

CLUSTER ANALYSIS OF TRAVEL BEHAVIOUR THREATS IN CHOSEN EUROPEAN FUNCTIONAL URBAN AREAS DURING THE ECONOMIC CRISIS

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ABSTRACT

Motives: Urban mobility models are constantly changing due to economic, social, infrastructural, and geographical factors. Preferences for transport modes vary by country, region, and city, and transport infrastructure and policy have a significant impact on residents' choices. Additionally, economic factors such as economic crises, public policy decisions, and events such as armed conflicts have a significant impact on the dynamics of mobility in functional urban areas (FUAs).

Aim: The main goal of the research was to create groups of countries (clusters) that have similar priorities regarding travel behaviour threats revealed as a result of the economic crisis resulting from the conflict in Ukraine.

Results: The study shows that the main threats during the economic crisis (resulting from the war in Ukraine) are economic factors (e.g., ticket prices, an increase in fuel costs), legal factors (e.g., loss of a driving license or passenger transport license), and infrastructural factors (e.g., poor condition of infrastructure). The analysed countries were grouped based on the hierarchical prioritization of threats, using Ward's hierarchical clustering method. Interestingly, the distance from the conflict epicentre did not significantly influence the prioritization of threat factors influencing transportation behaviour in FUAs. Instead, factors such as membership in international organizations, energy dependence on Russia, the level of economic growth, and transport infrastructure played a more key role in the priority-setting process.

Keywords: travel behaviour, threat factors, conflict, economic crisis, European case study, Ukraine

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INTRODUCTION

Urban mobility models are subject to constant transformation, prompting researchers to analyse the relationships between preferences and travel behaviour, as well as economic, social, infrastructural (Dudzińska et al., 2023), and geographical factors. The mobility of urban residents in Europe varies, and transport preferences may differ between countries, regions, and cities. These differences encompass approaches to public transport, transport infrastructure, transport policy, and travel culture.

Transport infrastructure plays a pivotal role in shaping residents' mobility. The development of public transport, bicycle, and pedestrian networks influences transport choices. Differences in transport policy and investments in sustainable mobility significantly impact the availability and popularity of alternative transportation modes.

Transport culture also plays a crucial role in the acceptance of various modes of transport across different regions. Geographic conditions, such as terrain or weather, influence the necessity to adapt to specific transport conditions (Curtis & Perkins, 2006; Kitamura et al., 1992). Moreover, the economic situation, income level, job availability, and adoption of modern transport technologies shape residents' choices. Travel costs, city demographics, social status, household characteristics, and social beliefs (Marsden et al., 2020) are also significant factors influencing transport preferences.

The literature also examines the impact of various events on travel patterns, such as resource mobility challenges arising from public transport collective disputes (van Exel & Rietveld, 2009), social and cultural events (Parkes et al., 2016), as well as security threats such as the COVID-19 pandemic (Nouvellet et al., 2021) and natural disasters (Lin et al., 2020). Economic factors such as economic or social crises (Papagiannakis et al., 2018) and public policy decisions in the area of public transport further influence the complexity of urban mobility dynamics.

The outbreak of the armed conflict in Ukraine, and the associated energy and economic crisis, is another

threat that has disrupted transport behaviour (TB) in many European countries (Dudzińska et al., 2023). The Russian invasion of Ukraine and the resulting political and energy crisis have impacted fuel markets, the automotive industry, and the spare parts sector in Europe. Research confirms that wars negatively impact social and economic areas, both in the countries directly involved and in neighbouring countries (Bozzoli et al., 2010; Iqbal et al., 2021; Smith, 2014). The effects of conflicts also include impacts on neighbouring economies (Collier, 1999; Koubi, 2005), although these are usually short-lived.

The economic downturn and disruptions to trade and investment are just some of the effects of the war. Military conflicts lead to migration and changes in the social structure of neighbouring countries. The sudden influx of migrants burdens the budgets of countries receiving war refugees (Lozi, 2013; Murdoch & Sandler, 2004; Salehyan, 2008), affecting the labour market, education, health care and housing availability. The impact of war and immigration on transport behaviour is complex and varied, depending on the specific situation and context of functional urban areas (FUAs).

The influx of immigrants could strain the city's transport infrastructure, leading to delays and congestion on public transport. An increase in walking traffic is observed as immigrants prefer walking, especially during the adaptation period (Faber et al., 2023) or it allows them to save money and gives the opportunity to exercise, but only if the destinations are close (Handy et al., 2008). With more inhabitants, local public transport systems may find it difficult to adapt to the increase in demand, requiring adjustments to timetables, increased transport options, and improved infrastructure. This may prompt society to look for alternative means of transport, such as bicycles, electric scooters, or car sharing.

These changes can have both positive and negative effects, and residents' reactions may vary depending on their individual experiences and perceptions of these events. These issues have been poorly researched, and the risks may vary in importance depending on existing urban transport patterns and each

country's political perspective, shaping perceptions of mobility risks in the context of an economic crisis resulting from armed conflict. Political issues such as international relations, membership in alliances between countries, or attachment to certain values may influence how a country assesses risks and threats to mobility. Economic aspects also play an important role. Countries with different levels of economic development may perceive different aspects of the risks associated with mobility during conflict (Papagiannakis et al., 2018). Social experiences of the crisis may also influence risk assessments of mobility behaviours. In countries more affected by the crisis, residents may be more willing to change their travel habits due to concerns about their safety and that of their families. Cultural aspects of society, such as attitudes towards security and the ability to adapt to changing conditions, may also influence threat assessments. Cultural differences can lead to different responses to a crisis. Therefore, the main aim of the research was to create groups of countries (clusters) that have similar priorities regarding TB threats revealed as a result of the economic crisis resulting from the conflict in Ukraine, which allows for a more precise adaptation of strategies and policies to the characteristics of a given cluster.

The study covered the European continent and aimed to verify the following research hypothesis: the distance from the epicentre of the conflict does not have a significant impact on the prioritization of threat factors in public transport (TB). It is an extension of previous research conducted by (Dudzińska et al., 2023) where a survey method was used. Experts from 20 European countries took part in the study. The survey was collected both before the outbreak of the conflict, in October 2021, and after the outbreak of the conflict in Ukraine in July 2022. The research included 6 questions: “1. Choose a maximum of 3 most relevant factors from the group of social factors that influence TB and can be identified as threats; 2. Choose a maximum of 3 most relevant factors from the group of economic factors that influence TB and can be identified as threats; 3. Choose a maximum of 3 most relevant factors from the group of legal factors that influence TB and can be

identified as threats; 4. Choose a maximum of 3 most relevant factors from the group of infrastructural factors that influence TB and can be identified as threats; 5. Choose a maximum of 3 most relevant factors from the group of technological/SMART factors that influence TB and can be identified as threats; 6. Choose a maximum of 3 most relevant factors from the group of environmental factors that influence TB and can be identified as threats.” (Dudzińska et al., 2023). A multidimensional comparative analysis of experts' opinions on risk factors in public transport was the basis for grouping European countries into clusters. The results of this study have the potential to support the development of effective crisis management strategies in the area of public transport.

