Energy and carbon efficiency (CO_2 emissions) of diffirent forms of distribution in Vietnam and a comparision in France (case study: yohurt)

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Abstract— Anthropoid Greenhouse Gas (GHG) emissions, when concentrating in the atmosphere, cause climate change and contribute to global warming. Transportation is responsible for an increasing part of these emissions, mainly road transport and within transport; the share of goods (about one third) is increasing. Air pollution and greenhouse gas (GHG) emissions are two major environmental challenges in transportation in big cities all over the world. In recent years, with the rapid urbanization of developing countries, traffic jams, traffic accidents, air pollution and emissions in big cities. Motorization of activities' transport that caused by a very large amount of carbon emissions that is accounted for about 70% of total greenhouse gas (the cause of the greenhouse effect and global warming over the past few years), these things are creating enormous pressure in big cities of developing countries in Asia. For this, this paper analyses the energy and carbon efficiencies of different forms of distribution implemented by major retailers in Hanoi, Vietnam and compares them with the corresponding supply chains in regional area of Paris (Ile de France) France. Through this study, we answer the following questions: What are the most efficient logistics organizations for energy and CO2 emissions of retail outlets?

Keywords— Carbon efficiency (CO_2 emission), energy consumptions, freight transport, supply chain

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1 INTRODUCTION

CURRENTLY, a large and growing share of freight transport is organized by a few large retailers seeking to control logistics flows even further upstream and to organize theses flows for their own benefit.

The increase in greenhouse gas (GHG) emissions from human plays an undeniable role in the acceleration of climate change (IPCC, 2013); increased concentrations of greenhouse gases in the atmosphere raises fears for the future, unprecedented climate variations. Transportation is responsible for an increasing share of these emissions, mainly road transport and, in the transport; the share of goods (about one third) is increasing. Currently, a large and growing share of freight transport is organized by some signs of large retailers who seek to control logistics flows ever further upstream store and organize them for their benefit. Our research concerned with the quantification of energy and CO2 emissions related to freight transport activities, particularly in the supply chain in France and in Europe Rizet C., and Keita B., (2005) and Rizet C., et al (2008, 2010).

The challenge of climate change and global warming are the effects of increasing greenhouse gases (GHG) in transport activity in general and goods transport in particular, especially road transport. Hanoi is an example in this research; Hanoi is a very fast developing city since the opening of the economy in 1986. The economic development has drawn increasing population in the dense major urban areas, the motorization of transport and dramatic changes in the distribution and in the supply chains organization. To achieve these objectives, this research tries to quantify and analyze the energy consumption and CO2 emissions on two products: yogurt and jeans from raw material to the consumer's home. So, we first conducted a survey face to face with companies (producers, transporters, distributors) and a web survey among consumers in Hanoi with assistance from students at the Faculty of Transport Economics at University of Transport and Communication (ESTC) in Viet Nam. This research also compare the energy consumption and CO2 emissions per kilo of product studied, each of the steps (road transport, platforms, stores, etc.) and, moreover, different chains according to their organization. These chains are compared between types of stores (hypermarkets, supermarkets, small shops of different types) and by types of store between France and Vietnam.

The starting point of this article is a research result on quantifying energy and GHG emissions from supply chains in France and in Vietnam: the case study of yogurt Quoc Dat LAM and Rizet C., (CODATU, 2015) and the case study of blue-jeans Quoc Dat LAM and Rizet C., (CIGOS, 2015). This research conducted surveys on the corresponding supply chains of Vietnamese distributions to obtain comparable data and quantify the energy consumption and emissions of CO2 by applying the quantification method used in France. This allows us to compare the energy and carbon efficiency of different forms of retail outlets in the cases studied of yogurt and blue jeans between Vietnam and France. A survey was conducted face to face with the operators (producers, transporters, distributors) and a Web survey with consumers (on shopping trips) which have bought these products in these retail

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outlets of Hanoi. The information collected in Hanoi that describes the supply chains of yogurt and jeans in Vietnam from the raw material up to the consumer's home. The differences between types of distribution or supply chains, in particular, relate to the type of retail outlets: a shop can belong to the producer in Vietnam, a retailer in France or an independent shop and the supermarket and hypermarket to major distributors.

