AN INITIAL FRAMEWORK FOR IMPLEMENTING MODAL SHIFT IN A FAST MOVING CONSUMER GOODS SUPPLY CHAIN IN WESTERN EUROPE

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ABSTRACT

The TransportNET is a network composed by eight leading University Groups involved in Transport Research and high-level Education, funded by the European Union under the Sixth Framework Marie Curie Actions Programme. Set up in 2003, TransportNET has as its main purpose the co-operation in the field of transportation research and research training. In this context, the following abstract is the result of a case study developed during this two-year Early-Stage Training (EST).

The obtained results, as the present paper, represent the final output of some fundamental elements during TransportNET project. The acquisition of high level academic knowledge, the possibility of interaction with members of the industry and the opportunity to work in a group are components that enabled for a complete and interdisciplinary a learning process.

Road Freight transport in Europe is growing at an unsustainable rate and consequently, is posing serious problems regarding environment, congestion and road safety. Despite the efforts done by the European Commission to support intermodal transport, the carriage of goods by truck is still a prevailing trend due to its inherent flexibility, high reliability and relatively low prices, up to now. Nevertheless, current oil price volatility and the increase of transportation-related externalities are boosting public awareness on the fact that all-road solutions will not be sustainable for the decades to come.

In this paper, the shifting from a dominantly road-based FMCG supply chain distribution to an intermodal solution is studied. An initial framework is presented in which the concept of “smart logistic hubs” is introduced. The challenge of this modal shift is not only about meeting current service level requirements (such as just-in-time deliveries), but also finding solutions to overcome important weaknesses of intermodal transport, such as reliability issues, longer lead-times and the need for higher inventory levels. Several studies showed that when economies of scale and distances are large enough, costs of intermodal transport, in some of the biggest freight corridors in Europe, are lower than all-road solutions. The network of “smart logistic hubs” focuses on optimizing and shifting freight from road, involving the co-location and integration of warehousing services of several companies. Furthermore, it would employ the concept of floating stock, implying a reduction of warehouse-related costs by replacing a part of the warehouse-held inventory by inventory in a “transport pipeline”.

To materialize this shift a network of “smart logistic hubs” is introduced. This initial framework was applied to a large FMCG company active in Western-Europe (P&G), in the finished product distribution (inside P&G and to retailers’ DC’s). Implementing intermodal transport in finished product distribution poses serious challenges to this industry, since an efficient supply chain management, with well-controlled transport and inventory management, is indispensable for sustained profitability in a FMCG company. In a first analysis, it was found that a significant portion of the ton-kms is produced by long distance road shipments; therefore in some corridors the freight volume is high enough to apply the concept of “smart logistic hubs” to this company alone. However, better results can be obtained (as it was already mentioned in previous studies) with the selection of the right partners or under the umbrella of a logistics provider, allowing the consolidation and balance of flows and additionally, increasing their frequency.

Keywords: TransportNET, Transport Research, Supply Chain Management, Smart Logistic Hubs, Intermodal Transport, Fast Moving Consumer Goods

1 INTRODUCTION

In the last thirty years the transport sector in Europe has experienced an important growth. According to the statistical book Panorama of Transports (Eurostat, 2007) freight growth can principally be attributed to road and sea transport. Both modes displayed large increases of respectively 38% and 35% from 1995 to 2005. This evolution in freight transportation "is influenced much more by the restructure of companies' production and distribution systems than by changes in the physical mass of goods in the economy or in the allocation of freight between transport modes" (McKinnon, 1998). Additionally, the enlargement of the European Union is seen as a factor contributing to an intensification of trade flows with neighbouring countries and road has clearly been the most successful transport mode for this (NEA Transport research and training, 2005). According to the ASSESS project (Transport & Mobility Leuven, 2005), the dominating trend for the next years is a continued growth of maritime and road transport. Rail transport and inland waterways will show considerably less growth according to this forecast.

The high mode share of road transport in general and freight road in particular, is posing serious problems regarding environment, congestion and road safety. The transport sector was already responsible for 28 % of all greenhouse gas emissions in 1998 and this share is likely to grow 50% between 1990 and 2010 (European Commission, 2006). Within the total transport emissions, road traffic accounted for the single largest share of 84%. As a result, unless major new measures for a more rational use of each transport mode are taken by 2010, heavy goods vehicle traffic in the EU will increase by nearly 50% over the 1998level. This means that regions and main routes that are already heavily congested will have to handle even more traffic (European Commission, 2001a).

Each mode of transport has its own characteristics regarding capacity, safety, flexibility, energy consumption and environmental impact. Therefore, a more rational use can consist of an intermodal chain that exploits the specific advantages of each mode. In reality, for some journeys, road transport can be the most efficient mode, but for others, intermodal transport is the best solution.

Intermodal transport allows each mode to play its role in building transport chains that are more efficient, cost effective and sustainable. According to Rodrigue (1998), a mode shift can occur when one mode has a comparative advantage (like cost, capacity, time, flexibility or reliability) in a similar market over another and depending on what is being transported; the importance of these factors varies (Rodrigue, 1998).

In this context, the Fast Moving Consumer Goods (henceforth FMCG) industry represents a particularly dynamic example where the absolute profit made on a product is relatively small but this is compensated by large selling quantities. Hence, an efficient supply chain management, with well-controlled transport and inventory management, is indispensable for sustained profitability of a FMCG company.

Therefore, with the aim of implementing a substantial mode shift in the finished product distribution and eliminating other transport inefficiencies, an initial framework is presented in which the concept of 'smart logistic hubs' is introduced. In the second section, with the state of the art, the intermodal transport in Europe is presented. In the same chapter, the supply chain design and trends of FMCG companies are covered. In end of this section the potential use of intermodal transport in an FMCG supply chain is discussed. In the third part, the methodology is determined. In the fourth section, interviews with transport and logistics managers of FMCG companies acting in Western Europe are summarized in order to analyze the elements that guide a company in the decision making process concerning production, distribution and transport. In the fifth chapter, an initial framework for implementing modal shift in supply chain management for FMCG companies is developed, in which the concept of 'smart logistic hubs' is introduced. The network of 'smart logistic hubs' focuses on optimizing and shifting the transport of goods from the road to other more sustainable transport modes, without compromising the current service level requirements. In the sixth part, the proposed model is applied on a macro level on the finished product flows of a large FMCG company active in Western Europe (P&G WE). The case study focuses on finished product freight flows inside P&G and to retailer Distribution Centres (henceforth DC). Other flows related with a FMCG supply chain, such as raw material flows and transport by retailers and consumers, also have a relevant impact on sustainability but fall beyond the scope of this study. In the seventh chapter, a summary of principles and future perspectives is given. Finally, some recommendations concerning the following steps of this research are presented.

