TRANSPORTATION SYNERGIES IN INBOUND LOGISTICS FLOW AT AUTOMOTIVE ASSEMBLER PLANT

João Ferreira (corresponding author)
Instituto Universitário de Lisboa (ISCTE-IUL), ISTAR-IUL
Av das Forças Armadas, Edifício ISCTE
1649-026 Lisboa, Portugal
Email: joao.carlos.ferreira@iscte.pt
Ana Lúcia Martins
Instituto Universitário de Lisboa (ISCTE-IUL), Business Research Unit (BRU-IUL)
Email: almartins@iscte.pt

Abstract
Transportation costs are responsible for a large portion of the logistics cost. This is particularly important in companies that are located in peripheral countries. Valuable cargo companies under these conditions tend to receive more often, which easily leads to LTL. The purpose of this paper is to assess alternative scenarios for reduction of transportation cost for a car assembler in Iberia, taking into account the development of a collaborative software to handle sharing process at low prices and risks, attempting a somewhat flexible solution in a rigid industry. The proposed approach looks for logistic data flows and identifies aggregation solutions for inbound flows using rail solution and sharing space with other players to balance outbound traffic.

Introduction

The Collaborative Broker is a goods aggregation platform that allows participation in the sharing transportation market, where synergies among several logistics departments are suggested towards low cost transportation of their goods. Sharing of cargo with other companies to achieve FTL is becoming popular and leads to transportation savings (Rushton, 2017).

The basis for this work was the logistic supply chain from Volkswagen-Autoeuropa (V-AE) cost reduction needs due to their geographic location. V-AE is a car assembler plant located in Portugal belonging to the Volkswagen Group. Each assembly plant tries to compete internally for the assembly of new models and costs are the main driver in the decision process. V-AE has reduced labour cost when compared to other European plants but logistics costs is higher. The Company's inbound material flows are originated in central Europe and the main transportation mode is truck. There is a large gap in volume between inbound and outbound flows as only empty racks are in the outbound flow). Eventually with other types of mechanisms the waste in the outbound volume could be minimized. Also, the motivation for this work comes from the fact that out of the total plant costs the most significant share besides materials comes from the logistic framework and material handling: Material 80%, Logistic 7%, Manpower 7% and Energy 6%. Nowadays the tendency in the automotive industry is that these 7% of logistic costs will to increase due to: 1) Increase of "Carry over parts" (COP) parts in the vehicles that are produced in V-AE, and consequently the increase of the distance from V-AE to those suppliers. This is due to the fact that V-AE is not the plant that consumes the biggest amount of the requested parts, making sense to have the supplier's parts placement closed to those ones; 2) Supplier's displacement to East Europe countries and to China due to production costs, increasing the distance from V-AE to those new locations, resulting in higher logistic costs. In the External Logistic Operations the problem is that there is not enough outbound volume in the trucks leaving V-AE compared to the inbound volume. The amount of money spent in External logistic operation is equally divided between the transportation to V-AE and the local logistic operations. This paper focus only on transportation costs, where two

types of truck trips can be considered: 1) Round trip – Inbound and outbound trips together; 2) Single trip – Only Inbound trip and this trip has high potential for a collaboration approach with others nearby companies.
The aim of this paper is to propose of a software solution identified as a collaborative broker that helps registered companies to share transportation resources and identify opportunities for train and maritime transportation, when high levels of transportation needs are achieved.
Basically this case study looks for: 1) What is the geographical distribution from suppliers; 2) Which are the routes truck performed; 3) Gather information about train and marine transportation; 4) What is the inbound / outbound volume associated to the currently existing truck; 5) Matching approach towards sharing.

Case Study: current transportation scenario
Figure 1 shows that the main concentration of V-AE suppliers is in Germany, representing 51% of the total, followed by Spain with 14% and Portugal with 10%. This value represents annual percentages taking into account year 2013 data. This process was performed based on geo-referenced suppliers and associated volume.

