Rail Freight Systems: *What Future?*

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Abstract

Today, a variety of *environmental problems* threaten our world. We are witnesses to climate changes at global level caused by environmental damages and ecological disproportions. The society has to struggle with this imminent threat quickly and efficiently, otherwise the situation will soon become irreversible. On one hand, unfortunately, the statistical data for CO2 emissions in European Community over the past years show undesirable stable states characterized with a slight increase, where among all the sectors, transportation contributes to CO2 total emissions by up to 25%. On the other hand, promisingly, freight transport continues to grow, with the largest increases being for the least energy efficient transport modes, i.e. road and air freight. Rail freight and inland waterways by contrast show a worrying decline in market share overall which is undoubtedly not a good thing. We believe that one possible way to change the trends in the transportation sector is to modernize the existing railway freight systems and then strongly encourage freight forwarders to transport by rail. It will have a direct positive effect on the greenhouse gas emissions, and hence on the environment as a whole. In this paper, a comprehensive discussion on railway freight systems and prognoses of how these systems shall evolve in the coming future is provided.

Keywords: CO2 emissions, Freight Transportation, Railway Freight Systems

I. Environmental Issues and Transport

Because of the industrial revolution in the past, the society faces environmental problems today. We are witnesses to climate changes at global level caused by environmental damages and ecological disproportions.

Realising the danger, the United Nations signed the so-called "Kyoto Agreement" which is a legally binding agreement between signed-up countries to meet emissions reduction targets of all greenhouse gases by 2012 relative to 1990 levels (UN 1998).

If we look at the data, however, it appears that insignificant reductions have been achieved so far, if any. In Chart 1, one observes CO2 emissions in European Community by Sector for period of 8 years, from 1998 through 2005. Unfortunately, the trends show undesirable stable states characterized with a slight increase.

Among all the sectors, transportation contributes to CO2 total emissions by up to 25% in EU. The European Environmental Agency has announced concern that the transport trends in Europe are still pointing in the wrong direction. The following results have been published (EEA 2008):

- In the EU 27 - driven by the growth in transport volume, emissions have increased by 27% between 1990 and 2006 (excluding international aviation and marine). If international aviation and marine are included this increase would be close 36%.
- Road traffic is by far the main source of exposure to transport noise. Almost 67 million people (about 55 % of the population living in agglomerations with more than 250 000 inhabitants) are exposed to daily road noise levels exceeding 55 decibells.

