



## Cover Page

### **RESEARCH JUSTIFICATION:**

**Integrating a weighing system to prevent the issue of overloading**

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## Management summary

This research justification provides information which serves as a basis for answering the following research question: “Is it worthwhile for P&S to integrate a new weighing system out of overloading concerns?”. The topic has been covered from different perspectives. In order to be able to answer the main question the following information gaps were identified:

(1) What is the environment and industry in which the company operates, (2) why the issue of overloading is relevant, (3) which constraints related to truck weight exist (4) which weighing systems exist, (5) what are the benefits and drawbacks of various weighing systems, (6) which system could be integrated and utilized by the company in order to prevent overloading issues, (7) is it worthwhile for P&S to integrate a new weighing system/device from financial, strategic, and ethical perspectives.

There are two main research methods which were utilized to fill in the information gaps: desk research and field research. The field research consisted of one interview with the worker from P&S and was mainly performed in order to acquire the information about the problem of overloading that the company had encountered in the past and identify all related to this issue factors. The field research was limited due to Coronavirus which considerably complicated the process of organizing and executing a bigger number of interviews. In contrast, desk research was used in order to fill most of the information gaps. There is enough of information available on the internet pertaining to the main research question and selected information gaps. It was ensured that only reliable and scientific sources were used.

Results of the research show that despite of relatively high short-term costs of acquiring a new weighing system, it is still beneficial for P&S to integrate the new technology in the long-run. Based on the research, the following reasons in favour of integrating the weighing system were identified:

- Positive impact on reputation
- Prevention of penalties
- Little dependence on future enforcements
- Minimization of costs

The recommendations and implementation plan are provided and described in detail in the end of this paper.

**Table of abbreviations & terms**

OWB	On-board weighing system
WIM	Weigh-In-Motion weighing system
Axle	An axle is a central shaft for a rotating wheel or gear. On wheeled vehicles, the axle may be fixed to the wheels, rotating with them, or fixed to the vehicle, with the wheels rotating around the axle
HGV	Heavy goods vehicles
Air suspension	Air suspension is a type of vehicle suspension powered by an electric or engine-driven air pump or compressor
Leaf suspension	Leaf spring suspension is made of a series of relatively long strips of steel attached at both ends to a frame and suspending the axle in the middle
Weighbridge	A weighbridge or a truckscale is a set of scale which is used to weigh bulk items. It is a set of scale which is mounted by the weighbridges manufacturer on a concrete surface.

## 1. Preliminary research

### 1.1 Company and product analysis

P&S Logistyka Sp Z O O (further in the text will be referred to as P&S) was found on the 17th of August 2011 on the initiative of the current owners Ilona Polak and Marcin Szydłowski. Since the establishment of the company, it has been able to realize nearly 100,000 shipments throughout Europe. Thanks to which the organization has gained vast experience and trust in the freight forwarding and transport industry. P&S currently specializes in transporting partial and full loads and highly focuses on the transportation of goods from Poland to Germany and vice versa (Interview: Vladimir Vorobiov, 2020). The fleet of the company consists of trucks meeting Euro 6 emission standard, meaning that the company strives toward zero emission road transport and maintains 0.08g/km of Nitrogen oxide. (RAC, 2020).

It provides the company with an edge against competitors since most of the countries strictly control emission levels and put penalties on the companies or even restrain trucks from entering their cities. One of the most prominent examples is Germany where the company has most of its orders from. P&S has its disposal Mega and Standard trailers. The trucks of the company are equipped with a satellite monitoring system, thanks to which forwarders can check the position of the vehicle at any moment in time (Interview: Vladimir Vorobiov, 2020).

The team of forwarders, communicating in Polish, Ukrainian, Russian, English and German is available 24 hours a day and constantly assists in choosing the means of transportation of goods and in providing information on the current position of cargo. There are three main departments which are engaged in the operations of the organizations, which are:

- Planning department which is primarily responsible for the route planning, maintaining contact with the drivers as well as ensuring successful delivery of goods.
- Finance department which is in charge of costs, revenues, salaries and other financial aspects.
- HR department is responsible for the acquisition of new workers, assistance in gaining necessary documents for foreign workers.

The HR department assists not only office workers but also drivers who are coming from other countries, but mainly from Ukraine (Interview: Vladimir Vorobiov, 2020).

The numbers of trucks and trailers has been gradually increasing since the year of 2012 up until 2019 respectively. Most of the trucks are being leased and the company has contracts with regard to the duration of use of all vehicles which are constantly renewed. The bar chart which represents the change can be found in the Appendix 5.

The change in the number of workers has also been rather positive and as of 2019 the number accounts for 90 employees. The bar chart is in the Appendix 6. The numbers include both internal workers which are located in the office as well as drivers of the vehicles.

Last but not least, the annual revenue of P&S and its considerable growth since the year of 2012 is shown in the Appendix 7 and reached the amount of 19356216,56 PLN in the year of 2019. Most of the freight forwarding operations are conducted for Polish or German customers and the main destinations where the cargo goes include Germany, The Netherlands, Belgium, and Poland.

The company primarily offers the services of transportation of goods: partial and full-truck transport services from Poland to Germany and vice versa, within Poland as well as within Germany. It is possible to transport from 1 to 38 standard pallets and any other type of goods. The maximum weight of the trailer is defined to be 24000 kg and the maximum length is 13,6 m. The company's trucks are adapted to transport hazardous materials - ADR - and all drivers have acquired the necessary training and certification (Interview: Vladimir Vorobiov, 2020).

## 1.2 Problem analysis

According to a recent logistics research study conducted by Capgemini – cutting transportation costs is still placed at the top list of challenges which have recently prevailed in the logistics industry (Logisticsmgmt, 2017)

Cost are usually comprised of numerous aspects, however, one of the most relevant aspects in the situation with P&S is penalties and fines paid due to the overloading of trucks (Interview: Vladimir Vorobiov, 2020). This issue has been gaining its importance gradually and had a touch on different organizations in the field of transportation of goods (Logisticsmgmt, 2017).

So far, the company has mainly applied static weights, even though it is worth mentioning that the weighing is not always required by the client (Interview: Vladimir Vorobiov, 2020). The main problem that P&S encountered in the past was overloading issues and consecutive penalties/fines paid by the company. The majority of the above-mentioned cases occurred in such countries as France and Austria. This is mainly due to the fact that the cargo and vehicle weight checks are conducted on a regular basis and these countries pay a lot of attention to this matter because of the possible damage to the road infrastructure (Interview: Vladimir Vorobiov, 2020).

Two tables below represent costs which were incurred by P&S due to the overloading of trailers conducted by the clients. Two clients operating in Austria and France (names of which are not mentioned out of privacy concerns) were noticed after overloading the trucks. Drivers were complaining about the weight of their trucks, more specifically saying that it is too heavy and it could be also detected because of the increased patrol usage by the truck. The tables include the amounts which were paid as penalties by P&S in the years of 2018 and 2019 respectively. In addition to that, it also shows the annual revenues generated from working with Austrian and French clients.

<b>Austria</b>	<b>Penalties</b>	<b>Annual revenue</b>	<b>% of revenue lost</b>
<b>2018</b>	3150,00 EUR	26657,37 EUR	12%
<b>2019</b>	750,00 EUR	8855,00 EUR	8,4 %

<b>France</b>	<b>Penalties</b>	<b>Annual revenue</b>	<b>% of revenue lost</b>
<b>2018</b>	4950,00 EUR	245231,87 EUR	2%
<b>2019</b>	6200,00 EUR	241004,52 EUR	2,6%

Source: Extracts from P&S 2018 and 2019 annual reports.

As it was already mentioned above, the industry has been developing at an extremely fast pace within the last decade, and therefore, the company has to ensure that it is able to integrate new ideas and systems. Otherwise, if the company remains at the same position, the same issues will continue to emerge causing damage to the company's revenues as well as image. Moreover, despite the fact that it seems like the company is performing well, it is still important to remember that P&S is a relatively small company which implies that penalties and fines which the company had paid caused significant damage to its financial performance and therefore this is the issue that has to be prevented in the future.

## 1.2 Information gaps

The main research question is formulated as follows: Is it worthwhile for P&S to integrate a new weighing system out of overloading concerns?

In order to acquire a clear idea of how the company could improve its operations in order to optimize the delivery of cargo and cope with the overloading issue, a number of information gaps should be addressed first. It is vital to determine and evaluate the current state of the company and the degree of impact that the issue caused in the past. Therefore, to answer the main research questions the following information gaps will be covered: (1) What is the environment and industry in which the company operates, (2) why the issue of overloading is relevant, (3) which constraints related to truck weight exist (4) which weighing systems exist, (5) what are the benefits and drawbacks of various weighing systems, (6) which system could be integrated and utilized by the company in order to prevent overloading issues, (7) is it worthwhile for P&S to integrate a new weighing system/device from financial, strategic, and ethical perspectives.

### **1.3 Project aim**

The main objective of this research was to find a system or method in which the company would be able to optimize its freight delivery process by coping with the overloading issue. In order to achieve this goal thorough literature analysis is planned to be executed with the aim of gaining insights about the industry and the environment in which P&S operates. Furthermore, it was accompanied by observational study within the company in order to see the structure of the organization and get a clear understanding of all the processes which take place at the different stages of service delivery.

Lastly, the internal worker was interviewed in order to acquire the overall perspective from which the firm sees current situation with regard to overloading issue. Due to this approach it will be possible to fill the information gaps and acquire necessary data to make relevant conclusions and draw up suggestions with regard to improvements and/or changes to the current organizational processes.

To conclude, the professional product that was delivered is a list of recommendations with the following implementation plan based around a new weighing tool which can be integrated into the trucks.

## **2. Research approach**

### **2.1 Approach per information gap**

As it was mentioned in the design section, there are 3 main approaches to be utilized for information collection: literature study, observational research and interview(s). The literature study was mainly applied in order to fill the first, the third, and the fifth information gaps. Based on the available literature, it was possible to acquire insights as to the environment of the company and the basic factors influencing the organization. This information was also used as a baseline for further research process which is observational research.

Observational research was mainly used in order to add to the first and partly the third questions. This method has been chosen due to the fact that the intern (researcher) was involved in the processes of the organization and therefore it will be possible to make observations as to how all the processes are organized and which approaches of running the business are utilized.

Lastly, the interview(s) was conducted in order to answer questions 4 and 5. It is planned to have two or three interviews, one of which would be conducted with one of the partners/clients of the company that has already utilized one of the modern weighing systems. Another interview would be conducted with a company which has no relation to P&S in order to acquire additional perspective on the effectiveness of weighing systems and their necessity for the organizations. Lastly, the third interview would be carried out with a company which actually sells and set ups the above-mentioned systems in order to have a clear understanding of the costs incurred and the complexity of system integration.

