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Freight transport – how to make it sustainable

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Freight transport is a basic means for the development of a society. In this chapter we shall study the structure of freight transport as it is today and identify the problems and possibility of creating sustainable freight-transport systems. In particular, we shall identify how to overcome the large problems caused – air pollution, noise, vibrations, oil discharge, rubber surplus – to come closer to the limitations set by nature.

9.1 The flow of goods

A single freight journey always has a starting-point, the sender, and an end-point, the receiver. These points represent two different geographical locations. Between the sender and the receiver there is a travelled distance, a straight line or a curved one. It can also be a line divided into shorter lines between some stopping-points like stores, terminals or other manufacturing plants which together make the whole transport chain. What the line or transport chain looks like also depends on the chosen route. Limitations in the infrastructure or heavy traffic often result in a route, other than the shortest distance between the two points, being chosen.

It is more difficult to create a sustainable freight transport system than a passenger one because most single freight journeys are unique. The flow of goods is not always planned by size, time and geographical destination. The physical journey between the sender and the receiver of the cargo also differs from time to time, because of geographical, economic or transport-capacity reasons. There are also seasonal variations in the flow of goods.

Traditionally, freight transport is classified according to the mode of transport, such as ship, train, truck or aircraft. But a freight journey between two points is not necessarily made by one single mode of transport or vehicle. In a survey of the output flow of goods by Swedish manufacturing industries, 28 per cent of the goods were transported in a transport chain including more than one mode of transport.

9.2 Freight transport as an integral part of the industrial process

Freight transport today is an integral part of the industrial process. This process begins with the transporting of raw materials from their source to an industrial plant. Raw materials are not the only items requiring to be transported for inputting into the industrial process. Other items can be finished or semi-finished products. At the other end of the industrial process, there is an output flow of products which are either finished or are to undergo a further industrial process.

In the survey of the Swedish manufacturing industries mentioned above, 42 per cent by weight in metric tonnes of the output flow of goods underwent a further industrial process. About half of that amount (22 per cent of the total) were subcontracted products, that is, parts and components made to the specification of the buyer for his own production process. The rest (20 per cent of the total) were the manufacturers' own products for delivery for undergoing production processes of other manufacturers.

It is traditional in the Swedish car industry to split the industrial process over more than one production plant, the so-called 'Volvo way of producing'.

The method was implemented in 1927 following the example of General Motors in the USA. As a consequence highly specialized industrial plants are developed in different geographical locations. All the industrial plants involved are not necessarily in the same ownership. One aim is to take advantage of a local supply of labour for a single industrial plant, another is to produce the best products at the lowest price. However, having different geographical locations for the various industrial plants results in lot of freight being transported. A system like this depends on cheap and fast freight transport to survive. It also results in more energy-consumption and emissions.

9.3 The 'just-in-time' system results in more freight transport

An industrial structure also includes storage. To maintain production, there is a need for storage at different levels. These stores, in different geographical locations, result in more freight transport. To save money, there is a tendency in Swedish manufacturing industries today to reduce storage.

The concept of 'just-in-time' makes storage less necessary. The idea is that a single freight delivery will arrive just in time to satisfy the necessary demand for goods for the production process. The transport vehicle in this scheme receives a new role as

Container-based transport

The development of the container and the swap body has resulted in a new way to transport goods. The load carrier is totally separated from the transport vehicle. We may today track the goods by following the transport chain, instead of the main transport mode. The result is often a transport chain including more than two transport modes. There are examples of up to six parts in a transport chain, including two or more transport modes. Some common examples from Swedish industry are:

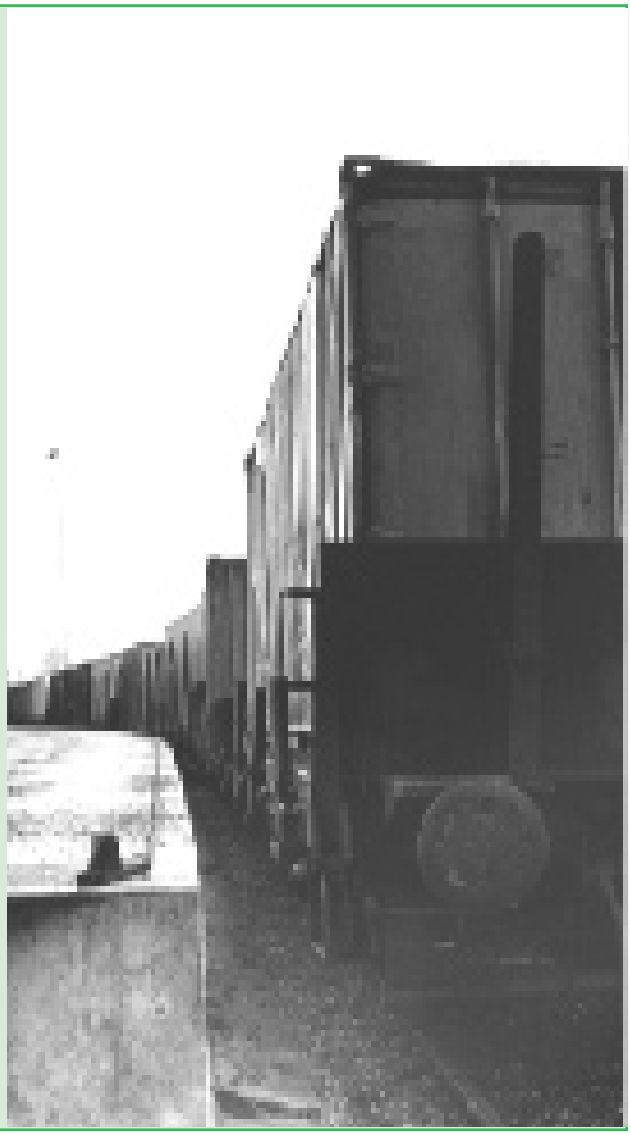
Regional Truck – Interregional Rail – Regional Truck

Regional Truck – Transocean Ship – Regional Truck

Interregional Rail – Transocean Ship – Interregional Rail

Regional truck or rail is a transport of less than 100 km, and interregional truck or rail a transport of 100 km or more.

Container-based transports has led to improvements: The environmentally best available transport mode may be used, such as rail for long distances, and truck for shorter ones, and reloading is very efficient. The total transport energy use and emissions have decreased due to this change. Right development of this approach will lead to a reduced number of trucks and diminished wear on roads. Its significance is however still limited. The different transport modes are more often competing than integrated in this rather conservative branch. In addition cost-effectiveness is not very competitive, since transport costs accounts for a relatively small part of the product price.



a rolling mode of storage. The timing and speed of the delivery are now matters of planning. The only important thing is that the freight arrives just in time for when it is needed. However, if there is only a short time between the goods being requested and needed, they must be transported quickly. In other words, it is a problem of planning and the chosen degree of service to the customer.

The 'just-in-time' concept makes industry more vulnerable. It also involves more frequent journeys than in other freight-transport systems and often results in more energy-consumption and emissions than necessary. There is often not the time to load a vehicle up to its full capacity, by weight or volume. From this point of view the 'just-in-time' concept causes more journeys.

Transport price is not so important here because, if the demanded goods did not arrive just in time this would cost more money in the form of an interrupted production process. To save time, there is a tendency today for Swedish subcontractors to locate closer to the contracted enterprises. Aspects of competition have shortened the time between the order for and the delivery of a product.

9.4 Cooperating or combined transport

As mentioned above, freight transport is often part of an integrated industrial process. The chosen carrier of the load throughout the production process even carries the load to and from the factory. This so-called 'system-transport' is often so specialized that it requires one particular mode of transport or vehicle only and there can be no other alternative. So the chosen industrial system decides the mode of transport or vehicle used.

Another development in freight transport is the use of unit loads, in the form of standardized containers or swap-bodies, which are standard for all modes of transport except aircraft. The load-carrier is for the first time in history totally separate from the transport vehicle and lives its own life. The result is that one truck can handle more than one load-carrier. One single truck can now do the same job as several others did before. The use of standardized containers and swap-bodies also reduces damage to the goods. The cargo goes undamaged from the sender to the

receiver and it does not matter how many modes of transport or vehicles that are involved in the transport chain. The change from one mode of transport or vehicle to another is carried out quickly and safely.

