INSTITUTE OF TRANSPORTATION STUDIES

Intelligent Freight Transportation Systems

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Contents

1 Introduction

The efficient movement of freight is essential to the economy and to the quality of life. Supporting an efficient, cost-effective freight transportation systems encourage local industries to compete effectively in international markets. Real-time information to track cargo, vehicles, equipments and inventories allowed carriers to enhance their transportation service. Carriers and shippers are able to automate and integrate a broad range of billing and data entry by Electronic Data Interchange (EDI).

The goal of Intelligent Transportation Systems (ITS) is to integrate individual transportation elements and join them through use of information and communication technologies into a single system. ITS provide the opportunity to increase the use of existing transportation system and generate additional capacity from the existing physical infrastructure. Other benefits of freight ITS include, but not limited to, Increase safety and security, decrease negative environmental impacts of freight transportation.

(PTV, 2010) Expects that future parcels provided with all essential data that find the route to the customer themselves! The cargo is turned into an intelligent shipment which is able to decide what kind of transport service it needs – always closely coordinated with the schedules from material flow and transport management.

2 Intelligence in Transport Logistics

> “The core of ITS consists in obtaining, processing, and distributing information for better use of the transportation system, infrastructure and services. It is traditional to examine Freight ITS according to the scope of the systems, classified into two broad classes: Commercial Vehicle Operations (CVO) for system-wide, regional, national, or continental applications and Advanced Fleet Management Systems (AFMS) dedicated to the operations of a particular (group of) firm(s)” (Crainic et al, 2009).

Both categories have some advance technology requirements. Most of these technologies also used for the e-business activities of the firm too. (Emmelhainz, 1990) defined EDI as the inter-organisation, computer-to-computer exchange of business documentation in a standard format. Reducing of manual data entry, increasing transaction speed and accuracy, lower communication costs, and simplification of procedures are advantageous of EDI for its user’s customer (shipper or large carrier). EDI become very popular in intermodal facilities and container terminals, because it supports automated and efficient operation and labor management (Ioannou, 2008). Preclearance activities at maritime and land border crossings require the using EDI for information transmission among shippers, carriers, and officials. Hus commercial vehicles required to have EDI capability.EDI helps Advanced Fleet Management Systems to communicate between dispatchers in control centers and vehicle operators in the field and ensure real-time and precise data flow between the planning and monitoring systems of the firm (Golob and Regan, 2005).

3 Freight Transportation Information Types

(Mirzabeiki, 2010) summarized types of freight transportation information that might be used in freight ITS:

1. *Traffic and infrastructure information*
2. *Vehicle and freight location information*
3. *Freight condition information*
4. *Freight positioning information*
5. *Warehouse operations and inventory information*
6. *Cargo information*
7. *Vehicle identity information*

Table 3-1 Presents detail data provided by each information type.

Table 3-1. **freight transportation information**

Information type	Data Items
1	• location of roads, • The status of roads (e.g., road quality or temporary construction on the roads) • types of vehicles that can utilize the road • limitations and congestion • Real-time information eg. congestion, accident
2	• location of the freight through the transportation network between the actors: • arrival of the freight • loading and unloading information • location of the freight in the warehouses, terminals, and ports
3	• physical attributes of the product during the transportation (in warehouse or through shipping) • Real-time information regarding the temperature, pressure, impact, humidity or the level of light in the vehicle during transportation
4	• placement and sequencing of the products when they are stored or being shipped • positioning of the products in warehouses presented in three axes of x, y and z • placement of the containers in the Ro-Ro ships
5	• number of items in the warehouses, • customers' orders for different items, • loading and unloading times for different orders • contents of different warehouses, types of items stored in the warehouses

Information type	Data Items
6	• types of shipped items and attributes (quantity, model, class, size, color, weight, price, ID number and other types of data depending on the type of items) • sender information, • receiver information
7	• type and class of the vehicle, registration number

4 Freight ITS

(Mirzabeiki, 2010) did a very comprehensive survey more than 60 companies producing or using the intelligent transportation technologies and systems. The documents include projects, progress reports, articles in industrial magazines, catalogues of the systems produced by the companies and the information available on the companies' websites. He summarized freight ITS into 9 groups:

1. *Traffic controlling and monitoring systems*
2. *Weight-In-Motion (WIM) systems*
3. *Delivery space (for parking) booking systems*
4. *Vehicle location and condition monitoring systems*
5. *Route planning systems*
6. *Driving behavior monitoring and controlling systems*
7. *Crash preventing systems*
8. *Freight location monitoring systems*
9. *Freight status monitoring systems*

An example for Vehicle location and condition monitoring systems is in international shipments. Identifying the arrival time of vehicles in advance and prepare the documentation on the borders can decrease waiting times of the trucks behind the borders. The port operators can send updated expected arrival time to trucks in case of delays of the ships. Driver can stay in safe designated parking zone to avoid congestion in port area.