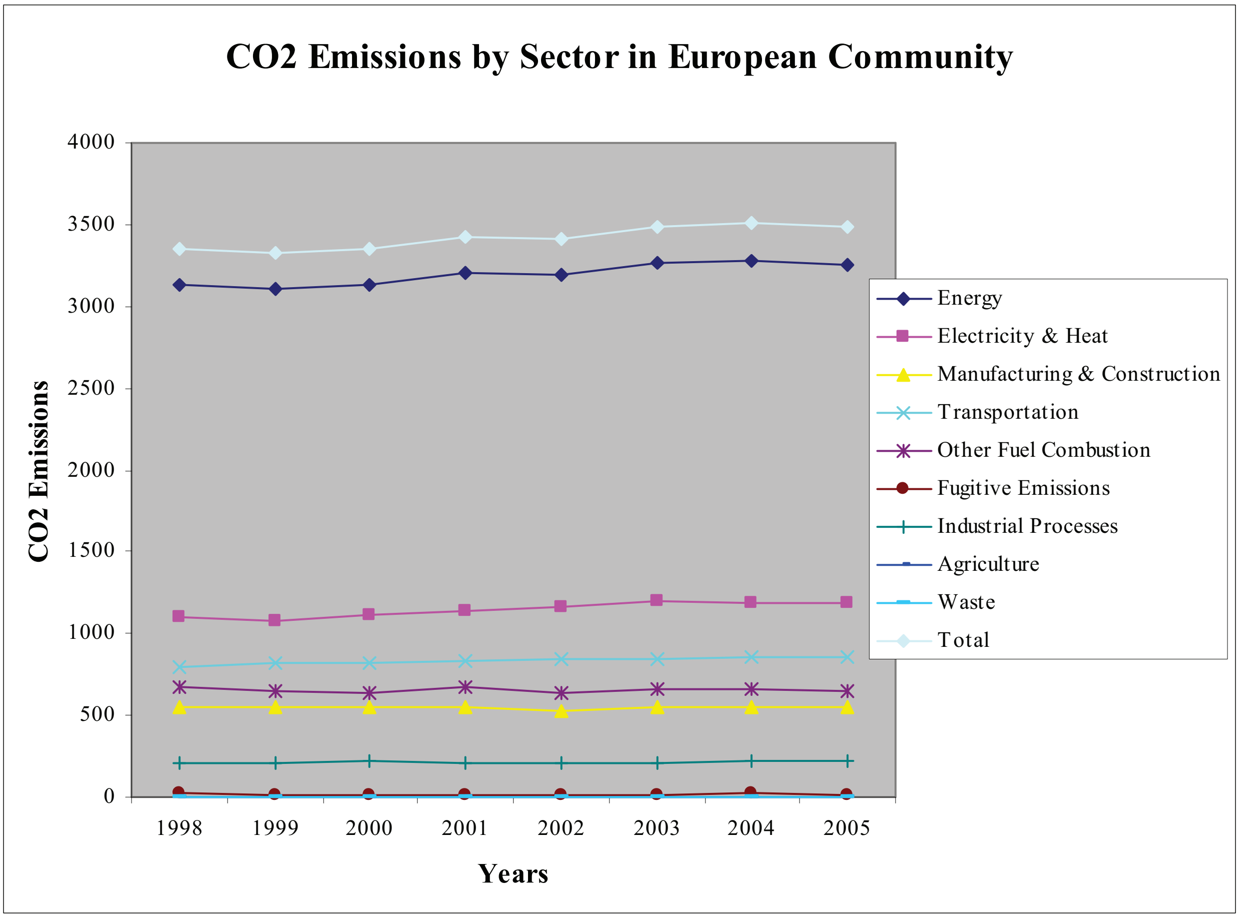

Chart 1. CO2 Emissions in European Community by Sector
Source: World Resources Institute, CAIT UNFCCC,
http://cait.wri.org, consulted on 30th July, 2009

- The transport sector's disproportionate impacts on the environment, there is little evidence of improved performance or a shift to sustainable transport across Europe so far.
- Travel by road and air has continued to increase throughout EEA member countries. Between 1995 and 2006 car ownership levels in EU-27 increased by 22 % (or 52 million cars), and passenger car use increased by 18 %. Although the number of kilometres travelled by passengers in EEA member countries only grew by 1%, from 2005 to 2006, this still represents 65 million extra kilometres travelled.
- Freight transport continues to grow, with the largest increases being for the least energy efficient transport modes, i.e. road and air freight. The total volume measured in tonne-kilometres for EU member states increased by 35 % between 1996 and 2006. Rail freight and inland waterways by contrast show a decline in market share overall.

Unfortunately, the current situation does not seem to be promising, just on the contrary. Radical changes are needed in all the sectors. In terms of transportation, many have argued that the railway transport has to be promoted. Many have argued that switching freight from road to rail is imperative, today. This is because: ... *Freight rail is fuel-efficient and generates less air pollution per ton-mile than trucking. Rail also is a preferred mode for hazardous materials shipments because of its positive safety record…* (AASHTO 2000, pp2.).

We believe that one possible way to change the trends in the transportation sector is to encourage freight forwarders to transport by rail. It will have a direct positive effect on the greenhouse gas emissions, and hence on the environment as a whole. The rest of this paper is dedicated to railway freight systems and our prognoses of how these systems will evolve in the coming future.

II. Current Situation with Railways

Railways are a major component of the international, national, regional and urban transport systems. They have several desirable characteristics including relatively low fuel consumption for the transportation they provide, low emissions as a result of low fuel consumption, and safety. The promotion of transport by rail is beneficial to society in general as well as to the railway industry.

For several decades however, the European Railways have seen a worrying decline. They have steadily lost market shares, falling from 10% to 6% of passenger kilometres and 20% to 8% of freight tonne kilometres. The European Commission addressed in its White Paper – European Transport Policy for 2010: Time to Decide, published in 2001, the following factors cause this awkward situation:

- lack of infrastructure suitable for modern services
- lack of interoperability between networks and systems
- shaky reliability of the service provided, which is failing to meet customers' expectations

A set of "*remedy actions*" has been launched by the European Commission in order to revitalize the European railway sector by creating an integrated, efficient, competitive and safe railway area as well as setting up a network dedicated to freight services.

It is thought that the new European Union railway policy based on encouraging the competition in the railway market by implementing vertical disintegration in the sector, is the remedy for the European Railway Decay. More precisely, vertical disintegration in terms of European Union

Railways means: separation of railway infrastructure from operation, where further opening of the railway market for entry of new railway operators (also called "undertakings") has been expected. Moreover, every Railway Operator must possess an operating certificate and must pay fees for infrastructure use ("access fees"). This new policy has been underpinned by a number of regulations, which have stipulated and framed the pace of the railway structural and legislative reform in Europe. We shall not provide a detailed discussion on this matter since the discussion is not new, but has been debated and all the information can be sourced from the official site of the European Commission, i.e., http://ec.europa.eu/transport/rail/index_en.html , consulted on Nov., 5, 2008).

Focusing on Rail Freight, roughly speaking, the main tendencies have been towards opening of the national markets, stimulating competition and promoting integration with the intention of encouraging the rail freight operators to have a more commercial attitude and hence better performance.

However, except for a few successful stories reported in some Case Studies (see CER, 2005, e.g.) and in the web page of the EC dedicated to rail transport and interoperability (http://ec.europa.eu/transport/rail/market/freight_en.htm , consulted on Nov., 5, 2008) i.e.,: "*On some major European rail corridors such as the one between Rotterdam and Genoa, traffic performance has increased in recent years from around 5% to 10%. This growth has been realised mainly due to block train/shuttle train activities where the new entry of railway undertakings has so far been the strongest*", the situation in the European Rail Freight Sector remains unchanged. The key(words) for this success appear to be <u>Rail Corridors</u> and <u>Block train/Shuttle train activities</u> which specify, to a certain extent, new freight transportation services by rail to be exercised in the future.

