The Challenges of Sustainable Logistics in Finland

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Abstract. This paper will give an overview of the logistic situation in Finland, especially on the sustainability viewpoint. Finland has quite extraordinary logistical situation in both international and national logistics. The need for transportation is significantly higher than any other EU country mostly because the geographical position and national economic structure. Because of these handicaps our transportation performance in both materials and persons is high comparing to other EU countries. This is a significant challenge for sustainable development, which is today one of the cornerstones in EU policies. How to cut down the energy consumption and emissions created in Finland by everyday logistics without distracting the holistic functionality of our society?

Keywords: Logistics · Sustainability · Finland

1 Introduction

Finland's international business environment and thus also its transport situation have changed enormously during the last 25 years. Finland's accession to the European Union and Russia's transformation towards a market economy have induced major changes for Finland. Economic and political integration to Western Europe has led to the EU becoming one of the financial centres of the world. Integration offers Finland a chance to act as a North European regional centre. The role as an mediator between east and west is important to Finland. Significant new opportunities are offered by the Barents Region where the increasing use of natural resources may increase transport operations through Finland and create a basis for new business activities [1].

During the years 1970–2000 has the goods transportation volume increased averagely about 1.7 % per year and personal traffic about 2.5 % per year [2].

Viewed from the continent of Europe, Finland is virtually an island. Vast majority of Finland's foreign trade (about 70 % of the import transport and 90 % of the export transport) is carried on by ship, and the harbours are its principal traffic nodes. The network of ports is indeed a dense one, but this means that most of the ports themselves are small and traffic flows are highly fragmentary. Icebreakers form an important part of the transport infrastructure, eight of these being responsible for assisting freighters and passenger ships into 23 harbours that are kept open all the year round. Given a normal winter, the harbours on the Bothnian Bay require icebreakers to keep them functioning

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for half the year, from November to May, while these are needed in the Gulf of Finland for about three months [3].

A large (total area 338 145 km^2 of which dry land 304 530 km^2) and low-populated (population of Finland is about 5.5 million inhabitants, which equals to 18 inhabitants per dry land km^2) country like Finland is challenging to organise countrywide distribution in. Population density in Finland can be seen at Fig. 1. Especially when taking into consideration the fact that the population is strongly concentrated in the Southern Finland as seen in Fig. 2.

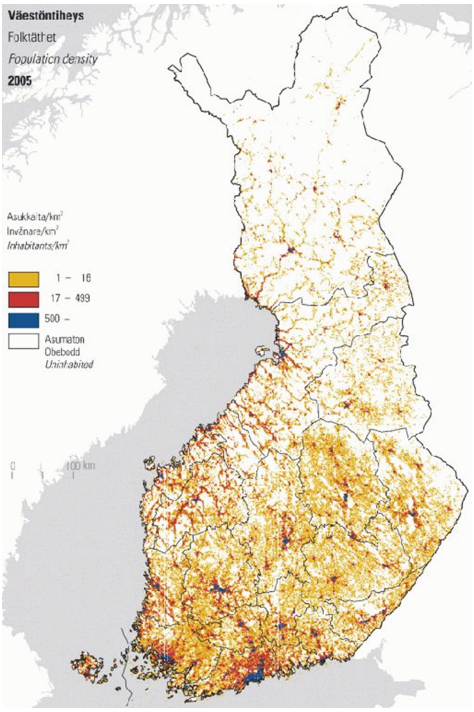

Fig. 1. The population density in Finland [4] (Color figure online)

Fig. 2. Map of Finland, where the most densely populated area having 50 % of the whole population is highlighted [5]. (Color figure online)

Finland has the lowest population density in European Union and it causes many logistic challenges because of long distances in both distribution and travelling as most of the country is inhabited and the same services and utilities ought to be provided to all citizens despite their location. In the Fig. 3 is described the transportation performance and population density in some European countries. There seems to be some correlation between population density and transportation performance.

