Transport Co-Modality and Intermodal Transshipment Terminals

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Co-modality means the efficient use of transport modes operating on their own or in multimodal integration in the European transport system to reach an optimal and sustainable exploitation of resources. Due to the growing demand for freight transport high efficiency and co-modality of different branches of transport in the European transport system are imperative. The basic criterion for assessing the effectiveness of all the available and proposed solutions must be economical bill, complex conducted both in terms of micro (at the level of each customer) and macro (at the level of the whole transport sector), endearing issues of economic, ecology, social, etc. An important aspect are the additional costs such as those related to the creation of new element of infrastructure, especially point elements of infrastructure.

Keywords: co-modality of transport; intermodal terminals handling; logistics infrastructure.

1. THE DEFINITION OF TRANSPORT CO-MODALITY

Co-modality means the efficient use of transport modes operating on their own or in multimodal integration in the European transport system to reach an optimal and sustainable exploitation of resources [8]. Due to the growing demand for freight transport high efficiency and co-modality of different branches of transport in the European transport system are imperative.

The term co-modality describes a set of activities that are designed to bring about cooperation of different modes of transport in order to achieve optimum use of existing infrastructure and other resources of the transport system of the globalizing Europe. It was introduced into the EU transport policy in 2006. Its implementation represents a departure in transport policy of the European Union from strive for sustainable development of transport through the modal shift policy. According to the concept of sustainable development of transport presented in the White Paper of 2001, road transport is opposed to all the other modes of transport. Currently, the overriding objective is to search for the optimum in the area of operation of all modes of transport including the multimodal transport. The reasons for changes in the previous policy is the fact that its implementation did not bring in some areas the desired result namely more efficient use of road transport alone. The policy change was adopted in part of communities, both positive (e.g. in the *IRU*[1]), and negative, like in the *EIM*[2], which accused the European Commission of providing more support for the less environmentally-friendly road transport at the cost of more environmentally friendly, such as rail transport.

The term of co-modality includes in its meaning intensification of use of the different means of transport, both new ones (such as the *Modular Concept* and *Big MAXX*) and the already known ones. The task of co-modality is also increasing the economic efficiency of intermodal and multimodal transport, which should be often used because of the long distance transport and different environmental conditions between countries and continents.

[1] *International Road Transport Union* – functioning all over the world organization representing entrepreneurs of the road transport industry.
[2] *European Rail Infrastructure Managers* – international organization associating independent rail infrastructure managers in Europe.

The basic criterion for assessing the effectiveness of all the available and proposed solutions must be a complex economical bill, conducted both in terms of micro (at the level of each customer) and macro (at the level of the whole transport sector), endearing issues of economic, ecology, social, etc. An important aspect are the additional costs such as those related to the creation of new element of infrastructure, especially point elements of infrastructure.

2. TRANSPORT AND ITS SPECIFICATION

Transport is the process of production (produces transport services), which aims to overcome the space [13] (obstacles resulting from the distance). It is one of the factors affecting the socio-economic development of the country by allowing the smooth functioning of the various sectors of national economy (such as mining industry or tourism and recreation), and is a factor that intensifies their development. On this basis it can be concluded that between the development of the national economy and the development of the transport system of the country there is a close relationship resulting from the fact that it supports other sectors of the economy [12].

Branch structure of transport in Poland is very diverse. Carriage can be made using the following modes of transport:

- rail transport,
- road transport,
- air transport,
- sea transport,
- inland waterway transport,
- pipeline transport.

The different modes of transport can be adapted to attain defined types of transport tasks (some cannot be realized by other modes of transport). They also complement each other. In the case of substitution, tasks should be carried by this mode of transport (and in such a way) that is more friendly for the environment. It is therefore necessary to set up a legal-economic system favourable to "proper" work-sharing in transport. In decisions concerning development of the transport the system should seek to ensure the effective implementation of transport tasks appropriate to each modes of transport. One of the solutions is the technology of intermodal transport.

