ECONOMIC FACTORS OF VACUUM RAIL'S COMPETITIVENESS IN POLAND COMPARED TO ALTERNATIVE SOLUTIONS

Małgorzata BIAŁAS, Joanna DUDA, Anna SUROWIEC
AGH University of Science and Technology

INTRODUCTION

Transport infrastructure is among the factors deciding national economic development and determining the process of international integration. Initiating investment into vacuum rail (referred to as Hyperloop hereafter) is a complex process that requires huge financial expenditure and long times of realisation. A decision to start such an investment requires comprehensive expert opinions and analyses that address a range of key technical and economic assumptions, such as: expected necessary spending, criteria and methods of evaluating effectiveness of investment, schedule of project work, and time of its implementation and realisation. Identification and designation of competitiveness factors of this form of transportation compared to alternative solutions is a major part of this multi-faceted analysis.

It is the aim of this paper to indicate selected factors that can decide competitive advantage of vacuum rail in Poland over other means of transport. Based on data forecasts, impact of a selected competitiveness factor, namely, price of transportation services, on profitability of the investment will be analysed in addition.

NOTION OF COMPETITIVENESS

Competitiveness is a very broad concept connected to rivalry among entities desiring to attain the same or very similar objectives. To be able to compete effectively, they must display competitiveness. Scientists dealing with competitiveness most commonly look for answers to the following questions (Nehring 2007, p. 23): what is competitiveness and why is it so important, what are principles of achieving continuing competitive advantage, if this is at all possible, what roles should the government and its economic policies play, which factors and actions are the responsibility of the state and which of the enterprise, and what institutions and entities contribute to building competitive standing. Competitiveness is in fact a result of a number of factors and does not exist in abstraction from operating conditions of an entity, since this system

Contact address: mbialas@zarz.agh.edu.pl; aduda@zarz.agh.edu.pl; asurow2@zarz.agh.edu.pl

comprises both elements dependent on and independent from an enterprise (e.g. conditions in the environment and arising from global policies). It needs to be remembered competitiveness can be addressed at a number of levels, therefore, many institutions studying this issue stress the definitions they adopt refer both to enterprises and various other aggregated units.

A review of literature quickly reveals that, despite repeated attempts, no prevailing definition is available of the concept, which began to gain popularity in the early 1970s. M. Porter himself (2001), the best known student of its origins, failed to define the notion, although he used it frequently while tending to concentrate on its mezo- and macroeconomic studies, though pointing to the role of enterprises in the whole process. At its simplest, competitiveness is the capacity for effective opposition to competition (Burnewicz 1993, p. 23). A similar definition is offered by W. Mantura (2002, p. 87), who wrote about 'an entity's ability to compete', while M. Gorynia (1998) claims this is the ability to attain and maintain competitive advantage. Enterprise competitiveness is also explicated as the capability for functioning in a competitive environment where other entities operate as well (Sipa et al., 2015) or a feature of an efficient enterprise associated with the process of firms competing against one another (Liao, Rice, Lu, 2015).

There are far more definitions of competitiveness. They are summarised and listed in Table 1.

Table 1 Selected definitions of competitiveness

Author	Definition of competitiveness
W. Bieńkowski	Ability to meet competition resulting from acceptance of enterprise's products
J.F. Caudredo-Roura	Winning and gaining benefits in a market with an increasing intensity of competition
I. Dunbar, M. McDonald	Set of an organisation's strengths and degree of its ability to take advantage of opportunities emerging in the market; an entity's capability of satisfying customer needs relative to its competitors
S. Flejterski	Ability to design, make, and sell goods of prices, quality and other characteristics more attractive than equivalent characteristics of competitors' goods
J.E. Lombana	Being profitable and maintaining a dominant market standing
M. Lubiński	A firm's capacity for sustainable development in the long term and tendency to retain and expand its market share
J. Misala	Ability of various entities in a given country to derive maximum possible benefits from the social division of labour that are greater than those attained by partners in order to increase income to be distributed in their own country and improve satisfaction of various customer needs
A. Stabryła	Measure of aggregated ability to compete against other firms to achieve or retain a competitive standing relative to market, financial, technical, and organisational criteria
L. Tyson	Ability to make products standing the international test of competitiveness while population takes advantage of sustainably rising living standards
P. Uri	Ability to create conditions for generating greater income
R. Veliytah, S. Zahra	A firm's capacity for matching product and organisational standards of industry leaders
A. Zorska	Ability to create and utilise competitive advantage over other domestic and international firms as a result of operations in a uniform global market
K. Żukrowska	Ability to adapt business entities or their production to changing conditions that helps to maintain or improve their standing in the global market

Source: The authors' own compilation based on: Misala 2011, pp. 64-68; Guzal-Dec and Zwolińska-Ligaj 2006, p. 55; Kolterman 2013, p. 46; Konkurencyjność przedsiębiorstw… 2002, pp. 73 and ff.; Flak and Głód 2009, pp. 34-38.

