

Transport susceptibility of cargoes as their classification criterion

Podatność transportowa ładunków jako kryterium ich klasyfikacji

Ruta Leśmian-Kordas

Maritime University of Szczecin, Faculty of Economics and Transport Engineering
Institute of Transport Engineering, Department of Commodities Science and Quality Management
Akademia Morska w Szczecinie, Wydział Inżynierjno-Ekonomiczny Transportu
Instytut Inżynierii Transportu, Zakład Towaroznawstwa i Zarządzania Jakością
70-507 Szczecin, ul. H. Pobożnego 11, e-mail: rutana@onet.eu

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Abstract

The article presents the evolution of the shaping of the term “transport susceptibility of cargoes” and the division of this susceptibility into partial susceptibilities. Currently a differentiated terminology coexists in transport literature, introducing considerable confusion into the unambiguous interpretation of factors determining the resistance of cargoes to conditions and time length of transport processes. Moreover, classification of cargoes has been given in branch transport on the example of marine transport, assuming as division criterion the systematised partial susceptibilities. There have also been outlined the principles of interpreting susceptibility and division of cargoes in intermodal transport.

Słowa kluczowe: podatność ładunków, klasyfikacja ładunków, transport gałęziowy, transport intermodalny

Abstrakt

W artykule przedstawiono ewolucję kształtowania się terminu „podatności transportowej ładunków” oraz podziału tej podatności na podatności cząstkowe. Obecnie w literaturze transportowej koegzystuje zróżnicowana terminologia, wprowadzająca spore zamieszanie w jednoznacznej interpretacji czynników określających odporność ładunków na warunki i czas trwania procesów transportowych. Ponadto, podano klasyfikację ładunków w transporcie gałęziowym na przykładzie transportu morskiego, przyjmując za kryterium podziału usystematyzowane podatności cząstkowe. Nakreślono również zasady interpretacji podatności oraz podziału towarów w transporcie intermodalnym.

Introduction

Transport is currently one of the chief elements of the functioning of economic units on worldwide and regional scale and in particular countries. The function of translocating material goods, ancillary in relation to the whole economy yet immanently bound with it, has to fulfil at least a few basic requirements, the sum of which determines the satisfaction of the receiver’s expectations. The quality of transport processes is of decisive significance here, including the speed and punctuality of deliveries, temporal and spatial availability, safety of processes constituting integral parts of the

logistic supply chain, reliability, cost, and above all safety and quality of material goods delivered to the receiver, defined as cargo.

Cargoes constituting the object of transport, also termed logistic products, are characterised by unusually high differentiation of properties, i.e. their most essential features.

In the present study, the term “transport”¹ defines activity aimed at the spatial translocation of

¹ In the subject’s literature the term “transport” most frequently denotes activity consisting of carriage of cargoes by means of transport and transshipment operations.

cargoes, made up of three successive phases, sometimes repeating themselves many times: carriage by means of transport, transshipment and loading operations (charging and discharging) and temporary storage in contact points of various transport means and branches, also constituting the first and the last phase of the transport process.

Taking into account the multiplicity of variable external factors affecting the cargoes in the streams of their flow from supplier to recipient, the possibility has to be assumed of various relations and effects in the system surroundings-cargo, frequently occurring simultaneously. Optimisation of these relations aimed at obtaining a smooth and safe translocation of cargoes keeping their high (original) quality, requires the systematising of processes, identification and grouping of external disturbing factors and the classification of a huge number of cargoes.

The classifications of cargoes for organisational and technical purposes in various branches of land, water or air transport are not harmonised, which is a result of their differentiated development in time, the carriage specificity of particular transport branches, resulting from the specialisation of particular transport branches with regard to cargoes carried, the application of different means of transport various transshipment techniques and technologies, as also a large span in the distance covered by the cargoes from the sender to the place of destination.