III. Freight Transportation Services by Rail

The freight transportation services by rail should be categorized according to the type of Customer being served and according to the type of Operating Form being exercised.

The customers are classified as Bulk Customers and as Non-Bulk Customers. The Bulk Customers are further distinguished into Customers that require to transport Primary Products such as: Aggregates, Iron, Ore, Coal, Agricultural, Forestry Products, Sand, Petrochemicals and Customers that require to transport Manufactured Products such as: Cement, Processed Metals, Construction Materials, Nuclear Waste, Waste Products, Steel, Automobiles. The Non-Bulk Customers are those that require the transportation of Consumer Goods, Manufacturers, Retailers as well as Containers.

The operating forms are subordinated to the Structure of Service being exercised. Structures of service can be:

- <u>Hub and Spoke</u> Structure – employed by rail freight systems[1] in which freight trains run according to classification (marshalling) yards of bigger dimensions. Demand origins and destinations are assigned to the classification yards over the railway network. Normally, there is one classification yard per region and all demand origins and destinations within this region are assigned to this yard. And there are daily freight trains between the

[1] Also successfully practised in the maritime and airline businesses for a long time service, namely by the dominant players who are thus able to serve many O/D pairs with greater productive efficiency.

classification yard and its demand origins and destinations as well as there are daily freight trains between the classification yards in the railway network;

- Point to Point Structure – typically exercised by truck systems, the point-to-point structure enables a greater number of routes over the network but some routes may have a low frequency of service, which is quite likely. Hub-and-Spoke structure is a mutation of the point-to-point structure and concentrates the movement on a lesser number of routes but the frequency of service is higher, thus minimizing time between most demand origins and destinations;
- Collection and Distribution Structure – broadly spread among the freight transport modes focusing on the transshipment from one mode to another providing local solutions for "How to collect and How to distribute" the freight.

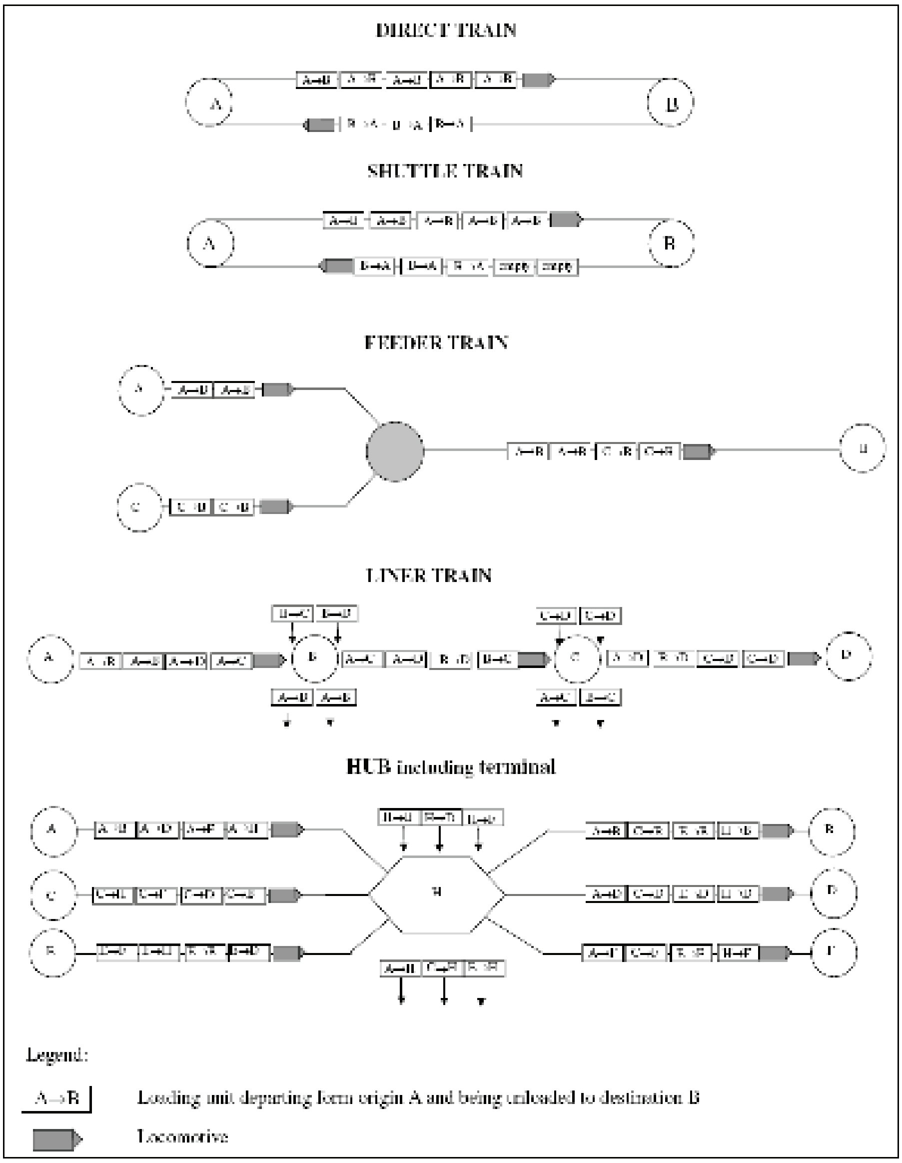

Fig.1 Alternative Rail Operating Forms
Source: Ballis and Golias (2004, pp. 422)

