it is also a way of transporting cargo to the Baltic countries,

where the INSTC approaches the TEN-T network. 3 out of the 9 corridors of the TEN-T are of direct importance for the INSTC, i.e., the North Sea–Baltic, Scandinavian–Mediterranean and Baltic–Adriatic ones. Especially the first one. Currently, Estonia, Latvia and Lithuania, as well as Finland and Poland are cooperating here within the Rail Baltica project. And although the current form of the TEN-T network does not cover Ukraine, it does have points of contact with the Black Sea basin (i.e., the Romanian ports in Sulina and Constanţa and the Bulgarian one in Burgas). It is also worth remembering that the independent, wider and chronologically earlier course of the European transport corridors, i.e., Pan-European ones (PEN), called "Crete corridors" or "Helsinki corridors", included connections with Odessa via Kyiv, both from Poland (through L'viv – the corridor III), Slovakia (also via L'viv – the corridor V) and Belarus, alternatively even from Russia (the corridor IX). Currently the key factor for the future of the INSTC is not the sceptical attitude of the Central Asian countries, or its connection with the TEN-T and thus the possibility of transporting cargo to the Baltic countries, but Iran–Russia relations. Here, cooperation includes large transport investments aimed at the rapid development of the INSTC, called in this context the Persian Corridor. The role and attitude of Azerbaijan seems to be critical here. It is Azerbaijan where the TITR supported by the EU, and the INSTC supported by Russia intersect. At the moment, the scales in favour of the TITR are to some extent tipped by the already ceased conflict between Azerbaijan and Armenia in Nagorno-Karabakh. Russia remained on the side of Azerbaijan trying to maintain good relations in the context of the INSTC.

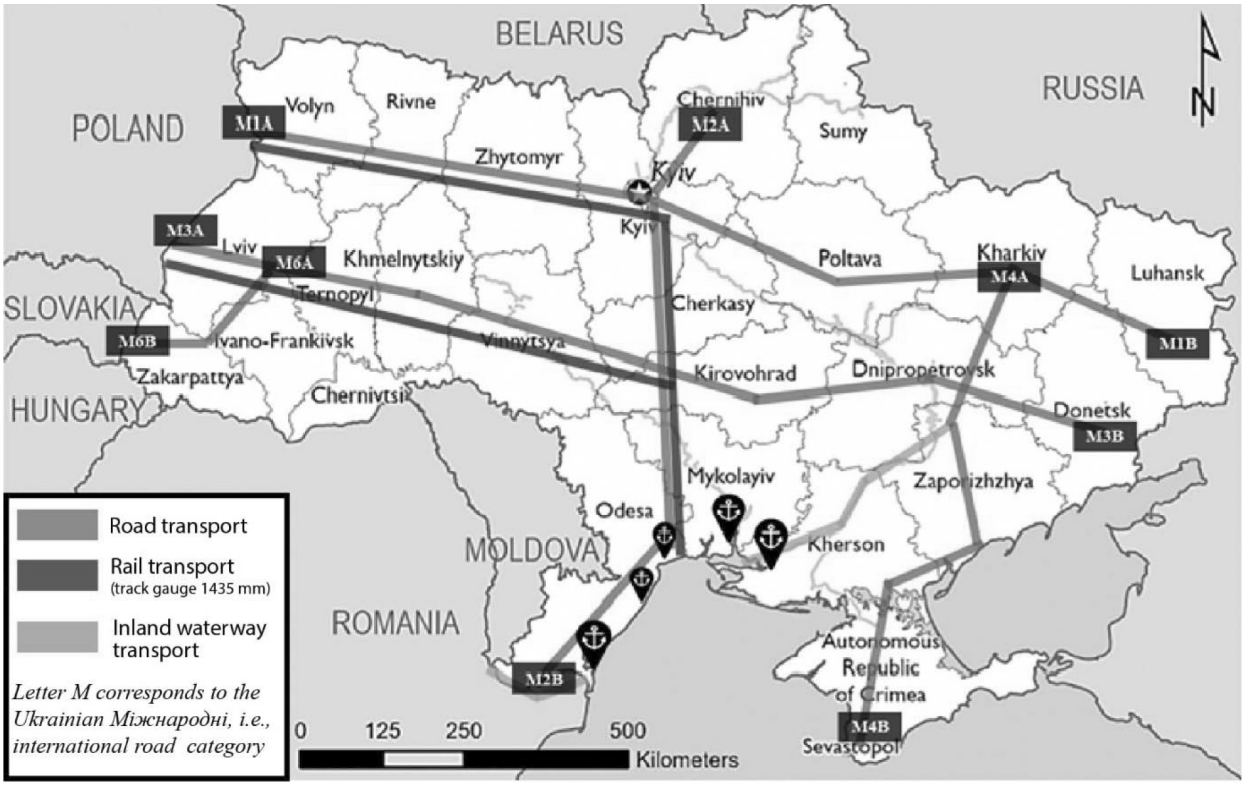
The second, although smaller and much less advanced North–South transport initiative is the Gdansk–Odessa International Transport Corridor, which runs exclusively through Poland and Ukraine. The corridor has a total length of approx. 1,800 km, of which the Ukrainian part includes over 900 km of railroad tracks and 1,200 km of motorways (WFP Logistics Cluster, 2023). The role of this corridor in relation to the INSTC can be perceived similarly to the role of the TITR in relation to the BRI, i.e., as an alternative omitting Russia and running through the Black Sea and then the territory of Ukraine to Poland, thus, being connected to the TEN-T.

