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Supply chain management in automotive international logistics: a scenario and its challenges

Miguel Merino Gil[1], Perfecto Mariño Espiñeira[2], Juan M. Lopez-Valcarcel Cerqueira[1]

[1] Enterprise Organization Department, University of Vigo, Campus Lagoas-Marcosende, Vigo, Spain

[2] Electronic Technology Department, University of Vigo, Campus Lagoas-Marcosende, Vigo, Spain

mmerino@uvigo.es, pmarino@uvigo.es, jmlopez@uvigo.es

Abstract: The automotive international logistics domain has a lot of standards for its supply chain management based on information technologies. The authors introduce a real case study as a representative scenario of "digital gap", which is challenging the usability of those information tools. Also is mentioned an experiment on RFID applications conducted by the authors. After a description of using "best effort" solutions in real applications, a more integrated information model is proposed where several agents must be involved, from network operators to service providers.

Keywords: e-Business, Supply Chain Management and Modeling, International Logistics, ODETTE, AIAG, Decision Support Systems, IoT, RFID, WSN

1. Introduction

In current traffic of auto parts among Chinese provinces and European automotive factories through the management of specialized logistics operators, we discovered that there are certain imbalances and problems arising from the non-implementation of data standards and the limited use of advanced information systems that support ICTs.

Currently this line of intermodal traffic truck-boat-truck and stores (consolidation of cargoes in containers) and destination (deconsolidation and service picking/kanban) to Tier1 factories in automotive industry, is managed so that local optima are obtained in each of the processes involved in each of transport modes, storage and management of load / unloading of containers at ports of origin, transit and destination (Moyano, 2009).

In particular we have analyzed a regular service between the store building and port of Shanghai, a port of transit to "feeders" in Algeciras (Spain) and port of Vigo and MAF target store in an area next to it. This is supported by management information systems specialized in each case, and mostly ERP to optimize local resources, and a standardized communication system in some cases through EDI/ODETTE messages and in other cases, at the request of the parties involved, through ad-hoc messages based on FTP or SMTP.

This system, moreover inefficient, impairs new extensions of the involved processes and therefore the competitiveness of the sector, avoiding the entry of new efficient actors through proprietary applications of information systems, while many incidents are causing delays and loss of information. Accordingly, the authors propose a model based on the current processes of intermodal transport and storage, not changing the current procedures, except as regards a basic identification currently relies on bar code labels, passing to radiofrequency identifiers (RFID).

However, there is a deep change in the system in terms of information, from a "push concept", in which events are transmitted by collecting the information by the means mentioned above, to a "pull concept" in which interested parties consult the information at the time that the need to replenish their stocks, and flows of goods, as close to real time. This new approach is based on information directly supported by RFID tags (Ahson, 2008; Morreale, 2010), retrieved through wireless sensor networks (WSN), (Dargie, 2010; Akyildiz, 2010; Verdone, 2008) which in turn have the IP address which will be recognized on the Internet.

2. Services in International Transport of Goods

The evolution of international transport is linked to the requirement of its customers and their needs. Modern logistics require compliance with a demand-based planning; hence the current management disciplines are grouped around the supply chain management (SCM) and seek to optimize the resources available to the transport, i.e., ordering of supplies, time, cost and information. Production needs condition the next supplies the place of consumption, and the sequence or order of delivery. Information systems have played a key role in responding to these requirements and the EDI has provided the necessary technologies to do so. Nevertheless, despite the extent of EDI systems that normalize the content of messages required for synchronization between systems, we encounter the difficulty of consolidating information between customers and suppliers with different software.

In the past 50 years the greatest innovation in international transport has been containerization. That it has done so can be attributed to the beneficial interaction of three broad kinds of factors: technical, economic and organizational (Frémont, 2009). We address the further case study, exclusively to transport in "containers" because the feature "multimodal" and the type of supply chain itself.

Since its advent of containerization has been bringing about the integration of the transport chain (Brooks, 2000), On the other hand, shippers´ and logistics operators needs have been increasing steadily as they take advantage of the opportunities offered by globalization, to develop their production and /or distribution activities at an international scale, and this necessitates synchronization of their activities in space and time through the introduction of logistics chains. The management of these chains is a source of control as well as providing a source of profit for all actors involved in these chains (Heaver T.D., 2001). All international transport companies now claim to be logistics operators capable of providing a customized response to the needs of their shipping clients (Frémont, 2009).

