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# SELECTED PROBLEMS OF SOME ITS ADVANCED TECHNOLOGIES APPLICATIONS FOR INTER-MODAL TRANSPORT CHAINS

The information plays very important role in the transportation process. Effective information systems improve the management of the process which is hard to control and requires excellent coordination.

The intelligent transport chain includes automatic location of vehicles, loads, and drivers. There are two basic technologies to be applied: (a) RFID-technology and (b) satellite (e.g. GPS, Galileo), to automatic location of vehicles and transport units. They have some advantages and disadvantages. In this article some issues of both technologies of freight transport chains are considered.

# WYBRANE PROBLEMY ZASTOSOWANIA NIEKTÓRYCH ZAAWANSOWANYCH TECHNOLOGII ITS W INTERMODALNYM ŁAŃCUCHU TRANSPORTOWYM

W artykule przedstawiono wybrane problemy związane z zastosowaniem automatycznej lokalizacji pojazdów oraz jednostek ładunkowych z wykorzystaniem technologii RFID oraz technologii satelitarnej, np. GPS, Galileo, w intermodalnym łańcuchu transportowym. Zwrócono uwagę na niektóre zalety i ograniczenia każdej z tych metod.

W artykule omawiane są zagadnienia znaczenia wymiany informacji dla efektywności procesu transportowego. Nowoczesne technologie wymiany i przetwarzania informacji stwarzają nowe, nieznane wcześniej możliwości zarządzania procesem transportowym.

## 1. INTRODUCTION

The supply chain can be defined as all processes concerned with the supplying of goods from point of origin to point of consumption. The transport chain is part of the supply chain, generally limited to the movement of goods.
Generally speaking, it may include:

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- Seamless transport systems that deliver goods on time, in peak condition, at an agreed value, using the best available technologies
- Ensuring flexibility to meet changing needs
- Building and maintaining effective business relationships between all players making-up the individual links in the transport logistics chain
- Successfully meshing transport modes across state and international borders
- Using the most efficient and effective transport means as agreed by the customer and the supplier
- Avoiding supply chain disruptions
- Covering transport chain management
- Incorporating transport intelligence as well as transport infrastructure (ITS)

When advanced information and telecommunication technologies (ICT) are fully used in a transport chain, it can be called intelligent.

## 2. INFORMATION NEEDS OF ACTORS IN INTELLIGENT TRANSPORT CHAINS

Firstly we will present the characteristic features of integrated supply chains:

- Elimination of barriers between participants of a supply chain;
- Coordination of material, information and finance flows along the chain;
- Partnership relations of the members of the chain based on win – win strategy;
- Reduction of costs in the whole chain instead of sub optimal solutions (e.g. lowering inventory level in the whole system) with the use of synergy effect;
- Regular meetings at different levels in order to find solutions effective from the point of view of the whole system;
- Free exchange of information between partners.

In the integrated supply chain decisions at one stage influence the whole system. What is optimal from the point of view of one element of the chain (one enterprise, warehouse, plant, sales point) can unprofitable from the point of view of the whole chain. For example in a warehouse high level of inventories can stored because it is profitable to buy and transport more goods at one time and economize on transport costs. But from the point of view of the whole supply chain it may appear it better to send goods more frequently in lower quantities because it makes the supply chain more stable and helps in this way increase efficiency (better service to customer with lower costs).

The information plays vital role in integrated supply chains. Without efficient information system the effective management of the whole supply chain in order to reduce costs and enhance customer service wouldn't be possible.

In the supply chain information are moved between:

- Suppliers of goods
- Their customers
- Carriers, forwarders, logistics operators and other service providers (e.g. warehousing services)
- Banks, insurance companies, customs authorities

An efficient and reliable information system helps in increasing the customer service level, reducing inventories of goods, increasing the productivity of resources thus enables in reaching the goal which in a traditional economy was very hard to obtain: gaining the high level of quality with low costs.
The information about requirements of the elements of the supply chain make it possible to gain at least two advantages:

- adjusting resources and processes to the actual needs
- put into practise theoretical tools and methods of optimalisation, simulation etc.