MATERIALS AND METHODS

Methods

The study was conducted in several stages, employing geographical methods and analytical tools, including Statistica PL v. 13 software, Ward's hierarchical clustering procedure, and QGIS v. 3.22.1. The research methodology encompassed key stages (Fig. 1), such as the identification of the research problem and literature analysis, selection of the research area, identification of international connections, including the recognition of indirect alliances between countries affecting the economy during the crisis, establishment of mobility patterns in the main cities (capitals) of selected countries, identification of threats to public transport, formation of groups of countries, and discussion leading to conclusions.

The implementation of the above stages enabled the achievement of the main objective of the study and the verification of the research hypothesis postulating that the distance from the epicentre of the conflict does not significantly affect the prioritization of threats to public transport in European countries.

According to research conducted by (Dudzińska et al., 2023), a list of potential threats to public transport in FUA was utilized, with their classification into three

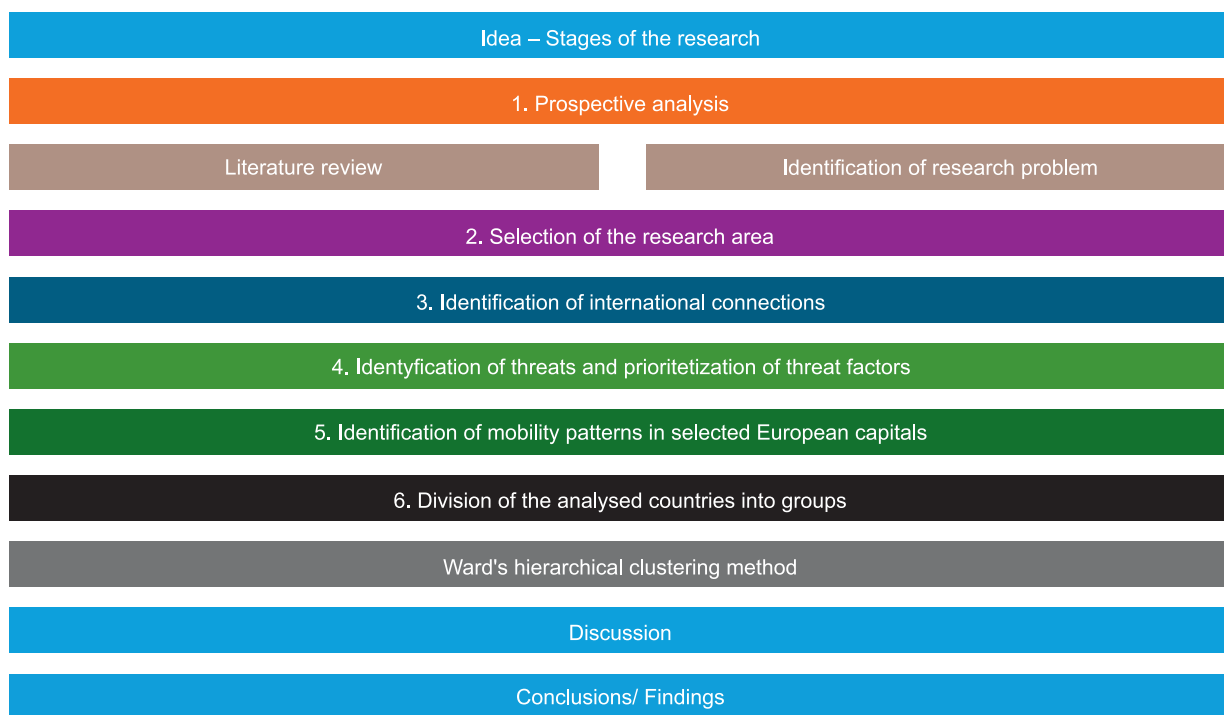


Fig. 1. Research framework
 Source: own study.

groups: economic, legal, and infrastructural. These groups exhibited high variability in identified threats before and during the conflict. The analysed countries were grouped based on the hierarchical prioritization of threats, utilizing Ward's hierarchical clustering method. Euclidean distance (unstandardised) was employed to measure distance. Ward's method relies on the analysis of variance to identify homogeneous subsets of objects. This method is used to minimise the sum of squared deviations within clusters. The sum of squared errors (ESS) is the sum of the squared differences between each observation and the group mean. ESS is calculated using the following formula:

$$ESS = \sum_{i=1}^k (x_i - \bar{x})^2 \quad (1)$$

where:

- x_i – is the value of the i^{th} observation;
- k – number of objects in a given cluster.

This method was chosen to aggregate low-value results with a transparent structure. In order to determine the critical cut line, an agglomeration chart and Mojena's rule were used.

$$d_{(i+1)} > \bar{d} + ks_d \quad (2)$$

where:

- $d_{(i+1)}$ – bond distances;
- \bar{d} – mean d_i ;
- k – constant Mojena, (Milligan & Cooper, 1985) propose to set it at $k = 1.25$;
- s_d – standard deviation d_i .

Research area

The study covered the European continent. The armed conflict in Ukraine and the resulting economic crisis are felt throughout Europe. Increases in fuel and energy prices became subsequent factors in the increase in food prices, which ultimately also resulted

in an acceleration of inflation (Prokopowicz, 2023). There are 47 countries in Europe (with a total area of 10.5 million km²), of which 27 are member states of the European Union (EU).

According to the United Nations Development Programme (UNDP, 2024), particularly the Human Development Report 2019 (United Nations, 2019), and the Inequality-Adjusted Human Development Index (United Nations, 2021), most European countries are developed and highly developed countries, excluding Moldova, Albania, Macedonia, and Bosnia and Herzegovina, which are characterized

by a moderate level of economic growth. The highest level of economic growth is recorded in Central and Northern Europe. The lowest GDP per capita was recorded in Southern Europe, i.e., Albania and Bosnia-Herzegovina, respectively 34 and 35. Basic geographical and economic data, including the degree of energy dependence of selected European countries that took part in the expert study, are presented in Table 1.