Relying on definitions provided by Ballis and Golias (2004, pp. 422 - 423), rail operating forms are introduced next, as follows (refer also to Figure 1):

- Direct trains - run between two terminals without handling on the way and are the most economic and rapid operating rail mode known today;

- Block trains are direct trains by nature and the number of freight cars that they carry in their compositions vary according to the daily demand for transport;
- Shuttle trains are direct trains too, however they are characterized with fixed composition seen in number of freight cars. The shuttle trains do not bear coupling/uncoupling services at terminals or yards;
- Group trains or feeder trains aim to link terminals of a region through—short—feeder links and fulfil the long distance transport in a complete train. Feeder trains are run in serving less-than-trainload (LTL) flows;
- Liner trains or multi-stopping trains are seen today as compositions which are loaded and unloaded and freight cars are coupled and uncoupled during the stop in way stations on their route. The number of freight cars in the multi-stopping train can be fixed, but this is not compulsory.

Traditional rail freight systems have been serving *Bulk Customers* mainly by running *Multi-stopping* and *Feeder trains* on *Hub and Spoke* principles. A failure of the "conventional" Hub and Spoke system is the delay. Delays occur when connections between freight trains fail and the clients do not receive their freight at the appointed time. The whole service is considered of poor quality and the rail freight providers experience a huge amount of long term average costs, i.e. diseconomies of scale.

In North America, this practice was addressed by car scheduling. Generally, car scheduling is what is called scheduled operation in North America. Every car is scheduled a complete list of connections. Freight trains operate when they have all their freight cars (except in the case of extreme delay, when freight cars are “rescheduled”). On the other hand Union Pacific has used a similar concept. Packages of freight cars are always on time because if they are delayed, they are rescheduled to be on time. This is an improvement over old loose freight car methods, but has a great shortcoming in operation. The variability involved in ensuring connections between freight trains adds to the chaos of improvised operation[2] in the railway network.

Looking at the official statistics of the EC for the last decades (e.g., Eurostat, news release Transport in the EU27, 49/2008 - 10 April 2008), it appears that the freight transport markets of today suggest that these traditional rail freight systems are obsolete to some extent and therefore new / alternative rail operating forms ought to be exercised and implemented in the future, starting from today as *Rotterdam* and *Genoa* rail corridor suggests. It would be foreseen that Direct, Block and Shuttle trains running on rail corridors dedicated to freight serving more and more Non-Bulk Customers will become traditional operating forms of European Rail Freight Systems in the future (by 2030 e.g.).

IV. Interoperability

An important factor in the railway freight success that has been experienced North America is interoperability. Standards for vehicles, signalling, operating rules, and accounting have been in place for over 100 years. In general, the standards have been developed and implemented by the industry. Often, government regulation of the industry is based upon standards developed by the industry.

[2] On “Scheduled vs. Improvised” Rail Freight Operations, the interested reader is encouraged to consult White (2005) and Marinov (2007).

Generally, a freight car loaded anywhere in North America may travel to any destination in North America. There are over 100 railway companies in North America, but they form a generally seamless railway network. The shipper must only make arrangements with the originating carrier, regardless of the number of carriers involved in the complete shipment. Payment arrangements for pick up, delivery, interchange between carriers, and delivery are made among the carriers and included in the fee paid by the shipper. There is an established payment structure for the use of wagons. A carrier will pay the owner of the wagon a specified fee for each hour (or in the case of wagons owned by private parties that are not carriers, each mile) that the wagon is on its line. There is a specified procedure for the return of wagons after a shipment is delivered. Fundamentally, an empty wagon may be loaded with any shipment that will take it closer to the lines of its owner. This reduces the amount of distance that wagons travel empty.

Wagon standards include specific dimensions and weight restrictions for wagons that can travel unrestricted throughout the continent. Procedures are in place for the movement of wagons and shipments that exceed the standard for unrestricted movement. As with billing, the entire movement is arranged among the carriers, generally with no requirement of participation by the shipper. Regardless of wagon weight or dimension, all wagons have standardized braking and safety appliances.

Although there are some differences in application among the railways, all of the railway operating rules in North America are based on a single set of principles. It is not difficult to know the application of the principles to the specific operating rules of a carrier. Thus, it is not unusual to find the operating crews of a railway handling a train on the lines of one or more other carriers during the course of a tour of duty. Signal systems are likewise based on some common principles regardless of the differences that may be found in the specific standards of each railway.