Intermodal transport is the freight transport in the same intermodal unit (large container, swap body, semi-trailer) or vehicle by different modes of transport but without transshipment of the cargo [7]. It should be emphasized using at least two different modes of transport with single transport contract and one of the transport service along the whole route. Intermodal transport can be dealt with due to the coverage: national, international, continental and intercontinental, and because of the transport vessel used.

The most common variants of intermodal transport are:

- rail – road transport,
- rail – sea transport,
- road – air transport,
- rail – road – sea transport,
- rail – road – inland waterway transport.

The major advantages of intermodal transport are as follows:

- highly specialized technology of loading and transportation, allowing for shorter lead times of transport tasks,
- common use of intermodal solutions, especially in long-haul groupage transport (sea and rail transport),
- large number of possible variants of intermodal transport,
- prompt and punctual delivery,
- high frequency feasibility of cargo operations,
- reduction the risk of goods damage by eliminating the need to directly influence the transshipment of the load.

The movement of goods in the national logistics system is implemented with the participation of the various modes of transport and the use of point logistical infrastructure. The effectiveness of the system thus depends on the efficient use of infrastructure elements. This is represented both in the cost of logistics services (transport, warehousing, etc.) as well as in the quality of tasks. Thus, studying the efficiency of transport plays an important role in goods transition points, where it is possible to consolidate or deconsolidate shipments. This allows for a substantial part of the smaller consignment routes to be moved by one means of transport with large capacity (carriages of small parcels / freight railroad cars). The usage of large means of transport is the basic possibility to reduce the cost of transport and environmental impact.

Based on the above analysis it can be assumed that:

- the transport system should carry out transport tasks due to the specification of

companies and sales markets appearing in the national logistics system,
- each transport task reported to the transport system should be optimized taking into account the criteria specific to each subsystem of the logistics system and taking into account the global criterion from the point of view of the whole system,
- for a predefined structure and size of the transport tasks carried out in the national logistics, the system should undertake action to rationally shape the potential of the transport system,
- shaping of the transport system should include activities related to the development of line and point elements of transport infrastructure and superstructure of transport, to seek to improve transport efficiency and reduce the negative impact on the environment,
- it should take into account the development of goods transition points, which allow to change their transportation form and means of transport as a particularly important way of increasing efficiency of transport.

3. TECHNICAL – ECONOMIC CONDITIONS OF TRANSPORT CO-MODALITY

According to the definition of co-modality, it serves to ensure optimal and sustainable use of different modes of transport. Sustainable transport should take into account the principles of environmental protection. However, in assessing the economic efficiency and optimum use of existing resources one must take into account the economic and environmental aspects. On this basis, co-modal transport can be defined as a transport that:
- is characterized by as little as possible negative impact on the environment,
- is economically efficient,
- uses the optimal level of existing resources.

The problem of transport co-modality can be considered as a multi-objective in which aforementioned objectives are considered as sub-criteria evaluation. They include:
- operational costs of logistics tasks,
- external costs of logistics tasks,
- the total cost of logistics tasks,
- unit operating costs of logistics tasks,
- unit external costs of logistics implementation of transport tasks,
- unit total costs of logistics implementation of transport tasks,
- the average degree of utilization elements of logistical infrastructure,
- minimal degree of utilization elements of logistical infrastructure,
- maximal degree of utilization elements of logistical infrastructure,
- operating profit of implementation of transport tasks attributable to the unit of transport work,
- quotient of operating profit of implementation of transport tasks attributable to the unit of transport work and unit external costs of realization of these tasks.

From the point of view of costs and the level of utilization of the infrastructure set of the above criteria may be limited to three of the following:
- unit operating costs of logistics tasks,
- unit external costs of logistics tasks,
- the average degree of utilization of elements of logistical infrastructure.

In terms of cost and environmental synthetic indicator of transport, co-modality can be a total unit cost of tasks realization in the function of the degree of utilization of infrastructure elements.

The level of total unit cost of logistics tasks includes among others:
- unit fixed operating cost,
- unit changing operating costs,
- unit external costs.