Generally, in recent years there has been observed a significant progress in cargo classification development, from one directed towards the satisfaction of needs resulting from the technique and technology of sequentially following process in the transport chain, through its more detailed specification due to the expansion of new transport and transshipment forms (e.g. dividing general cargo into units), and also the operation of modern warehouses and logistic centres, to taking into consideration of the kind of cargo transported, which in a certain degree brings these classifications to the kind systematics of products and services, so far applied first of all in goods turnover for purposes of statistics and identification. This development is witnessed by the introduction of a uniform goods classification in marine, railway and road transport in the form of NST 2007 [1], which is a strictly kind classification. In inland water transport the NST 2000 [2] is in force, almost coinciding with NST 2007. The NST 2007 kind classification constitutes a breakthrough in the standardisation of means of collecting, presenting and analysing data in sea and land transport. In the area of intermodal transport, though still little competitive in relation

to branch transport, but systematically increasing its share in the total volume of cargo transported, irrespective of other transport branches, own divisions are shaped of the nature of kind classification in accordance with NST / R – Nomenclature Statistic of Transport / Revised.

Independently of this clearly looming out development trend directed towards statistic and identification purposes, the cargoes' transport susceptibility remains an essential criterion of cargo classification for the needs of organisational and technical work, indispensable in transport for the correct choice of proper technologies and their execution.

Genesis and kinds of transport susceptibility of cargoes

M. Madeyski [3], starting from the assumption that omission or marginal treatment in transport subject matter of the transport object, that is the cargo "whose spatial existence is affected by the transport" and concentrating first of all on the use of means of transport and the organisation of transport processes and enterprises, causes an incorrect one-sided exposure of transport processes, prepared a theory of cargo carriage susceptibility and brought into the subject literature the concept of "cargo transport susceptibility", stressing that this concept and its significance was already given attention in 1949 by C. Pirath [4]. It is worth underlining that M. Madeyski is of the opinion that:

- all activities recognised as a part of the transport process organisation, starting from the selection of means of transport to the carrier's responsibility for cargo entrusted, are the function of *cargo properties* and its economic significance;
- successive activities of the multi-stage transport processes may affect negatively the cargo's quality, cause amount reduction of the cargo, including the cargo's destruction or loss;
- a condition for ensuring the unchanged quality and amount of transported cargo is classification of cargo taking into consideration specific criteria.

It should also be noted that the term "cargo transport susceptibility" is essentially related by M. Madeyski to the whole transport process, not just carriage.

According to M. Madeyskiego, the cargoes' transport susceptibility is: "*A set of features and properties characteristic for the cargo making up its resistance to the conditions and results of carriage; the cargo's transport susceptibility is determined by the degree of this resistance.*"

In susceptibility thus defined, the author of the theory singled out a natural, technical and economic transport susceptibility, simultaneously giving an interpretation of these partial susceptibilities.

Natural cargo transport susceptibility is determined by the cargoes' natural features (chemical and physical), which determine the effect of transport activities on their utility value and quantitative loss.

Technical cargo transport susceptibility is defined by factors determining the technique of transport activities, like mass, shape, size and kind of package.

Economic transport susceptibility is determined by the relation of transport value transferred onto the cargo (T) to cargo value (A), which may be determined by production cost A_f or selling price $A_z = A_f + T + C$, where C constitutes the selling cost with margin.

Thus, the economic transport susceptibility (E) is determined by the formulae:

$$E = \frac{T}{A_f} \quad \text{or} \quad E = \frac{T}{A_z} = \frac{T}{A_f + C + T}$$

Economic transport susceptibility, according to M. Madeyski, is also affected by the "degree of economic and social indispensability of transport".

Taking shape of the term "cargo transport susceptibility"

In result of work on the theory of carriage susceptibility carried out in following years by the author's co-workers, the term "cargo carriage susceptibility" was transformed to "cargo transport susceptibility", taking into account the multi-stage aspect of transport processes.

J. Marzec [5] distinguishes in transport susceptibility the concepts of carriage and transshipment susceptibility, stressing that some authors also distinguish storage susceptibility, that is the resistance of cargoes to conditions and effects of storage.

H. Mokrzyśczak popularised in her works [6, 7] the concept of cargo transport susceptibility. In H. Mokrzyśczak's depiction, transport susceptibility of cargoes is made up of carriage susceptibility and loading susceptibility. Apart from transport susceptibility, she also distinguished cargo storage susceptibility. According to this authoress, loading susceptibility is "the cargo's resistance to pile-up. It indicates the utilisation degree of transport means and storage areas. Hence, there may be distinguished the groups of cargoes:

- non-susceptible to pile-up (small loading susceptibility),

- susceptible to pile-up (high loading susceptibility)."

