Co-using Infrastructure for Sustainability in Maritime Transports

Emergent Research Forum paper

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Abstract

Sustainable transportation systems require optimal co-use of infrastructure. Different means of transportation use infrastructure for its operations. At certain points these means of transportation utilizes the same infrastructure, such as e.g. passages on or under bridges, which require co-modal coordination. To create means for such coordination, situational awareness needs to be established among involved actors by digitalization and principles for information sharing. In this short paper, a co-modal transport system, GOTRIS (Göta Älv River Information Services), is used as a basis for a deeper understanding of the challenges for reaching an optimal co-use of infrastructure. By integrating information from maritime transports as one source in this coordination effort, sustainable transportation systems can be reached. This challenge is formulated in a research question and a preferred approach is stated.

Keywords

Co-modal coordination, Co-modal transport system, Co-use of infrastructure, Maritime transport

Introduction

ITS is a Key Enabler for Sustainable Transportation Systems

In todays globalized world, freight transportation is a crucial supply chain component to guarantee efficient movements of different kinds of cargo and timely availability of such for the society and industries (Crainic 2003). The race for sustainable mobility is a global one and new technologies for vehicles and traffic management is a key component to reduce emissions related to transport emissions in European Union (EU) and in the rest of the world ("EUR-Lex - Recherche simple" 2012). Today the conventional transportation on roads is no longer an all-time feasible solution, which creates demands of multimodal transportations. In 2012 about 44.9 % of total freight transportation in EU countries were transported via road, 37,2 % via sea, 10,8 % via rail, 4 % via inland waterways and air transport 0,1 % (EC 2014). Transportation is a complicated process depending on several factors, such as: access to infrastructure, production, consumption and residential areas. Because of this complexity, investments in the transport sector must be based on long-term vision for sustainable mobility (EC 2009).

"Intelligent Transport System (ITS) are advanced applications which, without embodying intelligence as such, aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks." ("Intelligent transportation system" 2015). ITS is also seen as a key enabler and a central component for the sustainable development of high-capacity transport networks worldwide (Crainic et al. 2009). According to Andersson and Sternberg (2013) governments in countries world wide are aware of the importance of ITS and they are using a wide range of information technologies (IT) directed to the traffic domain to alleviate challenges such as increased pollution and

increasing fuel costs. As described by (Crainic et al. 2009) *"The core of ITS consists in obtaining, processing, and distributing information for better use of the transportation system, infrastructure and services"* (p. 543). The European Commission (EC) outlooks Information Communication Technology (ICT) solutions as an instrument to be developed to support better management and integration of transport flows (EC 2009) and within the different transportation domains ITS applications are being developed (EC 2011).

Infrastructure shapes mobility but building new physical infrastructure, e.g. roads, railroads, dredge channels, etc. is expensive and time consuming. The challenge and the way forward is to use the infrastructure more efficiently by managing different modes of transport through the use of ICT applications related to the infrastructure, like network services, on-board systems and operational and administrative procedures (EC 2009, 2011). IT infrastructure is often used to describe large and complex IT systems that support multiple organizational functions and operators. The idea behind an IT infrastructure is that it typically provides standardized systems and standardized data that ties together various stakeholders in accordance with predefined patterns and business processes. This typically requires a homogenization of work processes across the infrastructure network (Ciborra 2002). A functioning IT infrastructure requires almost constant availability (Edwards 2003), which brings several challenges such how it is designed, implemented, maintained, controlled and how the system itself is managed (Ciborra et al. 2000). Tilson et al. (2010) describes how new digital technologies has become a central part of modern infrastructure. The increased degree of digitization can link and support various organizations and influence people's work, life and interactions. Over the past 20 years we have seen how the increased degree of digitization has been absolutely central to alter previous "analogue" organizations. Today it is possible to discern an alteration in how previously disparate organizations can work together to create and disseminate various services and products due to an increased degree of digitization.

This is a call for enabling sea transports as an integrated part of the transportation system as a whole. Maritime transports, sea voyages and as inland waterway transports, would be of beneficiary for the transportation system since sea voyages is a sustainable mean of transportation. This does however require a good integration with the other parts of the transportation chain and a coordinated approach to the use of infrastructures, such as e.g. bridges, that several modes of transportation are co-using. In the paper co-use refers to actors utilizing the same infrastructure.