Definitions advanced by international institutions that study competitiveness generally refer to activities in foreign markets. The OECD (1997) assumes 'competitiveness refers to firms' ability … to generate, in conditions of ongoing participation in international rivalry, relatively high long-term profitability and commitment of factors of production'.

A. Kędziersk'a definition (2005, p. 98), according to which enterprise competitiveness is the ability to operate in a given sector in conditions of free market economy, deserves special attention. The author notes the greater the competitiveness, the more secure an enterprise's standing in a sector and the less its operations are exposed to external stimuli and slump, which becomes particularly important where economies are open and liable to easy 'infections' with crises.

Some authors narrow competitiveness only to offering terms of exchange that are better than those of other economic players, which is a typical supply-side perspective (Gorynia 1998, p. 266).

A more general take is offered by W. Walczak (2010), who sees competitiveness as a multidimensional characteristic of a firm that arises from its internal features and is connected with the skill of adapting to changes in the environment. It defines an enterprise's distinctive capabilities for taking actions providing for stable long-term development and contributes to market value. This definition stresses the dynamic aspect of this phenomenon and the fact it depends both on a firm itself and its broadly-defined environment.

This is a definition similar to the one advanced by *Centrum Badań nad Konkurencyjnością* (Centre for Competitiveness Studies), which mentions an enterprise's ability to continue offering products that match standards of social responsibility for which they are willing to pay more than for competing products. Thus, a firm's ability to discover changes inside and in its environment by continuing improvement of criteria of market competitiveness in comparison with its rivals is therefore pre-requisite to being competitive. Similar notions are offered by other authors, too, who write it is the sum total of properties and actions of a given product unit by means of which an enterprise can enhance its market share and/or profits in a period (Findrik, Szilard 2000, p. 23).

It can be seen competitiveness is defined in a number of ways due to a variety of its perceptions and dimensions. Most definitions emphasise an entity's ability to build competitive advantage and competitive standing better than those of its rivals, as well as generation of economic benefits (Nowacki 2018).

Competitive advantage may have its source in (Pawlak 2004):

1. Relatively lower costs and capacity for offering lower prices;
2. Cheaper sources of procurement, better location, cheaper labour;
3. Provision of top quality products or services;
4. Reliability of products, supplies, after-sales support;
5. Relatively greater innovativeness and flexibility (technological and organisational advantage, better quality of institutions, efficiency of mechanisms) that assure better adjustment of supply to demand, a broad

range of products suited to customer requirements, and fast response to their changing preferences;

6. Diversification and customisation of products and services that provide higher quality and utility value than offered by competition at comparable pricing;

7. Organisation and management actions that ensure high dynamics of production and sales growth and increasing goodwill.

Business knowledge and capability for knowledge absorption are listed among factors determining competitiveness as well (Stawasz 2019).

ANALYSIS OF PRICES AND TIMES OFFERED BY COMPETITIVE CARRIERS

The authors have decided fees for transportation services and time of travel would be the key competitive advantages in relation to other carriers.

In order to determine how competitive Hyperloop is in comparison with alternative means of transport, ticket pricing of competitive transportation on the following routes is analysed:

1. Warszawa – Łódź Fabryczna
2. Warszawa – Katowice
3. Katowice – Kraków
4. Warszawa – Kraków

The following carriers are taken into account:

1. LOT Polish Airlines;
2. PKP Polish Rail, in particular, Intercity, TLK, EIP (Express Intercity Premium);
3. Flixbus as a bus carrier;
4. BlaBlaCar – car travel. Of course, the price of travelling between two locations offered as part of this solution cannot be treated as fully covering costs of car operation. This scheme connects drivers who have free seats available in their cars and individuals seeking to travel in exactly the same direction. Nonetheless, BlaBlaCar pricing is competitive in the market of transport services.
5. Own car.

Second-class one-way travel is analysed. No discounts on ticket prices are taken into account. Table 2 lists the price ranges on the routes designated. Grey cells indicate maximum and minimum costs of travelling along a given route. Average price of travelling a given route is calculated as well.