In turn, in relation to maritime transport, the so-called Pan-European Transport Areas (PETRA network) are distinguished. One of these areas is the Black Sea, which is important for both Europe (including the EU) and Asia. As for the former, its two member countries, Bulgaria and Romania, have access to the Black Sea. The total length of their coastline is 579 km. The EU in 2015 transported via the Black Sea only or as much as 1/10 of total cargo, in terms of its weight, in relation to what is transported via Western European ports (Bosneagu, 2017). But so far, the involvement of the EU, especially Bulgaria and Romania, in the development of the Black Sea transport route has been less than moderate and very conservative. Currently, the situation has changed, and Turkey, which is very interested in the development of this route, joined the main players in the basin. This is Turkey, Ukraine and Russia, under the auspices of the U.N., who signed an agreement in July 2022 (U.N., 2023) on strengthening the transport of Ukrainian grain via the Black Sea. Shipments from the Ukrainian ports of Odessa, Chornomorsk and Yuzhny were directed via a safe route to the Bosphorus strait in Turkey. However, unexpectedly the agreement has been broken by Ukraine in April 2024. The next month Ukraine, due to its army actions, resumed transports by this route. On the eastern side of the Black Sea, Georgia, as announced in December 2022, plans to revitalize the failed/suspended project to build a deep-sea port in Anakila (next to the already operating port of Poti), as a response to the growing transport demand in the region caused by the Russian–Ukrainian conflict. The Danube River, constituting the IX, Rhine–Danube corridor of the TEN-T, can also play a significant role here. Already in 2022, the transport of Ukrainian grain was launched here using river ports in the cities of Izmail and Reni. The use of these ports became possible after the reclaiming of the Snake Island by the Ukrainians, the island located opposite the Bystroe distributary of the Danube. An alternative option is to use the Romanian parallel canal Bratul Sulina.

The concept of transit cargo transport East–EU via the territory of Ukraine

Based on the discussion presented in the previous sections, the key land transport routes connecting leading industrial areas of Ukraine with its international environment can be distinguished. In the north-south relation, the connection of the Black Sea and river ports on the Danube with the rest of the country, mainly Kyiv, and in the east-west relation, the connection from Donbas to the western borders of Ukraine (with Poland and Slovakia) – see Figure 1.