In crash preventing systems sensors are used to detect objects and measure the distance from one vehicle to the other vehicles via the transportation infrastructure. If a pedestrian jumps in front of a vehicle a signal is sent to the other vehicle to prevent an accident. Detection of pedestrians at night also decreases probability of accidents.

Freight location monitoring systems may help reduce the number of stolen items or it is used to distinguish the fake items from the original ones by using Auto identification technologies.

In Table 4-1 benefits and users of each of the freight intelligent systems are explained.

Table 4-1.Freight intelligent transportation systems

	Potential User	Benefit	Technology
1	• Authorities • logistics service providers	• Control the safety and security of transportation operations → Improve resource planning and management of the vehicles. • Decrease travel time→ increase environmental performance	• smart traffic lights • plate recognition cameras • speed measuring cameras equipped with sensors • traffic signs
2	• legislation, regulations and administration of the transportation	• Increase safety of transportation • decrease damages caused by the over-weight vehicles → Reduce the cost of maintenance of the roads	• Used for rail and truck weight measurement
3	• City authority • Retailers/	• maximize the utilization of the parking place • reduce total number of vehicle trips during a specific time period, and travel time →contribution to the environment	• Integrated system of online booking and parking capacity
4	• Shipper, career	• tracking and tracing of the goods and vehicles→ better fleet management • Improvement of the security and safety of transportation.	• GPS system • Mobile Communication system
5	• Careers, 3PLs	• reducing the Potential delay →better level of service • reducing the idling times on the roads → more eco-friendly transportation • dynamic vehicle routing and scheduling→ better resource planning	• GPS system • Mobile Communication system • Large scale Optimization
6	• Careers, 3PLs	• control the concentration of the driver→ reduce in accidents and improvement of the safety • control speed and acceleration of the vehicle→ reducing the fuel consumption	• GPS system • Mobile Communication system • Visual monitoring system
7	• Authorities Careers, 3PLs	• Prevent probability of an accident	Motion detector sensors
8	• Shippers • Careers, 3PLs • Ports, terminals • Warehouse	• reading a large number of tags at the same time • Eliminate manual data entry errors. • reduce inaccuracies about the number of items in inventories • Decreasing the loading and unloading time→ better resource planning • improve the safety and security	• RFID tags , auto-ID

	Potential User	Benefit	Technology
9	• Shippers • Careers, 3PLs	• control hazardous, sensitive or chemicals products→ increase safety and quality of service	• sensors for measuring physical attributes

In Table 4-2 (Mirzabeiki, 2010) summarized what type of information used in each of the transportation systems. Three group of tasks are introduced as “transportation resource management”, “ports and terminals operation management” and “freight and vehicle tracking and tracing” to show how freight information systems might use by different agencies. ‘Efficiency and effectiveness”, “safety and security’ and “environmental” are three measures to analyze in what direction each of the systems improve freight transportation.

Table 4-2. Supported or used transportation information types, supported transportation functions and improved transportation performance dimensions by using freight ITS (Mirzabeiki, 2010).

Freight ITS	Transportation information types							Supported transportation functions			Supported transportation performance dimensions		
	Traffic and infrastructure	*Vehicle and freight location*	*Freight Condition*	*Freight positioning*	*Warehouse operations and inventory*	*Cargo information*	*Vehicle identity information*	*Transportation Resource management*	*Ports and terminals operations management*	*Freight and vehicle tracking and tracing*	*Efficiency and effectiveness*	*Safety and security*	*Environmental*
1	x						x	x	x		x	x	x
2	x					x	x				x	x	x
3		x					x	x	x		x		x
4	x	x	x			x	x	x	x	x	x	x	
5	x	x						x			x		x
6	x						x	x				x	x
7	x											x	
8		x		x	x	x			x	x	x	x	x
9			x	x	x	x			x	x	x	x	x
Sum	6	4	2	2	2	4	5	5	5	3	7	7	7

Based on Table 4-2 traffic information and vehicle identity information are the most widely used source of intelligence in Freight ITS. Helping with environmental issues is adressed by all Freight ITS except by crash preventing systems and Vehicle location and condition monitoring systems. (Mirzabeiki, 2010) concluded that vehicle location and condition monitoring systems use and support the largest number of the transportation information types. Freight location monitoring systems and freight status monitoring systems are supporting a large number of transportation information types too.

5 Freight Data from intelligent transportation systems used for freight planning and modeling

There are not many sources of freight data available to planners even at very aggregate level. Many Metropolitan Planning Organizations (MPOs) have identified the lack of robust and accurate freight data as a major constraint in conducting meaningful freight planning. (Victoria and Walton, 2004) surveyed 40 MPOs to identify freight data needs for intelligent urban freight transportation. One goal was to assess the level of deployment of ITS technologies, and the use of archived ITS data to support urban planning activities. 18 MPOs responded to the survey. Some of the survey results are:

- Although two-thirds of the responding MPOs are conducting freight planning, only 26% of them have integrated both the passenger and freight components into their TDMs.
- 49% to 94% indicated a need for origin-destination patterns, routing details, shipment details, and commodity type information, while cargo data availability varied from 6% to 46%.
- Between 51% and 100% of respondents indicated a need for highway/truck data, rail data, air data, and water data,
- Between 0% and 40% indicated availability of transportation mode data
- Between 82% and 97% of respondents indicated a need for terminal/intermodal transfer facilities data, while the availability of this data varied from 3% to 18%.