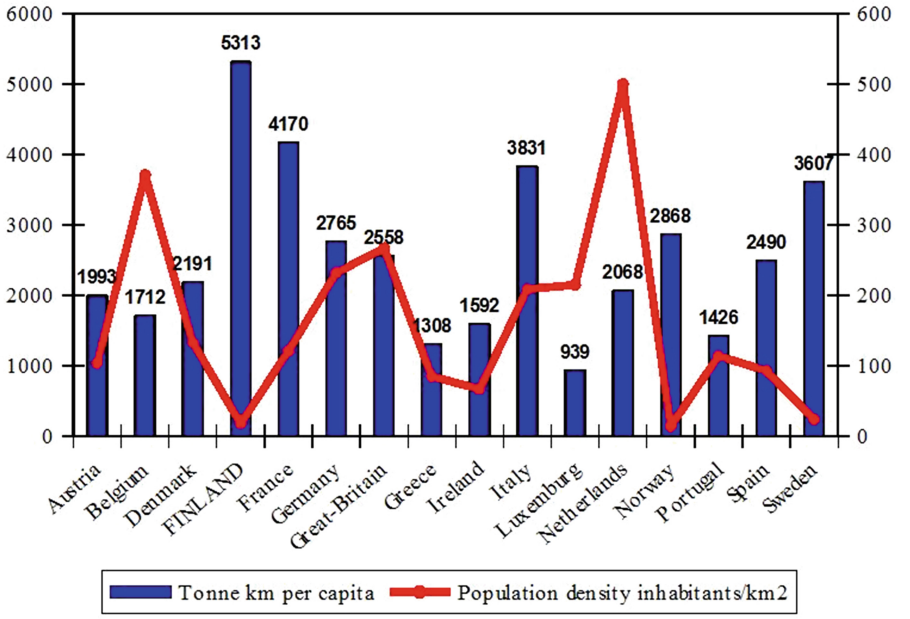

Fig. 3. Transportation volumes per capita and population densities of some European countries [6, 7].

2 Finnish Transport Network and Volumes

The Finnish transport network consists of the infrastructure needed for road, rail, water and air traffic, parts of which belongs to the Trans-European Network. The network of roads and streets amounts to a total of 454 000 km, which comprises 78 000 km of public roads maintained by the National Roads Administration, 26 000 km of streets maintained by municipal and other local authorities, and 350 000 km of private and forestry roads. Finland has about 880 km of motorways. Out of the national and municipal roads about 65 % (50 000 km) are asphalted and about half (41 000 km) are of low utilisation [8].

The rail network amounts to a total of 5 944 km, of which a bit more than half, 3 256 km, is electrified [9]. An evaluation of transit routes between West Europe and Russia shows that western European companies rank the service of the Finnish route highly The route is also easy and reliable and, compared to other routes the loss of goods is minimal [10].

Finland haves a direct railroad connection to Russia (same track width) and railship connection to Sweden and Germany (which requires special rail cars having changeable sets of wheels and wheel set exchange terminals). Also direct truck transport connections exist to Russia and Sweden. Trucks are also transported by ferries to Sweden, Estonia, Poland and Germany.

2.1 Domestic Goods and Passenger Transport Performance

The biggest users of transportation services are construction business, food cluster, forest industry and transito from and to Russia (Tables 1 and 2).

Table 1. The volume of Finnish goods transportation 2012 [11].

Vehicle type	Million tonnes	Million tonne kilometres
Trucks and lorries	294	22 000
Railways	35	9 300
Waterways	8	3 100
All	337	34 400
	Equals to 62 t per capita	Equals to 5 800 tkm per capita

Table 2. The volume of Finnish passenger transportation 2012 [12].

Vehicle type	Million person kilometres
Private passenger cars	65 270
Buses and motor coaches	7 540
Railways	4 040
Airways and others	1 720
All	78 600
	14 550 km per capita

2.2 Import and Export

Finnish import and export transportation quantity was at 2012 about 105 million tonnes. The share of sea transportation was 93 million tonnes and land transportation (lorries and trains) 12 million tonnes. The share of air transport is about 10 % of the total value, but the volume was mere 0.2 million tonnes. Domestic air freight volume was about 7 500 tonnes [11]. International transportation volume equals to about 20 tonnes per capita.

The Finnish port system is operational and its capacity is sufficient for the time being. There are a total of 60 ports and loading berths in Finland. The ports are mainly municipal. Additionally there are some ten substantial private industry ports and numerous small private loading berths. Foreign goods traffic is evenly distributed between the most important ports with emphasis on the southern coast.

The largest municipal ports are located in Helsinki, Kotka, Hamina, Rauma and Pori. Additional large private ports are in Sköldvik (oil refinery), Naantali (oil refinery) and Raahe (steel mill). The ports link railway and sea traffic. Train ferries maintain a service from Turku to Sweden and Germany. The largest transit traffic ports are located in Kotka, Hamina and Helsinki.

