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Load restraint with allsafe products. Part 1: choosing a semi-trailer – a systematic analysis

Wykorzystanie metod zabezpieczenia ładunków przedsiębiorstwa allsafe. Część 1: analiza systemowa doboru naczepy ciężarowej

Abstract

The appropriate selection of a semi-trailer in food transport is one of the most significant factors related to management in transport companies. Two parts of the paper present research and analytical issues concerning this subject matter (second part available in: TT 2/2018). The description of this logistics problem is initiated with the proper planning of the road transport process, from consignor to recipient. Furthermore, the choice of a modern vehicle and loading system is based on the transportation of fresh strawberries. The first part of the article discusses current legal provisions existing in the European Union and Poland that concern the transport of perishable products. Moreover, the paper presents community law that concerns load restraint, and the choice of a vehicle, which is done by means of weighted-average methodology.

Keywords: road transport, provisions of law, transport centre, legislative directive, transport operation, load-carrying semi-trailer

Streszczenie

Problem optymalnego doboru odpowiedniej naczepy ciężarowej do przewozu towaru żywnościowego jest jednym z najważniejszych elementów prawidłowego zarządzania przedsiębiorstwem transportowych. Problematykę badawczą i analityczną przedstawiono w dwóch częściach referatu (część druga dostępna w numerze TT 2/2018). Przedstawiono ten ważny problem logistyczny, zaczynając od prawidłowego zaplanowania procesu transportowego rozpoczynającego się u nadawcy, a kończącego u odbiorcy pod kątem i na przykładzie wyboru nowoczesnego pojazdu drogowego i systemu ładunkowego na przykładzie przewozu truskawki świeżej. W części pierwszej szczegółowo przedstawiono obecną sytuację przepisów prawnych obowiązujących w Unii Europejskiej oraz w Polsce związanej z transportem artykułów łatwopsujących. Szeroko zaprezentowano wspólnotowe przepisy prawne dotyczące prawidłowego zabezpieczenia ładunku oraz dokonano wyboru pojazdu drogowego metodą wagową (ważoną) do transportu wybranego ładunku.

Słowa kluczowe: transport drogowy, przepisy prawne, środek transportowy, dyrektywa, operacja transportowa, naczepa ciężarowa

1. Introduction

The provision of transport services has recently undergone dynamic growth that accompanies an enormous increase in the exchange of goods on national and international level. Transport constitutes a primary activity, carried out in the context of a range of logistic services. As for food transport, it is exceptionally difficult both for the carrier and the organizer of the transport operation. Many factors can work to the detriment of the load, such as changing conditions during transport, wrong choice of vehicles or faults in their construction, and lastly, improper packaging and securing of the load. The loss of food caused by inadequate transport conditions reaches 30% – this entails financial losses. The first part of the article describes present legal provisions of the European Union and Poland in detail. When it comes to the planning of transport operations, a number of measures connected with the load need to be integrated and logistically synchronized. Firstly, an appropriate vehicle needs to be selected at the planning stage, with consideration to rules and methods of appropriate selection. Planning and putting those plans into action determine safe load delivery that should be carried out in accordance with individual terms of contract.

2. Material and scientific research method

This article addresses a part of the problem of road vehicle selection – this is dependent upon: the type of load; conditions required by the consignor, in accordance with ATP treaty that establishes standards for international transport of perishable goods; the agreement on the international carriage of perishable foodstuffs; the special equipment to be used for a given scenario [1]. The aim of the article is to select an appropriate semi-trailer for the carriage of strawberries, taking into account technical parameters related to active and passive safety systems. The selection of a means of transport may performed in several ways (inductive method, observation method). A method of comparative analysis was chosen in order to evaluate a proper vehicle, and in turn, help the carrier to choose a vehicle that would enable full performance of the transportation task, at the lowest possible costs, and in compliance with legal regulations. A weighted-average methodology is a comparative method chosen for the purpose of this article. Determining significant requirements connected with the transport order and defining the importance of a given requirement is essential in making the appropriate selection of a vehicle. A further step is to determine the technical features of the main and additional vehicle parameters and their evaluation. It is significant *to conduct effective* evaluation of particular parameters and compare the main technical parameters of selected vehicles. In this case, two vehicles are compared, and the following parameters are treated as criteria [8]**:**

- compliance with legal requirements;
- compliance with cargo shipping requirements;
- meeting requirements connected with the maximum payload and volume capacity of a vehicle;

- assessment of loading- handling capacity and load protection against damage or theft;
- assessment of vehicle traction possibilities with respect to planned routes;
- vehicle evaluation in terms of active and passive safety;
- meeting requirements concerning vehicle and cargo supervision on the route.