They concluded that there is substantial need for freight data, especially among the small, mid-size, and mid-large MPOs. This study showed that data collected by electronic means such as those provided by ITS can be invaluable to urban freight planning.

(Hallenbeck et al, 2003) studied different ITS that provide truck flow data in Washington state including: corridor-level travel time information estimated by tracking transponders along ports, along freeways, and at the Washington/British Columbia border, Five GPS device installed in trucks and WSDOT's extensive loop-based freeway surveillance and control system. They noted that obtaining sufficient amounts of GPS data in a cost effective manner is difficult. Since these sources do not measure the same thing at the same time, there might be inconsistencies between the results even for the same section of freeway. They concluded that the integration of data from the entire range of ITS devices potentially offers more complete and accurate overall description of freight and truck flows.

(Srour and Newton, 2006) investigated methodologies for extracting and applying freight-specific data in benchmarking freight projects in Washington State. The Freight Mobility Strategic Investment Board (FMSIB) of Washington State deployed intelligent transportation systems (ITS) technologies Global Positioning Systems (GPS) and automated vehicle identification (AVI) with the stated goal of collecting freight-specific data. "An examination of the data collected for the FMSIB benchmarking test reveals that both sources of data can support the freight planning process. Travel times and preliminary route analysis are possible by using the GPS and CVISN–AVI data. Volume measures were not possible with either data sources. Both data sources also pose trouble in ensuring a statistically significant data set—with GPS, it is often difficult to recruit motor carriers willing to participate, and with CVISN–AVI the number of data points is linked to the number of transponder-equipped vehicles."

6 Examples

6.1 SmartTruck

Smart truck is a project for DHL (Deuche Post). The first two pilot trucks started to work in Berlin in March 2012. By combining advanced RFID, geo and telematics technology with dynamic route planning the SmartTruck is expected to increase efficiency in both pick-up and delivery Figure 5-1.

Figure 5-1.DHL Smart Truck[1]

Using taxi's travel time for real time routing depends on the current order situation and volume of traffic

[1] http://www.dp-dhl.com/en/logistics_around_us/from_our_divisions/dhl_smarttrucks.html

SmartTruck uses radio frequency identification (RFID) and a completely new type of route planning software, which navigates express vehicles and other vehicles away from inner city traffic jams. In order to receive relevant information on the traffic situation in Berlin center, DHL is working with Berlin-based taxi companies in a pilot project. If taxis are caught in a traffic jam, the information taken from the global positioning system (GPS) is automatically sent to DHL. The data are transmitted directly to the dynamic route planning system, which recalculates the routes, depending on the current order situation and volume of traffic. SmartTruck benefits the environment, since through efficient route planning the vehicles' fuel consumption and carbon dioxide emissions are reduced.

"The SmartTruck driver is automatically allocated a collection order which he can complete in the quickest time possible. If he is not able to keep to a given time window for a customer, his order is quickly transferred to another colleague in the destination area.

Project partner Motorola has developed the hardware components for the system, as well as the on-board computer. The vehicle itself is also continuously tracked using GPS."

6.2 SmartFreight[2]

SMARTFREIGHT is a 3 year research project co-funded by the European Commission (Westerheim, 2011). SMARTFREIGHT developed and evaluated technical solutions that can make urban freight transport more efficient, environmentally friendly and safe. The solutions support among others access control to areas or transportation network sections; priorities; monitoring and control with dangerous cargo; pre-bookings of loading bays; and information exchange between traffic management and freight distribution to support better planning of transport operations. Their results categorizes into two groups of framework and technology.

The framework results define the concepts and generic ICT solutions for urban freight transport. The framework should provide solutions for cities with different needs and different ICT infrastructures. The technology results were specified and demonstrated in the Trondheim demonstration and included a selection of the issues addressed by the generic framework.

7 Conclusion

This paper review application of intelligent transportation systems in freight logistics. The goal of Freight ITS systems are increase efficiency and effectiveness, increase safety of transportation and reduce Environmental impacts of freight transportation. Different sources of information and Freight ITS where studied. The focus of the study was more on road transportation, although intermodal facilities are one of the important users of Freight ITS.

By reviewing the literature and reports, it appears that hardware and technological aspects of freight ITS is far ahead of software and methodological aspect. In many cases the data provided by ITS is not fully utilized by freight planners or even it is not available to them with affordable cost.

[2] http://www.smartfreight.info/

Freight ITS is more popular in international shipments and urban freight movements rather than domestic long hauls. Also European countries seems to emphasize more on freight ITS compared to American authorities.

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