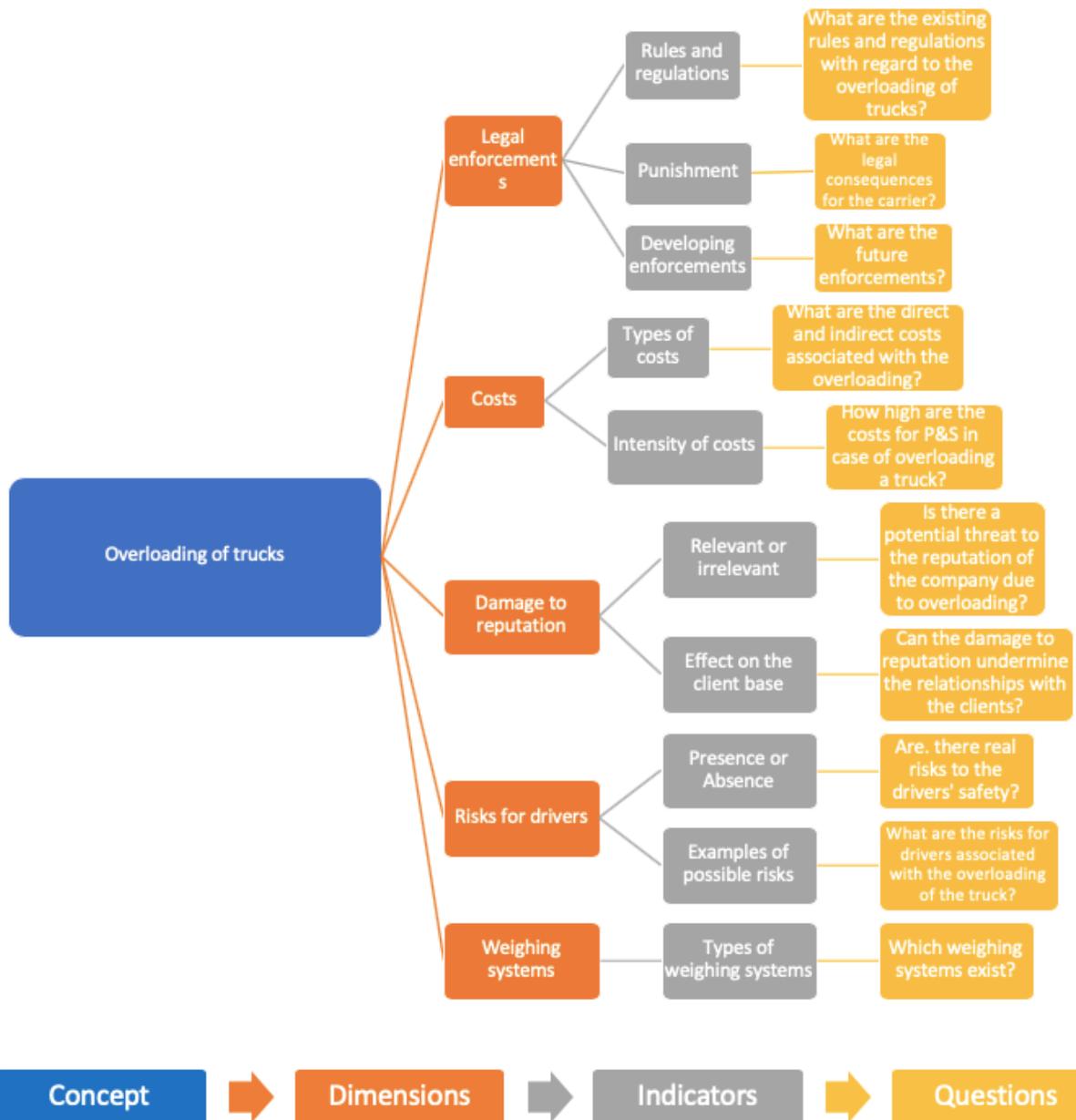
## **2.2 Research population**

The population of the research was mainly comprised of internal workers as well as partners and partners of the company. This decision was based on the fact that the information gaps which had to be filled were to a greater degree related to the internal processes of the organization and the way how the business is organized. In addition to that, partners and clients were included to the research population since they have different perspectives on the research problem and possible solution(s).

## **2.3 Data analysis**

The data analysis was executed after the each stage of research, meaning after the literature study, the observational research and the interview(s). It is done with the aim of exposing how data is linked together in order to create new, meaningful information (Arjan de Bont, 2014). The first step was structuring information and then analyzing it by using relevant theory and analysis models. In case of the interview(s), the recording was transcribed. The analysis was executed by considering all of the acquired data. This approach led to consistent and comprehensive conclusions and ensured that the information gaps were approached from different angles.

## 2.4 Operationalization



## 2.5 Reliability & Validity

In order to maximize the reliability and validity of research the following measures were taken:

First of all, only scientific sources for information gathering were used during desk research. This approach ensured the reliability of data. All of the main concepts of research were extracted from more than a single source.

Secondly, the researcher maintained objectivity and eliminated biases that could possibly undermine the validity of research.

Thirdly, the information was structured and organized in a manner that would maximize the level of comprehension of information.

## 2.6 Limitations

The main limitations associated with the research are the following:

- The issues caused by the recent developments associated with Coronavirus. This limitation had a huge impact on the overall results of the research. Initially, it was planned to conduct at least three interviews, however, due to the above-mentioned factor there was only one interview performed with the worker from P&S. Therefore, the whole research process was accompanied by observations conducted by the researcher at the working place. The information that has been gathered by observations included: the overall processes and tasks the workers are carrying out; situational behaviours and reactions, work culture and other aspects related to the working process in the office. In addition to that, a few suppliers of weighing sensors were contacted via e-mail in order to acquire some information on the products they offer. It was not possible to have the interviews with them either. Furthermore, suppliers preferred to have the conversation about the price arrangements directly with the managers of P&S rather than with the researcher.
- Lack of detailed information about the region/country where the company has its presence. The key players in the industry are Germany, Italy, France and the UK. Therefore, there was abundance of information related to the above-mentioned countries and the companies operating in the related industry. However, there were not many scientific sources which provided information about organizations in Poland.
- Reluctance of P&S to provide detailed financial information. There was not a lot of financial information available, since according to the worker from financial department the data is in the archives. It is hard to extract specific chunks of information; therefore, the data was limited. This factor also restrained any forecasting from financial perspective.

### 3. Results

#### 3.1 Overview of the industry

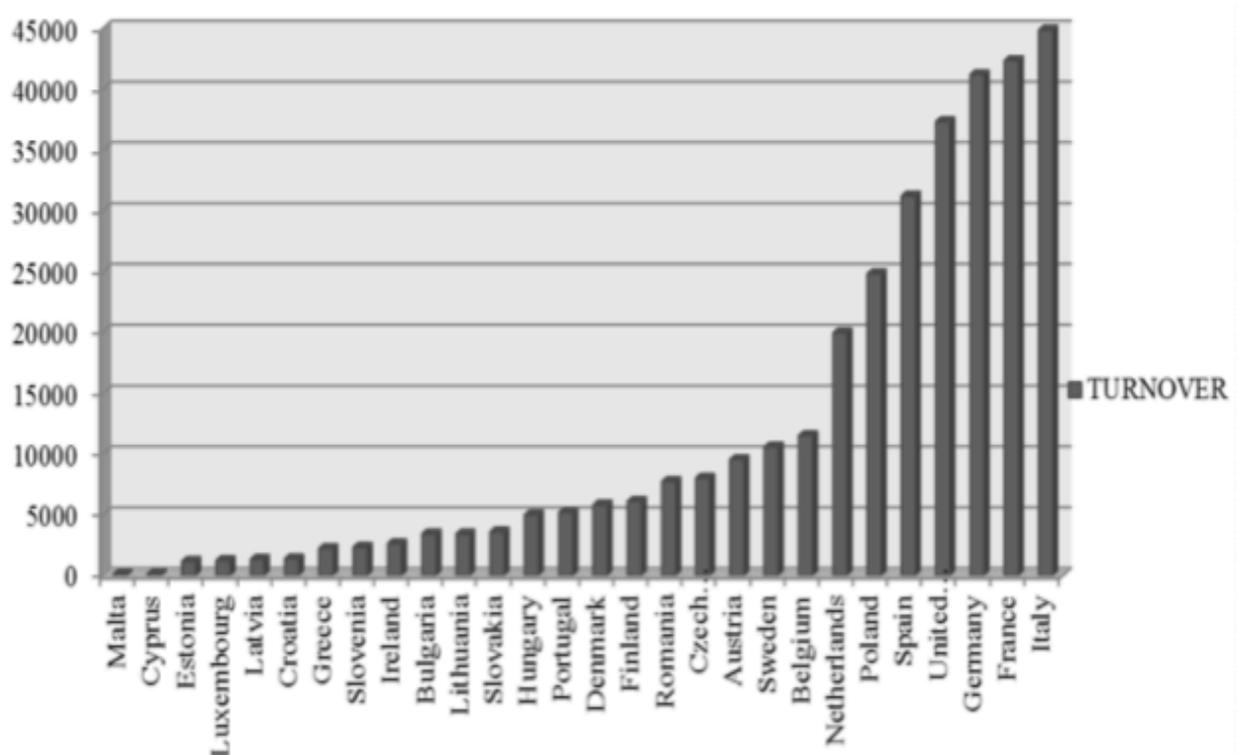
As it is already known from the company and product analysis, P&S operates in the road freight transport industry. It has already been operating in the industry for almost 10 years. "Road freight industry includes transportation of freight between companies and between companies and consumers" (Dora Naletina, 2018). Based on the information acquired from the related literature, road industry represents an extremely important sector in the European Union. In road freight transport industry alone, there are 3.07 million employees. Road transportation plays predominant role in the majority of all EU member states where "the modal split of freight transport on land is observed" (Dora Naletina, 2018). In fact, as of 2016, the median of road freight transportation share reached the point of 72.8%. Furthermore, this sector is also extremely important from the economic perspective since it generates nearly 2% of the GDP of the European Union, generating around 334 billion of Euros of total turnover in the year of 2015 (Dora Naletina, 2018).

The road freight market in EU is comprised of small businesses which normally employ less than 10 employees. In fact, as of 2016 the average number of employees reached the point of 5.36 employees. At the same time, the highest number of employees is common for Germany accounting for 11.56 people (Dora Naletina, 2018).

Another important factor to consider when analyzing the road freight transport industry is the average loading weight in road transportation. It plays crucial role in the respective industry, since many countries including Germany, France, Austria and Poland pay a lot of attention to this indicator as it has direct influence on the road infrastructure and associated costs. Therefore, the average loading weight in road transportation of goods in 2015 stood at the point of 13.7 tonnes. However, it is also worth mentioning that companies usually strive to use full capacity of trucks and reach 15 tonnes (Dora Naletina, 2018).

Another aspect which is often considered when dealing with road transportation of goods is called Empty runs. It mainly implies "trips by a transport vehicle without any freight loaded, i.e. all trips of a truck without freight are empty runs. They can cause considerable costs" (timocom, n.d.). During the years of 2005 and 2015, the number of empty runs was considerably reduced to 21% from 23% in 2005 (Dora Naletina, 2018).

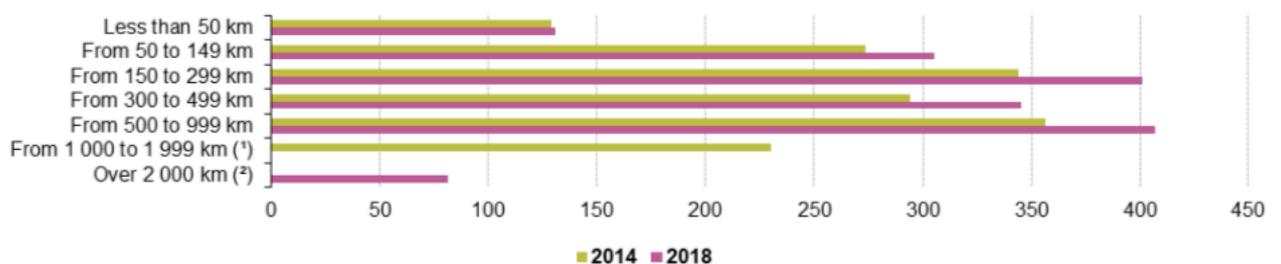
Chart 1. Turnover in road freight transport industry in the EU states in 2015 (mil. €)



Source: Dora Naletina (2018). Road freight market in the European Union.

From the perspective of tonnage, European road freight transport continued to rise in 2018 by 1,3% representing the highest value since 2014 (European Commission, 2019). In addition to the increase in tonnage, the same pattern could be observed in terms of distance in kilometers.

Figure 1. Road freight transport by distance class, EU, 2014 and 2018 (billion tonne-kilometeres).