2 STATE OF THE ART

2.1.m Intermodal freight transport in Europe

Despite of the Commission's effort to support intermodal freight transport, the all-road freight transport solution is still a prevailing trend. The reasons for this failure, as already mentioned in 1997 by the European Commission (EC) in COM(97)243, are the lack or the inadequacy of technical interoperability between modes and loading units, when transferring cargo between transport modes. In this communication, the points of transfer between modes were identified as being the weakest links in the current intermodal transport system and a major generator of friction costs. A decade after COM (97)243 this problem remains the weak point of intermodal transport. The market mechanisms alone or the Member States individually cannot overcome this issue.

Integration and reliability problems have resulted in a poor image of intermodal transport around Europe. To overcome this situation the European Union (henceforth EU) has been supporting research projects such as PROMIT, FREIGHTWISE and MOSES. PROMIT aims at helping the promotion of intermodal logistics and mode shift by disseminating best practices and opportunities (Ruesch et al., 2007). FREIGTHWISE specifically aims at supporting intermodal transport by advanced management tools and an open IT architecture (Kallstrom et al, 2006). MOSES aims at developing a network of motorways of the sea[1] (henceforth MoS) and consequently, increase the market share of short sea shipping and intermodal transport (Lindstad et al, 2008).

According to the ISIC final report, "interoperability and efficiency of intermodal transport can be stimulated more effectively when the efforts are focussed on a certain corridor, covering different countries and modes" (Van de Lande et al., 2005). In this context, intermodal terminal management would have to improve while integration of existing telematics systems should become a reality (European Commission, 2001b).

Several studies admitted that both rail in the EU, in general, and sea within countries with access to the Mediterranean, the North and the Baltic Sea, are the modes with the largest

[1] Motorways of the sea – "existing or new sea based transport services that are integrated in door-to-door logistic chains and concentrate flows of freight on viable, regular, frequent, high quality and reliable short sea shipping links" (European Commission, 2007).

potential to compete with road haulage (Van de Lande et al. 2005, NEA transport research and training, 2005).
Forecasts pointed to a significant growth of intermodal transport, from 54.5 million tonnes in 2002 to 116 million tonnes in 2015 (Kessel & Partners, 2004). However, the mode shift potential from road to intermodal transport is limited to the infrastructure capacity reserves. In this context, a study on the infrastructure capacity for combined transport by 2015 (in 18 trans-European corridors) showed a large number of bottlenecks located on the major European freight corridors (Kessel & Partners, 2004). Unfortunately, according with the findings of PROMIT project, some of these corridors are also considered the most promising ones for intermodal transport (Ruesch et al., 2007). Therefore, more investments on infrastructure are necessary in order to eliminate these bottlenecks and therefore, meet combined transport demand by 2015 (Kessel & Partners, 2004).

2.2. Supply chain specifics for FMCG companies

2.2.1. Current FMCG Supply chain

In a typical FMCG company products are moved into the company warehouse after production until they are transported to the Distribution Centre (henceforth DC). In the DC of the company, customer shipments are prepared. This involves preparing full pallets and mixed pallets based upon the orders from the retailer. Products are usually palletized and transferred in trailers or containers. The goods are then transported to the retailer DCs. From the retailer DC, the goods are then prepared according to the orders from the retail outlets (e.g. supermarkets), where they are bought by consumers (see Figure 1).

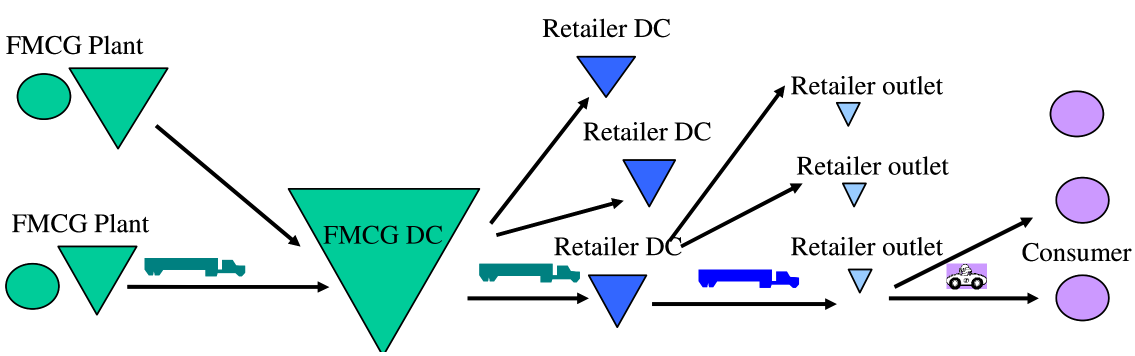

Figure 1- Current state of a FMCG Supply chain

Road transport has a near monopoly in the distribution of finished products at the lower levels of the supply chain, particularly in the delivery of retail supplies (McKinnon, 2006). Also the largest part of transport under the responsibility of the FMCG company occurs over road: from plant to the DC and from the DC to the retailer DC. A big portion of this transport occurs over long distance due to the centralization of production.
As of 2000, companies are developing Regional DC's (see Figure 2) in addition to European DC's (Tavasszy, 2008). One of the major reasons is related with retailers' procedures to keep inventory levels low. This is requiring ever shorter lead times and just-in-time (henceforth JIT) deliveries (Van Landeghem, 2005). Road transport operations have largely adapted to the related scheduling requirements.

