SEAMLESS COMMUNICATION IN SUPPLY CHAINS BASED ON M2M TECHNOLOGY

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ABSTRACT. **Background**: Access to information is the key element in the successful and efficient organization of transport & logistic processes. The importance of real-time access to information is confirmed by a panel workshop carried out with support of design thinking methodology. There are two ways of gaining access to the right information - manual, where human agency is needed and fully automatic, where new M2M technology is implemented. Implementation of such technology improves seamless communication during transport execution and allows real-time access to needed information. The aim of the paper is to evaluate the influence of the effectiveness of using M2M technology and traditional way of communication as well as data gathering in order to ensure seamless communication in the supply chain.

Methods: Survey, design thinking, desk research and real case study results were used in the paper.

Results and conclusions: Seamless communication and implementation of M2M technology within the whole supply (including modes of transport and transport units) chain is a backbone of the lean and reliable digital supply chain.

Key words: logistics, digital supply chain, seamless communication, M2M, supply chain visibility, time slots management, accounting of transport costs.

INTRODUCTION

Access to information is the key element in the successful and efficient organization of transport & logistic processes. At present, there are solutions that allow real-time communication between shippers and logistics service providers during the purchasing of services and planning. There is also a second group of solutions that allows the tracking and tracing of vehicle execution monitoring. As a result, transport & logistics services providers and their users need to use different systems in order to obtain information about the real-time execution of the process. Moreover, due to the technical constraints and roaming charges (in particular outside EU) track&trace of vehicles and cargo is difficult and expensive. Therefore, in order to manage the whole transport chain, enable communication with clients, drivers and vehicles, transport and logistics service providers are currently forced to use at least three independent solutions, including phone calls. As a result, seamless communication within the supply chain does not exist.

In addition to this, companies operate in large national and international networks in order to enlarge market reach. The challenge lies in the smooth management of data, proper execution of trade and transport with its complexities of distance and time, language and cultural barriers, and its dependency of national and international rules and regulations.

At the same time, energy, transport and increased human intervention in the environment have proven to be major contributors to climate change over recent decades. The European Union has planned to implement an ambitious target for emissions reduction for years. It is now confident of achieving its goal of cutting greenhouse gas emissions by 20 % in 2020 and has recently doubled its target, to bring about at least a 40 % reduction compared to 1990 levels, to be achieved by 2030 [Eurostat, 2015]. This relates not only to modal shift and use of more environmentally-friendly modes of transport, but also the way transport and logistics processes are organized.

Recent developments in communications technology allow automatization of data exchange between participants of the supply chains. This allows human errors to be eliminated in data exchange, as well as to significantly speed up access to the selected information and reduce the time needed to execute the whole transport process within the supply chain.

Therefore, the paper's objective is to present results of the authors' study on the effectiveness of using M2M technology and the traditional way of communication as well as data gathering in order to ensure seamless communication in the supply chain. Machine-to-Machine (M2M) communication can be said to be a form of data communication that involves one or more objects that do not mandatorily require human intervention in their communication process [Aslekar, Londhe, Gaikwad, 2016, Wu, Geng, 2011, Boswarthick, David, Omar Elloumi, 2012].

MARKET DEMAND FOR SEAMLESS COMMUNICATION

Authors made a panel study of the market demand in transport and logistics sector during dedicated workshops organised in Poznan, Krakow, Sopot and Bologna, attended by businesspeople and representatives of the scientific community. In total, 30 senior logistics staff took part in the panel. Logistics managers represents the following companies: Agri Plus, Animex, Azoty, Aluplast, Bakalland, CAT, Codognotto, Dachser, DB Schenker, DHL, Europapier, Kuehne+Nagle, Nova Trading, Onninen, Palmolive, PKP Cargo, Onninen, Pepsico, Raben, Rossmann, Volkswagen, Uni Logistics, Uniq Logistics, Speedbergx, Solid, Logit One, Dachser, Rail-Mag, Symlog, Infinity Management.

Panel participants were asked to design an ideal transport process which would eliminate their current bottlenecks. During the panel, a not only to modal shift and use of more environmentally-friendly modes of transport, but also the way transport and logistics processes are organized. design thinking approach was used. The Design Thinking process first allows panelists to define the problem and then implement the solutions, always with the needs of the user demographic at the core of concept development. This process focuses on needfinding, understanding, creating, thinking, and doing. At the core of this process is a bias towards action and creation: by creating and testing something, you can continue to learn and improve upon your initial ideas.

The design thinking process consists of these 5 steps:
- EMPATHIZE: Work to fully understand the experience of the user for whom you are designing. Do this through observation, interaction, and immersing yourself in their experiences.
- DEFINE: Process and synthesize the findings from your empathy work in order to form a user point of view that you will address with your design.
- IDEATE: Explore a wide variety of possible solutions through generating a large number of diverse possible solutions, allowing you to step beyond the obvious and explore a range of ideas.
- PROTOTYPE: Transform your ideas into a physical form so that you can experience and interact with them and, in the process, learn and develop more empathy.
- TEST: Try out high-resolution products and use observations and feedback to refine prototypes, learn more about the user, and refine your original point of view.

This process were used during individual workshops for need finding, understanding, creating, thinking, and doing [Brown, Tim, Jocelyn, 2015, Johansson-Skoldbelrg, Woodila, Çetinkaya, 2013, Dym, Clive, 2005]. Analysis of needs resulting from the panel shows that there is a demand for solutions enabling real-time transport management and for monitoring order completion progress in real time as part of the global supply chains. Companies are particularly interested in monitoring the progress of order completion and automatic conveyance of such data to customers.

