The Methodology of Research for Elaborating the Concept of High-Speed Rail Construction in Australia – Conclusions for Poland

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Australian economy is considered to be one of the most stable and competitive ones in the world. The country is a trading partner for more than 200 countries, with a 20% share of export in GDP. The economy is mainly based on services which constitute approx. 75% of GDP [1]. According to the UN Human Development Index, Australia is the second country in the world, after Norway, as far as quality and average length of life, health service and freedom of economic activities are concerned. The society's wealth constitutes one of the key factors that influence the number of cars as per person. The number of cars, which prevail among the passenger means of transport, and their harmful influence on the environment forced the government to focus on limiting the number of private cars by means of, among others, the concept of constructing high-speed rail.

Keywords: High-speed rail, Australia, passenger transport.

1. INTRODUCTION

Australian economy is considered to be one of the most stable and competitive ones in the world. The country is a trading partner for more than 200 countries, with a 20% share of export in GDP. The economy is mainly based on services which constitute approx. 75% of GDP [1]. According to the UN Human Development Index, Australia is the second country in the world, after Norway, as far as quality and average length of life, health service and freedom of economic activities are concerned. The society's wealth constitutes one of the key factors that influence the number of cars as per person. The number of cars, which prevail among the passenger means of transport, and their harmful influence on the environment forced the government to focus on limiting the number of private cars by means of, among others, the concept of constructing high-speed rail.

2. PASSENGER TRANSPORT

Australia has a very well developed transport system along south-east and south-west coast – in the most densely inhabited areas. It is also the area where most railways are located. The above mentioned areas can be characterised by the highest dynamics of Australians' relocations. The most frequently chosen destinations by particular means of transport are presented in Figure 1.

Australia is one of the most motorised countries in the world, with cars being the most frequently used means of transport. Due to enormous distances between agglomerations, also air transport is widely used. In 2013 in Australia 480 airports operated, including 349 ones with hardened surface, and 131 untreated ones [1].

In 2013 the length of roads was 823 thousand km, the total length of air routes was 160 thousand km, and the length of railways was 38.4 thousand km [1]. Railways where passenger trains run are presented in Fig. 2.

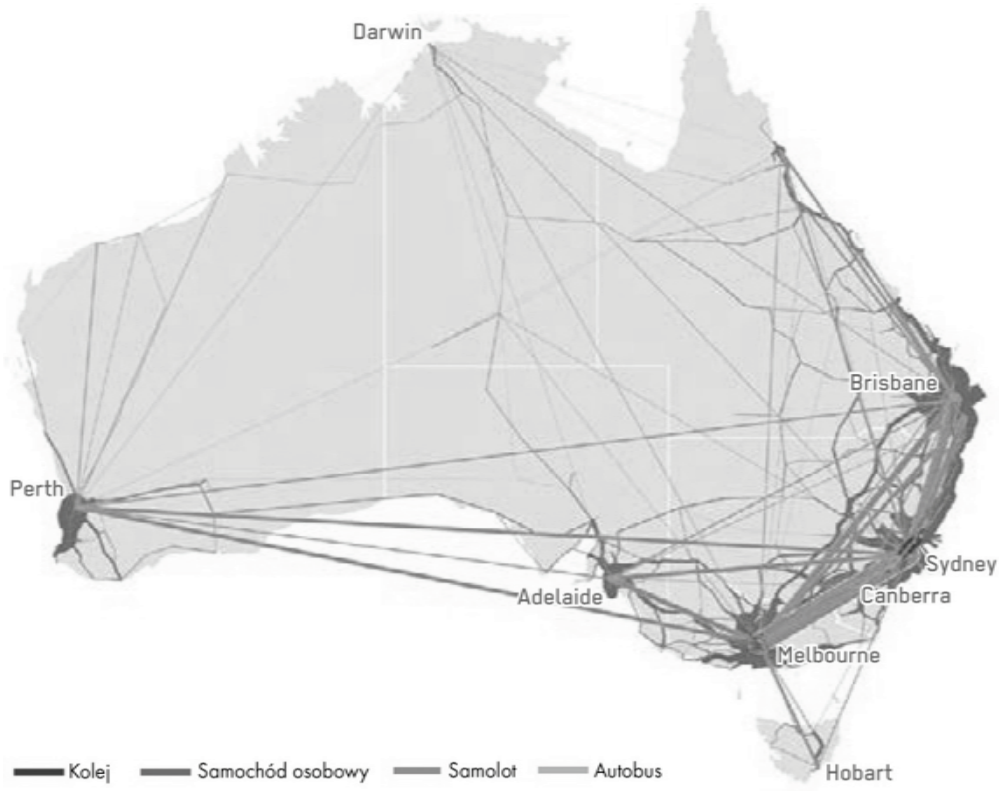

Fig. 1. Passengers' destinations by particular means of transport.
Source: www.media.bze.org.au/KDP/KDP_web_01_medium.pdf (12.03.2015).