2.2.2. Evolution of the FMCG supply chain

Traditionally FMCG companies have been operating according to an anticipative logistics model (Van Landeghem, 2005). Forecasting is used to estimate customer and consumer demand. For the FMCG companies, this model holds risk of obsolete stock due to overestimating demand or risk for stock-outs due to underestimating demand (see Figure 2). Hence, centralized stock keeping helps to control this aspect because inefficiencies are more easily detectable.

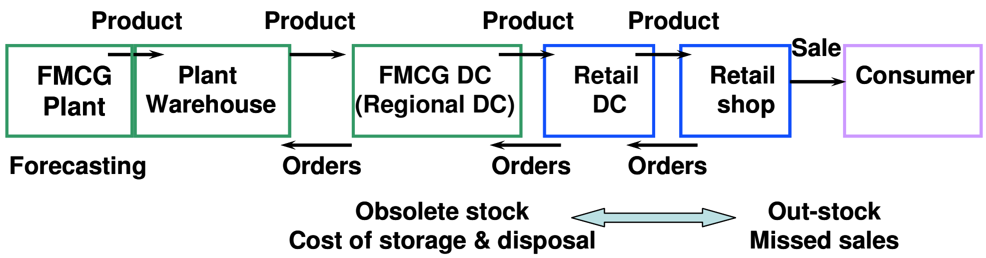

Figure 2 -The traditional concept of a FMCG supply chain

In the last years, FMCG companies are exploring a more responsive logistics model (Simchi-Levi et al., 1999). This implies changes in the logistic model, moving from pure "Push" to hybrid models that bring a "Pull-aspect" into the supply chain i.e. transforming the "inventory-based model" into a "replenishment-based model" (see Figure 3).

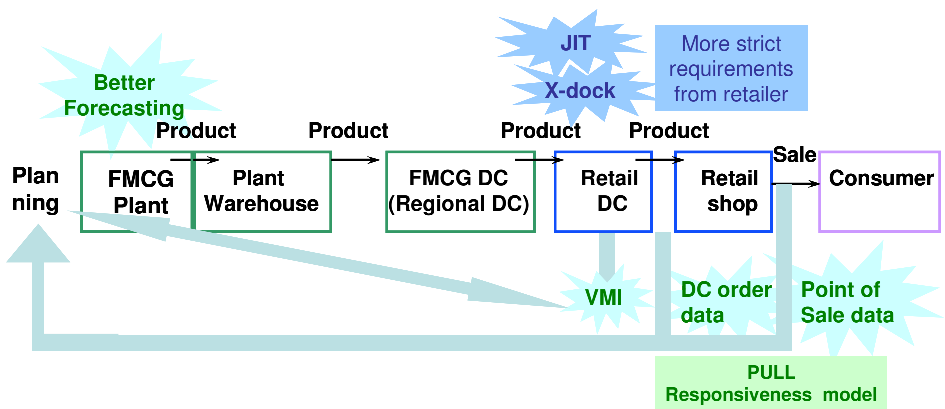

Figure 3 The evolution of the concept of a FMCG supply chain

In this context, major FMCG companies, in cooperation with the retailer customers have been exploring ways to use sales data from points of sale or from the customer DCs to feed their production and supply chain planning (Friedrich, 2008). These data can then be used to optimize production and deliveries to keep inventory levels under control or even to apply the "Vendor Managed Inventory" (henceforth VMI) model (see Figure 3), in which the inventory at the retailer is managed by the FMCG producer (Simchi-Levi, 2003). The actual demand data can also be used to segment products and find the daily or seasonal 'fast movers' (i.e. high turnover items) to be able to fulfil orders and avoid stock-outs.

Cross-docking is another fairly recent trend that uses turnover speed segmentation to cost-optimize the retailer operation (see Figure 3). This means that products do not enter the retailer's storage at the DC and are transferred towards the retail outlets immediately after arrival in the retailer DCs (Simchi-Levi, 2003). Therefore, deliveries must be reliable and punctual; otherwise the concept does not work. Usually it means that a delivery has a margin of less than one hour to arrive at the retailer DC. This technique allows the retailer to avoid storage and related handling costs, but clearly poses very strict requirements towards the FMCG company and its transport service providers.
As in other sectors, internet shopping may be an undeniable trend in the coming decade that will also pose challenges to logistics and transport organization of the FMCG industry: smaller orders, other retail partners, more frequent deliveries (Poirier and Bauer, 2001).

2.3. Potential use of intermodal transport in a FMCG supply chain

The opening of the European internal market in 1992 facilitated all international transport within the EU leading to the increment of competition and, consequently, several inefficiencies were driven out of the system. One of the outcomes was the significant decrease of road freight transport prices. These factors along with other external and internal changes during the 1990's, led FMCG companies to move from their National DCs towards European DCs (Tavasszy, 2008). This centralization allowed major reduction of capital-intensive inventory levels and generated considerable economies of scale.
Under these circumstances, road freight was the most suitable transportation answer thanks to its superior flexibility and relatively low prices (CEST, 2000). These prices led to an intensification of transport movements that in the end did not offset the large scale benefits and savings generated in production and supply chain by this centralization trend. "Several studies confirm that with regard to overall transport efficiency, JIT has the effect of depressing vehicle load factors" (McKinnon, 2000). Furthermore, current oil price volatility and the increase of social, financial and environmental externalities (congestion, toll, pollution) is increasing the awareness within the industry that this model will not be sustainable for the decades to come.
Therefore, to achieve a mode shift, the transport alternative has to fulfil all the needs of the supply chain, including also logistics costs in a broader sense (Blauwens et al., 2006). Once this requirement is fulfilled, intermodal transport becomes a viable alternative: a Protrans survey showed that 90% of the respondents agree to change the processes if the cost/service level remains the same or improves by the use of intermodal transport. (Andersson, 2002). Studies like the EU project REALISE[2] showed that when economies of scale and the distance is large enough[3], costs of intermodal transport in some of the biggest freight corridors in Europe are "lower - in terms of total cost/quoted prices - than all-road transport chains" (Vassallo et al., 2004).
Massifying transport flows is a method to build economies of scale in handling and allow reliable schedules (Geerts, 2004). Consolidation of freight flows can be achieved by the use of hub-and-spoke networks. However, as distances travelled and additional handling costs