So applying new technology solutions in a logistics chain not only speed up some activities but opens new possibilities. In traditional systems in practice there is no time to use e.g complicated simulation models because decisions have to taken quickly. But thanks to the modern technologies information can directly flow in to the information systems and be processed automatically – without the participation of a human being.
The information plays very important role in the transport process and appears at all stages of it. The efficiency of the transportation process depends on the information – e.g.:

- customer service (receiving orders, checking the financial status of the customers and the production potential of the service providers and its suppliers)
- the control of the run of the transportation process
- advising the incoming goods
- customs procedures

The results are:

- higher service – shorter time from receiving orders to their realisation, higher safety, access to the information about the status of the delivery for the customers, fewer errors;
- lower costs – drivers control, effective management of fleet, reducing the labour, better preparation in the transhipment points ("the information overtakes the goods")

The importance of information is even greater in intermodal transport chains which require excellent coordination.

New technologies open new possibilities for transport. For example a transport unit can be located before it reaches the point of destination (e.g. a port) and an optimal decision can be made at a very early stage of the transport process.
It is very important that information is obtained quickly, precisely and without personal contact. This information can be further automatically send to other applications. The information can be obtained also by a driver who also can make optimal decisions.

## 3. THE APPLICATION OF ITS IN MULTIMODAL TRANSPORT

One can ask a question: "what's the use of the new technologies in the multimodal transport?" or "what's the difference in the applications in the single modes of transport?. Is there any difference?"
There is a strong need for excellent coordination in multimodal transport chain and that coordination requires effective information system. The information is needed for:

- Monitoring goods in the whole chain (it is difficult because a consignment changes the transport modes during a journey)
- Planning the operations at individual stages of the multimodal process

The usefulness of new technologies appears already at initial stage when customers send orders to an operator. Customers can book services, monitor the status of delivery.
There is a big potential for improving effectiveness of the multimodal system by coordinating transport modes in transhipments points.
If goods have to be transported via sea port three elements have to be coordinated:

- Ship
- Road transport (e.g. railway)
- Port

A forwarder or operator organizing the transport has often very little time to make decisions: e.g. to reload with or without storing. Both options have its advantages and disadvantages. Unloading without storing is cheaper unless e.g. a ship is late and one has to pay extra costs for keeping wagons in a port and also for the staff or a company reloading goods in port. To make an optimal decision a forwarder needs exact information about the position of a vehicle as soon as possible, because it very difficult to plan the time of arrival of a ship and also a train.

The transhipment phase consumes costs and time. Apart from technical and organizational solutions new technologies help in reducing efforts. RFID tags gives information about location of an object (e.g. a container) and thanks to that there is a possibility to give up checking the goods coming to terminal. They can be send instantly after their arrival because the information is read from the tag automatically. In manual systems it happens very often that delivery reach the terminal earlier than documents. That situation causes problems for the staff in transhipment point. The information about delivery should not only arrives with goods but also precede them because it gives time to plan more effectively reloading and perhaps storing. Electronic form of documents allows access to information for every member of the transport chain in the real time what is also important.

In case a container is stored in a terminal before loading it on a vehicle, ITS with the use of satellite technology is very useful in managing it in the yard - finding the container, planning and managing the movement and reloading. It is more efficient if the processes are managed automatically instead of manually because in this way unproductive activities are reduced (checking, searching for a ITU[3], making decision concerning its movement). A driver

[3] ITU stands for *Intermodal Transport Unit ( Terminology on Combined Transport*. United Nations, New York and Geneva 2001, pp.56)

coming to a terminal can be directed to a proper place, where the queue isn't long. In this way the productivity of transport means and infrastructure can be enhanced. It is very important from the point of view of intermodal transport development. Intermodal system needs investment, but ITS should help in increasing the potential of existing one.

