SYSTEMY MONITOROWANIA ŁADUNKÓW W TRANSPORCIE INTERMODALNYM

CARGOS LOCATION MONITORING SYSTEMS IN INTERMODAL TRANSPORT

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Abstract: The article outlined the benefits of using location monitoring systems of intermodal units in rail transport, paying attention to safety. Discusses the technical solutions applied in Poland, as well as other European countries. The statement was made of it equipment and systems offered by the manufacturers. Authors drew attention to the ones that allow to identify the location of the load, monitoring of additional parameters and services arising from the functionality of the solution in question. In addition, the article drew attention to the location monitoring system of the entire vehicles in the train with the operational parameters of the locomotive.

Streszczenie: W artykule wskazano korzyści wynikające z zastosowania systemów monitorujących położenie jednostek intermodalnych w transporcie kolejowym zwracając uwagę na bezpieczeństwo. Omówiono rozwiązania techniczne stosowane w Polsce, jak również innych krajach europejskich. Dokonano zestawienia urządzeń i systemów informatycznych oferowanych przez producentów zwracając uwagę na te które pozwalają na identyfikację lokalizacji ładunku, monitorowanie dodatkowych parametrów i powiązanie z dodatkowymi usługami wynikającymi z funkcjonalności omawianych rozwiązań. Ponadto w artykule zwrócono uwagę na systemy pozwalające na monitoring położenia całych składów po-ciągowych wraz z parametrami eksploatacyjnymi lokomotywy.

Słowa kluczowe: monitorowanie ładunków, lokalizacja ładunków, transport

Key words: parameters monitoring, cargo location, transport

INTRODUCTION

By analyzing the available technologies offered by companies specializing in monitoring and cargo location in rail transport has been shown that the vast majority of companies use GPS technology. In addition, the services offered are primarily monitoring and cargo location, however, with the increasing requirements of customers offer is extended with additional functionality and applications on mobile devices.

Intermodal transport is one of the branches, which determines economic growth. Intermodal shipments are characterized by a high value of transported goods, mass production and large transport distance. Therefore, it is important that the transport process proceeded efficiently while minimizing the occurrence of risk (Gajewska, Szkoda, 2015). To ensure the

efficiency of transport are used equipment for the monitoring transport process, as well as the parameters and load (Stuart, 2005; Lorenc, 2013).

Very often value and weight of intermodal consignments are big, likewise distance of transportation are also long (Clott, Hartman, 2016). What is more, that type of cargos usually requires change of carrier and even mode of transport. Because of that, intermodal cargos owners and railway carriers want to have information about precise location of cargo, and also parameters inside container. Because of that most of technical solutions are flexibility and adjustable (like GPS module) to requirements of each client (Ciesielski, 2009). It does not matter whether cargo type is: industrial tools, dangerous goods, medicines or high value or expensive groceries (Lam, Gu, 2016).

Most modules available on market, allow to monitor observance of temperature range, measure power of shakes or register humidity, check lights and electromagnetic radiation inside container (Hall, 2015). More advanced modules intended for containers parameters monitoring also allow for cargo protection, e.g. checking that the container door is opened, the inside there were no movement or lights and other deviance from standard events (Dotoli, Epicoco, Seatzu, 2015).

Equipment used in intermodal transport are designed specifically for monitoring containers and railway wagons. They are most often mounted on the outer wall of the container, the sensors are mounted on the door or inside the container and are not sensitive to atmospheric conditions.

1. SYSTEMS FOR APPROXIMATE POSITION MONITORING

Presented systems allow to approximate position monitoring and stage in transport chain. Those systems use information exchanged between users, so do not use GPS modules or GPRS data transmission. Because of that, they not allow to precise location, but do not require additional devices installation on container. That systems are generally used in intermodal transport.

System Cesar is an international solution. Besides access to internet is required XML and Excel files support (EDI data transmission). According to customer, automatic transferring information about cargo status change is possible via e-mail. The system is mainly used by countries such as Austria, Germany, Italy, France and Slovenia.

System Track-Trace is functioning as web page. It allow to finding containers by container numbers that belong to 119 international carriers. For cargos, is possible to find it by

waybill. System use information from over 500 carriers. Moreover for selected carriers, like DHL, UPS, TNT, Fedex and DB Schenker it is possible to find cargos by its number. System is free. It is also possible to download dedicated application for mobile devices using Android systems.