As a main need, panellists stated that the ideal solution for the management of transport and logistics processes should eliminate the following problems of existing solutions:

− Global visibility of supply chains - global tracking of smart cargos and vehicles makes it possible to determine the status of a specific logistics service accurately. Companies who order the services of carriage or haulage companies who carry high-value goods (alcohol, paper, electronic equipment) indicate that it is necessary to determine accurately whether or not e.g. a driver pulled over or parked in an unauthorised car park.

− The time slots problem and the issue of deliveries to chain stores - another problem indicated by manufacturers who deliver goods to chain stores. Chain stores determine time windows for their suppliers (e.g. from 2 pm to 4 pm). If a manufacturer/supplier delays delivery, a chain store may impose a fine on them. Up until now, no solution has been available on the market which would allow accurate determination of the time a cargo or a vehicle is ready for loading.

− Automatic accounting of transport costs - this need was underlined by transport service providers and transport service users. Currently, to account transport services companies must wait for signed proof of delivery. In most cases this document is a paper document where the receiver confirms the delivery to the driver. In the next step the driver sends the document back to the forwarder or to his own company. Based on the proof of delivery companies can account transport costs. The whole process can last up to 4 weeks from the moment when the goods were delivered to the receiver.

− Production stoppages resulting from unavailability of information on the delivery status in real time. This problem was voiced by companies using the "Just in Time" system, meaning that delivered products are sent directly to the assembly line. In the event that goods are not delivered on time or a delay is not notified early enough, the entire assembly line is stopped as there are no materials for the line to work further.

− The missing cargo problem. This issue was raised by companies operating in Africa, Asia and South America. Solutions enabling cargo monitoring in these continents are virtually unattainable due to the limitations resulting from the inaccessibility of a GPRS channel and high GSM charges. The problem of high costs and other inefficiencies of using GPRS channel for data transmission is confirmed by other researchers [Ming, Fang, 2012, Sharma, Archana, Vineet Kansal, 2015, Hajdul, Kawa, 2015].

− Temperature and moisture monitoring in real time. This issue was raised by health-care sector companies who, in accordance with the latest best practice for drug distribution published by the European Commission, are obliged to monitor cargo temperature and moistness in real time and make these data available, also in real time, to all transport chain participants (shipper, consignee, carrier).

The first three points were mentioned by all panellists as being crucial ones that should be solved by an ideal solution for transport and logistics management. All of the points tackle aspects of access to data during the execution of transport. That is why most of the panellists stated that there is a need for improvements in communication between all actors involved in the supply chain. As a result, the panellists design an ideal supply chain system that allows seamless communication between services users, service providers and machines taking part in the execution of transport.
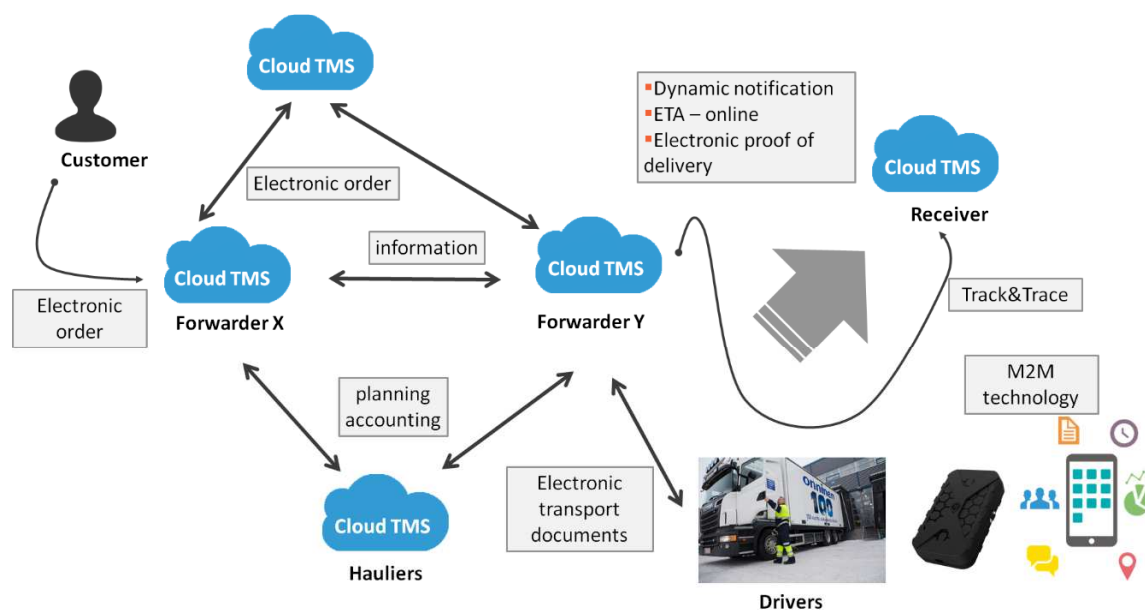
Source: own study

Fig. 1. Concept of the open transport management system that allows seamless communication
Rys. 1. Koncepcja otwartego systemu zarządzania transportem, który umożliwia bezproblemową komunikację

The main aim of the reference system drafted on figure 1 is to support seamless communication between users in the supply chain. All data needed are aggregated and stored in the cloud, with all users having access to authorized parts of the cloud. In particular, the panel participants underlined the importance of receiving the following real-time information during execution of transport:
- electronic order (booking),
- confirmation of receiving order,
- electronic notification about order status,
- electronic notification about ETA (estimated tome of arrival of goods),
- electronic transport order and documents transferred to the service provider/driver,
- electronic proof of delivery,
- electronic settlement of services within partners involved in the chain.