2 METHOD

The method in this paper is consulted in these researches Rizet C., Cornélis E. Browne M., and J. Leonardi (2010) and Rizet et al (2008). The main GHG emitted by the supply chain is the carbon dioxide (CO2) from the combustion of hydrocarbons. The amount of CO2 emitted at each stage of the chain is calculated as the product of the amount of energy used, multiplied by a factor of clean emissions for each type of energy. Energy consumptions in this analysis are diesel, gasoline, electricity and sometimes gas.

The emission factors used are shown in Table 1 below and are from the Information Guide CO2 transport services (ADEME, 2012) for diesel, gasoline and for electricity in France and the' Ministry Natural resources and Environment of Vietnam, (2010) for electricity in Vietnam. The amount of energy consumed in transportation is itself calculated at each stage of the chain, as the product of the distance (distance support and possibly empty distance) multiplied by a unit consumption (liters per hundred kilometers for trips road). Energy consumption and GHG emissions by step are then related to the amount of product; they are finally summed over the various stages of the supply chain. Surveys of enterprises, carriers and shippers were conducted face to face, in Vietnam and in France, with the responsible transport of these enterprises; the questions focused on journeys, vehicle type, and the quantity of the transported goods before and after the journey.

Three forms of energy have been encountered in the studied chains:

- Diesel, almost exclusive fuel for road transport and gasoline used primarily for consumer trips;
- Electricity used in manufacturing plants and logistic platforms;
- And, rarely natural gas.

Table 1 summarizes the coefficients to convert these different forms of energy into a common unit, the gram oil equivalent (gep) and the CO2 emission factors of these grams of CO2 energy (gCO2) per unit 'energy. When the energy consumed and emissions produced or are reported to the quantities transported, the indicators used are the gep / kg CO2 / kg of yogurt. To be able to aggregate and compare emissions from different sources energy, particularly oil and electricity we use emission factors 'well to wheel' or 'upstream combustion +'.

The surveys of operators (producers and transporters and distributors) in the two countries used to describe supply chains that yogurt was actually used in the two countries and quantify emissions at every stage from the farm where the milk is product to the store that sells yogurt. In addition, an online survey among consumers has quantified the CO2 emissions of the last trips of the supply chain: the movement of the consumer who will buy yogurt, in particular, the type of store where he goes shopping, in Hanoi or in the Paris region.

The formula for determining the fuel consumption of transport journeys:

$$Gnl = \frac{\text{[illegible]}}{\text{[illegible]}} (g/kg)$$

With:

- Gnl: fuel consumption per kg of product (g / kg)
- Lch: transport distance with loading (km)
- Lkh: transport distance without loading (km)
- Qnl: average fuel consumption of means of transport (liter / 100km)
- K: energy conversion value (gep / kg)
- Qhh: Total Cargo Volume (kg)

The formula for determining the CO2 emission of supply chains:

$$Q_{CO2} = G_{nl} \,.\, M \; (gCO_2/kg)$$

With:

- Q_{CO2}: Emissions per kilogram of transported goods (Gram CO_2 / kg)
- G_{nl}: Fuel Consumption of Means of Transportation (g / kg)
- M: Carbon dioxide emission values of the converted form (gCO_2 / kg of commodity)

Table 1: Equivalent energy and emissions factors by type of energy

Type of energy	Conversion factor (kg / unit)	Emission factor (g CO_2 / unit) The well to the tank	From tank to wheel	The well to the wheel
1 litre of diesel	0,83	0,58	2,49	3,07
1 litre of gasoline	0,791	0,47	2,24	2,71
1 kWh of electricity	0,086	0,053	0,000	0,053
-consumed in France		0,413	0,000	0,413
- consumed in Vietnam				
Natural gas 1 MWh PCI	0,77	0,04	0,21	0,25

Source: "Guide CO2 transport information services (ADEME, April, 2012) for diesel, gasoline and for electricity in France; Ministry of Natural Resources and Environment of Vietnam, 2010 for electricity in Vietnam

In France, the electricity is generated mainly from nuclear power while in Vietnam, fossil energy is still predominant.

From the Vietnamese electricity, which is produced with fossil fuels, is occupied 63.6% of the total fuel consumption of electricity plants (according to report of the Ministry of Natural Resources and Environment of Vietnam in 2010).

3.ENERGY AND CO2 EMISSIONS IN THE SUPPLY CHAIN YOGHURT IN VIETNAM AND COMPARISON WITH FRANCE:

For papers accepted for publication, it is essential that the electronic version of the manuscript and artwork match the hardcopy exactly! The quality and accuracy of the content of the electronic material submitted is crucial since the content is not recreated, but rather converted into the final published version.