[2] REALISE (REgional Action for Logistical Integration of Shipping across Europe) has as an overall objective to "take into account of what has already been achieved by EU and national activities and projects – is to develop technological strategies, methodologies, and tools for the European business community and decision-makers in order to encourage the use of short sea shipping. These efforts will focus on the carriage of unitised cargo" (Vassallo, W. et al., 2004).
[3] According with REALISE project, "the break even distance for rail/road (…) is 609 kilometers and for road/iww (…) is 153 kilometers." (Vassallo, W. et al., 2004).

might increase, the location of the hubs must be selected according to overall cost minimization objectives (Campbell et al., 2002). Whilst consolidation is clearly a technique for improving vehicle fill of small deliveries, it does not specifically address the issue of empty running. Empty return legs arise from outbound loads with no matched return load. The objective then is to find effective shipments to fill these return legs.
Moreover, unreliability (delays leading to unpredictable transport time) is considered to be the most important weakness of intermodal transport versus all-road solutions, by shippers and receivers.
Nevertheless, some of these negative aspects can be overcome through cooperation between all actors involved in the supply chain, by pooling their workload and transport resources, by synchronising deliveries and by collecting schedules. As an incentive to exploit intermodal transport, some authors suggested to split the benefits across all parties considered, FMCG and retailer, since not everyone involved in the process has as much to win as the others, by transitioning to intermodal transport (Verhulst et al., 2000).
Cooperation can even go further and increase the attractiveness of intermodal transport. Bearing in mind FMCG companies and their characteristics, in 1999 Vermunt suggested a form of collaborative hub network using both inland navigation and road haulage. The goal was to take advantage of economies of scale by shipping the majority of cargo by barge. Additionally, road haulage is used to add flexibility and responsiveness to the FMCG supply chains (Vermunt, 1999, Groothedde et al., 2005). Furthermore, if the concept of floating stock is applied, warehouse-related costs can decrease due to the fact that part of the inventory is in a virtual “transport pipeline” (Tavasszy et al., 2003, Groothedde et al., 2005). Nevertheless, to use this concept forecasting accuracy levels must improve as errors might cause lead time increases and in the end, compromise the service level of the supply chain.
In line with this trend, TNO foresees a move to more external collaboration towards multi-user hubs and horizontal bundling by 2020, allowing not only to consolidate flows, but also to balance and to increase frequency of shipments (Ruijgrok, 2007).

3. METHODOLOGY

In order to develop a semi-structured questionnaire (in Annex) to analyze the elements that guide a FMCG company in the decision making process concerning production, distribution and transport, it was necessary to collect further information about trade, traffic flows, transport and their evolution in Europe and neighbouring countries. Most information was found on the web pages of the World Bank, the Word Trade Organization, the Organisation for Economic Co-operation and Development (OECD), Eurostat, as well as through European projects such as PROMIT (Ruesch et al., 2007) and TEN-STAC[4] (NEA transport and research training, 2004), among other sources already mentioned in the previous chapters.
Therefore, the semi-structured questionnaire to be used in the interviews with transport and logistics managers of FMCG companies acting in Western Europe was divided in six sections: manufacturing and distribution network; transport infrastructure, storage policy, freight volume; transport means selection and expectations towards the future. When it was not possible to arrange face-to-face interviews, answers were collected via e-mail.

[4] TEN-STAC project has the aim to developed “a uniform and consistent framework to compare and assess the expected future impacts of various proposed transport infrastructure projects in Europe. The year chosen for the assessment and comparison is the year 2020.” (NEA transport and research training, 2004).

Companies were selected for the interviews based upon the presence of a large distribution network in Western Europe (henceforth WE).
With the state of the art findings and interview results, a physical distribution set-up is proposed that could enable FMCG companies to shift from all-road to a large portion of intermodal transport without compromising the level on service demanded from a modern FMCG supply chain.
In the end, the proposed model is applied on finished product logistics of a large FMCG-company active in Western-Europe: Procter & Gamble WE (henceforth P&G). The case study focused on freight flows: inside P&G (from the factory to the P&G DC) and outbound of P&G (P&G DC to retailer DC). Transport from the retailer's DC to the shop and transport by the consumer from home to the shop and back were not considered.

4. KEY RESULTS FROM INTERVIEWS

The findings of the semi-structured questionnaire (in Annex) used in the interviews with transport and logistics managers of FMCG companies active in Western Europe are summarized below.

Manufacturing and distribution network

- The set-up focuses on stabilization of the supply chain to have perfect order fulfilment. Companies try to achieve this by investing in accurate forecasting techniques and by having extra inventory capacity as buffer;
- Being on-time at the customer is another key goal. In this field, the logistics managers often mentioned the huge differences in DC organizations between the different countries. In this context, it was pointed out that Europe is much more complex than the USA, because it is a lot more fragmented. For example, in the Benelux, featuring small countries with high road density, retailers require very short lead times (below 24 hours often), while in larger countries retailers often accept delivery times of 48 hours and more.

Transport

- The most important factors for selecting the mode of transport are: reliability, cost, frequency and door-to-door transport time. Road transport is considered the most appropriate transport means due to its inherent flexibility and high reliability. Most transport is contracted out via long-term contracts. However express shipments are a regularly used measure to correct inefficiencies in the system or to deal with customer requirements. At peak periods (that often collide with vacation periods), hiring extra transport capacity costs a lot more than the standard contracted rates. In some cases transport capacity can even not be found.
- Intermodal transport is not often used. A possible explanation is the fact that transport operations are mainly outsourced which limits the involvement on transport mode selection. Furthermore, reliability issues, time-loss and cost of transhipment are seen as big risks related to the inherent mode shifting of intermodal transport. Issues with rail strikes (especially in some key European countries) and bad weather conditions when opting for sea transport were also mentioned in many interviews as a problem. Inadequately long lead time and the need for a higher inventory level are resulting major disadvantages. Currently a 3

shipments/week frequency with high reliability is considered a minimum to move a trade lane from all-road to intermodal without major disruptions.