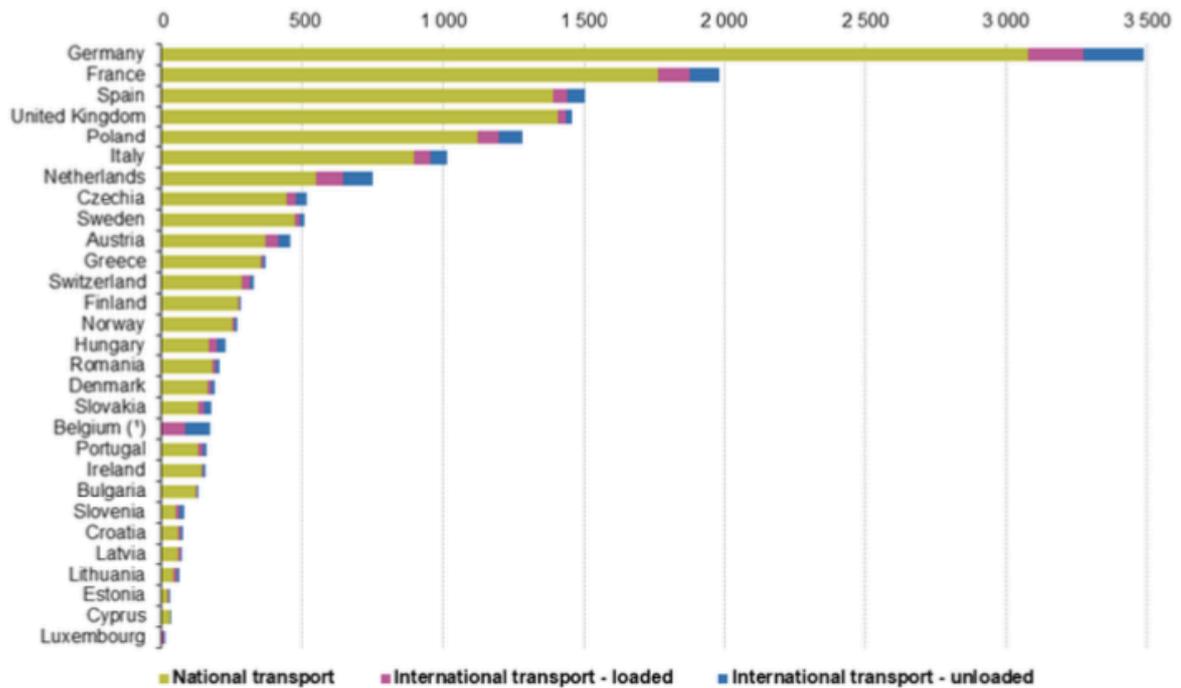
Note: Malta excluded (see chapter 'data sources'); Luxembourg data for 2018 not available  
 (\*) Confidential data for 2018  
 (\*\*) Confidential data for 2014

Source: European Commission (2018). Road freight transport statistics.

Figure 2 demonstrates the changes in terms of tonne-kilometres shipped by distance classes from 2014 up until 2018 for the EU member states. The biggest growth can be observed in the long distances, more specifically distances which exceed 1 000 km (European Commission, 2018).

There are four countries which represent the highest performance in the realm of road transport, these countries are: Germany, Spain, France and Poland. In fact, according to numerous sources these countries comprised 60.8% of the overall goods transported in the EU Member States (European Commission, 2018).

Figure 2. Transport of goods on countries' territory by type of transport, 2018 (million tonnes).



Note: Malta excluded (see chapter 'data sources'); Data for Luxembourg not available for 2018  
 (\*) National transport for Belgium is confidential

Source: European Commission (2018). Road freight transport statistics.

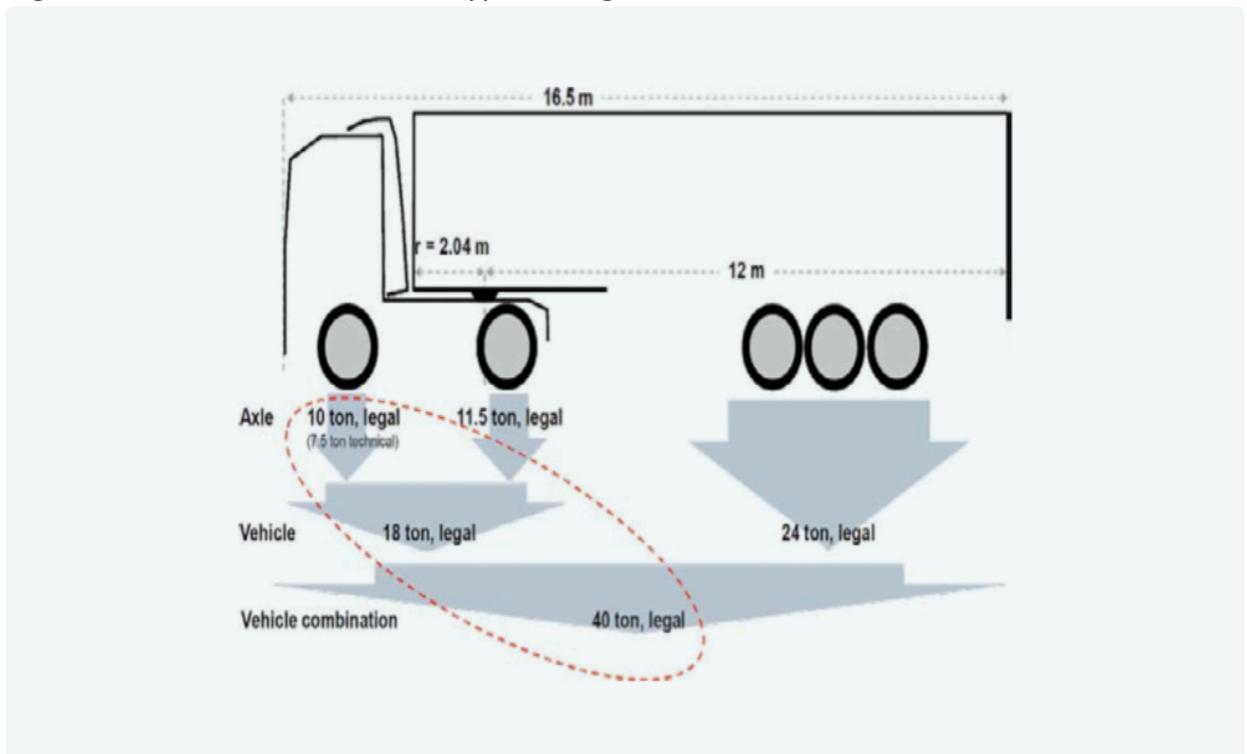
As can be seen from the figure above, Germany is ahead of other countries, however, Poland represents solid results accounting for nearly 1 500 million tonnes.

### 3.2 Heavy Vehicle Weights Constraints

Heavy Goods Vehicles or so, called HGVs have to follow weight and dimension standards which are specified in Directive 96/53/EC. The Directive defines “maximum common measures” (Aleš Žnidarič, 2015) to guarantee road safety and make sure that the roads, bridges and tunnels are not damaged by the vehicles.

Current EU law (Directive 96/53/EC) limits the maximum permissible vehicle mass to 40 tonnes, except for intermodal transports using 40-foot containers which are allowed a maximum weight of 44 tonnes. Maximum axle loads are 10t for a single axle and 11.5t for a driven axle (Aleš Žnidarič, 2015).

Figure 3. Load restrictions for a typical long-distance vehicle.



Source: Aleš Žnidarič (2015). Heavy-Duty Vehicle Weight Restrictions in the EU.

In addition to the road safety there are also other reasons why these restrictions are implemented including:

- Minimizing the costs of freight transport and acquiring consecutive economic benefits
- Reducing environmental damage and negative impact
- Improved overall safety on the roads

Source: Aleš Žnidarič (2015). Heavy-Duty Vehicle Weight Restrictions in the EU.

However, despite the fact that many countries in the EU are trying to achieve the above-mentioned goals, there are still issues that prevent many countries and organizations from succeeding in it. There are three main groups of issues that have been identified:

- The existing maximum dimensions of HGV's avert the industry from the uptake of more aerodynamic vehicles which could exceed the current HGV length limitations (Aleš Žnidarič, 2015).
- The defined dimensions fail to be in line with the technical improvements and developments of intermodal transport. "[...] the 45-foot containers used in maritime transport can only be transported on land with special permissions" (Aleš Žnidarič, 2015).
- Lastly, in the realm of stiff competition, those companies that are maximizing their loads despite the defined limits can acquire a considerable advantage over those organizations that actually follow the restrictions. (Aleš Žnidarič, 2015).

## **REASONS OF OVERLOADING**

- Economic factors

To start with, economic aspect is one of the predominant factors that causes overloading issues worldwide. In fact, transportation of 10% more load is approximately the same as 10% saving. Many organizations neglect weight restrictions regardless of high fines due to the fact that the probability of being caught is relatively low (Aleš Žnidarič, 2015).

- Irresponsible vehicle loading

Another factor is irresponsible vehicle loading in particular when multi-delivery transport takes place. Furthermore, there are some cases when axles of the vehicle can be lifted up off the ground which as a result causes axle overloading (Aleš Žnidarič, 2015).

It can be concluded that vehicle overloading is a major issue for the industry and especially for the organizations that are not able to keep up with the stiff competition. The problem is identified at various levels and it is of great importance for the countries to ensure rigid enforcement policies. Ultimately, if enforcement is followed, the drivers of vehicles are capable of learning how to load the vehicles properly and how to prevent axle overloading (Aleš Žnidarič, 2015).

### 3.3 Types of truck weighing systems

In order to be sure that the vehicle is not overloaded or examine the degree to which it is loaded different methods of weight measurements are used around the world. However, there are three categories of systems that are utilized practically worldwide. These weighing systems include: static, in-motion, or on-board weighing systems. More detailed division can be observed in Appendix 2.

#### Static weighing

By a wide margin one of the most precise techniques for gauging vehicles. Furthermore, it is considered to be the main system which is used in most of the countries as a reference when there is a case of purposeful overloading.

There are three main groups of devices for static weighing (Aleš Žnidarič, 2015):

- Weighbridges
- Axle weighers
- Wheel weighers

Weighbridges normally consist of a set of scales embedded between a steel gauging platform and a concrete foundation. The tool measures the weight of the entire vehicle together with the goods inside. This type of systems is integrated at the entrances of factories, warehouses or quarries (Aleš Žnidarič, 2015). The other two systems (axle weighers and wheel weighers) are considered to be more frequently used in Europe than in other parts of the world and mainly imply gathering information on the axle loads, however, their accuracy is normally much lower compared to the weighbridges. The deviation is mainly caused because of so-called stop-and-go driving over the weighing platform which quite often leads to substantial redistribution of the loading (Aleš Žnidarič, 2015).

#### Weigh-in-motion

It is important to distinguish two main types of it, which are low-speed weigh-in-motion and high-speed weigh-in-motion (WIM) (Aleš Žnidarič, 2015).

Low-speed WIM system mainly implies the measurement of a vehicle that crosses the sensors at a speed limited to 5 or 10 km/h. During the process, the driver is not allowed to accelerate or brake in order not to avoid inaccuracies. The whole process is always conducted in a fully controlled environment (Aleš Žnidarič, 2015).

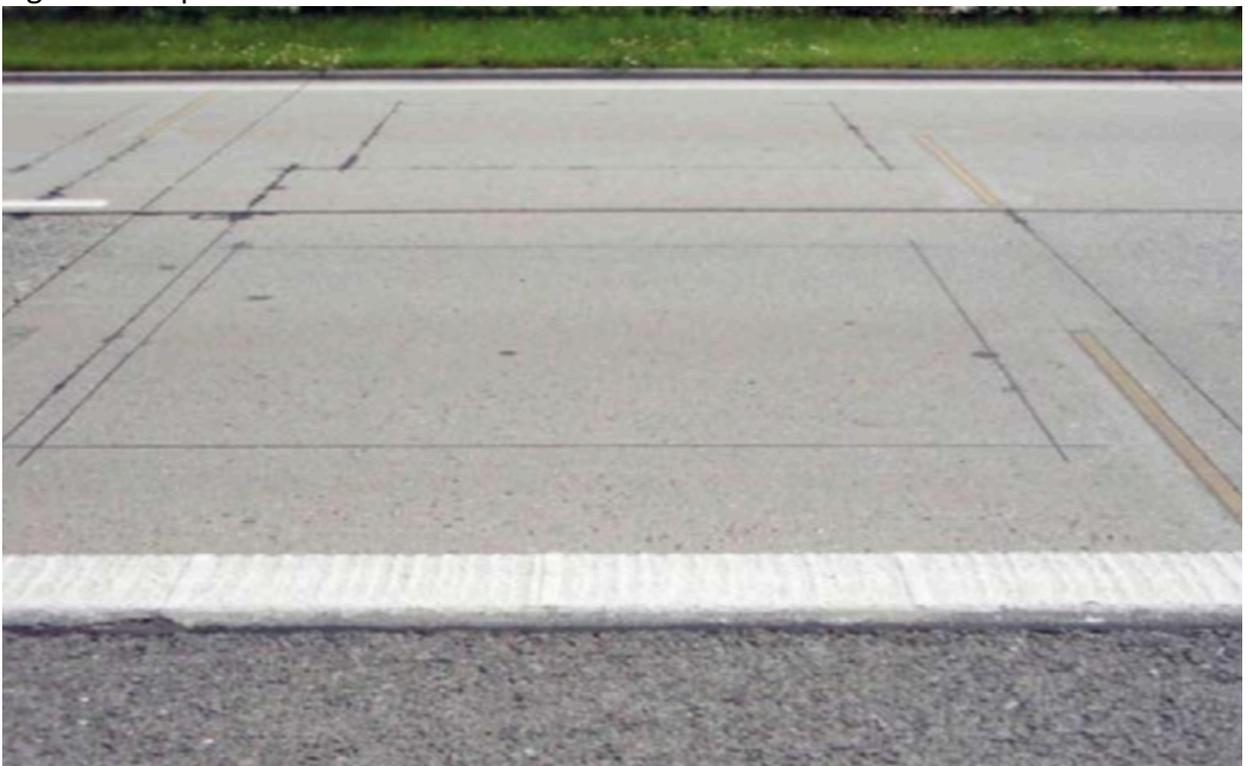
High-speed weigh-in-motion which is referred to as a WIM system, gauges the dynamic axle loads of the trucks in motion at full highway speed. Unlike low-speed system, the environment and conditions in this case are uncontrollable. Both of the systems are based on two types of sensors which are plate sensors and strip sensors. The two figures below provide a better understanding of how these sensors look like.