Energy autonomy can also significantly influence the prioritization of threats. As shown in Table 2, Norway is the only European country that is self-

Table 1. Basic geographical and economic data of selected European countries

Country	GDP per capita in PPS*, 2022	Population density [person/km ²], 2022	Population, 2023	Area [thousand km ²], 2023	Energy dependence rate [%], 2020
Austria	124	108.5	9 104 772	82.52	58.32
Bulgaria	62	62.5	6 447 710	110.00	37.88
Croatia	73	70.7	3 850 894	55.90	53.59
Czechia	90	136.1	10 827 529	77.21	38.90
Estonia	85	30.9	1 365 884	43.11	10.52
Finland	110	18.2	5 563 970	304.32	42.02
Germany	117	235.5	84 358 845	353.30	63.67
Greece	67	81.3	10 394 055	130.05	81.78
Hungary	76	106.4	9 597 085	91.25	56.63
Latvia	73	29.8	1 883 008	63.29	45.48
Lithuania	89	44.7	2 857 279	62.64	74.91
Netherlands	130	512.8	2 512 758	34.19	68.07
Norway	212	14.8	17 811 291	364.27	-623.06
Moldova	-	105	5 488 984	33.85	75.99
Poland	79	122.9	36 753 736	307.24	42.76
Romania	76	81.6	19 051 562	234.27	28.2
Slovakia	71	111.8	5 428 792	48.70	56.3
Spain	86	94.3	48 059 777	502.65	67.89
Sweden	119	25.6	10 521 556	407.30	33.51
Turkey	67	112	85 279 553	766.51	70.65

* PPS – purchasing power parities (PPPs)

Source: own study based on (Eurostat, 2021b, 2022a, 2022b, 2023a, 2023b).

Table 2. Most traded goods between the EU and Russia in 2021

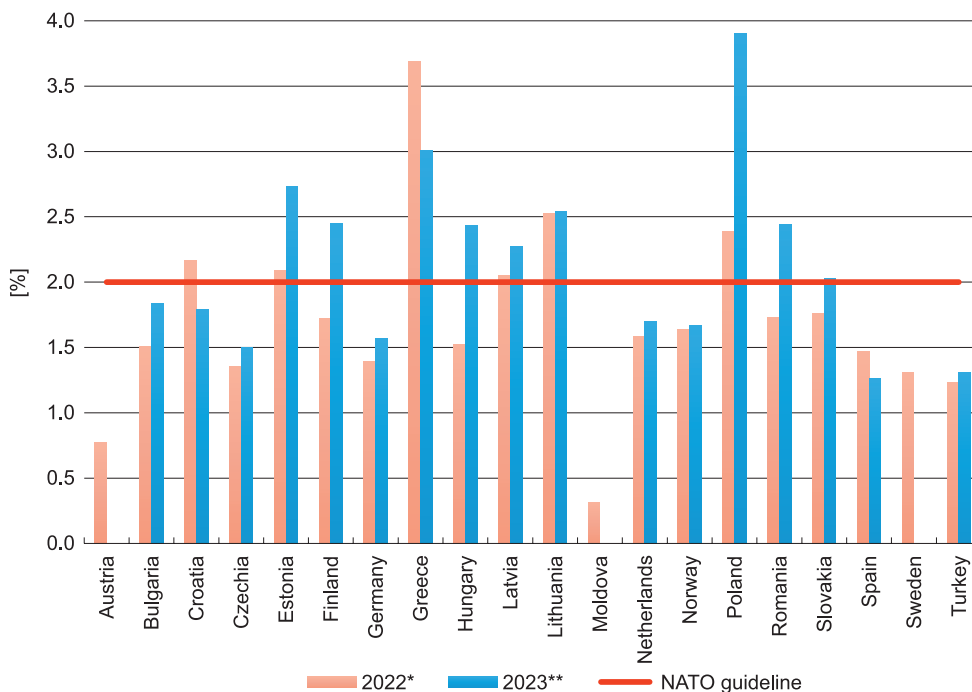
Code and label	Imports / € billion
333 Petroleum oils, crude	48.5
334 Petroleum oils other than crude	22.4
343 Natural gas, whether or not liquefied	17.8
542 Medicaments	0.0
321 Coal (not agglomerated)	5.1
999 Confidential trade	3.8
784 Motor vehicle parts	0.1
781 Motor cars and motor vehicles	0.1
335 Residual petroleum products and related materials	3.0
672 Ingots and related forms of iron or steel	2.8
792 Aircraft and associated equipment	0.2
682 Copper	2.4
541 Medicinal and pharmaceutical products	0.0
684 Aluminium	2.2
681 Silver and other metals of the platinum group	2.1
728 Other machinery	0.0
562 Fertilizers (other than those of group 272)	1.8
743 Pumps, compressors, fans and related products	0.0
667 Pearls and (semi-) precious stones	1.8
741 Heating and cooling equipment and parts, n.e.s.	0.1

Source: (Eurostat, 2021a).

-sufficient in energy supplies. The energy dependency rate is also low in Estonia and Romania, which import less than 30% of their energy. Russia is one of the largest exporters of fossil fuels in Europe. In 2020, Russia's share in natural gas imports was significant (Norway being the second largest supplier of natural gas in the EU, with its share in European imports dropping to 18.5% in 2020, according to Eurostat, 2021a). Russia was also the leading exporter of crude oil, supplying 25.7% of oil to the EU market in 2020. The EU was dependent on Russia for 49.1% of its coal imports. Fossil fuels are Russia's largest export to the EU (see Table 2).

As a participant in the armed conflict in Ukraine and the main exporter of fossil fuels to the EU, Russia has had a significant impact on Europe's energy security.

After the outbreak of the conflict in Ukraine, many countries began to increase military spending (Fig. 2). The exceptions are Croatia, Greece, and Spain, i.e., countries located further away from the armed conflict in Ukraine. Military spending increased in 2014 when the governments of NATO member states agreed to allocate 2% of their GDP for this purpose. This decision aimed to ensure the continuous military readiness of the countries within the alliance.



* SIPRI Military Expenditure Database;
 ** Defence Expenditures of NATO Countries (estimates); Austria, Moldova and Sweden – lack of estimated data for 2023

Fig. 2. Military expenditure (% of GDP)
 Source: own study based on (NATO, 2023; Stockholm International Peace Research Institute, 2024).