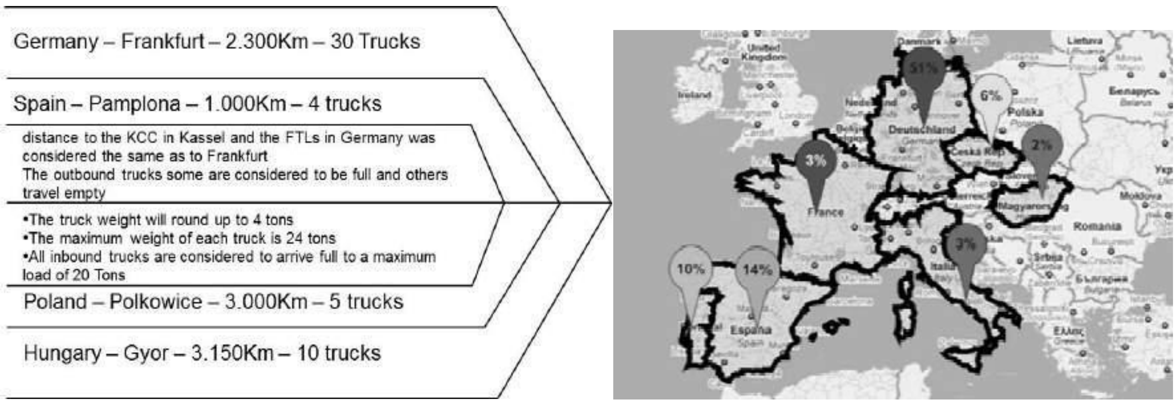

Figure 1 – Visual representation on percentage of suppliers per country

In terms of transport type form suppliers the following options are considered:

1. FTL – Direct Relations. In the case study transportation is done directly from the supplier to V-AE.
2. KCC – Consolidation Centre. Parts from several different suppliers, eventually from different countries, are joined together at a consolidation centre and then shipped to V-AE. V-AE manages two consolidation centres in Germany: one in the north in the area of Kassel, more specifically in a town called Baunatal, and another in the south of Germany in Kornwestheim, near Stuttgart.

A data analysis using several years data is available (from 1995) to identify transportation potential synergies and identify train transportation, based on: 1) supplier geographical location; 2) production volume; 3) defined stock level; 4) transportation mode (airplane, truck…); and 5) volume occupied by the required number of parts. Per supplier it is established a standard frequency of parts arrival to V-AE. This standard frequency can be changed at any time if a special event occurs. Figure 2 (B) shows the characterization of the suppliers by transport time. It can be seen that 53% of V-AE suppliers take 7 days to transport their components. These are followed by the suppliers that take 4 days (12%) and 9 and 8 days, respectively 9% and 7%.
Figure 2 (A) shows that 65% of V-AE supplier's send their production through the two Consolidation Centres in Germany (KCCs). Only 2% of the suppliers generally characterised as FTL's send their production directly to V-AE. From Central Europe, it is mainly components from other VW plants that appear as supplied to V-AE (engines, hot forming parts, etc...). The remaining 37% are generally characterised as GEBIET (purchased by the company at the door of the supplier, Volkswagen concept).
In terms of KCC there are 8 trucks/week of inbound and 2 trucks/week of outbound (this average value from 10 years data taking into account two production shifts).

In terms of FTLs from central Europe there are around 22 trucks/week of inbound and 10 trucks/week of outbound, 10 trucks/week of inbound and 5 trucks/week of outbound from Hungary, 5 trucks/week of inbound and 2 trucks/week of outbound from Poland; 4 trucks/week of inbound and 1 truck/week of outbound From Spain; and 17 trucks/week of inbound and 10 trucks/week of outbound from Portugal. Available for the collaboration process it is possible to consider (only inbound): 18 trucks/week from Germany and Spain, 3 trucks/week from Poland, 1 trucks/week from France and 5 trucks/week from Hungary. The output of this characterization process of the V-AE suppliers was based on:

1. Its geographical distribution: 1) 30 different countries; 2) 4 different continents
2. The main transportation flows: 1) 51% arrives from Germany; and 2) 14% arrives from Spain
3. V-AE standard transport days: 1) 53% of the suppliers with 7 transit days; 2) 12% of the suppliers with 4 transit days
4. V-AE stock's level; 1) 2 days (pending on type of part affected)

Taking into account these guidelines and production volume a software was developed to identify volume of swaped bodies (see section 4).