There also some other fields that can simplified thanks to modern technologies – like customs procedures for example. Customs procedures are very time and costs consuming activities thus every improvement in collecting, filling and sending appropriate documents influence the effectiveness the whole multimodal process. There can be errors in customs, transport or trade documents, they can inappropriate (copy of invoice instead of original one), there can be lack of them (e.g. certificates) or send too late (when a parcel is already at the border). New regulations in this field allow using electronic form of documents. Thanks to that the human participation in the process can reduce and as a result errors eliminated and effectiveness raised. Therefore quick sent relevant information to customs clearance point speed up the physical flow of goods. It enabled also by the possibility of tracking and tracing goods along the road a vehicle moves. Apart from the speed very important is reliability of deliveries especially in multimodal transport system because delays even in one point influence the whole chain.

## 4. ECONOMIC ASPECTS OF TECHNOLOGICAL IMPROVEMENTS IN A TRANSPORT CHAIN

Traditional economy stands that you choose between two goals: to minimise expenditures or to maximise effects. An efficient and reliable information system helps in increasing the customer service level, reducing inventories of goods, increasing the productivity of resources thus enables in reaching the goals which in traditional economy was very hard to obtain: gaining the high level of quality with low costs.

With the use of the telematics technology there is a possibility of reducing different kinds of costs (not only transportation costs). Transportation costs can be reduced but at the same time inventory maintaing costs also can be minimized. In traditional economy there is a trade – off between different options – e.g.:

- Send small parcels thus economizing on inventory but increasing transport costs
- Send full track loads to save transportation costs but the effect is also high level of inventories

Other trade – offs are:

- Better (but more expensive) carrier or worse (but cheaper) one
- Shorter time of delivery (higher costs of transportation) or to wait for the whole consignment
- More level of reliability of deliveries make it possible to lower the level of inventories

If the whole system is well coordinated it can obtain lower costs with better service. The best example are new technologies. For example replacing paper documents by electronic ones

allows not only decrease administration costs but also other – transportation, terminal costs and what's more increase service to customers.
But to calculate the effectiveness of the system we have to asses the advantages and disadvantages of the system. The advantages are:

- Quicker transhipments (better quality)
- More safety (lower costs of delivery and higher service, lower insurance costs)
- Lower costs in road transport, railway
- Lower costs in transhipments

Disadvantages are first of all costs of investments, but nowadays more and more activities can be outsourced. Carries needn't own their own trucks, information systems and so on. It means that more and more costs are converted from variable to fixed ones, which means lower risk.

Good information system helps a carrier to minimize costs (better planning and control) and at the same time to give better service to the users. Possibility like this exist when for example one can combine information about position of a vehicle and loads to pick up. Without these information a carrier would have to raise a production potential to meet different requirements of customers. Effective information system means less administrative costs and better service (shorter time of realizing the order, fewer errors).

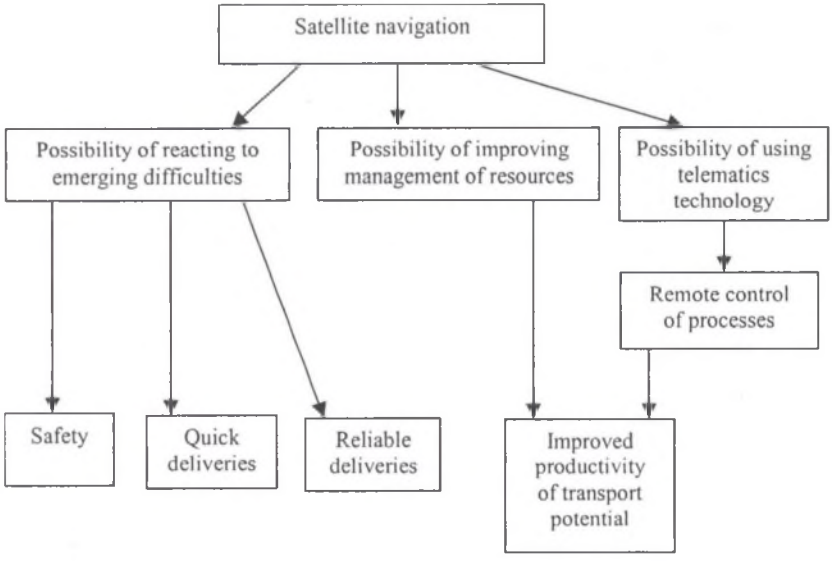


Fig.1. The results of implementing satellite navigation in the multimodal process

Of course we shouldn't forget that satellite technology is only a tool and that investment in it will be wasted if the information systems are not integrated with the effective physical potential (transport means, terminals, transhipment technology), human resources etc.