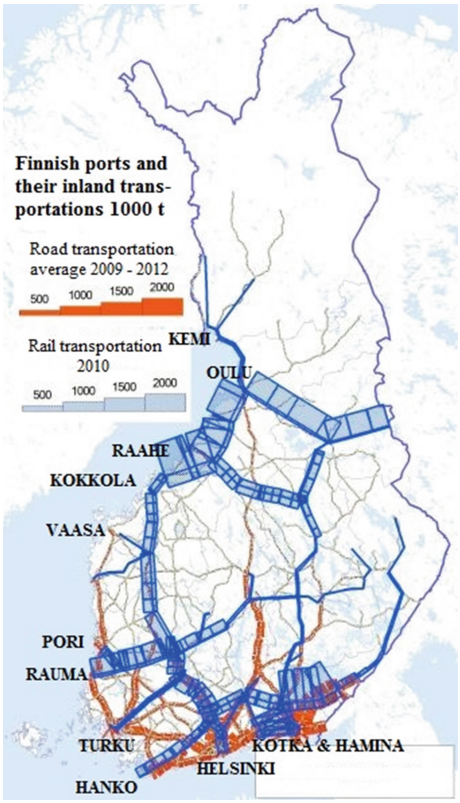

Fig. 4. Finnish foreign trade material routes and Finnish ports [13]. (Color figure online)

The harsh winter conditions raise the costs of building, maintaining and operating the transport infrastructure in Finland. The penetration of the frost into the ground means that all constructions have to be dimensioned and insulated properly to cope with the problem of freezing (Fig. 4).

Salt has to be dispensed on the roads to prevent icy conditions and this means that protective layers have to be installed in the road structures in areas where the groundwater deposits are located. Snow clearance, sanding and salting and the repair of frost damage are further sources of additional costs. Finland is also one of the few countries allowing the use of studded tires in winter, which causes severe abrasion problem to the road pavement especially on heavily used main roads.

3 Location of Finland in the Northern Hemisphere

The geographical location of Finland in EU is logistically very disadvantageous. The average distance from Finland to Central Europe is about 2 000 km and this means that Finnish companies have to add additional 1 to 2 days extra to delivery time comparing to Central European competitors, not to mention extra costs. The global location is relatively not so disadvantageous than the location in the EU because when the actual distance increases the relative disadvantage gets smaller, which can be seen on the Fig. 5.

The geographical location of Finland creates also some opportunities to increase Finnish international air traffic and especially to increase intercontinental traffic via Finland. The shortest and fastest flight connections from western and central Europe to e.g. Japan and from the American East Coast to the Far East are routed via Finland. Helsinki-Vantaa Airport acts as a node for long distance air traffic.

Logistically speaking Finland is very challenging country to operate in both domestically (low population density causes excessive distribution costs) and European

Fig. 5. The northern hemisphere and Finland in it [14].

wide (an additional 2 000 km to the distribution distance comparing to Central European competitors). Globally the location of Finland is not so big a handicap.

4 Sustainability

As described in previous chapters, there is a big need for transportation in Finland mostly because of very low population density and widely inhabited relatively big country. The way of life today requires lots of material to be transported to meet the needs of both industry and population. This all causes very large quantities of materials and passenger transportation needs.

4.1 Distribution Challenge

In Finland the highly developed information technology infrastructure supports the centralisation of distribution. Also geographical and demographical factors support this development. Therefore the basic question has become important: which location(s) may give the most cost effective way (in the long run) to distribute products nationwide?

The centralisation development in Finland has been very drastic during the last decades. As in 70's and early 80's it was normal to have at least 20 local distribution terminals in the case of nationwide distribution the amount of distribution centres is today 1 to 3 and usually distribution centres are also production units. Practically all of the distribution terminals having no production activities have been closed and the distribution has been centralised.

In a centralised system decisions are made at a central location for the entire distribution network. Typically, the objective is to minimise the total cost of the system subject to satisfying some service-level requirements. In a logistics system in which each facility can access only its own information, centralised strategy is not possible. With advances in information technologies, however, all facilities in a centralised system can have access to the same data [15].

By using the results of analysis done by the author at 2000 Finland can be divided into five regions:

(1) Most favourable locations,
(2) Favourable locations,
(3) Average locations,
(4) Unfavourable locations,
(5) Least favourable locations.

As shown in the Fig. 6 logistically favourable locations are strongly concentrated in the Southern Finland. The fact that the Finnish population has quite strongly concentrated into Southern Finland (as seen in Figs. 1 and 2) can be clearly seen from the results. Also the most of the companies dealing today with a nationwide distribution have their main distribution terminals located in area 1, which indicates that the analysis has gave in this case reliable results.