Levels of relevance (weight) are defined in points: scale from 0–10:

10 – necessary;
8 – very important;
6 – important;
4 – advisable;
2 – less important;
0 – unimportant.

Standard deviation, taking the values of:

1 – in accordance with the requirements;
0.7 – minor deviation;
0.5 – average deviation;
0.3 – divergence;
0 – significant divergence.

Furthermore, a summary table containing technical features of means of transport was established (0–10 scale).

The more satisfactory the technical conditions were, the higher the *score* was attributed to the vehicle. Subsequently, points were multiplied by weights and the results were divided by the sum of all weights.

I. The following parameters were adopted as technical comparative requirements:

- external parameter characteristics of semi-trailers;
- evaluation of traffic safety parameters and loading systems of the vehicles (technical characteristics).

II. Final choice of a vehicle (semi-trailer) with the use of weighted average – comparative method [8].

Weighted average – average value of technical parameters with weights assigned in such a way that elements with a higher unit value have a greater impact on the average value. The type of load and conditions set forth by a consignor are the main criteria taken into account. If all the weights are the same (all elements are of equal relevance), then the weighted average equals the arithmetic average.

Weighted average formula:

$$Śr\ \text{weighted avarage} = \frac{\sum_{i=1}^{n} \text{value}_i \cdot \text{weight}_i}{\sum_{i=1}^{n} \text{weight}_i}$$

$\sum_{i=1}^{n} \text{value}_i \cdot \text{weight}_i$ - Priority

$\sum_{i=1}^{n} \text{weight}_i$ - Conventional standard deviation

The total of points achieved by a vehicle/the total of priority points (possible to achieve) = weighted average.

Research was complemented by a substantive analysis that covers, inter alia, research relating to whether use of a given type of vehicle should be avoided due to its specific character. Therefore, there may be a need to change the conditions or reduce certain requirements that are not met – these changes could be achieved through adaptation or conversion of the routes, change in volume of load units, or taking measures that increase the utility and safety of the vehicle in question.

As for optimal storage conditions for fresh strawberries, the parameters are [1]:

- temperature conditions: temperature in loading area 0–1 [°C],
- atmospheric composition: humidity of the air 90–95 [%].

The means of transport and technology used during transport operations needs to meet specific requirements. Research analysis related to cold-storage vehicles need to meet the conditions of ATP (the Agreement on the International Carriage of Perishable Foodstuffs and on the Special Equipment to be used for such Carriage) [1]. Taking into account temperature and air humidity, a vehicle cooler should guarantee the proper storage and technical conditions (including physical, sanitary, bio-chemical and economic conditions). Considering standards of perishable food transport included in ATP, analysed transport operation requires 'B' class cooler vehicles equipped with cooling devices that maintain a temperature of +12 and -10 [°C] in a loading area, or 'C' class vehicles equipped with cooling devices that maintain a temperature of +12 [°C] and -20 [°C]. Currently, 'C' class vehicles are used most often, due to their broad range of maintained temperatures.

Further analysis of means of transport that are used for the carriage of strawberries will focus on two modern means labelled as FRC, in accordance with ATP (the Agreement on the International Carriage of Perishable Foodstuffs and on the Special Equipment to be used for such Carriage). These means of transport are heavily insulated class 'C' chiller trailers – FRC refers to [7]:

F – means of transport (chiller trailer)
R – heavy insulation (K coefficient k=0.4 W/(m^{2}K))
C – class C, cooler vehicle equipped with devices maintaining temperature +12[°C] and -20[°C] inclusive

Road vehicles analysed in the research process should meet additional technical requirements stipulated in regulations [14]:

1) Vehicle should provide any desired, practically constant temperature and air humidity, in conformity with the standards.
2) Airtight cargo area to prevent food from spoilage.
3) Water resistant, corrosion-proof and durable floor in cargo area.
4) Floor and walls of cargo area made of easy to clean materials that meet all hygiene requirements.

