SELECTED TELEMATIC SOLUTIONS IN ROAD TRANSPORT - A CASE STUDY FOR THE TRANSPORT OF FRESH FRUIT AND VEGETABLES

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Abstract

Dynamic economic and technological development places more and more demands on every walk of life, including road transport. Maintaining a significant position on the market is possible due to the applications of solutions supporting the efficiency and quality of transport, including through telematics solutions. This is particularly important in the case of transport of food (especially fresh products), which are much more sensitive to transport conditions. Under the influence of inadequate temperature, air humidity loses its quality, fades, withers or rot and is unfit for consumption. Therefore, it is very important to maintain proper conditions of transport and to make people responsible for the transport chain of these articles aware of the responsibility for decisions and possible preventive solutions. The aim of the article is to analyze selected environmental parameters inside the refrigerated semitrailer in relation to the quality of the transported goods. The scope of work included the analysis of 3 parameters: temperature, humidity and light. The analysis was carried out using specialized sensors recording inside the means of transport. Three refrigerated trailers were accepted for analysis.

The acquired data support management processes and contribute to increasing the level of customer satisfaction.

As a result of the analyses carried out at work, it was found that the use of measurement sensors and dedicated solutions has a positive impact on the quality of the transported product and the efficiency of delivery, and thus increased customer satisfaction.

Keywords: Telematics solutions, quality of the transported product, efficiency of delivery, conditions of transport

1. INTRODUCTION

Dynamic economic and technological development puts more and more demands on every branch, including road transport. In Poland, transport comprises around 6.5-7 percent of GDP. However, it is estimated that approximately 25 % of international transport in the EU is served by Polish enterprises. Therefore, its effective use is extremely important from the point of view of the state economy. In 2015 the Dutch company TomTom Telematics conducted a survey among 300 Polish senior managers. Research has shown that a large proportion of the surveyed companies do not control the time and manner of driving company cars. Only 13 % of Polish transport companies use telematics solutions [1]. An opportunity to achieve and maintain a significant position on the road transport market are, inter alia, modern telematic and ICT systems. Telematics systems allow for [2-4]:

- monitoring of the vehicle and transported cargo,
- control of vehicle operation parameters and drivers,
- collecting and analyzing data,
- reduction of administrative costs,

- automatic response to collision, emergency assistance, as well as assistance in crisis situations.

The recorded data is transferred to the center of their processing by means of telecommunications. The data obtained supports management processes as well as contributes to the reduction of environmental degradation e.g. through economic driving limiting exhaust emissions. In addition, telematic systems through automatic weighing of vehicles, navigation and identification are useful in cases of theft. The use of telematics solutions has a positive impact on road safety, as well as traffic efficiency and driver behavior.

The area associated with telematics is still developing and improving the ability to manage any operations related to transport from one place. In the field of telematics systems in freight transport, we distinguish among other things the application of [5 - 9]:

- GIS systems (Geographic Information System) - digital, navigational, thematic, 3D maps,
- Global Positioning System (GPS) systems with new generation GPS III satellites, EGNOS (European Geostationary Navigation Overlay Service), Galileo, GLONASS (Globalnaja Navigacionnaja Sputnikovaja Sistiema), Beidou, GPS + GLONASS,
- GSM radio communication (Global System for Mobile Communications), GPRS (General Packet Radio Service), UMTS (Universal Mobile Telecommunications System), WIMAX (Worldwide Interoperability for Microwave Access),
- Vision systems,
- Track & Trace systems,
- IT systems of the TMS type (Transportation Management System), ERP (Enterprise Resource Planning), SCM (Supply Chain Management),
- Transport exchanges,
- Terminals: drivers, PDA (Personal Digital Assistant), mobile phones, tablets,
- Sensors: RFID technology, Bluetooth, Zigbee, Wi-Fi.

