rail freight; Europe - China; alternative corridors; Trans-Sib

Dewan Md Zahurul ISLAM*, Thomas H ZUNDER, Ross JACKSON
NewRail Centre for Railway Research
Newcastle University, NE1 7RU, UK
Nina NESTEROVA
TNO, Van Mourik Broekmanweg 6, 2628 Delft, The Netherlands
Arnaud BURGESS
PANTEIA, Bredewater 26, P.O. Box 7001
2701 AA Zoetermeer, The Netherlands
**Corresponding author*. E-mail: dewan.islam@newcastle.ac.uk

THE POTENTIAL OF ALTERNATIVE RAIL FREIGHT TRANSPORT CORRIDORS BETWEEN CENTRAL EUROPE AND CHINA

Summary. The paper examines the potential of three rail corridors: Trans-Sib, Central and TRACECA for freight transport between Central Europe and China. The paper applies a qualitative research method including a review of current literature and interviews. The research examines the technical, operational and bureaucratic conditions of the corridors. The research finds that the unreliable transit time, higher cost and damage and theft of cargo are the most pressing barriers to towards offering an efficient and integrated logistics and supply chain service along the corridors. This is due to, amongst others, problematic, multiple border-crossings and the lack of visible cooperation among the countries. The technical and operational barriers include a change of gauge, differing power supply and signalling systems and non-automated and fragmented information systems. The research also finds that the Trans-Sib is the most attractive corridor currently running and shows promise with the active contribution from the Russian government and relevant direct stakeholders such as Russian Railway (RZD). The TRACECA route is the most problematic option due to, among others, numerous border-crossings, infrastructure and rolling stock constraints and other associated problems.

POTENCJAŁ ALTERNATYWNYCH KANAŁÓW KOLEJOWEGO TRANSPORTU TOWAROWEGO POMIĘDZY CENTRALNĄ EUROPĄ I CHINAMI

Streszczenie. Artykuł bada potencjał trzech kanałów kolejowych: Trans-Syberyjskiego, Centralnego oraz TRACECA dla transportu towarów pomiędzy Centralną Europą a Chinami. Artykuł stosuje badania jakościowe łącznie z przeglądem aktualnej literatury i wywiadami. Praca badawcza rozpatruje techniczne, operacyjne oraz biurokratyczne warunki oraz korytarze. Praca badawcza odkrywa, iż niewiarygodne czasy tranzytu, wyższe koszty i zniszczenia oraz kradzieże towarów są najbardziej naglącymi barierami do przejścia przy użyciu efektywnego oraz logistycznie zintegrowanego serwisu łańcucha dostaw wzdłuż korytarzy. Jest to spowodowane między innymi, problematycznością, przymusem pokonywania wielu granic międzynarodowych oraz brakiem widocznej współpracy pomiędzy państwami. Techniczne i operacyjne bariery zawierają zmianę szerokości, zróżnicowanie mocy zasilającej i systemów sygnalizacji oraz nieautomatyczne i rozproszone systemy informatyczne. Paca również przedstawia, iż trasa Trans-Syberyjska jest najbardziej atrakcyjnym korytarzem biegnącym obecnie i dającym nadzieję przy czynnym udziale Rosyjskiego Rządu i odpowiednich podmiotów bezpośrednich takich jak Rosyjska Kolej (RZD). Trasa TRACECA jest najbardziej problematyczna opcją, pomiędzy innymi, spowodowane jest to koniecznością wielokrotnego przekraczania granic, infrastrukturą i ciągłymi ograniczeniami zasobów i innymi powiązanymi problemami.

1. INTRODUCTION

Transport service options are vital for the competitiveness of trade and investment in any economy as it connects regions together and acts as an important medium for their economic activities. The majority of EU-27 external trade cargoes are transported by maritime transport (EC, 2011 p. 28). Similar views are opined in other publications (Vellenga et al., 2006), which suggest that maritime transport handles the majority of cargoes for trade flows between Asia and Europe. The maritime routes lengthen the supply chain and can take up to forty days resulting in higher inventory levels both in-transit and in-factories.

Recent changes in Chinese production systems have however provided new rail based alternatives to the traditional maritime mode of transportation. For example, Unilever has moved six factories from Shanghai to more than 1000 km west to the city of Hefei and Hewlett Packard has opened up a major computer-manufacturing base in Chongqing in Southwest China. This is in part due to rising labor costs on the east coastal areas of China but also the aim of capturing the potential market in the hinterland.

This traditional transport option could be complemented by Europe-Asia surface transport services. Wang and Meng (2011, p. 190) suggest that land bridge freight transport can integrate short-haul road freight services with long-haul rail services, through transfer of cargo units in terminals, to deliver continental rail–road intermodal transport services and that the North American land bridge is developed over the years as an efficient transport system that provides a competitive alternative for freight shipments across the Panama Canal. One land bridge route option could be the North American Continent as a ‘bridge’ between Asia and Europe. In this case, for example, a shipment would go from Hong Kong to Seattle, USA (or Vancouver, Canada) by maritime transport. The containers would then move by intermodal double stack rail transport to an East coast port such as Boston, USA (or Halifax, Canada); alternatively by rail intermodal transport via land bridges between Asia and Europe through Russia and other mid-Asian countries. This option is the main scope of this research. Such land transport increases the prospects for economic development; e.g. through lead time advantage, cost savings for manufacturing sector, retailers Hilletofth et al. 2007); not only in Europe and China, but also in all in-transit countries (such as Russian) along the Euro-Asian routes (Panova, 2011). In particular the landlocked countries such as Kazakhstan (which are dependent on each other for access to international trade) will benefit highly from such an international connection. The development of efficient Europe-Asian rail and/or road-rail intermodal transport routes could provide additional transport options to the existing maritime option. Through these alternative routes the services become competitive, increasingly reliable and it is anticipated that all countries along the corridor would benefit.