RESULTS

Identification of existing alliances between countries in connection with the economic crisis and the conflict in Ukraine

North Atlantic Treaty Organization (NATO)

It is one of the most important defence organisations in the world, bringing together countries in North America and Europe. Its purpose is to ensure the security and territorial defence of its members. NATO, also called the North Atlantic Alliance, is an intergovernmental military alliance consisting of 32 member states, 29 of which are in Europe and two in North America. The alliance was formed after World War II during the Cold War to counter the military threat from the Soviet Union. The North Atlantic Treaty, laying the foundations for NATO, was signed on April 4, 1949 (Cook, 2017; NATO, 2022).

NATO adheres to the principle of collective defence, according to which an attack on one ally is treated as an attack on all allies.

UE

It is a political and economic partnership that covers most European countries (currently comprising 27 members). The EU aims to promote economic, political, and social cooperation among its members. Membership of the European Union offers benefits to member states. The EU also upholds common values such as democracy, human rights, and state principles, which strengthen political and social stability. In addition, members have access to structural funds and investments, which support the development of infrastructure and regions. A common foreign and security policy enables a more effective response to global challenges. EU membership also opens the door to scientific, cultural, and educational cooperation.

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The Council of Europe

Its main goal is to promote human rights, democracy, and the rule of law in Europe. The Council of Europe addresses issues concerning the protection of human rights, intercultural dialogue, and the advancement of democracy and the rule of law.

It monitors its members' compliance with their obligations. If not, it imposes appropriate sanctions (Brummer, 2024). It is an organization that unites both EU Member States and other European countries outside the EU. Currently, it comprises 46 countries (excluding Belarus and Russia).



Fig. 3. The structure of political systems in Europe
Source: own study based on (European Union, 2023; NATO, 2022).

Organization for Security and Co-operation in Europe (OSCE)

It is an organization that brings together most European countries, but also some non-European countries, such as Canada and the United States, with the aim of promoting cooperation, security and stability in the region. The OSCE is a regional security organization within the meaning of Chapter VIII of the United Nations Charter. It brings together 57 participating countries with equal status.

The structure of political systems in Europe is presented below (Fig. 3).

Identification of mobility patterns in selected European capitals

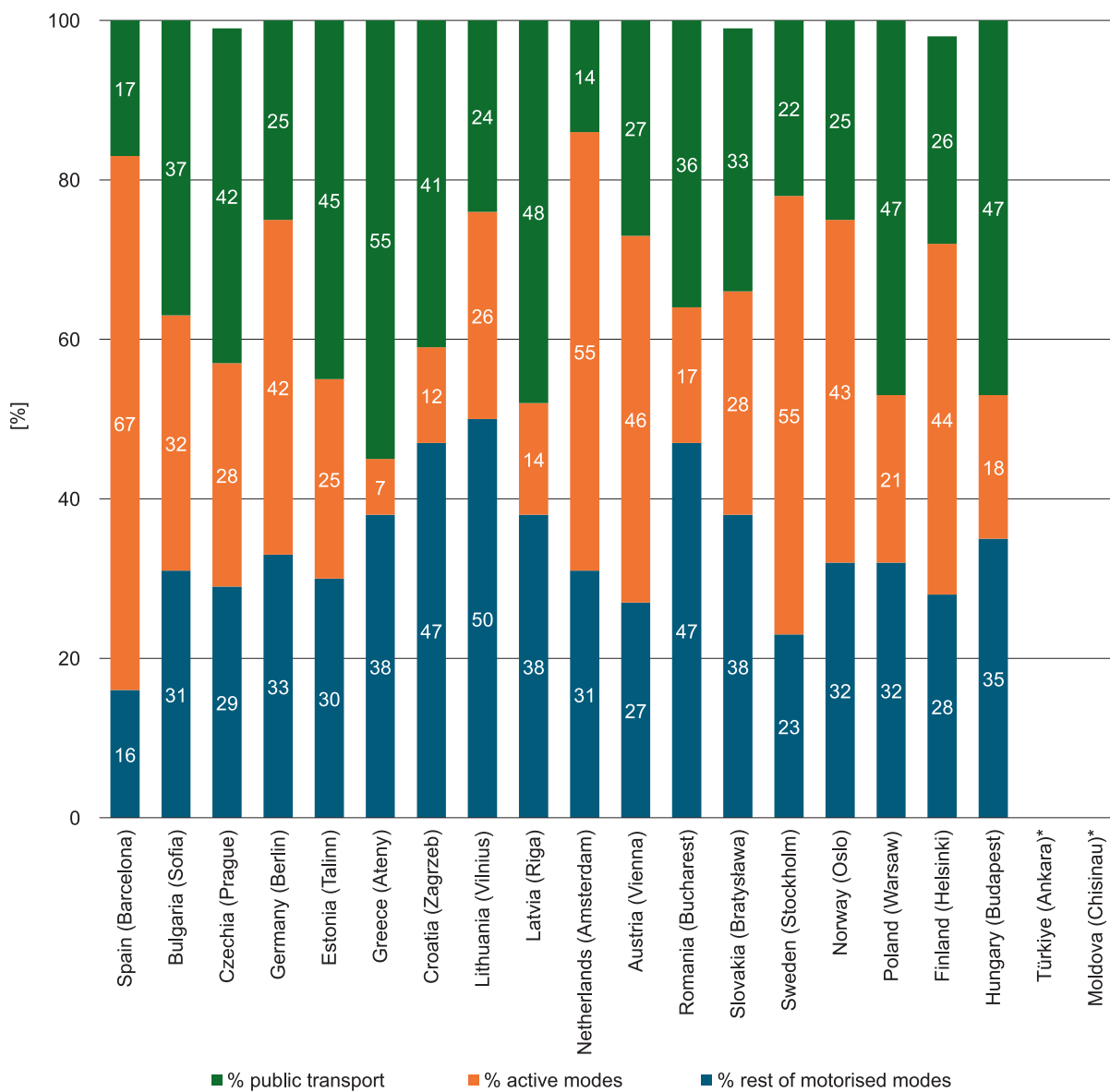
Modal share, which denotes the proportion of various means of transport in overall transport activity, serves as a pivotal metric for understanding mobility dynamics within cities. The mobility patterns of the capitals under scrutiny were derived from data sourced from the European Metropolitan Transport Authorities (EMTA), an organisation comprising municipal and regional bodies tasked with overseeing public transportation in metropolitan regions.

Modal share furnishes invaluable insights into residents' mobility preferences within urban settings. Delving into this metric facilitates the identification of mobility trends, evaluation of public transportation efficiency, assessment of transport system sustainability, and tailoring of infrastructure to meet urban demands. Moreover, modal share profoundly influences spatial planning and traffic management, fostering a more informed approach to urban transport development.

