PART 1

Optimization of Freight and Logistics

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Smart Logistics Corridors and the Benefits of Intelligent Transport Systems

Increasing globalization, competitiveness and customer demands have led to the need for the development of smart and seamless corridors connecting industrial clusters. Connectivity to achieve higher levels of resilience, responsiveness and service provisioning are needed in addition to solid and advanced information sharing. Intelligent transport system (ITS) can play a major role in this supporting concepts such as synchromodality, cross-chain control centers and single windows. Important breakthroughs can be achieved by combining existing technologies and know-how in the context of a shared vision about the future of logistics and the role technology will play. As most transport of goods take place between logistics hubs or clusters the concept of smart corridors connecting smart hubs can be used to define applications that will add value to individual companies by introducing extended connectivity and information sharing. This chapter will detail the concepts of smart corridors, what they are, what they encompass and what the opportunities for the short-term of ITS for the logistics industry will be.

1.1. Introduction

Logistics is a cross-sectorial activity impacting the entire supply chain from the producers and manufacturers to the end-customers. For this reason, logistics needs to be seen not only in the limited sense of goods transport and warehousing where it is a key determinant of business success at the micro-level but also in the wider context of the complex macro-economic role it plays in helping deliver a competitive industrial base. Usually, the broad logistics industry evolves in hubs, which are geographical clusters of logistics activities. They are characterized by

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high transport service levels and low transport costs. Freight moves along international and national trade routes via hubs, and such movements enable the efficient flow of goods worldwide. This leads to the need for the development of smart and seamless corridors connecting industrial or logistics clusters by solid, safe and secure infrastructures, real-time connectivity and information sharing, reduction of administrative burdens and enhanced intelligent control for resilient and flexible service provisioning. All this in order to cope with the increasing demands from end-users and customers for on-time, reliable, fast, sustainable but foremost low cost delivery. To achieve all this collaboration and joint efforts are needed to make most effective use of available knowledge, technology and operational enforcement.

Information and communication technology (ICT) can have a major impact on coping with the growing complexity of logistics and its importance as a major economic activity in Europe, especially by improving the supply chain visibility, responsiveness and efficiency. These benefits of ITSs can be realized on the level of the individual transport mode, such as eco-driving or truck platooning, and on the level of the transport within and across supply chains, such as coordinated planning and advanced and adaptive slot management. For the latter, there is a need for activities aiming at facilitating the implementation of information platforms, suitable for all stakeholders for bundling and consolidation purposes, as well as development of the “single window” and “one-stop administrative shop” concepts supporting e-freight. Finally, there is a need for service provisioning in the area of tracking and tracing (dGPS and geofencing) supporting developments such as slot and yield management.

In the past 10–15 years ITS has developed and advanced tremendously and opportunities lie in the fact that for several ITS systems freight transport has become a pioneer market due to its smaller size and more consolidated organization and ownership.

To capture the short- and middle-term opportunities and to put them into perspective, we will describe in more detail the challenges of the logistic sector, technological developments and its fit with the logistics domain and its challenges, new logistic concepts that will benefit from ITS and how both of them can be put into practice by mapping them on the smart transport corridor concept.

1.2. Challenges: past, present and future

Transport companies and logistics service providers are quite often part of a complex network of supplier or contractor relationships. Independent of this complexity, due to the fragmentized sector with a majority of medium-sized and

small companies, most companies still merely compete on costs, which in the more traditional supplier–shipper relationship was a manageable strategy. Nowadays, we see several trends that translate into an increasingly complex business environment. Globalization and longer and more complex supply chains, increasing customer demands with respect to shorter lead times, high reliability and reduced prices, demand for sustainable solutions and increasing compliance requirements in the field of safety, security and environment can be seen as important developments that require new strategies for the logistics industry.