The most commonly used is the combination of on-board devices with a touch screen installed in the vehicle, a GPS transmitter, a measuring device and monitoring the entire cargo transport process. The data sent can be read both on the computer and in the mobile application. Simultaneous monitoring of cargo parameters (temperature, humidity, shock, impacts, vibrations, tipping, lighting, leaks, atmospheric composition, etc.) is increasingly common - one of the requirements for the transport of refrigerated goods and food [10 - 12]. Solutions available on the market allow monitoring the climatic conditions in the vehicle, not the ambient conditions of the product. Seemingly, it might seem that there is no difference between these processes. However, with a deeper analysis of the problem, the conclusions can be drawn that the conditions prevailing in a vehicle semi-trailer can be uneven due to uneven air circulation. Very often, the semi-trailer is cooled by the aggregate in the front part of a semi-trailer and blowing in the rear part. The result is a higher temperature in the middle part of the trailer. By mounting the temperature recorder in the wrong place, the readings will also be incorrect. Often, especially when waiting for unloading or changing the means of transport (e.g. from a car to an airplane), the goods are also subjected to temperature changes.

In the article [13], the authors reviewed systems monitoring specific cargo parameters. Studies have shown that the most commonly available services relate to temperature monitoring using special sensors. However, the other parameters are dedicated to transported goods. **Table 1** presents selected solutions.

The aim of the project is to analyze selected products. The research concerned the monitoring of the following parameters: temperature, humidity, pressure and light.

Table 1 Examples of telematic solutions used in transport [13]

Lp.	The name of a system and producer	Monitored parameters	Technology used
1	Cargo Tracking Solution & Intermodal Transport Monitoring - AVANTE	Temperature, humidity, vibration, tipping	RFID technology using ZONER ™ RFID tags and RELAYER ™ readers. Data transfer via GPS, GPRS, SATCOM. Additional sensors for measuring chemical, biological, light, humidity and other factors.
2	Cargofleet - IDEM Telematics	Temperature, pressure, cargo safety	GPS, GPRS technology. The TCC server (TControl Center) administers the data flow and also monitors communication, while the cargofleet web application visualizes the data from the TCC server (Figure 23). Cargofleet Web Aplication provides SaaS solutions (Software as a Service) for conducting various types of analyzes. It is also possible to integrate with EPR programs owing to the possibility of sharing the obtained telematic data.
3	Tetis R	Temperature, humidity, lighting, cargo safety	The cellular system (GSM / CDMA / HSDPA) and location (GPS / GLONASS) allow one to track and monitor containers around the world and present information in almost any language. The system uses a variety of sensors, including a temperature sensor with a high sensitivity with an accuracy of ± 0.2 ° C.

2. MATERIAL AND METHODS

This article uses data from a company dealing with storage and transport of fresh fruit and vegetables. The data was collected by mounted special sensors in 3 trailers - 1 in each. Sensors allowed to measure the basic conditions of transport of the analyzed group of goods, i.e. temperature, level of lighting and humidity. The study was carried out during the transport of fruit and vegetables over a period of 10 days in March 2018.

The majority of the recording sensors used by carriers enable measurement of only humidity and temperature in increments of 10,15,30 minutes and data downloading via USB or direct printing from the device. However, owing to the measurement of the lighting level, one can determine the time of opening and closing the door of the trailer. In order to improve the quality of collected data, prototypes of sensors were used that allowed to measure every two minutes for two weeks and a remote reading from a distance of 15 meters using mobile devices. In contrast, data is saved in the EEPROM memory via Bluetooth Low Energy technology. The sensor consists of a SHT30 humidity sensor and a light sensor - BOW 34 S photodiode.

3. TELEMATIC SOLUTIONS - A CASE STUDY OF ROAD TRANSPORT OF FRESH FRUIT AND VEGETABLES

As part of the analysis, an attempt was made to identify the conditions of transporting fresh fruit and vegetables inside the means of transport. Observed changes in ambient parameters in analyzed refrigerated transport fluids such as: humidity, temperature and lighting will allow to draw conclusions.

