

Possibilities of Increasing the Role of Railways in the Public Transport System of the Urban Functional Area of Olsztyn

Adam DĄBROWSKI¹, Szymon KLEMBA²

Summary

This article presents the possibilities of increasing the role of railways in the public transport system of the Urban Functional Area of Olsztyn. First, the proposed extent of the rail service, the assumptions for the new transport offer and the principles for the development of the rail timetable were outlined. Taking into account the current state of the infrastructure, the feasibility of implementing the basic transport offer (10 pairs of trains per day) and its further development in the future was examined for each direction of transport, and graphical timetables were drawn up and presented, based on the assumption of cyclical departures (i.e. clock-face schedule for train departures). Part of the article is also devoted to measures in the area of bus transport in terms of organisation and infrastructure, which, if taken, would make it possible to better integrate it with the railway system. Taking into account the observations and conclusions in the previous chapters, the proposed investment activities involving the railway infrastructure necessary to implement and improve regional rail services, as well as a broader perspective on further investments enabling the development of the transport offer and increasing rail accessibility in the Urban Functional Area of Olsztyn, are presented. The main conclusion of the analyses carried out is the confirmation of the feasibility of implementing a cyclical timetable in the area under study for the assumed base number of connections.

Keywords: rail transport, public transport, integrated transport system, cyclical timetable

1. Introduction

In the article [1] the authors present the current state of rail transport in the Urban Functional Area of Olsztyn (MOF Olsztyna) and introduce – with examples of implementation – the topic of integration of public transport systems. One of the key conclusions was that the process of increasing the role of rail transport in the public transport system of the Urban Functional Area of Olsztyn should be of evolutionary nature, with an initial emphasis on a regional rather than suburban transport network (as was often proposed in the public debates at local level).

In order to carry out a technical verification of this thesis, in this article the authors have assumed a basic transport offer of at least 10 pairs of passenger trains per day (cycle time of 2 hours, increased during peak hours to 1 hour) on railway lines radiating from Olsztyn in the directions of Dobre Miasto, Morąg, Ostróda, Olsztynek, Szczytno, Biskupiec Reszelski and Korsze.

The authors have also considered the technical feasibility of expanding the transport offer, e.g. achieving (on the most popular routes) a fixed cycle time of 1 hour in the future.

The technical and operational analysis, supported by the development of framework cyclical timetables, must also take into account the need for other trains (in particular long-distance passenger and freight trains) to be able to run smoothly. Its result is an assessment of the potential of the existing rail infrastructure and the identification of necessary or recommended investment measures.

The authors also intend to elaborate on the integration of rail and bus services in the Urban Functional Area of Olsztyn. This requires knowledge about the current layout of suburban³, municipal and district bus networks, as well as the location of bus stops in relation to rail infrastructure. As a result, it is possible to present a set of potential infrastructure and organisational measures that should be considered in further work to increase the level of multimodal integration.

¹ M.Sc. Eng.; Railway Research Institute, Railway Track and Operation Department; e-mail: adabrowski@ikolej.pl.

² M.Sc. Eng.; Railway Research Institute, Railway Track and Operation Department; e-mail: sklemba@ikolej.pl.

³ They can be associated with the lines organised by the Board of Roads, Greenery and Transport in Olsztyn.

The solutions analysed in the article may have a greater effect when combined with ticket integration (i.e. the introduction of a common ticket for the Urban Functional Area of Olsztyn to the greatest extent possible) and a consistent information policy (common information systems, timetables and diagrams taking into account all modes of public transport), but due to the nature of the issue, these factors are not considered in the article.

2. Analysis of the possibilities of development of the regional rail transport in the Urban Functional Area of Olsztyn

The basic area of the integrated transport system should include the Urban Functional Area of Olsztyn. However, due to the specific nature of rail transport, including technical and organisational factors (operation of rail traffic) and economic factors (commercial potential of stations), it should be assumed that train services should be routed at least to the first town located outside the Urban Functional Area of Olsztyn which can generate a passenger flow suitable for rail transport, as indicated in [1]. According to this assumption, the boundary stations of the railway service area thus defined

would be (in alphabetical order): Biskupiec Reszelski (line no. 223), Dobre Miasto (line no. 221), Korsze (line no. 353), Morąg (line no. 220), Olsztynek (line no. 216), Ostróda (line no. 353) and Szczytno (line no. 219).

The system should include the greatest possible number of regional trains operating on longer routes towards Braniewo, Działdowo, Elbląg, Elk (also via Kętrzyn, Mrągowo and Pisz), Iława and Ostrołęka, while shorter-distance trains should complement the transport offer closer to Olsztyn.

The assumed area of integrated rail transport in the Urban Functional Area of Olsztyn and its surroundings (analysed in the article) is shown in Fig. 1.

2.1. Framework for the timetable

The timetable for trains creating the system of connections being a part of the integrated public transport of the Urban Functional Area of Olsztyn should be characterised by:

- the regularity of regional train services, which excludes pauses of several hours in any particular direction,
- the cyclical nature (clock-face schedule) of regional trains' departures, characterised by the same minute endings of their departure times⁴,
- routing of regional trains in a way that minimises journey times,

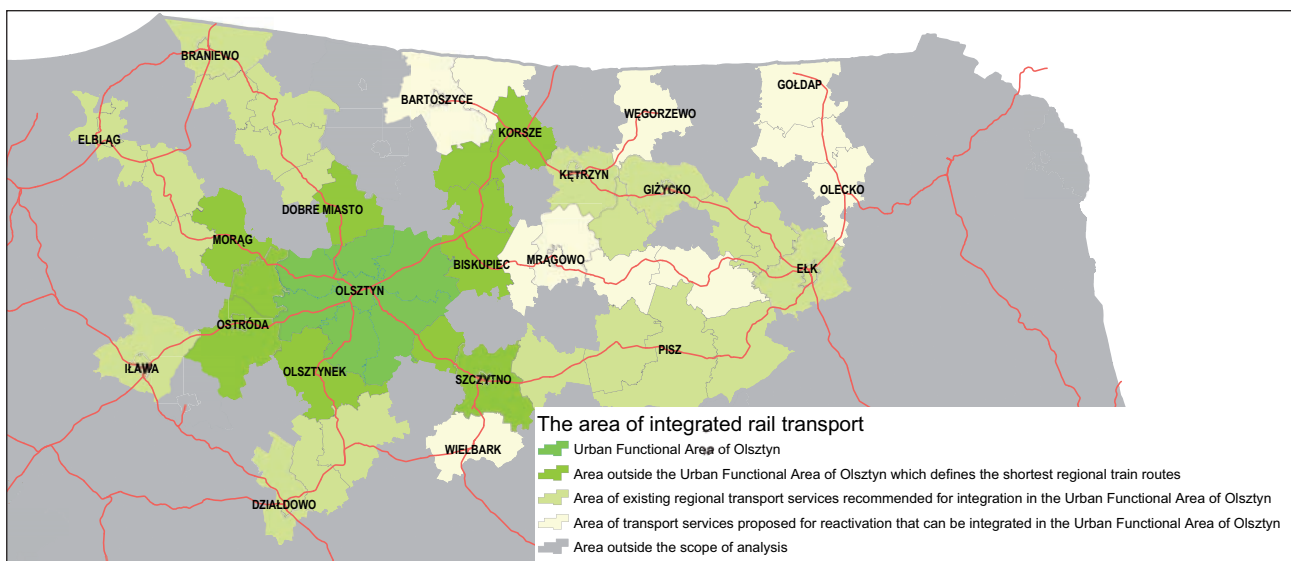


Fig. 1. The assumed area of integrated rail transport in the Urban Functional Area of Olsztyn and its surroundings [own study]

⁴ The principles of creating a cyclical timetable and the advantages of using this solution are described in the literature, e.g. in publications [3, 4].

- taking into account the needs related to commuting to places of work and study,
- routing of regional trains so that the cyclical timetable for long-distance trains can be implemented,
- as even as possible intervals between regional trains on the sections shared by the different routes (Olsztyn Gutkowo / Olsztyn Dajtki – Olsztyn Zachodni – Olsztyn Główny – Czerwotka),
- combining train routes in such a way as to allow direct connections from the direction of Korsze, Biskupiec Reszelski and Szczytno to the Olsztyn Śródmieście and Olsztyn Zachodni passenger stops and vice versa, or connecting westbound and eastbound trains as far as possible at Olsztyn Główny station (in a symmetrical manner),
- leaving a capacity reserve for freight traffic.

A train every 2 hours is proposed as the base frequency of regional trains in the Urban Functional Area of Olsztyn for each direction, with an increase in frequency to 1 hour in peak hours (at least 10 pairs of trains per day). The regional trains operating on longer routes included in this figure should run every 2 or 4 hours, depending on the needs and financial capabilities of the transport organiser (in this case the Marshall of the Voivodeship). The train traffic diagram should be designed in such a way that it is possible to increase the number of trains without having to revise the whole timetable, simply adding an additional route instead (in place of the one previously provided for in the traffic diagram, resulting from the adopted clock-face schedule).

In the target scenario, which would correspond to the model transport system, the frequency of trains in each direction in the Urban Functional Area of Olsztyn should not be less than 1 every 1 hour throughout the day, while in the case of sections extending outside the Urban Functional Area it should not be less than 1 every 2 hours, with additions during peak hours to adapt the transport offer to local needs.

The long-distance train offer should be adopted on the basis of the national transport plan [5], with a cycle time of 2 or 4 hours.

