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TECHNOLOGICAL ADVANCES IN THE DEVELOPMENT OF THE US RAILWAYS AGAINST THE COMPETITIVENESS OF THE ECONOMY IN THE YEARS 2000-2017

Summary. The overall contribution of the railway sector in the American economy is substantial. Since 2000, the volume of rail freight transport services in the United States has remained on a balanced and invariably high level, even though the total length of the railway network has declined. Over the recent years, owing to the deployment of advanced software and state-of-the-art technologies, rail freight transport has been performing more effectively than ever. This article addresses a study of the rate of GDP changes compared with measures reflecting the transport services performed in the years 1995-2015. This study comprised the transport performance achieved by means of railways (in billion tkm) against other transport sectors within 2000-2016 and addresses the volume of freight transport services performed in the American transport network. The authors discussed the mechanism functioning of rail freight transport, which is becoming an increasingly attractive means of transport, with reference to the intermodal freight transport, including the double-stack system. They have analysed the share of intermodal transport in the structure of domestic and non-domestic freight transport services in 2017. Furthermore, the latest observed trends in the American railway network in the sphere of the use and implementation of the

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state-of-the-art technologies supporting railway traffic management was brought to light with regard to the improvement of safety and assisting the relevant authorities.

Keywords: US economy, rail transport, technological advancement, safety.

1. INTRODUCTION

The dynamic advancement of American rail transport is determined by the continuous development of the economy. American railways transport more than two billion tonnes of raw materials and finished products annually using nearly 130,000 miles of railway lines that cut through 49 states. The increasing demand for the supply of goods to a wide range of industries and consumers in the country, as well as to global markets, has contributed to linking the internal market from the east to the west coast and connecting it with the rest of the world.

The overall contribution of the railway sector in the American economy is quite substantial, creating more than 1 million jobs,[3] and increasing tax revenues and the gross domestic product. Suppliers and service providers operating in the railway directly employ more than 125,000 people in production, repair, maintenance and leasing. Moreover, for every worker directly employed by the railway sector, further 4.2 jobs are supported by the business environment in its broad understanding, which means that 650,000 jobs are linked with goods suppliers and railway service providers, as well as their supply chains or the expenses of those whom these companies employ[4].

American railways were originally established and still currently operated on a nearly exclusive basis of private capital. Railway entrepreneurs who own both the infrastructure and the rolling stock are responsible for their maintenance, upgrading and repairs, while ensuring the flow capacity of the routes they manage. In most lines, advanced technologies are either already supported or presently being implemented, which has made it possible to increase traffic safety over recent years as well as to partially relieve roads of heavy vehicle traffic.

2. MAIN TRENDS IN THE DEVELOPMENT OF THE US ECONOMY

The United States of America is the largest and most important economy in the world. Its GDP value was USD 19.4 billion in 2017, which accounted for over 18% of the world's gross domestic product[5]. The United States has maintained its position of world economic leader for many decades, leaving far behind both the dynamically developing China (with its 2017 GDP of USD 12.0 billion), Japan (USD 4.9 billion) and Germany (USD 3.7 billion). In terms of GDP per capita, the United States was ranked 8th in 2017 (USD 59.9 thousand per capita), being second only to smaller countries such as Luxembourg, Switzerland, Macao, Norway, Iceland, Ireland and Qatar.

[3] Association of American Railroads; available at: https://www.aar.org/railroad-101/
[4] Railway Supple Institute, available at: https://www.rsiweb.org/-25sept18
[5] Statista; available at: https://www.statista.com/statistics/268173/countries-with-the-largest-gross-domestic-product-gdp/

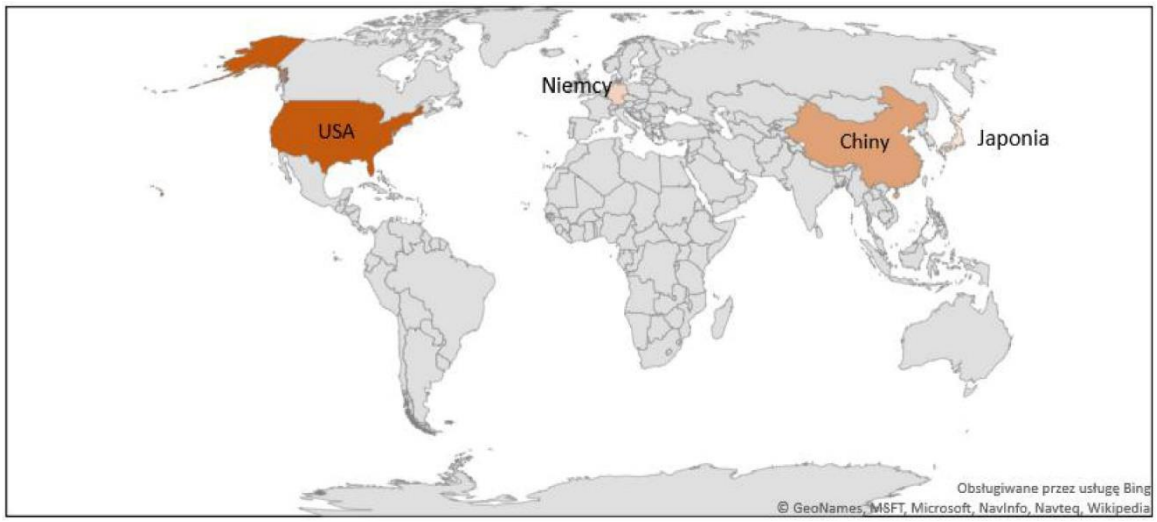

Fig. 1. Countries with the highest GDP worldwide
Source: https://inzynieria.com/wpis-branzy/rankingi/10/52442,najwieksze-gospodarki-swiata-2018,pozycja-rankingu-4-niemcy-3-68-bln-usd

The USA is the largest (single country) free-market economy in the world[6]. Compared to the economies of the European Union, it is characterised by significantly higher liberalism, lower taxes and absence of extensive social security schemes.