Currently there is one rail freight service that is run between Shenyang, China and Leipzig, Germany primarily to serve the supply chain of a BMW plant. BMW operates a plant in Shenyang to build components in China at a lower cost. Currently the 11,000 km rail transport haul takes about 23 days with a service every 24 hours for the plant at both ends (Wright, 2012). The direct rail freight service is more than twice as fast as maritime transport followed by transport to the Chinese hinterland which is seen as a major incentive for the Eurasian land bridge. The containers, in the range of 40ft to 50ft, containing BMW components travel via Poland, Belarus and the Trans-Siberian route where DB co-operates with local operators in each country, and the containers are transshipped by cranes at the breaks of gauge at the Poland-Belarus border and the Russia-China border at Manzhouli (Rail Gazette International, 2011). This indicates that there could be rail and/or rail-road intermodal service options open to any service users. The current paper will examine such options from a technical and operational perspective.

The literature review suggests that block trains between Europe and China are currently functioning more as a company initiative (e.g. DB – as discussed in the introduction), as there is not sufficient demand for the development of a regular block train for the origins – destinations in the countries of the alternative options. A fully functioning Eurasian rail corridor, like any other corridor in Europe or USA, is an ambitious endeavor - due to the fact that it crosses a number of countries with specific technical solutions, overcomes institutional and organizational barriers and deals with a variety of rail philosophies and cultures. The border crossing is an important barrier in any cross-country service due to time consuming formalities to be followed (Woodburn et al., 2010).

1.1. Objective

The objective of this paper is to examine the following alternative rail freight transport corridors and routes (to traditional maritime transport) between Europe and China: 1) Trans-Siberian corridor with three alternative routes, 2) Central corridor and 3) TRACECA corridor with two alternative routes.

1.2. Organizational structure of the paper

The remaining part of the paper is organized as follows. The methodology of the research is discussed in section 2; the background information on the alternative corridors and routes are discussed in section 3; and the section 4 identifies the strengths, weakness, opportunities and threats (SWOT) analysis. Finally the section 5 summarizes the research and draws the necessary conclusions.

2. METHODOLOGY

The research examines the technical and operational conditions of the corridors and routes. For this, the paper applies qualitative research methods including desktop research and combines economic forecast data and nineteen interviews with infrastructure managers, intermodal operators, rail operators, shipping lines, academics and freight forwarders in different countries along the routes (the profile of the interviewed companies can be seen in table 1; the personal profile of the interviewees are not published due to the confidentiality issue). Of the interviewed companies, ten are from Russia, 3 from China, 2 from Germany, 2 from Belarus, one each from Kazakhstan and Switzerland. The interviewee list included 6 rail operators, 4 intermodal container operators, 3 intermodal transport operators, 2 infrastructure managers, and 2 academics. It is difficult to obtain information about the rail and road transport system from anything other than official policy documents in the countries on the corridors under review. However, a number of missions were employed over the period of November 2011 to January 2012 to overcome such barriers to conduct physical interviews that enabled us to collect relevant information.

Table 1

Profile of the interviewed companies

Working field	Country	Company/organisation
Infrastructure manager	Russia	Russian Railways (RZD)
Intermodal transport operator	Russia	Russian Railways (RZD)
Intermodal container operator	Russia	Russian company (TransContainer)
Maritime shipping company	China	Chinese shipping company
Academic	China	Shanghai University
Academic	China	Beijing University
Infrastructure manager	Belarus	Belarussian Railways
Rail operator	Belarus	Belintertrans
Intermodal container rail operator	Russia	CJSC Russkaya Troyka
Rail operator	Russia	DVTG Group
Rail operator and forwarder	Russia	Eurosib
Intermodal transport operator	Switzerland	HUPAC Intermodal SA
Rail operator	Germany	InterRail Services GmbH
Rail operator	Russia	InterRail Trans Siberian Express Service LLC
Rail operator	Russia	JSC Freight One
Intermodal container transport Operator	Russia	JSC Transcontainer
Intermodal container operator	Germany	Polzug Intermodal Ltd
Intermodal transport operator	Kazakhstan	Transsystem
Rail operator	China	Trans Eurasia International Logistics

3. TECHNICAL AND OPERATIONAL CONDITIONS OF DIFFERENT CORRIDORS

3.1. Trans-Siberian (Trans-Sib) Corridor

Panova (2011 p.227) suggest that the Trans-Siberian Railway (Trans-sib) can play an important role for the international land bridge connecting countries from different continents: Asia and Europe. The Trans-Sib route (see Fig. 1) offers several possibilities to connect Europe with China using its branch lines to Kazakhstan, Mongolia and China in the Eastern part and linkages via Belarus/Poland or Ukraine to Western Europe:

- Trans-Sib – China via Kazakhstan (Kazakh route) - offers the shortest distance for rail transport between Moscow and Beijing and is favourable for connection with Western china;
- Trans-Sib – China via Mongolia (Mongolian route) is favourable for the transportation to and from Western China;
- Trans-Sib – China via Zabaykalsk (Manchurian route) is the shortest route for transportation between Moscow and the Northeast China;

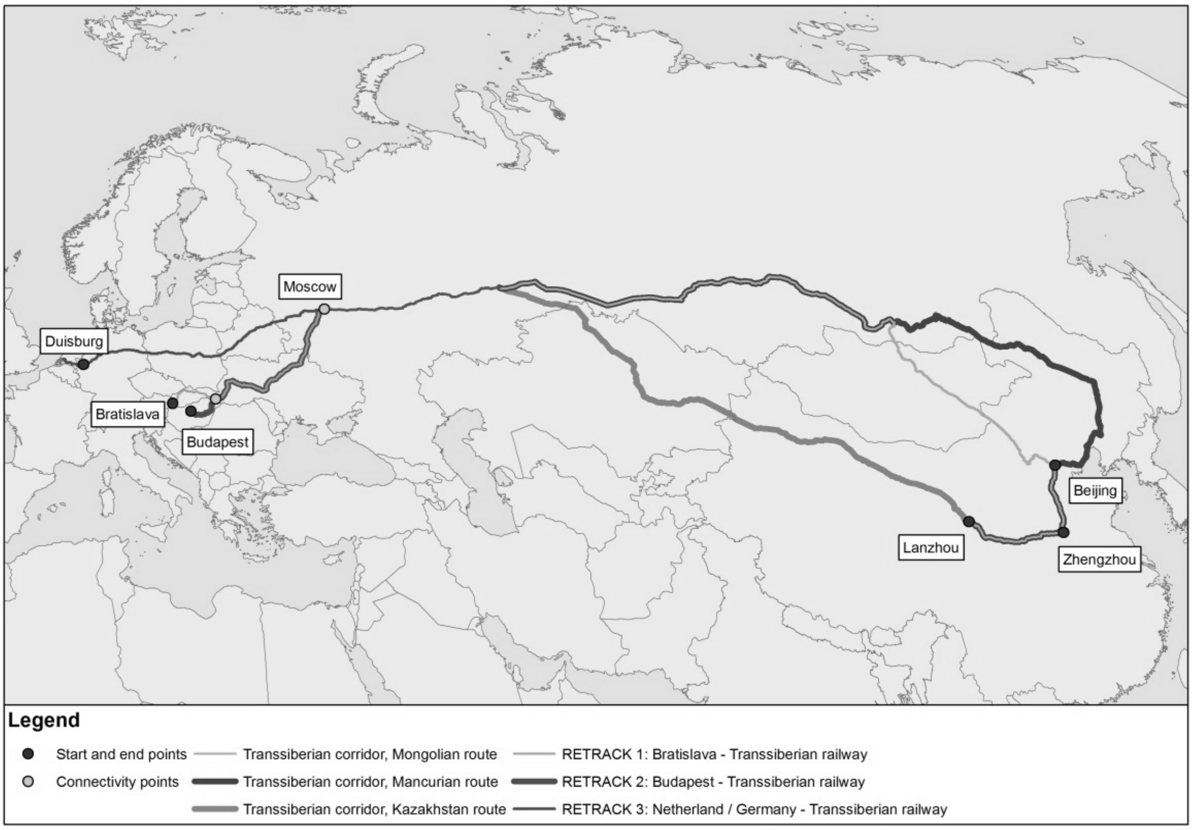

Fig. 1. Trans-Sib corridor with associated railway routes with Europe and China (Source: RETRACK, 2012, p. 90)
Rys. 1. Korytarz Trans-Syberyjski z powiązanymi drogami kolejowymi z Europą i Chinami (źródło: RETRACK, 2012, p. 90)

The terminal at Novosibirsk with an area of 30 ha is one of the largest terminals in Siberia with a capacity to operate two container trains per day. The terminal has two heated warehouses with an area of 10,000 sqm each, including a special area for temporary storing of customs cargo (1,250 sqm). The container storage capacity is 3,000 TEU. There is a shortage in container and handling capacity in the Russian Federation, as well as along the Trans-Sib Corridor. Additional container terminals make additional trains and combinations of domestic and internationally operating trains feasible and therefore, transit services will be more competitive due to economies of scale and scope. For example, the lack of return cargo from Europe to China could be eased by additional eastbound cargo to Russia. The container train “Eastwind” is already a good example of a joint production platform for European cargo, both for Russia and Asia. However, additional Russian container trains will compete with transit trains for the use of infrastructure and rolling stock capacity. There are programs to expand the Russian container handling capacity that will enhance capacity and use of the route.