Use-It (*Uniform System for European Intermodal Tracking and tracing*) is system developed and used by RAILDATA company. Online train tracking its possible by Internet network or ICT systems. Actually system is used by rail companies like: DB Schenker Rail Deutscheland, Rail Cargo Austria and Trenitalia Cargo.

2. SYSTEMS FPR POSITION MONITORING

Producers offer customers systems dedicated for monitoring posi-tion by GPS/GPRS network. To that systems could be included above presented one.

Savi Tracking is application based on SaaS solution (Software as a Service). That solution allow to share software via Internet network, and uses all available tag technology like GPS, GPRS, RFID and others. In that system is possible to create transport routes and alert users when real route will be different that planned.

MECOMO Tracking & Tracing Solutions offer self-developed solution called macFLEET, which is compatible with all devices offered by MECOMO company. System is also used for communication.

SMOK GPS system consist of location device and GPS receiver mounted in vehicle. Thanks to GSM/GPRS network system transferred data to monitoring server, used by final customer. System is easy to mounted, so each customer can do it by himself.

3. SYSTEMS FOR POSITION AND CARGO PARAMETERS MONITORING

More advanced systems enable not only to localize cargo but also to monitor cargo/container parameters. Most popular systems of this type have been presented in table 1.

Table 1 – Systems for position and cargo parameters monitoring

System	Main monitored parameters

Cargo Tracking Solution & Intermodal Transport Monitoring - AVANTE	Chemical and biology factors, light inside, humidity, cargo safety
Cargofleet	Temperature, pressure, cargo safety
Container Monitoring System	Temperature, humidity, vibes, load tilting
GPS Nadzór Cargo	Temperature, humidity, shakes, cargo safety
IMT IntermodalTracker	Temperature
Ovinto Sat	The fill level of the load unit, leaks, pressure, shakes, wagon mileage
PearTracker	Temperature, motion inside, cargo safety
Smart Autonomous Asset Solution (SAAS)	Temperature, light inside, motion inside, humidity, gas concentration
Tetis R	Temperature, humidity, lights inside, cargo safety
Vibration Energy Harvester	Temperature, pressure, leaks, cargo safety
Visirun	Temperature

Źródło: Opracowanie własne.

4. SYSTEMS FOR POSITION AND VEHICLE PARAMETERS MONITORING

Another advanced type of systems enable to localize cargo but are mainly dedicated to monitor parameters of vehicles. Systems of this type have been presented in table 2.

Table 1 – Systems for position and vehicle parameters monitoring

System	Main monitored parameters
Combo Client TRAIN	The condition and maintenance intervals for the vehicle, vehicle speed, engine rpm, fuel level, mileage and vehicle safety
GPS Monitor	Fuel level, vehicle speed, coolant temperature, oil pressure, the identification of the driver and monitoring of his work, breakdowns, engine load, power of main power generator, fuel temperature
MALUX	The condition and maintenance intervals for the vehicle, vehicle safety, supervising maintenance intervals, mileage, vehicle speed, wagons overload
OptaSense	The condition and maintenance intervals for the vehicle, vehicle safety
QGUAR Object Tracking & Monitoring (OTM)	The condition and maintenance intervals for the vehicle, vehicle speed and tilt of the vehicle
System Logistyki Kolejowej	The supervision of maintenance intervals, routes and identification of motorman

TELOC, Halser Eva+	The condition and maintenance intervals for the vehicle, vehicle speed, supervising maintenance intervals, percentage of braking, mileage, brake pipe pressure, digital signals, identification of base locomotive depot, the driver and vehicle
Trailermatics	The condition and maintenance intervals for the vehicle, vehicle safety, breakdowns, fuel level

Źródło: Opracowanie własne.

5. SYSTEMS DEDICATED FOR PORTS AND CONTAINER TERMINALS

Navis N4 is online application, developed by high calibrated and fault tolerant of technology. System allow to one or few ports/terminals management on the same time. The type of Navis N4 system is TOS (Terminal Operating System), so it is comprehensive application. System besides position localization allow to check status of the container. Application base on virtual model – for each container located on storage area is specified place assigned. That solution helps to achieve high accu-racy, but in case of fault causes problem with container localization.

E**uroport** is a project aims to examine the technical feasibility and profitability of integrated solution for optimize cargos transport, tak-ing place with the use of seaport. Europort also focuses on finding gaps or stages of intermodal transport chain, which are ineffective, and then is working on improvements. On that integrated solution, three groups of services are consist: activities of users, cruise optimization and activities of ports.