One of the main challenges for the present and in line with the above conclusions is to become more responsive and resilient while keeping costs at an acceptable level [OON 13a]. Responsive in order to cope with increasing customer demands in terms of lead times, price levels and flexibility but at the same time responsive to be able to optimize the various activities concerned with the transport of goods with respect to fuel efficiency, use of available transport capacity and operating costs. Resilient in order to cope with unexpected disturbances aimed at maintaining the primary functions. This means that two apparently contradicting requirements should be fulfilled: on the one hand, giving more time to the supply chain operations to adapt and to be able to maximize the opportunities of bundling and cooperation and, on the other hand, reducing operational costs in order to keep up with the increasing competitiveness. Often this is referred to as being lean and agile at the same time. The misunderstanding though is that for every business or supply chain lean nor agility as a whole is the solution. Companies or networks of companies should be very careful in determining where they can be lean and where they should be agile. This requires subsequently transparency, intelligence and finally intelligent cooperation based on data and information.

The future will involve constantly adapting synchronized multi-modal transport corridors, connecting industrial and/or logistics hubs thus strengthening the economic importance of the sector on a global scale. The challenge is to identify options for flexibility in time, place and choice of mode by bundling, temporizing goods, smart repositioning and at the same time solving administrative and contractual limitations for these options (new kinds of SLAs, transparency and interoperability). ITS and ICT are major solutions to facilitate increased information exchange among the actors in the logistics sector, similar to the cooperative systems approach in the ITS domain. Connectivity and information sharing will enable companies to better predict and develop operational strategies for the future and increased options for capitalizing efficiency and sustainability gains.

1.3. State of the art

The developments in the area of ITSs, especially short-range dedicated communication protocols (DSRC), cooperative systems connecting infrastructure-based systems with transport modes and all the technologies used for state estimation, situational awareness and automated control have the potential to shape the future of multimodal logistics. This future landscape consists of concepts now being developed such as synchromodality, cross-chain control centers, autonomous controlled transport vehicles and other highly automated transport systems, ultimately leading to self-organizing logistics [HÜL 07]. All these concepts require advanced information systems needed for adaptive control in complex situations.

Within the present logistic supply chains, various forms of ITSs are being used, varying from advanced planning software packages for multi-modal transport planning and port and terminal operations to automated and digitalized solutions for customs clearance, declarations and other compliance issues. Some front-runners have full visibility over their fleet and operations, using fleet management and floating transport data in order to enhance eco-efficient driving and optimize the operations they control. Furthermore, geofencing is slowly gaining ground to optimize the operations at terminals, transport hubs or cross-docking facilities making the handling as seamless as possible and thereby reducing waiting times, increasing safety and security and unnecessary transport movements. Initiatives by MARS and Heinz to organize the Dutch championship speed docking, challenges shippers and transport companies to use advanced technologies in daily operations aimed at reducing the time spent at distribution centers with the ultimate price to be crowned speed docking champion. These often solitary and fragmented initiatives and developments require a more tangible context and future perspective. Although logistics traditionally tends to concentrate activities in agglomerates of companies due to the physical component of transport, ITS and safe and secure information systems might enable optimized cooperation in a more virtual way, such as the concept of a virtual common transport terminal.

Administrative innovations have also had an important impact on the logistics industry. Arguably the most influential has been just-in-time deliveries. However, many other administrative innovations such as new forms of collaboration with customers, suppliers and even competitors are shaping the industry. An example of this is the use of shared services such as warehousing, transport and consolidation, which is helping groups of logistics companies to use their resources more effectively. Another form of administrative innovation lies in the field of smart trade facilitation. Especially in the opportunity of reducing costs of compliance by smart data sharing between global hubs for customs purposes or other regulatory affairs.

Nevertheless, all technological developments and commercially available means of tracking, tracing and safe and secure identification are not yet integrated and connected. For both the mobility area and the logistics domain, the need to make intelligent systems connected will be the most difficult challenge. In the next section, we will show the need for connectivity for new logistic concepts that are developing quickly.