Due to the technical conditions of railway traffic, which have an impact on the transport offer, and in particular the traffic limitations on single-track lines, the considerations concerning the timetable were carried out for the area limited by Braniewo, Działdowo, Elbląg, Elk and Iława Główna stations, i.e. wider than the Urban Functional Area of Olsztyn.

It should be noted that the purpose of this article is not so much to determine the optimum transport offer in each direction (which requires more advanced analyses), but to show the possibility of scheduling trains in a cyclic manner and to propose a practical approach to timetable design. At this stage, regarding

the transport offer, it should be maintained that it needs to be tailored to the transport demand on the individual lines, and it must at least ensure the fulfilment of basic life activities so that rail transport can be used as the primary means of transport. This is mentioned, among others, in the article [1], where, on the basis of German experiences, 10 pairs of trains per day are indicated as the minimum rational offer for regional traffic, as well as in the paper [2].

2.2. Feasibility of implementing the proposed timetable using the existing infrastructure

In order to explore the possibilities of using the existing rail infrastructure and identify its bottlenecks in the context of providing expanded regional transport services on the analysed line sections, a model timetable was constructed for each of the lines, taking into account the assumptions outlined in point 2.1. As a general rule, actual train running times were adopted, based on the 2021/2022 timetable, while a simplified calculation method was used for sections that required recalculation (e.g. those where services are not currently provided). This method involves calculating the travel time assuming that the motion of the train is uniform rectilinear or uniformly accelerated rectilinear and that the train is a material point. The infrastructure parameters were adopted according to the existing conditions, which are described in the article [1].

The model timetable was created for: section of line no. 38 Korsze – Elk, section of line no. 204 Elbląg – Bogaczewo, line no. 216 Olsztyn Gł. – Działdowo, line no. 219 Olsztyn Gł. – Szczytno – Elk, line no. 220 Olsztyn Gł. – Bogaczewo, line no. 221 Olsztyn Gutkowo – Braniewo, section of line no. 223 Czerwona – Biskupiec Reszelski and section of line no. 353 Iława Gł. – Olsztyn Gł. – Korsze. Conclusions from the development of a model timetable for the individual directions converging at the Olsztyn junction are presented in the following section.

Olsztyn Gł. – Ostróda – Iława Gł.

The fact that railway line no. 353 is a double-track line should facilitate the organisation of regional and long-distance train traffic with high frequency and on a clock-face schedule. The main problem in this situation is the difference in run times between the two categories of trains (due to the number of stops and the scheduled speed), which may result in trains having to overtake slower trains at one of the intermediate stations of the section. The passenger train being overtaken should be put on the track (preferably the main line other than the running line) at the platform edge to allow the fast train to pass on the running line. Unfortunately, the track layouts at Stare Jabłonki,

Biesal and Rudzienice Suskie stations are not suitable for such overtaking. It is only possible at Naterki, Ostróda and Samborowo stations. Furthermore, as railway line no. 353 is not equipped with an automatic block system and the sections are not divided into blocks, the overtaking operation requires a significant increase in the running time of the passenger train. The duration of this stop will include the time taken by the long-distance train to travel from the station behind the stopping point of the passenger train to the station ahead of it, together with the time taken to prepare and arrange suitable running routes. In practice, the construction of a timetable that involves overtaking should be avoided in this case.

On the basis of the constructed timetable, it can be stated that it is possible to schedule regional and long-distance trains at 1-hour intervals, on the condition that from Iława Gł. or Olsztyn Gł. station a slower train must depart just after a faster one (after clearing the track). A second way to schedule trains is to assume that a faster train will “catch up” with a slower train at a junction in Iława or Olsztyn. In addition, on the Olsztyn Gł. – Ostróda section, it would be possible to increase the frequency of regional trains to every 30 minutes, resulting in a rigid route pattern on the traffic diagram (particularly on the Olsztyn Gł. – Olsztyn Kortowo section), prone to secondary delays.

Despite the problems presented, it should be concluded that for the section Olsztyn Gł. – Iława Gł. it

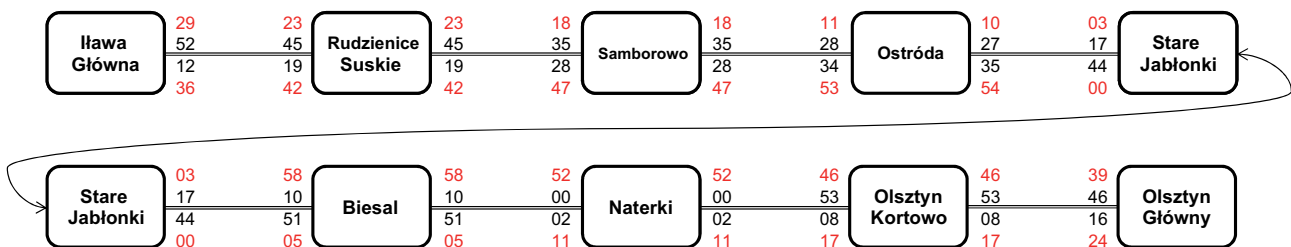
is possible to create a model transport offer which is consistent with the adopted assumptions without undertaking additional investment activities (Fig. 2). The legend for Figure 2 also applies to the following figures.

Olsztyn Gł. – Korsze – Kętrzyn – Ełk i Olsztyn Gł. – Biskupiec Resz.

The analysed section of the railway network comprises a double-track section of line no. 353 (Olsztyn Gł. – Korsze) and a single-track section of line no. 38 (Korsze – Ełk). In the construction of the timetable for the Olsztyn Gł. – Korsze – Kętrzyn – Ełk section it was decided that slower passenger trains (regional) will not be overtaken by faster trains (long-distance) due to the significant increase in journey time, as shown on the example of the line to Iława.

In the situation of train crossing on a single-track section, it is preferable that a train running without a commercial stop at a station passes through it without stopping. In certain situations, an additional stop of a train is needed to match the clock-face schedule or to increase the capacity of the line.

On the double-track Olsztyn Gł. – Korsze section, the distribution of the stations is sufficient to schedule the assumed number of trains at cyclical intervals. The constraints that may arise here are rather due to the assumed need for connecting trains at Olsztyn Gł. station and the need for train crossing on the Korsze



Legend for the graphical timetable

- 02 a minute of arrival / departure in a hourly cycle
- (02) a minute of arrival / departure in a 2-hour cycle in even hours
- /02/ a minute of arrival / departure in a 2-hour cycle in odd hours
- ((02)) a minute of arrival / departure in a 4-hour cycle in even hours
- //02// a minute of arrival / departure in a 4-hour cycle in odd hours

Minutes described above and below the line symbolizing the railway line refer to different directions of traffic

Fast (intercity) trains are marked in red

- station / passing point with train crossing at least every hour
- station / passing point with train crossing less often than every hour
- station / passing point without train crossing

Fig. 2. Train timetable diagram for Olsztyn Gł. – Iława Gł. section [Fig. S. Klemba]

– Elk section, which makes the train route layout more rigid along the entire section under consideration.

A cyclical timetable was constructed for the single-track Korsze – Elk section, with regional trains running at 2-hour intervals and long-distance trains at 4-hour intervals. The timetable constructed in this way involves trains crossing each other at all stations except Giżycko station.

With such a route layout, it would also be possible to run regional trains from Olsztyn to Kętrzyn at 1-hour intervals in the event of further transport offer development. Increasing the frequency of regional trains from 1 every 2 hours to 1 every 1 hour is possible on the whole Korsze – Elk section, except for times conflicting with long-distance connections – with crossings at Kętrzyn, Giżycko and Stare Juchy stations, as shown in Figure 3.

The authors also assume that it is reasonable to resume train services on at least part of line no. 223, but the possibility of convenient routing of such services may be adversely affected by the excessively long Barczewo – Czerwonka section (limited choice of running times). Trains running on line no. 223 are not shown in Figure 3.

In addition, the possibility of constructing the schedule is adversely affected by the lack of station or passing point between Stare Juchy and Elk (i.e. on a length of almost 20 km), which makes it impossible

to organise crossing of trains close to the railway junction. The disadvantages of the prepared timetable include a 9-minute stop for each long-distance train at Kętrzyn station in both directions and a technical stop due to crossing with a regional train at Tolkiny station (in both directions).

Due to the ongoing modernisation of line no. 38 together with its electrification, the assumptions presented in this chapter are likely to change in the future.

Olsztyn – Szczytno – Elk

As railway line no. 219 is a single-track line for the entire section, fixed train crossing locations must be chosen when constructing the cyclical timetable. In the case of this line – according to the transport plan [5] – no daily and year-round long-distance trains were included, which makes it possible to construct a parallel traffic diagram (i.e. one where all trains have the same speed, as well as the same run time on each route).

In the case of a transport offer that assumes a cycle time of 1 hour on the Olsztyn – Szczytno section and 2 hours on the Szczytno – Elk section during peak hours, the train crossing points are Marcinkowo, Szczytno, Spychowo and Drygały stations and passing points (Fig. 4).