Fig. 2. Trends in the American GDP in the years 2000-2017
Source: https://tradingeconomics.com/united-states/gdp

[6] More on this subject [at:] Mindur, M. (ed.): *LOGISTYKA Nauka-Badania-Rozwój*, [In Polish: *LOGISTICS Science-Research-Development*], ITE-PIB, 2017, 633 p.

The US economy is dominated by a highly developed and technologically advanced service sector, which accounts for nearly 80% of the GDP. Production is equally important, as it accounts for ca. 19% of the GDP[7]. The United States is the world's second largest producer and leader in the automotive, aviation and aerospace, machine building, telecommunications and chemicals industries [8].

Following the global economic crisis of 2009, owing to the massive government financial support, the US economy started recovering from the recession. Its economic growth has also benefited from such activities as research, implementation of innovation and capital investments. One cannot disregard the fact that the US possesses and extracts vast natural resources (including crude oil, natural gas and hard coal). December 2017 saw the implementation of a tax reform which, starting from 2018, effectively reduced the tax rates binding for companies from 35 to 21%. Individuals are also subject to lower taxes, and many other tax reliefs and deductions were changed[9]. The reduced corporate tax rates have been introduced for good, while the reliefs for individuals are expected to expire past 2025.

Despite the fact that the United States currently enjoys very good economic conditions, the country still faces numerous significant challenges. These include deteriorating infrastructure, stagnation in wages, growing income inequalities and costs of universal health insurance coverage, as well as a growing current account deficit and budget deficit[10].

Further potential threats include the recent changes in the foreign trade policy, which have undoubtedly had an impact on economic growth. The current state policy which entails imposing duties on imported goods is intended to encourage US consumers to purchase domestic products. Customs duties have been imposed on imports of certain goods from China, Mexico, Canada and the European Union, and it should be noted that all these countries have taken retaliatory action. In January 2017, the US representation broke negotiations concerning the Transatlantic Trade and Investment Partnership (TTIP) between the European Union and the United States. Experts are not in a position to predict whether and when talks on the adoption of this agreement will resume[11]. Faced with the current situation and the declining export volumes, US companies are anxious about the growing political and regulatory risks, especially since emerging markets are facing their own issues and the eurozone is experiencing economic growth deceleration.

Such an economic situation affects the condition of transport, as it is closely associated with other economic sectors. An increase in production translates into an increase in demand for transport services, as shown in Fig. 3. The 2018 share of transport and warehousing in the GDP was nearing USD 546 million (2.8% of total GDP)[12].

[7] The World Factbook; available at: https://www.cia.gov/library/publications/the-world-factbook/geos/us.html
[8] Focus Economist; available at: https://www.focus-economics.com/countries/united-states
[9] U.S. Bureau of Economic Analysis; available at: https://www.bea.gov/news/glance
[10] CNN Business; available at: https://money.cnn.com/2018/07/25/news/economy/state-of-the-economy-gdp/index.html
[11] European Commission; available at: https://ec.europa.eu/poland/events/170608_TTIP_pl
[12] Tradingeconomist; available at: https://tradingeconomics.com/united-states/gdp-from-transport

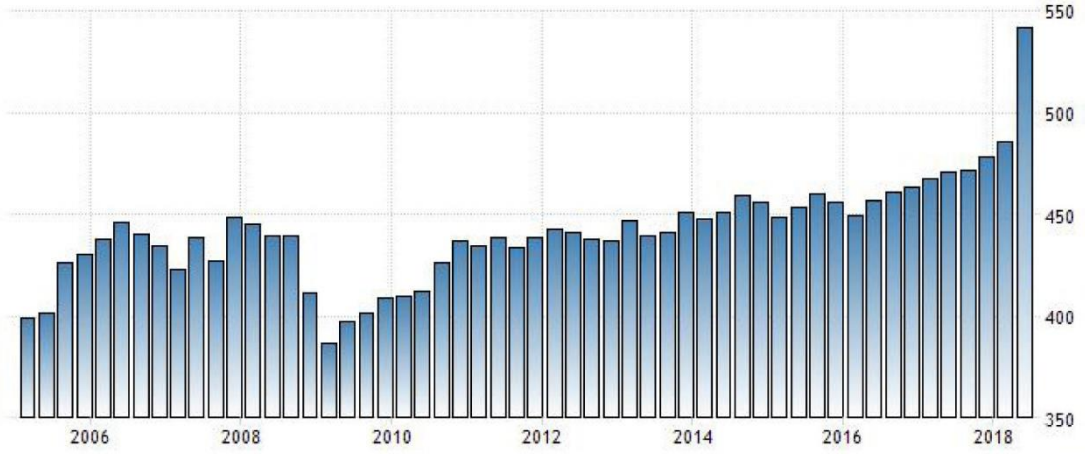

Fig. 3. Share of transport and warehousing in the US GDP in the years 2006-2018
Source: https://tradingeconomics.com/united-states/gdp-from-transport

3. ECONOMIC GROWTH VS. FREIGHT AND PASSENGER TRANSPORT SERVICES

The actual growth of the economy and transport services is well described by the polynomial curves, and confirmed by the R^2 coefficients. Figure 4 shows the growth of the US economy and transport services in the years 1995-2015. The variables included in the figure have been compiled with reference to real data based on the polynomial curve.