A transport chain can be either cooperative or combined. In both cases, two or more transport vehicles work together in a transport chain. The difference between them is that in a combined transport chain standardized containers, swap-bodies or semi-trailers suitable for combined transport are always used. 'Standardized" here means ISO (International Standardization Organization) or EC standards (European Community) for containers, swap-bodies and semi-trailers.

Every time there is a change from one transport vehicle to another the cargo requires handling. The handling equipment can be a top-lifting crane, a lift-truck or another technical system.

A transport chain consumes energy and causes emissions during the following stages:

- during transportation of the goods from the sender to the first handling- point or terminal point;
- during the transfer of the goods from one vehicle to another;
- during the switching of trains in the case of rail transport
- during transportation of the goods to a new handling-point or terminal point;
- during the transfer of the goods from one vehicle to another;
- during transportation of the goods from the handling-point or terminal-point to the receiver of the goods;

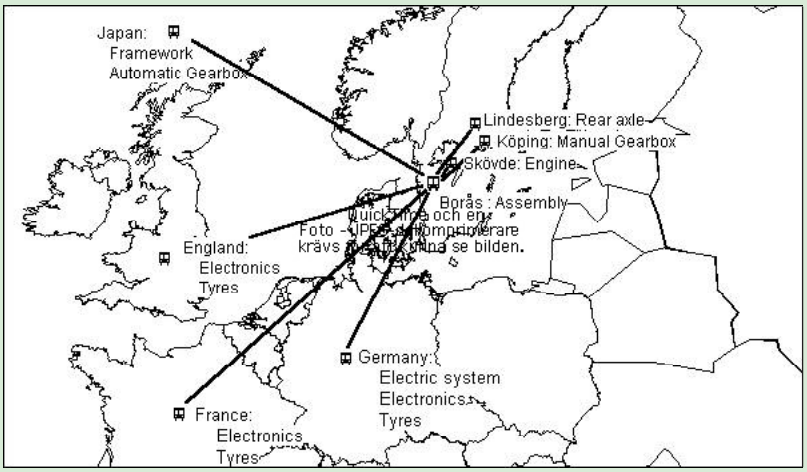
If there are even more parts in a transport chain, some of these stages will be repeated. All these various stages involved in the transportation and handling of freight, from raw material to consumer, cause energy-consumption and emissions.

Transporting goods to an industrial plant

Some of the main goods input and the transport chain used in the building of bus chassis by the Volvo Bus Corporation in Borås, Sweden:

Framework produced in Japan	Regional Truck – Ship – Regional Truck
Engine produced in Skövde, Sweden	Interregional Truck
Manual gearbox produced in Köping, Sweden	Interregional Truck
Automatic gearbox produced in Japan	Regional Truck – Ship – Regional Truck
Rear axles produced in Lindesberg, Sweden	Interregional Truck
Electric system produced in Germany	Interregional Truck
Electronics produced in England, France and Germany	Interregional Truck
Tyres produced in England, France and Germany	Interregional Truck

'Regional Truck' is a truck journey of less than 100 km.
'Interregional Truck' is a truck journey of 100 km or more.



9.5 The environmental cost of freight transport

Freight transport is the cause of a great deal of air pollution. All kinds of combustion engine cause emissions of carbon dioxide. The diesel engine in particular causes emissions of nitrogen oxides. Most of the emissions of sulphur dioxide come from ships using cheap oil with a high sulphur content. It is a question of price, because there are oils on the market containing less sulphur. Today there are also some new ships in operation that have engines with catalytic-cleaning facilities.

However, there are big differences between the different modes of transport in their level of emissions and their use of energy. Highly loaded ships causes low emissions and low energy-use per unit of loaded weight. They can of course only be used if there are the necessary waterways. Rail transport too has an infrastructure limitation because it needs railway tracks. Electric rail transport otherwise causes low-level or no emissions but it

all depends on how the electricity used is produced. Production in a hydro-electric power plant or a wind-power plant produces no emissions while electricity produced by burning oil or coal produces lots. Electricity produced by a nuclear power plant causes no emissions during its production but produces dangerous radioactive waste.

Electric rail transport has a low energy-use especially because of the technique of transferring braking energy to the overhead contact line every time the train brakes. With high utilization of the load-space, diesel rail transport causes low emissions and low energy-use per loaded unit of weight.