It was concluded that the current distribution of stations or passing points and the technical condition of the line allows regional trains to run at 1-hour

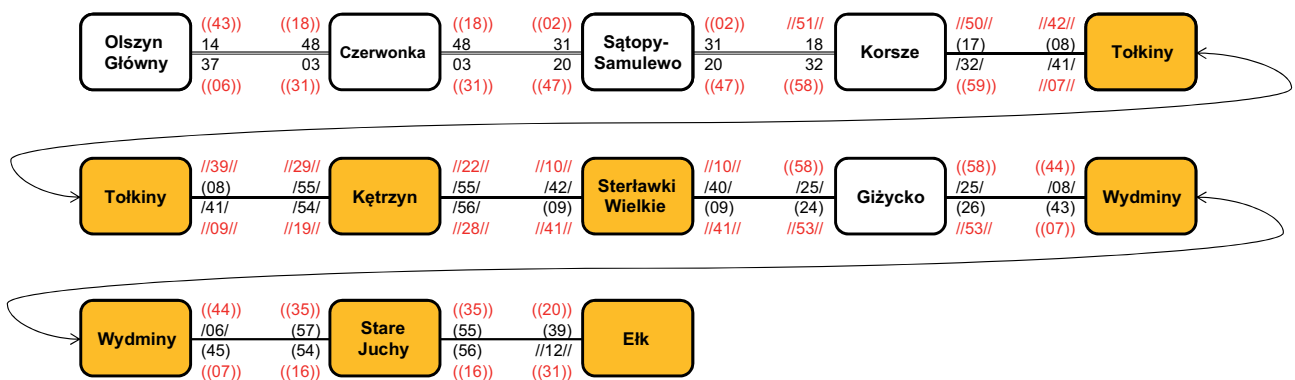


Fig. 3. Train timetable diagram for the Olsztyn Główny – Korsze – Elk section [Fig. S. Klemba]

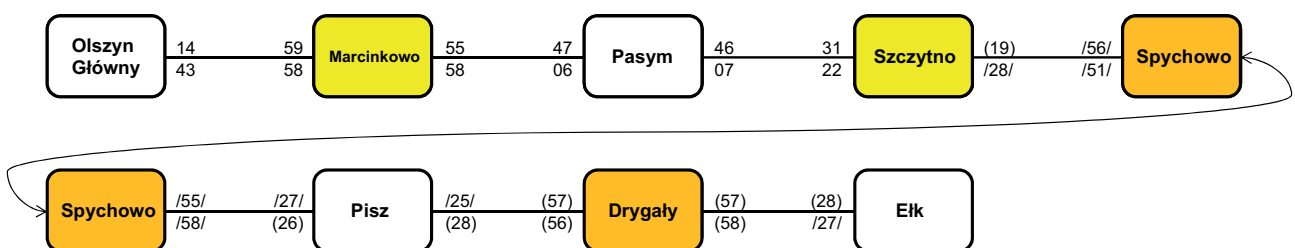


Fig. 4. Train timetable diagram for Olsztyn Gł. – Pisz – Elk [Fig. S. Klemba]

intervals along the entire section, assuming extended stops at selected stations. The layout of the routes in the traffic diagram is rigid and the departure times from Olsztyn Główny are closely linked to the arrival times, which can make it difficult to organise connections. Assuming a cycle time of 1 hour, trains can only cross at Marcinkowo, as this is the first station from Olsztyn Gł. station, and the run time on the Olsztyn Gł. – Pasy section clearly exceeds 30 minutes. It is also not possible (but potentially needed) to increase the frequency of regional trains between Olsztyn and Szczytno to 1 every 30 minutes, and running an additional train “outside” of the clock-face schedule would entail a considerable increase in its run time.

Despite the problems, it can be concluded that, with the current state of the infrastructure, it is possible to construct the proposed cyclical regional train timetable. In addition, assuming a limited number of trains of this category (not more frequent than 1 every 4 hours, i.e. about 5 pairs per day) on the Szczytno – Elk section, it would also be possible to run long-distance trains. The adopted route layout also makes it possible (if necessary) to connect Olsztyn-Mazury Airport by extending train connections from Szczytno, but due to the rather limited and variable flight offer, implementing a regular timetable and appropriate connecting times may be difficult in practice.

Olsztyn Gł. – Elbląg/Braniewo

The routing of regional trains from Olsztyn towards Elbląg and Braniewo is interdependent due to the common, and in addition single-track, section of railway line no. 220 Olsztyn Gł. – Olsztyn Gutkowo, used by trains running both routes. An additional complication is that railway lines no. 220 and 221 are single-track lines along their entire length. For these reasons, a separate analysis was first conducted for the Olsztyn Gł. – Olsztyn Gutkowo section and then for further sections of both lines. When designing the timetable for the Olsztyn Gł. – Olsztyn Gutkowo section, it is also necessary to take into account the distribution of stations or passing points on sections of lines no. 220 and 221 in the direction of Elbląg and Braniewo. The route layout on this section should be designed so as to allow trains to cross as seamlessly as possible on the further sections, while maintaining the framework assumptions for the timetable.

Olsztyn Gł. – Olsztyn Gutkowo

The bottleneck for rail traffic is the Olsztyn Gł. – Olsztyn Likusy section, which is 4.3 km long. Due to stops at the Olsztyn Śródmieście and Olsztyn Zachodni passenger stops, the run time for a regional train is approximately 7 minutes. The run time of a long-distance train is similar. Taking into account railway traffic technology, it must be assumed that in practice

it will be possible to run a maximum of 3 pairs of trains (including one long-distance train) per hour on this route, assuming an average of 20 minutes per pair of trains and a reserve necessary to run the trains smoothly and reduce any potential minor delays. In this situation, it was assumed that there would be one pair of regional trains running in the direction of Morąg (Elbląg) and Dobre Miasto (Braniewo) and one pair of long-distance trains per hour (according to the transport plan [5], long-distance trains are to run only in the direction of Elbląg). If a long-distance train runs every 2 hours, there will be the possibility of a freight train being scheduled for this section. The developed route layout for the Olsztyn Główny – Olsztyn Gutkowo section is shown in Figures 5 and 6.

Olsztyn Gutkowo – Elbląg

The analysed section of the railway network comprises the single-track Olsztyn Gutkowo – Bogaczewo section of railway line no. 220 and the double-track Bogaczewo – Elbląg section of railway line no. 204. Taking into account the previously discussed conditions resulting from traffic on the Olsztyn Główny – Olsztyn Gutkowo section, regional train traffic was scheduled at 1-hour intervals, and long-distance trains at 2-hour intervals. It turned out that in practice this volume of traffic exhausts the capacity of the Olsztyn Gutkowo – Gamerki Wielkie section, where, due to the nearly 20-minute run time of a regional train and the approximately 15-minute run time of a long-distance train, it is possible to run 1.5 pairs of trains (three trains in total in both directions) per hour – it is the longest section on railway line no. 220 (about 19 km). In practice, the section determines the entire timetable concept for the Morąg (Elbląg) and Dobre Miasto (Braniewo) directions. The second longest section, Małdyty – Pasłek (approximately 18 km), similarly limits the capacity of the line.

Finally it can be concluded that with the existing infrastructure it is possible to construct the proposed transport offer in the form of regional trains running at 2 hour intervals (on the Olsztyn – Morąg section it is 1 hour intervals during peak hours) and long-distance trains running at 2 hour intervals (Figure 5), but this creates a rigid system of train routes on the diagram. A disadvantage of the timetable are the technical stops of long-distance trains at Małdyty station and at the Żabi Róg passing point (necessary crossings). In addition, due to the lack of a block post between Bogaczewo and Elbląg stations, a short stop is foreseen for a long-distance train at Bogaczewo station in order to wait for a regional train ahead to clear the track. It is also not possible to increase the frequency of regional trains on the Morąg – Elbląg section (i.e. to lengthen the Olsztyn – Morąg connection and introduce a cyclical timetable with 1-hour

intervals on the entire Olsztyn – Elbląg line). Any expansion of the transport offer would require not only an improvement in capacity on the two above mentioned sections, but also on the Olsztyn Gutkowo – Olsztyn Główny section.

Olsztyn Gutkowo – Dobre Miasto – Braniewo

Taking into account the conditions described for the Olsztyn Gutkowo – Elbląg section, a cyclical timetable for regional trains has been drawn up, according to which trains run to Dobre Miasto every 1 hour, and to Braniewo every 2 hours. Given the design status of the ongoing modernisation of railway line no. 221, there should be no problems in scheduling the proposed transport offer (Fig. 6). Crossing of trains from Olsztyn Gł. to Dobre Miasto (Braniewo) would take place at the Olsztyn Likusy passing point and at Dobre Miasto station. In addition, at Olsztyn Gutkowo station there would be crossings with trains from Elbląg direction. The proposed timetable assumes the possibility of increasing the frequency of trains to 1 every 1 hour also on the Dobre Miasto – Braniewo section with a crossing at Pieniężno station.

An identified problem may be the run time on the Dobre Miasto – Pieniężno section, which has

been estimated at 29 minutes. It does not provide any reserve in the context of the possible 1 hour intervals between trains. With the assumed departures every 2 hours, the travel time for the Dobre Miasto – Braniewo section, estimated at 54 minutes, poses no risk of failing to meet the timetable (no need for scheduled crossings of regional trains between Dobre Miasto and Braniewo).

However, any further increase in the frequency of trains (e.g. from Dobre Miasto to Olsztyn during the morning peak hour) will require an increase in the capacity of the Olsztyn Gutkowo – Olsztyn Gł. section.