## 5. TECHNOLOGIES OF LOCATION SERVICES IN A TRANSPORT CHAIN

Inter-modal transport chains should ensure efficient flow of goods and information on the movement of goods. It includes location-based services. Location-based services consist of a broad range of services that incorporate location services with other information provided to the user. One of the location-services is called: assets tracking. Usually this is a service for professional users that want to keep control on transported goods (shipments) and their fleet.

Tracking services are based on various technologies for identification of transport units and transmitting information about moving transport units, for example by Internet. There also exist systems which are based on satellite telecommunications, incl. GPS. They are already in use, for example, in harbours for localising containers or straddle carriers. The core of tracking concept is identification systems and location systems; identification systems make it possible to determine the status and the location of transport units, in addition to identification. The collected information is transferred either in real time (on-line) or batch process (from time to time) to the transport planning and control system, etc. Since the identification of the transport unit is an inseparable part of the transport planning and control technologies, proper interfaces for transport planning, control and client service systems are needed. The interfaces are an essential part of the identification system, which sets demands on data content, information format and transfer technique.

RFID-technology (Radio Frequency Identification) enables automatic identification of transport units at terminals and other transfer points. A basic RFID-system consists of three components: an antenna; a reader (interrogator); a transponder (usually called a RF tag) with unique ID-code and possibly other information.

The antenna emits radio signals to activate the tag, and reads and writes data to it. Antennas are the link between the tag and the transceiver, which controls the system's data acquisition and communication. Antennas are available in a variety of shapes and sizes; for example, they can be built into a doorframe to receive tag data from persons or objects passing through the door, or mounted along on a transport network to monitor traffic.

Besides, the transport mode changes several times during a journey. Information about a moving transport unit must be transmitted between different companies and between different information processing systems. Large companies can transfer data with automatic EDI transfers or by Internet. In smaller companies (SMEs) the transfers are performed sometimes by fax, e-mail, or manually. These manual transfers lead to extra costs, transport delays, a lower level of transport planning and deficiencies in quality.

The satellite technology comprise two basic solutions: (a) satellite communication, when satellites are used as a transponder to enable communications between devices placed in various sites of the globe; (b) global positioning system, when a constellation of satellites is a provider of atomic time signals to receivers attached to vehicles, transport units or people (drivers). It enables to describe their geographical location, etc. The most knows global positioning system is Navstar GPS. In the near future it will be Galileo – European positioning system. The European Commission has been greatly involved in Galileo building and putting into operation, especially for navigation services in transport since the year of 2008. Galileo signals can also be combined with other global navigation systems, GPS and Glonass, and other systems such as e.g. GSM, UMTS.

## 6. THE RESULTS OF THE LAST FRAME PROGRAMMES OF EU IN THE AREA OF FREIGHT OPERATION

Within the 4th FP RTD EU (1994 – 2000) in the area of freight operation over more than ten projects were carried out. Their names are: CAPITALS, COREM, ENTERPRISE, INTERPORT, MULTITRACK, SURFF, TRACAR 1&2, EUROPE-TRIS, WELCOM, COMETA, INTACT, WISDOM, ARTEMIS, FECTEUR and FLEETMAP.