The singling out in transport susceptibility of loading susceptibility thus understood seems to be controversial. The resistance of cargoes to pile-up is an essential feature, but one among many features characteristic of cargoes both in carriage and in storage. Reservations can also be made about locating storage susceptibility outside transport susceptibility. Especially as in the work adduced H. Mokrzyśczak justifies at the same time that "...transport process is a wider concept than carriage process, as it embraces activities conditioning the performance of carriage, i.e. preparing the cargo for carriage, transitory **storage**, giving out the cargo and forwarding activities." The term "loading susceptibility" so conceived is confirmed by H. Mokrzyśczak's postulate concerning the need of applying additional classification criteria in order to fully ensure the fulfilment of the organisational and technical transport requirements, like basic methods of loading and cargo size.

Within this context, the classification of cargo transport susceptibility proposed by the author appears somewhat incoherent. Ten years later (1998) [8] the author corrects the definition of loading susceptibility, stating that loading susceptibility results from technical carriage susceptibility and constitutes the cargo's resistance to pile-up and **loading work carried out**.

In a lexicon of economic terms published in 1994 A. Pogonowska-Szuskiewicz [9] defines cargo transport susceptibility as "properties of cargoes shaping their resistance to conditions, time of duration and results of transport in all stages of the transport process:

- stage of translocation (carriage susceptibility);
- stage of performing loading activities (loading susceptibility);
- stage of storage (storage susceptibility)".

In this way A. Pogonowska-Szuskiewicz gives a different, proper meaning to loading susceptibility, taking into account the importance of loading work (loading and unloading) in the realisation of the whole logistic chain.

K. Misztal i S. Szwankowski, in a work published in 2001 [10] give a definition of transport susceptibility from an economic and technological point of view, respectively:

- "cargo properties affecting the social amount of labour indispensable for carrying out transport"; and "the cargo's degree of resistance to conditions and results of transport".

It is also stated by them that “the general transport susceptibility is made up of partial susceptibilities like susceptibility to carriage, transshipment, storage, division into units (containerisation, palletisation, packaging) etc. Moreover, the following are distinguished in general transport susceptibility: natural, technical and value² susceptibility, confirming thereby the opinion of J. Marzec, differing from H. Mokrzyszczak’s opinion, according to which it is justified to relate natural, technical and economic transport susceptibility only to carriage and from A. Pogonowska-Szuskiewicz relating these partial susceptibilities to carriage and storage.

General transport susceptibility and relations of partial transport susceptibilities

It follows from the presented outline of the term “cargo transport susceptibility” taking shape that as late as in the last decade, there was accepted the proper, complex depiction of cargoes’ susceptibility to changes (mostly negative) in the course of successive stages of transport processes, although, what should be clearly stressed – one still quite frequently observes in transport terminology the presence of concepts shaped in the sixties and seventies. Another aspect of the problem considered, mostly accepted as evident, is the imprecise way of expressing transport susceptibility by gradation (small, medium, large), due to lack of precise measurement standards.

High susceptibility, i.e. large resistance of cargoes to change of their properties during transport properties (e.g. bulk cargoes of mineral origins) facilitates and simplifies the efficient and safe performance of particular stages of these processes, at the same time preserving the original quality of the cargoes and small social labour input. Cargoes of small susceptibility, that is small resistance to changes of properties under the effect of exo- and endogenic factors and time (e.g. perishable cargoes), require special preparation of proper technical conditions in various stages of the transport processes, and apart from this, and an immeasurably larger labour input due to the need of systematically monitoring the correctness of its course.

Taking the above into consideration, the following definition of cargo transport susceptibility: *Cargo transport susceptibility is the degree of resistance of cargoes to changes in their*

properties effected by the conditions and duration of transport processes, covering the stages of carriage, loading /unloading and storing/storage, warehousing).

The practical utilisation of the term “cargo transport susceptibility” thus defined for grouping cargoes with respect to their sensitivity to the effect of various factors, threat of transport to the surroundings, necessary preparatory activities in the pre-transport stage, preparation of proper means of transport and their equipment, applying proper cargo-handling devices, ensuring optimal conditions during transitory storage at junction points of the transport chain etc., that is in all respects decisive about the technique and technology of cargo transport, requires first of all the establishment of a set of distinguishing features of criterional cargo classifications – partial susceptibilities, defining them, and then determining their mutual relationships, taking account of the degree of importance.