The use of common information technology is of foremost commercial importance. The important characteristics (e.g., length, width, tare weight, load limit) of all wagons in North America are found in one common database. As well, movement information of every wagon is found in a single database. The common database is updated by the information system of each carrier. A customer may determine the current location of a shipment anywhere in North America. Each terminal receives detailed information about the wagons in each train long before its arrival. Each carrier is provided a detailed list of wagons to be delivered in interchange long before arrival. The same advance information is also provided in advance of the shipment crossing the Canada/USA or USA/Mexico border. Unless there is a specific security threat associated with a shipment, a border crossing may occur in an hour.

We believe that interoperability in the North American model, to a certain extent provides opportunities for success for the European Rail Freight Systems. Therefore, this model could be explored in greater detail with the purpose of identifying the best practices and successful stories and further developing strategies of how such practices and stories could be adopted and implemented in Europe in order to increase the probability of success in European rail freight transportation, regardless of the structure and form of the service.

V. High-Speed Rail for Freight

Nowadays booming systems are the high-speed trains, which provide faster transportation services. European high-speed trains have revived passenger services and over the next decade will connect more major cities in Europe, with further opening of new rail lines.

Looking at European rail corridors dedicated to freight, one should see High-Speed Systems for freight. Needless to say, the High-Speed Systems for freight will speed up the time for transport and delivery and hence the level of production will be significantly on the increase directly competing with air freight transport mode. But high-speed track and rolling stock is high cost. High speed trains also have a much higher operating cost because of the energy consumption. Like high speed trains are suitable for only a very small portion of the entire freight market and for freight traffic, it is something of a distraction - *is that true*, however? According to RAVE[3] this is a strong pillar, though.

Fig.2 Portuguese High Speed Rail Network
Source: RAVE (2008, p. 6)

As pointed out in RAVE (2008, p. 5) Press Release: "… *strong pillar of the Portuguese High-speed rail network is the strategic bet on the freight. Lisbon to Madrid, Porto to Vigo and (in the next future) Aveiro to Salamanca axis will be prepared for freight, connecting the biggest national ports and airports to the rising national logistics platforms network, creating new high-capacity corridors to Spain and to the rest of Europe*." Figure 2 shows the Portuguese High Speed Rail Projects already approved by the government and currently under construction.

Examples of High Speed Freight Trains already exist in Europe. These are the postal TGV trains of Fret GV in France. The interested reader is encouraged to consult the official web site of Fret GV: http://fret.sncf.com/fret/580-high_speed_freight.html , accessed on January, 23rd, 2009. The 2008 - 2015 vision of Fret GV is to operate "*on the Paris – Mâcon - Cavaillon line, with a*

[3] RAVE - Rede Ferroviária de Alta Velocidade S.A., Portugal

processing capability of 60,000 tons, that is, 2000 trains per year, of mail and express parcels. On track for 2010 with the opening of new terminals in Lyon and Marseille, 2 additional Freight TGVs a day are planed to be available on this route."

For the time being, there have been arguments that such High Speed Freight Services cannot go outside France because of lacks the sort of continuous high-speed rail network that currently exists in this country. In the coming future, we believe that alongside the high speed train revolution in the European rail networks such lacks will be overcome and High Speed Freight Trains running at (more than) 350 km/h will take part in the future traditional practices of Freight Railways at European level by 2030 on Western European Rail Networks and by 2050 on Eastern European Rail Networks.

Let us be remained that the idea of High Speed Rail Systems was born also because of the need to create a transportation system that is able to compete with air. However, there is a transport market for freight in the relatively high speed conventional rail networks where the freight trains run at 150 – 200 km/h. This issue is worth mentioning because there is a middle ground just between high speed rail freight and conventional rail freight that appears to be able to compete very well with trucks. It seems to be the case in many existing European rail lines. If we consider freight trains designed to high speed standards and capable to operate on conventional routes, consequently there seems to be a future for transportation high-value, time-sensitive goods by a scheduled, conventional relatively high speed (operating at high speed where available) service by rail in competition with trucks. The commodities being transported could be palletized goods delivered by local truck or freight tram to a railway terminal, and picked up at a railway terminal by local truck or freight tram if such a system for distributing freight in cities exists[4].

VI. Trucks on Rails

… *It is often stated, that combined transport (mainly truck-train-truck) might be a very CO2 efficient mode. …* **(**Jochem and Buhler 2009, pp.1). Trucks on rails, rolling road, rolling highway or lorries by train is a freight transportation system that teams up road and rail as making the trucks less environmentally harmful thanks to the rail freight mode, where the concept combines the line haul efficiencies of rail with the local pick up and delivery flexibility of highway. Over great distances, carriage of the truck and driver as well as the trailer is not economical. However, this concept is well-suited to short-to-moderate distance movement of trucks bypassing congested areas of highway. The rolling road is effectively a high-capacity, high-efficiency bypass toll highway for trucks.

The rolling road technology is known as "Piggybacks" and allows the trucks to be loaded onto special low-loading wagons and then carried by rail. The service begins with the arrival of the truck at the intermodal terminal equipped with specialized ramps that allow the truck to arrive onto the "Piggyback" which is a technically articulated platform car. Then the engine of the truck can be cut off as on the piggyback remains only the (semi)trailer, but it is not mandatory, so the truck can be carried complete (Figure 3). Next the truck is secured on the Piggyback and the truck driver(s) can go and relax in the recreation wagon. On arrival, the same operation are fulfilled but in the reverse order.