Figure 4. Plate sensor installation



Source: Aleš Žnidarič (2015). Heavy-Duty Vehicle Weight Restrictions in the EU.

Figure 5. Strip sensor installation



Source: Aleš Žnidarič (2015). Heavy-Duty Vehicle Weight Restrictions in the EU.

## On-board weighing

This system is used and integrated into the vehicles all over the world. There are two categories of OBW systems which are generally distinguished based on gauging: Gross vehicle weights and Axle loads. When dealing with HGV the axle load system is utilized (Aleš Žnidarič, 2015).

The axle load systems are embedded into the truck as additional sensors. Nowadays, many heavy vehicle manufactures have already come up with numerous ideas and solutions pertaining to effective axle load sensing devices (Aleš Žnidarič, 2015). There are three main sensors which are integrated into the vehicle based on the suspension type of the vehicle and accuracy requirements: load cell sensors, air pressure sensors, strain gauge sensors (Aleš Žnidarič, 2015). Pictures of devices can be observed in Appendix 3.

Table 1. Characteristics of OBW sensors

	LOAD CELL	APT	STRAIN GAUGE
<b>Accuracy*</b>	++ better than 1%	+ between 3-5%	+ between 1-2%
<b>Reliability</b>	+	-	+
<b>Ease of installation</b>	-	+	+
<b>Durability</b>	+	-	+
<b>Costs per axle</b>	from €8,000	from €600	from €1,200

Source: Aleš Žnidarič (2015). Heavy-Duty Vehicle Weight Restrictions in the EU.

**SWOT ANALYSIS**

**Static weighing**

S Strengths	W Weaknesses	O Opportunities	T Threats
<ul style="list-style-type: none"> <li>- High accuracy</li> <li>- More durable</li> <li>- Higher load capacity</li> <li>- Cheaper to maintain</li> </ul>	<ul style="list-style-type: none"> <li>- High construction and operational costs</li> <li>- Large area of land required</li> <li>- Expensive to install</li> <li>- Time consuming</li> <li>- Requires staff</li> <li>- Selection of trucks</li> <li>- No remote access</li> <li>- Necessity to pay for weighing</li> </ul>	<ul style="list-style-type: none"> <li>- No necessity to invest</li> <li>- Accurate data</li> </ul>	<ul style="list-style-type: none"> <li>- Not many facilities (factories) possess this type of a system</li> <li>- Can be manipulated</li> </ul>

**Weigh-in-motion**

S Strengths	W Weaknesses	O Opportunities	T Threats
<ul style="list-style-type: none"> <li>- Reduced costs of maintenance</li> <li>- Improved productivity &amp; efficiency</li> <li>- Cost effective</li> <li>- Comprehensive reporting</li> <li>- Can be used at highway speeds</li> </ul>	<ul style="list-style-type: none"> <li>- Less accurate</li> <li>- Sensitive to electromagnetic disturbances</li> <li>- Dependence on road surface</li> </ul>	<ul style="list-style-type: none"> <li>- No need to invest</li> <li>- Convenience in use</li> </ul>	<ul style="list-style-type: none"> <li>- Not always possible to acquire data</li> <li>- The trucks are checked when already loaded</li> <li>- Used by the government not by the companies</li> </ul>

**On-board weighing system**

S Strengths	W Weaknesses	O Opportunities	T Threats
<ul style="list-style-type: none"> <li>- Truck load optimization</li> <li>- Driver supervision</li> <li>- Elimination of unauthorized cargo</li> <li>- Lowered costs for suspension</li> </ul>	<ul style="list-style-type: none"> <li>- High short-term costs</li> <li>- Low durability</li> <li>- Necessity for calibration</li> </ul>	<ul style="list-style-type: none"> <li>- Compliance with national and European automobile standards</li> <li>- Beneficial for reputation in the long-run</li> <li>- More opportunities</li> </ul>	<ul style="list-style-type: none"> <li>- The static weighing may become more widespread and required by the government</li> <li>- The information passed to the planners may be inaccurate/outdated due to a bad</li> </ul>

maintenanc e - Less fines - Better safety of drivers - Real-time control - Load/unload duration control - Detailed analysis	- Current shortage of suppliers in the market - Lack of reliability of suppliers - The system is relatively new	s for efficient planning - Lowered costs in the long-run (maintenance) - Possibilities for the optimization of logistics processes - Opportunity to avoid road accidents	internet connection - Can become difficult for understanding for the workers - Can require installation of additional software - Can be incompatible with some of the current tracking systems of P&S
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Based on the SWOT analysis above, it can be inferred that On-Board-Weighing systems or OBW provides clear advantages and opportunities for the company. Despite the fact that there are also weaknesses and threats, this type of weighing system has solid edge against Weigh-In-Motion and Static weights. The OBW system is directly integrated into the axels of the vehicle and provides real-time information whenever it is necessary. The information is precise but sometimes deviations may occur. It facilitates more efficient and effective planning and assists in the load optimization and consecutive costs minimization.

The static weights are used primarily at the loading and unloading facilities, however, as it was retrieved from the interview with Vladimir from P&S: “the weighing process is not always required and conducted” (Vladimir Vorobiov, 2020). Sometimes workers at the loading facility can refuse to go through the procedure. In addition to that it is highly time-consuming.

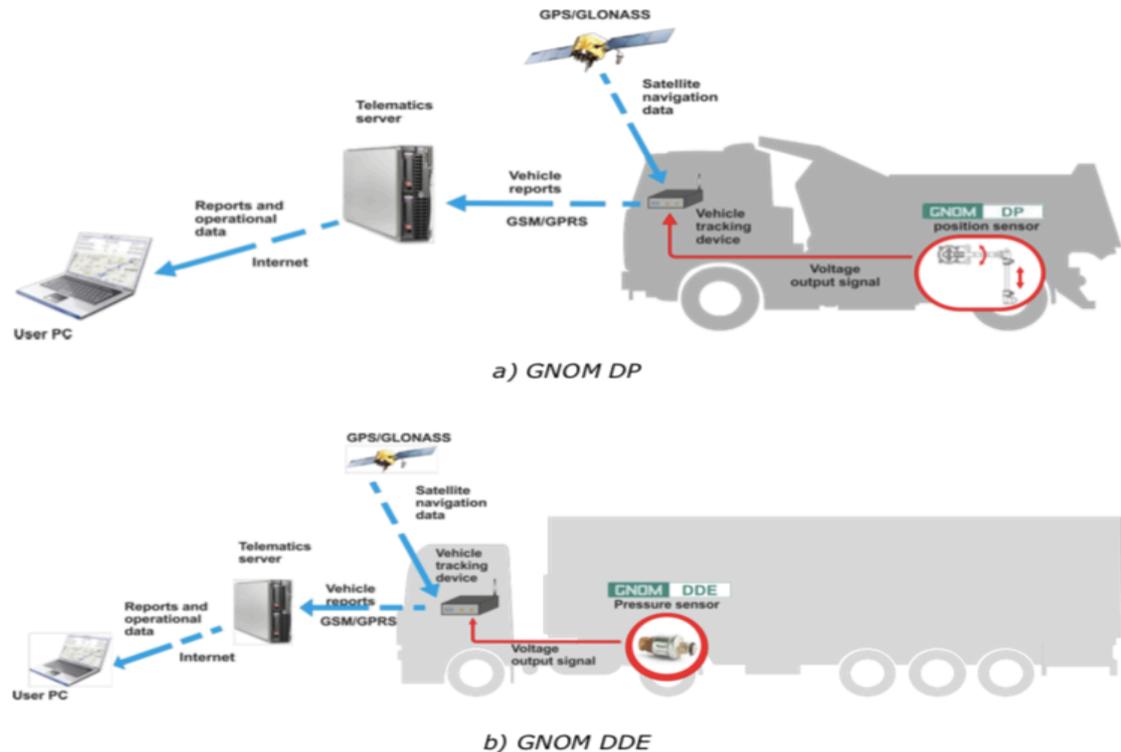
The Weigh-In-Motion system provides its benefits from the perspective of convenience, since the weights can be carried in the truck itself. However, usually these types of weights are used by the police on the road and the procedure of weighing is conducted when the truck has already been loaded. Therefore, in case of overloading, the company will incur costs in the form of a penalty or a fine. Furthermore, this type of weighing system requires frequent maintenance and hence the costs are higher compared to other systems.

Thus, based on the information and analysis above, the OBW system seems to be the most viable for the company. The system may imply high costs for the company in the short-term, however, the company may benefit in the long-rung from the perspective of optimization of planning and associated costs. In addition to that, it can have a positive impact on the company’s reputation since the number of overloading cases can be reduced to zero.

### 3.4 P&S and its vehicles

P&S has in its disposal vehicles only with air suspension, which implies that the (OBW) sensor which is supposed to be embedded into the trucks is GNOM DDE. It is a pressure sensor which is designed to measure axle load and cargo weight specifically on vehicles with air suspension (Technoton operational manual, n.d)

Figure 7. GNOM DP and GNOM DDE systems.



Source: Technoton: Operational manual (n.d.)

The operational principle of axle load sensors in the vehicle tracking system is the following: GNOM DDE gauges the pressure of compressed air in suspension circuit of the vehicle. Pressure depends on the weight of the load.

According to the information provided in the manual by Technoton: “sensors transmit measured values to the tracking device by generating analog voltage output signal. Tracker records and processes the sensor data for further transmission to the telematics server. Server software processes and analyzes the received data to generate analytical reports for a selected period of time. The user gets the report containing figures, counters, charts on vehicle axle load” (Technoton operational manual, n.d.).

There are numerous benefits of using the GNOM DDE measuring system:

- It ensures efficient load of the truck
- It provides the company with online cargo weight monitoring
- It prevents frequent overloading cases and consecutive penalties
- It provides solid ground for logistics processes improvements

- It creates possibility for a detailed analysis of the technological process of freight.

Source: Technoton. Operational manual (n.d.)

The standard GNOM DDE system pack includes:

- 1) Pressure sensor
- 2) Specification
- 3) Washer
- 4) O-ring
- 5) Mounting kit GNOM MR DDE1

Source: Technoton. Operational manual (n.d.)

In order to ensure that the weighing system works properly, it is necessary to have it compatible with the tracking device that is already installed on the trucks. Therefore, the tracking systems that the trucks of P&S have installed is are FleetBoard, Optifleet, RIO, Gbox (Interview: Vladimir Vorobiov, 2020). It has direct connection to the Transis software which is in turn installed on the computers in the office. The software allows to track not only the location of trucks but also how much time the drivers spend being idle and how much time they are on the move. This facilitates more precision in planning and execution of order (Technoton: Operational manual (n.d.)).