Panelists define the following generic data as crucial to be received automatically for track&trace transport execution:
- date and hour of reaching loading point,
- date and hour of loading of goods,
- real-time location of transport asset,
- date and hour of reaching unloading point,

- receiving proof of delivery from the driver.

Once these data are received, the process of settling services can be also organized automatically in a standardized digital format.

The next three chapters present a comparison of the current way of monitoring transport execution with a new approach to collecting data. In the current approach, all data are requested and distributed by humans. In the new approach, however, M2M technology is implemented in the vehicle executing transport. The basic version of M2M technology that can be implemented in transport is a simple GPS tracker connected to an online system that allows open access to process users. This allows human work in selected part of the processes to be eliminated. Moreover, automatically receiving information about transport execution allows the manager/forwarder better planning and synchronizing other transport orders [Mes, Martijn, 2016].

REAL-TIME VISIBILITY OF TRANSPORT PROCESSES

Currently, to collect information about real-time location and status of the transport there is a need to involve at least two persons (forwarder and driver). When information about the current location of a transport-asset is needed, the forwarder has to call the driver in order to check this. Figure 2 presents the AS-IS situation, based on the process analysis done in Speedbergx forwarding company operating in Europe. Figure 3 presents the TO-BE situation, where the whole process has be automatized by implementing M2M technology.
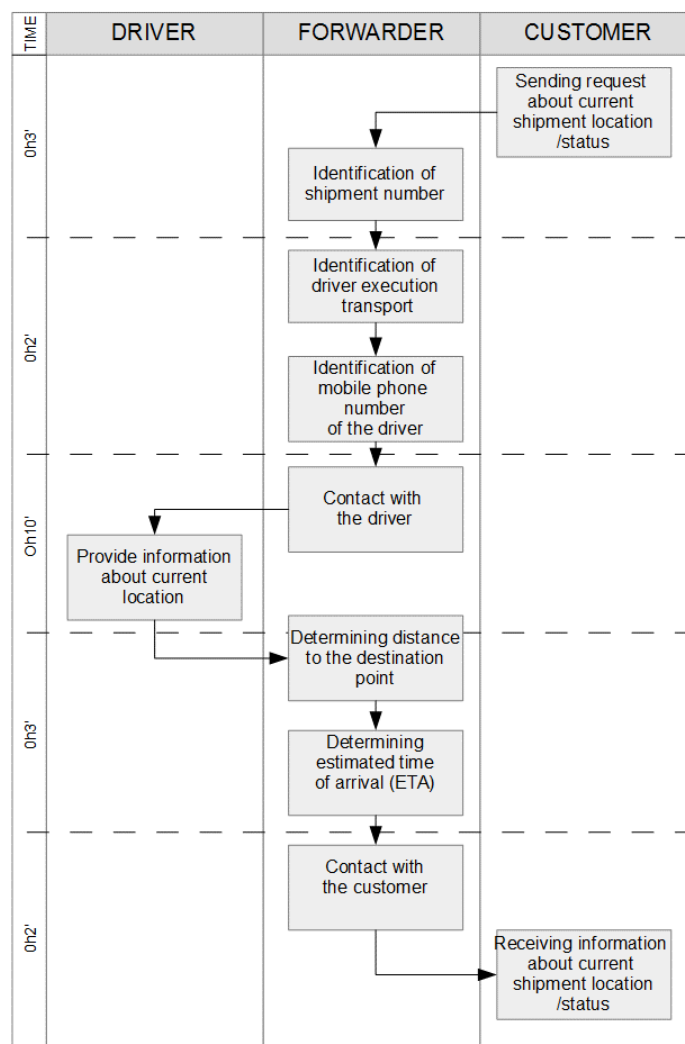
Source: own study

Fig. 2. AS-IS process allowing monitoring of shipment execution (visibility)
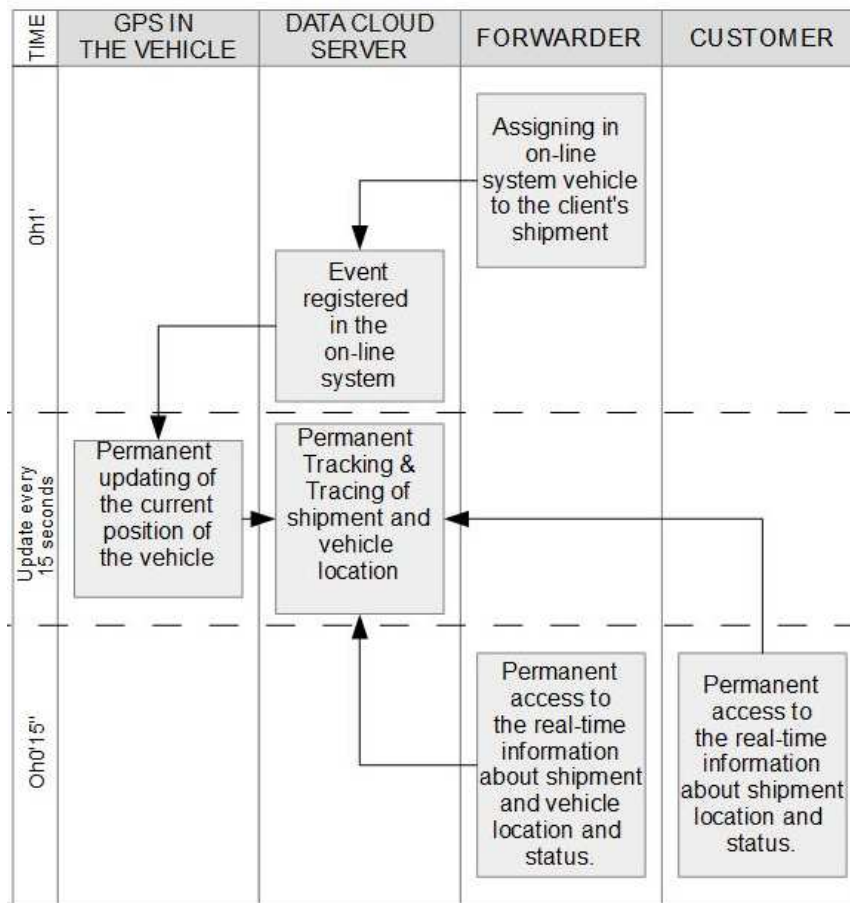Rys. 2. Bieżący proces identyfikacji stopnia realizacji przewozu