Macroeconomic variables and transport measures are characterised by steady growth, and the highest growth is demonstrated by the polynomial curve describing the GDP, the second highest being that of the passenger transport curve, while the lowest level trend is one which describes freight transport performance. The rate of changes in the GDP compared to the measures reflecting transport services within the period subject to analysis, has been steadily increasing (with the only abrupt decline observed in 2009), which implies that the economy grew faster than the transport sector, and that the share of transport services in the American GDP has been decreasing.

4. DEVELOPMENT OF THE US RAILWAYS

The US rail transport is dominated by freight services, while passenger services, once a large and important part of the domestic rail transport, now plays a limited role compared to many other countries in the world.

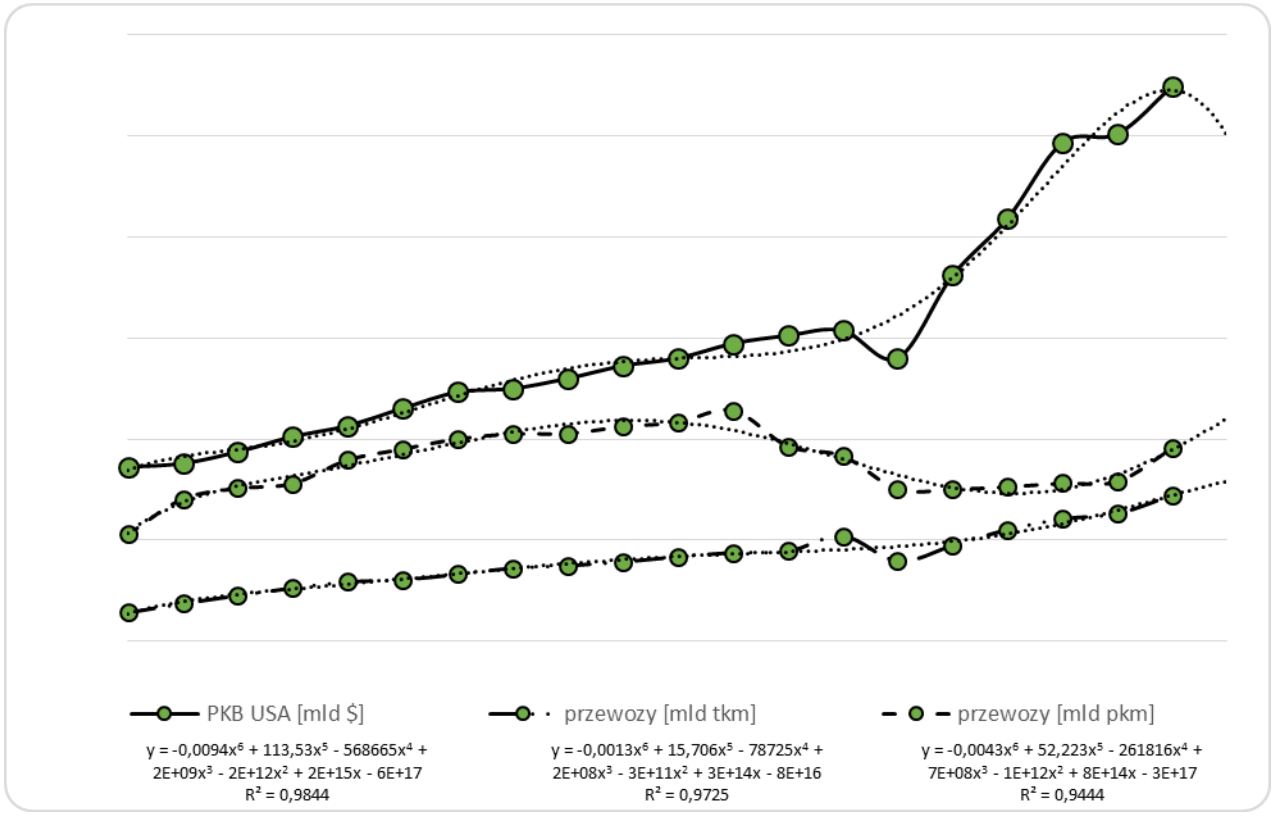

Fig. 4. Macroeconomic indices characterising the economy (GDP) and measures of transport services (tkm and pkm) in the United States of America
Source: North American Transportation Statistics Database 2007-2015, available at: http://www.rita.dot.gov/bts/data_and_statistics