Figure 1
Ukraine's post-war inland transport system adapted to handle cargo transport between countries of the East and the EU – the concept



Source: own work.

The detailed characteristics of particular corridors in the presented concept are as follows:

- The east-west connection includes the two main corridors, north (M1) and south (M3). Both run latitudinally from Donbas, the eastern, highly industrialized region of Ukraine, to its western border with Poland (and via corridor M6, a branch of M3, also to Slovakia). Donbas covers two main administrative areas of Ukraine, i.e., the Luhansk Oblast and Donetsk Oblast. The northern corridor starts in Luhansk, and the southern one in Donetsk, although both cities are symbolic starting points for the transport of cargo from the entire above-mentioned oblasts.
- The M1 corridor (northern one) – leads from Luhansk, along the M03/E40 road (approx. 800 km) through Kharkiv, Poltava to Kyiv and further along the M07/E373 road (approx. 500 km) to the border with Poland (Dorohusk–Jagodzin border crossing). Alternatively, a railway connection from Luhansk to Kyiv, via Kharkiv or Donetsk, and further to the same border crossing with Poland (about 1,200 km) can be considered.
- The M3 corridor (southern one) – runs mainly along the M04/E50 road (approx. 1,100 km) through the towns of Dnieper and Vinnitsa to Ternopil, from Ternopil to L'viv by the national road N02 (over 100 km) and further along the M10/E40 road (approx. 100 km) to the Polish border (Korczowa–Krakovets border crossing). An alternative railway connection from Donetsk to L'viv, via the Dnieper and Vinnytsia, and further to the same border crossing with Poland (approx. 1,300 km) can also be considered here. This connection fits in with the joint, partially implemented plans of the Ukrainian logistics company GOL (Global Ocean Link), the leader in container transport, and the container giant Maersk. The plans regard the launch of permanent railway connection between Ukraine (including the port of Odessa) with Germany and the Benelux countries (including the port of Rotterdam, the Netherlands). The connection leading through the Polish territory (here the port of Gdansk) (GOL, 2023).
- The M6 corridor (a branch of the M3 one) – leads from L'viv (the main logistics hub of Western Ukraine), along the M06/E471 and E50 roads (approx. 300 km) to the border with Slovakia (Vyšné Nemecké–Uzhhorod border crossing). Or by a railway connection leading through Mukachevo (about 250 km). It also

creates the possibility of connecting with Hungary (via the nearby border crossing in Chop–Zahony).

Corridor M3 leads to the logistics Euroterminal in Slawkow, Poland, which is especially important for the railway connections L'viv–Mostyska–Przemysl. According to the draft of the Ukraine Recovery Plan (National Council, 2022, p. 14), the gauge of the tracks is to be changed from 1,520 mm to 1,435 mm along the aforementioned railway connections, which will have a positive impact on the speed of cargo transport due to the lack of technical differences between the Ukrainian and Polish infrastructure, and then the EU's one. The Ukrainian railway terminal in Mostyska, which has a capacity of 100K TEU/year and storage capacity of 4K TEU, will become an important logistics hub (CTM, 2023).

As a result, the east-west connection within both main corridors, the M1 and M3, covers approx. 1,300 km of international roads (category M) and approx. 1,200–1,300 km of railway roads (excluding the M6 branch of the southern corridor M3).

Similarly, the north-south connection also includes two corridors, west (M2) and east (M4). Both lead from the northern cities of Chernihiv and Kharkiv (Ukraine's second largest city) to the Black Sea coast (Odessa, Ukraine's third largest city, and the Crimean Peninsula), as well as to the Danube delta and the border with Romania.