1.4. New logistics concepts

One of the new perspectives in connected society is synchromodality. Synchromodality as a concept was first introduced roughly 3 years ago in the Netherlands by Professor Jan Fransoo and was quickly adopted by the academia, RTOs and industry front-runners such as Ett Coil Till. A first study was performed to define a common roadmap with all stakeholders on this topic [OON 11] and soon this topic became one of the main pillars of the Dutch economic top sector on logistics, launched in 2012. From 2012 onward, the concept has also been adopted internationally. From this first study, we learn that synchromodality can be seen as the next step after co-modality and inter-modality and means the cooperation within and between supply chains, transport chains and infrastructures aimed at using the right mode of transport at all times. This concept requires shippers to book their transport independent of the modality of use in order to create a pseudo-modality. This is modality on the meta level consisting of all applicable modalities that can be used including a cost function that determines the trade-off for a certain modal split at different times and circumstances. Within this pseudo-modality, it is the challenge to capture as much of the potential as possible by increasing the intelligence on alternatives and options for flexibility and responsiveness. For individual companies, this means that we search for more planning and allocation flexibility and information to support decision making under complex and often uncertain circumstances. Closely related to this topic is the development of virtual control towers [VAN 12] not only to control transport from a designated logistics hub or area for normal supplies but also for service logistics and especially in the combination of the two. Flexible decoupling and coupling of supply and demand by controlling large volumes of cargo from various shippers can deliver huge shared benefits in the area of reduced cash out expenditures. New solution providers might emerge that only control and manage these virtual systems based on proven technologies from the world of ICT. In the past year, several first pilots with synchromodal control towers were developed and tested in practice in the Netherlands with LSPs like Seacon Logistics and inland terminals such as Container Terminal Utrecht. Now we have to find ways to develop harmonized concepts that can be easily used and scaled.

At the same time, administrative and regulatory burdens and barriers for increasing the responsiveness of the industry should also be addressed. Quick wins can be found in redefining service level agreements and contracts, which now sometimes narrow down the options for creativity. Important to mention in this respect is that synchromodality does not mean modal shift to barge and/or railways and includes addition to vertical collaboration as proposed by Paganelli [PAG 13] as horizontal collaboration and the opportunities of horizontal collaboration such as bundling.

In order to achieve a next level of synchromodality, control towers and enhanced intelligence, the logistics sector has to acknowledge that by combining existing close-to-market technology and know-how an important breakthrough can be achieved in the area of ICT and ITS, which encompasses benefits for the individual companies as well as the whole sector. Technology therefore is a key enabler through which coordination is achieved. Projects like the EU-funded iCargo[1] project and the WINN project[2] will help to establish a common ICT architecture to enable the development of new services and connected supply chains.

1.5. Using corridors as our playing field

For the transport of goods, the transport will take place in networks of supply chains. Within these networks, we can distinguish cross-border corridors. In Europe, there is a clear focus on the TEN-T program on international corridors and there are already so-called smart corridors being developed among others in Canada[3]. Interestingly, within the TEN-T program the new requirements on connecting the TEN-T corridors with the urban areas and the need to address multi-modal transport broadens the scope and aligns the transport policy domain much better with the industry focus on networks of supply chains not limited to the TEN-T network[4]. The question is: "What is a corridor and especially from an ITS perspective what is an intelligent or smart corridor?". In addition, how does it help to achieve the challenges such as zero-emissions city transport, low-carbon freight transport and sustainable competitiveness?

Intelligence means adding a distinctive mental capacity and/or understanding. ITS in this means then for the logistics sector the ability of the transport systems used to think and act as humans. When we add smart to this, we rule out human

1 http://i-cargo.eu/.
2 http://www.winn-project.eu/.
3 Ontario-Quebec Smart Corridor; see http://onqcsmartcorridor-onqccorridorintelligent.ca/english/web/index.htm.
4 http://ec.europa.eu/transport/themes/infrastructure/index_en.htm.

intervention and use automation and systems to do the right thing in complex situations. From various dictionaries, we can find that a smart corridor is defined as "a well-travelled route used by cars, trains, boats or planes, operated with a minimum of human intervention, using automatic control aimed at doing the right thing in a wide variety of complicated circumstances". A corridor includes infrastructure components essential to the transportation networks, which facilitate international trade and support domestic flows [CRO 11]. The primary objective of a smart corridor is to support a sustainable, secure and efficient multimodal transportation system by applying new and emerging technologies to improve operational efficiency and to share information among systems to achieve benefits of coordinated operations[5].

From this definition, several questions might arise as follows:

– how does a corridor related to its origin and destination? What about the connecting smart hubs or smart cities?

– is there a difference between a smart corridor and smart use and how does that influence our focus and developments?

