
Evaluation of Modal Shift in Freight Transport: Case Study of Poland

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Abstract:

Purpose: This paper aimed to assess the degree of implementation of the modal shift concept in international transport flows to/from Poland.

Design/Methodology/Approach: The first stage of the research study included the literature review indicating the Polish and EU projects aimed at promoting the transport modes being an alternative for road transport. Next, data regarding Poland's international trade were prepared and confronted with the assumed targets.

Findings: In international freight transport to/from Poland, i.e., transportation of both imported and exported cargoes, an increase in the significance of road transport is noticeable. It is possible to discern periods when the share of road transport dropped (imports in 2005-2010 and exports in 2010-2015), nevertheless, despite measures taken at the national and supranational level, a desired modal shift from road transport to rail transport or inland shipping or short sea shipping was not achieved. It can also be noticed that rail transport was more often used in imports than in exports.

Practical Implications: The obtained findings, which specified the degree of implementation of the modal shift concept on the example of Poland, may be an indication for the entities that set priorities in economic policies regarding the level of effectiveness of measures included in the prepared documents/programs.

Originality/Value: The literature still lacks comprehensive research studies that verify the implementation of the modal shift concept at the level of individual countries. This paper demonstrates the effectiveness of implemented strategies and programs in the example of Poland. Moreover, it proposes changes to be considered by decision-makers who shape the goals and tools of economic policies and differences regarding management decisions.

Keywords: Modal shift, international trade, modal split, transport modes, transport policy, White Paper.

JEL classification: E61, F18, R48.

Paper Type: Case study.

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1. Introduction

Transport constitutes an important area in the context of measures taken to protect the natural environment. Under the opinion of the European Commission, the competitiveness of the EU economy will be compromised, and the state of the natural environment will deteriorate unless appropriate measures are taken towards sustainable transport. (European Commission, 2018; European Commission, 2020).

One of the paradigms resulting from the idea of sustainability, aimed at counteracting adverse effects of the predominant share of road transport in inland freight transport, is the modal shift paradigm, also referred to as 'the shifting paradigm.' The idea of the modal shift paradigm is changing the approach to the patterns of production and service consumption patterns, which considers the limitations found in natural resources. Regarding transport, it aims to reduce the cargo volumes carried by road while increasing the rail and waterborne transport volumes (Wojewódzka-Król and Załoga, 2016).

Efficient and sustainable modes of transport have been promoted in the European Union since as early as 1992 when the significant goals stipulated in the White Paper included changes in the modal shares (European Commission, 1992). In 2001, it was stressed that it was essential to increase the percentage of cargoes transported by rail up to 35% by 2010 (European Commission, 2001).

The currently binding document (European Commission, 2011) stipulates that at least 30% of road freight transported over 300 km should be shifted to other modes of transport, and by 2050 that modal share should exceed 50%. The European Green Deal also confirmed these assumptions. Despite the significant number of publications regarding various factors that impact modal shift, its potential in the contemporary economy, or expected outcomes, few studies are still about the actual level of completed intermodal changes.

2. Literature Review

To complete the intermodal shift as stipulated in the White Paper, the modal share of road transport in total inland freight transport should be reduced from 75% to 52%. As a result, the modal share of rail transport should increase from 21% to 39%, and that of inland shipping - from 4 to 8% (assuming that the modal shift from road transport is evenly distributed between rail transport and inland shipping). This would mean that rail transport and inland shipping should cover 88% of all cargoes (L. A. Tavasszy *et al.*, 2011). By 2050, the modal split would be subject to more radical transformations. Halving the road transport-level would reduce its share in total transport volume from 75% to 38%, whereas the percentage of rail transport would rise to 50%, and that of inland shipping - to 11%.

Despite the assumed targets related to the transport policy, the modal shift assumptions have been implemented only to a small extent (Kaack *et al.*, 2018; Bjork, 2021; Islam *et al.*, 2015). In particular, it is possible to notice a downward trend when it comes to rail transport in the EU (Eurostat).