Moreover, during analysis of the AS-IS and TO-BE situations at Speedbergx, the MTM method was used to measure real time needed to execute specific tasks in the process. MTM stands for Methods-Time Measurement. It is a predetermined motion time system that is used primarily in industrial settings to analyse the methods used to perform any manual operation or task and, as a result of that analysis, set the standard time in which a worker should complete that task [Manns, Wallis, and Deuse, 2016, Nur, Nurhayati, 2015].

In the TO-BE situation, simple GPS trackers provided by Nova Tracking company were installed in Speedbergx vehicles (figure 3). Trackers sent data to T-Traco platform that

allows real-time transport process management and seamless communication between the forwarder, customer, driver and the vehicle.

Time measurements in AS-IS and TO-BE situations were carried out according to M2M methodology and are averages for specific actions in the process. Figure 4 presents the TO-BE situation, where M2M technology was used to collect necessary data. Figure 5 presents visualised data received from the GPS device in the on-line TMS T-Traco system.

Source: own

Fig. 3. GPS device allowing track&trace of the vehicle
Rys. 3. Nadajnik GPS pozwalający na monitorowanie pojazdu

Source: own

Fig. 4. TO-BE process allowing monitoring of shipment execution (visibility) with M2M technology
Rys. 4. Docelowy proces identyfikacji stopnia realizacji przewozu z wykorzystaniem technologii M2M
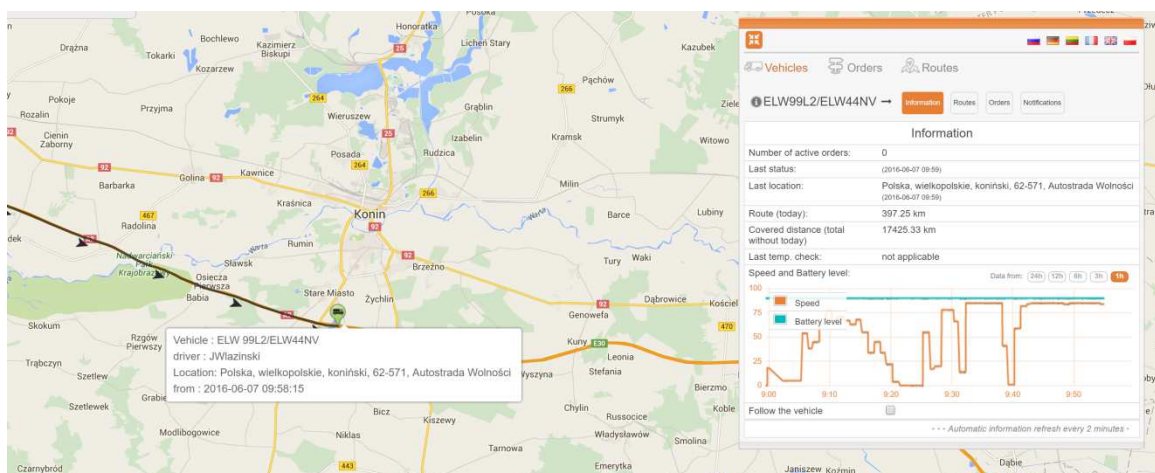
Source: own

Fig. 5. Visualisation of data received from GPS device in the on-line TMS system T-Traco
Rys. 5. Prezentacja danych otrzymanych z urządzeń GPS w systemie T-Traco dostępnym on-line

TIME-SLOTS MANAGEMENT

Many customers expect their shipments to be delivered at a specific hour or in a specific time slot (e.g. 13:00 - 13:00). It is essential to manage time-slots and generate timely delivery reports. Moreover, offering customers proof of delivery at specific time-slots is an emerging business strategy in transport and logistics services because it has the potential to improve the service level [Chen, 2016].