Expectations towards the future

- Oil price volatility is convincing transport managers that measures for a more efficient distribution and transport are needed for FMCG companies to remain economically sustainable.

- Pushed by the consumer and the governments, the ecological aspect of sustainability is also becoming more important for FMCG companies and their retailer customers. According to the respondents, there is still a cultural/geographical difference in Europe: Scandinavia, The Netherlands and Germany are considered the most “eco-conscious”. Measures mentioned to respond to this “eco-consciousness” are often more organizational than infrastructural in nature: efficient roundtrip planning systems, decentralized production and more efficient truck loading.

- Using intermodal transport for shipping products to customers is still seen as a real challenge in the future due to the tight requirements and the inadequacy of anticipating forecasting techniques. FMCG transport managers interviewed do have difficulty imagining that retailers would accept to co-operate on exploring rail/waterway solutions, especially because some have very scattered DC locations and most of them are not connected to these modes.

5. MAKING THE MODAL SHIFT IN FMCG FINISHED PRODUCT DELIVERY HAPPEN

In this paper the possibility to move from a dominantly road-based transport distribution to an intermodal transport solution for a FMCG supply chain is studied. It is obvious that moving the internal transport part to other transport modes is relatively easier due to the fact that the company is both sending and receiving party. This is more difficult for the outbound part, because changes impact the supply chain of the customers who might not see immediate benefits. However, once outbound transport towards customers occurs over a longer distance (like in bigger countries), logistic managers explained that customers are more willing to accept longer lead times. As the transport leg from plant to the own DC is fully within the responsibility of the FMCG company, it can be assumed that it is possible to optimize the loading of this transport to Full Truck Load (henceforth FTL) basis.

5.1. Definition of a “smart logistic hub” network

In order to achieve both consolidation and balancing of flows, a concept of “smart logistic hubs” could be installed at strategically located transport nodes.
Smart logistic hubs are defined as:

- logistic hubs that focus on optimizing the intermodal transport chain by realizing efficient low-cost transhipment among modes through
    - consolidation of trade flows of several companies;

  - the use of state of the art transhipment technology;
  - intelligent transportation systems (planning, tracking and tracing,…).
- “smart” in the sense that they
  - make use of the best suitable alternative transport mode at a given time for specific cargo;
  - efficiently organize, balance and consolidate the in- and outbound short distance transport to and from the region around the hub;
  - involve co-location and integration of warehousing services of several companies beyond just loading unit handling;
  - apply loading unit fill rate optimization (light goods mixed with heavy goods in one loading unit);
  - feature floating stock (products in a virtual “transport pipeline”);
  - host value-added operations, cross-docking, customization services.

This network of smart logistic hubs should be based on geographical factors such as existing transport infrastructures and future opportunities, but also on economic factors like trade flow analysis of prospected major users of these hubs (see Figure 4).
Each “smart logistic hub” must have at least two means of transport available to reach other hubs. This enables a company to anticipate upon crisis situations or reliability issues in transport lanes. Ideally these hubs should be operated by one or a few FMCG companies and/or retailers with sufficiently large volumes or more probably by an independent logistics provider that can combine flows of plural companies.
By consolidating flows at “smart logistic hubs”, the economic viability of non-road transportation increases and therefore, large constant volumes of goods can be shipped by rail, rail/road or transported by sea (e.g. MoS). Peak transport capacity or occasional express shipments can still be carried by truck.

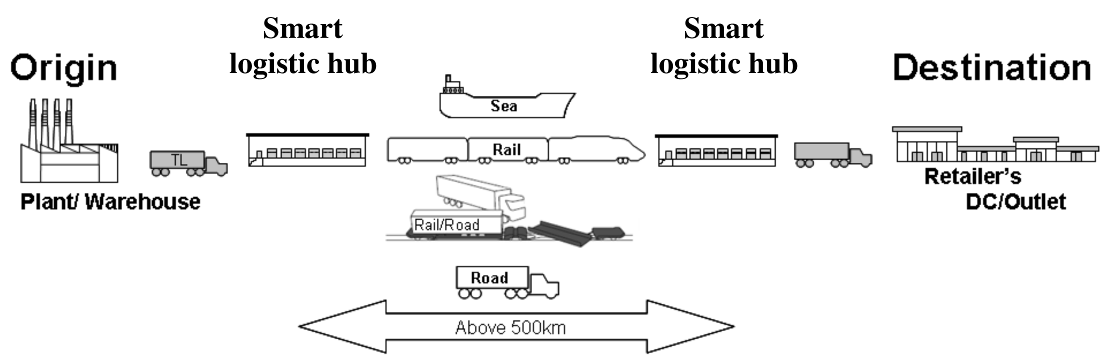

Figure 4- Future state of a FMCG company supply chain: “smart logistic hub and spoke”

Additionally, when possible, short to medium range outbound traffic should be combined with several suppliers of a retailer DC. This set-up may possibly permit goods to be transported by rail or barge, or at least to load a full truck. In the cases when sufficient volume is consolidated, shared truck transports could go directly to retailer outlets, by-passing the retailer DC.

5.2. Characteristics of a smart logistics hub network

Delays can be related to interruptions in the transport parts or at the transhipment operation. To deal with the delays at the transhipment operation, “smart logistic hubs” should be equipped with state of the art technology allowing rapid mode shifting.
The “smart part” also means that they would focus on operational aspects beyond the traditional intermodal chain: improving vehicle fill and productive time. Both are also described as major improvement areas for the FMCG transport industry.
Inventory management by the “smart logistic hubs” would involve segmentation according to requested throughput. This means that fast moving goods would not be stored at the manufacturer, but at the “smart logistic hubs”. From there, they would be ordered from the production plant on a replenishment basis (below a certain level of inventory, a production batch is ordered). Once transported to the “smart logistic hub”, they can either be stored or cross-docked to efficient non-road transports (e.g. rail/road or MoS) closer to their final destinations. Super fast movers (products that need to be replenished (almost) daily at the supermarket) can often be used to fill up remaining capacity in loading units.
To reduce the need for storage capacity at the “smart logistic hub”, the concept of “floating stock” should also be applied, meaning that inventory is advance-shipped and taken into account in the inventory policy. Response times and storage costs can be reduced by having products in the transport-pipeline towards their final destination before they are actually ordered. In this way shifting to intermodal transport can lead to cost saving without affecting the service level.
Relatively slow moving goods (e.g. re-ordered less than weekly by a supermarket) should still be centrally stored at the manufacturer. The available inventory of these products counted in number of days is usually relatively high and lead time is less critical than for the fast movers. More upstream storage of these products helps to keep inventory levels under control and reduces complexity at the “smart logistic hubs” by keeping the number of stock keeping units under control.