Although the overall modal share of rail transport in the UE-28 countries has dropped, the trends for transport modes differ depending on the land (Dionori *et al.*, 2015). It is indicated that only a few European countries have achieved the White Paper assumptions regarding the modal shift in transport. As for road transport of containerized cargo on distances exceeding 300 km, its share has decreased, confirming the shift paradigm's assumptions. Such a decrease was found in the Czech Republic (18.6%), Luxembourg (9%), Sweden (6.9%), and Hungary (6.2%) (Kowalska, 2020). The literature on the subject still lacks research focused on national transport systems in reaching modal shift targets.

Research studies have shown that the EU policy and measures taken by member states at the national level have halted or slowed down the increase in road transport, both in absolute figures and in terms of shares held by individual modes of transportation in cargo haulage. As a result, the dramatic downward trend shown by the modal share of rail transport in freight carriage was reversed. Also, the impact of funds earmarked for railway infrastructure development, especially cross-border connections, and interoperability, was underlined (European Parliament's Committee on Transport and Tourism, 2018). Table 1 presents the programs implemented on the national (Poland) and EU level, covered by the case study.

Table 1. Selected measures to support modal shift in Poland and other EU member states

Name	Spatial scope:	Goals
II National Environmental Policy (2000)	Poland	1) The need to rationalise transport via changing the transport system and developing the rail transport while reducing freight transit by road 2) Development of public transport in cities
White Paper on transport (2001)	EU	Aiming at the 1998 modal split, as the model for 2010
Marco Polo I Programme (2003-2006)	EU	Shifting 12 bn tonne-kilometres of cargo traffic per year from roads to other, more ecological means of transport.
Sectoral Operational Programme (2004-2006)	Poland	The need to shift the demand from road transport to rail haulage, in particular between: 1. S-7 (Gdańsk-Warszawa) expressway and E-65 (Gdynia-Warszawa) railway line, 2. S-8 (Warszawa-Piotrków) expressway and E-65 (Warszawa-Katowice) railway line, 3. S-7 (Warszawa-Radom) expressway and Warszawa-Radom railway line (not included in TEN-T corridor)
National Transport Policy 2006-2025 (with a perspective towards 2030), (2005)	Poland	Taking measures towards division of the total number of tonne-kilometres between the means of transport in such a way so that the ones with the least adverse environmental impact are used to the greatest extent.

Marco Polo II (2006-2013)	EU	Shifting the total annual increase in the number of tonne-kilometres in the international road transport to short sea shipping, rail transport, waterborne transport, inland shipping, or combined transport.
Country Development Strategy (2007-2015)	Poland	The need to enhance the role of rail transport (in particular in relation to heavy cargoes that are hazardous to humans and the environment), shifting freight “from road to rail”.
White Paper on transport (2011)	EU	1) By 2030, 30% of road freight transported over 300 km is to be shifted to alternative transport modes. By 2050, the share should exceed 50%. 2) By 2050, part of the medium range passenger traffic should be shifted to rail transport.
The strategy for sustainable production and consumption patterns (2011)	Poland	Implementation of measures aimed at introducing sustainable production and consumption patterns. The modal imbalance in both passenger and freight transport was observed.
Strategy for Sustainable Development of Transport by 2030 (2019)	Poland	The need to shift some tonne-kilometres from road to alternative transport. The key factor should be development of railway and inland shipping infrastructure, as a result of which the shift may be noticeable after 2025.
Sustainable and Smart Mobility Strategy - putting European transport on track for the future (2020)	EU	Enhancing the role of rail transport and inland waterways in inland freight transport, which today is served by road transport in 75%.

Source: The authors' own analysis on the basis of: II National Environmental Policy, 2000, White Paper of 2001, European transport policy for 2010: time to decide; Sectoral Operational Programme Transport for years 2004-2006; The Marco Polo programme — Results and outlook COM(2013) 278 final; Country Development Strategy 2007-2015; White Paper of 2011, Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system; The strategy for sustainable production and consumption patterns; Strategy for sustainable development of transport by 2030; National Transport Policy 2006-2025; Sustainable and Smart Mobility Strategy - putting European transport on track for the future, COM (2020) 789 final.