As a result of marketing research designed to determine price levels acceptable to those queried, the following price list has been compiled:

o   Warszawa – Łódź route – ticket price PLN 150
o   Warszawa – Katowice route – ticket price PLN 400
o   Katowice – Kraków route – ticket price PLN 250.

Table 2 Prices of selected carriers for the routes under analysis

1. **Warszawa – Łódź Fabryczna**			
Means of transport	Ticket price /PLN/		Comments
	from	to	
Air			No one-way flights have been found for November 2020
Train	31	34.90	
Bus	17.99	17.99	
Car (BlaBlaCar)	15	29.99	
Own private car	35.60	42.73	
Average price	**PLN 29.60**		
2. **Warszawa – Katowice**			
Means of transport	Ticket price /PLN/		Comments
	from	to	
Air	107	202	
Train	49	60	
Bus	59.98	59.98	
Car (BlaBlaCar)			No offers
Own private car	84.86	96.02	
Average price	**PLN 109.90**		
3. **Katowice – Kraków**			
Means of transport	Ticket price /PLN/		Comments
	from	to	
Air	198	271	A change in Warsaw, no direct connections
Train	13	29	
Bus	14.99	29.99	
Car (BlaBlaCar)	8.00	15.00	
Own private car	28.06	44.92	
Average price	**PLN 65.20**		
4. **Warszawa – Kraków**			
Means of transport	Ticket price /PLN/		Comments
	from	to	
Air	143.01	221.47	
Train	49	150	
Bus	59.99	79.99	
Car (BlaBlaCar)	30	35	
Own private car	85.18	123.89	
Average price	**PLN 105.28**		

Source: The authors' own compilation as of 20.10.2020[1]

The prices offered by Hyperloop are considerably higher than those of alternative transportation listed above, whereas travel time and safety are indubitable advantages of Hyperloop. Table 3 illustrates travelling times depending on routes and means of transport. The shortest and longest times of travelling along the routes are marked grey.

---

[1] Compiled n the basis of: https://bilet.intercity.pl; https://koleo.pl/rozklad-pkp; https://pl.omio.com/searchfrontend/results; https://www.viamichelin.pl; https://shop.flixbus.pl; https://www.esky.pl; https://www.pasazer.com; https://www.fru.pl; https://www.skyscanner.pl; https://www.blablacar.pl

Table 3 Travel times by selected carriers on the routes analysed

1. **Warszawa – Łódź Fabryczna**			
Means of transport	Time of travel		Comments
	from	to	
Air			No one-way flights have been found for November 2020
Train	1h 22'	1h 31'	
Bus	1h 35'	1h 55'	
Car (BlaBlaCar)	1h 10'	1h 55'	
Own private car	1h 19'	2h 7'	
2. **Warszawa – Katowice**			
Means of transport	Time of travel		Comments
	from	to	
Air		0h 55'	
Train	2h 25'	3h 37'	
Bus	8h 15'	9h	
Car (BlaBlaCar)			No offers
Own private car	3h 17'	4h 16'	
3. **Katowice – Kraków**			
Means of transport	Time of travel		Comments
	from	to	
Air	4h 35'	11h 05'	A change in Warsaw, no direct connections
Train	1h 28'	2h 14'	
Bus	1h 10'	1h 30'	
Car (BlaBlaCar)	0h 57'	1h 45'	
Own private car	0h 57'	1h 47'	
4. **Warszawa – Kraków**			
Means of transport	Time of travel		Comments
	from	to	
Air		0h 50'	
Train	2h 23'	6h 09'	
Bus	4h 15'	4h 25'	
Car (BlaBlaCar)	3h 30'	3h 50'	
Own private car	3h 40'	4h 54'	

Source: The authors' own compilation as of 20.10.2020[2]

The times and costs of travel given above are based on data available on the Internet. This information suggests implementation of high-speed rail will reduce travel times on these routes.

To determine the way changes of the key factor, namely, pricing, will affect profitability of the investment project of constructing vacuum rail, future cash flows associated with such an investment are estimated.

ANALYSIS OF SPENDING, COSTS, AND EFFECTS OF THE INVESTMENT

A variety of methods and measures are taken into consideration when evaluating competitiveness of an enterprise. From the viewpoint of the service sector, which certainly includes high-speed rail, methods combining the

---

[2] Compiled on the basis of: https://bilet.intercity.pl; https://koleo.pl/rozklad-pkp;
https://pl.omio.com/searchfrontend/results; https://www.viamichelin.pl; https://shop.flixbus.pl;
https://www.esky.pl; https://www.pasazer.com; https://www.fru.pl; https://www.skyscanner.pl;
https://www.blablacar.pl

customer perspective on perception of market offer and the perspective of enterprise and its efficiency seem the most adequate.