### **3.5 Reasons for P&S to integrate the weighing system**

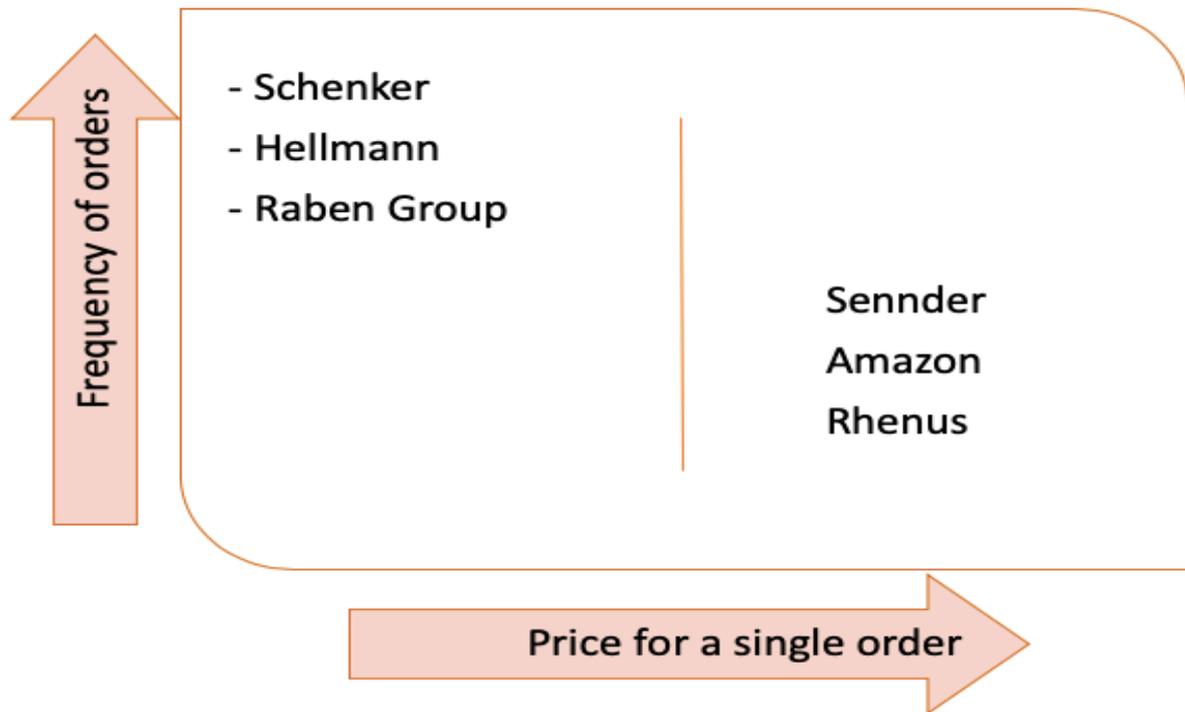
#### **Reputation**

Firstly, it is beneficial for the reputation of the company. The company does not have a website and a marketing department which would be responsible for maintaining high level of attractiveness of the company in the transportation market. It is accompanied by absence of any formal framework for measuring and dealing with the reputational risks. P&S is highly dependent on the client base that has so far been acquired which in turn can be sustained and increased only if the company continues to support positive and consistent reputation (Interview: Vladimir Vorobiov, 2020).

It is vital to deeply perceive the idea that “Effectively managing reputational risk begins with recognizing that reputation is a matter of perception. A company’s overall reputation is a function of its reputation among its various stakeholders [...]” (Robert Eccles, Business Harvard Reviews. 2007). One of the most important stakeholders of the company are its clients.

There are six key players/clients that the company is focused on which in turn divided into two groups according to the frequency and price of the orders:

Figure 8. The main clients of P&amp;S



Source: Interview: Vladimir Vorobiov (2020), Appendix

**Schenker** - Schenker is the world's leading global logistics provider — we support industry and trade in the global exchange of goods through land transport, worldwide air and ocean freight, contract logistics and supply chain management (dbschenker, n.d.). The company signs a contract with P&S yearly and provides orders weekly which on average accounts for fourteen tours (dbschenker, 2020)

**Hellman** – is one of the leading logistics companies located primarily in Germany. The organization has developed a broad network of 20,500 people in 489 branches in 173 countries (Hellman, n.d.). The relationships that P&S maintains with Hellman are practically the same as with Schenker. The orders are received weekly and the contract is normally signed from six to twelve months (Vladimir Vorobiov 2020, interview)

**Raben Group** has been present on the European market for over 85 years offering comprehensive logistics services. Companies of the Group are located in 12 European countries in: the Czech Republic, Estonia, the Netherlands, Germany, Lithuania, Latvia, Italy, Poland, Slovakia, Ukraine, Hungary and Romania (rabengroup, n.d.). One of the most frequent providers of order for P&S. The companies has been maintaining partnership for over three years already and has built strong and reliable relationships (Vladimir Vorobiov 2020, interview)

**Sennder** is an organization which positions itself as a digital road freight logistics partner. It maintains relationships with a number of companies that actually have trucks in their possession and that are responsible for the execution of the transportation of goods. Sennder provides orders for the company on a weekly basis and serves as one of the main income flows (sennder, 2020).

Another important client is **Amazon** which supplies orders on the transportation of goods primarily within Germany. It has become an extremely important client for P&S

especially during the times of Coronavirus. It is the only client that did not reduce the number of orders and actually has put efforts in order to maintain good relationships with P&S and continue working together towards in order to satisfy the needs of customers (Vladimir Vorobiov, 2020)

Lastly, there is **Rhenus Logistics**. It is a German logistics group that has its presence and serves customers in Europe, South America and Asia (rhenus-data, 2020). P&S receives orders from them every one or two weeks and considers Rhenus to be one of the most important clients and sources of revenue (Vladimir Vorobiov, 2020).

The issues with the overloading may become a serious hindrance and threat to the reputation. If the truck gets caught being overloaded while executing the order, it will cause not only short-term financial loss in the form of a penalty, but will also consume a lot of time.

### **Penalties**

The importance that European countries put on the overloading problem and measures that are implemented to cope with the issue can be another highly vital factor to take into consideration by P&S. The possibility that the amount the amount companies are charged with when being caught overloaded can considerably increase in the future. Most of the European countries attach great importance to the quality of road infrastructure and safety of its citizens (Aleš Žnidarič, 2015). Germany is a prominent example of a such scenario.

According to German legislation, the fines for overloading large vehicles begin from the overloading of the vehicle by 2% in relation to the gross vehicle weight rating. The table below provides a detailed description of the penalties to be paid in relation to the weight of a truck (TransInfo, n.d.).

Table 2: Penalties for overloading in Germany

Gross Vehicle Weight Rating (GVWR 3,5 tonnes):	Category according to the scale of charges:	Amount of penalty for a driver/carrier:	Penalty points:
up to 40.800 kg	no penalty		
above 40.800	over 2 percent	30 euro / 35 euro	0
> 42.000 kg	over 5 percent	80 euro / 140 euro	1
> 44.000 kg	over 10 percent	110 euro / 235 euro	1
> 46.000 kg	over 15 percent	140 euro / 285 euro	1
> 48.000 kg	over 20 percent	190 euro / 380 euro	1
> 50.000 kg	over 25 percent	285 euro / 425 euro	1
> 52.000 kg	over 30 percent	380 euro / 425 euro	1

Source: TransInfo. N.d.

As can be seen from the table, the amount of penalty to be paid by the driver or carrier can reach 425 euros. If we take into account the fact that the average price for a single order that P&S receives falls in the gap between 300 and 700 euros, then it becomes evident that such scenario can inflict considerable damage to the company's financial results. Moreover, it can undermine the relationships with the clients (TransInfo. N.d.).

In addition to the penalties which are paid out by the carrier, when the truck is being stopped and declared overloaded, the responsible inspection body will demand to reload the excess of transported goods to another truck (TransInfo. N.d.). This in turn, causes additional issues for the carrier including looking for the available truck that would currently be nearby.

### Future enforcements

Most of the European countries have been putting efforts in order to reduce overloading issues. In fact, there is a recently emerged "REMOVE" vision, which is gaining popularity across Europe and which focuses on the promotion of a "[...] harmonised approach to enforcement, where all member states are able, within their own national legislation, to apply sanctions which are in the main compatible across the whole of Europe" (Aleš Žnidarič, 2015). In order to achieve improvements, the "dual carrot & stick" approach is being integrated and applied in many EU member states. The model can be observed in Appendix 2.

Instances of a successful use of the above-shown approach can be observed in the Netherlands and France. In case of these two countries the approach implied gathering of information about offenders with a following company visits (Aleš Žnidarič, 2015). This

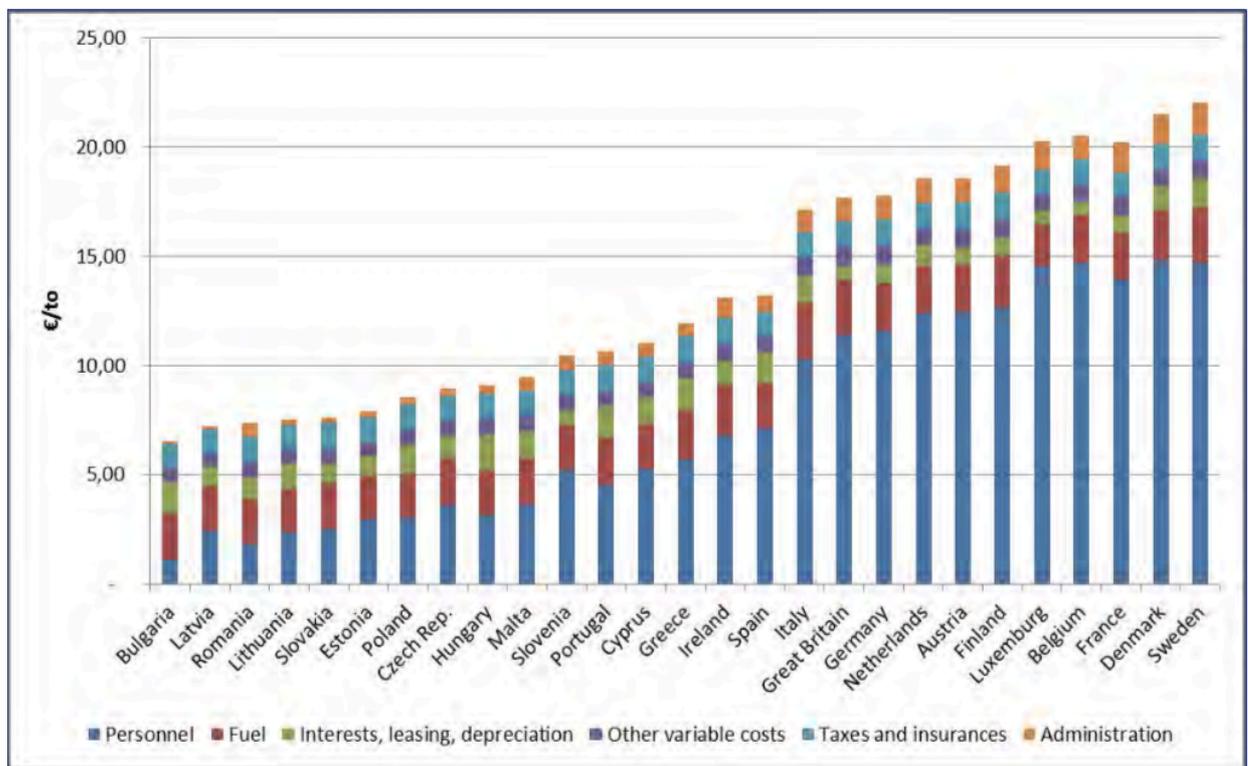
resulted in the changed behavior and attitude towards overloading issue in more than 90% of the companies that being caught on overloading. (Aleš Žnidarič, 2015).

Another aspect which has been widely reconsidered is current fining policies. So far, most of the offenders has been caught inconsistently. In addition to that, the amount that the offenders are charged with usually varies in many countries from hundreds to thousands of Euros. However, it becomes reasonable to suggest that if more money is going to be collected through fines, it will become easier to finance the repairs associated with the damage cause to the infrastructure (Aleš Žnidarič, 2015).

**Minimization of costs**

Aside from the fact that penalties imply unnecessary direct costs for the company, there are also indirect costs which are associated with the issue.

Figure 7. The cost structure of road transportation in EU



Source: European Commission (2018). Road freight transport statistics.

The figure above depicts the cost structure which is prevalent for the EU member states in the road transportation industry. It can be said that the common pattern for most of the countries is high personnel costs. This is mainly associated with the fact that companies incur costs associated not only with the personnel within the office but also with the drivers, the number of which usually goes beyond 100 people (European Commission, 2018). However, the interesting element of this bar chart is that for Poland, the costs associated with fuel are nearly as high as personnel costs.

Therefore, for the majority of the organizations in Poland this factor requires special attention and plays crucial role in financial results.