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[4] We further comment on Rail Systems in Urban Freight in Chapter VIII. Rail Freight in Cities of this article.

The piggybacks' services have a number of advantages encompassing efficiency, production, costs, profit, reliability, customer satisfaction, ecology; a list is provided next:

- The piggyback freight trains are made up of about 20 cars, where each one is able to carry 2 standard unaccompanied semi-trailers, meaning 40 semi-trailers are carried by one piggyback freight train;
- Trucks carried by piggyback freight trains experience a reduction of both operating costs and costs for repair/maintenance and a more rational utilization of the trucks is thus achieved;
- Non-stop transportation service seen in the freight travel towards its destination without any time loss and hence waiting and idle costs are on the decrease;
- Totally environmentally-friendly freight transportation option; Nitrogen, CO_2, particulate matter emissions and other harmful substances directly to the atmosphere by the trucks during their ride on the highways are on the decrease;
- Decongesting the highways / less trucks on the roads and hence the number of the accidents and fatalities on the roads is on the decrease.

Fig. 3 A "Piggyback" Train of ÖKOMBI company

Source: http://www.oekombi.at/index.php?lan=2 , accessed on February, 3, 2009

Rolling road operations with piggyback trains are one of the freight transportation services of 21st Century. Evidences for this are brought by a number of rolling road providers in Europe, such as:

- ÖKOMBI – ROLA that generally provided rolling road services in Austria and thus significantly contributes to the general transport policy aims of the expanded European Union (the interested reader is encouraged to consult: http://www.oekombi.at , accessed on February, 3rd, 2009)
- LORRY- RAIL uses the "Modalohr" concept and operates in France on a distance of 1050 km connecting the terminals of Bettembourg (Luxembourg) and Le Boulou (Perpignan) (for more information can be found at: http://www.lorry-rail.com, accessed on February, 3rd, 2009)

Up to now rolling road services have received a desirable attention in Western and Central European countries and this track accompanied with adequate actions will continue in the coming future. Unfortunately, this situation appears to be different in the Eastern European countries, where such services have only been discussed but no formal actions have been taken so far.

VII. Double – Stacking

"*Can Double-Stack international standard-size containers be run on European rail corridors and if so is it an economically viable option*?" - Will such a question be raised in the future?

The idea of the first double stack freight car to carry one container on top of the other (Figure 4), also known as well type car, was brought to light in the Early Eighties and since then Double-Stacking has been successfully practicing in North American Railroad and in Mexico, in parts of Australia and Canada, in China as well as this discussion was open in India a few years ago by introducing the concept of running double-stack on flat cars (see Kumar 2006).

The foregoing rail systems run their freight trains mainly with diesel traction because of the fact that their rail networks are not electrified vastly. This situation allows the movement of double-stack containers because there are no overhead wires to impose height restrictions and the double-stack container trains are thus able to run where other restrictions such as clearance along bridges, tunnels and overpasses as well as load per axle are satisfied. For instance, the US rail network required some substantial work to enlarge tunnels for double stack trains and still works remain to be done in order to make double-stack capable the entire US rail network.

Fig. 4 A Double-Stack Car owned by the TTX Company
Source: http://en.wikipedia.org/wiki/Double-stack_car , accessed on January, 25, 2009

A question that comes here is: *Is that possible to run double-stack container trains with electric traction and if so is there any evidence for such a practice*? There are evidences that the Chinese Railways already run Double-Stack container (DSC) trains with electric traction by using well type wagons. It was reported in JICA (2007, pp. 17), as follows: …" *the JST has visited China to observe the DS container operation under wire and concluded that this indeed was a proven technology. The analysis carried out in the JICA Study concludes that from the aspect of economics and transport demand needs, double stack container operation adopting the well type wagon was verified to be superior*." More specifically, the Chinese Railways currently operate DSC trains under 25kV OHE by using $8^{1/2}$ ft height ISO standard size containers. In the coming future the challenge will be how to run their DSC trains under the catenary wire by using $9^{1/2}$ ft height ISO standard size containers.

There have been arguments that Double-Stack container concept cannot be implemented in Europe because of loading gauge restrictions. But *is this the case all over Europe*?

According to the best of our knowledge the recently constructed rail corridor from Rotterdam to Germany heartland, called Betuweroute is engineered in a way that allows Double-Stack container trains to run subject to tunnels, electrification and other technical characteristics of the corridor. However, there are no DSC trains in operation yet.