The priorities mentioned above, and planned measures aimed to achieve an intermodal shift from road transport to alternative, more ecological modes of transportation, particularly rail transport and inland shipping. Based on the collected data, the authors of this paper attempted to verify the assumptions of the concept of an intermodal shift in the vehicle, on the example of international freight transport to/from Poland in the years 2005-2019.

3. Methodology

The authors comprehensively reviewed the documents that formulate challenges regarding intermodal shift (at the level of Poland as a country and the European Union) and publications of other authors that tackled this issue. The data used in the studies completed for this paper were obtained from the unpublished resources of the Polish National Revenue Administration. The data reflecting the transport modal split cover the years 2005, 2010, 2015, and 2019. The presented figures show the weight (expressed in tonnes) of the cargoes transported as part of Poland's international trade.

In 2019, Polish carriers transported the most cargo out of all other European countries (Eurostat, 2019). Moreover, the authors focused on international transport due to its importance in the total intermodal transport in Poland, which is demonstrated by its high percentage of the total intermodal transport in Poland³. Additionally, in 2019 the average transport distance per tonne of cargo in international trade was 729 km, which makes it possible to infer that a considerable part of cargoes is carried over distances exceeding 300 km, which qualifies them for the purposes of the intermodal shift as proposed in the White Paper (Statistics Poland, 2019).

Poland became a member state of the European Union on 1st May 2004. Poland's accession entailed new legal and political conditions as well as changes in the principles of trading between Poland and the EU member states. Therefore, the first period included in the analysis was 2005, for which the data show the modal split still without the EU policy intervention. Additionally, in 2019 the average transport distance per tonne of cargo in international trade was 729 km, which makes it possible to infer that a considerable part of cargoes is carried over distances exceeding 300 km, which qualifies them for the intermodal shift as proposed in the White Paper (Statistics Poland, 2019).

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Moreover, 5-year time intervals were applied, except the last year included in the study, where 2020 was replaced by 2019 due to the European wave of the Covid-19 pandemic. The outbreak of the pandemic had an impact on the transport modal split and the trade balance; hence the authors decided to exclude the short-term data temporarily affected by the pandemic, as the purpose of the research study was the effect of measures taken to promote intermodal changes, and an analysis of changes regarding the modal shift, in the long run (Bonk and Kowalska, 2020).

Based on the collected data, the following categorisation of transport modes was adopted:

- road
- rail

³Depending on the accepted criterion (freight unit, weight, TEU or transport performance), the share of international transport in the total intermodal transport in Poland fell between 75.6-79.2% in 2019. Quoted from: *Report on rail transport market operations 2019*, Urząd Transportu Kolejowego, Warszawa, 2020, p. 89.

⁴Meaning the beginning of the EU transport policy introduction and implementation of new EU programmes to support the development of intermodal transport and the modal shift concept.

- seaborne
- inland shipping
- airborne
- other
- unspecified

The first five categories reflect the standard, generally applied categorization of transport modes, whereas the last two were made to reflect the specific nature of the data. ‘Other’ covers categories such as postal consignments, fixed transmission systems, and transport of self-propelled machines (e.g., transportation of an ordered ship that arrives on its own at the destination). The ‘Unspecified’ category, in turn, includes the cargoes for which no INTRASTAT declarations were submitted, or the weight of the transported cargo did not exceed 0.5 kg. Moreover, it should be noted that intermodal shifts were supposed to take place on distances over 300 km. However, the collected data did not make it possible to specify the haulage distances. The authors assessed the level of implementation of the challenges stipulated in the transport policy documents. Also, they compared the achieved results with the findings of studies carried out on the examples of other EU countries.