5) Watertight floor pan.
6) Vehicles used for food transport need to be cleaned and disinfected.
7) Loading area with no sharp edges or angles for rapid cleaning and disinfection.
8) Driver's compartment separated from cargo area.
9) Separate temperature zones allow the transport of different food products.

2.1. Research resources

Comparative research was based on the example of two modern semi-trailers:

1. Schmitz Cargobull semi-trailer TRIAXIAL FERROPLAST Type SKO 24/L- 13.4 FP 60 COOL (Table 1) [2, 3].
2. Krone Cool Liner cooling semi-trailer with double floor system by allsafe ATD II (Table 2) [5, 6].

The aim of the analysis of technical features is to check whether the trailers meet the requirements to perform the transport of strawberries. Particular attention will be paid to parameters that influence the technical capacities of vehicles used in transport of palletised strawberries. Additionally, road safety systems, driver's comfort, technical condition standards, modern systems of load securing, work economy, load safety and handling capacities will be described (Figs 1&2) [2–5].

Fig. 1. Volvo FH 4x2 420 and Schmitz Cargobull cooling semi-trailer

Table 1. Technical data of Schmitz Cargobull semi-trailer

Technical data	
King pin load: 12,000 [kg]	Inner height: 2,650 [mm]
Axle load: 27,000 [kg]	External length: 13,550 [mm]
Allowable gross weight.: 39,000 [kg]	External width: 2,600 [mm]
Tare weight with cooling unit and tank : 8,500 [kg]	Total height without load: 4,000 [mm]
Internal length: 13,310 [mm]	Loading capacity: 87.45 [m^3]
Internal width: 2,470 [mm]	Wheelbase: 7,875 [mm]

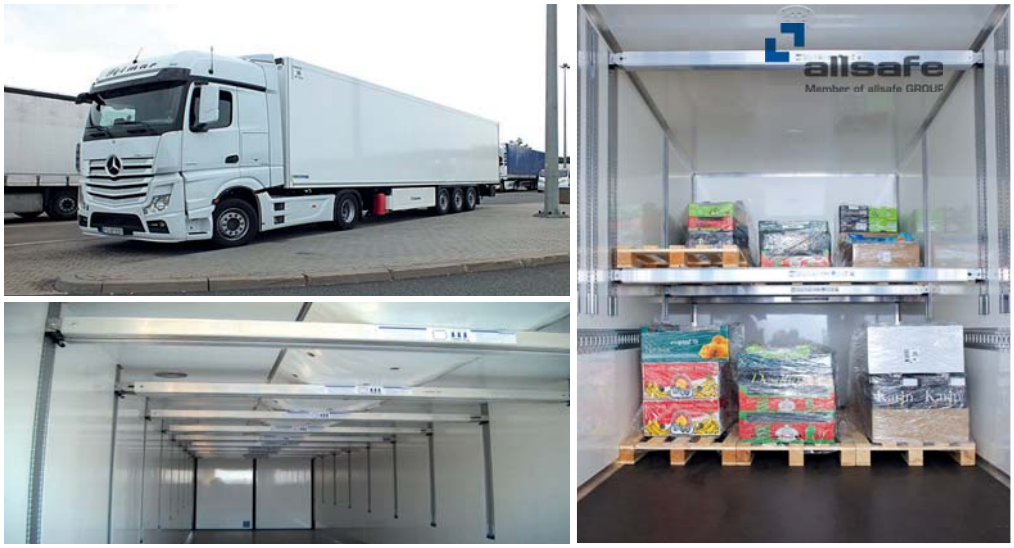

Fig. 2. Mercedes TGX 6x2 480 and Krone Cool Liner cooling semi-trailer with ATD II system