The following should be included in the set of criterional distinguishing features of cargo division:

Universal partial susceptibilities, defined as:

- *Natural cargo transport susceptibility*, i.e. the resistance of cargoes to changes in their properties effected by the conditions and duration of transport processes resulting from chemical, physical and biological properties of the cargoes;
- *Technical cargo transport susceptibility* – the resistance of cargoes to changes in their properties effected by the conditions and duration of transport processes, resulting from their external properties, i.e. state of aggregation, transport form, carriage form, the size of singly transported bulk, the size and shape of cargo or degree of size reduction, the kind of packaging and activities performed for the purpose of adapting to transport (e.g. dividing into units significantly increasing the technical susceptibility);
- *Economic cargo transport susceptibility* – the resistance of cargoes to changes in their properties effected by the conditions and duration of transport processes, resulting from the relationship of total transport cost to the cargo value.

Stage partial susceptibilities, defined as follows:

Carriage susceptibility – the resistance of cargoes to changes in their properties effected by the conditions and duration of carriage;

Cargo handling susceptibility – the resistance of cargoes to changes in their properties effected by

² K. Misztal and S. Szwanowski are of the opinion that the term “value transport susceptibility” is more appropriate than “economic transport susceptibility”.

the conditions and duration of cargo handling operations (including direct and indirect cargo handling, covering loading and unloading work).

Storage susceptibility – the resistance of cargoes to changes in their properties effected by the conditions and duration of storage (storing, warehousing).

A proposal of mutual relations between selected distinguishing features of general transport susceptibility has been presented in figure 1.

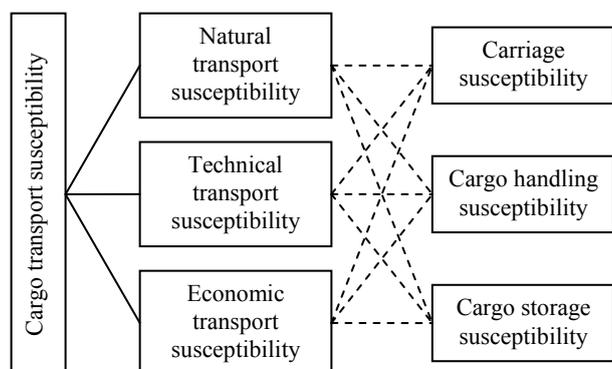


Fig. 1. Diagram of mutual relations between partial susceptibilities, making up the general transport susceptibility of cargoes [source: own study]

Rys. 1. Schemat wzajemnych relacji podatności cząstkowych, składających się na ogólną podatność transportową ładunków [źródło: opracowanie własne]

J. Neider [11] mentions, apart from three universal transport susceptibilities (natural, technical and storage), a fourth susceptibility kind, namely *unique susceptibility*. This seems to be a rather controversial proposition. What seems right, on the other hand, is the singling out of the group of unique cargoes, which was taken into consideration in further content of the present work, in connection with evaluation of cargoes.

What speaks in favour of the kind of subordination of partial susceptibilities is the universal character of natural, technical and economic transport susceptibility, in that they determine the technique and technology of all stages of transport processes, so they can be recognised as criterional distinguishing features of cargo classifications of the 1st degree. In that case, transport, ship-handling and storage susceptibilities constitute subordinate criteria of cargo division in relation to natural, technical and economic susceptibilities, constituting criterional distinguishing features of cargoes of the 2nd degree.

On each of the partial transport susceptibilities (natural, technical and economic) there depends the carriage, cargo-handling and storage susceptibility. These interrelationships should be taken into consideration when organising the carriage process.