The analysis of transport modal shares in urban settings encompassed 16 FUA city cores across the study's target countries (refer to Fig. 4). Transport modes were categorised into three primary divisions: active transport, encompassing pedestrian and bicycle traffic; comprehensive public transport systems; and other motorised modes including cars, scooters,

among others. Findings revealed that active transport predominates in three FUA city cores – Barcelona (Spain), Amsterdam (Netherlands), and Stockholm (Sweden), whereas Athens (Greece), Warsaw (Poland), and Riga (Latvia) exhibit a significant reliance on public transport for mobility. In contrast, Vilnius (Lithuania), Bucharest (Romania), and Zagreb (Croatia) demonstrate a prevailing dependency on other motorised modes, particularly car transport.

The obtained results made it possible to divide the studied FUA city cores into three groups. In the first group, which includes Barcelona (Spain), Amsterdam (Netherlands), Stockholm (Sweden), Oslo (Norway), Vienna (Austria), Helsinki (Finland), and Berlin (Germany), we observe a high share of active transport, and public and other transport at a much lower level. These FUA city cores are characterized by an environment with infrastructure (bicycle paths, etc.) adapted to active transport. The second group, with representatives such as Tallinn (Estonia), Athens (Greece), Riga (Latvia), Bucharest (Romania), Budapest (Hungary), is characterized by a much lower percentage of active transport, lower than 20%. The last group is represented by Bratislava (Slovakia), Vilnius (Lithuania), and Zagreb (Croatia), where we observe a high percentage of “rest of motorized modes”, and Sofia (Bulgaria), Prague (Czech Republic), and Warsaw (Poland) with a high share of public transport. It is worth noting that Ankara (Turkey) and Chisinau (Moldova) did not have data available in the analysis. This structured approach allows to better understanding mobility preferences in different FUA city cores. The number of registered motor vehicles per thousand inhabitants in the analysed countries was also examined (Fig. 5). Poland has the highest rate, reaching 687 vehicles per thousand inhabitants, although in Warsaw 47% of inhabitants prefer public transport. A similar situation occurs in Estonia, where there are 620 vehicles per 1000 inhabitants, and in Tallinn as many as 45% use public transport. The lowest rates were recorded in Latvia (404), Romania (400), and Bulgaria (414).



* Lack of data

Fig. 4. Share of transport modes in urban traffic in the capital cities of the analysed countries

Source: own study based on (BIM Consulting, 2019; EMTA, 2024; Primăria Municipiului București, 2015; Rudolph et al., 2021).

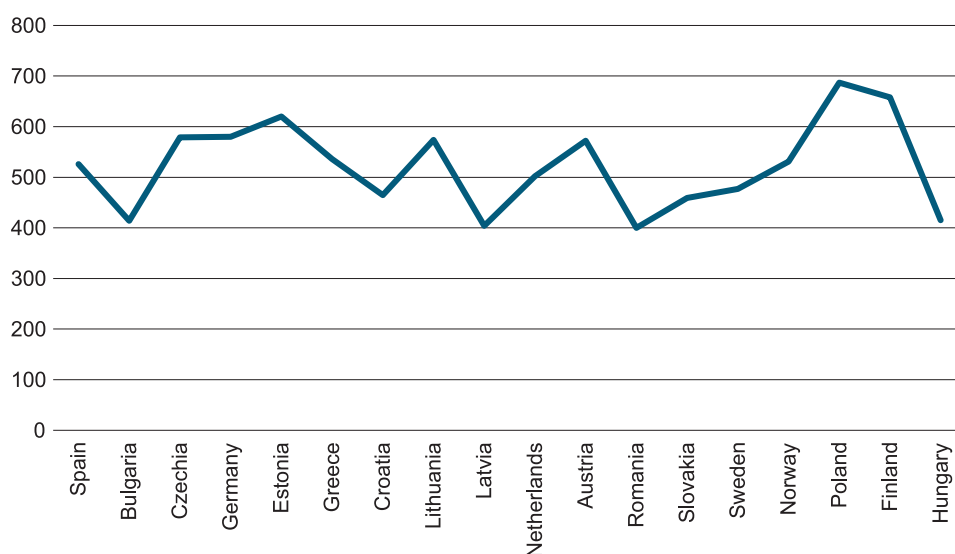


Fig. 5. Passenger cars per thousand inhabitants (2021)
Source: own study based on (Eurostat, 2021c).

TB threats and prioritisation of threats affecting TB

The number of potential threats in the analysed groups varied. Ultimately, three groups of factors (potential threats) were adopted for analysis (Table 3). The choice of groups resulted from the high variability

of threats in these groups between the analysed countries before and during the conflict.

The examined factors were expressed on a nominal scale and were further analysed using the zero-one integer programming method (0 – not indicated, 1 – indicated). Ultimately, 23 factors were selected for analysis (7 economic factors, 6 legal factors,

Table 3. Chosen threat factors that influence TB in FUAs

Economic	Legal	Infrastructural
1A – High cost of spare parts, vehicle maintenance and repair services	2A – Loss of driver’s license or passenger transport license	3A – Prolonged construction and modernisation of roads, bike paths, etc.
1B – Ticket price is high/tickets are difficult to buy	2B – Downtown area is closed to traffic	3B – Traffic congestion (caused by the existing transport network, e.g., the only access road in a given direction)
1C – Parking fees / fees for driving into the city centre	2C – Driving restrictions on rental cars (restricted driving area, zones where parking is not allowed)	3C – Traffic bottlenecks and unsafe junctions
1D – Lower service frequency (such as a bus line), changes in public transport timetables	2D – Speed limits	3D – Poor roadway design and construction errors
1E – Increase in fuel/electricity prices	2E – Urban vehicle access regulations (e.g. diesel cars are prohibited from entering the city centre)	3E – Shortage or decreased availability of parking spaces
1F – Problems on the market of transport services (strikes, bankruptcies)	2F – Introduction or expansion of paid parking zones in the city	3F – Decrease in the number of public transport stops
1G – Interrupted supply of fuel or electricity		3G – Lack of transit hubs
		3H – Prolonged travel time
		3I – Low condition of infrastructure
		3J – Inadequate road signage

Source: own study based on (Dudzińska et al., 2023).

and 10 infrastructure factors). Cluster analysis was performed to verify the research hypothesis assuming that the distance from the conflict epicentre does not significantly affect the prioritization of TB risk factors in FUA areas.