- The M2 corridor (western one) – starts in Chernihiv, from where the M01/E95 road (approx. 150 km) leads to Kyiv, the capital and largest city of Ukraine. Further along the M05/E95 road (approx. 500 km) leads south to Odessa (seaport), next to which there are two other Ukrainian seaports, Chornomorsk and Pivdennyi. To the east, along the M14 road, it leads to another two seaports, Mykolaiv and Kherson (200 km from Odessa). By road M15 (approx. 250 km), the M2 connection leads to the Ukrainian river ports of Izmail, Reni and Ust-Danube (also known as Ust-Dunaisk or Kiliya) located on the Danube River. Ports connected to the Black Sea via all three branches of the Danube delta, i.e., located on the Romanian-Ukrainian border Kilia (E80-09) and two Romanian ones, St. George (E80-16) and especially Bratul Sulina (E80-14). All three branches are part of the Rhine-Danube Corridor IX (E80) of the TEN-T network, and their shipping standard, although not equally high in every section, is regulated by the European Agreement on Main Inland Waterways of International Importance (AGN). As a result, the estuary of the Danube connects the Ukrainian river ports located here not only with the Black Sea, but also with the EU countries, as far as German Kelheim and further, among others, via the Rhine River with Rotterdam in the Netherlands. The corridor IX, connecting the North Sea with the Mediterranean one, has been heavily developed for years. About 70% of the funds allocated to transport under The Connecting Europe Facility (CEF) program are directed to this corridor, and most of them go to the expansion of the Rhine-Danube waterway. As a result, the M2 connection covers a total of approx. 1,100 km of international roads (category M), alternatively, from Chernihiv through Kyiv, Zhytomyr, Vinnitsa and Odessa to Izmail, there are approx. 1,000 km of railroad tracks and 150 km of inland waterways (from Reni to the estuary of the Danube in Sulina). As well as three river ports in the cities of Izmail, Reni and Ust-Danube, whose current and maximum capacities (as of 2022) amounted to approx. 8.4, 6.7 and 0.7M t/year, respectively (values estimated on the basis of study by Kolisnichenko (2022)) and 5 seaports of Odessa, Chornomorsk, Pivdennyi, Mykolaiv and Kherson (capacities of 22.6, 25.6, 13.6, 29.8 and 0.7M t/year, respectively). The first of these three seaports could be used mainly for import and transit, while the last two (as well as the port in Mariupol, which can be a perspective part of the east-west connection) mainly for the export of products made in Ukraine. Such a division of tasks may prove necessary due to transport costs. Future expectations regarding certain types of cargo handled along the M2 corridor are influenced by the economic conditions of Ukrainian cities and oblasts through which the north-south connection runs, an access to the Black Sea, thus, also to the countries of the Middle East (especially Turkey) and Asia (China), and finally the connection with the corridor IX of the TEN-T network. And so, Mykolaiv could handle the export of natural resources and industrial production from the so-called Kryvbas, Kherson exports of agricultural products transported by the Dnieper River, while Mariupol exports from Donbass. The port in Odessa could handle transit and containerized cargo. This is facilitated by its geographical location (including relation to main road connections and railway lines) and the fact that it was a leader in handling this type of cargo before the ongoing war.
- The M4 corridor (eastern one) – starts in Kharkiv, through which the M1 corridor also passes. Due to its size and location between Kyiv and Donbass, Kharkiv is likely to become the main logistics hub in north-eastern Ukraine. The M4 corridor would continue along the M29 and M18/E105 roads, past the city of Dnieper, to the

city of Zaporizhzhia (approx. 300 km), near which a large logistics and passenger hub is planned to be built (National Council, 2022, p. 14). Then, continuing southwards, the M4 corridor runs along the M18/E105 road (across the bridge into the Chonhar strait, destroyed in 2023 by the Ukrainian side), leading to the Crimean Peninsula, the city of Simferopol (approx. 370 km). From Simferopol to Sevastopol takes the H06 highway (approx. 80 km). Sevastopol may become a port offering connections with Turkey or Georgia. Along the way, the M4 corridor intersects with local roads connecting the ports on the Sea of Azov (Mariupol and Berdyansk) with the ports on the Black Sea (Kherson and Mykolaiv). The total length of the M4 corridor is approx. 450 km of land roads.