6. ADDITIONAL SERVICES OFFERED BY SYSTEMS COMPANY

Producers of systems dedicated to monitor location and parameters of intermodal transport units, usually offer also additional systems functions. Very often that systems enable to connect location module with special sensors for monitor parameters of cargo, helping to notice interference of third parties or monitor vehicle parameters. Most providers offer online version of software, what allow to access from any place in word, and any devices. More and more popular becoming mobile application with Android or iOS systems. What is more additional function of that systems is integration with ERP systems possibility, data archiving, creating special reports and statistics. Some of systems offered possibility of setting POI, areas or routes important for users. In case of incompatibility with that points or elongation of the expected residence time systems alert user about that situations.

Each of software producers specialized in specified market. It causes concentration on additional services different from the competition. Summary of additional services and functionality of the systems shown table 4-7.

Table 2 – Systems for approximate position monitoring

System, Producer	
Group of clients	**Additional services and functionality**
Cesar, Cesar Information Services s.c.r.l.	
Intermodal operators, railway carriers, direct clients	- no need to install location modules - information about the carrier change
Track-Tracem, Webfokus	
Intermodal operators, railway carriers, direct clients	- no need to install modules location - information about the change of carrier - search by container number, of the consignment note number and shipping for DHL, UPS, TNT, Fedex, DB Schenker companies
Use-It, RAILDATA	
Intermodal operators, railway carriers, direct clients	- users can receive information about expected time delays of loading unit delivery to the destination - transmission of information via servers FTP and SMTP

Źródło: Opracowanie własne.

Table 4 – Systems for position monitoring

System, Producer	
Group of clients	**Additional services and functionality**
MECOMO Tracking & Tracing Solutions, MECOMO AG	
Intermodal operators, railway carriers, road carriers, direct clients	- variety of monitoring modules - locate vehicles, cargo and people - ability to use via mobile devices
Savi Tracking, Savi Technology	
Intermodal operators, direct clients	- web browser application - ability to use via mobile devices - creating and sending messages about certain events - integration with other systems, e.g. ERP - operation data from independent sensors

Źródło: Opracowanie własne.

Table 5 – Systems for position and cargo parameters monitoring

System, Producer	
Group of clients	**Additional services and functionality**
Cargo Tracking Solution & Intermodal Transport Monitoring, AVANTE	
Intermodal operators, railway carriers, direct clients	- online detecting the door opening / intrusion into of the loading unit - the use of identifiers for staff to quickly locate of the loading unit - „PANIC" function – immediately call for help in case of cargo theft risk
Cargofleet, idem telematics GmbH	

Road carriers, intermodal operators, direct clients	- web browser application - ability to create user groups with different privileges - integration with other systems, e.g. ERP - variety of monitoring modules
Container Monitoring System (CMS), Kirsen Global Security GmbH	
Intermodal operators, see carriers, , container terminals, direct clients	- web browser application - creating and sending messages (SMS) of a specific event - integration with other systems, e.g. ERP - variety of monitoring modules
GPS Monitor, ElLTE GPS Sp. z o.o.	
Railway carriers, road carriers, privileged service, shipping industry	- flexible customized solutions to individual needs - warranty and post-warranty service - creating analyzes, summaries, statistics analysis - creating and sending messages (SMS) of a specific event - monitoring exploitation parameters - identification of the driver and working hours - reacting to anomalies by setting up appropriate criteria for the various departments
GPS Nadzór Cargo, GPS Nazdór	
Railway carriers, road carriers, seaports, container terminals	- long locator battery life GPS - record of transport conditions - flexible customization - access to the system via a web browser or mobile phone (Android, iOS) - creating reports
IMT IntermodalTracker, Intermodal Tracker BV	
Railway carriers, cargos owners	- notification for a long time standstill - archiving location data and cargo parameters - optimizing the use of containers, wagons, tractors - monitoring and graphing of temperature
Ovinto Sat®, Ovinto cvba	
Railway carriers	- ability to work at high temperatures up to 85°C - the ability to data encryption
PearTracker, PearTrack Security Systems, Inc.	
Intermodal operators, direct clients	- web browser application - creating and sending messages (SMS, e-mail) of a specific event - data archiving
Vibration Energy Harvester, Perpetuum	
Intermodal operators, railway carriers, direct clients	- increased battery life time through the innovative energy recovery - assisting in the planning of the maintenance system - additional possibility of use through mobile devices

Źródło: Opracowanie własne.