Natural, technical and economic transport susceptibility of cargoes determine:

- in carriage, selection of proper packaging, method of dividing into units, kind and amount of indispensable rolling stock, e.g. in marine transport the type of ship: conventional general cargo ship (cargoes of high transport susceptibility) or specialist vessel – refrigerated vessel or container ship (cargoes of small natural carriage susceptibility, sensitive mainly to the effect the surroundings' microclimatic conditions) etc., as also the way of securing the packaged cargo, in a cargo unit, on a means of transport, method and frequency of quality monitoring and the conditions of carriage, maximum distance and time length of carriage (cargoes of small transport susceptibility and small value are not susceptible to long-distance carriage);
- in cargo handling – the technology of cargo handling, selection of proper cargo-handling devices for the technology chosen and the organisation of cargo handling;
- in storage – the selection of warehouse building: closed warehouse, conventional or specialist (cold stores, storage rooms, store houses of dangerous cargoes and other) and closed containers; half-open warehouses – umbrella roofs, bunkers and open containers; open warehouses – stacking yards; choice of storage technology, taking into consideration microclimatic conditions, pile-up, kind of mechanised equipment and the organisation of the storage process.

An increase of cargo carriage and storage susceptibility is achieved by increasing their natural transport susceptibility by initial preparation for carriage and storage consisting in increasing their durability, that is resistance to carriage and storage conditions by physical methods (drying, smoking, cooling, thermal setting), chemical methods (salting, sweetening, applying preservative means) and proper packaging (hermetic, active etc.). An obvious method, confirmed in practice, is increasing carriage, cargo handling and storage susceptibility of cargoes by making of cargo-handling units: pallets, packages and containers.

Classification of cargo in branch transport

The application of individual techniques and technologies of transport processes for a huge and systematically growing number of cargoes, with unusually differentiated natural properties, is not practically possible. The grouping of cargoes of similar natural properties, technical parameters and

values, that is grouping of cargoes with respect to selected partial susceptibilities that constitute the basic classification criteria, and next taking into consideration additional distinguishing classification features characteristic of these susceptibilities and relating them to particular stages of transport processes, permits the restriction and minimisation of the variety of applied transport techniques and technologies, thereby increasing the repeatability and standardisation of transport activities, means of transport, cargo-handling devices, mechanised equipment, warehouse buildings and storage technologies, clearly influencing the homogenisation and rationalisation of transport organisation and costs. So, the classification of cargoes groups and subgroups has a multi-stage and multi-criterion character.

Taking into account the limited volume of this work, figures 2 and 3 present merely the main cargo groups generated with regard to the natural and technical transport susceptibility, essential in marine transport.

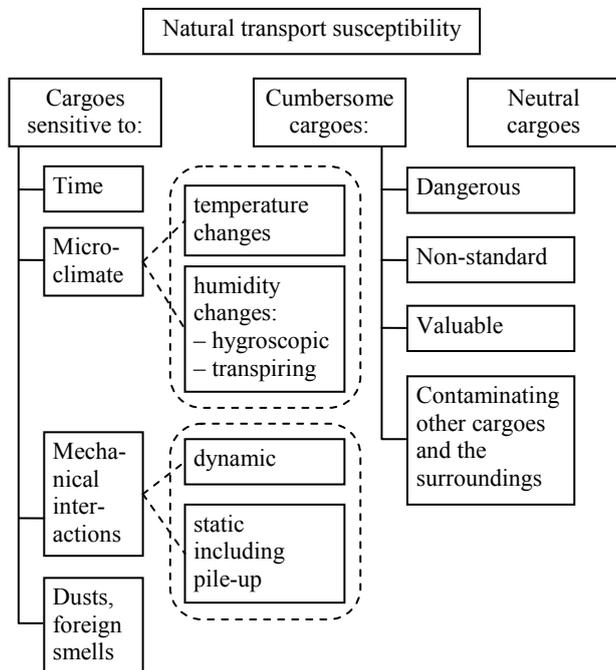


Fig. 2. Classification of cargoes into cargo groups with respect to natural transport susceptibility [source: own study]

Rys. 2. Klasyfikacja ładunków na grupy ładunkowe ze względu na naturalną podatność transportową [źródło: opracowanie własne]

Further division into cargo groups into subgroups has been given on the example of cargoes sensitive to microclimate, leading to distinguishing cargoes sensitive to temperature changes and humidity (including hygroscopic and transpiring cargoes), and also of cargoes sensitive to mechanical interactions, leading to distinguishing

cargoes sensitive to dynamic and static interactions (including pile-up).