The level of unit external costs of logistics tasks realization is dependent on the impact of transport on the environment, the level of the fixed unit operating costs of logistics tasks realization is dependent on the degree of (rational) the use of resources of the transport system However, the level of fixed unit costs of logistics tasks realization and variable unit costs of logistics tasks realization is expressed so called economical transport. Thus, minimizing the total unit cost of logistics tasks realization is provided transport co-modality, i.e. its environmental performance and economical when rationally utilized resources.

As already mentioned, the modes of transport are complementary and substitutable. For the sphere of complementarity it is necessary to properly shape the infrastructure for implementation transshipments between different

modes (single and multiple modes of transport). Particularly noteworthy are the terminals for handling cross-docking, rail and road terminals, seaports and river ports, and logistics centres which are the basis of the national logistics system. The development of multimodal transport modes (especially intermodal transport) should be considered a priority. Multimodal transportation allows to combine the advantages of different transport modes during the realization of transport tasks (it is mainly point of origin and destination of transportation and the size of the task) dedicated to road transport, which has the most negative impact on the environment. Consequently, the development of multimodal transport is accompanied by reduction of road freight taken over long distances, and thereby it reduces environmental pollution and threats to human life (accidents). Given the years of inaction regarding the construction of logistics centres in Poland, it should be noted that the implementation of the idea of transport co-modality requires urgent real action in this area.

From the point of view of substitutability of different transport modes fundamental problem remains identification of reserves in production capacity of different transport modes and, taking additionally into account current market conditions, policies to ensure co-modal use of transport (with particular regard to its impact on the environment). Therefore, what matters here is a well-thought-of (because it is based on existing technical and organizational conditions) transport policy, which will really affect the behaviour of buyers of transport services. An important issue in this area is the successive internalization of external costs, and creating privileges for subsystems least harmful to the environment.

4. THE ROLE OF INTERMODAL TRANSSHIPMENT TERMINALS IN THE ORGANISATION OF CARGO FLOW

As it has already been mentioned the transport co-modality is an activity aimed at efficient use of different transport modes. Practically all modes of transport have a strong features of economies of scale. Through the adoption of more cargo to the transport, enterprises are able to make better use of their vehicles due to capacity or increase service frequency and number of routes. They also use larger and more efficient vehicles, whereby it is possible to efficiently spread the cost. In order to achieve economies of scale, enterprises use the consolidation process of cargo, i.e. combine consignments from various sources and send to different destination places and move at different times for the efficient utilization of vehicles.

There are three basic approaches to the consolidation of cargo [3]:

- *time:* collecting of consignments (changing of transport at the time) to achieve the desired vehicle filling,
- *transshipment:* transhipment between incoming and outgoing vehicles to achieve the desired load paths,
- *route:* the construction of routes in such a way as to cover a lot of places of taking and putting consignments in order to achieve the desired load value.

Transshipment of cargo between different modes of transport is possible if the point elements of infrastructure, such as transshipment points, terminals (including intermodal terminals), logistics centres, etc., are properly developed. Each change of means of transport changes transportation parameters such as time, cost and quality. In the realization of logistic processes in the national logistics system cargo transfer points play an important role. In them there are carried out various activities related to their handling, such as changing the type of means of transport, consolidation, deconsolidation, formation, reformation, etc. In general, these are the nodes in the logistics distribution network where goods are temporarily stored or transferred in the way which leads through the network of the relation in the entire logistics chain. In these points occur processes in both warehousing and movement. On the one hand, there is the concentration of cargo flows, on the other hand, their distribution on the elementary kinds of transport ways. One kind of this type of objects are intermodal transshipment terminals.

Based on the definition of intermodal transport an intermodal transshipment terminal can be defined as a transition point of cargo where it is possible to change mode of transport. It is not possible to change the content of the consignment. So in this point it is possible to concentrate and deconcentrate cargoes arriving from/to multiple consignors/consignees. Also temporary storage is possible. Below there are examples of the location of intermodal transshipment terminals which operate at the link of different modes of transport.