Common Information Environment Require Interoperability

Organizations amass and generate large quantities of data and traditionally, this data will spread out over several different information systems (IS), which creates difficulties for the entire organization to exploit it. Something which in a larger perspective can lead to redundancy of stored data that can have negative impact on organizational efficiency and productivity (Davenport 1998). Another dilemma for organizations is that historically IS have been closely linked to a specific function or department (Erasala et al. 2003; Johannesson and Perjons 2001), which when exposed to new requirements demands an increased integration among the systems. A system that is structurally independent has an open structure where each part is independent. Various independent components or devices can be merged or disassembled under different circumstances and occur in new amalgamations. Independent structures can operate in stand-alone parts, integrating alternately or overlap. A vivid example of this integration can be taken from the world of music where the Polish composer and orchestral conductor Witold Lutoslawski pursued the artist's individual freedom, with his 'controlled aleatoricism', where he tried to link two intricate independent layer that through complementary processes created an integrated, harmonious whole ("Lutoslawskiåret - Polska institutet i Stockholm" n.d.). The concept of harmony is central to architectural IT Management (Magoulas and Pessi 1998), to have a strategy in which the function, structure and infologi harmonizes is rudimentary and the degree of independence and dependence is a balancing act tailored to each form of the system within its specific environment, relationships and dynamics. Through this harmony and good knowledge of a system and its building blocks a good information environment can be achieved.

Big Data, Open Innovation and Open Data as Contemporary Trends

We have entered the Big Data era, in a time when several business activities are digitized new sources of information are generated and collected, which makes it possible for decision makers to make decisions based on real-time data (Jagadish et al. 2014; McAfee and Brynjolfsson 2012), or noted by McAfee and Brynjolfsson 2012 *"Data-driven decisions are better decisions—it's as simple as that"* (p. 63). Big Data consists of digitized messages from different sources, like GPS signals, messages from smartphones, Emails being sent, information generated in computer systems, etc. (McAfee and Brynjolfsson 2012).

Another trend is the move towards open innovation and open data. Various organizations have realized that they are not able to change the world themselves; others have realized that they can complement other organizations' innovations to encourage customers (Moore 1996; O'Leary and Vij 2012). An emerging number of organizations sees the benefits of working together and build on the joint creation instead of working independently and then cross each other's paths (Huxham 1993). In order to break new ground and expand into new areas, organizations need access to other information resources. Resources that can be accessed by collaborating with external partners and make them a part of their innovation process. Something that can benefit all parties in the innovation process (Andersson and Sternberg 2013).

Exploring Third Party Development as a Mean for Increased Sustainability

The purposes of this ERF paper is to show how an ITS for managing different modes of transport could decrease bunker consumption, decrease the environmental footprint and increase the awareness among the actors in the transport ecosystem, could be built by third party developers if data was shared. Founded in theory and as an application of a co-modal ITS solution for co-using infrastructure, this paper will elaborate a research question that will guide further research.

GOTRIS as a co-modal solution to the co-use of infrastructure

GOTRIS (Göta Älv River Information Services) is a case that shows how ICT and ITS solutions can be used between different modes of transport and between organizations in different domains to create situational awareness, increased interoperability, predictability and punctuality within an area where a number of inbuilt differences and conflicts of interest (i.e. the development of Gothenburg vs. regional development of Västra Götaland and the Lake Vänerna area; Bridge height vs. vessel heights; Commuter trains vs. vessel traffic on Göta Älv, etc.), all of which are a result from a lack of access to infrastructure resources on which the interested parties depend on to run their operations.

In July 2012 GOTRIS was granted funds to develop a platform to demonstrate co-modal traffic management of different modes of transport on Göta Älv. By bringing together actors enabling railway, shipping and road traffic to share information and services in a River Information System for Sweden's largest river, Göta Älv, with its 12 bridges (soon to be 13 bridges with a new railway bridge spanning the river within the city of Gothenburg). The aim of the project demonstrated how navigation on Göta Älv could be managed for passages of bridges and locks to reduce disruption to road traffic and rail transport while optimising vessel traffic. During the project, a pilot version of the GOTRIS platform was developed in which information sources (based on real-time data) from several governmental agencies like, the Swedish Transport Administration (STA), the Swedish Maritime Administration (SMA) and the City of Gothenburg was integrated. Models for control and optimisation, as well as functions for vessels, traffic management systems and road systems were also developed.