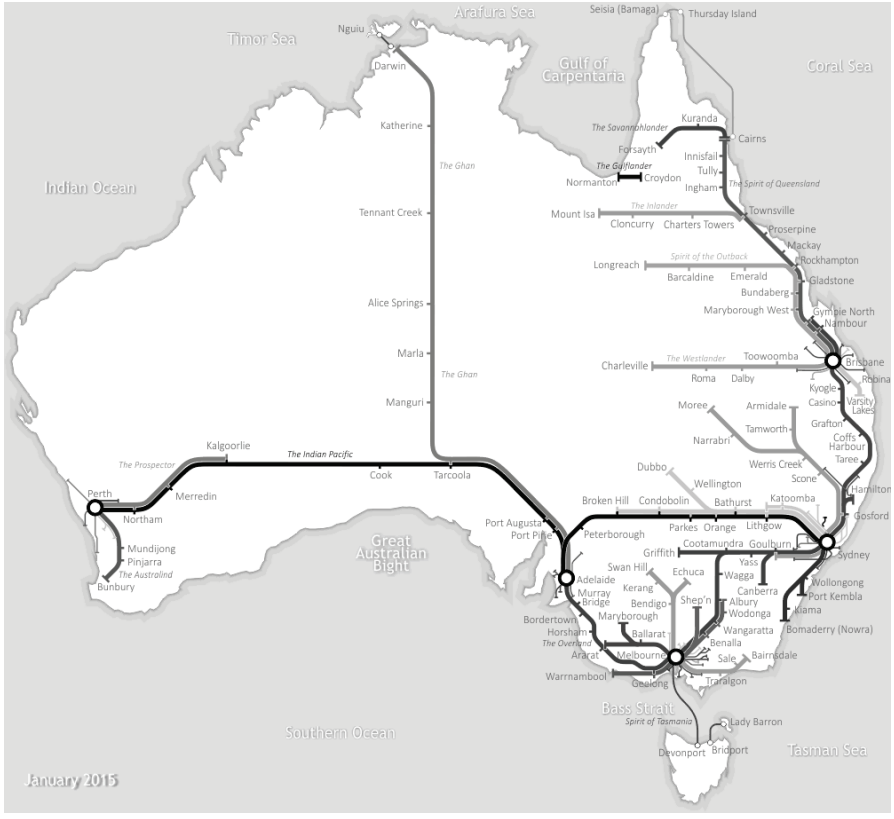

Fig. 2. Passenger railway connections in Australia.
Source: www.railmaps.com.au/ (15.03.2015).

Table 1 presents carriages performed by particular means of passenger transport in 1995-2013. The fewest passengers selected rail although a systematic increase in railway carriages can be observed. Railway connections are mostly used for shorter distances, with Sydney and Melbourne having a relatively well developed suburban railway.

Table 1. Passenger carriages as per means of transport in 1995-2013, in billions of pass-km.

Means of transport	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013
A car	200.6	222.87	239.81	262.11	262.06	260.95	262.52	265.18	267.14	267.76
A bus	17.71	16.11	17.00	17.79	18.84	19.30	19.80	20.29	21.09	21.40
A train	10.04	10.34	11.38	11.86	14.01	14.78	14.74	14.97	15.19	15.24
A plane	11.24	26.89	32.69	45.55	56.67	57.96	59.45	63.57	64.77	76.61

Source: Statistical Report: *Australian Infrastructure Statistics Yearbook 2014.* Australian Government. Department of Infrastructure and Regional Development;
www.bitre.gov.au/publications/2014/files/BITRE_YEARBOOK_2014_Full_Report.pdf (14.03.2015)

Carrying passengers by train in 2013 amounted to 15.24 pass-km and since 1990 it increased by 1.5 times. It must be observed that the participation of rail transport in 2013 is 17.5 times smaller than carriages by cars, and 5 times smaller than by planes.