For container identification, the current standard which deals with the coding, identification and marking of containers is DIN EN ISO 6346, dated January 1996. (Fig 1) (BIC, 2010).

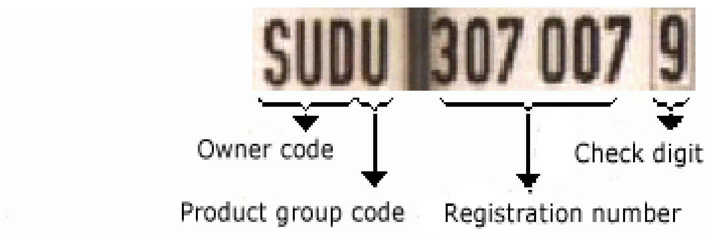

Fig. 1: Container's codification

In any case, these codes are targeted in preference to identify the physical units of containers and some supplementary information on the load (weight, dangerous load, etc.), but nothing about its actual content, or their origin or destination.

One important advantage of containerization is the development of logistics services. The entire logistics chain extends from supplier to end client. It must enable the overall management of resources in order to provide the best service for current and forecast customer demand, including physical transport flows, with their associated information flows and interfaces management between different actors in the chain from producer to consumer.

In sea transport there are a large number of intermediate agents (IA) involved, causing a large flow of information from the logistics operator to each of them. The only information physically available is the number (code) that identifies the container, so that all information associated with their content and routing has to be transferred in parallel throughout EDI messages, EDI / XML, EDI / SMTP, to update the databases for each agent.

Tags based on RFID technologies provide the opportunity to incorporate the same content and routing information, which would not necessitate the transmission of messages or files between different actors. Complete information would be captured by WSN sensors and available for SCM. There are five major areas where RFID can be effectively used in a port cargo terminal: Access controls, Container security, Container identification and Location, Activity Tracking and Regulatory Compliance (Mullen, 2007).

The Electronic Product Code (EPC) standards and RFID technology give the global coding object to each entity as a unique code, and construct a global real-time network for sharing material goods information. EPC code + RFID + Internet put together Internet of things (IoT) (European Commission, 2009), (Forum Europe, 2010). EPC could be made by a bar code or RFID based. RFID technology is a cornerstone of the EPC, and it has become a Global Identification System (EAN.UCC System) (Laowe, 2010).

This approach would provide new services throughout the supply chain based on a container with extended encoding information relevant to such services (Table 1):

Table 1: Logistic services and technologies (Cárdaba, J., 2008) and own elaboration

Logistic Services	*Identification of container* **current**	*Ext.Container Identification* **future**
Container management	Tracking	Tracking and tracing + stowage + priority
Parcel	No	Pallet tags; Routing
LTL&LT. Consolidation warehousing	No	Cargo consolidación + routing
Location Tracking	CCTV/GPS/RFID	RFID/EPC/WSN

Activity tracking	GPS/RFID	RFID/EPC/WSN
Multimodal Transport	EDI/XML/SMTP	WSN/IoT
Logistic reception	EDI/XML/SMTP	WSN/IoT
Clearance	EDI/XML/SMTP	WSN/IoT

As an example of current RFID tags technology, in the figure 2 there is a picture of a real product used by the authors in SCM projects (UPM RAFLATAC, 2011).

In this transparent tag the inlay (chip and antenna) is clearly visible. A microelectronic chip (IMPINJ, 2011) is placed as a black point in the centre, and the antenna is like a symmetrical pattern extended from the chip towards the inlay ends.

Fig.2: Real implementation of RFID tag
(Courtesy of UPM RAFLATAC)

In the picture (Fig.3) is shown a RSU for trucks (section 4), implemented by the authors. The RFID tags are attached to the on-board products.

On the right side of the road there is a pole with two antennas (white boxes) oriented to the trucks, for reading the RFID tags inside the moving truck.