The biggest cost elements of the company are leasing & purchase of trucks as well as gas & material expenses (see Appendix 8). The personnel costs are divided into two main categories: workers in the office and drivers accordingly. All together the personnel costs account for 28%. Hence, for P&S expenses which are associated with fuel are essential and always taken into account.

In P&S, the truck on average consumes 25 liters of fuel per 100 kilometers. In order to reduce costs associated with the fuel, all of the trucks are filled to its max capacity in Poland. In contrast, when it is necessary to refuel a vehicle in Germany or other countries, the tank is filled with the amount that would be enough in order to reach the place of loading, the place of unloading and with a small margin left for the next refueling point. However, if the truck is overloaded, the amount of fuel which is burned grows up to 30-33 liters per 100 kilometers. It does not only increase the costs of refueling but also forces the driver to stop more frequently in countries where it is more expensive to refuel.

#### 4. Conclusion

As it was covered in detail in the results part of the research, there are different ways of weighing the truck which are applied throughout Europe. However, there are three main categories: Static weighing, Weighing-in-motion (WIM), On-board-weighing (OBW). Each of the methods has its advantages and drawbacks. Static weighing is applied less frequently than the other methods regardless of the fact that it is one of the most precise methods. The weighing scales are embedded in the roads which is not always convenient and possible for gauging the weight of the vehicle. WIM, in turn, is a set of sensors which are also integrated into the road and which allow to measure the weight of the vehicle at both high and low speed. Lastly, OBW system. The system that P&S has been mainly considering. This method of weighing is hailed as the most convenient since the sensors are integrated directly into the axles of the vehicle. This in turn guarantees that the responsible for planning employees are always capable of checking the weight in real-time. It automatically provides the opportunity to prevent overloading.

As it was mentioned in the parts above, there is a serious threat to the reputation of the company because of the overloading. P&S relies on its regular clients which are Amazon, Sennder and Raben. Therefore, it is a necessity to ensure that P&S maintains the reputation of a reliable partner the trucks of which will not be stopped during the execution of one of the orders.

Therefore, the measures of overloading control are getting more and more sophisticated as well as more rigid for the offenders. Based on all of the information above, the final conclusion is the company needs to integrate the OBW system. The improved reputation and consistency in successful deliveries of goods can promote the company and attract more partners. P&S has not implemented any promotion of its services and does not have a website, therefore, the decision of integrating the OBW system can serve as a strong edge that the current clients would take into account when choosing logistics service provider.

## 5. Recommendations

As it was described in other research parts above, there are numerous reasons for P&S to integrate a new weighing system. The reasons included reputation of the company, minimizations of costs, security of drivers, prevention of penalties and reduced dependence on future enforcements. All these factors serve as a solid basis against short-term costs related to the purchase of a new system. Therefore, the following recommendations as to the purchase and integration of a new system were identified:

### Type of weighing system

First of all, based on the SWOT analysis provided in the results parts, it can be concluded that the most appropriate system to use is OBW sensor and more specifically GNOM DDE. The choice fell upon this model due to the fact that it measures axle load and cargo weight specifically on the vehicles with air suspension (Technoton: Operational manual (n.d.)). All the of company's trucks are equipped with the air suspension and therefore, the OBW system will serve as an effective tool to keep track of all trucks in real time. As it was also revealed from the conversation with one of the firms that is offering weighing sensors, the device is compatible with any GPS tracker with voltage input up to 5V which implies compatibility with all of the trackers that P&S has been using so far: Gbox, Optifleet, Fleetboard, and RIO (Kristina Pechkurenko, Appendix 9). The main factors in favour of choosing OBW system to static or weigh-in-motion scales is its flexibility from the perspective of usage and the number of additional features that it provides (Kristina Pechkurenko, Appendix 9):

- Truck load optimization - data from sensor are used for detecting truck overload and underload.
- Driver supervision and elimination of unauthorized cargo.
- Avoiding fines for exceeding maximum axle load.
- Decreasing costs for suspension maintenance - if vehicle is loaded optimally, suspension will last longer.

### The time span for integrating a new system

The approximate time span for integrating a new system would be between 12 to 20 months. The device is relatively small and does not include many manipulations during the installation process. However, there is still a necessity for the delivery of the device and the process might be complicated amid the current situation with Coronavirus. Most of the companies that are offering the product are closed at the present time but it is still possible to come to an agreement as to the purchase of the product and the delivery dates. Furthermore, apart from the situation with Coronavirus, after the installation, the device has to be tested and calibrated according to the specifications of the company's

trucks (Technoton: operation manual, n.d.). Lastly, regardless of the fact that the sensor is compatible with the company's trackers, it is still necessary to ensure that all of the information that is gathered by the new sensor will be successfully transmitted to the software which is installed in the office. In order to ensure it, the technician that P&S is cooperating with has to get acquainted with a new technology and also expose it to a number of tests.

### **Training of staff**

There is no necessity to develop training programs for the drivers since they are not involved in the usage and processing of information which is generated by sensors. However, the planning department needs to get acquainted with the new features which are coming with the new device. Firstly, the technician will conduct numerous tests in order to optimize and tailor the software to the new sensor. Secondly, in order to achieve the best results, the planning department will have to cooperate and provide feedback throughout the whole process of trials. This will ensure the effectiveness of the program and the maximum convenience in the usage of new features. Most of the workers in the planning department are students and early technology adopters, therefore, it should not be an obstacle to adapt to the new technology. However, it has to be specified by the management what exactly is expected from the workers when they are applying the new system.

### **Choosing the right supplier**

As it was already covered in the other research parts above, there are not many OBW systems currently available on the market. More specifically, the device normally goes with the same features regardless of the country of the producer. Most of the supplying companies are trying to compensate similarities of the device and stand out among competitors by fostering partnership relationships with the customers. One of such companies is Technoton. The company has been established in the year of 2000 and "[...] offer comprehensive solutions for remote monitoring of road and off-road trucks" (Technoton, n.d.). The company has numerous products available apart from the vehicle weighing systems and therefore it would be beneficial to arrange the purchase of the product and cooperate with them in the future. In spite of the fact that Technoton has not specified the conditions for possible partnership they are still open for conversation and already cooperating with numerous companies (Technoton, n.d.). It was however mentioned by one of the representatives that the price conditions can be arranged with the management depending on their goals. Normally, the prices for OBW sensors on average reach the point of €600 per axle. Thus, if the company decides to integrate the OBW device then the overall amount would reach approximately €43,800 since the company has 73 trucks in its possession. The price can be high for P&S since the company operates on a small scale, however, the potential benefits can pay off in the long-run.

**Explain why the system is needed**

Apart from the fact that the staff of the company is needed to be taught on how to use the new features which are coming with the sensor, it is also important to outline why the system is needed. As it was described in the McKinsey 7s analysis, there is no clear vision of the future that P&S sees itself in. The employees of the company therefore, may not understand why it is necessary to integrate a new system if the short-term costs can be high. In addition to that, not all of the workers are aware of the fact the European legislation is constantly getting adjusted in order to minimize damage to the road infrastructure (Aleš Žnidarič, 2015). Moreover, not all of the employees may not recognize the importance of the reputation and which role it plays in the acquisition of new customers. Thus, it is recommended for the management of the company to explain the main reasons for integrating weighing sensors as well as mention what are the possible benefits both for the employees and P&S in overall. This will prevent unnecessary friction and doubts of workers when applying the new system.

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## Appendices

### Appendix 1. Interview: Vladimir Vorobiov. P&S.

**R:** Hello Vladimir. Thank you for agreeing to come for the interview.

**V:** Hi Roman, no problem. Unfortunately, I do not have much time but I hope I will be able to help you.

**R:** I understand, I hope you don't mind if I record the interview?

**V:** No problem

**R:** Alright, then think we can start. Could you briefly tell about yourself and your position within the company?

**V:** Yes, sure. I started working for the company from the moment it was established in 2011. At that moment we did not have many workers and even did not have a good office. There was our management Ilonad Polak and Marcin Szydłowski and a few other workers in financial department. At that moment we only had a few trucks which were used for the transportation of goods and I was responsible for the planning and controlling of drivers. After some time we acquired new workers, the company started growing and we had more trucks. I decided to change my role and moved to the financial department while other or new workers took responsibility for the drivers and planning.

**R:** In your opinion the company has been developing in the recent years? If so, how fast and effectively?

**V:** The company has been definitely developing and growing. As I already mentioned to you before, the number of trucks and trailers has been growing as well as the number of employees. The revenues have been growing as well and I can provide you some numbers if you want a little bit later.

**R:** Can you tell what is the current number of employees?

**V:** We have 90 employees including drivers. Actually, we have 73 drivers and all the rest are workers from the office.

**R:** Are these employees Polish, Ukrainian or German?

**V:** Most of the workers in the office and the drivers are Ukrainian. Our management is Polish but they also speak German. We decided to take Ukrainian workers and drivers because there is a really big flow of workforce coming from the country and it is very convenient to work with them from the perspectives of costs as well as cultural similarities.

**R:** Alright, maybe we could talk now more about the business and how it is organized. Could you describe the process of acquiring customers and the company actually maintains relationships with them?

**V:** Almost from the beginning of our operations we have been using the platform which is called TIMOCOM. This is a platform or you can even call it an auction where clients or customers place different orders. Then transportation companies can contact them and tell whether they are capable of conducting the order and then they can arrange the price and conditions. We are still actively using this method. For example such clients as Schenker, Hellmann, Raben were acquired through this platform. We executed a few orders for them at the beginning as a trial and then after maybe two months we actually started signing yearly contracts with them. The same actually worked for Sennder and Amazon. We carried out a few orders for them and then offered to sign a contract. Now we are regularly working with them.

**R:** Okay, I see. Maybe you could name some of the main clients and partners of P&S?

**V:** One client is Rhenus. At the beginning we only had 1-2 orders from the weekly. Now we have a lot more. We started working with them 3 years ago and we still maintain good relationships. In terms of stability, I can mention Schenker, Hellmann and Raben. We receive orders from them on a regular basis. If we are talking about money and profit then it is Hellmann and Schenker.

**R:** Alright, you already mentioned profits but what are the main expenses of the company?

**V:** I think it is fuel and personnel. Also trucks. We pay for fuel, leasing and maintenance.

**R:** And what are the main brands of trucks that the company has in its possession right now?

**V:** We are mainly using MAN, Reno and Mercedes.

**R:** Okay, and as I understood each truck is equipped with a tracking system. Are these systems all the same?

**V:** Yes, you are right. They are all equipped with a tracker system but they can be different. Our MAN trucks are using the system which is called RIO, Mercedes trucks are using FleetBoard and Reno trucks are using OptiFleet. In addition to that some of the trucks are equipped with Gbox system. All of the programs have cards which are sending the information to our software in the office. These trackers are bought by the company. Usually, these tracking systems are offered in salons where you are buying the trucks and the monthly access costs approximately 2 euros.

**R:** Could you describe in more detail how it actually works?

**V:** We have a software which was developed and tailored specifically to our company. It is called Transys. This software reads the information from the trackers and saves it on computers in real-time. It does not matter which tracking system is used, it is compatible with the software and all the information can be gained when needed. Sometimes we have problems of course. Maybe because of the internet connection or some errors. But the software is regularly improved and nowadays works much better than when we just started using it.

**R:** I have already started looking for some information with regard to the weighing sensors and systems and one of the first things that I came across was the question about the type of suspension which is used on the trucks. There are two types: leaf spring suspension and air/pneumatic suspension. Could you tell which type is used by the company's trucks?

**V:** Yes, our trucks as well as most of the trucks which are used for international transportation of goods are using air/pneumatic suspension.

**R:** What is the average weight of trucks with and without the trailer?

**V:** The average weight of the truck itself is around 7-8 tones. If we are talking only about the truck. Because all of our trucks obviously have trailers. So if we are taking empty trucks with trailers then it is on average 14-15 tones all together. But it also depends... Sometimes... When the truck is in the process of weighing, it has to drive on the platform with an empty fuel tank because it also influences the weight. That is why, on average we usually consider the weight of the truck to be from 13,500 to 15,500 tones. Sometimes it can be over 16 tones. If you need precise information then it is possible to find it in the registration documents in each trailer of the truck.

**R:** Alright, I understand. And how many axles are there on the trucks?

**V:** The truck itself has usually two axles and the trailer has 3 axles. But again, there are trailers which have one axle which can be lifted and not used.