Figure 6 presents the AS-IS process of time-slot management. Figure 7 presents the TO-BE process of time-slot management with M2M technology. Finally, figure 8 presents a visualised report automatically generated by the on-line system based on the data received from GPS trackers.
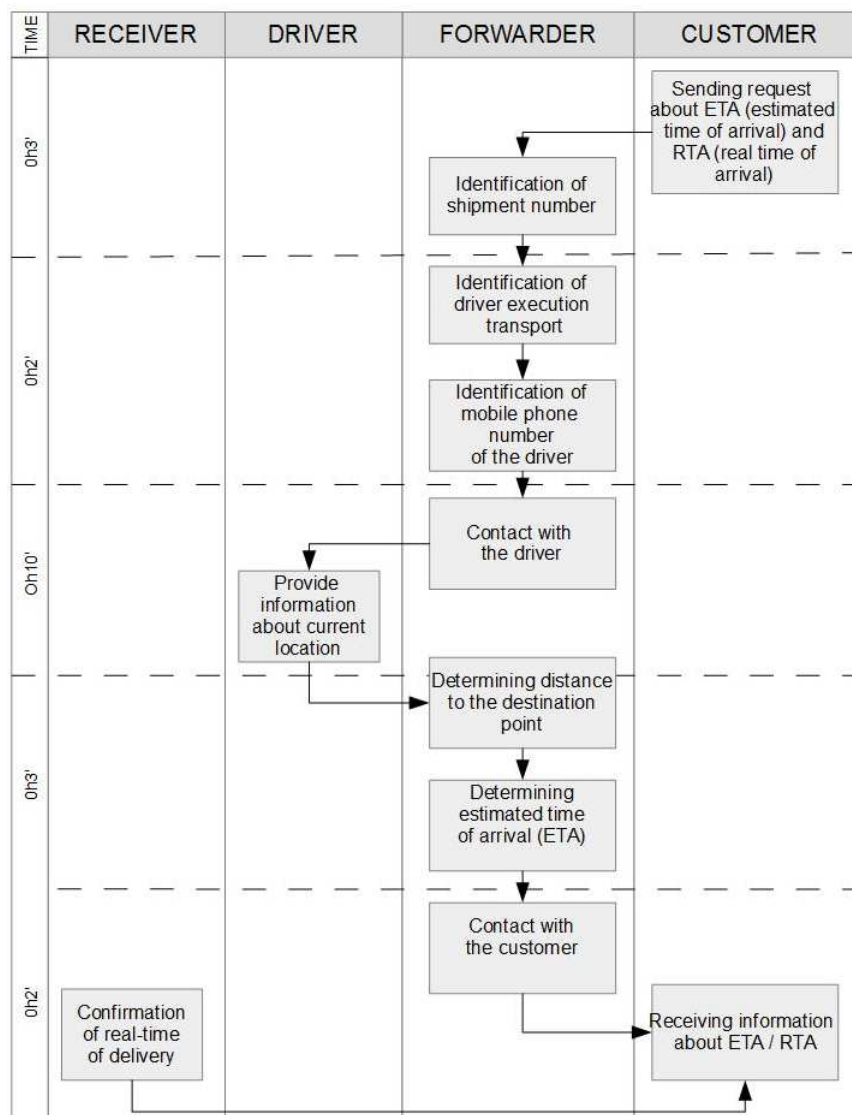
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Fig. 6. AS-IS process allowing time-slots management