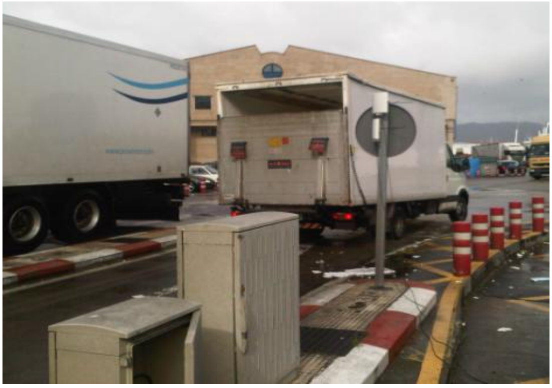

Fig.3: Implemented RSU for trucks
(Pole and white antennas)

3. A SCM Case Study in Ail

The automotive industry employs some of the most sophisticated networks of suppliers worldwide. Automobile manufacturers demand supply chains becoming more streamlined and efficient to support new models of development and shorter product life cycles. Logistics Services Provider (LSP) must manage "just-in-time" applications for distribution centers and transportation, as well as services related to receipt of goods by multi-modal transportation, consolidation or de-consolidation package, storage, inventory control, "picking" and sequenced synchronous or “Kanban” deliveries.

The current case study refers to multinational company, a leading producer of engine cooling elements, acting as a Tier 1 in supplying parts to assemblers of cars and trucks. The company has retained the services of a global logistics provider for the supply of component parts of its products, from its factories in China to its plants in Europe, including consolidation centers and picking services from a store close to its assembly plant, which also is the safety stock of components, for possible stock shortages driven by transportation and other incidents since the beginning (Fig. 4).

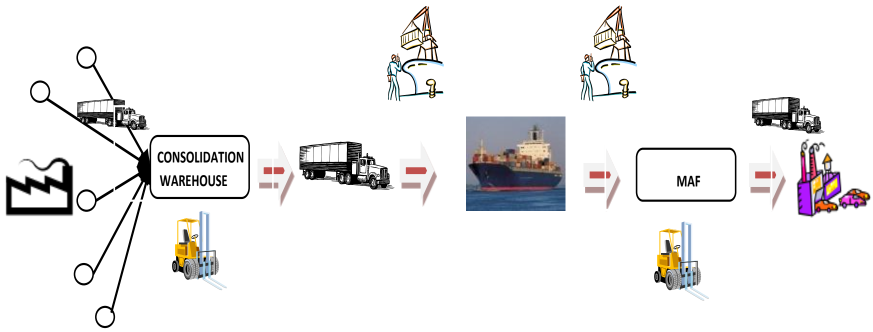

Fig.4: Flow of freights

The physical flow of goods is based solely on the use of Odette standards (Odette Transport Label v3). The information about the part must be accessed via the relevant back-end system or other databases from each of the actors involved throughout EDI transmissions.

The data structures on the RFID tag in Odette recommendation permit three fundamentally different scenarios of the process design with RFID support, which place different demands on the total system (tag, reader, network, middleware, applications, organization, etc.)

For some processes in the automotive sector, RFID is already superior to other identification procedures in terms of process efficiency and quality criteria. This technology distinguish as before the class of parts (code number, type of container), but individual entities of a class (code number and serial number, or type of pallet cage).

The real potential of using RFID with automotive parts occurs when the different elements of the value chain use the same standards and technologies, and information is processed at every stage in an open loop system (Odette, 2010)

The matrix of considered scenarios is made in Table 2.

Table 2: Matrix of considered scenarios

	Read/Write permissions on Tag	
	No	Yes

User-Data used	No	Scenario: 1 Tag contains only part ID	
	Yes	Scenario 2: Read access to user data	Scenario 3: Read/Write access to user data

In Scenario 1, the only data field used is “part ID”. It is protected and cannot be over-written.

The Scenario 2 covers other user data requirements, whereas in the Scenario 3 the user data can be modified in the process.

The principal structure of the data stored of the tag has been defined in the “air interface” standard according with ISO/IEC-18000-6C.