Many of them aimed at making inter-modal transport chains more attractive by the use of advanced telematics applications for transhipment, storage, and transportation. Some projects focused on particularly novel use of technology, for example RFID and satellite on specific corridors, some on cargo types and some on the overall infrastructure required.. One group of projects focused on these architectural issues and built upon the recommendations of previous projects to develop a generic tool to facilitate the realisation of integrated management systems in freight transport. Projects aimed to apply existing and proven technologies for the implementation of improved working procedures between various actors in the transport chain at key interface sites (e.g. the port as the land/sea interface). On-board architecture requirements for commercial vehicles were also developed, especially COMETA. Focusing on corridors and sites, projects studied the requirements for extending the inter-modal capabilities of West European corridors towards Eastern Europe and using innovative technology to monitor the inter-modal transportation of sensitive goods across a North-South land corridor. The technological implications on the infrastructure required to support services (such as tracking and tracing) when including a non-land link in the chain (e.g. maritime or air) were covered by these projects. A few projects studied satellite applications for freight operations, for example, MULTITRACK. Besides, facilities to improve the accessibility of information systems in freight centres in order to support the sustainability of freight flows in inner-urban areas were developed, tested and validated. Other projects focused on specific land/sea/ land corridors for high value customised goods and dealt with Just-In-Time concepts to reduce inventory requirements for these expensive goods, and also with the value-added network to balance a sets of retailer requirements against the dynamic 'mobile inventory' status. Strictly speaking, some results of a few projects have currently become out of date, especially if referring to traditional EDI, today being replaced by XML/EDI.

Furthermore, within the 5th FP RTD, IST (1998 -2002) the issue of keeping track of goods in transit is continued, especially in PARCELCALL project. The project has developed a scalable real-time, intelligent, end-to-end tracking and tracing system for transport and logistics applications – to operate across European borders, carriers and modes of transport. PARCELCALL uses RFID-technology, where an RFID tag or thinking tags is attached to every parcel in a shipment. Another interesting project is EMILY.IST. It covers a description of location-based services, including assets tracking, however, all final results of the project have not been published yet.

## 7. COMPARISON OF RFID AND SATELLITE TECHNOLOGIES

The are some positive and negative features of the mentioned technologies for location-based services applied in a inter-modal transport chain.

The main difference between the two technologies lies in the distance. The RFID-technology is applied when a vehicle or a shipment equipped with a tag is passing near the intelligent beacon. In case of satellite technology, it has no practical meaning.

Another difference is that the exact position of the shipment or vehicle can be known if a there is a fixed roadside infrastructure (beacons), however they are connected with fixed routes and have to be relocated if the route of vehicles suddenly changed. Furthermore, if a beacon fails, all vehicles and passing shipments cannot be identified. Besides, vehicles and shipments cannot be tracked if they travel off-route, e.g. in case of road works, when the road is closed.

The satellite tracking is independent of route and road infrastructure. What is more, no line-of-sight requirement between the transmitter and the receiver is needed. However, in built-up areas, among high buildings and under bridges or in tunnels the received signals are often obscure.

There are two basic ways of tracking vehicles and shipments: interrupted or continuous tracking. GPS receiver can be easily switched to one of the modes of tracking. When using RFID-technology rather interrupted tracking is practically possible.

Accuracy of position may depend on the use of one of the technologies. The exact position of vehicles is most often better at beacons than when using satellite signals. However, the satellite positioning is still improving.

Last but not least, the cost of location-based systems will be sometimes crucial to choose one of the technologies. The capital and running costs of the systems based on the two different technologies can vary greatly. From the user point of view, the most important is the cost of delivered information compared with the value of received information when choosing the way of tracking vehicles and shipments.

## 8. CONCLUDING REMARKS

Inter-modal transport chains need a fluent process of positioning vehicles and shipments. This mode of transport is becoming more and more competitive with single modal transport.

Location-based services for users in inter-modal freight transport can be based on various technologies. Two of them seem to be very attractive and competitive: RFID-technology and satellite technology.

These technologies develop very fast and find numerous applications in the transport chain in many countries.

In sum, the future of satellite-based solutions precisely connected with the process of globalisation of the world economy and globalisation of goods transportation. The future of RFID-technology solutions seem to be effective in a local or regional context.

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