5.3. SWOT analysis for the concept of the “Smart Logistic Hubs”

The supply chain strategy developed to accomplish a modal shift through a network of “smart logistic hubs” is a model that will be implemented in a dynamic environment. To explore the robustness of this model, a SWOT analysis was conducted (see Figure 5).

		HELPFUL to achieving the objective	HARMFUL to achieving the objective
INTERNAL ORIGIN	attributes of the system	•Consolidation of flows to make intermodal transport economically viable and to achieve high frequency •Strategically placed hubs (mutually well-connected with long distance rail and/or waterways) and good access to road transport (both for radius distribution and variable volumes) •State of the infrastructure and ITS at the hubs	•Direct shipments from plant to customer pass through extra •Lack of flexibility in changing O/D of big flows •Smart Logistic Hub not able to optimize the several flows •One Hub has problems the entire network suffers the •Investment in Smart Logistic Hub's infrastructure and ITS too high?
EXTERNAL ORIGIN	attributes of the environment	•Long term oil price raises, lower the break-even point of intermodal vs road •Internalization of externalities, less sustainable modes penalized •Night rail shuttles in countries with major bottlenecks (e.g. DE, FR) •Regular and frequent SSS/MoS links can be used overnight or in weekends •Cheap balance capacity on deep sea shipping for low value density slow movers •Balancing flows (e.g. with countries from Eastern Europe - NMS, Russia, Turkey; with partners from North Europe) •Implementation of new technologies to overcome interface problems (e.g. Modalohr system and alike) •Social and environmental benefits	•Strikes (rail, ports, waterway infrastructure owners) •Liability problems (who is responsible?) •Bottlenecks (e.g. intermodal corridors and terminals) •Priority to passengers in rail corridors •Increasing requirements for just in time deliveries •Lack of suitable technologies to overcome interface issues •Common interests (products, location of hubs, corridors selected) with other companies? Possible to collaborate? •Future of Intermodal transport: a market for "niches", mainly in Western Europe, concentrated on a few corridors, particularly across the Alps? •Lack of standardization of loading units (swap bodies, semi-trailers; maritime containers)

Figure 5 -SWOT analysis for the concept of the "Smart Logistic Hubs"

One of the strengths of the "smart logistic hubs" for example is that these would be equipped with technology that allows rapid mode shifting. This has an important impact on the performance of the intermodal freight chain. Investment cost could be justified by the high volumes from different cargo owners. A solid benchmarking of the different mode shifting technologies should occur per interface to prevent issues with technical interoperability. This implies assessing various aspects of each solution in relation to best practice. Next to the best technical solutions, benchmarking should include the identification of the best corridors and/or areas where the implementation of these technologies could have the largest impact on the improvement of the intermodal transport chain.

Intermodal infrastructural technology is improving fast. Several innovative systems are being developed. One rail/road example is a system called Modalohr. It has been patented and is working between France and Italy and between Luxemburg and Southern France. The concept is based on the use of a pivoting railway wagon, enabling the transportation of standard roadway semi-trailers on the existing railway network without a server station (crane or reach-stacker). This holds an opportunity by reducing the time between cargo transfers by the ability of parallel loading of the wagons.

One inherent weakness will be the lower flexibility of changing origin/destination of important trade flows. The considerable investment required to install "smart logistic hubs" will also require enough partners to justify the costs. As a network, the concept is prone to "network related" domino effects: when one hub closes down, the entire network will be affected.

A major opportunity is related with the lower dependence of oil price. In a peak-oil scenario with long term rising evolution of oil price, this holds a major opportunity for lower cost. In a time of high oil price volatility it means a more reliable cost picture but not always a cheaper one than using road only transport. The break-even point of rail versus road moves with the changing of oil price. As an example: a calculation on a specific corridor from the REALISE project shows that the break-even point of road/rail versus road decreases from

approximately 600km to 500km, when the oil price raises from 40USD/barrel to 100USD/barrel (Vassallo, W. et al., 2004).
As an opportunity area it is for example interesting to consider night-time shipping for freight rail when more rail capacity is available because passenger traffic is low. Of course, future evolutions like freight rail exclusive tracks (like the Betuwe line in The Netherlands) or other planned expansions (as foreseen by Trans-European Transport Network) should be exploited to the fullest. Motorways of the sea could also operate at night to anticipate lower speeds compared to road transport. There are already plans for "Fast Motorways of the Sea" in Europe (with fast ships) and these could also be very good links between hubs. For slow movers free capacity on deep sea shipping for low value density slow moving goods could also be considered to transport items between hubs. With the plans of the European Commission to internalize external costs, intermodal solutions will be more appealing because they are more sustainable and less penalized than road only solutions.
Threats that can jeopardize the operation of the "smart logistic hub" network are for example: strikes on transport modes or in interfaces, less clear responsibility for damaged cargo, dependence on a few large cargo owners, bottlenecks in intermodal corridors and lack of standardization of loading units. Also varying partners and the lack of compatibility of the different products could challenge the operation of the network.