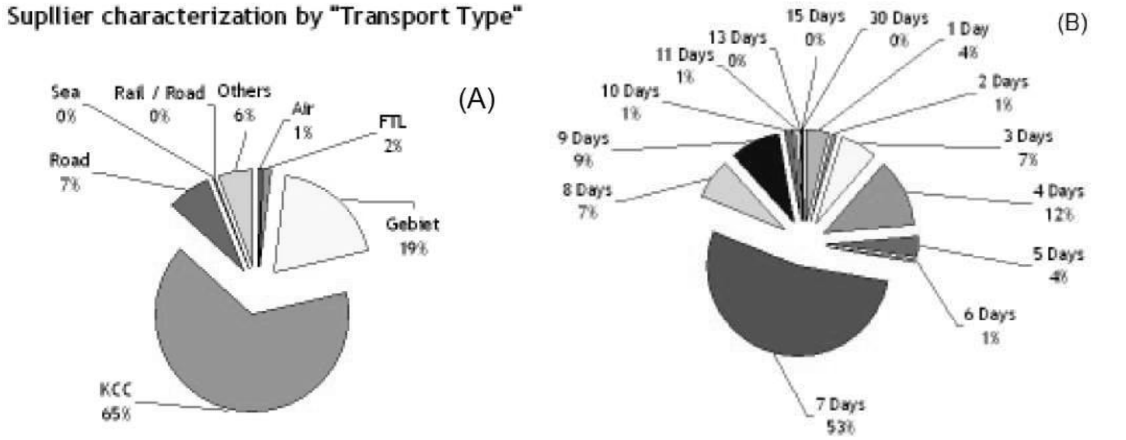

Figure 2 - "Transport type" by specific type of supplier (A) and by transport days (B) (source V-AE)

Road Versus Rail Transportation Modes

Evolution of Transportation in the European Union - In the past three decades, the railroads share of all freight transport in the EU has dropped from 21% to less than 8% - compared with 40% of all freight in the United States – according to the UE transportation officials (Blum, 2005). Still, that trend may be starting to reverse. Europe's roads are increasingly saturated and environmental concerns are putting pressure on road transport. EU transport ministers intend to review the road transportation market amid calls for a more levelled playing field among different forms of transportation. Rail freight, measured in metric ton-kilometres, raised 2 per cent EU-wide in 2004, with the most solid growth in Germany and the Netherlands. But it continued to fall in France, where a three-year restructuring plan, started in 2003, is shedding marginal clients in a bid to cut losses, which had reached 15 per cent of turnover (Eurostat, 2013). Delays are the major deterrent. According to EU data, in 2001 less than 48% of trains ran on time (EU, 2001). That number raise to 65 per cent in 2004, but 7 per cent was delayed for as long as 24 hours (EU, 2014). When comparing this to the 95 per cent - 98 per cent punctuality record of road transport, there is a lot of catching up to do. Speed is less important for freight operators than on-time delivery (EU, 2014). One can say that "Reliability is the key!". Crossing borders are the biggest source of delays, involving different voltage and signalling systems, rules on permissible loads, safety and working practices. Railroad tracks in the Baltic States, Spain and Portugal are wider than those in the rest of Europe and locomotives have to be changed for different types of networks. Railroads could be safer, less polluting and more suitable than roads for transporting large quantities of goods over long distances. But Europe's problem is that its train freight services were designed to serve domestic markets. According to data from INE (Portuguese National Institute for Statistics), transportation by rail road represents only 3.2% of the total weight transported in Portugal in 2007, against

96.8% transported by road (EU,2014). International data also shows the same trend, with a value of 2.6% of total weight transported by Rail, against 97.4% using Road means of transportation (Eurostat, 2016). Table 1 resumes freight transportation evolution in EU (Eurostat, 2016).