Olsztyn Gł. – Olsztynek – Działdowo

The analysed section of the rail network includes the entire single-track line no. 216. As it is possible to switch to double-track line no. 353 at the Olsztyn Kortowo junction signal box, the Olsztyn Kortowo – Olsztyn Główny section can be considered as multi-track. The line is characterised by an uneven distribution of stations and passing points and sections lengths alternately of 10 and 16–19 km, which is unfavourable in terms of timetable design. In practice, creating a cyclical timetable has caused the most difficulties on this very line. An additional problem is the

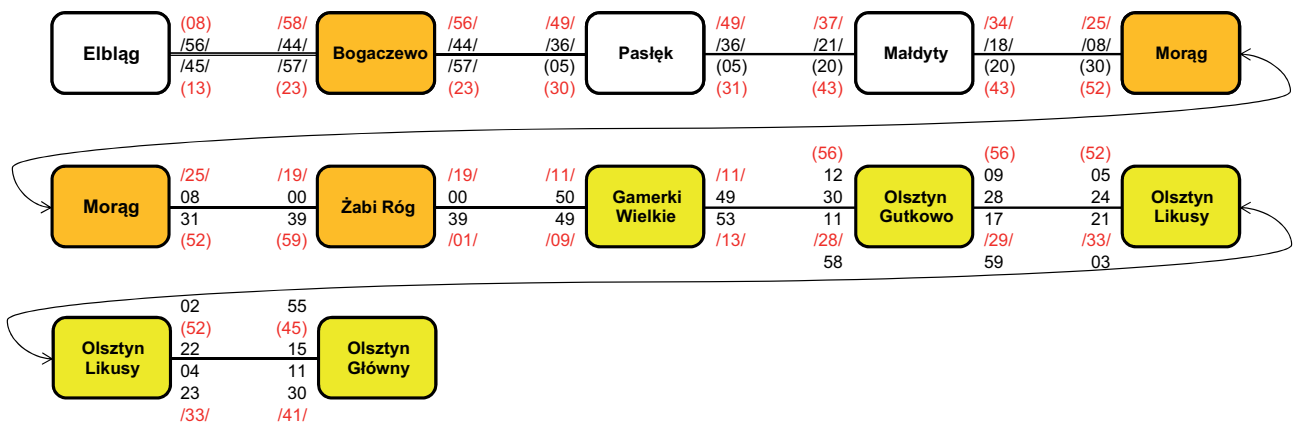


Fig. 5. Train timetable diagram for Olsztyn Gł. – Olsztyn Gutkowo – Elbląg [Fig. S. Klemba]

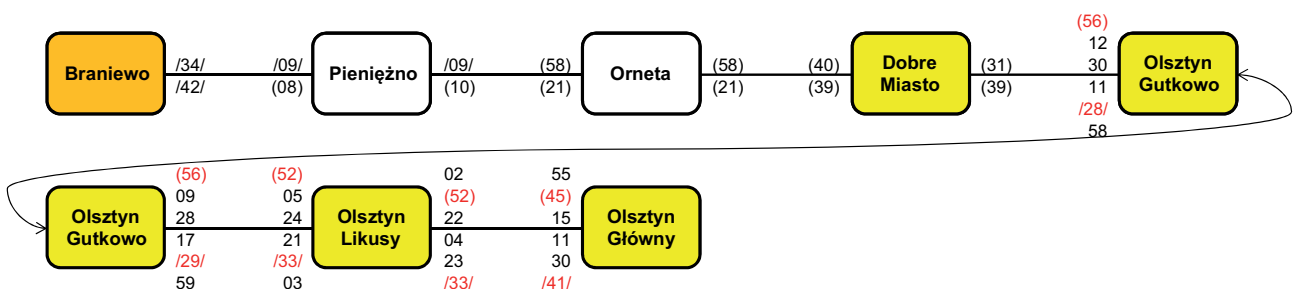


Fig. 6. Train timetable diagram for Olsztyn Gł. – Olsztyn Gutkowo – Braniewo [Fig. S. Klemba]

need to take into account the trains that run on line no. 353, especially in view of the need for the trains exiting or entering line no. 353 to stop at the Olsztyn Śródmieście station.

After many attempts, a cyclical timetable was constructed, taking into account the movement of regional trains from Olsztyn to Olsztyniek with a frequency of 1 hour, and from there with a frequency of 2 hours to Działdowo. At the same time, long-distance trains are scheduled to run at 2 hour intervals. It can be concluded that for the current state of the infrastructure it is possible to construct the proposed transport offer (Figure 7), but the prepared solution has certain disadvantages: the stopping time of long-distance trains at Olsztyniek station has been extended (up to 6–7 minutes depending on the direction), and these trains also have to have a technical stop at Waplewo (in one direction) due to crossing with regional trains. Regional trains also have extended (due to crossings) journey times. With the current distribution of stations and passing points, there is no possibility of implementing a cyclical timetable with a higher frequency than that assumed.

Traffic on the approach to Olsztyn Gł. station from the west side

The entrance of railway lines no. 216, 220 and 353 to Olsztyn Gł. station (from the west) needs to be discussed separately. What is characteristic of the existing layout is the fact that the single-track line no.

216 runs in parallel with the double-track line no. 353 from the Olsztyn Kortowo junction signal box, where it is possible to change tracks as required. Single-track railway line no. 220 also runs parallel from the Olsztyn Zachodni passenger stop. Between Olsztyn Gł. and Olsztyn Zachodni passenger stops, all four tracks (lines no. 216, 353 and 220) have no connection, which makes it impossible to use flexibly individual tracks and limits the capacity of line no. 220.

Figure 8 shows a diagram of the train timetable on the tracks adjacent to Olsztyn Główny station from the west, consistent with the previously presented timetables for each direction. The busiest track on line no. 220 is the one on which all trains run to and from Morąg (Elbląg) and Dobrze Miasto (Braniewo). Only regional trains are routed on the track assigned to line no. 216 because the platform of the Olsztyn Śródmieście stop is located there. Regional trains heading towards Iława were routed along line no. 353, i.e. bypassing the Olsztyn Śródmieście stop, due to a route collision with another train.

The layout of the train routes loads the individual tracks unevenly, and also results in 5 of the 8 trains having to run in the return direction at the Olsztyn Kortowo junction. It is not possible to change it due to traffic conditions on the other sections of the network under study, in particular the need for as many trains as possible to stop at the Olsztyn Śródmieście station (this is possible for 7 out of 8 trains).

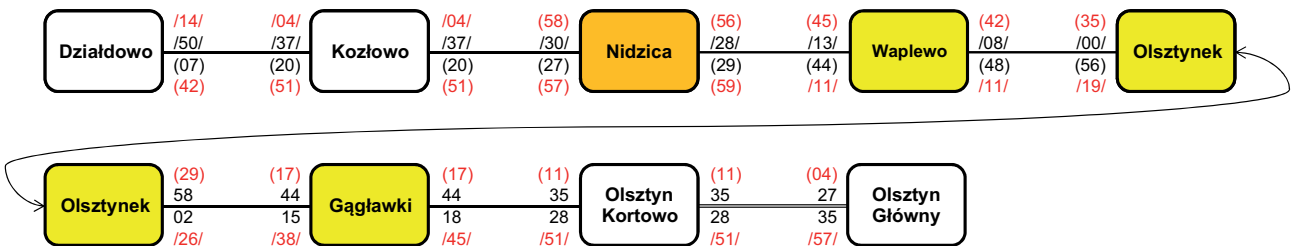


Fig. 7. Train timetable diagram for Olsztyn Gł. – Działdowo [Fig. S. Klemba]

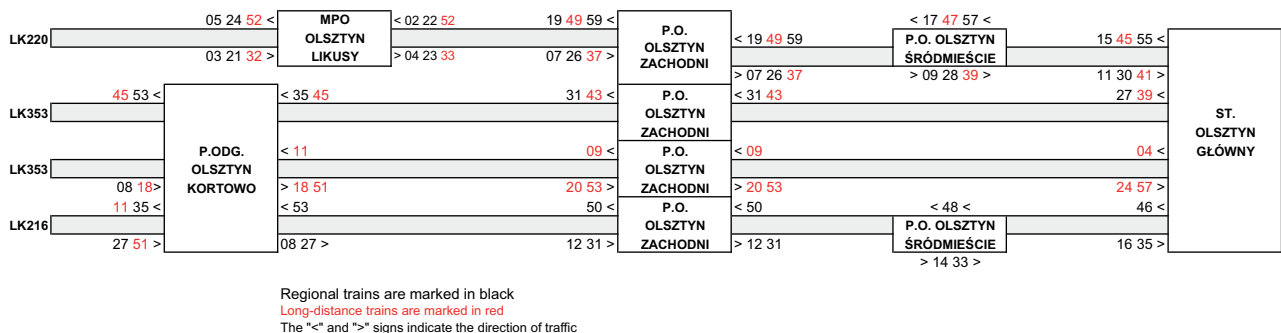


Fig. 8. Train timetable diagram for the Olsztyn Główny – Działdowo section [Fig. S. Klemba]

A key limitation for the track layout is that there is no possibility of exiting from line no. 220 onto line no. 353 in the vicinity of the Olsztyn Zachodni passenger stop when travelling in the direction of Olsztyn Główny, which would help to increase the capacity of the Olsztyn Gł. – Olsztyn Likusy section. In addition, due to the need to stop at the Olsztyn Śródmieście passenger stop, there is no connection allowing exiting from the line no. 220 onto line no. 353 after this stop when running from the direction of Olsztyn Gł. station towards Iława Gł.