Analysis of vacuum rail's competitiveness has focused on several economic factors of competitiveness: investment spending, need for sources of financing, operating costs, and effectiveness.

In order to determine effectiveness of high-speed rail construction, an investment accompanying construction of the STH (Solidarity Transport Hub), ten years of realisation and thirty years of operation have been adopted. The time of investment operation is based on life-times of key parts of high-speed rail infrastructure. Investment spending comprises construction costs of capsules, routes, and infrastructure. The estimated costs and operating revenues of the project are based on estimated investment spending in two scenarios: wheel and levitation drives. The costs of financing are a major factor in the substantial investment expenditure, as shown in Figure 1.
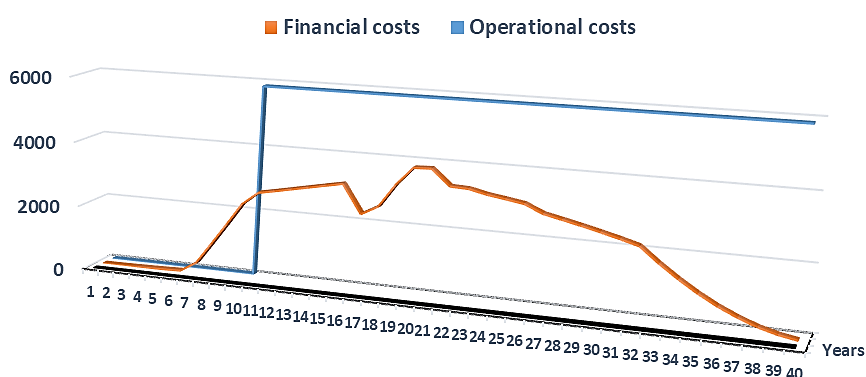

Fig. 1 Forecast costs of the project
Source: The authors' own compilation

Financial results in particular years of an investment project are affected not only by investment and financial costs but also potential revenue from ticket prices acceptable to the public, frequency of capsule travel, and numbers of potential passengers, which are determined by way of marketing research. In effect, positive financial results are only generated in the final period of the investment operation (Figure 2).
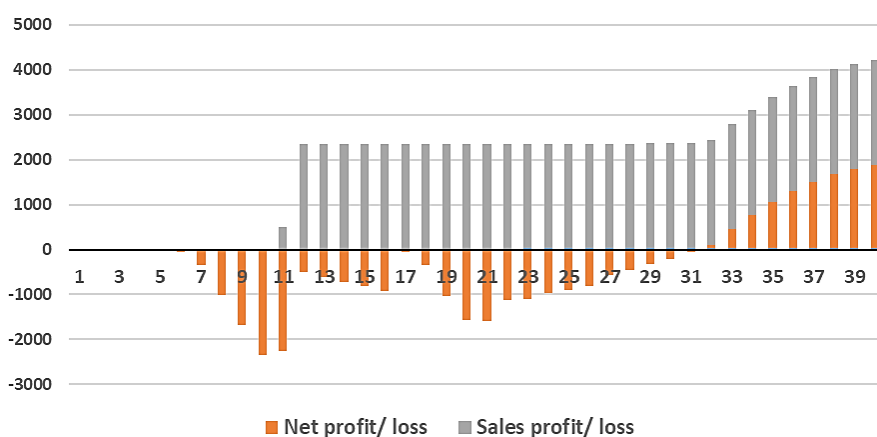

Fig. 2 Forecast financial results of the vacuum rail project (PLN m)
Source: The authors' own compilation

Quality and pricing of services are considered essential factors influencing competitiveness of service enterprises. From the viewpoint of economic benefits, it is reasonable to analyse impact of price changes on generation of potential profits in the case of such a unique investment as high-speed rail. This is the core of the analysis, since possibilities of cost reductions and service diversification are restricted.

As part of evaluating competitiveness of the high-speed rail investment, capital requirements are analysed if pricing of passenger travel and cargo transportation are first raised and then lowered by 10% compared to the initial assumptions. The successive Tables 4 and 5 illustrate effects of changing transport prices on sources of financing requirements, and NPV and IRR ratios for the wheel-drive investment scenario.