Table 1- Freight transportation per mode evolution in EU, from (Eurostat, 2016).

Freight transport in the EU	2000	2012	Variation 2000/2012
Total tkm (billion)	3513.3	3768.1	+7.3%
Road	1521.6	1692.6	+11.2%
Sea	1322.8	1401.0	+5.9%
Rail	405.5	407.2	+0.4%
Inland Waterway	133.9	150.0	+12.0%
Oil Pipeline	127.1	114.8	-9.7%
Air	2	3	+50%

Characterization of Rail operators - The two main operators working in Portugal for rail transport are CP Cargo and Takargo. CP Cargo is a company constituted with public capital, whereas Takargo is the first private operator working this type of service in Portugal. Table 2 shows the main operators involved in this operation and the main characteristics to consider in rail transportation process.

Table 2- Rail Freight operators and main characteristics

	Portugal	Spain	France
Infrastructure (maintenance, construction, management of ral traffic, slots)	REFER	ADIF	SCCF
Public Operator (management of transport service)	CP	RENFE	DB
Other private operators	Takargo and wheels	Comsa and Transfesa	SAR; Wheels and Transfesa
Gauge	1668mm	1668mm	1435mm
Weight (allowed)	800 Ton	900 Ton	
Length (allowed)	550 meters	450 meters	Until 750m

Figure 3 (left side) presents the Basis Concept with main locations, expectancy for transit times between main locations and key points of the operation. This was the basis for this service were based on production amount 3 to 4 trains were required per week, therefore around 180 swap bodies of 3 meters high (usable space). This would represent around 5000 transports of trains between Portugal and Germany. Rail transportation is advantageous over road transportation for distances greater than 550 Kms. For the case of V-AE the proposed solution is to implement Intermodal trains including swap bodies that contain the materials and will introduce a new door to door delivery integrated concept. Swap bodies take advantage of the large number of trailers used to carry standard ISO containers. The design of swap bodies and roller container is optimized to minimize empty weight, saving on trucking fuel cost (less dead weight to be transported) and cost of built reloading terminals. In case of a failure or delay this concept can be used to transfer cargo to truck. Based on the associated tracking solution (see section 4) it is possible to follow materials and check of inefficiencies with the analysis of past data. A SWOT analysis of the Train project is also provided in Table 3. Other analyses are also performed, as for example the Investment that is needed from the transportation company, in terms of quantity of transport material needed, infrastructure and respective costs analysis.

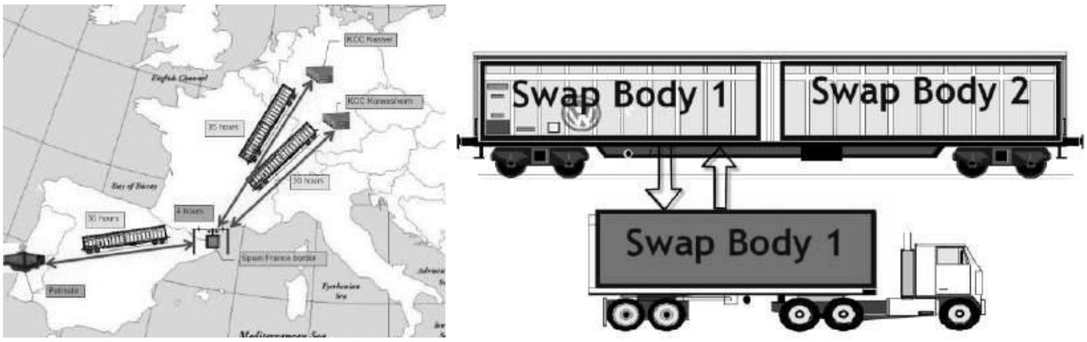

Figure 3 - Concept presentation of Transit times between main locations, (left side). (One-Way trip aprox. = 70 hours). Figure right side the Swap Body concept, to perform easy changes of transportation mode: Train-Truck and Truck-Train.