3. Possibilities of increasing the accessibility of the regional railway in the Urban Functional Area of Olsztyn through integration with bus transport

As mentioned in the article [1], from 2021 onwards – after long years of total or partial transport exclusion, a positive trend can be observed in district and municipal public transport around Olsztyn. At present, all municipalities in the Urban Functional Area of Olsztyn have regular bus transport services, organised either independently by the individual municipalities (Jonkowo, Gietrzwałd – Figure 9, Stawiguda, Barczewo, Dywity) or by the Olsztyn district (Purda). Although in most cases the transport offer is quite poor and characterised by considerable variability (new solutions need to be tested in practice), it provides a basis for taking further steps towards building a sustainable public transport system, the structure of which, in the authors' opinion, should also include regional rail transport. For this to happen, action is needed to integrate rail and bus services more closely, both in terms of infrastructure and organisation. Among other things, there is a need to improve the conditions for transfers between buses and trains and to coordinate their timetables (the current bus services are not connected to the railway).



Fig. 9. The Gietrzwałd Municipal Public Transport bus line no. 534 during a stop at Dajtki bus terminus in Olsztyn [photo A. Dąbrowski]

3.1. General characteristics of the transport network and demographic conditions of the Urban Functional Area of Olsztyn

The layout of the railway network in the Urban Functional Area of Olsztyn fits quite well with the existing third-level administrative division, i.e. all municipalities neighbouring Olsztyn (a city with district rights), with the exception of the municipality of Dywity, have a railway line running centrally through their area from/to Olsztyn, which may be the main or one of the main axes of the public transport system providing a connection to the voivodeship city. In the municipality of Jonkowo this is a line no. 220 (direction Morąg), in the municipality of Gietrzwałd – no. 353 (Ostróda), in the municipality of Stawiguda – no. 216 (Olsztynek), in the municipality of Purda – no. 219 (Szczytno), and in the municipality of Barczewo – no. 353 (Korsze and Biskupiec Reszel). The municipality of Dywity is the only one with an extremely unfavourable location in relation to the railway network, as it has only a peripheral passenger stop Bukwałd on line no. 221 (direction Dobre Miasto), so the axis of the target public transport system there will remain national road no. 51, especially after it is relieved of through traffic following the construction of the planned northern bypass of Olsztyn.

Regional rail can gain a stronger position in daily transport to/from Olsztyn where there is less pressure from road transport. This is particularly the case in the municipality of Jonkowo (peripheral course and rather poor performance of voivodeship road no. 527) and part of the municipality of Purda. In other cases, road transport is better developed and therefore a split of the catchment areas between rail and bus service should be assumed.

In terms of demographics, the municipality of Dywity has the highest population density, excluding the municipality of Olsztyn, while the municipality of Purda has the lowest (but also unevenly distributed). The characteristics of the demographic potential and the number of railway operating points for passenger boarding in the area of the city of Olsztyn and neighbouring municipalities are shown in Table 1.

3.2. Possible infrastructural and organisational measures for integrating rail and bus passenger transport in the Urban Functional Area of Olsztyn

Possible infrastructural and organisational measures for the integration of rail and bus passenger transport in the Urban Functional Area of Olsztyn (referring to all rail operating points of the Urban Functional Area of Olsztyn with the exception of the

Table 1

Basic demographic data of the Urban Functional Area of Olsztyn and the number of railway operating points for passenger boarding [6]

LGU	Area [km ²]	Population	Population density in LGU [number of persons/km ²]	Number of operating points for passenger boarding
City of Olsztyn	88.3	169,793	1,922	8
municipality of Dywity	161.2	12,579	78	1
municipality of Barczewo	320.0	18,198	57	3 1 under construction
municipality of Stawiguda	222.9	11,705	53	4
municipality of Jonkowo	168.7	7,561	45	4
municipality of Gietrzwałd	172.3	6,754	39	3
municipality of Purda	318.1	8,797	28	2

Olsztyn Zachodni and Olsztyn Śródmieście passenger stops located in the city centre and the Olsztyn Główny station), are shown in Table 2. Proposals for infrastructure measures include the creation of integrated interchange nodes (ZWP), as well as smaller interchange points. For this purpose it is also proposed to change locations and names of bus stops, to improve access and to provide adequate infrastructure for private transport (construction of P&R car parks, K&R points and B&R bike parkings). Proposals for organisational measures mainly concern the reorganisation of the current bus network layout or the launch of new bus lines that increase the accessibility of the rail infrastructure.

The proposals for measures regarding the city of Olsztyn and the neighbouring municipalities presented in Table 2 are summarised in the following paragraphs. These should only be regarded as an initial „catalogue of possibilities” to serve as a basis for further consideration. The validity of these measures cannot be analysed in isolation from the overall vision of the transport network of the Urban Functional Area of Olsztyn, or at least of a given municipality. The next step should be to test the proposed solutions using advanced analytical methods, such as computer modelling.

Municipality of Jonkowo

The village of Jonkowo lies in the eastern part of the municipality (closer to Olsztyn), having direct access to the railway line no. 220, but not to the voivodeship road no. 527. This location creates the conditions for the construction of a public transport system based on an integrated interchange node at the Jonkowo railway station, enabling convenient transfers from the radially converging municipal public transport (GKP) bus lines to regional trains in the direction of Olsztyn and vice versa. Consequently, the GKP bus

routes should cover the municipality’s area only (and furthest to the ZWP Gutkowo Stacja in Olsztyn), while traffic to and from the centre of Olsztyn should be taken over by regional rail transport.

Complementary train connections with GKP buses can be implemented in Wołowno and Gamerki Wielkie. In addition, all passenger stations and stops should be provided with P&R and B&R infrastructure.

Municipality of Gietrzwałd

The village of Gietrzwałd lies away from the railway network, but next to national road no. 16, which provides a convenient connection with Olsztyn. Biesal and Naterki railway stations and Unieszewo passenger stop may serve as interchange points, covering selected parts of the municipality area (mainly located south of railway line no. 353). For this to happen, it is necessary to improve the location of bus stops in relation to the platforms (making transfers as convenient as possible). The potential of Naterki station to serve as an interchange point could also be increased by extending S-3 line (GKP Stawiguda) from its current Tomaszkowo – Wulpińska Pętla bus terminus to the new Naterki Stacja bus stop, but this would require cooperation between the municipalities of Gietrzwałd and Stawiguda.

Municipality of Stawiguda

The village of Stawiguda has access to railway line no. 216 and the S51 expressway. While the both mentioned above provide convenient connections with Olsztyn, the proposed public transport measures envisage a dominant role for rail transport in accessing the voivodeship city. The existing bus line no. 129 should be closed or possibly limited only to times of the day when regional trains don’t run.

The passenger stops of Stawiguda and Bartąg, having greater commercial potential due to the current

(Stawiguda) and potential (Bartąg) population size in the catchment area, may become integrated interchanges in the future. The potential of the Gryźliny stop is somewhat smaller, although especially in high season it can play a role in supporting recreational traffic (e.g. providing transport to Gryźliny airport and the village of Zielonowo). The commercial role of the Gaławki passing point, due to its location in an undeveloped area, is limited, but it performs an important function in the management of rail traffic on line no. 216.

Municipality of Purda

The village of Purda lies approximately 4 km from the railway station in Marcinkowo, away from the national and voivodeship road network. For this reason, the creation of an integrated interchange node at Marcinkowo station was one of the proposed measures. Provided that bus and train services are properly integrated, Marcinkowo station would enable transport from the Purda and Marcinkowo areas to Olsztyn and back to be carried out by trains, with a reduction of about 15 minutes in total travel time (currently the journey from Purda to Olsztyn by PKZ bus theoretically takes about 3–40 minutes). The role of an interchange point is also planned for the passenger stop in Klewki, wherein a strong alternative is direct access to Olsztyn via national road no. 53.

Municipality of Barczewo

The town of Barczewo lies in the centre of the municipality and has access to railway line no. 353 and national road no. 16, with the accessibility of road no. 16 being greater than that of the railway station, which is located slightly to the side. Nevertheless, it has been suggested that an integrated interchange node should be created at the railway station, which would act as an intermediate stop on the way to Barczewo for bus lines from the direction of Biskupiec or Jeziorany, and as a terminus for the other directions for bus lines extended from Barczewo (organised by both the Olsztyn Road, Greenery and Transport Authority (ZDZiT) and the municipality). Such a solution would preserve the convenient transport conditions in the centre of Barczewo and, at the same time, greatly improve the accessibility of the railway station where regional and – very importantly – long-distance trains stop! The passenger stops of Nikielkowo (under construction) and Wipsowo, as well as Łęgajny station, can serve as interchange points for parts of the municipality (mainly located near or north of railway line no. 353). For this to happen, it is necessary to improve the location of the bus stops in relation to the platforms and, perhaps, to launch a new municipal feeder bus line, e.g. along the route ZWP Barczewo Stacja – Barczewo Pętla – Biedowo

– Barczewko – Łęgajny Stacja – Nikielkowo Stacja – Wójtowo, well connected with rail services to and from Olsztyn. It is also necessary to synchronise the timetable of the ZDZiT buses on lines no. 114 and 124 and trains in such a way that train and bus connections complement each other and can be used interchangeably by travellers within a single ticket offer, which would also encourage them to switch from private transport.

Municipality of Dywity

The location of the village of Dywity in the southern part of the municipality (closer to Olsztyn), with access to national road no. 51, makes it well suited to the role of a municipal interchange node connecting the municipal (GKP) and suburban (ZDZiT) bus lines. The role of rail transport in the municipality, due to the remoteness of railway line no. 221, is significantly limited. The railway may be the fastest and most convenient way to get to the centre of Olsztyn for the residents of Bukwałd and Barkweda, but this requires an improvement in the conditions of bus and train connections at the Bukwałd passenger stop (currently undergoing modernisation).