Equipment of points of concentration and deconcentration of cargo and their organization of work, determine the point capacity, i.e. the ability to accept and send specified volume of cargo per unit of time. It is connected with costs which are a function of the size of supported cargo flow and the type of equipment of the transshipment object. Thus, the capacity of logistics facilities can be modified by modernizing equipment because of its type and number. It is connected with incurring financial expenditures and affects on the total labour costs. Co-modality may be perceived, in these conditions, as a way to increase the capacity of major transitions points for selected groups of materials and modes of transport while reducing labour costs of these points. The role of the points of cargo concentration include stabilization of the logistics system.

Figure 1 presents the example variants of the location of intermodal transshipment points of cargo in road transport. This branch is used for the transportation relatively small or medium-sized batch of cargo on long and short distances. Due to the flexibility and availability of road transport it is used as complementary for rail transport and inland waterway transport. The main role of the co-operation of road transport with intermodal transshipment terminals is to serve as pick-up and drop-off. The radius of pick-up and drop-off generally is limited to 25 km [7]. Means of road transport pick up cargo from individual shippers of intermodal transport units, then the transshipment takes place on the mean of mass transportation (train, plane or ship). The same operations are performed for drop-off of cargo to individual recipients.

- an extensive network of roads with unlimited reach and availability,
- wide variety of available types of means of transport,
- lack of central control,
- flexibility due to the loading and unloading and the execution time of transport cycles,
- high-speed of transport,
- low unit costs of maintenance of road infrastructure,
- wide availability of means of transport, transport roads and places of loading and unloading,
- simple procedures for transport.

Road transport is also characterized by negative characteristics, such as:

- limited capacity of means of transport which makes mass transport difficult,
- high energy consumption,
- external costs of pollution, noise and the reduction of space by the road network,
- difficulties with controlling technical condition of vehicles and respecting the rules on maximum loadings,
- high unit costs of transport.

Rail transport due to its qualities is widely used for transportation of large amounts of material over long distances. The weight of the cargo cause the complication of expeditionary process and difficulties related to the loading work. For this reason, rail transport is a basic component of a combined technology, intermodal and bimodal transport realization and it may be a component of multimodal transportation due to the fact as the major part of traffic in these technologies is carried

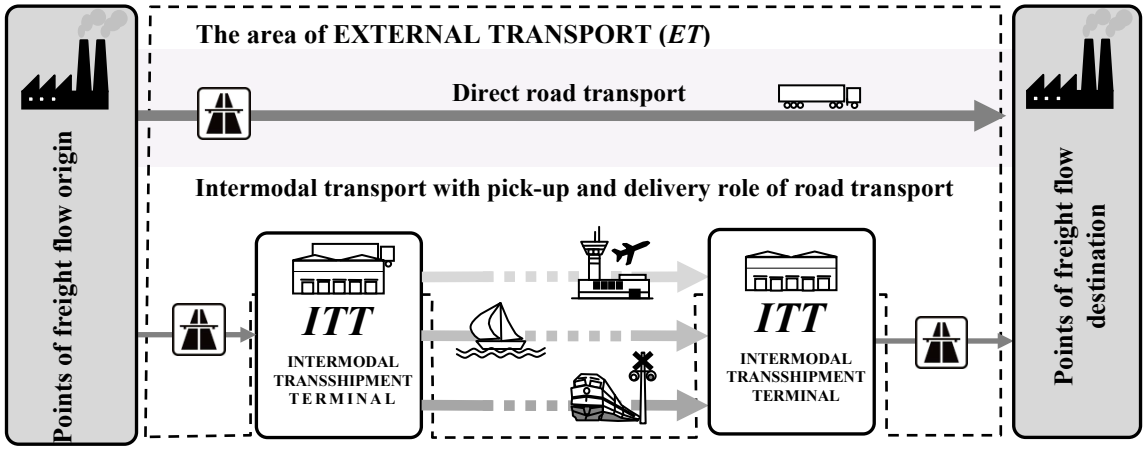

Fig. 1. Scheme of the location of intermodal transshipment terminals in road transport
Source: own work based on [5]

Road transport is used in the process of freight flow due to:

out by means of rail, air and sea transport. This branch is the basic one in participating in the

movement of cargo between intermodal terminals. Variants of the location of the intermediate points of freight service in rail transport is shown in figure 2.