Table 3: SWOT analysis of train transportation option

Strengths	Weeknesses
• Volume- one train replace 26 to 32 trucks • Less Co2 • Lower costs for long distances (more than 500km) • No traffic delays and does not depends on weather conditions	• No standardization at rail system in Europe and transfers time between France and Spain • Handling costs • Consolidation platform required
Opportunities	**Threats**
• EU target goal to reduce Co2 emission • Increases of fuel prices and transportation restriction	• Road solution is reliable • Volume need means less flexibility • Jiga trucks soon available in Europe • Missing time frames for goods transportation

Collaborative Broker Software and Methodology

The impact study is focussed on relevant problems and drivers of the ICT R&D in the large-scale deployment of the mobility solutions. The aim is to meet the scope of policy intervention taking into account the main general and specific objectives mentioned. Wherefore the methodological concept underlying the work plan structure has a strongly inductive approach and is based on empirical evidence from data manipulation of transportation data available from 10 years. The dynamic process considered has four main steps (Input, Process, Output representation and tracking process through the use of low cost BLE (Bluetooth low energy) sensors). This process is presented in Figure 3 (right side) and followed Yin's (2009) recommendations. Also temperature, humidity, door open can be implemented in a Bluetooth transmission to a master, with the big advantage of no cable. This process only required batteries that can be used for periods of 2 to 3 years. The data collected was systematized taking into account weight, volume, date, transit time and geo-referencing. Process phase has the objective of content analysis and assessment for the improvement. To simplify the process each supplier uses swap bodies and price is based on this. The system alerts for train schedules and available capacity taking into account the need of more volume in the outbound flow because V-AE has more inbound than outbound. The proposed software allows the: 1) Characterization of the current transportation network from V-AE; 2) Characterization of the current transportation network from partners within the empty outbound volume of V-AE; 3) Create a truck synergy scenario for both parties, because the interface is available to inform potential clients are register their needs in the platform; 4) Create a potential Train scenario based on the truck synergy scenario using the same approach identified for item 3). In a first phase potential partners were contacted directly and invited to upload their transportation needs to the system. Example of these suppliers are: 1) Colepccl; 2) Corticeira Amorim; 3) Grohe; 4) Karmann Ghia; 5) Simoldes; 6) Labsfal, among others.