District City of Olsztyn

In the case of the City of Olsztyn, the greatest interchange potential for transport to and from the centre can currently be found at Olsztyn Gutkowo station, where it has been proposed to create an integrated interchange node (Łupstych and Gutkowo estates, the villages of Gutkowo, Wilimowo, Mątki and Warkały), also provided with P&R car park and B&R bike parking. In order to increase the catchment area of the ZWP Gutkowo Stacja, consideration should be given to running a local bus line from the Łupstych estate (intensively developing area). Transfers from a bus or car (K&R) to a train and vice versa can also be done at the Olsztyn Redykajny passenger stop (on the Redykajny – Śródmieście route).

Due to its characteristic location in a narrow strip of land between lakes and forest, the Olsztyn Likusy passenger stop and the Olsztyn Jezioro Ukiel passenger stop fulfil local functions and in their catchment areas are accessible within a few minutes on foot or by bicycle. Consequently, only K&R and B&R infrastructure has been proposed for them.

The Olsztyn Dajtki passenger stop, located on the outskirts of a large single-family housing estate, is also of local significance. Improving the accessibility of this stop would be justified, particularly as a means of facilitating travel to/from Ostróda and Olsztynek, but given the current road and transport system this is quite a challenging issue, requiring a separate study. At the moment, only the construction of K&R and B&R infrastructure is indicated in Table 2.

Table 2
Analysis of infrastructural and organisational measures to integrate rail transport into the transport network of the Urban Functional Area of Olsztyn

Railway	Bus	Infrastructural measures for consideration	Organisational measures for consideration
		Municipality of Jonkowo	
Jonkowo PO*/220	Jonkowo Lipowa (300 m) [J-3]	Conversion of the passenger stop to a passing point or station with relocation of the platform to ul. Lipowa (*). Creation of the ZWP Jonkowo Stacja integrated interchange node . Construction of P&R and B&R parkings.	Reorganisation of the layout of the GKP bus network so that its main interchange becomes ZWP Jonkowo Stacja (while still providing transport to the centre of Jonkowo). Limitation of the GKP network to the municipality area only (and furthest to the ZWP Gutkowo Stacja in Olsztyn), taking over the transport to/from the center of Olsztyn by the railway.
Godki PO/220	Godki (600 m) [J-1, J-2]	Construction of P&R and B&R parkings (including improved access from Godki and Porbody villages).	-
Wolowno PO/220	Wolowno (350 m) [J-4]	Launching of the Wolowno Stacja bus stop next to the level crossing and of a path from the crossing to the platform (or eventually moving the platform to the level crossing). Construction of P&R and B&R parkings.	Integration of the GKP train and bus timetables to the extent that they complement the functions fulfilled by ZWP Jonkowo Stacja.
Gamerki Wilk. MPO/220	Gamerki Wilk. (same location) [J-5]	Construction of P&R and B&R parkings.	
		Municipality of Gietrzwałd	
Biesal ST/353	Biesal Stacja (350 m) [584, 585, 586]	Launching of the Biesal Stacja bus stop in the vicinity of the railway station (with renaming of the existing Biesal Stacja stop to Biesal Przejazd). Construction of P&R and B&R parkings.	Integration of the Biesal Stacja stop into the GKP network with integration of train and bus timetables for the approximate catchment area: Biesal, Tomaryny, Śródka, Guzowy Piec, Parwólki, Jadaminy.
Unieszewo PO/353	Unieszewo Ceram. (350 m) [534, 583]	Launching of the Unieszewo Stacja bus stop in the vicinity of the railway station. Construction of P&R and B&R parkings.	Integration of the Unieszewo Stacja stop into the GKP network with integration of train and bus timetables for the approximate catchment area: Unieszewo, Pęglity, Łajsy.
Naterki ST/353	Naterki Diam. II (600 m) [534]	Launching of the Naterki Stacja bus stop near the intersection of Rubinowa and Dionizosa Streets and a proper access path from the stop to the platform. Construction of P&R and B&R parkings with road access.	Integration of the Naterki Stacja stop into the GKP network with integration of train and bus timetables for the approximate catchment area: Sząbruk, Gronity, Naterki. Extension of S-3 line from the existing Tomaszkowo – Wulpińska Pętla bus terminus to the Naterki Stacja stop (connection organised in cooperation with Stawiguda and Gietrzwałd municipalities).
		Municipality of Stawiguda	
Gryźliny PO/216	Gryźliny Szkoła (800 m) [129] [S-5]	Launching of the Gryźliny Stacja bus stop near the platform entrance (ul. Krótka). Construction of P&R and B&R parkings.	Correcting S-5 line's route by changing its terminal stop Gryźliny Pętla to Gryźliny Stacja with the possibility of a variant extension to the airport and Zielonowo village. Integration of train and bus timetables for the approximate catchment area: Gryźliny, Zielonowo. Complete elimination or reduction of services on bus line no. 129.

Railway	Bus	Infrastructural measures for consideration	Organisational measures for consideration
Stawiguda PO/216	Stawiguda Stacja (150 m) [S-4]	Relocation of the Stawiguda Stacja bus stop to the immediate vicinity of the platform entrance (e.g. at ul. Kolejowa) with a view to further developing the ZWP Stawiguda Stacja integrated interchange node. Construction of P&R and B&R parkings.	Integration of train and bus timetables for the approximate catchment area: Rybaki, Pluski, Stawiguda. Complete elimination or reduction (while simultaneously changing the route to run through ZWP Stawiguda Stacja) of the services on bus line no. 129.
Gąglawki MPO/216	Gąglawki Stacja (same location) [S-5]	Construction of P&R and B&R parkings.	Integration of train and bus timetables for the approximate catchment area: Gąglawki.
Bartąg PO/216	Bartąg Stacja (150 m) [S-2]	Construction of P&R and B&R parkings. In the near future, due to urban development in the Bartąg area, there may be a need for an integrated interchange node at ZWP Bartąg Stacja .	Integration of train and bus timetables for the approximate catchment area: Bartąg, Ruś, Bartąg.
		Municipality of Purda	
Klewki PO/219	Klewki Wieś (400 m) [105] [573, 576]	Launching of the Klewki Stacja bus stop near the platform entrance. Construction of P&R and B&R parkings.	Integration of the Klewki Stacja stop into the PKZ and ZDZiT network with integration of train and bus timetables for the approximate catchment area: Trękus, Wojtkowizna, Klewki, Szcześnie, Stary Olsztyn, Linowo, Trękus, Bruchwałd, Wygoda, Kaborno.
Marcinkowo ST/219	Marcinkowo Stacja (same location) [573]	Creation of an integrated interchange, ZWP Marcinkowo Stacja , primarily to ensure Purda has access to transport services. Construction of P&R and B&R parkings.	Integration of train and bus timetables for the approximate catchment area: Purda, Wyrandy, Marcinkowo, Purda Leśna, Purdka.
		Municipality of Barczewo	
Nikielkowo* PO/353	Nikielkowo (350 m) [124]	Nikielkowo passenger stop is under construction (*). Nikielkowo Stacja bus stop and P&R and B&R parkings are proposed to be built next to the entrance to the platform.	Integration of the Nikielkowo Stacja stop into the ZDZiT and GKP networks (launch of a feeder line from the direction of Wójtowo). Integration of train and bus timetables for the approximate catchment area: Nikielkowo, Wójtowo.
Łęgajny ST/353	Łęgajny Kaszt. (200 m) [124]	Launching of the Łęgajny Stacja bus stop in the vicinity of the railway station (replacing the current Łęgajny Kasztanowa stop). Construction of P&R and B&R parkings.	Integration of the Łęgajny Stacja stop into the ZDZiT and GKP networks (launch of a feeder line from the direction of Barczewko). Integration of train and bus timetables for the approximate catchment area: Barczewko, Łęgajny.
Barczewo ST/353	Barczewo (600 m) [114, 124] Ruszejny Kolonia (500 m) [B-4]	Creation of the ZWP Barczewo Stacja integrated interchange node . ZWP Barczewo Stacja can also act as an interchange point for regional travel, e.g. on the route Jeziorany – ZWP Barczewo – Olsztyn. Construction of P&R and B&R parkings.	Reorganisation of the layout of the ZDZiT and GKP bus network so that the main point of the network becomes ZWP Barczewo Stacja (while still providing transport to the centre of Barczewo). Synchronisation of train and bus timetables for lines no. 114 and 124.
Wipsowo PO/353	Wipsowo Wieś (300 m) [B-1]	Launching of the Wipsowo Stacja bus stop in the vicinity of the railway station. Construction of P&R and B&R parkings.	Integration of the Wipsowo Stacja stop into the GKP network with integration of train and bus timetables for the approximate catchment area: Niedźwiedź, Ramsowo, Ramsówko, Wipsowo.