Vietnam is a country at the Southeast of Asia, with experiencing an explosion in demand for dairy products that domestic production does not cover. To reduce the importations, the government has decided to launch a comprehensive national dairy (2010-2020) to rapidly increase milk production. The goal is to answer 80% of the demand of consumption of Vietnamese in 2020. Currently the company Vinamilk is a great company of milk and dairy products in Vietnam. The yogurt is manufactured in Vietnam by Vinamilk Company, from raw materials Vietnamese. It is a food product whose lifetime is short (about one month) as in France. Currently, there are 2 Vinamilk manufacturing factories: a factory in Bac Ninh in North Vietnam (province 30 km from Hanoi) and one in Binh Duong in the South of Vietnam (a province 25km from Saigon). In this research, we chose the supply chain yogurt at the north of Vietnam. There are more than 10 provinces that produce milk in the northern of Vietnam: Son La province, Tuyen Quang province, Ba Vi District (Hanoi Capital), Ha Nam province etc.; at the Centre of Viet Nam in Nghe An province, Ha Tinh province, Thanh Hoa province and at the Central Mountain (Tay Nguyen) and the South of Vietnam: Cu Chi District (Hochiminh City), Lam Dong province, Binh Duong province, etc. These provinces supply milk fresh for Vinamilk's factories are located in industrial parks at the North and South of Vietnam. The Centre of Vietnam, there is another factory also produces yogurt: TH True milk society.

The dairy products in Vietnam are manufactured primarily by: Vinamilk (90%), TH True milk (7%) and other companies. There are also some imports from Japan, Australia, Germany, France, and UK...

In this research, we focus on the yogurt consumed in Hanoi; they are produced by Vinamilk factory in Bac Ninh is supplied with milk by the North and Central Vietnam. Three farms provide most milk for the manufacture of dairy products of this factory:

- The dairy farm of the town Moc Chau in the province of Son La, west of the northern region of Vietnam with an estimated 300 km to the Bac Ninh factory;
- The dairy farm of Tuyen Quang, north-east of the northern region, with an estimated 180 km;
- The dairy farm in the municipality of Nghia Dan, in Nghe A province, north of the central region of Vietnam, with an estimated 350 km.

The morphology of these chains is almost identical between the different types of distribution studied and we distinguish seven steps for all yogurt chains studied:

- Step 1- Milk collection and other supplies materials and products used in the composition of yogurt.
- Step 2 - yogurt production plant. In Vietnam, the plant is studied in Bac Ninh province to thirty kilometers from Hanoi, while in the French case the plant is located in the Lyon region to nearly 500 km from Paris.
- Step 3 - The transport from the factory to the platform located just before the store.
- Step 4 - The logistics platforms, the producer or distributor in Vietnam, producer and distributor in France.
- Step 5 - The last transport platform to the store.
- Step 6 - The store: hypermarkets, supermarkets and three convenience stores (small or independent outlets in Vietnam, supermarket in France).
- Step 7 - The consumer journey between the store and his home.

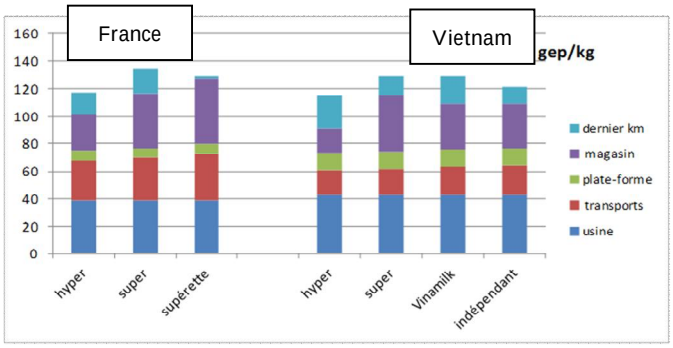
The Vietnamese yogurt factory uses 136.5 million liters of milk per year, for an annual production of 91,000 net tons of yogurt. The quantity of milk collected in the 3 state farms is 124 million liters; an additional 12.5 million liters of milk is purchased on the Vietnam market.