Truck transport is often the worst when it comes to emissions and energy-consumption mostly because of its low capacity in weight or volume in comparison with other modes of transport. Truck transport has the very best infrastructure coverage and is the most flexible way of transporting goods.

Air transport causes high emissions and high energy use because of its low capacity per loaded unit of weight and fuel with high octane levels. Air transport is limited by the location of airports.

The amount of energy-consumption and emission depends on the chosen transport vehicle, its speed and level of energy-consumption, weather conditions and the level of energy-consumption of the handling equipment used for loading/unloading.

The difference in energy consumption between a half-full and a fully loaded vehicle is small. To get efficient transport it is therefore important to get high utilization of the vehicle, both in load-capacity and time-use. If fewer vehicles can do more work, it is beneficial both for the owner of the vehicle and the environment.

Decreasing emissions from a vehicle can, in some situations, even increase energy-consumption. A good example of this is the first regulation to control emissions from Swedish cars which was issued in 1976. The regulation caused higher energy-consumption by the cleaned engines than by the previously uncleaned ones. It is therefore important to minimize both energy-consumption and emissions.

A sustainable transport system can minimize energy-consumption and emissions by changing to cleaner and more energy-efficient vehicles and transport chains as well as the handling equipment used for loading/unloading or by improving the utilization of transport vehicles in respect of loads and time.

9.6 Expansion of freight distances

To develop a sustainable freight transport system the geographical locations of the industrial plants play a key role. The larger the distance between them, the more freight journeys will be done. Today, however, there are no strong incentives to limit the distances of freight transport chains. An example of this is the 'Volvo way of producing'. Some of the main goods input to the Volvo Bus Corporation in Borås, Sweden, in building bus chassis come from Japan, England, France, Germany and Sweden (see box).

There are of course thousands more journeys involved in inputting goods to this factory. The iron needed to make the steel for the production of the framework by Mitsubishi in Japan comes from Australia and is made into steel in a steelworks in Japan.

From Borås the bus chassis then go further to different coachwork builders all over the world according to the wishes of the customers. An example is Volvo buses recently delivered to South Africa. Their coachwork was built in Brazil.

Another example is the model FH from the Volvo Truck Corporation. If you consider that a Volvo FH truck today contains over 40,000 parts and that most of it is manufactured in geographical locations other than the Volvo FH assembly factories in Sweden, Belgium, Scotland, Poland, Botswana and Australia, it is easier to understand all the input freight transport that is needed. If you then consider all the deliveries of the new 20,000 or so new Volvo FH trucks sold in 1995 to customers all around the world, it is easier to understand all the output freight transport that is needed.

Other examples of transport concepts are:

- Danish milk transported to France for the production of yoghurt which is then transported back for sale in Scandinavia;
- bread produced in northern Sweden and transported to southern Sweden in a lorry that returns north empty;
- another bread produced in southern Sweden and transported to northern Sweden in a lorry that returns south empty.

These two bread producers ought to coordinate their transport to save the environment and their own money but they do not do it. There are many 'unnecessary' freight journeys happening all around the world.

9.7 Optimizing the geographical locations of industrial plants

The main reason for extensive freight transport is its low cost. The transport cost is often a very low proportion of the market price of a finished product. The more a product is processed, the higher is the finished product's price and the higher is the transport cost that the product can bear. So, as long as the cost of transport is low, transport will continue.

The geographical location of an industrial plant can be:

- close to a raw material source;
- close to a energy source;
- close to other cooperating industrial plants
- close to the market

The geographical location of an industrial plant is very important. It decides how much freight transport the plant will generate. The total distance travelled by all

the goods input and output by an industrial plant can be minimized so the optimal location can be choosen from the point of view of freight transport. This can be done either by changing the locations of starting-points or receiving-points of the goods input and output or by changing the location of the industrial plant itself.

The benefits of an optimal location are:

- shorter transport distance for the goods;
- shorter transport time for the goods;
- lower energy-consumption by the transport vehicle
- lower emissions by the transport vehicle
- higher degree of service by shorter transport time
- more flexible production by shorter lead times in the production process.

The disadvantages of an optimal location are:

- geographical concentration of industrial plants;
- geographical concentration of competent labour;
- geographical concentration of population;
- increasing thinly-populated areas.