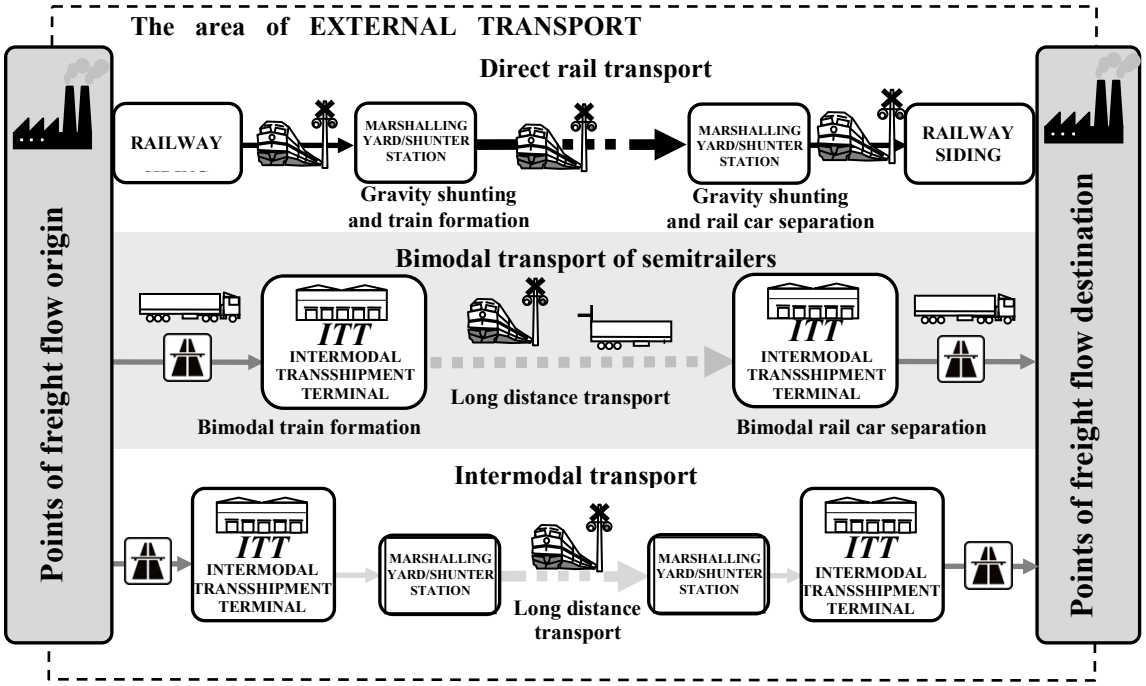

Fig. 2. Scheme of the location of intermodal transshipment terminals in railway transport
Source: own work based on [5]

Rail transport and road transport represent the dominant type of land transport in Europe. The main features of rail transport are:

- mass character of transport,
- low energy unit consumption of transport,
- lower than for road transport and inland waterway energy consumption and pollution of the environment,
- regularity of transportation.

The negative features of rail transport are:

- impeded availability of points of loading and loading infrastructure,
- relatively low flexibility of transport,
- imposed from above the organization of transport connected with constructing and respecting timetables,
- low profitability of transport for small batches of materials,
- low commercial speed extending the duration of transport process (including loading and unloading times),
- complex procedure for transport organization,
- high unit share of infrastructure maintenance costs,
- the need to maintain appropriate services,
- deteriorating state of the railway infrastructure in Poland,
- the lack of specialized, modern fleet of wagons and traction vehicles.

The organization of cargo flows plays an important role in intermodal transshipment terminals connecting different modes of transport with inland waterway transport. Inland water transport in Poland is used for handling seaports. Furthermore it is necessary to customize inland waterway transport in Poland to support intermodal transport (especially container), which partially would solve problems with the service of intermodal transport units in road transport and rail transport. Schematic location of intermodal transhipment terminals in inland waterway transport is shown in figure 3.