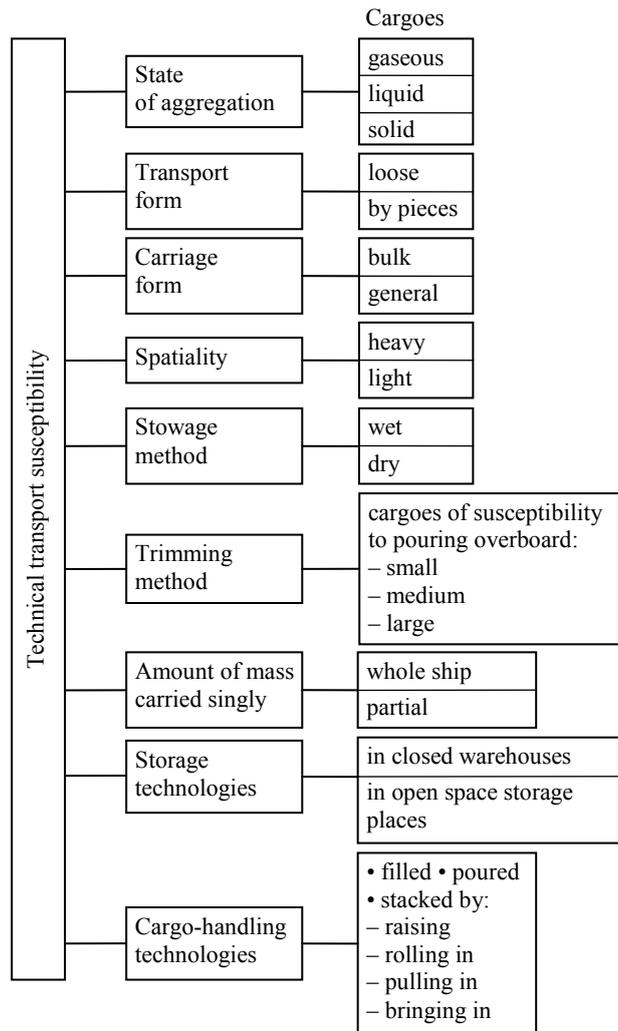


Fig. 3. Criteria of cargo classification with respect to technical cargo susceptibility and additional specific classification distinguishing features related to carried, cargo handling and storage [source: own study]

Rys. 3. Kryteria klasyfikacji ładunków ze względu na techniczną podatność ładunkową oraz dodatkowe specyficzne wyróżniki klasyfikacyjne odniesione do przewozu, przeladunku i przechowywania [źródło: opracowanie własne]

Valuation of cargoes for the needs of determining the economic transport susceptibility leads to their division into small-, medium- and high-value. Sometimes cargoes of particularly high value are distinguished. Higher cargo value is bound with the need of increased care for it during transport, and therefore with larger number of activities ensuring the delivery of cargo to the consignee in a state responding to his needs and expectations, increasing the cost of transport. The economic transport susceptibility is significantly influenced by increased expectations and needs of recipients with respect to the quality of transport service rendered, which is measured by time,

punctuality and safety as also in relation to the quality of cargoes supplied. Cargoes of small value, requiring the application of suitable security measures, due to the threat that they pose in logistic chains, transported at long distances are economically non-susceptible.

A separate group is constituted by what is called unique cargoes (J. Neider, 2008) characterised by very low transport susceptibility. These are priceless treasures of national culture, e.g. monumental and modern works of art, goods with worldwide cultural value (e.g. excavations), and exceptional unique specimens of valuable jewellery. Because of the cargoes' exceptional values, their translocation, selection and equipment of means of transport must be accurately planned in a way that excludes any qualitative or quantitative changes.

Susceptibility and classification of cargoes in combined / intermodal transport

The technologies of intermodal transport do not find application for all goods appearing in branch transport. The cargoes' susceptibility to intermodal transport is measured by their susceptibility to containerisation, transport in replaceable bodywork and semitrailers [12, 13]. Cargoes susceptible to intermodal transport are high-value cargoes, impermanent, of high cargo-handling labour consumption, standardised and with parameters adapted to the dimensional series, permitting their single or double division into units. These are first of all general cargoes (up to 80% of mass of these cargoes). Bulk cargoes, appearing in transport in large amounts, having a relatively small value, are classified as non-susceptible to intermodal transport. Among bulk cargoes privileged with respect to containerisation are cargoes sensitive to the surroundings' microclimatic factors (e.g. cement, plaster stone) and burdensome ones, causing pollution to other cargoes and the surroundings, but also succumbing to pollution themselves. In NST/R classification, which is in essence division of goods with respect to kind, they were divided into ten groups of goods, and these in turn into goods sub-groups, which were classified into three categories with respect to natural susceptibility to technologies of intermodal transport:

Category I – goods with high susceptibility to intermodal transport:

Group 0 – products of agriculture, forestry and livestock farming.