It should be noted that Double-Stack is not an automatic route to direct efficiency. It depends greatly on distance for transport and on the nature of the shipments. Nevertheless, we believe, the double-stack container services with electric traction by rail may prove economic, environmental, safety and customer benefits, seen in:

- A possible reduction of the Number of container trains for the same throughput;
- A possible increase of the Payload capacity of the container train;
- A possible reduction in the container terminal congestion;
- A possible reduction in the Dwell time of containers at terminals and ports;
- A possible reduction in the Cost of unit transportation;
- A possible increase of the rail freight Market share with the same rolling stock;
- A possible reduction in the Overall transit time of containers;
- A possible reduction of the number of Lorries on the highways;
- A possible reduction of damage and theft in transit due to the unique design of the well type freight cars which do not allow the doors of the lower containers to be open, when the containers are on the well wagon (Figure 4);
- A possible increase in the shipping productivity for customers;

We are very well aware of the fact that the European Railways were not constructed to fulfil Double-Stack Container operations and reengineering of the systems will have to be launched which will not come without costs, just on the contrary. It should be noted that we do not insist upon that double-staking ought to be implemented on every single European Rail Corridor. Instead, we wish to suggest a programme on determination of specific routes for double stack container trains to identify and develop plans for the fulfilment of such services on specific routes which will further prove double-stack container operation be an economically and environmentally viable option, over time (by 2040 – 50, e.g.). During the lifetime of such a programme it may be that in many cases, modifying the existing infrastructure for longer freight trains may be economically superior vs. modifications for double-stack. This also relates to the nature of well-type freight cars. A well-type freight car is substantially longer than the container in order to accommodate the trucks as well as articulation. Therefore, it may be necessary to modify the infrastructure for longer freight trains in order to run a DS train of economical length.

A double length container train still has twice the containers, but the rail infrastructure would also benefit other commodities. It would also be useful for the instances in which double stack is not a sound economic or service alternative to trucks, meaning, where the delay involved in accumulating containers overcomes the benefit because of the length of haul and nature of the shipments.

VIII. Rail Freight in Cities

Urban Freight Transportation and City Logistics is an area of intensive discussion today. For our purposes, we shall restrict the current presentation by focusing only on how the rail systems are seen within urban freight transportation areas. More specifically, what systems have been in existence, what have happened and what is the future of rail in urban freight transportation.

Robinson and Mortimer (2004a) wrapped up in conclusion "… *There is no doubt that rail no longer commands a prominent place in urban freight activities. There are some grounds for believing that rail can rebuild market presence, but this will need to be done with a much greater recognition of the market's needs and requirements and how these continue to evolve. Shippers are now accustomed to slick, sophisticated, road-based logistics services and are very unlikely to be prepared to sacrifice these for a less capable and more costly alternative."* Such conclusions sound unpromising for the future of rail systems in urban freight transportation. However, this is the literal truth. Over the last decades we have been witnesses to the ruination of the rail freight systems in many European cities. Once the rail passenger stations of medium and big dimensions were planned and built with areas explicitly thought for providing freight services. The first wagon in any passenger train composition was normally a freight car used for transporting merchandises. In many rail passenger stations in the bigger cities there was a personnel employed to deal especially with freight services that were once provided by the rail systems.

Nowadays the picture is different. We observe abandoned rail lines and neglected sidings, rail freight storages and workshops in a wretched state, rail freight cars left somewhere in the network rusting and deteriorating day by day, pieces of rail infrastructure that were once in exploitation but no one is interested in their utilization any more.

Regardless of all advantages that it possesses such as: a typical freight train removes 50 HGVs from our roads, and tonne for tonne, rail produces less than one-tenth of the carbon monoxide, 5% of the nitrogen oxide, and 10% of the volatile organic compounds, lorries are also involved in a significant percentage of road deaths, the traditional rail freight transport mode is not as flexible as road (trucks) mode, and the market kicked the rail freight systems out. The rail systems may have had a product to sell, however it appears that they have failed in the strategic positioning of this product in the marketplace.

There have been efforts in reviving rail systems for urban freight services (see e.g. Robinson and Mortimer 2004b). The interested parties have looked at possibilities for providing inter-urban and intra-urban freight operations by rail systems. They have focused on:

- **The rail capability to service flows of freight traffic into and between urban areas** – this initiative requires a well deployed rail network within the cities in order for rail to be able to compete against road haulage. In many cities the rail suffers accessibility problems because of lack of infrastructure. Therefore, this matter is dependent upon strategic decisions and policies favourable to rail that are part of the integral planning process of the city development. The city infrastructure must be thought of to provide a strong non-discriminative physical and economical platform to the freight transport modes for their businesses;
- **The capability of underground/metro systems to service commodity flows within the city** – arguments for such an initiative have occurred arguing that the incorporation of freight into the existing underground/metro systems requires the development of an entirely new logistic concept, pilot projects for innovative thinking as well as significant work accompanied with significant investments for the invention of underground rolling stock to carry different types of commodities. *Is it worth the trouble?;*
- **The capability of tram and light rail to service commodity flows within the cit**y – this initiative is about urban freight trams and light rail city freight trains that are to run

on existing city infrastructure in off-peak hours according to urban passenger/public traffic. These freight trams and city freight trains will have to be equipped with modern freight cars/vehicles specified to carry different categories of commodities. There have been some experiments in Germany and as a result Dresden has successfully deployed modern cargo trams in an innovative but prescribed logistics application shuttling between two automotive plants.