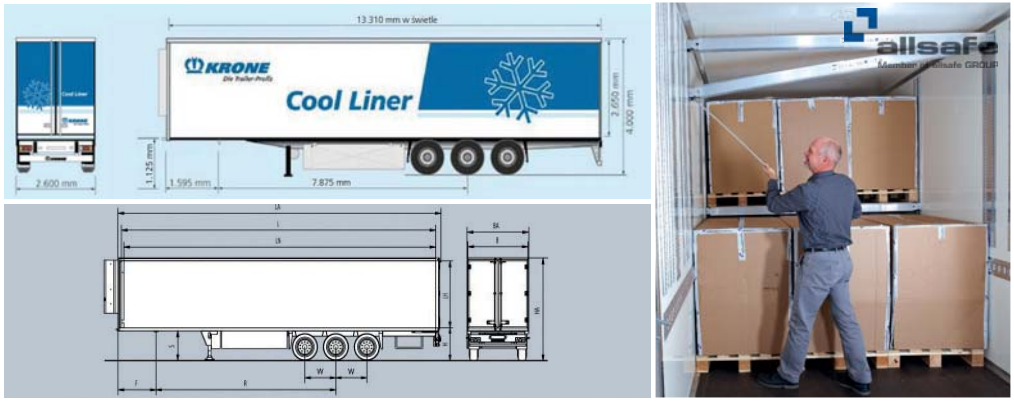

Fig. 3. Dimensions of Krone Cool Liner cooling semi-trailer with ATD II system

Table 2. Technical data of Krone Cool Liner semi-trailer with ATD II system

Technical data	
King pin load : 12,000 [kg]	Internal height: 2,650 [mm]
Axle load: 27,000 [kg]	External length: 13,550 [mm]
Allowable gross weight .: 39,000 [kg]	External width: 2,600 [mm]
Tare weight with cooling unit and tank : 8,500 [kg]	Total height without load: 4,000 [mm]
Internal length: 13,310 [mm]	Loading capacity: 87.45 [m^3]
Internal width: 2,470 [mm]	Wheelbase: 7,875 [mm]

2.2. Legal regulations concerning transport operation

Here follows the basic regulations referring to the transportation of goods and food in the European Union:

a) Regulation (EC) No 1071/2009 of the European Parliament and of the council of 21 October 2009 came into force on 4 December 2009 and became obligatory on 4 December 2011 – this established common rules concerning the conditions to be complied with to pursue the occupation of road transport operator. Regulation (EC) No 1071/2009 of the European Parliament and of the council regulates basic issues concerning undertakings that relate to requirements such as [10]:
   - establishing a transport manager in an undertaking;
   - having a head office of the establishment;
   - having authorization to pursue the occupation of a road transport operator (this is the same for all EU member states);
   - maintaining a good reputation;
   - having appropriate financial standing;
   - having rules concerning obtaining, suspension and withdrawal of licence.

b) Regulation (EC) No 1072/2009 of the European Parliament and of the council of 21 October 2009 on common rules for access to the international road haulage market, came into force as Regulation1071/2009 on 4 December 2009 and started to be obligatory on 4 December 2011. Regulation (EC) No 1072/2009 regulates issues concerning [10]:
   - member states licence to carry out international road transport;
   - driver's certificate for non-resident hauliers;
   - cabotage operations.

c) Regulation (EC) No 561/2006 of the European Parliament and of the Council of 15 March 2006 on the harmonisation of certain social legislation relating to road transport is a basic EU act that concerns driver's working and rest time [9].

d) Act of 16 April 2004 on driver's working time (Journal of Laws of 2004, No 92, item 879 as amended) regulates the system of drivers' working time [9].

e) The International Consignment Note on the international road haulage of goods was signed in Geneva in 1956. It was then ratified by Poland in 1962 when Poland became a party in international trade along with many other European countries. This note introduced and regulated requirements concerning road haulage and transport documentation. The application of the mentioned rules pertains solely to paid services in the international road haulage of goods carried out by professional road hauliers who have obtained appropriate authorisation in their countries [9].

f) International treaty on the carriage of perishable foodstuffs and on the special equipment to be used for such carriage. ATP (the agreement on the international carriage of perishable foodstuffs and on the special equipment to be used for such carriage) is a document of an extensive and complex structure concerning the implementation of transport requirements with reference to goods that demand controlled temperature. The agreement is valid from 1970 and it was adopted and

signed by Poland in 1984. It consists of 20 articles listed in 4 chapters and 3 appendices. The last amendment of the agreement took place in 2011 and includes [7]:

- types of perishable foodstuffs,
- temperatures required during transport,
- special conditions that vehicles need to meet to perform the transport of the mentioned products,
- required vehicle tests and signatures.