**R:** Can you tell which types of weighing systems are used in general and which types are used specifically by P&S?

**V:** Usually static weights are used. So if we are talking about the weighing system which is used it can depend on different goals. If we are weighing the truck it is usually done for the goals of loading and unloading. That is why we are using static weights. If the weight of the truck has to be controlled and checked on the road then the weighing system is embedded into the road itself and checked by responsible authorities.

**R:** And if the weighing process is executed on the static weights then this procedure is completed during each loading and unloading?

**V:** Not always. Not all of the loadings and unloading require weighing.

**R:** What were the main reasons for considering weighing sensors?

**V:** The issues were related to the overloading and created pressure on the axles. We had a period of time when we served a client and had transportation of goods to Austria and in Austria the government and local authorities are very strict when it comes to the weight of trucks and overloading. We had issues in Austria but we also had some problems with the client from France who were loading the truck with 25-25,500 tones even though in documents they were writing 24 tones. In addition, the trucks were not weighed. So we had a situation when the drivers started to complain that the truck is overloaded. We were looking into the documents and according to documents everything was fine. So in documents we had normal weight which is allowed by the government. Another time we had a situation when the truck was stopped and pulled over by the police. The truck then was weighed and it was revealed that the truck was seriously overloaded. It was a French client but the truck was stopped in Germany. So the control point was in Germany. The goods loaded in France but going to Germany. Usually for this client we were going with empty boxes to France and then they were loaded and sent back to Germany.

There is another issue. Quite often we have agreements with the clients about the time of each loading and unloading. I mean the duration. But sometimes the actual loading or unloading lasts

much longer than it is specified in the agreement. So the truck can be already under the ramp and we have a limit of two hours but in reality the truck stays there for 6 hours. So they are taking the goods, checking them and then slowly loading the truck and instead of the agreed two hours the truck can spend there four, six or even eight hours depending on the situation. The agreement is actually supposed to optimize the time since each driver can only work for 13 hours or 15 in total, 9 of which can be spent on driving. So the driver is not working for 8 hours even though he could already be going to the next location or simply having rest. This was also one of the elements which played its role in order to start thinking about new sensors.

**R:** You mentioned that in Austria it is stricter than in other countries?

**V:** It is strict in all countries but in Austria it is checked more often. I think there is not country where it is allowed to be overloaded but Austria pays a lot more attention to it. The roads in Austria have many embedded weights and so the weighing can be completed more frequently in different locations.

**R:** And which types of sensors you already considered?

**V:** Honestly speaking, I researched this question superficially and a long time ago. I can't tell you precisely but I think it was a German or Polish system called TPMS. But it was not the name of only one device, it was the whole system. But it was a long time ago so I can't remember and I did not do a thorough research.

**R:** Alright, I think it will be my last question since we agreed that the interview will not take a lot of time. You mentioned that there were cases of overloading in Austria and France. Did you incur high costs related to these issues?

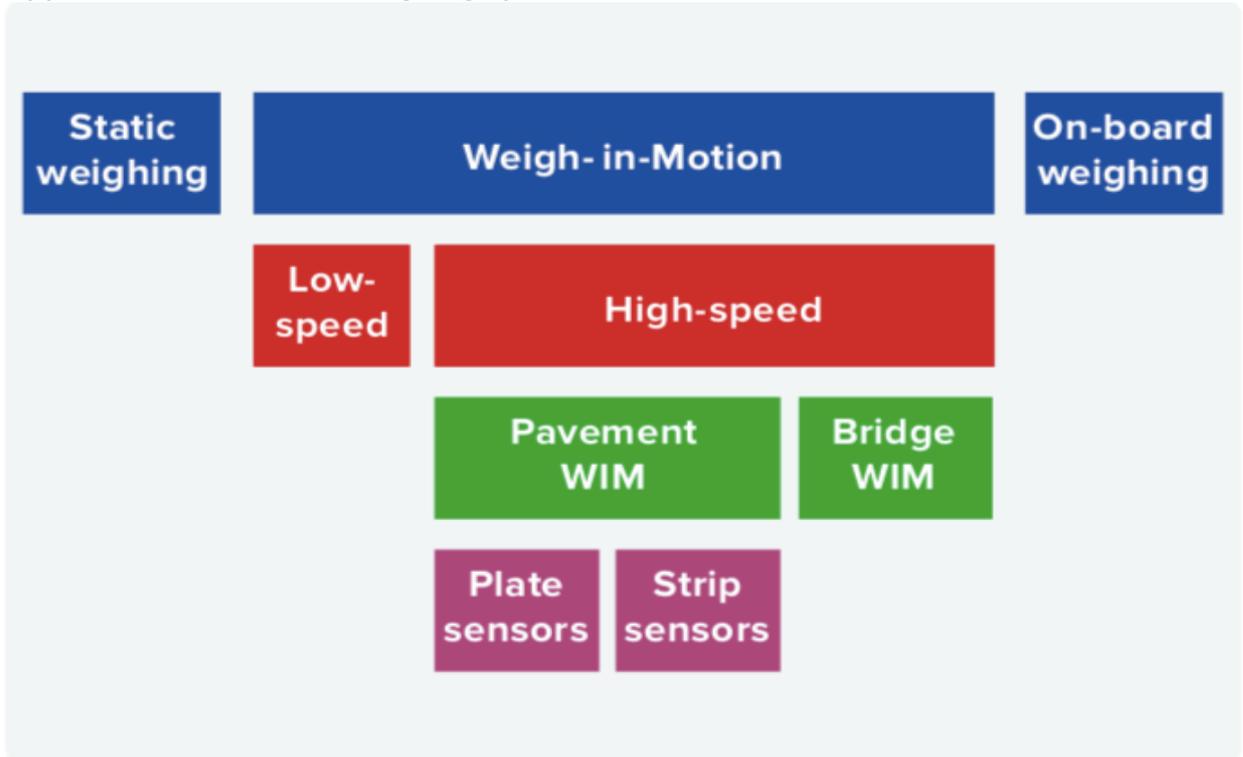
**V:** Yes, we did. I can't remember the exact numbers but I can look it up a bit later and send them to you. We had cases when the drivers were stopped in Austria and also in Germany but I need to look up for this information in our archives. I will send it to you as soon as I find it.

**R:** Yes, sure. I will be waiting for it. Thank you again for the interview and for your time spent on it.

**V:** No problem, I hope it was useful. I will try to find the information that you asked for and send it to you.

**R:** Thank you!

**Appendix 2: Division of weighing systems**



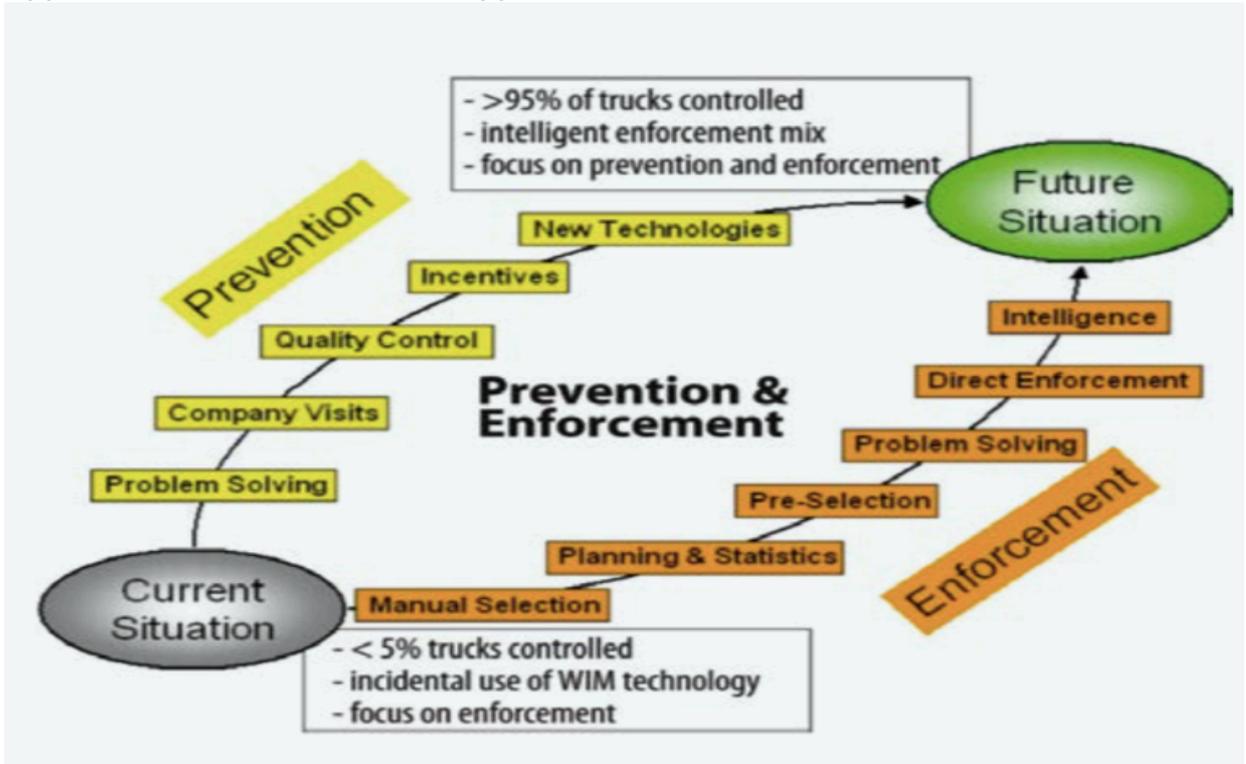
Source: Aleš Žnidarič (2015). Heavy-Duty Vehicle Weight Restrictions in the EU.

**Appendix 3: Three examples of OBW sensors.**



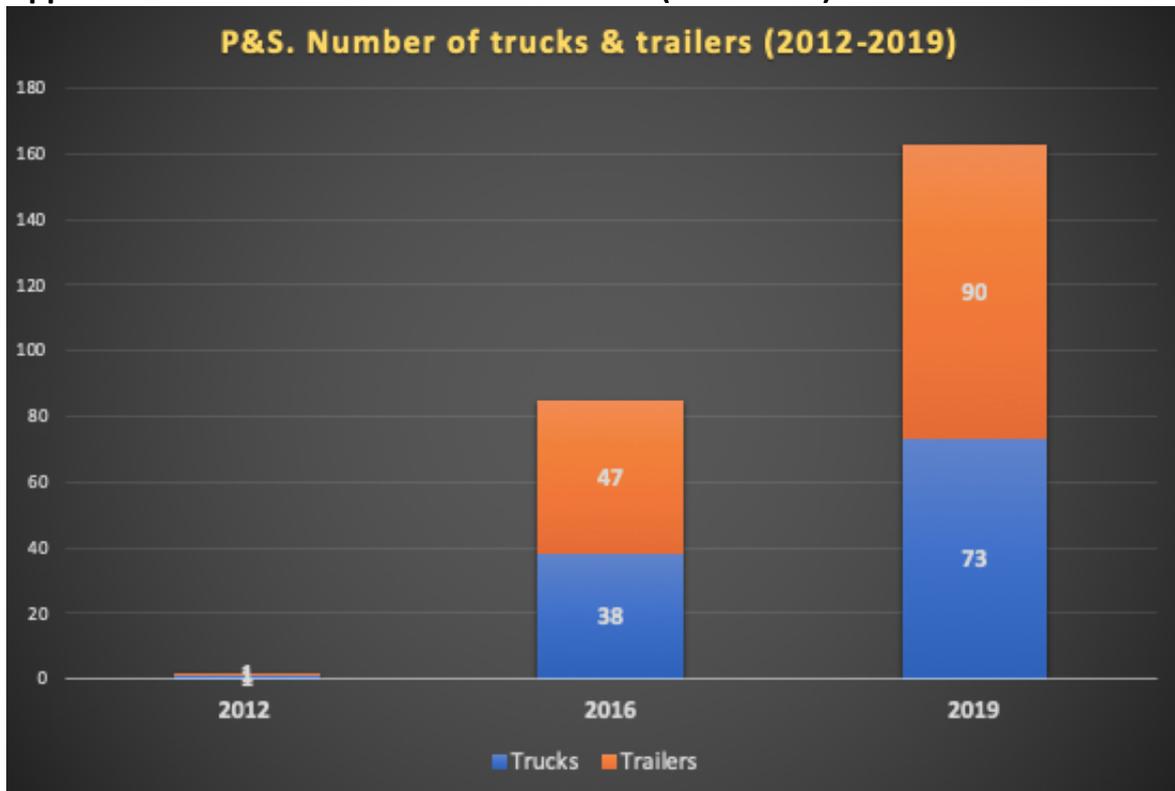
Source: Aleš Žnidarič (2015). Heavy-Duty Vehicle Weight Restrictions in the EU.