3.2. Central Kazakhstan (Central Corridor)

3.2.1. Technical and operational condition of Central Corridor

The Central corridor (see Figure 2) is an alternative route through the territory of Kazakhstan to currently existing and functioning railway routes. If cargo has to be delivered from Eastern Europe (e.g. Budapest, Bucharest to Western China, the most common options which exist are:

- road transport through Ukraine, Russia and Kazakhstan
- container rail transport through Moscow and Trans-Sib railway, or through Moscow and Kazakhstan via Ozinki/Iletsk station.

The railway infrastructure of Kazakhstan offers many options in connecting China and Europe. Some of them are already represented via international railway transport corridors in the territory of Kazakhstan. Due to historic reasons the main railway lines in Kazakhstan were built connecting Moscow, the capital of the former USSR. The railway line Dostyk – Almaty – Kandagash – Makat – Ganushkino (KAZ) – Aksaralskaya (RF) forms one of the major lines, which cross the country from East to West. For our current research this option is termed as the Central Corridor.

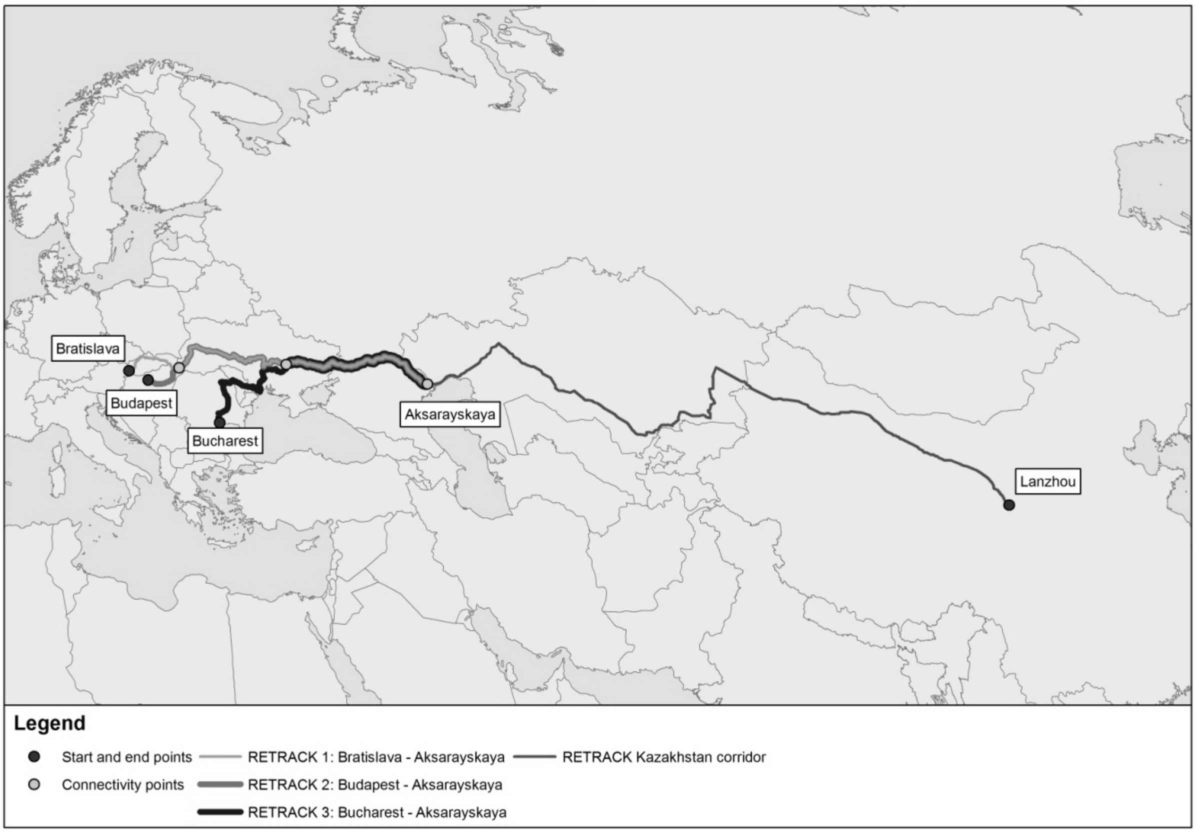

Fig. 2. Central corridor and its connections with Europe and China (Source: RETRACK, 2012, p. 121)
Rys. 2. Centralny korytarz i jego połączenia z Europą i Chinami (Źródło: RETRACK, 2012, p.121)

3.2.2. Main terminals on the Central route

There are three marshalling yards of national importance situated on the Central corridor: Kandyagash, Arys and Dostyk and two freight yards: Shimkent and Almaty I. Ganushkino is an important station, as this is an official border crossing station with the Russian border and the Dostyk station for the Kazakhstan – China border. The redistribution of cargo which is to go to other Central Asian countries (e.g. Tashkent) takes place at the Arys station. Dostyk railway station is the most important of the Kazakh intermodal terminals because it provides connection with the Central corridor, TRACECA rail routes to China. The main operations performed at the Dostyk terminal are: the breaking – up and making-up of trains and performing the gauge change from broad gauge (1,520mm) in Kazakhstan to standard gauge (1,435mm) in China. During these operations customs clearance is also conducted. The wheel change works are carried out at Dostyk station, as there are no wheel change facilities in Alashankou. The works to change wagons crossing the border are carried out by the recipient side.