The treaty sets forth two main goals:

- maintaining quality and improving conditions of the transport of perishable foodstuffs, especially in international trade,
- contributing to growth in trade of the mentioned products.

Vehicles intended for the carriage of perishable goods should fulfil the requirements stipulated in the ATP agreement that concern [13]:

- heating equipment which is capable of raising the inside temperature of the empty body to + 12 [°C], and maintaining it for not less than 12 hours at;
- mechanical refrigeration which is capable of lowering the temperature inside the body from +12 [°C] to 0°C, from +12 [°C] to -10 [°C], and from +12 [°C] to -20 [°C];
- insulation equipment.

At the stage of transport *planning*, the transport manager should be acquainted with the range of temperatures that each product requires as this influences the choice of one of four vehicle groups that are accepted by the ATP agreement:

- mechanical refrigeration equipment,
- non-mechanical refrigeration equipment,
- heating equipment,
- insulation equipment.

2.3. Characteristics of legal provisions concerning the securing of loads

The system of legal regulations that refer to road transport is undergoing constant changes. Provisions are continuously being updated due to sustained progress in automotive technology. Much attention is paid to issues connected with transport safety and methods of securing loads. If restrained properly, loads should not displace or overturn, which would affect the safety of all traffic participants. A moving load may damage other cargo in the body or the body itself, it may constitute a danger for people or a serious obstruction to the traffic flow.

2.3.1. International provisions of law

a) Directive 2014/47/EU of the European Parliament and of the council of 3 April 2014 on the technical roadside inspection of the roadworthiness of commercial

vehicles circulating in the EU and repealing Directive 2000/30/EC, together with the international guidelines concerning safe load clamping on roads International Commission on Technology IRU (CIT) IRU_CIT-2014 version 01'. The aim of the guidelines is to provide information and instructions on loading/unloading, and the securing of loads for every participant of a transport chain, including consigners, carriers and freight forwarders. The instructions may be useful for controlling bodies and judicatory, or serve as a basis for organising vocational courses for drivers and carriers such as the Certificate of Professional Competence for drivers and the Certificate of Professional Competence for road hauliers. The guidelines provide a reference work of safe and effective load securing in all situations that may appear during a typical transport operation. These regulations should be treated as common ground for practical usage and the enforcement of load fixing. The document promotes safe ways of load restraint in the road transport of goods; moreover, it gives useful tips and information on how to achieve a safe level of load clamping in accordance with legal requirements and standards EN 12195-1:2010. Additional indications may shed the light on vital requirements to be complied with in reference to specific types of loads but should not aim at creating new requirements or limitations. Standard EN 12195-1:2010 contains more details useful for road hauliers such as 'Load Affixing Sets on Road Vehicles. Safety, Part 1:Calculation of Lashing Forces'.

b) German industry standards VDI
The standards describe ways of securing loads in detail, depending on its type. Standard VDI 2700 describes basic forces that influence the load, rules of cargo placement and practical tips on load clamping. Standard VDI 2701 refers to required clamping elements and standard VDI 2702 provides specifies rules concerning the choice of clamping elements. VDI standards are abundant with concrete examples and pictures that present how to clamp a load and secure it in a proper way, for example: huge glass panes, steel pipes, etc. [7].

c) Characteristics of standard PN – EN 12195 – 2 : 2010
This standard was introduced to assure compliance with basic safety regulations that relate to lashing strap traps used in Europe. Standard PN –EN 12195-2 'Load Clamping. Safety, Part 2: Lashing Straps' describes requirements concerning lashing straps for trucks and trailers, ships, railway wagons, and combinations of these [12].