Rys. 6. Bieżący proces zarządzania oknami czasowymi dostaw
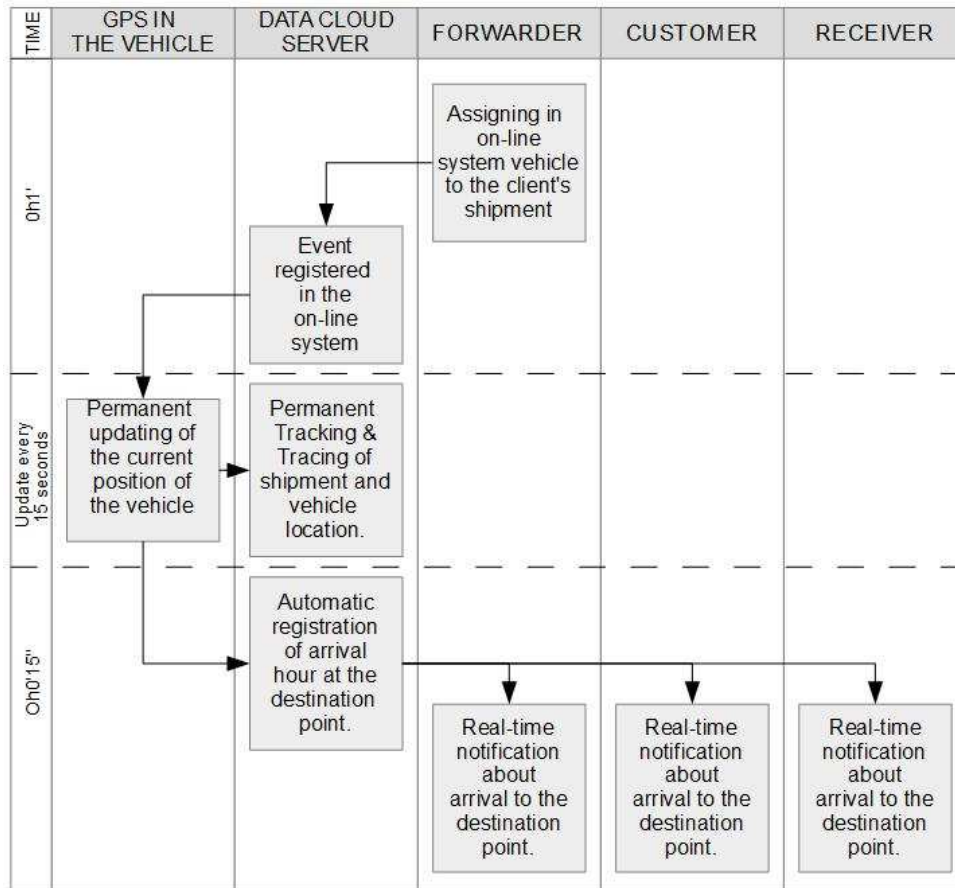
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Fig. 7. TO-BE process allowing time-slots management based on the M2M technology
Rys. 7. Docelowy proces zarządzania oknami czasowymi dostaw bazujący na technologii M2M
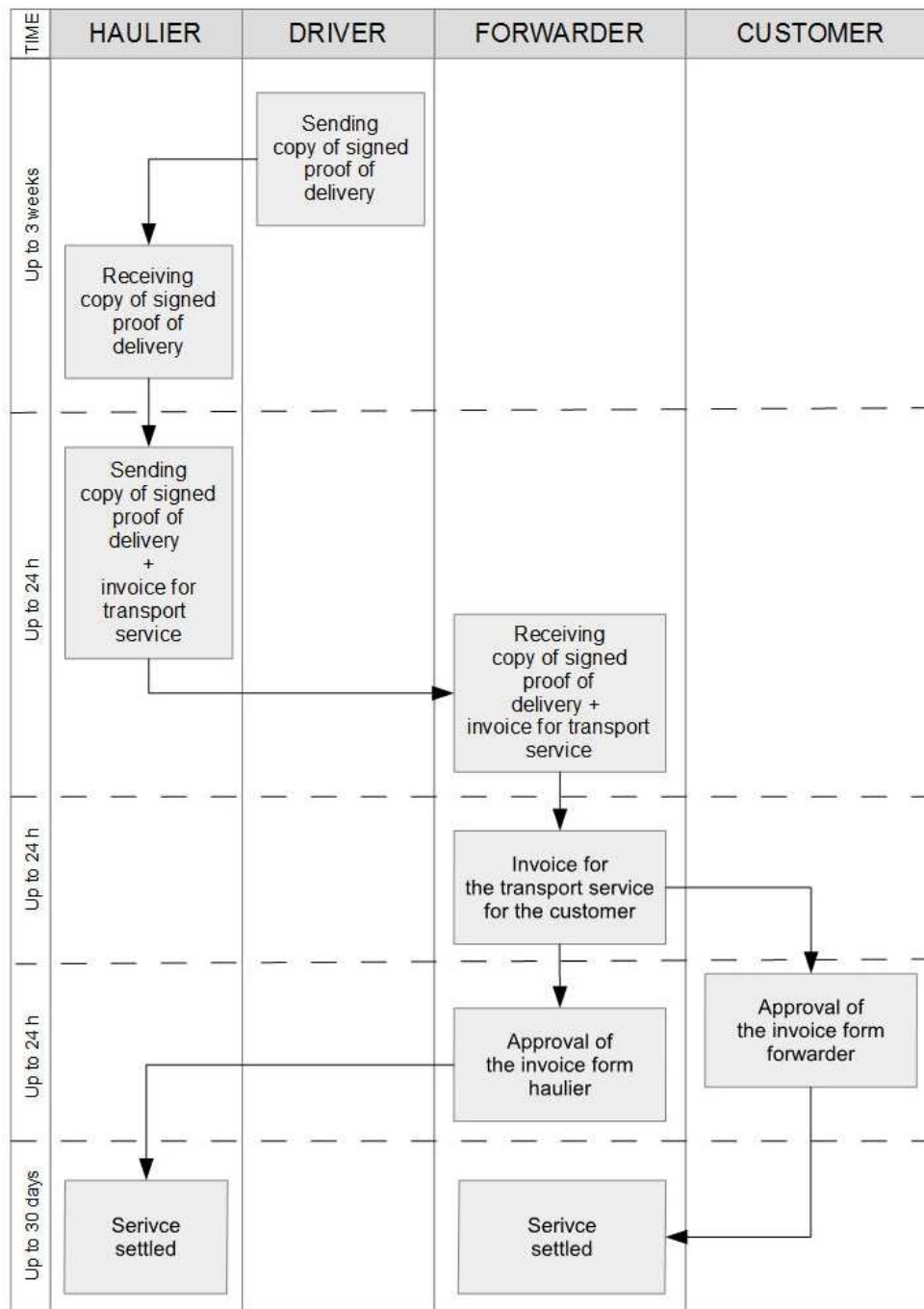