Dostyk has 5 types of yards and 7 types of transhipment points. The JICA (2007) study reports that some of the cargo handling equipment at the station requires major overhaul and the equipment does not match the current cargo volume. In 2009 the Dostyk rail freight terminal was capable of handling a maximum of 620 rail cars per day (JICA, 2007). The actual cargo handling amount of the Dostyk Station is already at 80 – 90% of its overall capacity. As some of the reloading spots are situated in the open air, in the winter the handling capacity of the terminal is lower, as handling works are impossible due to snowfall or fierce winds. The survey conducted with the freight forwarders within the JICA (2007) study has indicated that the shortage of reloading facilities is critical at Dostyk. The improvement of the Dostyk station facilities is currently in progress.

3.3. Traceca corridor

Although the TRACECA (see Figure 3) initiative brings the countries together in order to develop and promote the common transport corridors, in practice the integrated TRACECA railway corridor does not exist. At present infrastructure improvement initiatives are carried out on a national level. Two alternative TRACECA corridor routes were studied that provide the connection between Southern Europe and China:

- The TRACECA – Turkmenbashi route, which goes from Poti in Georgia, Azerbaijan, Turkmenistan and Uzbekistan and to Dostyk in Kazakhstan;
- The TRACECA – Aktau route, which goes from Poti in Georgia, Azerbaijan, the Aktau port in Kazakhstan and then further through Kazakhstan to the Dostyk border crossing with China.

The TRACECA – Turkmenbashi and TRACECA – Aktau routes follow the same railway segments from Poti to Baku and from Arys to Dostyk and further to China. They vary in their central section, with the TRACECA – Aktau route following only through the territory of Kazakhstan.

3.3.1. Main terminals on TRACECA – Turkmenbashi route

There are several intermodal and logistics terminals (see table 2) along the TRACECA - Turkmenbashi route.

Table 2

Main freight loading unloading terminals on TRACECA – Turkmenbashi route

Country	Type of the station	Name of the station
Georgia	Freight	Rustavi, Tbilissi U., Tbilissi G. and Poti
	Marshalling yard	Tbilissi S. and Samtredia II
Azerbaijan	Marshalling yard	Baku
	Freight	Boyuk Kasik
Turkmenistan	Marshalling yard	Gypchak, Anev, Farab,
Uzbekistan	Marshalling yard	Buhara, Havast and Chukursay,
	Freight	Tashkent
Kazakhstan	Marshalling yard	Arys
	Freight	Almaty I and Dostyk

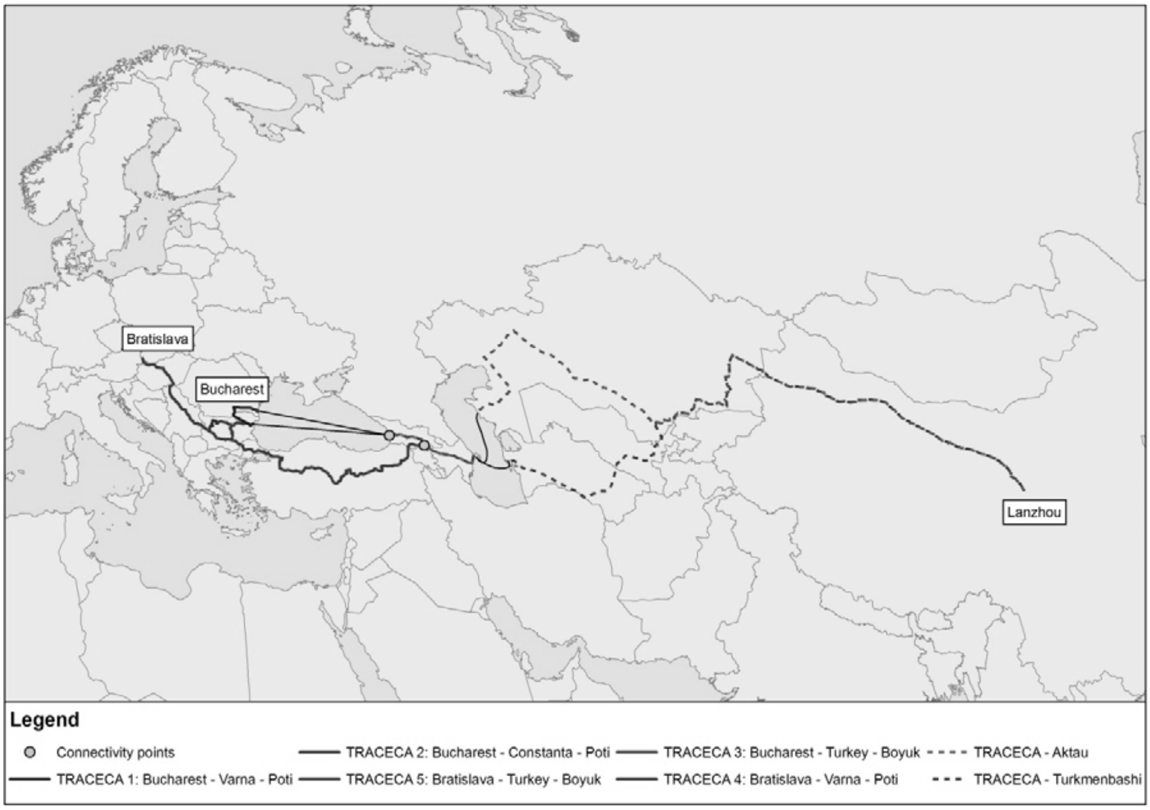

Fig. 3. TRACECA corridor and associated routes with Europe and China (Source: RETRACK, 2012 p. 140)
Rys. 3. Korytarz TRACECA i drogi powiązane z Europą i Chinami (Źródło: RETRACK, 2012, p.140)