In the next stage of the research, cluster analysis was performed in the Statistica PL v. 13 program (StatSoft Polska). A dendrogram that presents hierarchical connections between objects based on their decreasing similarity was developed (Fig. 6).

The cut-off point on the dendrogram was determined using an agglomeration plot (Fig. 7). It is useful for determining where multiple clusters are concentrated with the same binding distance. This is one of the simplest methods of selecting the location of the critical cut line. Analysing Fig. 7, it can be seen that the dendrogram should be cut off after the 18th step. In order to precisely determine the location of the

critical cutting line, Mojena's stopping rule was also used (Stanisz, 2007).

Table 4 shows that the difference $d_i - d_{i-1}$ has a maximum of 1.661, and the quotient of these values has the highest value (1.436). The above values and calculations again indicate that the critical cutting line should be carried out after step 16. Mojena's rule, assuming a constant of 1.25, is $d_{(i+1)} > 4.566549096$.

The cut-off point in the dendrogram was determined with the use of Mojena's stopping rule (Stanisz, 2007). As recommended by (Milligan & Cooper, 1985), the value of Mojena's constant was set at $k = 1.25$ to obtain the most reliable results. The results were additionally validated by comparing them with the chart of the course of agglomeration's analysis. Three principal groups of countries were identified based on the results (Table 5).

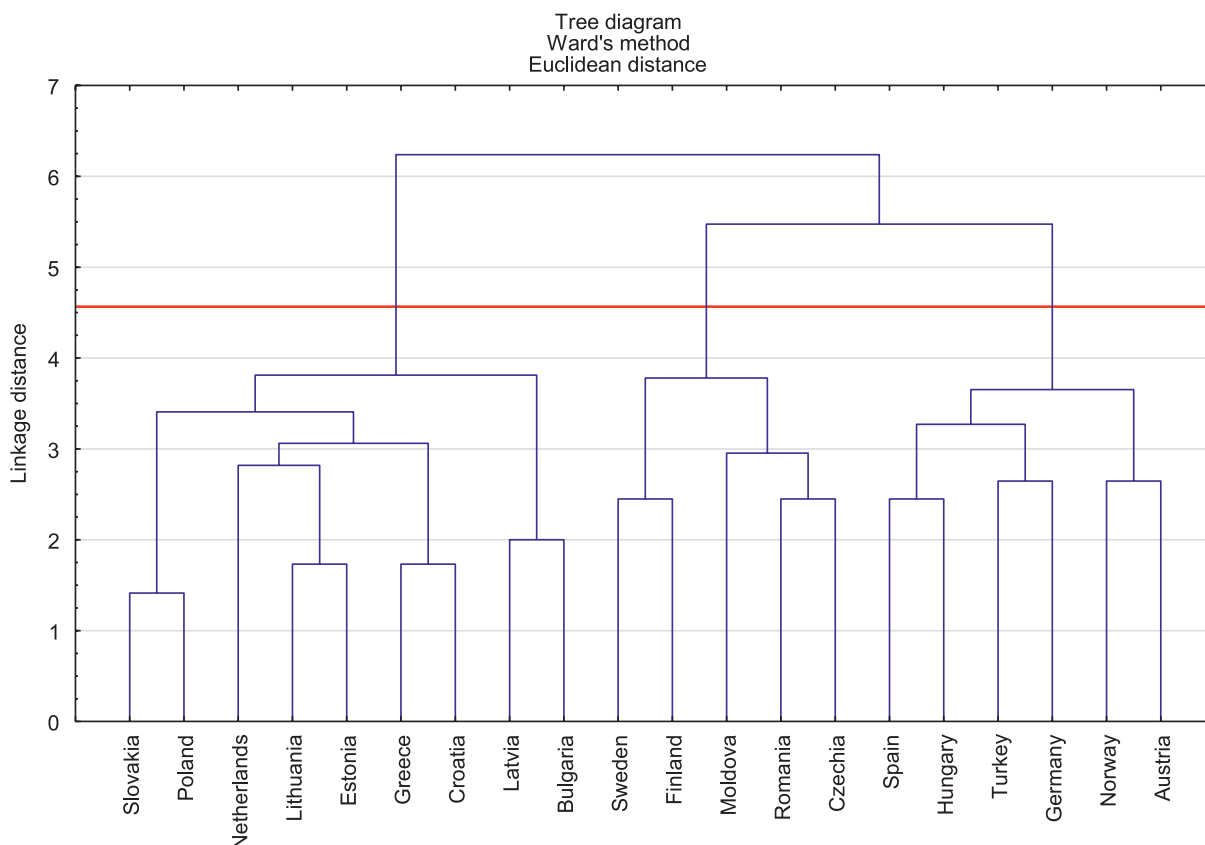


Fig. 6. The dendrogram created with Ward's method
Source: own study.