The approach adopted in GOTRIS for designing the architecture of the system reflected the context in which it is was going to be deployed. Normally, a dedicated traffic coordination system that is built, managed, maintained and operated by *one* organization with coordination responsibility may very well be designed as an enterprise system with all parts of the system under the strict governance of one organization. However, when GOTRIS was designed, a complex, operational, coordinating platform outside the traditional organizations, involving several organizations (Governmental agencies and private organizations) exchanging information, a different approach was chosen, a distributed one. Hence, this choice, the intention was that several modes of transport and governing organizations share responsibility for information and the services it enables, since services and information could be provided from several sources and organizations.

The GOTRIS project was based on the idea of 'adaptation through external actors' intentions'. By knowing the intentions of other actors in a system (of systems), each actor can optimise its own performance and actions. Each actor incrementally and dynamically adapts the changes in the actor systems. Translated into the transport system and GOTRIS, it means that train operators can plan the utilization of bridges for train passages better, if they know in advance at what time they can expect a bridge opening. At the same time, the captain or the pilot of the vessel can adjust the speed of the vessel to arrive at the bridge when it is ready to be open without interfering with the train services and the public transport passengers, seeing that the bus will be delayed by 10 minutes, may choose to take the ferry that crosses the river.

Another cornerstone of GOTRIS has been to show how it is possible to create complex, operational, coordinating platforms outside the traditional organizations such as STA, SMA, and the city of Gothenburg without large infrastructural and integration projects. When there is a need to coordinate the use of physical infrastructures where responsibility overlaps between different organizations or authorities, the normal approach is to create new organizations with supporting enterprise systems. The GOTRIS approach explores how digital coordination platforms, based on ability and willingness to publish enterprise information, enables external integration of information (data outlet, API, information hubs, etc.). GOTRIS with its integration to several different data sources could have been built without technical support from the data-providing organizations if the information had been available in some sort of a public or semi-public sources of data.

By combining these two perspectives, the project developed a demonstration platform for a collaborative information-sharing and coordination system in which several relevant actors provided and received information, which was critical to their operational situation. The project also developed a set of services supporting the different actors in coordinating the traffic on and over Göta Älv: ETA predictions, passage predictions and confirmation, pilot information tablets, bridge/lock traffic overviews, which were tested by more than 100 vessels performing 500 voyages on the river during the eight months long trial period.

The GOTRIS approach provided a neutral, centrally organised 'information hub' that worked as a 'switchboard' of services enabled on the platform. The hub was also responsible for sensing the 'correctness' of the different services as well as issues such as access, metadata and possibly data quality.

Conclusion

Setting the Scene for Future Research

When creating a tool in a multi-organizational setting to create a common situational awareness for high predictability in a co-modal transport system, involving several business actors involved in the transport system, it is important to address a common goal and to be aware of that every organization in the ecosystem has its own goals and business agenda. Therefore it is also important to take the organizational culture into consideration during this design endeavor (c.f. Ferreira & Otley 2009; Adler, 2011). Successful coordination of different process steps builds upon sharing relevant information. Information about assignment outcomes and performances that concerns the overall process is necessary to share. To achieve the effects from a tool to create common situational awareness, it is necessary to relate the overall performance to single organizations' performances (Haraldson & Lind, 2010). It is also important to show that the more information you share the more information you get. When working together with other organizations for a common purpose, a balance of cooperation and competition is key to success (often referred to as coopetition).

This research explores a distributed approach to multi-actor collaboration using GOTRIS as one case for the creation of coordination platforms based on ability and willingness to share data enabling external integration of information (data outlet, API, information hubs, etc.). GOTRIS rely on the integration of public or semi-public data sources.

In this short paper, a research theme has been outlined using one case to direct attention to an unexplored area in theory; the effects of a more open information environment within the maritime sector for the purpose of coordinating the co-use of infrastructure. A proposed focus for further research and more applications is to explore: *What the effects would be on transport systems if co-modal transport data were made available to different actors?* A preferred approach for this exploration is to engage in authentic settings relying on multiple actors sharing information on e.g. intentions and occurrences that is needed for the different actors to reach a high degree of coordination.

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