The history of the development of the US railways dates back to the years 1762-1764, when the first railway line was built by British military engineers in areas near the Niagara Falls in Lewiston, to be used by a vehicle known as a mechanised tram[13]. In 1826, the 4.8 km long Granite Railway line was opened to transport stone blocks from the local quarry to the port on the Neponset River near Boston. In the construction of this line, 1,524 mm gauge wooden rails with iron overlay were used. The first (unsuccessful) attempt to use the Stourbridge Lion steam locomotive took place on the railway line from Carbondale to Honesdale, Pennsylvania, in 1829. In 1830, a 21 km long B&O railway section connecting Baltimore and Ellicott's Mills was commissioned, featuring horse traction. The same year saw the opening of the Tuscumbia–Courtland–Decatur RR (Alabama) horse railway, established to transport cotton, and it was the first railway west of the Appalachians, later to become a part of the SOU network. Other important events included the opening of a section of the first regular steam traction line in January 1831 (with the Best Friend of Charleston steam locomotive) near Charleston, operated by the South Carolina Canal & RR Co., extended in 1833 to Hamburg, running on a track of the 1,524 mm gauge. The railway was built at a great pace and with great savings, using flat and wooden rails, and track substructure instead of

[13] First railway in America Built in Lewiston. Spring 2010; available at: http://historiclewiston.org/wp-content/uploads/2016/06//the_cradles_tramway_placemat.pdf

embankments. It was later gradually adapted to normal standards[14]. The first transcontinental line, 3,067 km in length, was built in the 1860s, connecting the existing eastern railway network in Omaha (Nebraska) with the Pacific coast in Oakland Long, San Francisco Bay[15]. This investment laid the foundation for the creation of a modern transport system in the United States. Much of the original route is still used today. The railway line construction investments of the second half of the 19th century had the greatest impact on the American transport system of the time. Following the standard historical interpretation, railway lines were crucial for the development of the domestic market in the United States and served as a model for the organisation, financing and management of a large corporation[16].

The contemporary US railway network is the longest in the world (Fig. 2). In 2017, its total length came to 126,195 miles,[17]including 93,339 miles (data of 2016) of class I lines, with 21,358 miles managed by the main rail passenger transport operator, Amtrak, with the US federal government as the major shareholder.

American freight railways are divided into three classes based on the distances they cover and the wages, and so there are seven large class I railway lines, 21 regional class II lines, and 547 short class III lines. Class I railways were operated using more than 26,000 locomotives. Ca. 1,500,000 freight cars are currently used in the United States, and they are broken down according to technical specifications as follows:[18]:

- open cars – 540,000 units
- box cars – 360,000 units
- tank cars – 255,000 units
- platform cars – 210,000 units
- refrigerator cars – 135,000 units

The main carriers operating class I lines are[19]:

- Burlington Northern and Santa Fe Railway (BNSF), established in 1996 by the merger of ATSF and BN, currently one of the largest railway companies
- CSX Transportation (CSXT): established in 1987 by the merger of Chessie System (former C&O of B&O) with Seaboard Air Line RR, Atlantic Coast Line RR, Louisville & Nashville RR; presently, one of two railway systems functioning east of Mississippi
- Norfolk Southern Combined Railroad Subsidiaries (NS): railway company established in 1990, mainly on the basis of the SOU railway network, the first Norfolk Southern Rly., Virginian Rly., Norfolk & Western RR, half of the Conrail network; along with the CSXT railway, it services the east of the country
- Union Pacific RR (UP)
- Grand Trunk Corp
- Soo Line Railroad
- Kansas City Southern Railway (KCS)

[14] Available at: http://mikes.railhistory.railfan.net/r013.html
[15] Vernon, Edward (ed.), Travelers' Official Railway Guide of the United States and Canada, Philadelphia: The National General Ticket Agents' Association. June, 1870, Tables 215, 216
[16] Alfred D., Chandler Jr., *The Visible Hand: The Managerial Revolution in American Business*, 1977, p. 81-121
[17] Bureau of Transportation Statistics; available at: https://www.bts.gov/
[18] Bureau of Transportation Statistics, available at: https://www.bts.gov/sites/bts.dot.gov/files/docs/browse-statistical-products-and-data/transportation-statistics-annual-reports/215041/tsar-2017-rev-2-5-18-full-layout.pdf
[19] Association of American Railroads; available at: https://www.aar.org/data-center/railroads-states/