In France, the farms that supply the milk factory are located in a radius of 100 km around the factory. The vehicles used for milk collection are insulated (not refrigerated) trucks with trailers and semi-trailers. The reference plant uses 149 million liters of milk per year, while the amount of milk thus collected is only 124 million liters, leaving a shortfall of 25 million liters. This gap is filled by the purchase of additional milk in the domestic market. The main points of supply for this supplement are average weighted by the tonnages, 354 km from the plant. As these vehicles are highly specialized, they return empty too systematically. Besides milk, the factory also supplies packaging and other ingredients necessary for the production of yogurt (container, fruit, lids, banners, cleaning products, sugar, etc.). These products come from different regions in France and abroad (Germany, Poland, and Spain). All these inputs are delivered by road, with suitable vehicles and represent nearly 2,500 deliveries per year for an estimated consumption of 276.000 liters of diesel. On the other hand, the yogurt production also produces a residue, serum, which is shipped to another site located about 250 km from the yogurt factory, at 6 tanks of 22 tons on average per week. The energy consumption of this transport, we intend here with the supplies is estimated at 51000 liters of diesel fuel per year.

Considering the energy consumption of the entire chain, in

Figure 2, the steps are compensated and this chart indicates no significant difference in efficacy between the two countries. It shows however slight differences in efficacy between the different forms of distribution analyzed. The various supply chains lead to differences of energy per kilo of yogurt than 20% with consumption in the two countries, a slight advantage to the hypermarkets that appear to have the highest energy efficiency among the different forms of distribution analyzed.

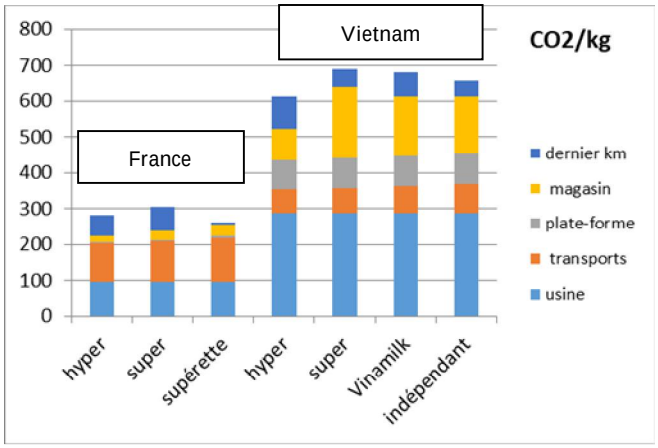
Figure 2: Energy different strings yogurt studied in Vietnam and in France



However, when this energy is converted into CO2 emissions, all French chains emit much less than those of Vietnam and this was mainly due to the difference between emission factors for electricity in both two countries.

The organization of supply chains studied is very similar between Vietnam and France. The main difference lies in the use of platforms: in Vietnam, the yogurt through a single logistics platform after its manufacture, while in France, it spent systematically by two platforms: a platform as producer for the grouping of products made in different regions and a distributor platform for the preparation of their journeys to stores. The two French platforms together consume less energy per kilogram as the only Vietnamese platform which seems to be related to oversizing Vietnamese platforms.

Figure 3: CO2 different chains studied in Vietnam and in France



For a given type of store, the energy consumption is quite close between France and Vietnam but the distribution of this energy between steps in the chain is different: the energy spent in transport is more important in France, despite the relief and smaller trucks in Vietnam, due to longer distances. The carbon efficiency of logistics platforms is better in France while these look better in Vietnam. Finally, the consumer in movement of passenger is less differentiated between logistics platforms in Vietnam in France: in Vietnam, in the cases studied, a significant part of these trips is transported by motors regardless of the type of store.

4 Conclusion

The method of calculating carbon dioxide (CO2) emissions in yogurt supply chains in Hanoi has shown a higher level of emissions compared to supply chains for similar products in France. Total emissions of supermarket distribution systems, retail outlets in Hanoi have a greater carbon footprint than in Paris (France). This sheds light on the supply chain (in the case of research into yoghurt products) from raw materials to supermarkets, shops and travel emissions of people in Hanoi. Out dust and air pollution from road transport vehicles and the distribution of goods into the city. At the same time, from this research, the author continues to open up further research directions for the flow of material and other commodity supply in urban areas. Develop methods for calculating carbon emissions in other urban supply chains; mainly for motorized vehicles. For example: calculate the fuel consumption g / Ton or Tkm or gCO2 / ton or g / T. The usage of new calculation methods depends on a number of factors such as the choice of long or short supply chains, the distribution models choice and the flow of goods from the big distributors in Vietnam.

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