Group 1 – other food products and animal fodder.

Group 8 – chemical products.

Group 9 – machines, means of transport, half-processed products and finished products.

Category II – goods with medium susceptibility to intermodal transport:

Group 5 – iron, steel, semi-products of non-ferrous metals.

Group 7 – chemical fertilisers.

Group 10 – petroleum products and their compounds.

Category III – goods non-susceptible to intermodal transport. Among them are: mineral solid fuels, e.g. coal, coke (Group 2); crude oil and gas (Group 3); ore and waste (Group 4); raw materials and processed minerals, building materials (Group 6).

It follows from the data presented that the division of cargoes with respect to the criterion of transport susceptibility leads to qualitatively differentiated effects: in branch transport to distinguishing cargo groups essential in transport techniques and technologies, in intermodal transport, on the other hand to goods classification according to kinds, into goods groups and sub-groups.

Conclusions

1. In transport literature there continues to be applied a differentiated terminology determining the resistance of cargoes to conditions and duration of transport processes.
2. The assumption of the term "cargo transport susceptibility" is justified by relating it to all stages of transport processes.
3. Uniform classification of cargoes with respect to general transport susceptibility of cargoes is not possible.
4. Distinguishing partial transport susceptibilities (natural, technical and economic) permits the grouping of cargoes on the basis of their natural properties, shape and form of appearing in transport and their value, related to successive stages of transport processes: carriage, cargo handling and storage.
5. The criterion of transport susceptibility leads to different grouping of cargoes / goods in branch and intermodal transport.

References

1. Rozporządzenie Komisji (WE) Nr 1304/2007 z dnia 7 listopada 2007 r., Dz.U. L290/14.
2. Standard Goods for Transport Statistics, Komitet Transportu Śródlądowego Europejskiej Komisji Gospodarczej ONZ, 2002.

3. MADEYSKI M.: Podatność przewozowa ładunków. Problemy transportu samochodowego. Ośrodek Badań Transportu samochodowego, nr 2, Warszawa 1960.
4. PIRATH C.: Die Grundlag der Verkehrswirtschaft. Berlin 1949.
5. MARZEC J.: Postęp techniczny w procesach transportowych. PTE, Stowarzyszenie Wyższej Użyteczności, Warszawa 1974.
6. MOKRZYSCZAK H.: Ładunkoznawstwo. Wydawnictwa Komunikacji i Łączności, Warszawa 1985.
7. MOKRZYSCZAK H.: Podatność transportowa i magazynowa ładunków. SGPiS, Warszawa 1988.
8. MOKRZYSCZAK H.: Profesora Mariana Madeyskiego teoria podatności przewozowej w literaturze transportowej. Problemy ekonomiki transportu, Ośrodek Badawczy Ekonomiki Transportu Politechniki Poznańskiej, z. 4(104), Warszawa 1998.
9. POGONOWSKA-SZUSZKIEWICZ A.: Leksykon pojęć ekonomicznych stosowanych w polskim transporcie kolejowym. Warszawa 1994.
10. MISZTAŁ K., SZWANKOWSKI S.: Organizacja i eksploatacja portów morskich. Zarządzanie, organizacja, eksploatacja. Wydawnictwo Uniwersytetu Gdańskiego, Gdańsk 2001.
11. NEIDER J.: Transport międzynarodowy. PWE, Warszawa 2008.
12. TYLUTKI A.: Podatność transportowa ładunków na przewozy kombinowane. Problemy ekonomiki transportu, Ośrodek Badawczy Ekonomiki Transportu Politechniki Poznańskiej, nr 2, Warszawa 1998.
13. WRONKA J.: Transport kombinowany / intermodalny. Teoria i praktyka, Szczecin 2008.

*Recenzent:
prof. dr hab. Zofia Cichoń
Akademia Ekonomiczna w Krakowie*