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Fig. 8. Visualisation of time-slots data received from GPS device in the on-line TMS system T-Traco
Rys. 8. Prezentacja danych dotyczących okien czasowych dostaw w systemie T-Traco

AUTOMATIC ACCOUNTING OF TRANSPORT COSTS

Once the shipment is executed, payment should also be settled as soon as possible in order to ensure the proper cash flow in the company. In order to settle shipment and transport costs, it is necessary to receive a copy or original of proof of delivery signed by a receiver. In most cases proof of delivery is the receiver's transportation letter (CMR). Figure 9 presents the AS-IS process

of shipment settlement. Figure 10 presents the TO-BE process of shipment settlement with the support of M2M technology.

Source: own

Fig. 9. AS-IS process allowing accounting of transport costs
Rys. 9. Bieżący proces rozliczania usług transportowych
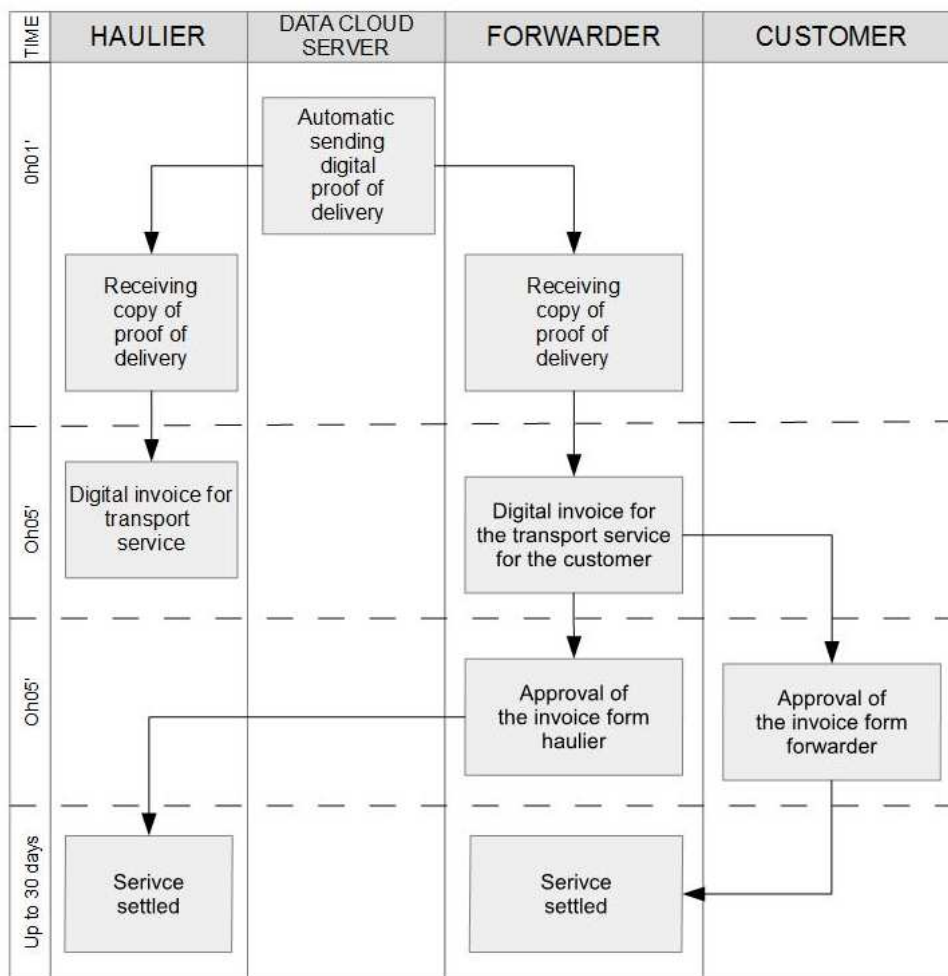
Source: own

Fig. 10. TO-BE process allowing accounting of transport costs
Rys. 10. Docelowy proces rozliczania usług transportowych

CONCLUSIONS

According to ALICE - European Logistics Technology Platform, freight transport and logistics is the link between different processes in the value chain of goods from raw materials to finalized products and end-of-life management. In that sense, transport needs to be seen from a systemic perspective, allowing end-to-end solutions addressing first mile, long distance transport and last mile in the context of cities, regions, countries European and global transport. Therefore, the transport and logistics market is in a need of a lean, secure and reliable solution for seamless communication within the supply chains. One of the crucial issues in data sharing is to know what type of information is relevant for the companies in the freight management for all transport modes. The crucial expectation from the market is to get an IT solution with the following features: real-time visibility of the whole supply chain for all transport modes, service as software, inexpensive, reliable, global coverage of tracking logistics assets, geofencing and mobility, real-time ETA, ATA, ETD, ATD. In order to achieve the expected results, there is a need to implement automatization (through M2M communication) to data exchange during the execution of transport.

Finally, based on the studies carried out at Speedbergx, the following results, presented in table 1, were obtained.

Table 1. Results of the study on the efficiency of the implementation M2M technology for communication in supply chains
Tabela 1. Rezultaty badań skuteczności i efektywności sposobu komunikacji wykorzystującego technologię M2M w łańcuchach dostaw

Process	Total time needed to execute all tasks in the process	
	AS-IS (traditional way of communiation)	TO-BE (using M2M technology for communication)
Real-time visibility of transport processes	0h20'	0h01'15"
Time-slots management	0h20'	0h01'15"
Accounting of transport costs	Up to 24 days + up to 30 days of payment terms	0h11' + up to 30 days of payment terms

Based on our findings, it can be clearly stated that implementing M2M technology allows seamless communication in supply chains. It saves time needed to collect all the necessary information. Moreover, through the automatization of data collection, drivers and forwarders can focus on their primary tasks. This leads to improved effectiveness and efficiency in the whole company.

Finally, wider implementation of M2M technologies is also a step towards a truly integrated transport system for sustainable and efficient logistics. This is a future concept, which is currently being developed by the ALICE technology platform. A truly integrated transport system is based on an open and global system of transport and logistics assets, hubs, resources and services operated by individual companies. They are fully visible and accessible to market players, hence creating a network of logistics networks. The coordination of logistics, transport, infrastructure and supply networks aims to move, store, supply and use physical objects throughout the world in a manner that is economically, environmentally and socially efficient, secure and sustainable. The system will be based on physical, digital, and operational interconnectivity, enabled through modularization as well as standardisation interfaces and protocols.

REFERENCES

Aslekar P., Londhe P., Ashwini Gaikwad A., 2016, M2M Communication - Power Link Technology, IJSRD - International Journal for Scientific Research & Development| 4, 01, ISSN (online): 2321-0613.

Boswarthick, David, Omar Elloumi, and Olivier Hersent, 2012, eds. M2M communications: a systems approach. John Wiley & Sons.

Brown, Tim, Jocelyn Wyatt, 2015. "Design thinking for social innovation." Annual Review of Policy Design 3.1, 1-10.

Chen, Cheng-Chieh Frank, Yu-Chieh Cindy Chen, 2016. "A Dynamic Programming Model for Attended Delivery Time Slot Management."Transportation Research Board 95th Annual Meeting 16-0559.

Dym, Clive L., et al., 2005. "Engineering design thinking, teaching, and learning."Journal of Engineering Education 94.1, 103-120.

Johansson-Sköldberg U., Woodilla J., Çetinkaya M., 2013, Design Thinking: Past, Present and Possible Futures. Creativity and Innovation Management, 22: 121-146. doi: 10.1111/caim.12023.