3.4. Comparison of technical and operational features of the three corridors

In order to gain an understanding of the potential difficulties associated with establishing a service along each of the corridors, tables 3 and 4 below describe the technical and operational features/characteristics of each of the corridor.

Table 3

Characteristics of the three alternative corridors

Corridor	Characteristics
Trans-Sib corridor with 3 routes	Trans-sib corridor has three alternative routes to China (see Figure 1). All Three Trans-Sib route options have a common section from Moscow to Yekaterinburg. All of these route options have same gauge 1520mm. But due to the different power supply system, the traction of freight trains uses different types of locomotives and at least three changes of locomotives are required along the Trans-Sib main route (from Moscow to Nakhodka). The maximum allowed train speed for freight differs on separate line sections. It is 80 km/h on most of the line and 90 km/h on the sections with a total length of 151 km. The average allowed speed for freight trains over the entire line is 76.7 km/h, maximum train mass is 2800t and maximum train length 1000m. Maximum axle varies 23/25t in Kazakh route option and 25t in other two options.
Central corridor	The total distance of the corridor is 3,930.8 km, of which only 1,228km are double track. Currently 790 km are electrified, but before 2019, it is planned that about 1,260 km more will be electrified. The railway gauge of the corridor is 1,520 mm. The maximum freight train speed varies from 60 to 80 km/h depending on the condition of the railway infrastructure. The maximum train mass is 2,800t – 3,200t and the maximum axle load varies from 23t to 25t.

TRACECA corridor with 2 routes	Half of its length is double track. Some sections of the railway line currently bear traffic near to maximum capacity. Almost all the lines have a semi-automatic blocking system which does not allow more than one train between two stations. The maximum train mass differs between 2,500t to 3,000t on the different sections. The Azerbaijani section of the railway up until Baku is a double track line with the exception of one bridge with a single track in Powlu which reduces the capacity of the entire line. There are a lot of ongoing initiatives and projects for the modernization and rehabilitation of the railway infrastructure within the TRACECA region. The majority of these projects have a national character. Some are aimed at creating new railway lines and some are focused on the upgrade of the existing infrastructure.

Table 4

Technical Capabilities of the three router

Route	Distance (km)	Double track	Electrified	Average Speed (km/hr)	Line Voltage	Loco Changes
Trans-Sib corridor with 3 routes	9288	Most part	Most part	76	50KV AC, 3KV DC	3
Central corridor	3930	One eighth	One eighth	40	25KV AC	3
TRACECA corridor with 2 routes	5000	Less than half	Less than half	40	3kv AC, 6KV AC	2 or 4

4. STRENGTHS AND WEAKNESSES OF EACH ROUTE (SWOT ANALYSIS)

The strengths and weakness of each route are displayed in table 5.

Table 5

Corridor and routes	Shipment Compatibility	Transit time & Transit time Variability	Price	Frequency	Theft of Cargo
Trans-Sib corridor and routes	There are different speeds in further development of the signalling systems at main routes to be observed.	Many aspects have an impact on the travel time along the route. Technical differences (gauge width, power supply), the number of border crossing points (different rules and regulations, ruling languages) and type of cargo.	The tariffs on transit transportation along the Russian railways in 2008 considered the imbalance of freight flows on routes going East-West (USD 900 per loaded 40 TEU container), and West-East (USD 800 per loaded 40 TEU container and USD 400 per empty 40 TEU container).	Every train on the Trans-Sib consists of 57 wagons, each transporting two 40'-containers. That is equivalent to 228 TEU per train. The total volume of international traffic amounted to nearly 70 million tonnes during first 8 months of 2011	In 2010, more than 1,9 thousand acts of unlawful interference with rail transport were registered in Russia