Railway	Bus	Infrastructural measures for consideration	Organisational measures for consideration
		Municipality of Dywity	
Bukwałd PO/221	Barkweda Wies (350 m) [D-1]	Launching of the Bukwałd Stacja bus stop near the platform entrance (including improved access from the village of Barkweda). Construction of P&R and B&R parkings.	Integration of the Bukwałd Stacja stop into the GKP network with integration of train and bus timetables for the approximate catchment area: Bukwałd, Barkweda.
		District City of Olsztyn	
Olsztyn Gutkowo ST/220/221	Sokola (Bałtycka) (500 m) [106, 111] [J-1, J-2, J-3]	Creation of the ZWP Gutkowo Stacja integrated interchange. Construction of P&R and B&R parkings.	Integration of ZWP Gutkowo Stacja into the ZDZiT and GKP network. Opening of a local ZDZiT bus line providing services from the intensively developing Łupstych and Gutkowo areas to Bałtycka Street (possibility of transfer to or from buses no. 106 and 111 in the area of the Bałtycka/Żurawia intersection) and ZWP Gutkowo Stacja (e.g. Łupstych** – Czajki** – Gościnna – Kresowa – Wołodzjowskiego – Żurawia – Bałtycka – Sokola – ZWP Gutkowo Stacja – Łukasiewiczza Baza Paliw). Integration of train and bus timetables.
Olsztyn Redykajny PO/220	Żbiczka Hozjusza (200 m) [101, 127, N02]	Relocation the Żbiczka Hozjusza bus stop to the platform entrance with a name change to Redykajny Stacja. Construction of K&R and B&R infrastructure.	Integration of train and bus timetables to provide services to the Redykajny estate.
Olsztyn Likusy MPO/220	Grabowa (Balt.) (200 m) [101, 106, 111, 127, N02]	Construction of K&R and B&R infrastructure.	–
Olsztyn Jez. Ukiel PO/220	ZSE (Bałtycka) (200 m) [101, 106, 111, 127, N02]	Construction of K&R and B&R infrastructure.	–
Olsztyn Dajtki PO/216/353	Okrağla (Sielska) (700 m) [107, 113, N02]	Construction of K&R and B&R infrastructure.	–

[line no.] – district transport, [line no.] – municipal transport, [line no.] – ZDZiT Olsztyn transport
*) planned development to serve as a passing point or a railway station, **) required adaptation of the road system of the Łupstych and Gutkowo estates

Table 2 does not include the city centre rail infrastructure (Olsztyn Zachodni – Olsztyn Śródmieście – Olsztyn Główny), which by its nature is the destination point of most journeys to Olsztyn (and in the opposite direction their starting point).

Measures outside the Urban Functional Area of Olsztyn

Although the subject of this chapter is the measures proposed for the Urban Functional Area of Olsztyn, it should be made clear that the integration of rail and bus transport should be implemented throughout the area analysed in this article, especially in the larger towns which are the seats of districts (Ostróda, Szczytno) and municipalities (Olsztynek, Biskupiec), as well as in the smaller municipal towns with unfavourably located railway stations (Dobre Miasto, Pasym).

In the case of Dobre Miasto, it is worth mentioning that PKS regional buses used to arrive (also by a short deviation from the main route) at the station there. The return to this solution should be considered for the resumption of passenger transport on line no. 221 once the modernisation is completed.

4. Proposed rail infrastructure investment measures

The traffic analysis carried out earlier in this article allows to conclude that the basic transport offer analysed in this article, i.e. assuming the running of 10 pairs of trains in all directions converging at the Olsztyn junction, can be realised without significant investment in railway infrastructure. The key point is to keep it at least in its current technical condition to achieve the journey times assumed for the analysis.

The need for some regional trains included in the basic offer (travelling in the direction of Iława) to skip the Olsztyn Śródmieście stop remains a problem. For this reason, as well as for the sake of traffic fluidity on the section of line no. 220 between Olsztyn Główny and Olsztyn Gutkowo, it is advisable to provide the new track connections indicated earlier in this article. It is a connection allowing exit from line no. 220 onto line no. 353 as close as possible to the Olsztyn Zachodni passenger stop on the journey in the direction of Olsztyn Główny and a connection allowing exit from line no. 220 onto line no. 353 behind the platform of the Olsztyn Śródmieście passenger stop on the journey in the direction of Olsztyn Zachodni.

The latter connection will be constructed as part of the ongoing modernization of Olsztyn Główny station. The further investment measures indicated in the following subsections should be regarded as initial author's proposals, to be implemented in the future.

These measures are aimed at achieving two main objectives:

- ensuring that, in the future, it will be possible to expand the range of transport services beyond the basic offer (i.e. providing regional rail transport services in the Urban Functional Area of Olsztyn with a capacity of more than 10 pairs of trains per day) – section 4.1,
- increasing the accessibility of rail transport through the construction of new passenger boarding points – section 4.2.

The authors are aware that confirming the validity and defining the technical scope of the indicated measures requires a more detailed analysis and a separate study. Some of them should be implemented in parallel because of the synergy of their effects.

The final design of the track layouts at stations and passing points, as well as their distribution (location) along the railway line, should also depend on results of computerised traffic simulations as one of the criteria.

4.1. Investment measures to further develop the transport offer

Complete reconstruction of the track system in the area of the Olsztyn Zachodni railway station

In order to ensure flexible train routing on parallel tracks of lines no. 216, 353 and 220, it is necessary to analyse the possibilities of comprehensive redesign of the track layout on an approximate length from the crossing of lines no. 216 and 353 with Sielska Street and the crossing of line no. 220 with Jeziorna Street to the Olsztyn Śródmieście passenger stop, ensuring the most universal and at the same time technically feasible layout of connections of all four tracks. Consequently, depending on the solution adopted, the Olsztyn Zachodni passenger stop would begin to fulfil the traffic functions of a railway station or junction signal box, with the possibility of incorporating its traffic control equipment into the control area of the Olsztyn Główny computer-based interlocking system.

The modernization of the Olsztyn Zachodni track layout should include a double track exit of line no. 220 in such a way that a second track on the entire Olsztyn Zachodni – Olsztyn Gutkowo section can be added in the future.

Reconstruction of the Olsztyn Zachodni – Olsztyn Gutkowo section to a double-track line

An analysis of the timetable for the existing Olsztyn Główny – Olsztyn Gutkowo section has shown that, despite the recent opening of the Olsztyn Likusy passing point, its capacity may still be a barrier to the development of an above-baseline regional rail service in the direction of Morąg and Dobre Miasto, due

to the need to handle long-distance passenger and freight traffic at the same time. Thus, the construction of a second track along the entire length of the section in question may be justified in the future.

Construction of a new station (or passing point) on the Olsztyn Gutkowo – Gamerki Wielkie section on line no. 220

In order to increase the capacity of the route in question and consequently create the possibility of creating a more flexible timetable on the Olsztyn Gutkowo – Morąg – Bogaczewo section (and further to Elbląg), it is recommended to build a new station (or passing point) between Olsztyn Gutkowo and Gamerki Wielkie. Because of issues related to traffic, its location in the vicinity of the current Godki passenger stop would have the best effect. An alternative location is the current passenger stop (former station) of Jonkowo, in the area of which this article considers the creation of a municipality-wide integrated interchange node (see section 3.2). For the time being, the second option, the construction of a small station in Jonkowo, is likely to be implemented.

Construction of a block post on the Barczewo – Czerwonka section on line no. 353

The division of the Barczewo – Czerwonka section into two blocks (formerly this function was fulfilled by Wipsowo station – currently only a passenger stop) will shorten the time between trains and thus improve the conditions for railway traffic and increase the flexibility of creating the transport offer (timetable) in the context of the considered resumption of passenger traffic on the section of line no. 223 Czerwonka – Biskupiec Reszelski – (Mrągowo).

Construction of new stations (or passing points) on sections Ełk – Stare Juchy and Wydminy – Giżycko on line no. 38

The effect of the investments in question should be an increase in the capacity of line no. 38, thereby ensuring the possibility of flexible creating of a transport offer (timetable) for the entire section of the railway network from Olsztyn via Korsze to Ełk. It should be made clear that this conclusion is based on a traffic analysis of line no. 38 prior to the ongoing modernisation and electrification. The prospect of combining fast trains travelling at speeds of up to 160 km/h and slower passenger and freight train traffic means that, once the modernisation is complete, this conclusion will not only remain relevant, but its priority may even increase. This is also due to the fact that at present the procedure is underway to include railway lines no. 353 and 38 (Poznań Wsch. – Toruń Gł. – Olsztyn Gł. – Korsze – Ełk) in the freight corridor „North Sea – Baltic” of the TEN-T core network, which in the

future may involve the necessity of ensuring an adequate reserve of capacity for increased freight traffic (verification of the conditions for conducting traffic on this railway line should be the subject of a separate study) [7].

Construction of new stations (or passing points) on railway line no. 219

In order to expand the transport offer beyond the basic one, it is recommended to build new stations (or passing points) on the Olsztyn Główny – Marcinkowo section (in this case a location in Ostrzeszewo is recommended in combination with the construction of a new passenger stop), Pasym – Szczytno (Grom passing point), Szczytno – Spychowo (Świątajno passing point), Spychowo – Pisz (Ruciane-Nida station), Pisz – Drygały (Kaliszki passing point) and Drygały – Ełk (Bajtkowo passing point). The locations indicated in brackets are tentative, based on the assumption of as even a distribution of existing rail sections as possible, and may change as a result of further analysis.

Construction of new stations (or passing points) on railway line no. 216

In order to expand the transport offer beyond the basic one, it is recommended to build new stations (or passing points) on the sections Działdowo – Kozłowo (Komorniki passing point), Nidzica – Waplewo (Dobrzyń passing point) and Olsztynek – Gałgawki (Stawiguda passing point together with the integrated interchange node discussed in the article). The locations indicated in brackets are tentative, based on the assumption of as even a distribution of existing rail sections as possible, and may change as a result of further analysis.

Construction of a block post on the Elbląg – Bogaczewo section on line no. 204

The division of the Elbląg – Bogaczewo section into two blocks will enable faster trains to run closer to slower ones and provide greater flexibility in creating the transport offer (timetable) for the Urban Functional Area of Olsztyn.