Figures 1 - 3 show changes in the analyzed parameters over time using monitoring sensors inside the means of transport.

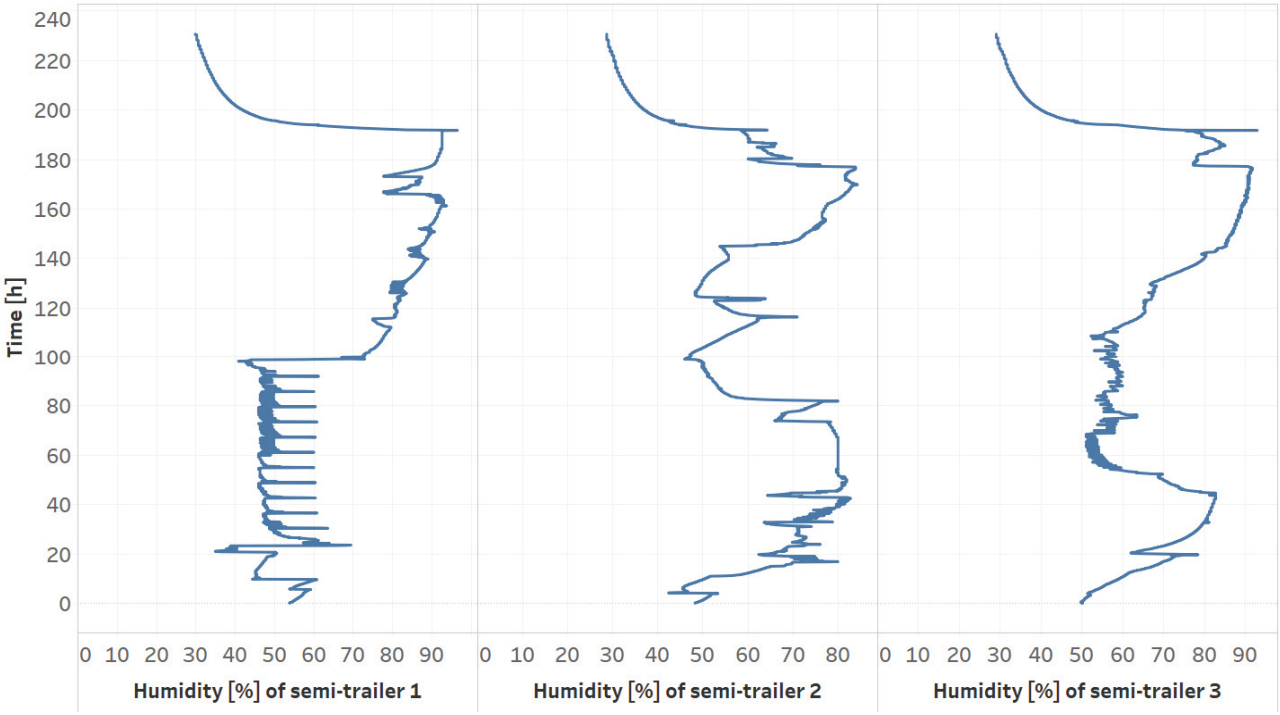

Figure 1 Change in humidity over time for 3 trailers [own study]

The above charts show that between the start time and around 194 hours of driving there is a big change in the humidity levels in each of the three trailers. However, then the level is levelled out and oscillates around 30 % of the ambient humidity in the trailer.