We believe there is future for rail systems in urban freight. It appears that the Londoners do so as well. According to TfL London Rail (2007, pp. 6) "… *TfL believes it is important for rail freight to flourish alongside a developing passenger railway in London. Rail freight also makes an increasingly successful contribution to the economy and quality of life of Londoners and people throughout the UK",* which is a very good example which should be followed by many other cities. With both some political pressure based on Push Concept for encouraging the shift from road to rail and solid measures of interventions into the sector based on Pull Concept[5], rail systems for transporting freight to, from, within and though cities will become reliable players/providers in this market and their positive role will be on the increase. CityCaro appears to provide evidences for this to be true (consult the official web site of CityCargo: www.citycargo.nl , visited on January, 26, 2009).


Fig.5 & **6** City Cargo in Amsterdam
Source: www.citycargo.nl , accessed on January, 26, 2009

More specifically, CityCargo distributes freight in Amsterdam by using the existing tram network within the city. The freight to be transported is received in warehouses on the outskirts of Amsterdam, where this freight is shipped in cargo trams. The cargo trams go to locations inside Amsterdam as they may use alternative routes on the existing tram network, meaning the routes of cargo trams are not explicitly fixed and can be specified subject to demands, congestions, peaks and off-peaks. Using different routes is also not to intervene with the passenger tram services. After arriving at the desired location inside the city, the cargo trams are met by "Green" vehicles (also called E-Cars, see Figures 5 & 6) that transport the freight from the cargo trams to its final destination, i.e., "*door delivery to the customer*".

Transporting freight within cities by rail systems such as trams (both conventional and wireless[6][7]), metros, light rails, has a number of benefits to the city environment and to the citizens as a whole. These benefits are seen in:

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[5] On "Pull and Push" Concepts the interested reader is advised to consult Hopp and Spearman (2004).
[6] www.alstom.com/home/news/news/business_news/56752.EN.php?languageId=EN&dir=/home/news/news/business_news/ (accessed on 23rd March, 2009)
[7] For further information, consult ALSTOM Transport: http://www.transport.alstom.com/home/, (accessed on 2nd August, 2009)

- A significant reduction in lorry kilometres in cities
- A significant reduction of air pollution in the cities
- A significant reduction of noise
- A significant reduction of congestion
- A significant reduction of cost for city roads' maintenance
- A significant reduction of fatalities and injuries caused by road traffic because of an increase of road traffic safety

Our prognoses are that in the coming future more and more cities will be grabbing the concept for satisfying their freight transportation needs by rail systems. Similar concepts as "City Cargo" will be spread and implemented broadly for the sake of economic and environmentally sustainable future (by 2035 – 45 e.g.).

As far as our knowledge goes there are successful inner city goods' distribution operations that involve the use of a lorry from distribution centres to locations on the edge of the city. The distribution scheme is very well applied to cities within which the streets are narrow and operation of large trucks is difficult, and is as follows: the lorry carried several small delivery vehicles from a distribution centre situated in the outskirts of the city to a location deep inside the city where these small delivery vehicles are unloaded from the lorry. Then, the small vehicles make their distribution rounds to the customers' doors and once this operation is competed they return to the lorry again for the trip back to the distribution centre. We believe this could also be very well accomplished by a rolling road operation as one makes the best use of abandoned and old rail infrastructure, in the cases where it would be possible. In this way neglected sidings, abandoned rail freight storages and workshops in a wretched state could be revived and turned into the inner city station locations for such a distribution service. It should be noted that the advantage of rolling road in urban freight and city logistics is that many more distribution vehicles could be handled by a train than by a lorry and also once a freight train carried the distribution vehicles and unloaded them, this train could then serve other distribution vehicles or be used for other services instead of remaining parked on the station platform.

IX. Rail Freight System of the Future

In the spirit of stimulating discussion and action we have exposed our prognoses and suggestions for the future development of rail freight systems. Alongside the foregoing suggestions, we favour frequent, scheduled freight service by rail with passenger-type punctuality which appears to be another missing part for bridging the gab between the rail freight past and the rail freight future; comprehensive discussion of which should be open hereinafter. Seamless operating processes with freight trains and frequent services fulfilled on optimized strict-fixed schedules multiply the utilisation and the efficiency and hence the level of production of the rail freight systems. These operational and management issues are crucial for the success of the rail freight systems of the future and must be always on the agenda. The rail freight systems must fulfil their service with freight trains as a perfect timepiece. Let us not forget that we can develop rail freight systems that are the envy of the world but they shall be unprofitable; they shall not bring the desirable benefits to society in the forms of reduced fuel consumption, emissions, congestion, and reduced cost of highway accidents if we do not exploit them properly.

We shall bring this discussion into an end and provide our formula of the rail freight system of the future, as follows:

[**AROF** + **HSRF** + **ToR** + **DS** + **CCC**]^ **FSPrfs** = **Rail Freight System of the Future**

, where

AROF = **A**lternative **R**ail **O**perating **F**orms
HSRF = **H**igh-**S**peed **R**ail for **F**reight
ToR = **T**rucks on **R**ails
DS = **D**ouble - **S**tacking
CCC = **C**ity **C**argo **C**oncept
FSPrfs = **F**requent, **S**cheduled, **P**unctual **r**ail **f**reight **s**ystem

Now we shall stay tuned to find out whether our prognoses will come true or not! …

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