Appendix 4: Dual carrot & stick approach

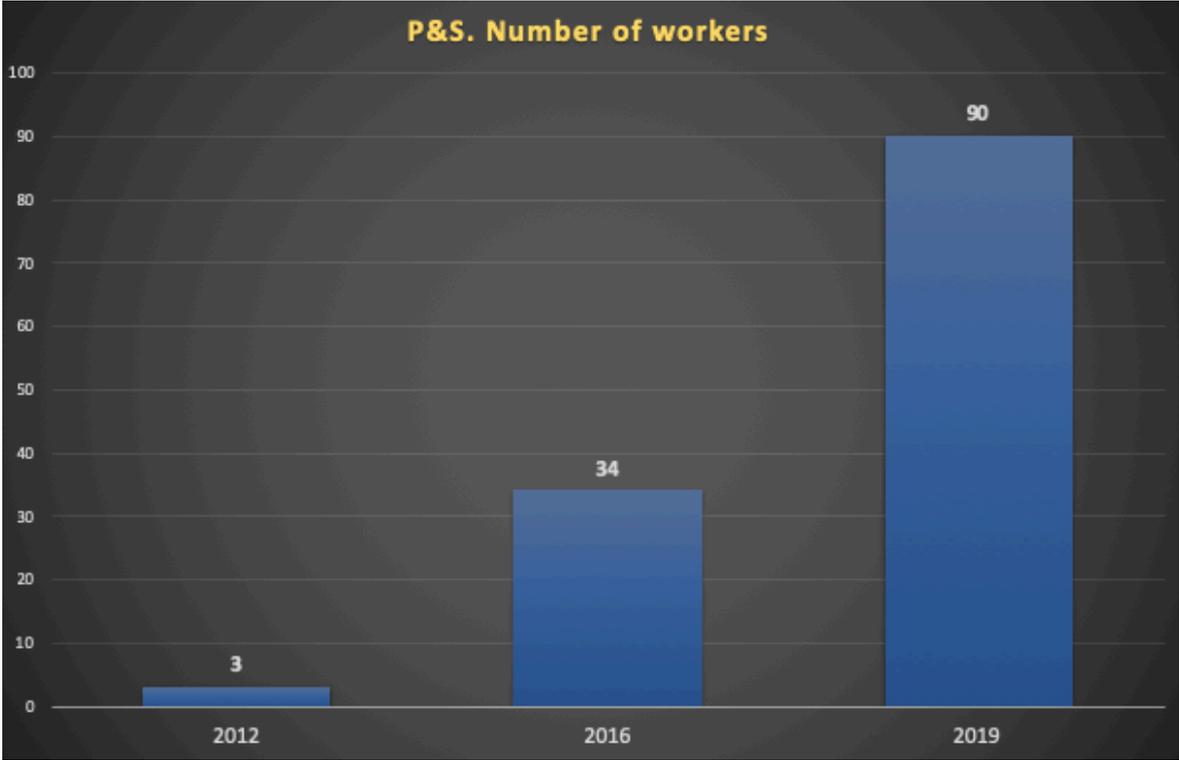


Source: Aleš Žnidarič (2015). Heavy-Duty Vehicle Weight Restrictions in the EU.

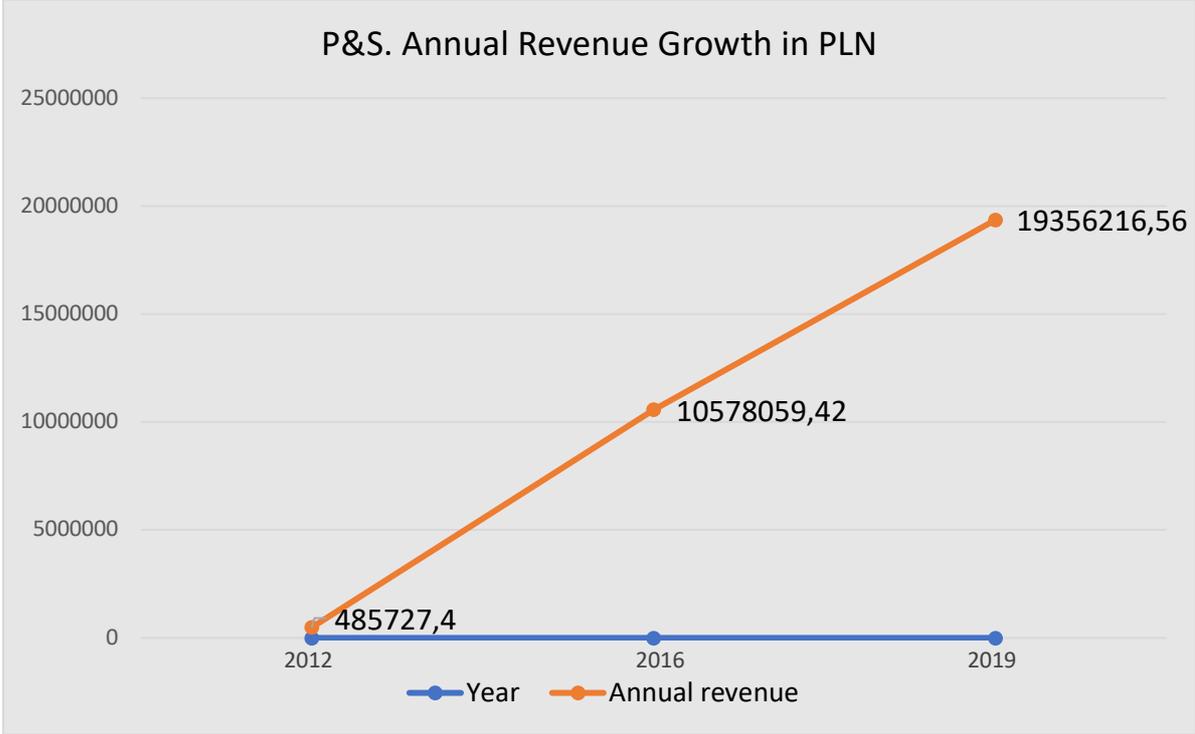
Appendix 5: P&S number of trucks & Trailers (2012-2019)



**Appendix 6: P&S. Number of workers**

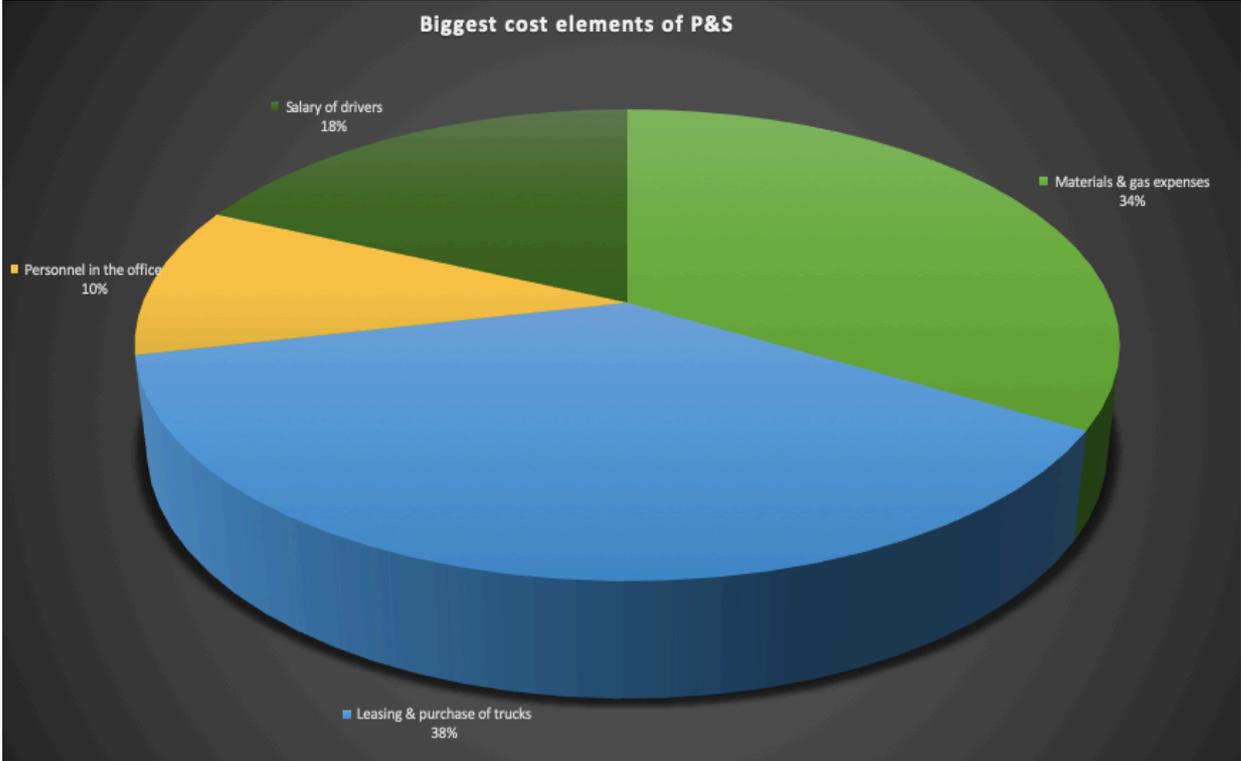


**Appendix 7: P&S. Annual Revenue Growth in PLN.**



**Appendix 8:**

Pie chart 1. The biggest cost elements of P&S



Source: Extract from P&S annual report (2019).

## Appendix 9: Extracts from the conversation with the representative of Technoton

**R:** What is the price for the GNOM DDE system. If, for example, the company has in its possession 73 trucks which are used for the transportation of goods around Europe. What are also the benefits of the system in short and long-run?

**Nikolay Fialkovskij:** The main advantage is that you can get information about how much weight is loaded on your truck. This information can help you understand how rationally your trucks are used.

This info will also help you to monitor the weight of your trucks in real-time which can help you to avoid penalties for the overweight which are very high in Europe.

I will attach the presentation about our GNOM solution which will surely give you better understanding on how our solutions are working.

May I know what suspension type do your trucks have?

What tracker are you are using?

**R:** All of the trucks have an air suspension. The sensor is embedded into all of the axles?

**Nikolay Fialkovskij:** If you have an air suspension then it is possible to install a pressure sensor instead of the standard sensor that is integrated into most of the other trucks. You will need only one sensor per truck since there is no necessity to install them on each axle. Then sensor GNOM DDE connects to GPS tracker. The tracker transmits all of the information on the server of the company where all the data can be observed.

Could you tell me which trackers you have?

**R:** P&S mainly uses trucks of the following brands: MAN, Mercedes and Reno. So the trackers which are used are: RIO, Gbox, Fleetboard and Optifleet. The information is automatically read from the tracker and transmitted to the software which was developed for the company – TranSys.

## Appendix 9: Extracts from the conversation with the representative of Wagencontrol company

**Kristina Pechkurenko:** Dear Roman, Thank you for the request. My name is Kristina, I represent Wagencontrol company.

Roman, tell me please about the company you represent and its scope of business.

GNOM axle load sensor is a device which resolves the following tasks:

- Truck load optimization - data from sensor are used for detecting truck overload and underload.
- Driver supervision and elimination of unauthorized cargo.
- Preventing fines for exceeding maximum axle load.
- Decreasing costs for suspension maintenance - if vehicle is loaded optimally, suspension will last longer.

So, the benefits of using the system in the short-term period are the following: less fines, prompt loading / unloading events registration. In the long-run the vehicle's wear out as well as maintenance costs are decreasing. Thus, the company will be able to keep statistics of the transported cargo and build more accurate econometric models of enterprise performance.

Tell me please, what tracking device is installed on trucks. I will check its compatibility and suggest you the right model of GNOM.

**R:** Good afternoon. Since the trucks that are used to transport cargo are mainly MAN, Mercedes, and Renault, three trackers are used: RIO, Fleetboard and Optifleet.

**Kristina Pechkurenko:** Dear Roman. I have checked our list of compatibility with trackers <https://www.jv-technoton.com/compatibility/>. Unfortunately, I have not found the manufactures you have mentioned in previous email. Although it is not very important, because any GPS tracker with voltage input up to 5V can be used with our GNOM sensors.