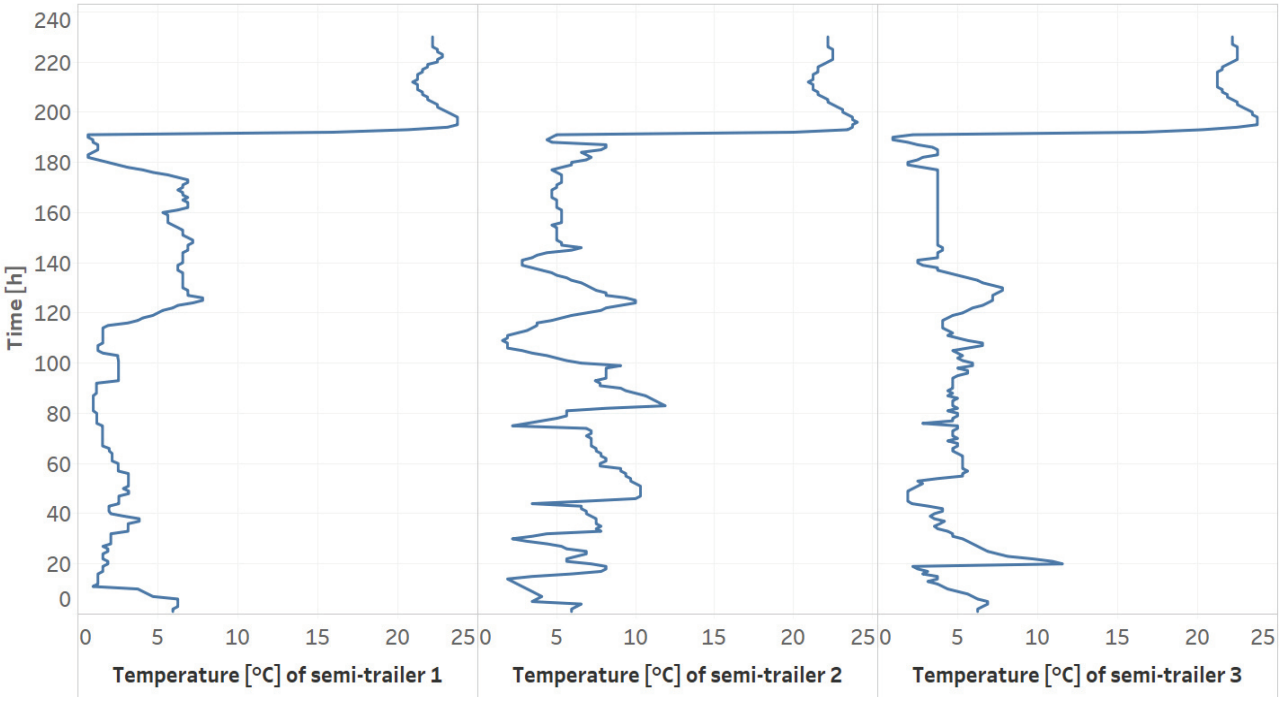

Figure 2 Temperature change over time for 3 trailers [own study]

Similarly to the case of humidity parameters, the fluctuations from the moment of take-off to around 192 hours of driving are also noticeable in relation to temperature. Then the temperature increases drastically and stays

at 20-25 degrees Celsius, which may cause a decrease in the value of products, as well as their decay or spoilage.

Changes in moisture and temperature parameters are caused by the process of fruit and vegetable breathing. The reduction of oxygen (O2) in the vicinity of the trailer effectively reduces the rate of all chemical and biochemical reactions with the participation of oxygen - hence the equalization of values after exceeding 193 hours of driving - and the increase in temperature. It is therefore recommended to use appropriate devices to maintain the storage temperature and relative humidity, as well as through physical and chemical measures limiting the transpiration of vegetables and fruit.

It is assumed that a rapid rise in temperature and a decrease in humidity after around 190 hours of analyzed trailers results from the probability of disassembling the entire commodity and switching off the operation of the refrigeration unit.