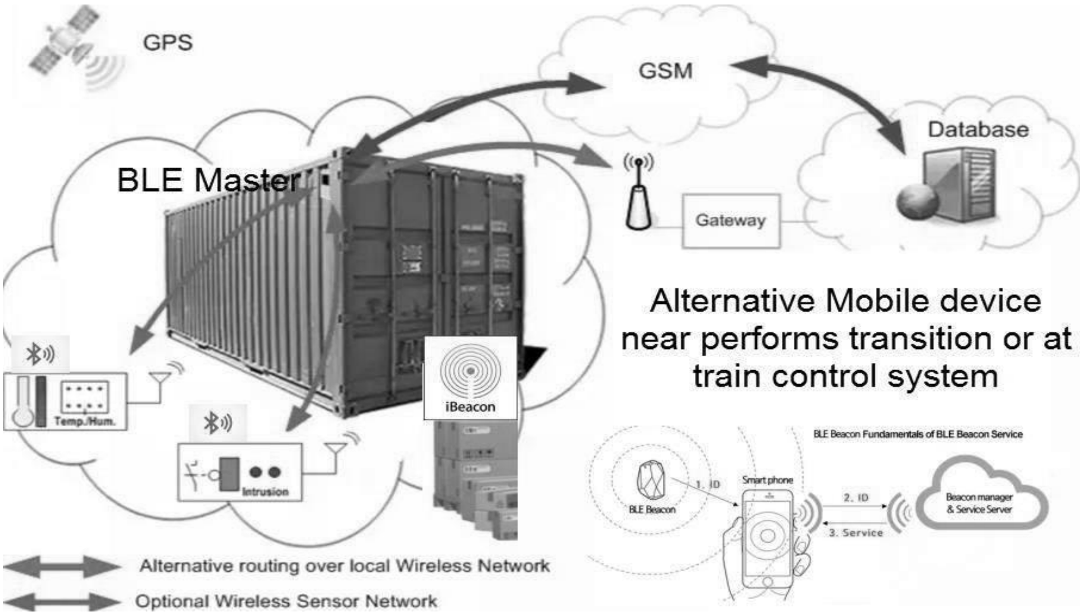

Figure 4 – Trucking Process based on low cost BLE

The suppliers that agree to join the project need to fill the following information in the system: 1) For which countries does your company export?; 2) For each country, which are the place(s) of loading?; 3) For each country, which are the place(s) of unloading?; 4) For each country, what is the frequency of trips?; 5) For each country, what kind of material is sent (plastic, steel...)?; 6) What kind of packaging is used (steel, card, plastic, wood...)?; 7) For each destination, which are the weights, dimensions and average volumes?; 8) Are there any special requirements or limitations for the transport, loading or unloading? Matching programing process was: 1) Country - In this work only companies operating in Portugal were considered; 2) Exporting activity - In this work only companies with significant exporting activity were considered otherwise the partnerships would not be possible; 3) Exporting destinations - In this work were considered companies exporting to central Europe because V-AE receives most of the material from there; 4) Type of materials/products - In this work several different type of materials/products were considered like metal, plastic, cork, rubber, fabrics, clothes, shoes (transport of animals and food were excluded); 5) Type/size of packaging - In this item there was not any restriction as the cargo can be transported in mega-trailers, the type of truck mainly used by the logistic operators working with V-AE. So it was considered pallets, boxes, racks, etc.

5- Major findings

Corticeira Amorim - Amorim & Irmão and Amorim ACC are exporting respectively: Cork stoppers for wine cellars, transported in FTL and other different materials. Courier transports are being used, as for example UPS, TNT and DHL French market. To the French market material is also sent from Amorim & Irmão to Bordeaux (Dept. 33). A large quantity goes in FTL. Some material is also Capillary distributed. Volumes are variable, with a frequency of 2 to 3 trucks per week to dept.66 and with a frequency of 1 to 6 trucks per week to Dept.33. Poland market (Krakovia) – 2 trucks per week. Hungary market – some volume, but is a difficult market due to the fact that it is a hard country to work in site, with 5 to 6 deliveries representing 1 full truck per week. German market - Until 2007 it was the best Truck market, contributing with 48% of sales volume. Amorim group uses the following packaging: Filmed Europallets; Belted Europallets; Boxes and Bags. For the "floor" dimensions are 1,2x1x1m, with a weight of 800Kg, Boxes have the following dimensions: 1,2x1x2m, Cork Bags have dimensions: 1,2x1x1,75m or 1,2x1x2,8m, Materials for Containers have dimensions: 1,2x1x2,5m, Isolating materials have dimensions: 1,2x1x2,2m.

Simoldes does have following destinations: 1) France (Vallenciene); 2) Germany; 3) Poland (from Simoldes Portugal to Simoldes Poland); 4) Hungary (goes from Poland to

Hungary); 5) Spain (Barcelona area). Simoldes they are always interested in FTL rather than "grouping". The transporters are Graveleau - Dasher (Germany) and Gefco from PSA group, which is a challenge for the management of VW empty racks / boxes, that requires a very tight control from Simoldes in order not to lose money due to defective or lost racks.
Colep CCL Portugal - Embalagens e Enchimentos, S.A. is engaged on the production and sale of metal and plastic packaging products in Europe. It operates as a contract manufacturer of personal care, cosmetics, over-the-counter pharmaceuticals, and household products. The company's product line includes aerosol packaging products, such as tinplate aerosols; general line packaging products, including cylindrical, conic, and rectangular cans for paints and varnishes, lubricants, olive oil, and biscuits; and injection molding products consisting of aerosol caps, handles, and closures, as well as other plastic parts.
Grohe AG is Europe's largest and the world's leading single-brand manufacturer and supplier of sanitary fittings, holding roughly 80% of the world market. As a global brand for sanitary products and systems, Grohe is setting standards in quality, technology and design.
Karmann-Ghia de Portugal was established in 1992, taking full advantage of the competitiveness and opportunities provided by the automotive industry in Portugal. Karmann-Ghia de Portugal is specialized in the production of seat covers in fabric and leather for the automotive and aviation industries.
Table 4 provides additional information about Grohe AG and Karmann-Ghia de Portugal.