6. CASE STUDY: APPLYING THE 'SMART LOGISTIC HUB NETWORK' CONCEPT TO A FMCG COMPANY IN EUROPE

The model suggested higher was applied to the supply chain of a FMCG company active in Western Europe (Procter & Gamble). The company has production and distribution centres in most countries of Western Europe. In accordance with the total industry's modal split, the majority of transport occurs currently over road.
For reasons of secrecy, confidential data has been omitted in this report and data is presented in a schematic format. In this exercise only P&G is considered, but, ideally, as explained above, the concept would look for collaboration with other companies. In a first set-up, the application looks at installing "intermodal hubs" without the complexity of warehousing and value-added services. The vision is that the transport movements will give the backbone of the network design and the "smart logistics" parts can be implemented in a later stage.
The current transport lanes in the supply chain were mapped. A high level analysis of aggregate trade flows shows that a high percentage of traffic is moved in both directions on the North-South axis in Western-Europe. There is also a lot of traffic between the UK and France. Important traffic flows are also travelling eastbound to several countries in Central and Eastern Europe.
According to specific requirements mentioned below, freight flows were then consolidated into a hypothetical future state of a "smart logistic hub network" for P&G. A key parameter used for the identification of potential hubs was the fact that the hub had to be in the vicinity of the currently existing production sites of P&G or the final customer DC's. The main driver was to limit road transport generated by the initial and last leg of the intermodal chain (the part between plant/warehouse or retailer DC and hubs).
Another important requirement is that there needs to be sufficient cargo moving in both directions between hubs. For rail, based on the trade flow analysis, chose the "smart logistic hubs" based on the minimum requirement to have a balanced full freight train per week

(assuming 2 equally sized partners to make it a viable proposition because it would mean 3 trains/week).

The distance between hubs needs to be sufficiently large to justify the use of intermodal transport as the most economically viable alternative. A break-even point of 500km for road/rail intermodal versus all-road was assumed (corresponding to an oil price at 100USD/barrel). By consequence, the distance between hubs ideally should exceed this distance in the application of this concept. However, in some cases (waterways or high volume rail or congested lanes) considerably shorter distances could still be viable. An analysis of the composition of the road traffic of the company showed that a significant number of the transports cover a distance above 500 km. These long-distance legs are responsible for a large part of the tonne-kms generated. For this hypothetical scenario these are converted into intermodal road/rail and Motorways of the Sea, implying an opportunity for a substantial reduction of the environmental footprint generated by the transport of the company.

The resulting hypothetical network of smart logistic hubs tailored for P&G are pictured in Figure 6. The hubs are mentioned below and specified by region or nearest large city. In the North of Europe - London, Liverpool, Cologne, Nord Pas de Calais and Malmo; in the Centre of Europe - Lyon and Milan; in the South of Europe: Barcelona and Rome; in Eastern Europe – Warsaw, Budapest and Trieste (since this hub has traffic going to East Europe). The hubs for traffic towards Eastern Europe cannot be internally balanced and therefore, are called "future smart logistic hubs". This name was chosen to highlight the potential to balance these with westbound flows from Eastern-Europe (see Figure 6).

Figure 6 is showing the locations and the transport connections between the hubs. The locations of all hubs were chosen in order to exploit rail and/or sea links. As explained in the model, in order to maintain reliability of the network, there is a need to have alternatives that keep the network operating during crisis in specific modes or lanes. A crisis can be a strike, infrastructure problems or climate and geographical events. For this specific case study it was possible to identify alternative modes of non-road transport that could replace or complement rail transport temporarily or permanently.

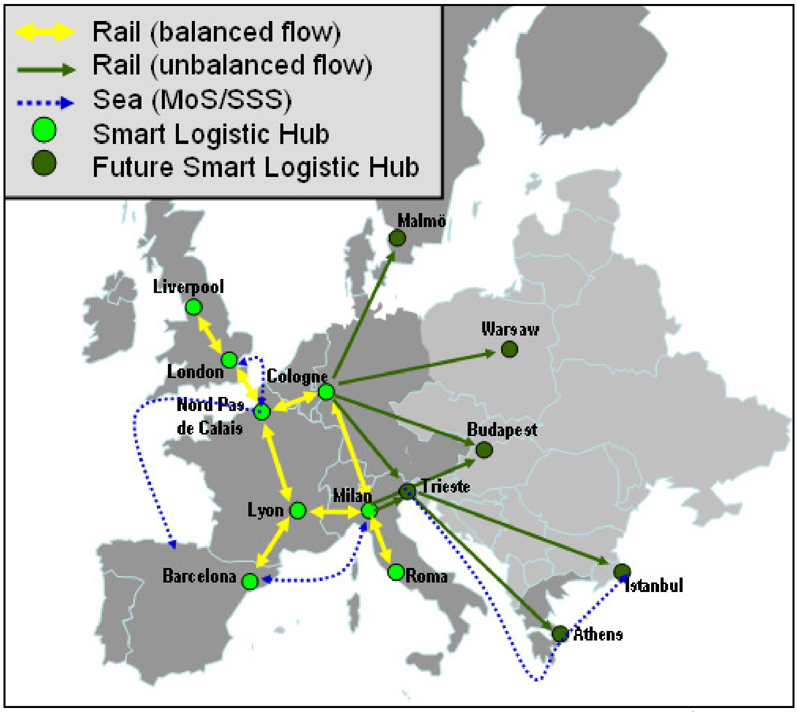

Figure 6 -Initial framework of smart logistics hubs applied to P&G WE

Some concrete examples show the potential alternatives. There is a short sea shipping service from Trieste to Istanbul (see Figure 6). The service was started in 1994 by a group of transport operators that created a Ro-Ro company to provide an alternative for road transport through the Balkan area during the war. Many years after the war, the service is still successful and currently offers the shipment of vehicles and semi-trailers with a schedule of one departure a day from Istanbul. The round trip journey (Istanbul-Trieste-Istanbul) takes a total of 6 days including loading and unloading of the vehicles. If that lane encounters issues, an alternative option could be freight rail from the area of Trieste over Budapest to Istanbul.
Another example is the from Milan to Barcelona over Lyon and back In case the rail alternative has issues (for example in France), the port of Genoa (close to Milan) could provide a short sea shipping alternative to Barcelona. Another interesting alternative to rail transport could be identified in relation to the connection between the North of France and the UK. The different modes of transport that are considered are rail transport trough the Eurotunnel or ferry services between France and the UK.