Table 4 Requirements for sources of financing for the wheel system investment if prices rise and fall by 10% (PLN K)

Source of financing	The assumed pricing	Ticket pricing raised by 10%	Difference	Ticket pricing reduced by10%	Difference
Own capital	172 600 000	159 200 000	13 400 000	185 600 000	-13 000 000
Bond issue	148 070 000	148 066 000	4 000	148 070 000	0
Crediting	154 950 000	154 950 000	0	156 700 000	-1 750 000
Total	475 620 000	462 216 000	13 404 000	490 370 000	-14 750 000

Source: The authors' own compilation

Table 5 Calculation of NPV (PLN) and IRR for the wheel system investment

	The assumed pricing	Pricing raised by 10%	Pricing reduced by 10%
Rate of discount	6.00%	6.00%	6.00%
NPV =	6 645 274 286	7 096 101 376	5 706 017 976
Rate of discount	6.50%	6.50%	6.50%
NPV =	5 951 017 501	6 327 874 550	5 110 379 681
Rate of discount	7.00%	7.00%	7.00%
NPV =	5 348 399 629	5 663 398 152	4 592 059 755
Rate of discount	5.50%	5.50%	5.50%
NPV =	7 449 731 184	7 989 073 204	6 394 707 477
IRR =	19.83%	19.82%	18.89%

Source: The authors' own compilation

The foregoing calculations indicate increasing travel prices by 10% will cut own capital requirements by more than PLN 13 m and by PLN 4 m in the case of bond issue. The change will not have a significant effect on assessment of investment effectiveness. A price reduction by 10% will raise own capital requirements by PLN 13 bn and PLN 1.75 bn in the case of borrowing. The

change will not have a significant effect on assessment of investment effectiveness.

A parallel analysis is undertaken with regard to effects of travel price changes on requirements for sources of financing and NPV and IRR ratios for the levitation investment scenario (Tables 6 and 7).

Table 6 Requirements for sources of financing for the levitation system investment if prices rise and fall by 10% (PLN K)

Source of financing	The assumed pricing	Ticket pricing raised by 10%	Difference	Ticket pricing reduced by10%	Difference
Own capital	457 200 000	443 400 000	13 800 000	470 300 000	-13 100 000
Bond issue	304 070 000	304 070 000	0	304 070 000	0
Crediting	286 900 000	286 900 000	0	288 520 000	-1 620 000
Total	1 048 170 000	1 031 370 000	13 800 000	1 062 890 000	-14 720 000

Source: The authors' own compilation

Table 7 Calculation of NPV (PLN) and IRR for the levitation system investment

	The assumed pricing	Pricing raised by 10%	Pricing reduced by 10%
Rate of discount	6.00%	6.00%	6.00%
NPV =	14 355 035 510	14 762 916 773	13 638 289 389
Rate of discount	6.50%	6.50%	6.50%
NPV =	13 703 485 431	14 043 684 802	13 081 638 214
Rate of discount	7.00%	7.00%	7.00%
NPV =	13 103 941 090	13 387 645 721	12 562 212 420
Rate of discount	5.50%	5.50%	5.50%
NPV =	15 070 297 645	15 559 319 993	14 240 930 331
IRR =	33.97%	33.96%	33.84%

Source: The authors' own compilation

The calculations in Tables 6 and 7 show increasing travel prices by 10% will lower own capital requirements by PLN 13.8 bn. The change will not have a significant effect on assessment of investment effectiveness. A price reduction by 10%, on the other hand, will increase own capital requirements by PLN 13.1 bn and PLN 1.62 bn in the case of borrowing. The change will not have a significant effect on assessment of investment effectiveness, either.

CONCLUSION

In the perspective of decisions made, determinants of competitiveness can be divided into internal, related to decisions made by an enterprise, and external, concerning factors over which an enterprise has limited or no control. Effectiveness is the chief economic factor of competitiveness. Effectiveness is generally understood as a result of actions and described as a relation of effects

to expenditure. Investment effectiveness in respect of vacuum rail must be seen in a long time-frame, given the time of infrastructure appreciation as well as maturity of committed sources of financing. Analysis of potential demand groups for transportation of cargo and passengers is also important to estimation of future revenue. According to the figures presented here, it can be said primarily other than economic factors, that is, time and safety, have impact on competitiveness of vacuum rail investment in Poland. However, considering effectiveness of the investment in a very long time-frame, given the assumed demand and pricing, the investment provides for economic effectiveness as well.

REFERENCES

Burnewicz J. (ed.) (1993), Ekonomika transportu, Wydawnictwo Uniwersytetu Gdańskiego, Gdańsk.