2.3.2. National regulations

a) Law on road traffic
The Traffic Code regulates issues connected with load lashing in Poland. Moreover, a significant document that relates to load lashing is act of 20 June 1997, amended by an act 29 October 2010 r. on the amendment of the act on Road Traffic and other acts (Journal of Laws of 30 November 2010 No 225, item.1466).

b) Polish legislature introduced the Regulation of the Minister of Infrastructure and Construction on 6 May 2016, which amends the regulation on technical requirements,

as well as the scope of the necessary equipment, introducing the description of clamping points. Currently international road carrier association in Poland (ZMPD) translated "International guidelines referring to safe load lashing in road transport" which are unfortunately only guidelines, not regulations.

c) Transport Law

Pursuant to Article 65, Paragraph 1 of Transport Law the carrier shall be liable for the loss, partial loss, or damage of the consignment, occurring between the acceptance of the consignment, for handling and its delivery, as well as for late delivery. The liability of the carrier is not dependent upon fault, but rather on accepted risk. To hold the carrier liable on the basis of Article 65, four obligatory regulations were introduced [7]:

- Damage needs to take the form of loss, partial loss or damage;
- Damage takes place under the care of the carrier;
- A direct causal link between the occurring circumstances and the damage has to exist;
- A person entitled to compensation needs to perform so-called 'acts of diligence'.

Damage is the basic premise for a carrier's liability, which may take the form of loss, partial-damage or breakage. Loss of a load takes place when a carrier can't release the consignment to the receiver when the transportation deadline has expired. Partial load damage takes place when, at the moment of load release, there are losses in the form or decreases to weight, measures or number of units in comparison to the moment of its acceptance for transport. Damage of a parcel occurs when its market value is reduced, or its usability is decreased, due to quality changes. Such damage may be the result of mechanical factors (breakage, crushing, indentation), external factors (soaking, freezing, rust), biological or chemical changes (decay, fermentation, mould) [11].

3. Research results

Research of technical parameters and the basic requirements of the examined vehicles are presented in Table 3.

Adding together all points awarded to the researched semi-trailers across the separate groups of criteria, the following results were obtained:

- Schmitz Cargobull semi-trailer TRIAXIAL FERROPLAST Type SKO 24/L- 13.4 FP 60 COOL – 159 points;
- Krone Cool Liner cooling semi-trailer with double floor system by allsafe ATD II – **192 points.**

Taking into consideration the technical characteristics and results obtained according to the weighted average method, the Krone Cool Liner cooling semi-trailer, with double floor system by allsafe ATD II would be the most satisfactory choice for the transportation of strawberries [6].

Table 3. Results of road vehicle choice by the use the weighted average method

The method of weighted average was used in order to choose optimal means of transport on the basis of technical criteria										
No.	Requested technical parameters and basic requirements				Technical parameters and basic requirements for vehicles			Technical parameters and basic requirements for vehicles		
	Details	Unit of measurment	Figures or established requirements	Relevance	Volvo FH 4x2 Schmitz Cargobull cooling semi-trailer			Man TGX 6X2 Krone Cool Liner cooling semi-trailer (ATD II) Krone – box liner 40'		
					Figures or features	Standard deviation	Weight points	Figures or features	Standard deviation	Weight points
1	allowable gross vehicle mass	KG	42,000	9	4,000 kg	1	9	4,000 kg	1	9
2	tare weight	KG	18,000	8	14,845 kg	1	5	16,865 kg	1	9
3	authorised maximum load for a trailer	KG	32,000	9	31,040 kg	1	8	31,090 kg	1	9
4	authorised maximum load for a semi-trailer truck	KG	26,000	7	25,155 kg	0.7	7	25,250 kg	1	8
5	external dimensions of cooling semi-trailer (length/width/ height) [mm]	MM	13,600/2,600/40oo	6	13,600/2,600/4,008	0.7	6	13,550/2,600/4,000	1	6
6	internal dimensions of cooling semi-trailer (length/width/ height]	MM	13,400/2,500/2,650	8	13,315/2,460/2,650	0.7	8	13,310/2,470/2,650	1	8
7	double-deck loading	Y/N	Y	10	N(optional)	0.7	5	Y	1	10
8	maximum amount of pallet units	Pcs.	66	5	33	0.7	5	66	1	10