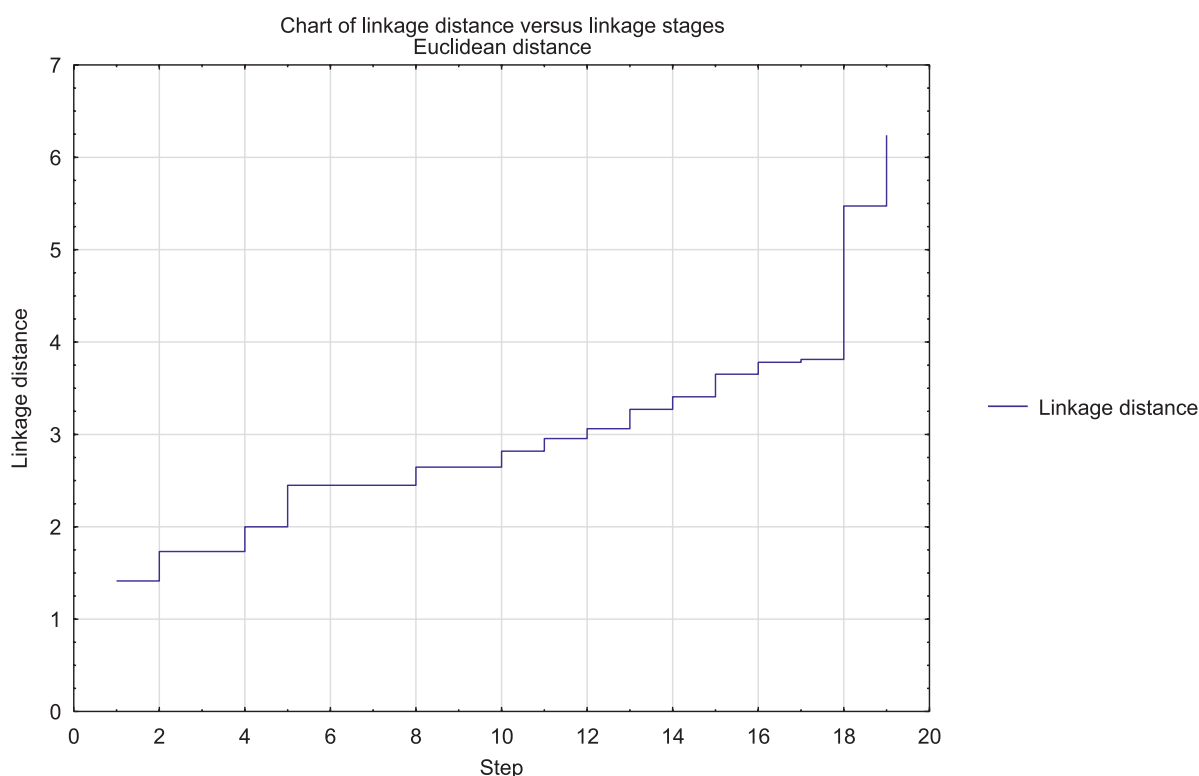


Fig. 7. Chart of the course of agglomeration
Source: own study.

As the data in Table 5 show, in each of these groups, economic risks proved to be the most important. The next in line of threats are those caused by legal circumstances. The last in order are threats from the infrastructural category.

Fig. 8 presents a classification of analysed countries based on similarities in the prioritization of threats that influence TB.

Group 1 comprises Slovakia, Poland, the Netherlands, Lithuania, Estonia, Greece, Croatia, Latvia, and Bulgaria, countries situated in Central and Eastern Europe except the Netherlands. It's worth noting that the majority of these countries border nations embroiled in armed conflict. Group 1 countries exhibit similar levels of economic growth, with the Netherlands having the highest and Bulgaria the lowest level of economic growth, standing as outliers. All group 1 countries are member states of the European Union and NATO. With the exception of Estonia, all countries in group 1 were

characterized by dependence on fuel imports from Russia. Consequently, key threats identified in the FUA for this group of countries include an increase in fuel/energy prices.

In these nations, urban mobility heavily relies on public transport, except in Lithuania and the Netherlands, while active transport like walking and cycling is the least popular, except in the Netherlands and Bulgaria. The dominance of public transport can be attributed to the growing significance of threats related to parking fees/entrance fees to city centres. The implementation or expansion of paid parking zones in cities and traffic congestions (stemming from existing transport networks, e.g., the only road in a given direction) might hinder car travel for residents of these regions. Conversely, these countries demonstrate awareness of environmental threats, evident in concerns about restricting access to urban vehicles, such as banning diesel cars from entering city centres.

Table 4. Factors for determination of Mojena’s rule

Steps	Linkages	di-di-1	di/di-1
1	1.414		
2	1.732	0.318	1.225
3	1.732	0.000	1.000
4	2.000	0.268	1.155
5	2.449	0.449	1.225
6	2.449	0.000	1.000
7	2.449	0.000	1.000
8	2.646	0.196	1.080
9	2.646	0.000	1.000
10	2.819	0.174	1.066
11	2.955	0.135	1.048
12	3.062	0.108	1.036
13	3.271	0.208	1.068
14	3.408	0.137	1.042
15	3.652	0.245	1.072
16	3.781	0.128	1.035
17	3.812	0.031	1.008
18	5.474	1.661	1.436
19	6.239	0.765	1.140
	$\bar{d} = 3.052$	$s_d = 1.212$	

Source: own study.

Group 2 consists of the following countries: Sweden, Finland, Moldova, Romania, and Czechia. This group includes two highly developed countries: Finland and Sweden, which are members of NATO. In these countries, active transport is a popular mode of urban transport, while in the remaining countries in group 2, public transport dominates, especially in Romania and Czechia.

Romania and Czechia are countries with an average level of development, with GDP per capita of 72 and 90, respectively. On the other hand, Moldova is neither a member of the European Union nor NATO. In group 2, the key threat, recognized by FUA residents, is the increase in fuel/energy prices, despite the relatively low dependence on Russia for energy imports. Key risks identified for FUAs in this group of countries also include the loss of driving or passenger transport licenses and errors in road design and construction.

Group 3 consists of Spain, Hungary, Turkey, Germany, Norway, and Austria, encompassing highly developed countries, with the exception of Turkey and Hungary. It’s noteworthy that Austria is the sole non-NATO member, while Norway and Turkey are

Table 5. Typological classification of European countries based on similarities in the prioritisation of threats influencing TB

Group number	Threat factors	Threat category
Group 1: Slovakia, Poland, Netherlands, Lithuania, Estonia, Greece, Croatia, Latvia and Bulgaria	1E – Increase in fuel/electricity prices	Economic
	2E – Urban vehicle access regulations (e.g. diesel cars are prohibited from entering the city centre)	Legal
	1C – Parking fees / fees for driving into the city centre	Economic
	2F – Introduction or expansion of paid parking zones in the city	Legal
	3B – Traffic congestion (caused by the existing transport network, e.g., the only access road in a given direction)	Infrastructural
Group 2: Sweden, Finland, Moldova, Romania and Czechia	1E – Increase in fuel/electricity prices	Economic
	2A – Loss of driver’s license or passenger transport license	Legal
	3D – Poor roadway design and construction errors	Infrastructural
Group 3: Spain, Hungary, Turkey, Germany, Norway and Austria	1B – Ticket price is high/tickets are difficult to buy	Economic
	1D – Lower service frequency (such as a bus line), changes in public transport timetables	Economic
	2F – Introduction or expansion of paid parking zones in the city	Legal
	3E – Shortage or decreased availability of parking spaces	Infrastructural

Source: own study.