Table 6 – Systems dedicated for ports and container terminals

System, Producer	
Group of clients	**Additional services and functionality**
Europort, European Space Agency	

Intermodal operators, railway carriers, direct clients	- determining the optimal route
NAVIS N4, Navis®	
Seaports, container terminals	- distribution optimization of cargo on board - optimization of the equipment used for the loading and unloading - automatic scheduling of work of loading and unloading - optimization of the storage space at the port - ability to integrate with devices of automatic identification - documentation management and freight forwarding[28]

Źródło: Opracowanie własne.

Table 7 – Systems for position and vehicle parameters monitoring

System, Producer	
Group of clients	**Additional services and functionality**
CargoWatch, ORBCOMM Inc.	
Intermodal operators, railway carriers, direct clients	- web browser application - create and send messages and alerts about events - archiving data, creating statistics - notification for a long time standstill [29]
Combo Client TRAIN, Keratronik Safety Sp. z o.o.	
Railway carriers, cargos owners	- fleet management - determine the POI and route planning, accompanied with verification their compatibility - tunneling - notification for a long time standstill - archiving location data and vehicle parameters - developing schedules for the routes, means of transport - the ability to connect a RFID card reader - the system is available for mobile devices (Android) [33]
Honeywell Global Tracking, Honeywell International Inc	
Intermodal operators, direct clients	- web browser application - creating and sending messages (SMS, e-mail) of a specific event - integration with other systems, e.g. ERP - variety of monitoring modules
MALUX, Kapsch CarrierCom	
Railway carriers	- ability to create individual rules generate notifications - tools to assist system of wagon maintenance - trading system - integration with other systems, e.g. ERP
QGUAR OTM, Quantum software S.A.	
Railway carriers	- web browser application - creating and sending messages about events - system implementation and its adaptation to the individual user's needs - user training, consulting - warranty and post-warranty service - an additional set of statistics - remote devices diagnostics
SLK System Logistyki Kolejowej, Petrosoft.pl Technologie Informatyczne Sp. z o.o.	

Railway carriers	- management of wagons, locomotive and railway sidings - preparation of rail documents R7 and consignment notes - ability to integrate with mobile devices - supervision of maintenance intervals - trains scheduling - creating analyzes, summaries, statistics, alerts module - history shipments, documents and customer debts
Smart Autonomous Asset Solution (SAAS), Globe Tracker®	
Railway carriers, road carriers, sea carriers, container terminals	- data sharing with other users - ability to install additional sensors - ability to expand the system in container terminals and on board ships - operation using a PC, tablet or smartphone - archiving location data and cargo parameters - set of analytical tools [21]
TELOC, Halser Eva+, HaslerRail AG	
Railway carriers	- registration: registration locomotive number, parent a locomotive depot driver and the vehicle, number, weight and length of the train, braking, - recording exploitation parameters: vehicle mileage, pressure in the main pipe, two-state (binary) signals - informing about breakdowns, information about the states of the devices - record of service information for diagnosis [14]
Tetis R, Starcom Systems	
Railway carriers, road carriers, seaports, container terminals	- ability to integrate with mobile devices - creating and sending messages about specific events - integration of multiple sensors - built-in accelerometer - creating reports [25]
Trailermatics, NOVACOM SERVICES	
Railway carriers, cargos owners	- web browser application - creating and sending messages about specific events - archiving location data and vehicle parameters - set of tools to create statistics and reports - various monitoring modules - ability to data encryption [18]
Visirun, Visirun S.p.a.	
Railway carriers, road carriers, seaports, container terminals	- creating reports, analyzes and statistics - integration with other systems, e.g. ERP - mobile document scanner - creating POI - satellite view and function Street View - creating and sending messages about events [23]

Źródło: Opracowanie własne.

7. CONCLUSION

Those paper focused on analyze of systems for location of a cargos and vehicles used in intermodal transport chain, mostly in rail transport. The companies in Europe with a particular

focus on Polish companies has been analyzed. Most popular in Europe systems were classified on five type: systems dedicated for ports and container terminals, systems for approximate position monitoring, systems for position monitoring, systems for position and cargo parameters monitoring and systems for position and vehicle parameters monitoring.

What is more additional services offered by producers were identified and compared. In that combination was also identified groups of systems users.

The analysis shows that on the market there are many companies offering both location-based services and monitoring cargo or vehicles/rail wagons parameters. Most of them uses GPS technology, so the location is realized directly. Customer requirements is still increasing, especially regard to the availability and usability of tracking and monitoring solutions. To stay competitive and meet the increasing requirements of the client the companies are increasingly deciding to develop additional functions and applications dedicated for mobile devices with Android or iOS system.

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