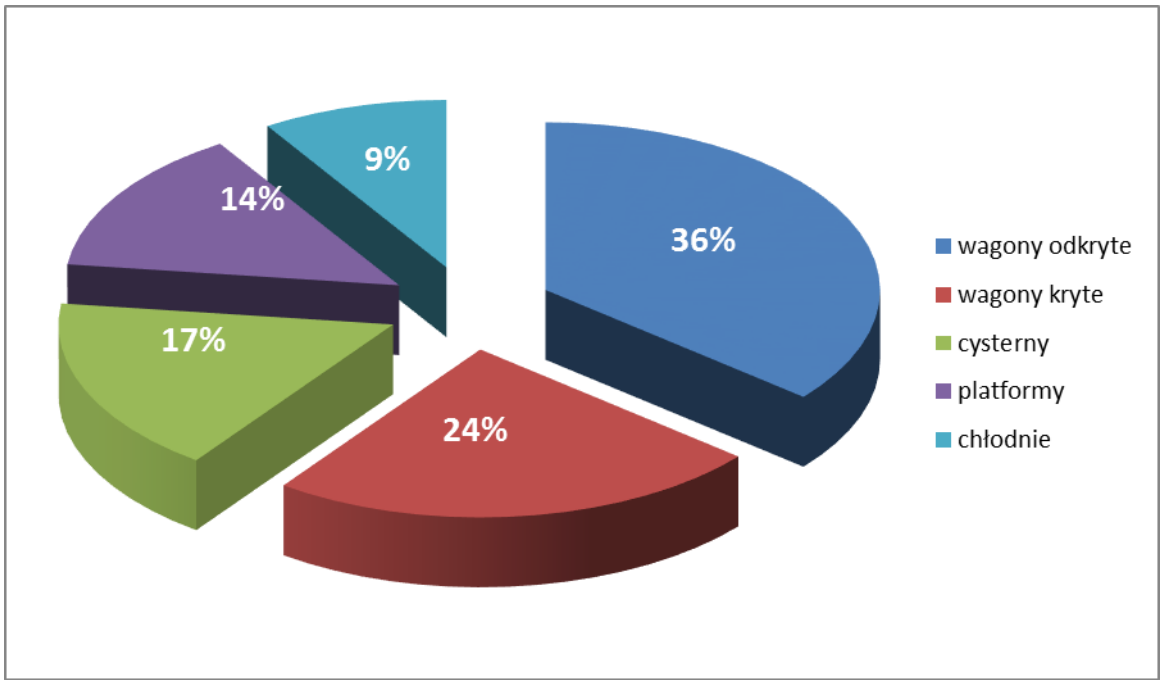

Fig. 5. Percentage share of cars in freight transport services according to body types
Source: authors' own study based on: https://www.bts.gov/sites/bts.dot.gov/files/docs/browse-statistical-products-and-data/transportation-statistics-annual-reports/215041/tsar-2017-rev-2-5-18-full-layout.pdf

Next to the aforementioned major corporations, the US rail freight market is also served by regional railway operators, local railways as well as railway companies providing shunting and terminal services.

Since 2000, the volume of rail freight transport services in the United States has remained on a balanced and high level, even though the total range of the railway network has declined. Between 1990 and 2013, the length of class I railways decreased by almost 30%, and many sections were transformed into short lines or simply abandoned,[20]however, this reduction has not undermined the high growth rate of freight transport (Fig. 6). The volume of railway transport performance has been compared with other modes of transport in Table 1, while the cargo volume in tonnes transported by rail between 2000 and 2016 is illustrated in Fig. 7.

Transport services in the United States are dominated by road transport. Congested and frequently in poor condition (since a passenger car is by far the most popular means of transport for Americans), road have not been sufficiently subsidised for many years, and are becoming increasingly dangerous. On average, 1/3 less transport is carried out by rail. The exception was 2014, when the rail and road transport performance was at a similar level. The volume of transport services was affected by the global economic crisis of 2009 and the economic slowdown of 2012 in the aftermath of the significant reduction in federal spending, mainly on defence[21].

[20] Association of American Railroads; available at: https://www.aar.org/data-center/railroads-states/
[21] CNN Business; available at: https://money.cnn.com/2013/01/30/news/economy/gdp-report/index.html

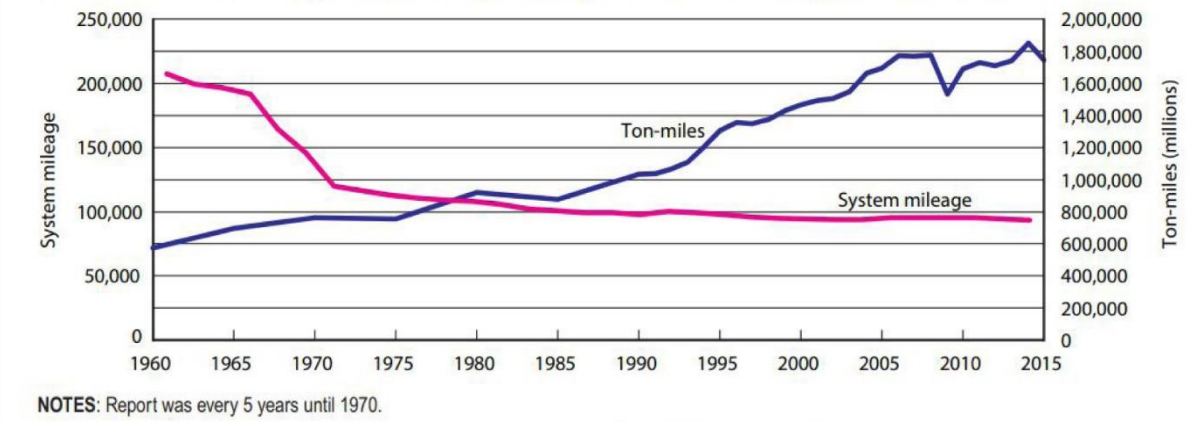

Fig. 6. Changes in the mileage of means of rail transport and transport performance in the years 1960-2015 in tonne-miles
Source: https://www.bts.gov/sites/bts.dot.gov/files/docs/browse-statistical-products-and-data/transportation-statistics-annual-reports/215041/tsar-2017-rev-2-5-18-full-layout.pdf

Tab. 1.
Transport performance by transport modes in the years 2000-2016, in millions of tonne-miles

Year	Transport mode				
	Road	Rail	Pipeline	Air	Total
2000	2,326,524	1,546,319	967,819	14,983	5,501,444
2001	2,362,063	1,599,332	924,162	13,069	5,520,312
2002	2,427,693	1,605,532	880,504	13,370	5,539,180
2003	2,478,740	1,603,564	875,570	15,231	5,579,251
2004	2,427,170	1,683,895	870,635	16,451	5,619,322
2005	2,453,347	1,696,425	865,700	15,002	5,621,751
2006	2,405,811	1,771,897	860,766	14,702	5,614,804
2007	2,495,786	1,770,545	855,831	14,612	5,689,924
2008	2,752,658	1,777,236	981,323	13,133	6,044,871
2009	2,449,509	1,532,214	947,252	11,503	5,417,599
2010	2,512,429	1,691,004	955,986	12,026	5,673,656
2011	2,643,567	1,729,256	1,018,082	11,590	5,902,243
2012	1,890,797	1,712,567	856,873	11,836	4,946,,830
2013	1,941,029	1,740,687	842,392	11,883	5,001,082
2014	1,993,456	1,851,229	867,379	12,273	5,228,831
2015	2,002,544	1,738,283	876,456	12,519	5,120,429
2016	2,022,879	1,585,440	896,320	13,157	4,995,657