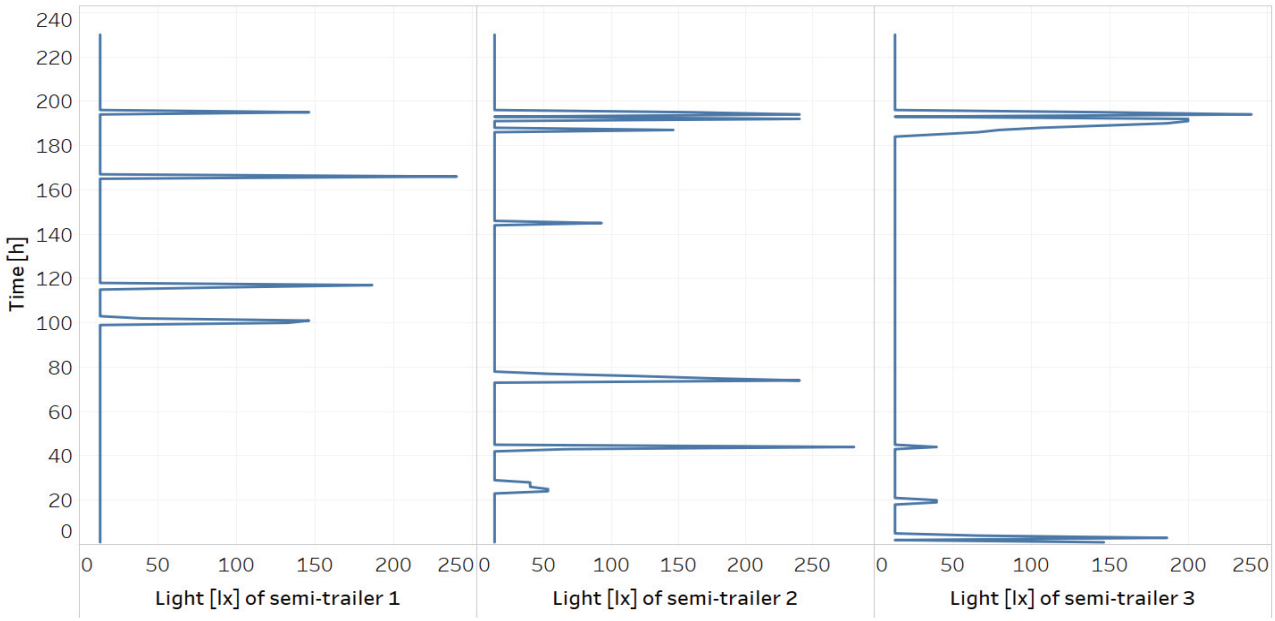

Figure 3 Changing the lighting in time for 3 trailers [own study]

The lighting level should not change without the process of opening and closing the door of the trailer. The analysis showed that there are noticeable deviations from the constant value, which may be caused by goods inspection or unloading operations of individual recipients. Similarly to temperature and humidity, the majority of fluctuations are registered up to approximately 194 hours of driving.

4. CONCLUSIONS

The use of telematics solutions affects the quality and efficiency of freight transport. In particular, it is important to monitor environmental parameters in the case of perishable products such as fruit and vegetables. The use of modern sensors measuring not only temperature and humidity, but also the level of lighting allows to determine the time of opening and closing the door of the trailer - which can affect significant changes of these parameters. Therefore, light intensity should not change during transport. The location of the sensors is also important. Interpretation of the results relating to the temperature depends on the type of product transported. Fruit and vegetables are characterized by the release of water vapor, which can cause an increase in temperature and humidity in the vicinity of the trailer. In such a case, it is recommended to use appropriately tailored solutions to increase or decrease the temperature and humidity during transport.

The limitations in the conducted tests are that only 1 sensor monitoring the ambient parameters inside each of the three trailers was accepted for the tests, and the studied period covered 10 days. In subsequent works, it is planned to expand the research by a larger number of refrigeration vehicles while using more sensors tracking ambient conditions inside each refrigerated vehicle, as well as at different times during the year.

It is also planned to examine the impact of ambient conditions inside the refrigerated vehicle with the driver's driving style in order to optimize transport costs.

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