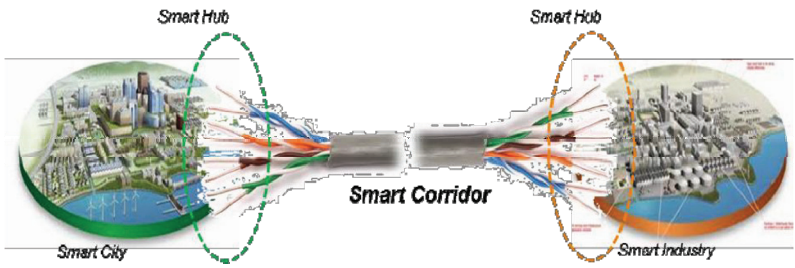

Figure 1.1. *Illustration of smart corridor concept. For a color version of the figure, see www.iste.co.uk/jacob/freight.zip*

1.5.1. *Smart corridors and smart hubs*

For the first question, it is apparent that for a smart corridor ending at an ill-managed hub or city or vice versa, the effect and impact of adding intelligence to the corridor is very limited. Especially for the logistics sector, this is an issue where on-trip alternatives are lacking and the impact of delays in terms of customer

5 Stakeholder Workshop Series I, June 2011, Ontario – Québec Smart Corridor | Corridor Intelligent, Concept of Operations.

satisfaction, costs and inefficiencies due to build-in slack is much more severe than in the area of mobility of people. In other words, smart corridors need to connect smart hubs and they need to do this for all the transport modes available between the hubs. Only then, we can make the transition toward synchromodal transport.

For the latter question, we can take a well-known ITS application as a use case: platooning. Truck platooning has been proved to be technical feasible among others by the SARTRE project [CHA 12] but basically platooning has been developed, tested and evaluated since the 1970. At present, we require a facilitating infrastructure to apply platooning in real life: we need information about other non-intelligent vehicles and their behavior, we need some kind of communication infrastructure, we need to know what the origins and destinations of the participating trucks are, etc. So, in this perspective platooning is more smart use than part of the smart corridor concept. Facilitating highly automated vehicles or trucks is then part of the smart corridor concept.

From this, we can say that a smart corridor is all about goods being transported, about traffic and transport management, about monitoring and control aimed at bundling, slot management, dynamic planning and fleet management. Smart use then is all about modalities, about smart transport and about monitoring and control aimed at support and control of the transport itself such as advanced driver assistance systems, platooning, driving behavior and green driving support.

In traditional ITS most of the applications and development are focused on on-trip advise, warning or control. Even within the new developments of road–vehicle automation where the traditional inform–warn–intervene framework is no longer applicable, and we will see more flexible and adaptive use of different levels of automation, the functions are all to support the operator of the transport mode. Although facilitating smart use of corridors during the trip by ITS, especially advanced traffic and transport management and in-car applications, is valuable for the logistics sector, achieving connectivity between smart hubs in and between corridors will have more impact. This is due to the fact that pre-trip intelligence will enhance better decision making when allocating cargo volumes to different modalities, time, location and customer requirements. For example, small-scale collaboration between logistics service providers and shippers can prevent empty container transports back to depot. Any trip prevented to go on the road will contribute to the transport system. The same small-scale collaboration might help SMEs in making modal shift economically feasible by bundling of volumes for barge or rail. After these first steps in the field of ITS, the addition of information on queue length at terminals, alternatives in case of severe incidents (such as low tide on inland waterways) will only help companies to use available data and information for more effective, responsive and adaptive transport in their supply chain networks, resulting in more sustainable transport, competitiveness

and innovative climate. At present though, companies lack sufficient information to be or become responsive although the data are there only not connected in a suitable way for individual companies to do some cherry picking for what they need for their own operations.

The latter is important because any uptake of more ICT and ITS in logistics will be driven by business cases at the company level. The step afterward will be to create small alliances to capture more of the potential of sharing data and operations, thus also enhancing the value and need for wider expansion of information solutions in connecting networks or between corridors.