Source: https://www.bts.gov/sites/bts.dot.gov/files/docs/bts_program_resources.pdf

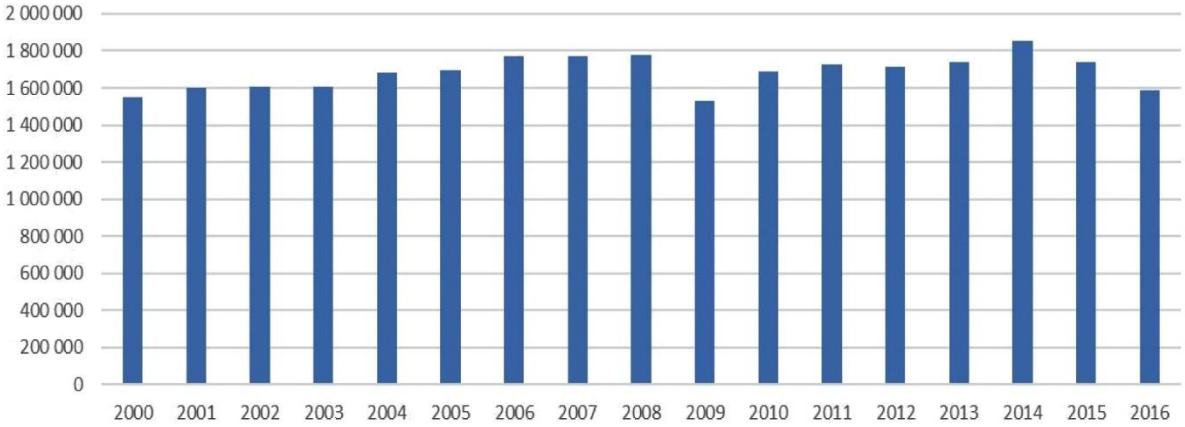

Fig. 7. Volume of cargo transported by rail in the years 2000-2016, in tonne-miles
Source: https://www.bts.gov/sites/bts.dot.gov/files/docs/bts_program_resources.pdf

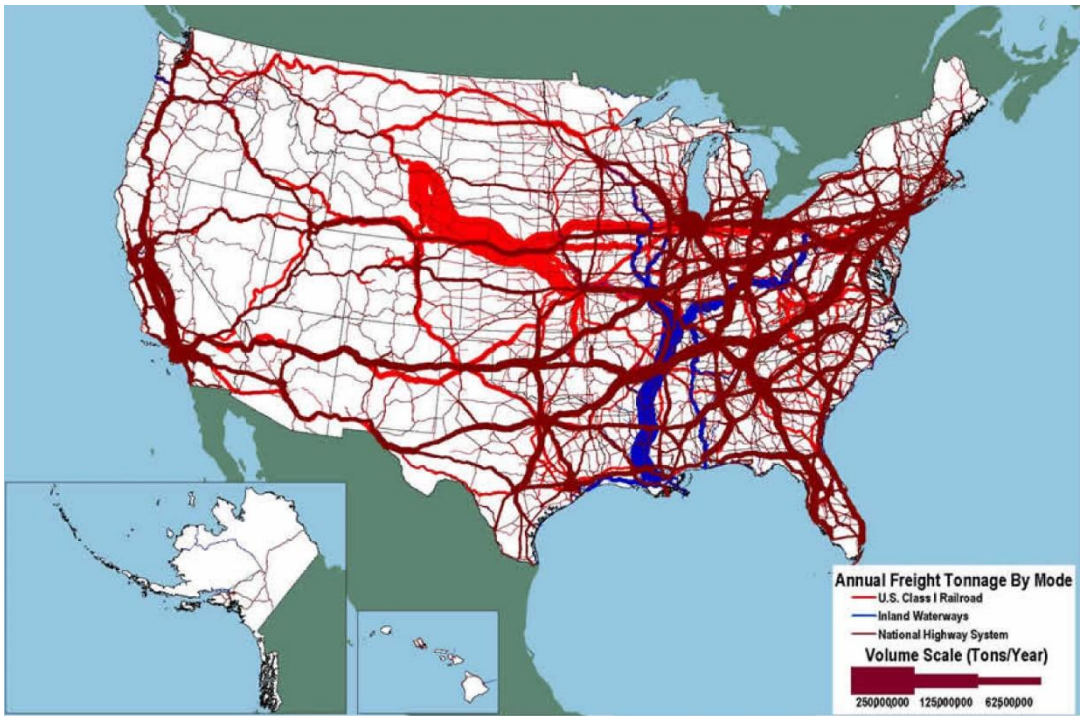

Fig. 8. Freight transport volumes in the US transport network
Source: US Intermodal Network; available at: http://www.worldshipping.org/industry-issues/transportation-infrastructure/u-s-intermodal-network

5. TECHNICAL PROGRESS OF THE US RAILWAYS

Intermodal transport is the most rapidly growing segment of the rail market in the United States, as the volume of intermodal transport services has tripled over the last 25

years[22]. In 2018, freight railways carried 14.5 million intermodal units[23]. Intermodal transport services are perfect for enabling cooperation between long-distance railways and door-to-door road transport.