3. THE PLAN FOR THE CONSTRUCTION OF HIGH-SPEED TRAINS

The construction and exploitation of high speed rail (HSR) in Australia has been investigated since 1980. Back then a case study of constructing HSR was elaborated by Clean Energy Group Beyond Zero Emission (BZE) along with a German company Deutches Zentrum fur Luft- und Raumfahrt eV (DLR) [9]. In the following years the next projects came into existence, including a 1984 feasibility study based on a French technology TGV (Train à Grande Vitesse) which assumed building a railway along the east coast that would connect Melbourne, Canberra and Sydney. The cost of construction was estimated at $2.5 million. Both private and public sectors were interested [9]. However, both this and other project that followed it, which were often the element of election programs of political parties, were rejected by the government as uneconomic.

At the end of 2010 the new government instructed a detailed research on the high speed rail along the east coast with Brisbane, through Sydney and Canberra, till Melbourne. The final reports were published after the 2 research stages [2].

Stage 1 was completed in 2011. In the report published after completing this stage it was estimated that the cost of building a new two-line railway between Brisbane and Melbourne, of the length of over 1,600 km will amount to between $61 and $108 million. The journey time by train which can go at 350 km/h would take 3 hours between Brisbane and Sydney, as well as between Sydney and Melbourne; 40 minutes from Sydney to Newcastle, and 1 hour between Sydney and Canberra. It was estimated that until 2036 the assumed number of passengers who would use the connection would amount to 54 million annually, and the ticket prices would be competitive in comparison to other means of transport.

The report elaborated in 2013 on the basis of research works carried out within stage 2 was more comprehensive than the first one, especially as far as estimated costs and demand are concerned. It was assumed in the report that the railway which would connect Brisbane and Canberra will be 1,750 km long. Apart from 4 main stations in Brisbane, Sydney, Canberra and Melbourne, the construction of 4 peripheral stations was planned, as well as stations in Gold Coast, Casino, Grafton, Coffs Harbour, Port Macquarie, Taree, Newcastle, Southern Highlands, Wagga Wagga, Albury Wodonga and Shepparton (Fig. 3).

In stage 2 it was estimated that 84 million passengers would travel by trains on given routes. The journey time would take less than 3 hours between Melbourne and Sydney, and Sydney and Brisbane. The realization of HSR program would start with building a railway from Sydney to Canberra and back, and the following stages of the project would cover connections Canberra-Melbourne, Sydney, Newcastle-Brisbane-Gold Coast and Gold Coast-Newcastle. The forecasts referring to the number of passengers using the connections and the suggested rates showed that the investment would not require public subsidies in the future.

Fig. 3 Planned railways for high speed trains – stage 2. Source: Department of Infrastructure and Regional Development; www.infrastructure.gov.au/rail/trains/high_speed; Chapter 6:Staged delivery (12.03.2015).

The simulations that were carried out confirm substantial savings in journey times as compared to journeys by other means of transport. The comparison of journey times for different means of transport for selected routes is presented in Table 2.

Table 2. The comparison of journey times for different means of transport.

Details	Melbourne–Sydney	Sydney–Brisbane	Sydney–Canberra
Distance	824 km	797 km	280 km
Present time for journey by train	10 h 30 min	13 h 35 min	
Time for journey by car	9 h 12 min	10 h 40 min	3 h 27 min
Air services*	3 h 00 min	3 h 05 min	
HSR distance	894 km	854 km	283 km
HSR journey time (maks. 350 km/h)	2 h 44 min	2 h 37 min	64 min

*Journey time includes getting to the airport from the city-centre, the flight, and getting from the airport to the city-centre in the target city.
Source:
www.championsofthebush.org.au/Images/High_Speed_Rail_Briefing_Paper. Pdf (12.03.2015).

The cost of building the whole corridor was estimated in stage 2 at approx. $114 million (according to prices from 2012), and most of initial capital costs would have to be covered from public money. The project is likely to be realized basing on governmental funds and private capital, or as a public-private partnership, but it will be mainly financed by the state.

4. THE POSSIBILITIES AND CHALLENGES AHEAD OF IMPLEMENTATION OF HIGH SPEED TRAINS SYSTEM IN AUSTRALIA

In Australia, the same as in Japan and in Europe, there are big mountain ranges, and the HSR technology requires placing rails on very long curvatures with an appropriate radius and low gradients for the line width (usually no more than 1.5 %). Therefore, the key challenge for designers and constructors are the rolling landscapes of the east coast (e.g. the western part from Brindabella to Canberra, or north of Sydney, through Kurinaggai Chase National Park and Broken Bay). One must also consider the influence of railway on specially protected areas such as national parks and swamps. Every HSR line along the east coast of Australia will have to run across the areas of exceptional natural and cultural importance [3]. The HSR route research that has been carried out covered among others geotechnical conditions that influence position of pillars, possible roadbeds and ballast, including their influence on natural environment, noise or creating vibrations.