4. Modal Shift in Poland

In accordance with the classification above, Table 2 presents the modal split of transport to/from Poland in the years 2005-2019. The modal split in international transport demonstrates the concrete trends in the development of the individual modes of transportation of cargo to/from Poland. It is essential to focus on the visible increase in the modal share of road transport by 3.5 percentage points in imports and 20.0 percentage points in exports in the years 2005-2019. At the same time, there was a drop in the modal share of rail transport (by over 2% in imports and nearly a half in exports) and that of inland shipping. Although seaborne transport in implications rose by 17.9 percentage points in the discussed period, simultaneously the exports showed a drop amounting to 13.4 percentage points between 2005 and 2019. Tabularisation of data in weight units makes it possible to interpret them in terms of implementing the modal shift concept (Table 2).

Table 2. Cargo volumes carried by the particular transport modes to/from Poland in 2005- [k tonnes]

	Mode of transport	2005	2010	2015	2019
Imports	road	24,609	30,293	35,660	47,295
	rail	19,608	29,018	24,350	29,925
	seaborne	9,856	20,048	29,720	44,755
	airborne	66	98	77	86
	inland shipping	50	10	1	5
	other	24,524	20,760	19,030	14,105

	unspecified	13,572	20,569	22,134	20,566
	Total	92,283	120,796	130,973	156,737
Exports	road	21,044	31,069	39,636	53,169
	rail	18,124	13,876	15,165	12,691
	seaborne	22,901	17,306	21,861	18,613
	airborne	42	247	70	83
	inland shipping	1393	678	694	75
	other	648	261	1,341	1,313
	unspecified	12,016	16,633	29,305	25,668
	Total	76,167	80,071	108,072	111,611

Source: Own study based on the data obtained from Polish National Revenue Agency.

Table 3. Percentages of the particular transport modes used in freight to/from Poland in 2005-2019 [% tonnes]

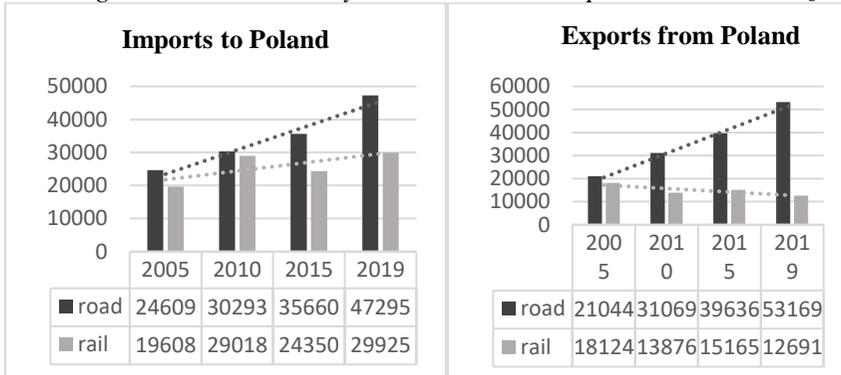
	Mode of transport	2005	2010	2015	2019
Imports	road	26.667%	25.078%	27.227%	30.175%
	rail	21.247%	24.023%	18.592%	19.092%
	seaborne	10.680%	16.597%	22.692%	28.554%
	airborne	0.071%	0.081%	0.059%	0.055%
	inland shipping	0.054%	0.008%	0.001%	0.003%
	other	26.574%	17.186%	14.530%	8.999%
	unspecified	14.706%	17.028%	16.899%	13.121%
	Total:	100%	100%	100%	100%
Exports	road	27.628%	38.802%	36.676%	47.638%
	rail	23.794%	17.330%	14.032%	11.370%
	seaborne	30.067%	21.614%	20.228%	16.677%
	airborne	0.056%	0.308%	0.065%	0.074%
	inland shipping	1.829%	0.847%	0.643%	0.067%
	other	0.850%	0.326%	1.241%	1.176%
	unspecified	15.776%	20.773%	27.116%	22.998%
	Total:	100%	100%	100%	100%

Source: Own study based on the data obtained from Polish National Revenue Agency.