As a result, the north-south connection within both corridors, the M2 and M4, covers approx. 1,550 km of international roads (category M, and partly H – highways) and alternatively, within the M2 corridor only, approx. 1,000 km of railways and 150 km of inland waterways.

Conclusions

In the post-war period Ukraine will ultimately need international roads in order to carry out large import-export and transit transports. But in the initial period mainly motor roads will be necessary to deliver relatively small, from a global point of view, quantities of cargo to rebuild point infrastructure. Therefore, road transport will be temporarily more important than rail one. Moreover, financial and environmental constraints (e.g., the "Fit For 55" package, which is focused among others on air and maritime transport markets), will force infrastructural development in successive stages:

- Construction of a frame for road transport system, due to the need to deliver door-to-door loads for the reconstruction of sites concentrated primarily in the east of the country, where, on the one hand, the hostilities were the most intense, and on the other, is the greatest economic potential.
- Modernization of the railway network, including the change of the track gauge from 1,520 mm to 1,435 mm between the main logistics hubs (Kyiv, L'viv, Odessa) and the state borders, i.e., the Kyiv–Yahodyn–Dorohusk and Odessa–L'viv–Mostyska connections.
- Inclusion of the Romanian-Ukrainian border section of the Danube River, i.e., the Kilia branch of the estuary (E80-09, approx. 54 km) into the European TEN-T network, which will contribute to the development of river ports in the south of Odessa Oblast (Izmail, Reni and Ust-Danube).
- Modernization of seaports and their specialization (types of cargo and main directions of their flow).
- The use of the Dnieper River on the section between Zaporizhzhia city to the estuary to the Black Sea (even in the face of the Nova Kakhovka dam destruction in 2023), to transport bulk cargo (cereals, heavy industry products) to the ports of Kherson and Mykolaiv, taking into account periodic restrictions on this transport in winter (the river freezes).

The proposed concept of the transit cargo transport East–EU via the territory of Ukraine and the above presented actions to be taken within the post-war recovery of the transport infrastructure result from and stay in conformity with the discussed in the article supply, demand, infrastructural, and geopolitical potential of Ukraine. They significantly increase the potential of Ukraine to handle the transport of cargo between the East and the EU, thus, the internationalization of Ukrainian transport. It can be also expected that logistics and transshipment centres will be built along the main transport corridors connecting Ukraine with the EU, which will improve the country's economic situation. It will also translate into a favourable economic situation for large carriers and logistics providers that have enough capital resources for the development of complex services. For the EU it will be both, an opportunity (access to the low-cost transport, mineral resources and agricultural products), and a potential threat (increased competition for their own transport and production sectors), as well. Enhancing the role of Ukraine as the transit and export country will also mitigate the probable perspective of diminishing its trade exchange with the former Soviet bloc being crucial so far.

In particular, the proposed transport system allows exports and imports of goods from and to the eastern, the most industrialized Ukrainian oblasts, and transport them to and from the EU countries, especially Poland and Germany (more than one-third of the all-Ukrainian export and import). It also fits into the perspective, post-war rebuilding needs of Ukraine. Further, the proposed transport system allows for transit transport of goods from the East (Middle and Far) to the EU. This, in turn, fits into the concept of an alternative route to the Belt and Road Initiative (BRI). The transit engaging Ukrainian Black Sea ports. This will enhance a significant potential and better utilization of Ukrainian sea ports in the Black and Azov Sea basins, and further development or reactivation

of the GO-Highway infrastructural project of connecting the two seas, Black and Baltic ones, as well. And finally, it allows to connect Ukrainian transport system with the TEN-T Trans-European Transport Network in the efficient way. The latter stays in conformity with the perspective Ukrainian accession to the EU. Thus, the proposed transport system will enhance not only Ukrainian domestic and export/import movements of goods, stimulate the country's economy, but will also build the alternative west-east route that bypasses the territory of Russia. As for Poland, it will be the chance for the railway Euroterminal in Slawkow, but at the cost of the terminal in Malaszewicze.