The system of high speed railway is supported by many ecological organizations, mainly due to the possibility of limiting the emission of greenhouse gases. In Australia the majority of greenhouse gases per person is emitted by planes (240g CO_2/km), the next are cars (225g), followed by buses (75g) [3]. With the use of the cutting edge technology for electric traction power, sourced from renewable energy sources, the expected emission of greenhouse gases generated by HSR can be reduced to 40g.

In 2014 the previously mentioned Beyond Zero Emission (BZE) published detailed research referring to government report included in stage 2. In the document Zero Carbon Australia High Speed Rail, prepared by Melbourne Energy Institute in cooperation with Deutches Zentrum fur Luft und Raumfahrt German Aerospace Centre a lot financial assumptions were the same as those in the government report. However, in order to minimize cost of construction,, a changed, slightly longer route of HSR was suggested – 1,799 km

instead of 1,748 km (Fig. 4). At the same time the length of tunnels was decreased by 44%, and bridges by 25%, assuming greater use of the existing transport corridors. The document criticized not only the 45-year construction schedule, but also the cost of the complete transport corridor planned in stage 2. According to the forecasts of BZE the investment can be completed within 10 years (the completion is planned for 2025) with the financial expense of $84.3 billion. To confirm the possibility of realizing the investment in an apparently ambitious time of 11 years, the foreign railway projects are mentioned. Only the financial aspect of the investment remains the barrier.

Fig. 4. The HSR route suggested in the Zero Carbon Australia High Speed Rail document, along with the planned journey time.
Source: Melbourne Energy Institute, Deutsches Zentrum fur Luft- und Raumfahrt German Aerospace Center; www.media.bze.org.au/KDP/KDP_web_01_medium.pdf (12.03.2015)

The report says that despite ticket prices lower than airplane ones already in 2030 (when full carriage capacity will have been reached) the operating income will increase to $7 billion, which means that the initial costs of investment will be paid in the year 2040. The planned route of the high speed rail will cover 21 stations which will link 12 regional centres, including Wagga Wagga, Lismore and Shepparton, thanks to which the area in the radius of 50 km from the route will cover over 12 million (60%) people of Australia. Within 5 years it will allow to serve 68 million passengers per year. The journey from Melbourne to Brisbane will take 5 hours 56 minutes, including Melbourne to Sydney in 3 hours. Building the high speed rail would decrease air journeys between Canberra and Sydney by 65%, and as a result it would eliminate the need to build the second airport in Sydney. If the HSR project was fully based on using renewable energy, than in 40 years the emission of carbon dioxide generated by transport would be decreased by 150 tons.

5. CONCLUSIONS

Undoubtedly, railway is an important element of the country's infrastructure and it plays the key role in a balanced development of the infrastructure. Moreover, high speed trains immensely influence economic growth of cities and regions, and they also motivate local governments to cooperate with one another. Therefore, Australian rail organizations should present to the government and to the business representatives strategic directions for the railways development, pointing out to the fact that in the future it is able to fulfil demand for passenger carriages of high standard, and may become competitive for air carriages and cars.

The presence of railways on the passenger carriages market is considerable, but the participation of passengers travelling between big cities of the Australian east coast is still rather insignificant, mainly due to low speed and infrequent rides. People travelling in this area on longer distances usually choose a plane, and while travelling around cities and in the countryside they use mostly cars. Opening up HSR will involve numerous advantages, including the following:

- Less air pollution,
- Fewer car accidents, and less congestion,
- Timeliness of trains and safety of travellers,
- More comfort than on planes, also due to possibility of using mobiles and the Internet, quieter compartments, no limits on baggage.

The Australian government is still consulting on the profitability of the project for constructing high speed rail [8]. AT present they are focusing

on the role of HSR in a long-term planning of the country's policy. Also the solutions referring to technology for building the lines and the use of the appropriate rolling stock are open and are awaiting decisions.

The problematic issues of constructing HSR in Australia have been considered and analysed for many years. The acquired experiences could be successfully used by Polish decision-makers and designers in order to facilitate research on high speed rail in our country, including economic and technical issues, exploitation and spatial planning.

6. SUMMARY

The formation of the passenger transport in Australia, in accordance with the respective means of transport indicating a little role for railway transport, was subject to an analysis in this article. This analysis comprised the years 1995-2013. The investigations on the implementation of the construction and exploitation of the high-speed railway (HSR) in Australia carried out since 1980 till now, along with the proposed options for routes of the HSR, construction costs of the HSR and construction termination dates were also subject to an analysis in this article. Some shortcomings and advantages in relation to the possession of the high-speed railway were also described in this article.

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