Table 4: Characterization of Karmann-Ghia de Portugal and Grohe

	Country of Destination	City/ place of load	Nº of pallets (per week)	Weight (ton/week)	Volume (m3/week)
Grohe	Germany	Hemer	6	48	
Karmann-Ghia	Germany	Kitzinger	2	0,3	6
	Czech Republic	Dubice Liberec	22	6,2	57
	Total		**24**	**6,5**	**63**

Based on these inputs and taking into account the collected transportation volume needed it was possible to identify 58 (33+14+7+4) truck per week for outbound synergies (see Table 5). The same procedure can be applied for inbound.

Table 5: Resume of supplier needs for outbound traffic per week in terms of FTL

	Spain	France	Germany	Poland
ColepCCL	16			2
Cort. Amorim	6	3	4	2
Grohe			2	
Karmann Ghia			1	
Simoldes	11	11		
Total	**33**	**14**	**7**	**4**

5 –Train Implementation

Takargo has introduced train transportation in March 2010. It runs 7 trains per week for Ikea Company, using the concept of swap bodies. As a comparison note, for IKEA, 20 swap bodies (based on IKEA needs) are being used in train option in a shared option.
The concept of swap bodies is done at the Spanish/French border at "Irun", located in the north border, or "Portbou", in the south border, for the transfer from the Iberian to European rail system. The proposal is that one train should take around 30 to 36 swap bodies. Capacity is limited due to the capacity of secondary railways that are used to reserve cargo trains allowing faster train to pass by in Portugal. Based on average production values, V-AE project requires 3 to 5 trains in transit per week, therefore around

90 to 150 swaps. This represents around 4320 to 7200 swap bodies transported between Portugal and Germany per year as detailed and explained in Table 6.

Table 6- Train arrival scenarios based on assumption- 1year=48 weeks and 1 train=30 trucks= 30 swap bodies = 15 wagons

	Scenarios	3 trains Week	4 trains Week	5 trains Week
Weekly	Trains	3	4	5
	Power units	3	4	5
	Wagons	45	60	75
	Swap bodies	90	120	150
	Trucks	90	120	150
Yearly	Trains	144	192	240
	Power units	144	192	240
	Wagons	2160	2880	3600
	Swap bodies	4320	5760	7200
	Trucks	4320	5760	7200

Conclusions

Train option was implemented and in spite of problems of different operation system, rules and rail gauge different sizes in Iberia from the rest of Europe. Also was proved that is possible to use train deliver JIT parts to automobile plants in Iberia with several associated problems (missing train transportation habits and also infrastructure). After a two years testing (2010 and 2011), the start Rail Project was January 2012. Investment prices were supported by Takargo based on a 5-year contract. An estimative indicates that they are required 4 motor wagons; this would mean a minimum investment of 20 million euros. Rough calculations from Takargo are that the total investment would be needed to cover the need of 400 to 600 Swaped bodies, representing 25 Mio Euros. Rough cost of one train is 5 (five) Mio euros (One Power Unit and 14 goods-wagon). This would represent an investment by Takargo of approximately 50 Mio Euros. Taking into account average truck price against train Takargo price represents a potential saving of around 20% of Logistic costs (calculation performed at V-AE taking into account truck versus train costs), when train and supplier synergies were introduced. This means the reduction of the V-AE logistic costs from 7% to 5.6%, a reduction of 1.4% points of total Plant costs. For flexible suppliers enrolled in the project there are also saving because they can pay less than 50% of the real cost, mainly due to the usage of spare capacity in the outbound. This approach reflects a particular case study, therefore findings cannot be generalised (Yin, 2009). Nonetheless the tool is easily adapted to other situations as the solution is flexible.

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