Construction of a sidetrack at the Olsztyn Kortowo junction signal box

The Olsztyn Kortowo junction signal box, opened in 2018, has connection to the Olsztyn Kortowo spur tracks, serving the combined heat and power plant of Miejskie Przedsiębiorstwo Energetyki Ciepłej Sp. z o.o. Two tracks of the spur are electrified, one is non-electrified and not in use, and departure from it is only possible onto the track of railway line no. 216 in the direction of Olsztyn Główny station following the group railway signal. In order to create the additional possibility of running trains from the eastern

direction through Olsztyn Główny station and then Olsztyn Śródmieście, Olsztyn Zachodni and Olsztyn Dajtki passenger stops, consideration should be given to the possibility of adapting the currently unused spur track of the MPEC to the function of a main track by repairing its substructure, electrifying it and modifying the railway traffic control equipment.

4.2. Analysis of the possibility of increasing the accessibility of rail transport by building new passenger stops

As part of the development of the rail transport offer of the Urban Functional Area of Olsztyn, the possibility of increasing the accessibility of rail transport by building new passenger stops should be analysed (Figure 10). The authors believe that analyses of potential should be carried out for at least the following locations (working names):

- **Olsztyn Wschodni (line no. 219, km ~2,200)** – vicinity of the road viaduct at ul. Towarowa, located in the industrial zone of the city, in the immediate vicinity of the Voivodeship Road Traffic Centre;

- **Trękuszek (line no. 219, km ~13,000)** – in the vicinity of the road viaduct on the Trękuszek – Kaborno municipal road, in the village of Trękuszek (279 inhabitants as of 2010) a large agricultural facility;
- **Ostrzeszewo (line no. 219, km ~4,100)** – vicinity of a road viaduct on district road 1464N; Ostrzeszewo village (241 inhabitants as of 2011) located in the immediate vicinity of the administrative borders of Olsztyn, close to its industrial zones located at ul. Piłsudskiego (including the Michelin S.A. tyre factory); the possibility of combining the investment with the construction of a passing point;
- **Olsztyn Track (line no. 353, km ~301,950)** – vicinity of current footbridge (planned conversion to road viaduct) near Track bus terminus (ul. Tracka); industrial area with high development potential.

5. Conclusions

The analysis presented in the article shows that the existing railway infrastructure has sufficient potential

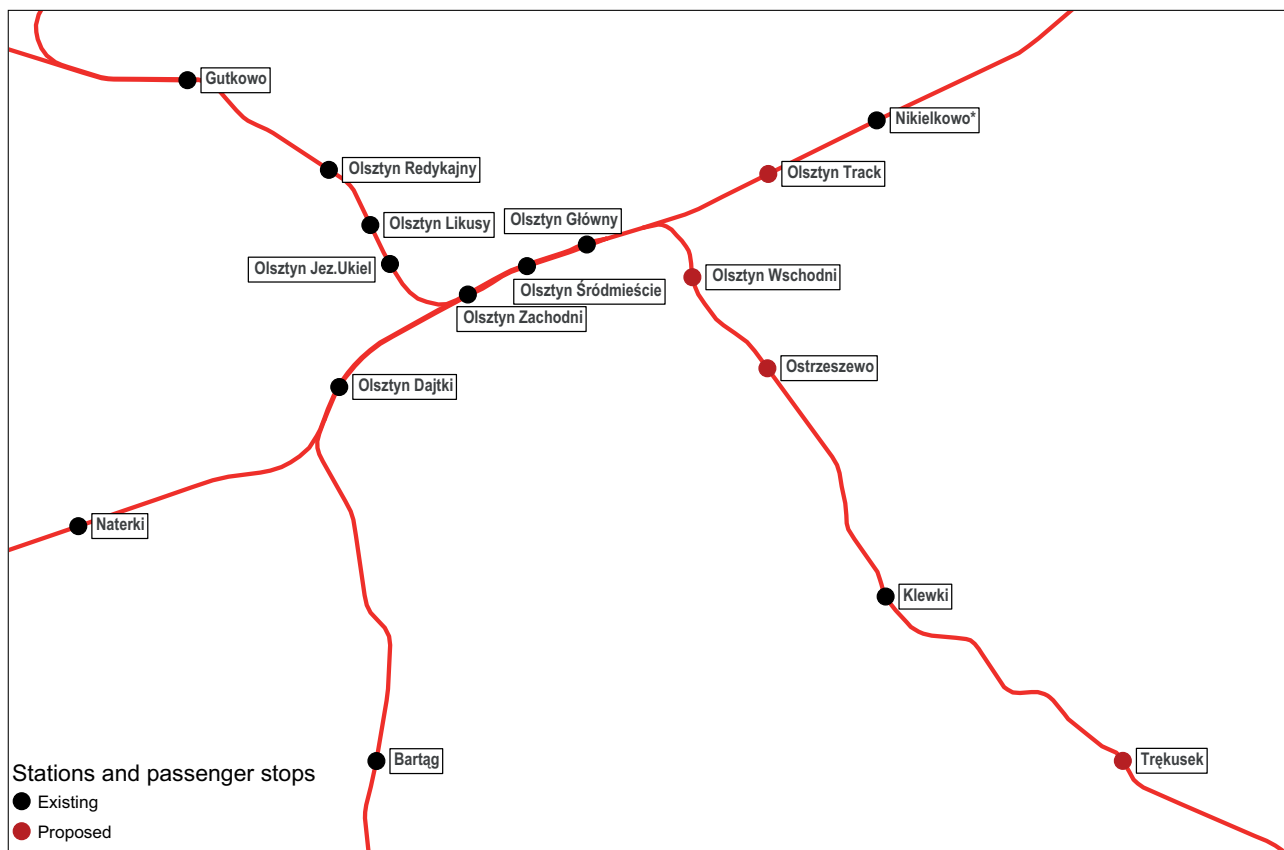


Fig. 10. Diagram of existing and proposed (for further analysis) new passenger stops in the Urban Functional Area of Olsztyn [Fig. S. Klemba]

to introduce a basic transport offer of 10 pairs of trains in each direction from the Olsztyn junction, while maintaining the principle of cyclicity of train departure times.

The execution of additional investment works, which have been characterised in general terms in the article, may enable the further expansion of this offer. Measures to be considered in order to increase the capacity of the line include the construction of a second track (on the Olsztyn Zachodni – Olsztyn Gutkowo section) or passing points on single-track lines, as well as block posts on double-track lines.

To improve rail accessibility, it is proposed to add new passenger stops to the network of boarding points.

These measures should be implemented in a coordinated manner in order to achieve the so-called synergy effect to the greatest possible extent (for example, the construction of passing points or block posts in combination with the construction of passenger stops makes it possible to increase the accessibility of rail transport without reducing the capacity of the railway line).

The railway system should be treated as an element of the entire transport network, and increasing the degree of its integration with bus transport will contribute to a more efficient operation of public transport in the Urban Functional Area of Olsztyn. At present, there is a base in the form of the ZDZiT Olsztyn suburban lines, as well as the district and municipal bus lines that have been opened in recent years, but which are not yet integrated with the railway. Infrastructural and organisational measures that can ensure this integration include the creation and organisation of larger integrated interchange nodes (ZWP Jonkowo, Barczewo, Stawiguda, Marcinkowo, Olsztyn Gutkowo, and potentially Bartąg), as well as strictly local measures related to, for example, improving the location of bus stops in relation to rail passenger boarding points.

At the same time, an appropriate ticket policy (in particular a common ticket) and information policy (communication channels covering all modes of public transport) are essential. At present, there is no uniform ticket system in the Urban Functional Area of Olsztyn and information about the individual transport lines is scattered.

The analysis carried out is a broad framework on the subject, and the proposed solutions should be subjected to further, more detailed studies, including using computerised systems for modelling and forecasting of traffic and rail traffic simulation.

References

1. Dąbrowski A., Klemba S.: *Ocena stanu transportu kolejowego i możliwości zwiększenia jego roli w systemie publicznego transportu zbiorowego Miejskiego Obszaru Funkcjonalnego Olsztyna* [Assessment of Rail Transport Conditions and of the Possibility to Increase the Role of Rail Transport in the Public Transport System of the Urban Functional Area of Olsztyn], *Problemy Kolejnictwa*, 2022, vol. 195.
2. Chyliński P.: *Krajowy zintegrowany cykliczny rozkład jazdy (KZCRJ)* [National Integrated Cyclical Timetable (KZCRJ)], *Przegląd Komunikacyjny*, 4/2017, pp. 25–29.
3. Żurkowski A.: *Intermodalne uwarunkowania rytymizacji przewozów pasażerskich* [Intermodal conditions of the rhythmization of passenger transport], *Logistyka*, 3/2012, pp. 2591–2597.
4. Massel A.: *Cykliczne rozkłady jazdy* [Cyclical timetables], *Technika Transportu Szynowego*, 3/2006, pp. 60–69.
5. Regulation of the Minister of Infrastructure of 4 December 2020 on the plan for sustainable development of public transport in long-distance and international passenger transport and in voivodeship rail passenger transport (Dz.U. [Journal of Laws] 2020, item 2328).
6. Local Data Bank, *Ludność w gminach bez miast na prawach powiatu i w miastach na prawach powiatu wg płci*, as at 31 December 2021, <https://bdl.stat.gov.pl/bdl/start>, [last accessed on 3 October 2022].
7. Proposal for a Regulation of the European Parliament and of the Council on Union guidelines for the development of the trans-European transport network, amending Regulation (EU) 2021/1153 and Regulation (EU) No 913/2010 and repealing Regulation (EU) No 1315/2013, COM(2021) 812 final, Strasbourg, 14 December 2021.