4. A Model for Data Integration

4.1. Rationale for Automotive International Logistics (Ail) And Description Of Basic Operations

Relying on new ICT standards and available technologies, we propose to modify the operational support as follows (Fig 5):

- Planning the shipment according to production needs and safety stock located in the MAF - Vigo (transit time forecast from port to port about 31 days).
- As supply chain pallets are being built, transport unit tags are loaded to pallet tags identifying contents, which built the shipment, purchase order number, and when the shipment was built. Pallets are sent to storage consolidation.
- In consolidation warehouse, as pallets are loaded into the container, pallet tags are loaded to container supply chain tags identifying contents, which built the shipment, purchase order number, container ID, eSeal ID, and when the container was stuffed.
- Container loaded onto chassis. When the tractor connects to the chassis, container information, chassis ID, and tractor ID is loaded to the On-board Unit (OBU) through Communication Air Network (CAN).

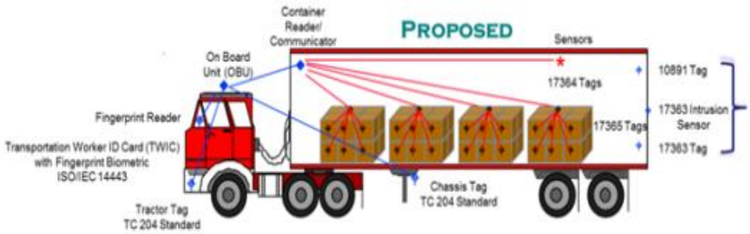

Fig.5: On-board proposed operational support(Harmon, 2010)

- At the border crossing point in warehouse exit, the contents of the OBU are transferred to the Road-side Unit (RSU-WSN). The Road-side Unit (RSU) might also capture information from the Container ID, eSeal, and Supply Chain/Manifest tag.
- Well known wireless communication standards for Intelligent Transportation Systems (ITS) are CALM and WAVE.(ITU-T , 2007), (Uzcategui, 2009), (Williams, 2008)
- OBU also able to drive GPS system
- Information is available in the WSN through an IP network to be read from the management point LSP (Fig. 6).

Fig.6: Roadside operational support

(Harmon, 2010)

- In MAF – Vigo, operations are symmetrical and inverse to the consolidation warehouse. The MAF input-output is linking to IP network through smart WSN like China.

The new basic operations in this case study are affected by the following standards, under the recommendations of American Industry Association Group (AIAG) (Harmon, 2010) (Table 3):

Table 3: Standards based upon

	ISO/IEC JTC 1/SC31
TECHNOLOGY	RFID (ISO/IEC 18000); SENSORS (IEEE 1451); WIRELESS SENSOR INTERFACE (ISO/IEC/IEEE 8802-15-4)
DATA CONTENT	DATA SYNTAX (ISO/IEC15434); DATA SEMANTICS (ISO/IEC15418); UNIQUE ITEM IDENTIFICATION(ISO/IEC 15459); ENCODING (SIX BIT) (ISO/IEC29162); UNIQUE TAG ID(ISO/IEC15963); UNIQUE SENSOR ID(IEEE EUI-64 – ISO/IEC/IEEE 21451-4)
CONFORMANCE	CONFORMANCE TO AIR INTERFACE; (ISO/IEC 18000)
NETWORK	SENSOR NETWORKS (IEEE 1451)
APPLICATION STANDARDS	PACKAGING (TC122-ISO 1736X); FREIGHT CONTAINER (TC104); SHIPS (TC8); ITS (TC204); ANTI-COUNTERFEITING (TC247)

4.2. Proposed Network Model

In the figure 7 is depicted a network model for AIL applications where all involved agents in the value chain, between the "product origin" (PO) and "product destination" (PD) are connected.