Intermodal transport plays a crucial role in building significantly more efficient logistics by suppliers and sellers, while its high efficiency translates into enormous competitive advantage of the United States in the global economy. The US intermodal network forms a common system of government agencies (owners of roads, bridges and ports) and private companies (managing or operating other system components, including heavy vehicles, trains, tracks and most port terminals).

The share of intermodal transport in the structure of domestic and non-domestic freight transport services in 2017 was analysed in Table 2.

Tab. 2.

Share of intermodal transport in the structure of domestic and export freight transport services in 2017.

Cargo type	Domestic		Non-domestic	
	QTY	%	QTY	%
Intermodal	14,256,000	48.7%	14,729,000	48.0%
Coal	4,738,000	16.2%	4,623,000	15.1%
Other goods not elsewhere classified	2,352,000	8.0%	2,933.000	9.6%
Non-metallic minerals	1,782,000	6.1%	1,773,000	5.8%
Chemicals	1,725,000	5.9%	1.920.000	6.3%
Agricultural products	1,283,000	4.4%	1,305,000	4.3%
Food products	879,000	3.0%	942,000	3.1%
Metal ores	719,000	2.5%	699,000	2.3%
Crude oil	662,000	2.3%	767,000	2.5%
Basic metal products	457,000	1.6%	52.700	0.2%
Glass and stone	409,000	1.4%	444,000	1.4%
Total	4,623,000	100%	30,663,000	100%

Source: https://www.aar.org/data-center/railroads-states/

The US intermodal transport system is predominantly based on strategically located railway terminals (Fig. 9). In the recent years, railways have invested billions of dollars to build and expand intermodal terminals and furnish them with the state-of-the-art equipment and instrumentation, including emission-free electric cranes with GPS units, capable of moving intermodal containers between trains, heavy vehicles and ships within minutes, while reducing pollution at the same time. Introducing optical scanners and automated gantries enable cars to reach railway facilities faster, thus reducing idle time and increasing safety. The network of "smart routes" featuring detectors provides real-time feedback on the condition of the railway infrastructure and equipment. The strategic locations of these terminals (there are

[22] Federal Railroad Administration; available at: https://www.fra.dot.gov/
[23] Association of American Railroads; available at: https://www.aar.org/issue/freight-rail-intermodal/

more than 180 intermodal facilities all over the United States) have made railways highly competitive with regard to domestic freight services. Intermodal transport currently accounts for ca. 23% of railways' total revenue[24].

Fig. 9. Logistic and technical hubs in the US railway network
Source: https://www.mapsofworld.com/usa/usa-rail-map.html

Since the 1980s, transport of containerised cargo using the double-stack system has been growing in popularity. In its intermodal form, cargo containers are stacked on a railway platform, one on top of the other in two layers (Fig. 10). Using the double-stack solution translates into significantly improved efficiency of a standard railway set, which is the reason it is used in most North American railway lines. The requirement for the deployment of this mode of railway traffic is the redevelopment of many routes in major lines, including bridges and tunnels, in order to adapt them to very high loads and dimensions. The double-stack transportation system currently uses 20', 40', 48' (14.63 m) and 53' (16.15 m) long containers[25]. They are placed on pocket-type railway platforms, which reduce vibrations while the train is running, by their swinging motion, thus protecting the cargo against damage or opening of the container door. Over the years, lighter and more durable aluminium structures have been redesigned, including platforms used to transport coal to power plants, and the traditional timber transport rolling stock has been upgraded to facilitate loading and unloading.

[24] Association of American Railroads; available at: https://www.aar.org/article/preparing-future-intermodal-freight-rail/
[25] CSX Corporation; available at: https://www.csx.com

Fig. 10. Transport of containerised cargo using the double-stack system
Source: https://www.sdcexec.com/transportation/news/20986754/us-intermodal-rail-volume-on-recordsetting-track

Certain aspects of the transport of containerised cargo in the double-stack system have been revolutionised by recent communication technology. The railway company operating the Union Pacific line has implemented a computer system enabling direct communication between the crew and the marketing department, making it possible to report vehicles approaching the unloading point or returning to the depot in real time. Such a solution also translates into flexibility in sending service orders to a train when en route. In Roanoke, Virginia, the huge Norfolk Southern cargo hub is equipped with a technology enabling remote control of the trans-shipment process. The computers set the brake lever and braking pressure, and control the switches on board the vehicles in the sorting plants. The operators working in a strategically positioned tower can change the frequency at which locomotives are made ready by adjusting the rate of cars moving through the service yard[26].