Because the Finnish geographical facts cannot be changed the only ways to change the situation are:

(1) Distribute the population more evenly, which is in the open society like Finland practically impossible and today the trend is quite opposite.

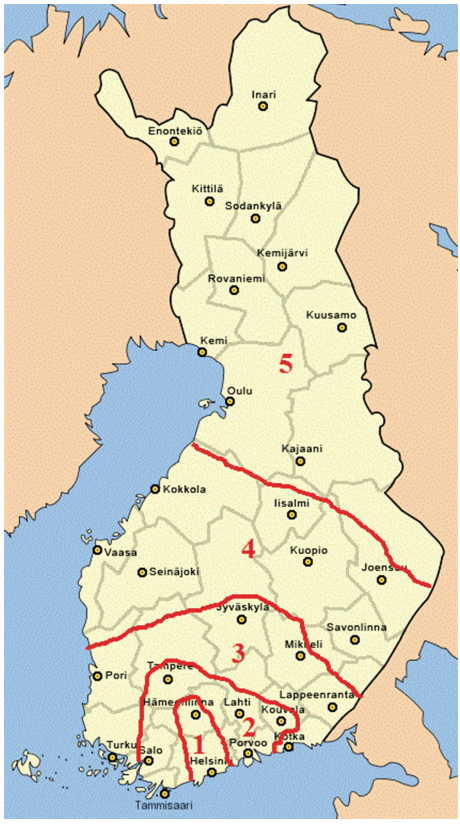

Fig. 6. Finland divided **into** five logistic regions

(2) Change the consumption behaviour of the people

- with taxation some consumption patterns could be changed,
- local retail services instead of mega-sized shopping centres would decrease the shopping distances and the use of a private cars could also decrease – some governmental actions against suburban or rural mega shopping centres have already been made.

(3) Increase the distribution vehicle efficiency

- there is two ways to improve vehicle efficiency: maximise the utility level of the vehicles (two-way-distribution, route optimisation) and increase the vehicle capacity,
- very efficient route optimisation tools and for example strategic alliances in order to achieve two-way distribution maximising the utility level of the vehicles have been used successfully,
- Finnish road law allows bigger vehicles (Fig. 7):

	EU average	Finland
Max. length	18.75 m	25.25 m, with special permission 34 m
Max. height	4.00	4.40 m
Max. weight	40–44 t	76 t

Fig. 7. The "Ecotruck" - the biggest allowed 34 m long truck in Finland [16]

(4) Create industrial activity at less favourable areas which are not so dependent on the distribution costs:

- local markets; then the market area is smaller and local optimisation can be done – recent consumer trends are supporting this approach,
- international markets, because in this case all locations in Finland are more or less equally unfavourable (look Fig. 5) - most of the Finnish industry is already export-oriented,

– production of products, which have a low transportation cost comparing to its value – nowadays the average value of Finnish import and export is slightly over 1 € per kg, which is surprisingly low.

Nationwide distribution should be organised using favourable locations as distribution centres. Both international and local distribution can be done economically also in disadvantageous areas because all the locations are equally distant internationally and naturally local distribution is not so much dependent on the region.

4.2 Mobility Challenge

During the last decades there has been a significant migration to so called growth centres in Finland. This means, that lots of people has been moved to live on areas, which can provide better working possibilities because of successful industrial companies and offices. Most of these people have found their accommodation from relatively distant suburban living areas which has increased the average pendeling distance.

About 700 000 people (over 25 % of working people) in Finland have their working place outside their living municipality. This is all a result of improved mobility of the Finnish citizens. All the enormous investments to Finnish road infrastructure and automobilisation of Finnish households had led to situation, in which earlier impossible distances between home, work, shopping, school, hobbies, recreation etc. have become everyday reality.

We travel more and more to do our everyday activities because we can, and our society and in a way our modern civilisation has designed to accommodate that. Now, because we can, we **have to** travel long distances for the services and things which used to be near - available on walking or cycling distance. This is the biggest sustainability challenge concerning the modern society mobility.

This is also environmental issue. At 2013 the share of traffic on total energy consumption of Finland was 16.5 % = 182 petajoules (PJ), which equals to 800 l of fuel per capita. The share of traffic was about 40 % of all oil energy used in Finland. The share of traffic has been slightly increasing on recent years [17].

The emissions of vehicles has been reduced since 1970's, but the increasing traffic has been slowing down the total emissions decreasing. The emissions dangerous on health have been decreased significantly. The traffic is still significant source on many emissions – 87 % of carbon monoxide (CO) and about half of hydrocarbon and nitrous oxide emissions come from traffic (Table 3).