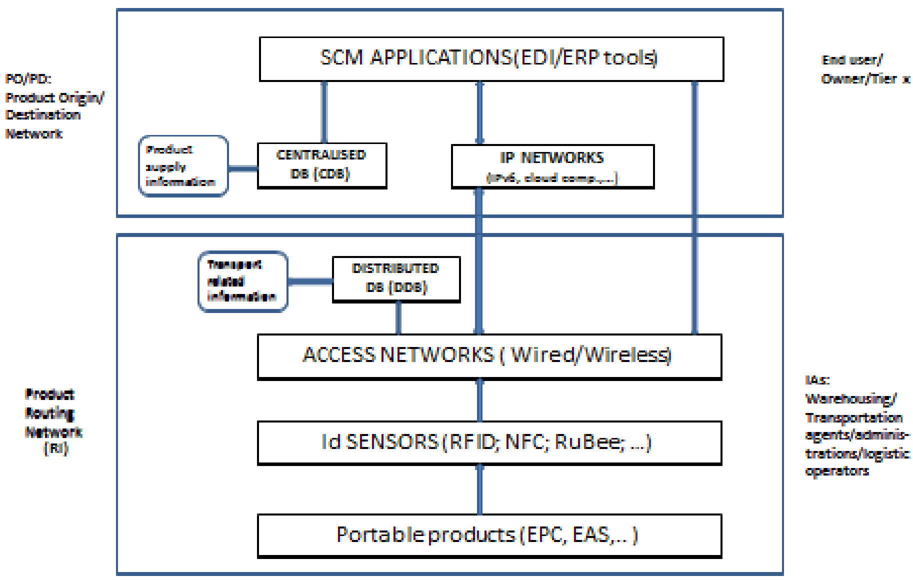

Figure 5: Framework of SCM Information-centric networking for AIL

Fig.7: Framework of SCM Information-Centric networking for AIL

Those intermediate agents (IAs): warehouses, carriers, administrations, legal advisers, logistics operators, etc., are considered "in-flight" or "on-route" producer-consumers ("prosumers") of "routing information" (RI). Therefore there is a two-ways data flow PO<->RI<->PD, with multiple input/output operations depending on the use of particular "access networks" (AN) from the diverse aforementioned IA ́s. In this network model all participants can access, if it is technically possible, to a distributed data bases (DDBs) or centralized ones (CDBs), whether directly or indirectly through the "cloud", sharing real-time information about the state-of-routing from a given product between its origin and its destination.

Therefore some considerations should be made in order to assure the affordability of this model, if technical, economic and complexity barriers must be overcome for each involved enterprise. For example, in the value chain, SMEs could be not interested in complex procedures, using heavy ERP tools with specialized workers, and high communications costs, among other possible reasons. In this model is possible given its open structure, to include other indirect partners from the information and communication technologies (ICT) providing: new ERP tools, more practical standards, affordable access networks and information-based logistic services. New ERP tools should integrate moreover its "product ID" also its "origin ID" and its "destination ID". Each IA in the value chain can profit these data to give more flexibility to its business model.

More practical standards could facilitate information formats with generalized use by diverse AIs, in order to achieve compatible software tools and file transfers.

Affordable access networks are possible giving the new legal agreements from the providers ́ sector about next generation networks (NGN), where networks operators can generate creative offers to new industrial customers not necessarily early-adopters minded, giving flexible and customized options for specialized demands.

Information-based logistic services could find a new niche market for creative service providers, able to collaborate with the IAs grouped in a particular "value chain". Given the abovementioned model, an example could be an ISP providing services of hosting and housing for DDBs, CDBs and ERP tools in a particular AIL application.

5. Conclusion

The authors have been involved for years in enterprise projects related with applications in the topic of supply chain management (SCM). Currently their area of activity is devoted to the applied research in the automotive international logistics (AIL), where some challenges should be overcome in order to enhance the productivity of the business involved in the SCM domain.

These challenges could be faced by the ICT market providing software tools (ERPs) better integrated in the business´ models. In this paper the authors present the following contributions:

A real case study of AIL between the Shanghai port (China) and the Vigo port (Galicia, northwest Spain), where some SCM challenges have been detected in the "best effort" practices actually made, to say the least.

A wide insight over the state-of-the-art of relevant international standards in the field of AILS provided from several institutions like: ODETTE, AIAG, European Union, IEEE, ISO, IEC and others.

A proposal from the ICT market giving new information codes for RFID tags better sensors deployment (WSNs) in the access network (RSUs), freight containers and vehicles (OBUs).

An open network structure which in order to provide the basic rationale for potential users, network operators and service providers, and to have a clear framework where new offers (infrastructure networks and ICT services) could be better integrated in existing business software tools.

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