Today there is no move towards optimal location because of the low transport costs. A new situation with a much higher energy price can, in a short time, change the locations of many industrial plants. If the benefit is big enough, there is potential to rationalize the flow of goods. Industry has always been good at rationalizing.

Another way to minimize freight transport is for authorities to expand the review of new industrial plants to include the generation of transport. However, there is a risk of the different goals of society colliding. A concentration of labour is not good for regional balance in a country. A concentration of industry can produce unexpected effects in the form of social problems and so on.

Characteristics of a sustainable freight transport system

- Revised structure of industrial production from raw material to consumer products
- Restructured geographical location of industrial plants
- Improved distribution system from industrial plants to shops and warehouses
- ”Green” pattern of consumers’ behaviour of buying
- System of recycling

The conclusion is that a sustainable freight transport system demands a new life-style where local production and caring about materials and energy come more into focus. As a result of this, the physical freight journeys will decrease, but not disappear. There are still many things that cannot be produced everywhere.

9.8 Obstacles to the flow of goods in the Baltic region

In central and western Europe a balanced flow of goods is developing. Big volumes of cargo mean a high frequency of freight transport. However, the roads are not in good condition and cargo is moving over to rail or inland waterways.

In Scandinavia, the Baltic Sea constitutes a barrier. Most of the exported and imported cargo must change its mode of transport at least twice. This calls for handling and delays the freight. Swedish industry talks of a time handicap in comparison with other European countries of 10 hours for exports. The flow of goods is small, the distance long and often there is a low frequency of freight journeys. The geographical situation for freight transport in Scandinavia is more like that in countries such as Australia or Canada. There is also a lot of transit freight transport, especially through Denmark, Sweden and Finland. Most of it goes by truck and therefore causes extra emissions. The main flow of the transit freight transport goes from Germany to Russia.

In the Baltic States there is a sea barrier too with all the delay caused by handling and changing the mode of transport. The distances in the region are short and the flow of goods small except for transit freight transport.

In a sustainable freight transport system, the goods should be transported by rail in a combined system of sea/rail or road/rail. Austria, and especially Switzerland, have solved this problem well. But the change to a more deregulated transport market has instead, for example in eastern Germany and Poland, resulted in increasing truck transport and big emission problems. To create a sustainable freight transport system it is rather important to take care of the existing rail system and to develop combined systems of sea/rail and road/rail transport.

9.9 Creating a sustainable freight transport system

The creation a sustainable freight transport system is hindered by:

- international agreements like GATT on free world trade;
- the free inner market of the European Union;
- different costs of labour in different countries which favour low-cost countries;
- different tax regulations in different countries which favour low-tax countries

All these obstacles, singly or together, generate more freight transport. The development of a sustainable freight transport sys-

tem is therefore an international task in a long time perspective. All the existing investments in infrastructure and industrial plants cannot be changed in a short time. Also legislation and different legal agreements take time to be revised. Last, but not least, the change of attitude required by all the people involved in manufacturing industry and freight transport may take at least one generation to happen. There is a long way to go to reach a sustainable freight transport system but it is very important to move in that direction. Every little step towards sustainable freight transport system is a step towards a better future.

There are two ways to approach the future: either through market forces or through political forces where legislation and taxes are the instruments for creating a sustainable freight transport system.

In the first approach, the free market has to act against cheap freight transport that causes excessive pollution. Cleaner fuels are not so cheap, so transport costs will increase. Another problem is that the railway system is mostly owned by the state. It is therefore harder for the free market to change the rules and attitudes of the railway companies which is important if a freight transport system is to be efficient. However, there are other valuable aspects of a sustainable freight transport system, such as recycling, clean air and water, which produce profits in the long run.

In the second approach, politicians have to change legislation and taxes so that every mode of transport pays its own penalty for pollution. Another aim is to make the cost of transport so high that all 'unnecessary' freight transport disappears.

Which way is the better? Maybe a combination of the market and political mechanisms is the solution. For the Baltic region, the most important task is to take good care of the railway system which is a good basis for creating a sustainable freight transport system in the future.

However, in order to develop a sustainable freight transport system in the long run, the geographical location plays a key role. A restructuring of the geographical location of industrial plants, in order to minimize freight transport, is necessary. Other complementary measures are changing industrial concepts, distribution systems and consumers' behaviour.