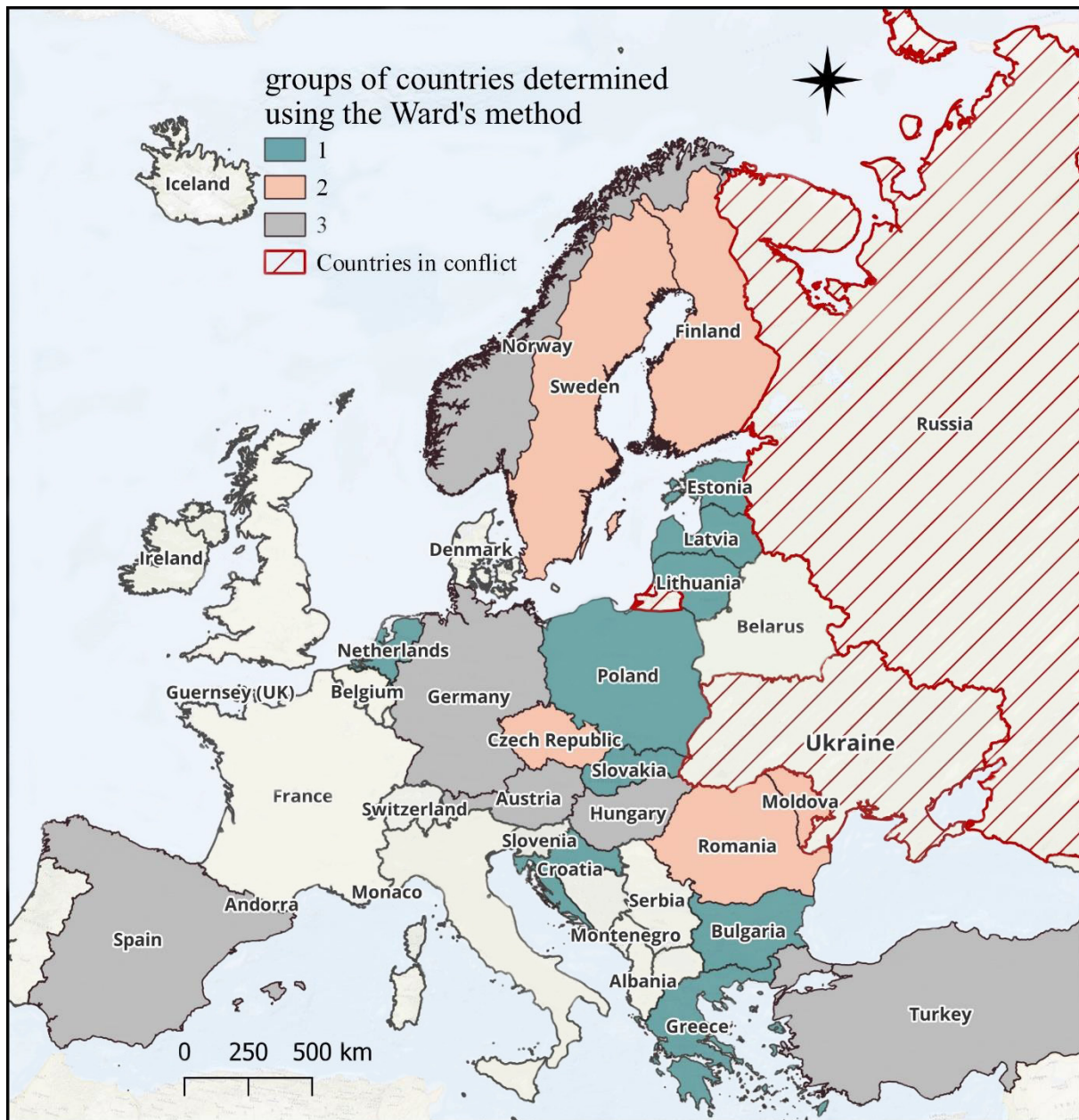


Fig. 8. Classification of analysed countries based on similarities in the prioritisation of threats that influence TB
 Source: own study.

not part of the EU. This group is characterized by a significant geographical distance from the epicentre of armed conflicts.

These nations were marked by relatively high energy dependence on Russia. Active transportation predominates in FUA core cities, except for Budapest

(Hungary), where public transport assumes a pivotal role. Barcelona (Spain) notably emerges as a leader in active transportation.

Remarkably, the primary threat within this group lies in the implementation or advancement of paid parking zones in cities, alongside high ticket prices

or challenges in obtaining them. The substantial reliance on fuel imports from Russia for most countries in this group (excluding Norway) has led to escalated fuel/electricity costs.

The distance separating each group of countries from the epicentre of the conflict was analysed with the use of a complex cartogram. The 1st group of countries form a cluster of neighbouring states that border Russia and Ukraine, excluding the Netherlands, Bulgaria, and Greece. However, TB in these countries could be similar despite considerable economic and cultural differences. The 3rd group of countries are separated by the longest distance from the epicentre of the conflict, which could explain why their perceptions of safety and the key threats identified in these countries differ from those indicated by group 1 and 2. Despite the fact that countries from the 2nd group are relatively close to the red zone, they prioritised threats differently than group 1. Poland (group 1) and Moldova and Romania (group 2) are situated in the immediate vicinity of the conflict zone, but they responded differently to threats influencing TB. These observations confirm the research hypothesis postulating that the distance from the epicentre of conflict does not significantly influence the prioritisation of threat factors affecting TB in FUAs. These results also suggest that threat ranking is also influenced by other factors, including energy (supply of gas, crude oil, and coal), economic growth, and membership in international organisations such as NATO or the EU.

CONCLUSIONS

In the current study, geographical methods and tools were employed to identify and categorise threat factors affecting TB in various modes of passenger transport within FUAs. A total of 23 threats were identified and classified into three key categories. An expert survey was conducted to assess the perceived significance of threats in each category, with the importance of each threat ranked based on responses received before and after the outbreak of the conflict in Ukraine, which carries serious implications for

Europe. The survey revealed that economic, legal, and infrastructural factors were considered key threats during times of conflict. Similarities and differences in the prioritisation of threat factors were identified through comparative analysis of two study samples and selected European countries. Ward's method was employed in hierarchical cluster analysis to group examined countries based on their perceptions of threat severity during the conflict in Ukraine. The analysis showed that distance from the conflict's epicentre did not significantly alter the prioritisation of threat factors influencing TB in FUAs. Other factors, such as membership in international organisations, energy dependency on Russia, level of economic growth, and transport infrastructure, played more significant roles in the prioritisation process.

The obtained results expand upon existing classifications of factors influencing travel attitude (De Vos et al., 2018) and public transport safety (Janczarska-Bergel, 2021). Latent factors in transportation mode choice (Md Nor et al., 2007) were not considered in the adopted threat classification. The study does not provide a comprehensive picture of European sentiments regarding threat factors influencing TB, as the survey was conducted with a minimum of five experts from each country. Further research is needed to examine expert opinions in countries that did not participate in this survey for reasons independent of the authors. In the future, the authors plan to develop universal indicators for ranking threats that influence TB in FUAs within the context of specific modes of passenger transport.

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