Manns M., Wallis R., Deuse J., 2015. "Automatic Proposal of Assembly Work Plans with a Controlled Natural Language." Procedia CIRP 33, 346-351.

Mes, Martijn RK, Iacob M.-E., 2016. "Synchromodal Transport Planning at a Logistics Service Provider." Logistics and Supply Chain Innovation. Springer International Publishing, 23-36.

Ming, Fang, et al., 2012. "GSM/GPRS Bearers Efficiency Analysis for Machine Type Communications." Vehicular Technology Conference (VTC Spring), 2012 IEEE 75th. IEEE.

Nur, Nurhayati Mohd, et al., 2015. "The effects of energy expenditure rate on work productivity performance at different levels of production standard time." Journal of physical therapy science 27.8, 2431.

Paul D. Reynolds, 2001. National panel study of U.S. business startups: Background and methodology, in (ed.) Databases for the Study of Entrepreneurship (Advances in Entrepreneurship, Firm Emergence and Growth, Volume 4) Emerald Group Publishing Limited, 153 – 227.

Sharma Archana, Vineet Kansal, Tomar R.P.S.. 2015. "Location Based Services in M-Commerce: Customer Trust and Transaction Security Issues."International Journal of Computer Science and Security (IJCSS) 9.2, 11.

Wu, Geng, et al., 2011. "M2M: From mobile to embedded internet." Communications Magazine, IEEE 49.4, 36-43.

BEZPROBLEMOWA KOMUNIKACJA W ŁAŃCUCHACH DOSTAW DZIĘKI WYKORZYSTANIU TECHNOLOGII M2M

STRESZCZENIE. **Wstęp:** Dostęp do informacji jest kluczowym elementem skutecznej i efektywnej organizacji transportu i procesów logistycznych. Znaczenie dostępu do informacji w czasie rzeczywistym potwierdzają przeprowadzone badania panelowe. Do realizacji badań wykorzystano metodę design thinking. W dalszej części pracy omówione zostały dwa sposoby pozyskiwania niezbędnych informacji w trakcie przewozu - manualny, gdy zachodzi konieczność pracy ludzkiej oraz w pełni zautomatyzowany, przy zastosowaniu technologii M2M. Wdrożenie technologii M2M poprawia bezproblemową komunikację podczas realizacji przewozu i umożliwia dostęp w czasie rzeczywistym do potrzebnych informacji. Celem pracy było ustalenie wpływu wykorzystania wybranych technologii M2M oraz tradycyjnego sposobu komunikacji na zapewnienie niezawodnej komunikacji w łańcuchu dostaw.
Metody: W pracy wykorzystano badania panelowe, metodę design-thinking, przegląd literatury jak i rezultaty z praktycznego wdrożenia systemu TMS w firmie Speedbergx
Wyniki i wnioski: Bezproblemowa wymiana informacji w czasie rzeczywistym w ramach globalnych łańcuchów dostaw (włączając w to komunikację ze środkami transportu oraz jednostkami ładunkowymi) jest podstawą realizacji wiarygodnych i wydajnych procesów w ramach cyfrowych łańcuchów dostaw.

Słowa kluczowe: cyfrowe łańcuchy dostaw, bezproblemowa komunikacja, M2M, zarządzanie oknami czasowymi dostaw, rozliczanie kosztów transportu

PROBLEMLOSE KOMMUNIKATION IN LIEFERKETTEN DURCH DIE ANWENDUNG DER M2M-TECHNOLOGIE

ZUSAMMENFASSUNG. Einleitung: Der Zugriff auf die Informationen ist das Schlüsselelement einer leistungsfähigen und effizienten Organisation von Transport- und Logistikprozessen. Die Bedeutung des Zugriffs auf die Informationen in der Ist-Zeit bestätigen die durchgeführten Panelforschungen. Für die Ausführung der Forschungen wurde die Methode von Design Thinking in Anspruch genommen. Im weiteren Teil der Arbeit wurden zwei Vorgehensweisen bei der Gewinnung von unentbehrlichen Informationen während der Beförderung erläutert, und zwar die manuelle, wenn die Notwendigkeit der menschlichen Beteiligung am Prozess besteht und die vollautomatisierte Vorgehensweise unter Anwendung der M2M-Technologie. Die Einführung der M2M-Technologie verbessert die problemlose Kommunikation während der Durchführung einer Beförderung und ermöglicht den Zugriff in der Ist-Zeit auf die unentbehrlichen Informationen. Das Ziel der Arbeit war es, den Einfluss der Anwendung der ausgewählten M2M-Technolgien und der herkömmlichen Art der Kommunikation auf die Gewährleistung einer zuverlässigen Kommunikationsweise innerhalb einer Lieferkette festzulegen.

Methoden: In der Arbeit wurden Panelforschungen, die Design-Thinking-Methode, die Fachliteratur-Übersicht sowie die Ergebnisse einer praktischen Einführung des TMS-Systems bei der Firma Speedbergx in Anspruch genommen.
Ergebnisse und Fazit: Der reibungslose Austausch von Informationen in der Ist-Zeit innerhalb der globalen Lieferketten (einschließlich der Kommunikation mit den betreffenden Transportmitteln und Ladungseinheiten) schafft die Grundlage für die Durchführung von glaubwürdigen und leistungsfähigen Prozessen innerhalb der digitalen Lieferketten.

Codewörter: digitale Lieferketten, problemlose Kommunikation, M2M-Technologie, Management von Lieferungs-Zeitfenstern, Abrechnung von Transportkosten

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