There was a significant increase in total cargo volumes in the said period, both imported (by nearly 70% in the years 2005-2019) and exported (by almost 47% in the same period). When focusing on the transport modes addressed in terms of modal shift, it is possible to notice a considerable increase in road haulage of both imported and exported cargoes in terms of carried weight. There was also a significant increase in imported loads carried by rail; however, exports, in this case, decreased by ca. one-third. As for inland shipping, despite the growing imports in 2015-2019, the other periods covered by the study saw considerable drops in cargo volumes, both in imports and exports.

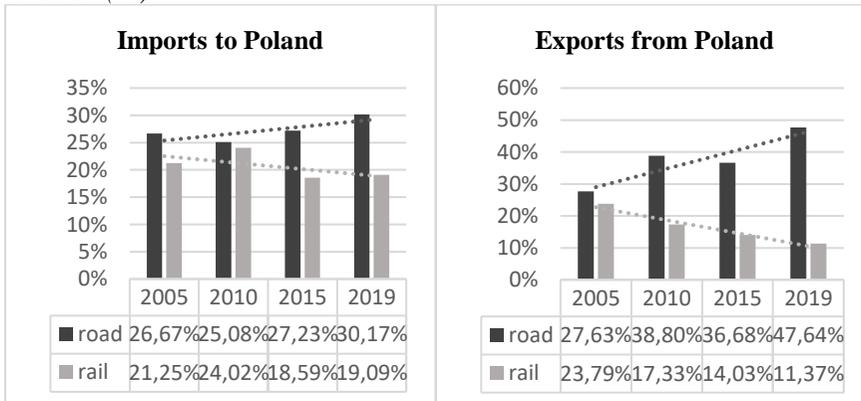
Given the need to shift road transport to rail, Figure 1 below shows the cargo volumes transported by road and rail.

Figure 1. Cargo volumes carried by rail and road transport in 2005-2019 [k tonnes]



Source: Own study based on the data obtained from Polish National Revenue Agency.

Figure 2. Modal shares of rail and road transport in imports/exports to/from Poland in 2005-2019 (%)



Source: Own study based on the data obtained from Polish National Revenue Agency.

Based on the above data it is possible to conclude that road transport plays a dominating part in the transport system of Poland. Even though there are EU programs targeted at achieving sustainable development goals and changing the modal shares to favor the modes that are alternative to road transport, such as rail transport and inland shipping, they have not had a significant impact on the percentage of modal shares in the total transport volume since Poland joined the EU. Given the completed research study, one can also conclude that it seems impossible for Poland to achieve the target stipulated in the White Paper of 2011, i.e., a 30% shift in cargo volume from road transport to rail haulage or inland shipping by 2030.

In the case of Poland, the long-standing increase in imports and decrease in exports of goods by rail and seaborne transport is primarily connected with the economic changes that took place after the 1989 transformation (Gołata, 2009). Poland departed from the role of an exporter of natural resources (such as coal). It moved towards a modern economy based on industrial production, which required an increase in

imports of essential resources (which, due to their bulk nature, tend to gravitate towards rail and seaborne transport). As shown in Table 3, this trend significantly accelerated after Poland joined the EU. The above-described systemic changes on the Polish market also resulted in a decreased share of large state-owned enterprises that were being privatized (Jarmołowicz, 2013) and an increased share of the SME sector.

Due to smaller trading volumes, new private enterprises often have higher production value and the need for transport flexibility, prefer road transport rather than rail haulage. Despite the high costs of rail transport, its decreased flexibility, and poor punctuality (in the case of Poland), the volume of cargoes carried by rail (in terms of cargo weight) has increased significantly over the studied period (Table 3). The demonstrated changes regarding the held cargo volumes and the transport modes may also be due to the new concept of Polish international trade connected with reorganizing the trading with particular countries. This is exemplified by the increased trade volume between Poland and Germany, becoming one of Poland's major trade partners.

Due to the geographical location and the small distance between the two countries. Because the most significant increase was shown between 2005 and 2010, i.e., at the time of implementing the first documents regarding development of transport within the framework of the European Union (Polish Ministry of Infrastructure, 2005), it is possible to assume that it is also the result of the developed and adopted EU strategies and programs. The multi-factor decrease could also influence the importance of inland shipping from which some cargoes could be shifted to rail. It is also possible that due to the EU initiatives, the percentage of road transport in Poland's overall international transport volume has not been as high as it might have been.