1.5.2. *Needs for research and development*

How do the above conclusions translate into needs for research and development? As stated previously, the logistics domain will most likely automatically benefit from the transport mode focused ITS developments such as increased vehicle automation (platooning and energy efficient intersection control). On the other hand, the benefits of ITS in the field of pre-trip optimization of transport in networks (i.e. transport management) could be even bigger. In addition to the research and development needs for automation, the main topics for transport management are as follows:

– Data and information management:

- how can we integrate (real-time) data for different transport modes and from various sources into one ICT operating environment that includes a semantic model sufficiently flexible to accommodate adding new data sources?

- what is the structure for data governance in order to combine privately owned and privacy sensitive data from different organizations?

- how can we add intelligence by making use of available algorithms and models for better control?

- how can we assure high-quality information provisioning by real-time data auditing.

– Transport management:

- what are practical solutions for second screen or mirror-link functionality between decision support applications and integrated business applications (SAP, APS, WMS/TMS)?

- how can we harmonize design principles for plug and play 4C's (cross-chain control centers) in order to support the development of interoperable solutions?

– Development and deployment:

- what are new business models to support advanced uptake of ITS in the logistics domain?

- what are the validation and assessment requirements?

– Cooperation and organizational development:

- how can we develop and implement robust systems for gain sharing in different alliances?

- what are the social consequences of more cooperation and integration?

- how can we use simulation and gaming to show ex ante impact of different scenario's or logistic innovations [KAT 13]?

Quite a lot of technological solutions are already available, especially in the area of safe and secure data storage, segmentation and provisioning. Interoperability issues and network connectivity topics have been researched for decades. Nevertheless, the importance of the abovementioned research topics is a recurring issue of trust and a subjective feeling of competitive risk that makes companies reluctant to share data and information in networks of supply chains. Due to the relative lack of integrated automation in the transport sector and the fact that huge amounts of decisions are still being made by humans, the first applications should contain an objective and tangible surplus in value that is so interesting in these economically difficult times that companies have to go along with them. This is not so much of a logistics issue but rather an issue that should be evaluated upon economic and financial criteria. A commonly made mistake therefore, is to discuss these collaborative applications with supply chain managers rather than with CFOs or managing directors. A very effective way of creating insight into the impact of collaborative applications using ICT or ITS is the use of serious gaming as shown by Van Balen Blanken *et al.* [VAN 13] and Katsma and Dalmolen [KAT 13]. One of the main outcomes is that the participants experience that the benefits are much higher than the risks they envisaged and that collaboration is not as big a deal as they thought it would be. However, companies that are willing to collaborate and share information should make sure that the chosen (collaborative) innovations have a good fit with their present business model and organization in order to reduce the risk of failure.

1.6. Short-term opportunities

To summarize the challenging though interesting developments in logistics and ITS we see that transport is becoming increasingly a complex puzzle that we need to optimize from various perspectives: customer satisfaction and demand, costs

of operations, competitiveness, sustainability, etc. In order to stay in control of our business and logistics operations, there need to be a few factors in place and in their correct sequence: better data and information provisioning (transparency), intelligent and value-added applications and, finally, cooperation or alliances.

The level of transparency, intelligence and cooperation might differ from company to company but all operations need to be better suited to know what to do when incidents occur, how much decision time they have and how they can create flexible and adaptable networks.

For an individual logistics company, the chances in the short-term lie with having advanced fleet management systems that are connected to the vehicle dynamics and the outside world. On the one hand, this combines the more traditional ITS vision of connected cars using vehicles as data sources and informing drivers in the area of safety and efficiency and, on the other hand, the need for capturing data for transport management on corridors. This same approach is easily transferred to other transport modes such as barges and less easily so for trains.

The other chance is with creating data pipelines for transport management and cross-border trade facilitation where port and vessel data are combined with inland terminal data and fleet management data in order to create seamless operations in the whole corridor. The solutions in this area can range from relatively quick wins (real-time transport information or advanced slot management) to larger pilots proofing new concepts for container consolidation for barge operations.

Another chance lies with further development of smart truck parking areas on the TEN-T network as named as one of the priority areas in the ITS action plan and the ITS directive of the European Commission. These are small intermediate hubs where we can enhance the use of flexible options such as bundling, temporizing of transport and even modal shift but also enables the possibilities for creating the long-run platoons of trucks.

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