The strengths and weakness of route

Central corridor	Shares common technical, operational standards and rolling stock with Russia.	Obsolete railway infrastructure and rolling stock considerably slow the train speed on the Kazakh network. The estimated transit time from Bratislava (Europe) to Lanzhou (China) via this corridor is estimated in total +/- 36 days.	The market price for the delivery of the 20' container from Bratislava to Lanzhou via the Central corridor by a single wagon load train in January 2012 was 6,773 - 6,892 USD. The current rates for transportation of cargo to Kazakhstan and Belarus are quoted with 0% VAT for the Russian railway transit tariff, due to the Customs Alliance. However, in order to speed up shipment at the Kazakh-Chinese borders, the "acceleration fee" varies from 30 to 100 USD per container.	2011 flows currently using other routes: China to Ukraine: 110,000 tonnes (labelled as "other goods", e.g. consumer goods, electrical goods, chemicals) Russia to China: 200,000 tonnes fertilisers (are currently transported through Tobol) China to Russia: 200,000 tonnes "other goods" (are currently transported through Tobol).	Damage and theft main reason to avoid transport of cargo along this route. Generally due to lack of unified track and trace system and historic organizational heritage.
TRACECA Corridor and routes	All the countries on the TRACECA corridors inherited common operating standards, infrastructure and rolling stock, thus, intermodal transport can be organized.	The transit time for the single wagon load train from Poti to Alashankou, using the TRACECA – Turkmenbashi route, is a minimum of 24 days; a block train can cover the same distance in 21 days. Reliability of the transit time is one of the weakest points on the TRACECA rail corridors.	The parties within TRACECA signed a number of documents relating to certain benefits and reduced tariffs (e.g. a 50% discount on rail freight and ferry transportation of empty wagons; abolishment of taxes and fees on transit cargoes). In practice, the composition of the rail tariff fluctuates. Tariff establishment is the general concern of all railway operators in the region - making it nearly impossible to make any reliable price forecast.	Theoretically spare freight train capacity exists. However in reality the port of Aktau is already highly congested with wagons waiting to be discharged. Also critical - as with the other routes described – is the capacity at border crossings between Kazakhstan and China.	There is high risk of damage to and theft of cargo, which affects the shipper's decision to transport their cargoes. There is no unified tracking and tracing system.

5. SUMMARY AND CONCLUSION

The research finds that the unreliable transit time, higher transport cost, loss, damage and theft of cargo are the most pressing logistics and supply chain issues along all three corridors. This is due to, amongst others, problematic multiple border-crossings, bureaucratic procedures, differing gauge, loco change and the lack of visible cooperation among the countries on the routes. Other operational barriers include poor infrastructure, rolling stock, non-electrified track, single track, differing power supply and signalling systems and non-automated information systems. Corridor and route specific issues are summarised below.

5.1. Trans-Sib Corridor and Routes

To connect Europe and China, the route involves several countries (five or six, depending on the specific corridor option) with different technical railway standards, which pause challenges for an effective transport organization. The RZD is implementing a number of projects to remove organizational and technological barriers. The electrification of missing links along the Kazakh route and the transhipment capacities at Dostyk are technical barriers, which need to be improved.

Availability of containers, wagons and wagon positioning are important barriers that need to be removed. Also the right type of container and wagons at the right time, in the right place is another logistical barrier that needs solving. In particular there are a few wagons for public use the RZD outsources the rolling stock to daughter companies.

The transit time from Moscow to the border crossing with China differs slightly for the three studied routes. A block train from Moscow to border crossings points with China may take: 8 days up to Dostyk via the Kazakh route; 10 days using the Mongolian route (Erenhot) and 7 days using the Manchurian route (until Zabaykalsk). The transit time also differs for the single wagon load trains. There is enough capacity to introduce new freight services on all of the three options. Shipment compatibility is an asset for this route, as the route mainly passes railways having the same technical requirements, such as gauge, safety systems, etc. but these requirements change at the EC border and the Chinese borders.

5.2. Central Corridor

The Central route crosses the Kazakhstan territory from its Western border with Russia to the Eastern border with China. The maximum freight train speed varies from 60 – 80 km/h. The average freight train speed is 40 km/h. The corridor offers one of the shortest options to connect Western China and Central Europe with a minimum number of transhipment points. The major weakness is that the railway infrastructure on the corridor is in poor condition, and is not electrified over its longest section and is mainly single track. Considerable improvement is foreseen within the National Transport Strategy and targeted projects of international organizations. Moreover, neighbouring countries (e.g. Russia) have additional projects which will impact the overall performance of the corridor. The number of container block trains running through the Kazakhstan territory is increasing constantly. There is enough railway capacity to introduce a new regular train service. Several studies conducted forecast the increasing potential of this route in terms of volume for the provision of the internal Kazakh train, EU – Kazakhstan trade, as well as the EU – China transit. According to the experiences and estimations, it takes a maximum of 13 days to run a block train from the Aksaralskaya/Ganushkino border through the Central corridor to the Dostyk railway station. When the on-going infrastructure modernization plans, as well as the Khorgos terminal are fully functional, this transit time will be considerably decreased.

Currently, there are several technical and operational bottlenecks on the corridor service to China: different gauges, different electrification and signalling systems; the infrastructure and rolling stock condition require a frequent change of locomotives and increase the transit time; time consuming procedures at Dostyk border crossing due to insufficient terminal capacity and lack of administrative clarity. The potential clients of the corridor refer to the following risks associated with this route: lack of administration clarity; lack of common interpretation of related laws and regulations; difficulty in guaranteeing the reliability of a transport service; high risk of damage and theft of cargo and absence of modern track and trace equipment.

5.3. TRACECA Corridor and Routes

Two alternative TRACECA routes were studied that provide connection between Southern Europe and China. The maximum freight train speed varies on average from 60 – 80 km/h. On some sections of the TRACECA – Turkmenbashi route, the train speed is limited to 20 - 40 km/h due to the infrastructure condition. The average train speed along both corridors is 40 km/h. Both routes of TRACECA corridor have comparable infrastructure conditions, only half of the distance is double track and both have electrified and non-electrified sections. Thus the capacity of the routes is considerably limited by single track and the general condition of infrastructure and rolling stock.