Table 3. Continuation

The method of weighted average was used in order to choose optimal means of transport on the basis of technical criteria										
No.	Requested technical parameters and basic requirements				Technical parameters and basic requirements for vehicles			Technical parameters and basic requirements for vehicles		
	Details	Unit of measurment	Figures or established requirements	Relevance	Volvo FH 4x2 Schmitz Cargobull cooling semi-trailer			Man TGX 6X2 Krone Cool Liner cooling semi-trailer (ATD II) Krone – box liner 40'		
					Figures or features	Standard deviation	Weight points	Figures or features	Standard deviation	Weight points
9	king pin load	KG	12,000	5	11,500 kg	0.5	5	12,000 kg	1	6
10	load securing systems	Y/N	Y	10	Y	0.7	7	Y	1	7
11	telematics systems (internal load monitoring)	Y/N	Y	10	Y	1	8	Y	0.7	8
12	ATP-FRC Certificate	Y/N	Y	10	Y	0.3	6	Y	0.5	6
13	loading platform in semitrailer	Y/N	Y	7	Y	1	7	Y	1	7
14	support lashing for intermodal transport	Y/N	Y	8	Y	0.7	8	Y	1	8
15	centre dividing insulated wall	Y/N	Y	9	Y	1	9	Y	1	9
16	load securing tracks in a side wall	Y/N	Y	6	Y	1	6	Y	1	6
17	load securing longitudinal and transverse tracks in side walls	Y/N	Y	10	Y	1	10	Y	1	10
18	additional all-around kick strip	Y/N	Y	8	N (OPTIONAL)	1	5	Y	1	8
19	ABS+ASR	Y/N	Y	8	Y	1	5	Y	1	5

Table 3. Continuation

The method of weighted average was used in order to choose optimal means of transport on the basis of technical criteria										
No.	Requested technical parameters and basic requirements				Technical parameters and basic requirements for vehicles			Technical parameters and basic requirements for vehicles		
	Details	Unit of measurment	Figures or established requirements	Relevance	Volvo FH 4x2 Schmitz Cargobull cooling semi-trailer			Man TGX 6X2 Krone Cool Liner cooling semi-trailer (ATD II) Krone – box liner 40'		
					Figures or features	Standard deviation	Weight points	Figures or features	Standard deviation	Weight points
20	aerodynamic system of semi-trailer	Y/N	Y	8	Y	0.6	8	Y	0.6	8
21	EBS with tilt stabilisation system RSP	Y/N	Y	8	Y	1	8	Y	1	8
22	automatic axle load measurement	Y/N	Y	10	Y	0.7	10	Y	0.7	10
23	telescopic locking bars on rubber feet	Y/N	Y	7	N (OPTIONAL)	0.5	5	Y	0.5	7
24	automatic safety locks	Y/N	Y	10	N (OPTIONAL)	1	5	Y	1	10
	TOTAL						159 points			**192 POINTS**
	$\sum_{i=1}^{n} \text{mean}_i$						0.81			0.97

4. Conclusions

The present legal situation concerning rules of transport operations and methods of load securing during transportation is governed by Polish and EU laws. The priority is to provide protection for people engaged in loading, unloading and transport, and also other traffic participants, pedestrians, the load itself and the vehicle. Loading and unloading should be performed by trained staff who are aware of the possible dangers. The analysis revealed that the Krone Cool Liner cooling semi-trailer with a double floor system by allsafe ATD II is the optimal choice – **192 points** (evaluation of competitive vehicle – 159 points). Loading capacities of semi-trailer and modern systems connected with load securing were the most decisive factors. Usage of double floor system ATD II by allsafe with adjustable height, allows the loading of sixty-six pallets at one time (the task required the usage of 64 pallets), whereas in the case of the Schmitz Cargobull semi-trailer TRIAXIAL FERROPLAST Type SKO 24/L- 13.4 FP 60 COOL, due to its low load capacity, there would be a need to use another set, or organize another transport – this would increase costs. Apart from economic factors, safety parameters also influenced the result (EBS and RSP in Krone) together with an additional load securing 'pallet stop' that allows reducing or avoiding the use of bars (or other security systems), thus reducing the load pressure on the front wall – this simplifies and shortens loading time. In the second part of the article, the weighted average method was used in the analysis of the safety systems of three producers. The rules of proper load placement and securing during transportation was discussed together with safety systems aimed at reducing the risk for the driver, the environment and other road traffic participants

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