6. SAFETY AND COMPETITIVENESS GROWTH FACTORS

The current federal legislation on rail transport is largely prescriptive and does not encourage railway corporations to freely introduce technologies to improve safety and efficiency. In order to increase railway safety, particularly in light of the growing number of fatal accidents between 2002 and 2008, the US Congress adopted the Rail Safety Improvement Act in 2008, introducing new regulations to control the various spheres related to railway safety, such as hourly requirements towards railway workers, interoperability of rail transport, track inspection standards, locomotive certification system and level crossing

[26] Trains Magazine, Why no double stacks outside of North America?; available at: http://cs.trains.com/trn/f/111/p/204998/2244756.aspx

safety. The very same year saw the government obligating railway carriers to implement the PTC (Positive Train Control) system, a modern technology supporting railway traffic management while providing subsidies from the state budget at the same time (in 2017 only, USD 199 million was allocated for this purpose). The PTC system enables automatic deceleration of trains or stopping them completely when facing a high probability of derailment or collision. According to the applicable laws passed by the Congress and the provisions of the arrangements with the Association of American Railroads, PTC is currently being tested on 83.2% of the target railway routes. The system is expected to be fully operational by 31 December 2020. By the end of December 2018, class I railway operators had invested USD 10.5 billion in the expansion, installation and implementation of PTC. All lines feature 100% of the necessary technical facilities (roadside equipment, office facilities, locomotives) and have completed all the necessary personnel training required by law[27].

According to data concerning railway safety, between 2008 and 2017, the rate of accidents involving trains dropped by 40%. These were the safest years in the history of the railway sector. This result was undoubtedly influenced by the investments made by private operators over the stated period in the deployment of advanced technologies on railway lines, averaging more than USD 25 billion per annum[28].

Train accidents caused by the technical condition of the rolling stock account for 14% of all accidents. Their number has declined by 16% since 2008. Wagon upgrades, advanced equipment control technology and company-wide asset management programmes have all contributed to the improvement of safety, while the human-induced accident rate, whose share in the total number of rail accidents is typically the highest (38% in 2017), dropped by 20% since 2008. In order to curb such incidents, employees are required to participate in mandatory rigorous training and fatigue management programmes.

Rail freight carriers transport many hazardous materials. In order to maintain the highest possible safety in transport, carriers cooperate in this respect with forwarders of hazardous substances, suppliers of railway lines and the government's partners in preparing highly specialised initiatives, regulations and standards. Combined with the railway sector's ongoing commitment to infrastructural investments, technological innovation, rigorous employee training, self-imposed operational practices and community safety efforts, all these initiatives have made freight railway lines, the avant-garde of safety improvement endeavours undertaken in the United States.

Highly specialised IT systems monitor the technical condition of railway equipment in real time using smart sensors, advanced analytics software and solutions for sharing data across the entire railway sector. Detectors installed along railway tracks use a wide array of different technologies, such as infrared and lasers, to assess the condition of bearings, axles, wheels and springs as trains travel at speeds of up to 60 MPH. Specialised software analyses images and warns the railway staff of anomalies requiring further analysis.

Other technologies used on the US railways to analyse the technical condition of the track superstructure include ultrasounds and drones. Similarly, electromagnetic ground-penetrating radars allow railway workers to detect any abnormalities, such as the presence of water in the ballast, which may cause degradation of rails, particularly at welds. Railway operators use these solutions to identify potential problems and plan maintenance.

[27] RailFreight.com; available at: https://www.railfreight.com/railfreight/2019/02/15/almost-all-railways-in-us-operate-positive-train-control/?gdpr=accept

[28] Federal Railroad Administration; available at: https://www.fra.dot.gov/Page/P0151

7. CONCLUSIONS

The development of the US railways over the recent decades has been driven by a number of factors, which includes economic progress, the diversity in the demand of individual regions extending over vast territories for specific goods, and the dynamic international trade. The economic attractiveness of railways rests upon the foundation of increasingly competitive prices, not imposed by any monopolist.

Rail transport plays an important role in the US economy, particularly in terms of the movement of imported and exported containerised cargos alongside coal and crude oil supplies. The most rapidly growing segment of the rail market has recently been the intermodal transport sector, whose volume has tripled over the last 25 years. The efficiency of intermodal transport provides the United States with an enormous competitive advantage in the global economy context.

The progress observed in the rail transit of goods results from the considerable capital expenditures for investments in and operation of railway infrastructure and rolling stock. It involves upgrading of traffic organisation, and application of strict rules concerning the operation and maintenance of rolling stock and traffic control. Ensuring safe and efficient operation enables railway operators to maintain their competitive advantage. Thanks to the use of highly advanced software and state-of-the-art technologies, rail freight transport has been performing more effectively than ever.

Since 1980, the density of rail traffic has increased by about 300% without substantial growth in the railway network size, while the efficiency of locomotives has increased by 93% and the average cargo transported per train, by 63%. The improvement in the operating efficiency of railways is also a source of dividend for rail freight forwarders, and consequently, helps it maintain prices on a low level. In fact, freight forwarders can now move around twice as many goods for almost the same price as in 1980.

Since 2006, the US Congress has consistently implemented a research and development (R&D) programme by allocating approximately USD 35 million annually[29] in various research institutions, universities and consulting companies, to be utilised for the purposes of research and development efforts towards addressing current technological challenges tackled by railways. The methodical approach to the financing activity over the recent years has allowed the Federal Railroad Administration, the official party in charge of spending the allocated funds, to build a strong scientific base, a key important factor to the programme's success. The stability of the financing scheme increases the programme's efficiency making it possible to run multiannual projects, invest in test facilities and equipment, such as those used in high-speed intercity passenger trains, in addition to building and maintaining highly specialised expertise. Universities can develop educational programmes to provide qualified personnel for the industry and build partnership with industry stakeholders. However, most importantly, the regular funding of the research and development activity constitutes a means of direct support for the efforts aimed at continuous improvement of railway safety.

[29] Ibid.

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