An area for further research can be the impact of the said programs on preventing the emotional growth of the modal share of road transport in the overall transport volume and the development of alternative modes of transportation. It would also be advisable to search for new instruments which would reach first and foremost cargo shippers to enhance their knowledge about the modal shift and point to the advantages of such transport solutions. It would also be necessary to take up the issue of the costs of accessing the infrastructure, which in the case of rail transport in Poland are still high.

According to the authors, for any future instruments to be more successful, in addition to considering the above-mentioned problems, they should also provide comprehensive solutions that reach every participant of the transport network.

5. Conclusions

Given the data demonstrating the percentage modal shares in transport, it is possible to conclude that the modal shift programs and strategies developed for many years under the EU transport policy have not achieved the intended goal (Dong *et al.*, 2018). On the other hand, however, opinions indicate the impact of the modal shift initiatives

on implementing the hitherto paradigm of intermodal shifts. According to them, the number of tonne-kilometers completed by road transport and reflected in the modal split might have been diminished due to the measures taken, which prevented a larger modal share of road freight transport (European Commission, 2017).

In Poland, road transport has the most significant share in the transport volume (30% in imports and 48% in exports in 2019), which may affect its features such as flexibility or availability. In the case of Poland, the high percentage modal share of road transport may also result from the relatively low costs of running transport activity due to relatively low (compared to, e.g., Germany or France) drivers' earnings. This means a more downmarket entry barrier for new offers of transport services. At the same time, their business remains profitable on the open EU market, making it possible for them to maximize their profits due to applying West-European rates per km or possibly offering competitive rates due to lower payroll costs.

Many Polish transport companies and also high rates per km about the payroll level in Poland make it possible in West European countries to reduce the prices in the case of return trips to Poland (to prevent "empty miles"), which can be another reason why the percentage modal share of road carriage in international transport is so high. The above conclusion could also justify addressing the issue in terms of carried cargo volumes, which have also been rising in imports carried by rail. This might mean that the adopted strategies, though justified and practical, are not sufficient in terms of the concrete determinants of the local transport market. Further study of the fragmentary needs would make it possible to specify the scope of impacts of the programs.

Considering the above, it is possible to conclude that it is reasonable to continue the adopted policy aimed at increasing the significance of the transport modes that are alternative to road transport and to point out its weakness, i.e., the insufficiently addressed need to lower the entry barrier for intermodal transport. Lowering the walls could be affected via technological unification within the EU, cost reduction in rail transport (particularly about the cost of accessing the infrastructure), increasing its availability, or attempts to take additional measures targeted at those participants of transport chains, who tend to be neglected by support programs, such as cargo shippers. As for any future initiatives, it would also be advisable to consider the impact on intermodal shift shown by the pending investments, co-financed by the EU, in rail, seaborne or inland waterway transport infrastructure, which upon their completion may change the distribution of cargo volumes among the individual transport modes.

Another issue that needs to be taken into account in any future projects is the potential impact of changes in the cargo structure, which result from, i.a. the EU environmental policy, which in Poland may lead to partial replacement of coal with more ecological biomass (Mańkowska *et al.*, 2021) (which will have to be imported using modes of transport that are alternative to road transport, probably by rail). Changes to the environmental policy and its acceptance by the society also may induce cargo shippers

to change their modes of transportation to more ecological ones for their companies to improve their image to be better perceived by the public.

As part of the purpose of this paper, it was assessed that in international freight transport of both imported and exported cargoes, an increase in the significance of road transport is noticeable. Only in some periods, there was a drop in the share of loads carried by road transport. Moreover, rail transport was found to be more significant in imports compared to exports. The findings constitute a basis for further research of trends observed in Polish freight transport. First and foremost, it is necessary to specify the reasons for those trends and then indicate ways to reduce the activity of freight transport in Poland according to the modal shift paradigm.

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