Table 3. Traffic emissions in Finland

Emission	1990 (t/a)	2012 (t/a)	Change	Share of road traffic
CO_2	10 900	11 200	+2.8 %	75 %
CO	470	72.5	−84.6 %	87 %
NO_X	134	39	−70.9 %	45 %
HC	68	9.8	−85.6 %	77 %
SO_2	5.3	<0.1	−99.1 %	0.6 %

Road traffic is the most significant source of emission except on SO_2 emissions, which come almost solely from sea transportation [17]. The reason for that is the use of low quality and sulphur rich heavy fuel oil on ship engines. On Baltic Sea the accepted sulphur content of the fuel was decreased to 1 % at 1st of January 2012 and further to 0.1 % at 1st of January 2015. This will cut down SO_2 emissions significantly [18].

In heavy road traffic the gradually tightening motor requirements have cut down emissions and on smaller vehicles improved engine efficiency and catalyst technology have cut down many emissions significantly. Although technical development on emission control has been most successful, is the ever growing traffic negatively compensating this development.

Emissions are just one element of traffic problems, traffic has additional effects like noise pollution, dust, vibration and the space required for roads and parking areas required for more and more cars. Also traffic causes all kinds of solid (junk cars, old tires and accumulators etc.) and liquid (lubrication oils and other auto chemicals) waste, which can be very dangerous if not disposed correctly.

The main problem is the ever increasing volume of traffic – necessary or unnecessary. We must seriously think, is all the traffic necessary, or are we wasting natural resources on needless mobility? Distant working is for example considered as partial solution for this problem. Today in the age of wireless communication many kinds of activities can be done practically at any physical location. This could at least decrease the need for commuting to office every day. Is our working culture ready to accept this?

4.3 Economics Challenge

As the sometimes needless and unsustainable consumption and distribution caused by it increases transportation logistics and its negative effects there is also the economics aspect to keep in mind. Our current economic crisis is partially caused by diminished consumption of goods, which leads to lower demand causing unemployment on manufacturing, distributing and retailing businesses. And this affects negatively on national economy and peoples willingness to consume – and vicious circle is created.

So, what to do – should we keep on consuming despite its unsustainable consequences in order to help the economy to maintain its urge to continuous growth? Can economy based on paradigm of continuous growth co-exist with sustainable development in a world with limited resources? If the continuous growth means more materials and energy to be utilised to manufacture, distribute and retail unnecessary things and gadgets to consumers – it will not work.

But if the growth is achieved by immaterial services, IT-assisted distant working, virtual experiences etc., which require very little or no physical materials or energy to make and distribute, it is very possible.

5 Conclusion

A country like Finland having low population density and high living standards is facing lots of logistic sustainability challenges. Today the unnecessary use of materials and energy is in any case harmful for sustainable development, but in which way we

could control or even limit it? Most of these behaviour and consumption decisions we make are voluntary and therefore avoidable. The sustainable awareness is needed and with information and education some progress can be achieved.

The best way to improve sustainability of logistics is to eliminate reasons for unwanted behaviour and practices. Decreasing the need for move things and people with vehicles would be of course the most sustainable way to deal this matter. This is a problem of infrastructure and municipal planning. Today we have a world of big distances to work, school, shopping, leisure etc. - because it is possible. Could we create a world of smaller distances – and with less transportation needs? This would require a change of paradigm in the whole society. It is necessary, but is it possible?

Another very efficient way to improve sustainability in logistics is to improve the fuel efficiency of vehicles and functionality of the infrastructure. Traffic congestions waste both time and fuel and exist because of bottlenecks in the infrastructure. In Finland the congestion situation is much better than in many countries having much bigger population density, but there is no reason for satisfaction, because of very high traffic performance in both goods and persons traffic.

What about the stick instead of the carrots? Should we governmentally/municipally restrict the consumption and travelling behaviour of Finnish peoples in order to decrease the need for traffic? Are the private persons unable to make the sustainable decisions without rules and regulations requiring it? There is very positive examples of restricting rush-hour traffic with city tolls from both London and Stockholm which show that good results can be achieved with restrictions.

Finally the dilemma of economics based on eternal growth and sustainable economics, can it be solved? If we stick on out old habits and behaviour, this dilemma will be absolutely unsolvable. But if we can find a new paradigm to combine our economic system (and logistics as a part of it) and sustainable development and this way change our mode of behaviour very positive results are possible.

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