Considering the presented above actions to be taken (and their order) within the post-war recovery of the Ukrainian transport infrastructure it can be concluded that, according to the formulated hypothesis, the post-war inland transport system of Ukraine can be adopted to handle cargo transport between countries of the East, Ukraine itself and the EU.

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Adam Redmer, PhD (Hab) Eng.

Lecturer, trainer and business consultant. Poznan University of Technology employee. The scope of interests and experience: logistics (transportation and warehousing), including: analysis and optimization, fleet management, inventory management, mathematical modeling and design of distribution networks, business process analysis and redesign. Cooperation with: Lukasiewicz Research Network /Institute of Logistics and Warehousing, ABC Academy, Center of Logistics Education – CEL, Managers Academy, Management Academy, ECR Poland, WYG Consulting, high schools (WSL and Higher Vocational School "Kadry dla Europy"). Total number of publications – more than 60, research projects – more than 25, consulting projects – about 20 and trainings for leading companies – more than 75. UE scholar (doctoral studies at Polytechnic Institute of Porto, Portugal and scholar at Mercury Associates, Inc., USA, also at University of Texas, USA). Member of NAFA Fleet Management Association (USA – 2013), Polish Logistics Association (since 2001 to 2018), EURO Working Group on Transportation (since 2000). Nominated for Who's Who in the World – 2011.

Krzysztof Wyrwicki, MSc Eng.

Student of the Doctoral School of Poznan University of Technology, graduated from the Faculty of Transport at Poznan University of Technology, data analyst. Area of interest: assessment and parameterization of the freight transport market, systems dynamics theory, transport law, optimization of transport processes, mathematical analysis and modeling of transport processes. Professional experience: international freight forwarder, data analyst for freight transport at Oskar Group. Co-author of publications and business analyses.

Dr hab. inż. Adam Redmer

Wykładowca, szkoleniowiec i doradca biznesowy. Pracownik Politechniki Poznańskiej. Obszar zainteresowań i doświadczeń: logistyka (transport i magazynowanie), w tym: analizy i optymalizacja; zarządzanie taborem; zarządzanie zapasami; modelowanie matematyczne i projektowanie systemów dystrybucji; analiza procesowa i przebudowa procesów gospodarczych. Współpracownik Sieci Badawczej Łukasiewicz/Instytutu Logistyki i Magazynowania, ABC Akademii, Centrum Edukacji Logistycznej – CEL, Akademii Menedżera, Akademii Zarządzania, ECR Polska, WYG Consulting, szkół wyższych (WSL i Wyższej Szkoły Zawodowej „Kadry dla Europy"). Autor ponad 60 publikacji, ponad 25 projektów badawczych i ok. 20 projektów doradczych. Przeprowadził ponad 75 szkoleń dla czołowych firm. Stypendysta UE (studia doktoranckie na Politechnice w Porto w Portugalii oraz staże w firmie Mercury Associates, Inc. i na Uniwersytecie w Teksasie w Stanach Zjednoczonych). Członek NAFA Fleet Management Association (2013 r.), Polskiego Towarzystwa Logistycznego (w latach 2001–2018), EURO Working Group on Transportation (od 2000 r.). Uwzględniony w 28. edycji Who's Who in the World – 2011.

Mgr inż. Krzysztof Wyrwicki

Słuchacz Szkoły Doktorskiej Politechniki Poznańskiej, absolwent kierunku Transport na Politechnice Poznańskiej, analityk danych. Obszar zainteresowań: ocena i parametryzacja rynku transportu ładunków, teoria dynamiki systemów, prawo transportowe, optymalizacja procesów transportowych, analiza i modelowanie matematyczne procesów transportowych. Doświadczenie zawodowe: spedytor międzynarodowy, analityk danych ds. transportu ciężarowego w Grupie Oskar. Współautor publikacji oraz analiz biznesowych.