There are however international initiatives to promote the development of the railway and road infrastructure in the region. For example, considerable railway infrastructure improvements are expected in Georgia, Azerbaijan and Kazakhstan. The operating system of the railway transport is the same and there are no shipment compatibility problems along the corridors. In the majority of cases bottlenecks may occur, but are not due to the limited capacity of infrastructure but due to the mismanagement or mis-operation, e.g. the congestion in the Baku and Aktau ports. Therefore, the potential exists to open additional rail services. At the same time the route does not meet major supply chain requirements, e.g. the transit time is unreliable, market price is hard to assess and is not transparent and the risk of damages and thefts is very high. The low speed also increases cost and time. In addition, the container transport/block trains are intermingled with general freight and passenger transport. The estimated travelling times for the block trains on the route from 21 days for the Turkmenbashi route and 24 days for the Aktau route. The conditions of the pick and delivery service and transhipment operations remain unclear and have a low reliability.

5.4. Conclusion

- All three alternative Trans-Sib routes offer advantages compared to other corridor and routes and have the best potential to compete with maritime services.
- The second best choice is the Central corridor which has a strong potential to provide an alternative service.
- The TRACECA corridor and routes are not yet in operation and has less potential.
- The simplification and mutual recognition of border crossing procedures are of utmost importance for all the corridors and routes. Infrastructure improvement and renewal of rolling stock are vital for the corridors and routes. The countries on the corridors under review must take steps to reduce the loss, damage and delay of cargo in transit. The authors are in the opinion that the countries on the Trans-Sib corridor are likely to take visible steps on these issues compared to other corridors.
- Electronic data flow can improve the freight train operations significantly. This measure needs mutual recognition by all participants. Scheduled train operations are another step forward. Ultimately, operations are somewhat constrained by the change in track gauge between China which uses standard gauge and countries such as Kazakhstan, part of the former USSR which use broad track gauge still used in Russia. The restrictions imposed by railway gauge change are and can be overcome in a number of ways such as a variable gauge system, which allows rail vehicles to travel across a break of gauge by changing the distance between the wheels. These systems are already in operation between Poland (part of the Trabs-Sib route) and its neighbouring countries. Alternatively, and as a more cost effective option it is common in cross border gauge changes to substitute the bogies of the rail vehicles to a bogie with the appropriate wheel set. Ultimately cargo-handling operations at terminals and marshalling yards will play a very significant role in the aspirations of cross border rail freight traffic between Europe and China.

6. ACKNOWLEDGEMENT

A lot of information has been found by native speakers of the Chinese and Russian languages that contributed to this research work. The authors thank to the interviewees for their contribution. Without their contributions, the research would have been very difficult for the authors. The authors thank European Commission for the part funding for the research under RETRACK project - REorgansiation of Transport networks by advanced Rail freight Concepts. Also the authors would like to thank to the anonymous reviewers for their valuable positive criticism and comments that made the paper of better quality.

Bibliography

1. *The Study for the project of the integrated logistics systems and marketing action plan for container transportation*. JICA. 2007. P. 1-20.
2. DB Schenker to launch daily freight train to China. *Rail Gazette International*. 30 September 2011.

3. Vellenga, D.B. & Spens, K.M. Expansion of container traffic from Asia to the EU. In: Hilmola, O.P. (Ed.) *Contemporary Research Issues in International Railway Logistics. Research Report 171*. Lappeenranta University of Technology. Kouvola. 2006. P. 111-118.
4. European Commission. *EU Energy and Transport in Figures*. Statistical Pocketbook. 2011. 28 p.
5. Woodburn, A. & Allen, A. & Browne, J. & Leonardi, J. & van Essen, H. International Road and Rail freight transport: the impact of globalization on activity levels. *Globalisation, transport and the environment.* OECD Publishing. 2010. P. 121-158.
6. Wright, R. Transport choices: New trains of thoughts on freight modes. *Risk Management. Supply Chain in Financial Time.* 20th March 2012.
7. Hilletofth, P. & Lorentz, H. & Savolainen, V.V. & Hilmola, O.P. & Ivanova, O. Using Eurasian Landbridge in Logistics Operations: Building knowledge through case studies. *World Review of Intermodal Transportation Research*. 2007. Vol. 1. No. 2. P. 183-201.
8. Panova, J. Potential of connecting Eurasia through Trans-Siberian Railway. *International Journal of Shipping and Transport Logistics*. 2011. Vol. 3. No. 2. P. 227-244.
9. Wang, X. & Meng, O. The impact of landbridge on the market shares of Asian ports. *Transportation Research Part E: Logistics and Transportation Review.* 2011. Vol. 47. No. 2. P. 190-203.
10. Davydenko, I. & Landa Maxta, I. & Martens, R. & Nesterova, N. & Wark, T. *Potential for Eurasia land bridge corridors & logistics developments along the corridors.* RETRACK REorganization of Transport networks by advanced RAil freight Concepts. Deliverable no. 13.2. 2012. P. 90-141.

Received 03.10.2012; accepted in revised form 27.11.2013