7. SUMMARY AND PERSPECTIVES

The network of "smart logistic hubs" that is proposed is a network of collaborative distribution/logistics centres organizing the freight transport and logistics of at least one, but ideally several FMCG-companies to allow the shift of predominantly road to intermodal transport. The distance amongst hubs is large enough to make intermodal transport economically viable. This concept bases itself on the fact that the modae shift should occur without major disruptions in service level of the supply chain. The consolidated freight volume and freight balancing between the hubs allows high frequency shipments with rail and waterway solutions. Road transport is used for variable inter-hub excess volume and for the final legs of the inbound and outbound transport to and from the hinterland of the hub. The “smart logistic hubs” focus on optimizing both the freight transport in the network of hubs and the inbound and outbound short distance freight transport to the hinterland around the hub. Next to freight optimization via intermodal transport, “smart logistic hubs” integrate logistics and inventory management. They also use product segmentation (fast mover/slow mover) and value density (low/medium/high) to optimize the storage policy. Other tools at their disposal are “floating stock” and “transport load optimization with fast movers”.

In the trade flow analysis of a FMCG company (P&G WE), it was found that a significant portion of the tonne-kms is produced by long distance road shipments. Theoretically, a large fraction of these could be shifted to intermodal transport. In order to achieve this, a network was proposed of 8 “smart logistic hubs” with internally balanced flows and 4 “future smart logistic hubs” with currently still unbalanced flows. Balancing could occur with selection of the right partner companies. These results are in line with Vermunt (1999) and Groothedde et al. (2005) findings, as having partners would allow companies to consolidate and balance flows and also, to increase their frequency. Indeed, a certain volume of shipments must be achieved so that intermodal transport can be used without compromising the level of service of FMCG supply chains.

Strategic positioning of the hubs appears to allow sufficient alternatives for the network trade lanes when temporarily blockage or capacity issues occur. Also several existing and emerging technologies were found that will facilitate and speed up mode shifting without major infrastructural investments.

Although principles presented in this paper should remain valid, the presented framework is still in the early stages of development (case study covered only one company), therefore a more in-depth analysis involving more companies is required to validate its viability in an industrial context.

8. RECOMMENDATIONS

Follow-up research should investigate the impact of “smart logistic hubs” on the inventory levels of the companies in the FMCG supply chain (FMCG-companies, Retailers). Calculation and simulation is needed to investigate the required capacity and the financial picture (investment, storage cost/total logistic cost). The optimal freight volume per hub (also determined by the optimal number of users) and the robustness versus cargo volume variation also deserves further investigation both purely operational and for the impact on the accessibility and capacity. Given the importance of oil-price for the break-even point of road/rail, a sensitivity analysis could be done on this, adjusting essential parameters like ideal distance in-between hubs.

From a technology point of view, benchmarking of the most suitable technical solution for the mode interface is needed (capital investment as well as long-running operating cost). To examine the economic viability a business model could be developed for operating a “smart logistic hub” network, taking into account planning, warehousing and value-added services mentioned above.

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ANNEX

Semi-structured questionnaire

Section 1: Manufacturing and distribution network

1. Where are located the major production facilities?
   - country …………………………………………………………………………………......
   - area/city ………………………………………………………………………………......
2. Considering the total freight volume which percentage is
   - Produced and distributed in Western Europe …….%
   - Produced in Western Europe and exported outside of Western Europe …….%
   - Imported from outside Western Europe and distributed in Western Europe …….%
3. Considering your plants and DC's, which percentage of your production is
   - Sent from plant to DC and then to Customer DC/shop …….%
   - Sent from plant to DC …….%
   - Sent from plant to Shops …….%
4. How many of your DC's are managed
   - By your company …….%
   - By third parties …….%
6. Which transport route is within your company's responsibility? (Y/N)
   - Raw Material Producers ➔ Production Facilities
   - Production Facilities➔ Warehouse
   - Warehouse ➔ DC
   - DC➔ Wholesaler (customer)
   - Wholesaler ➔ Shops
   - Shops➔ Customer
7. What is the average distance from the
   - Production facility to the warehouses/DC? ……km
   - DC's to the customer (DC or shop)? ……km

Section 2: Transport infrastructure

1. Which percentage of outbound cargo is unitized? …….%
2. Which are the main loading units that your company uses?

…………………………………………………………………………………………………..

Section 3: Storage policy

1. How much finished product is approximately stored (in days of sales/tonnage) in the
   - Production facility/warehouse …….%
   - DC's …….%
   - Customer DC's ..…...%

2. What are the differences according to storage policy (turnover rate; slow/fast movers ABC)?

……………………………………………………………………………………………………..

Section 4: Freight volume

1. In relation to the main corridors, what are the trade volumes (n° containers/tonnages)?

……………………………………………………………………………………………………..

2. Do you use different freight lanes for fast/slow movers?

……………………………………………………………………………………………………..

3. What are the most problematic areas? Why?

……………………………………………………………………………………………………..

4. What are the main bottlenecks? Why? (specify their nature e.g. infrastructure capacity, seasonal variation, etc.)

……………………………………………………………………………………………………..

Section 5: Transport means selection

1. Selection: what is most important on making the transport decision? (please circle 3)
   - Reliability
   - Low cost
   - Appropriate frequency
   - Reduced risk of loss & damage
   - Contract length needed
   - Robust partnership
   - Door-to-door total transport time
   - Customer service
   - Low environmental impact
   - Dedicated service
   - Others

2. Experience with other transport modes excluding trucks: current and past success/failures?
   - Rail: Pure rail
     Rail/road combination
   - Waterways: Inland waterways (barge)
     Short sea shipping (RoRo and similar or other versions)

Section 6: Expectation towards the future

1. In your opinion, what are the challenges towards the future for the logistic chain? Any specific trends?

………..

2. What (dis)advantages would you expect comparing all-road to intermodal transport solutions?

………..

3. If compromises have to be made, what do you think are the most acceptable properties to compromise on?
    - Extra storage at DC's or Customer's (how much)
    - Cost
    - Exact time of arrival at DC or customer
    - Reliability
    - Frequency of transports
    - Moving from dedicated transport to shared transport
    - Moving from dedicated DC's to shared DC's

Comments concerning the questionnaire or further remarks/ideas ……………………………………..