Findrik M., Szilard I. (2000), International Competitiveness – Competition of Skills, Kossuth Kiado, Budapest.

Flak O., Głód G. (2009), Konkurencyjność przedsiębiorstwa. Pojęcia, definicje, modele, cz. 1, Wydawnictwo Akademii Ekonomicznej w Katowicach, Katowice.

Gorynia M. (1998), Konkurencyjność przedsiębiorstwa – próba konceptualizacji i operacjonalizacji, *Zeszyty Naukowe Akademii Ekonomicznej w Poznaniu*, seria I, Poznań.

Guzal-Dec D., Zwolińska-Ligaj M. (2006), Konkurencyjność przedsiębiorstwa a otoczenie lokalne [in:] Zarządzanie przedsiębiorstwem w warunkach konkurencyjności. Determinanty konkurencyjności przedsiębiorstw, ed. M. Juchniewicz, t. 1, Wydawnictwo Uniwersytetu Warmińsko-Mazurskiego w Olsztynie, Olsztyn.

https://bilet.intercity.pl

https://koleo.pl/rozklad-pkp

https://pl.omio.com/searchfrontend/results

https://shop.flixbus.pl

https://www.blablacar.pl

https://www.esky.pl

https://www.fru.pl

https://www.pasazer.com

https://www.skyscanner.pl

https://www.viamichelin.pl

Kędzierska A. (2005), Wzrost konkurencyjności przedsiębiorstw poprzez fuzje i przejęcia [in:] Konkurencyjność przedsiębiorstw w świetle Strategii Lizbońskiej, ed. J. Bieliński, CeDeWu, Warszawa.

Kolterman K. (2013), Innowacje technologiczne w procesie budowania przewagi konkurencyjnej MŚP, Difin, Warszawa.

Liao T-S., Rice J., Lu I-Ch. (2015), The vicissitudes of competitive advantage: Empirical evidence from Australian manufacturing SMEs. Journal of Small Business Management, 53(2), pp. 469-481.

Mantura W. (2002), Identyfikacja czynników sukcesu i konkurencyjności przedsiębiorstwa [in:] Problemy wdrażania strategii rozwoju województwa wielkopolskiego, ed. E. Skawińska, PTE, Poznań.

Misala J. (2011), Międzynarodowa konkurencyjność gospodarki narodowej, PWE, Warszawa.

Nehring A. (ed.) (2007), Rozwój i konkurencyjność małych i średnich przedsiębiorstw w Polsce, Wydawnictwo Uniwersytetu Ekonomicznego w Krakowie, Kraków.

Nowacki R. (2018), Determinanty konkurencyjności przedsiębiorstw usługowych w Polsce – znaczenie i poziom realizacji, *Handel Wewnętrzny* 6(377), pp. 435-450 (tom I).

OECD (1997), New Directions for Industrial Policy, Paris.

Pawlak K. (2004), Determinanty konkurencyjności międzynarodowej – ewolucja poglądów, *Ekonomia* nr 16, pp. 107-120.

Porter M. (2001), Porter o konkurencyjności, PWE, Warszawa.

Sipa M., Gorzeń-Mitka I., Skibiński A. (2015), Determinants of competitiveness of small enterprises: Polish perspective. Procedia Economics and Finance, 27, pp. 445-453.

Skawińska E (ed.) (2002), Konkurencyjność przedsiębiorstw – nowe podejście, PWN, Warszawa-Poznań.

Stawasz E. (2019), Factors that Shape the Competitiveness of Small Innovative Companies Operating in International Markets with a Particular Focus on Business Advice, Journal of Entrepreneurship, Management and Innovation, Vol. 15, Issue 1, pp. 61-82.

Walczak W. (2010), Analiza czynników wpływających na konkurencyjność przedsiębiorstw, „E-mentor", nr 5, SGH, Warszawa.

Abstract.
A comparative analysis of factors of vacuum rail's competitiveness in Poland relative to other means of transport is presented. Only such determinants of competitiveness as price and time of travel are focussed on and compared with alternative solutions on selected routes. Impact of price changes on effectiveness of vacuum rail construction is additionally analysed. Investment effectiveness in the case of vacuum rail is considered in the long time-frame, given the time of infrastructure depreciation and of due return on sources of committed financing. The analysis helps to identify key factors which may decide competitive advantage of vacuum rail in Poland over other means of transport.

Keywords: firm competitiveness, competitiveness determinants, investment effectiveness