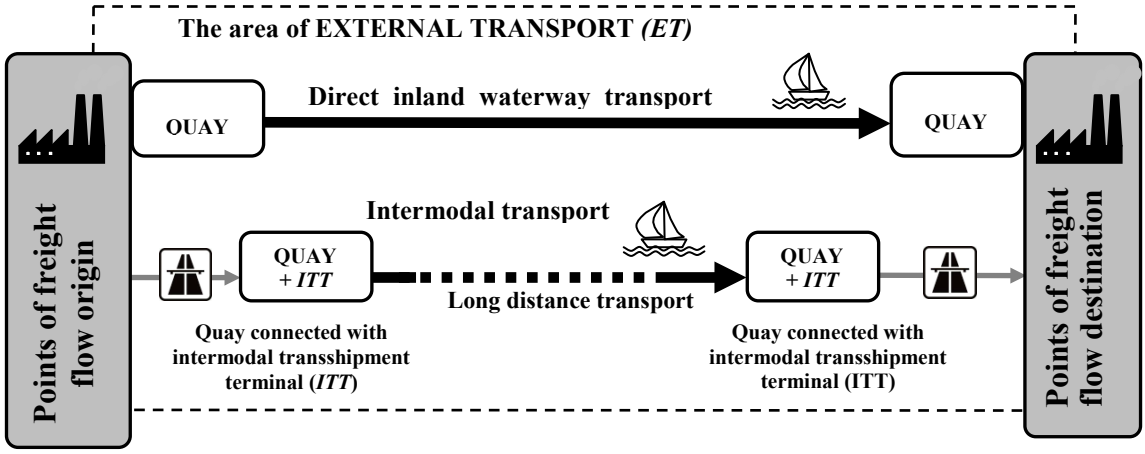

Fig. 3. Scheme of the location of intermodal transshipment terminals in inland waterway transport
Source: own work based on [5]

The benefits of using inland waterway transport in the transport of freight are:

- environmental protection,
- unit costs lower by about 1/3 in comparison with other modes of transport,
- natural access to large industrial establishments invested in the surroundings of rivers,
- natural connection with seaports,
- potential possibility of utilization inland waterway transport in Poland for intermodal transport.

As the negative characteristics of the inland waterway transport the following issues can be mentioned:

- the need for continuous improvement of inland waterways, their deepening and widening,
- necessitated transport routes for which the alternative is digging canals,
- low speed of movement,
- difficult access to loading points,
- a small number and length of well-prepared inland waterways in Poland.

Summing up the discussion it should be noted that all types of crossing points which are the points of concentration and distribution of freight flows, like the intermodal transshipment terminals, are equipped with infrastructure capable of handling several modes of transport. Due to their location in large nodes of major transport routes they serve as natural regulator of rational load on each transport road, and of handling of cargo in the large urban areas. The concentration of freight of domestic and international forwarding agents and multimodal transport operators implies offering complex logistics services, thereby raising the quality of transport services, including in particular the time and cost of transportation.

5. SUMMARY AND CONCLUSIONS

Intermodal transshipment terminals are one of the groups of punctual elements of transport infrastructure which are contained in the logistics system. They perform a very important function in the movement of freight on the network. Through them it is possible to change the means of transport from pick-up/drop-off into a long-distance means of transport without changing the transport vessel and vice versa. The idea of the construction of intermodal terminals is consistent with the policy of the European Union, which promotes the development of intermodal transport.

Co-modality is the efficient use of different transport forms for optimal and sustainable utilization of resources. One of these resources are intermodal transshipment terminals, which are punctual elements of the infrastructure. In the terminals it is possible to connect several modes of transport, which results in the increased efficiency of the various means of transport. Based on the analysis a proposal can be presented that the construction of new intermodal terminals is a way to co-modality of transport in the area of the specified region, such as a country.

Thanks to the implementation of the co-modality in the transport, the EU Member States carry out its policy and therefore the value of transport is rising progressively. Transportation services are of higher quality, and customers prefer to choose cargo transportation in intermodal transport technology.

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