XI Congreso Galego de Estatística e Investigación de Operacións
A Coruña, 24-25-26 de outubro de 2013

A CONCEPTUAL MODEL FOR A COLLABORATIVE GREEN LOGISTICS DECISION SUPPORT SYSTEM FOR FREIGHT TRANSPORT COMPANIES

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ABSTRACT

Over the last century, with the globalization of markets, the goods flows has increased throughout all over the world and this fact has created uncontrolled environmental problems.

Considering the need for the evaluation of green practices in organizations, this paper reports the development of a conceptual model that incorporates green practices in order to support environmental sustainability throughout the supply chain.

The model has been developed following the main aspects reported in the literature and from insights gathered from interviews to Portuguese carriers whose sample represents a large part of national transport sector. Such interviews allowed the assessment of which are the green measures adopted by each company and what procedures and policies are essential to conduit a greener logistics. Some of the measures are enforced by UE and Portuguese legislation.

The main objective of the paper is therefore twofold: (1) to present a Green Model (GM) that helps companies to evaluate their activities, in real time, throughout the analysis of key performance indicators (KPI) developed and presented for each level of decision; and (2) to ascertain the actual degree of accomplishment of the "green" legislation by Portuguese carrier companies.

Keywords. Intermodal freight transport, Green logistics, Sustainability.

1 Introduction

The supply chain and their flows are directly connected to the pollutant emissions into atmosphere by the impact of their processes. With the growth of concerning about environmental conditions on our planet, green logistics (GL) has emerged as a modelling and solution approach to introduce these environmental concerns into decisions taken in all supply chain flows. To do so, GL takes into consideration the constant search of solutions to measuring and minimizing ecological impact and, simultaneously, to maintaining high levels of efficiency and competitiveness [1]

As part of logistic activity, transportation is a significant component of most supply chains, both in terms of benefits and in terms of drawbacks. In this context, the European Commission created some official programs (e.g. Marco Polo I and II) and EU regulations that aim to reduce the environmental impact of road freight transport activities.

Since the environmental problems and externalities associated to road transport are a milestone in evidence in the European community, and societies in general, there are innumerous pressures that the decision makers (and their organizations and companies) are subject to. These pressures can be social, environmental, governmental and customers. Not only will the customer ask the supplier to measure the carbon footprint of its business, but also will the European Union issue a considerable amount of environmental legislation in the area that the carrier must meet.

It is important therefore to transportation companies and other stockholders to develop a generic model which allows them to identify the factors that affect the impact of their activity on the environment. Most of such factors can then be changed or improved from adequate analyses grounded on monitoring an adequate set of key performance indicators (KPIs). On this way, analyzers can measure progress toward green organizational goals, providing that KPIs are (as should be) quantifiable. It is also important to set targets to each KPI.

The result of applying a strategy for green logistics to a road transport operator is a cost reduction and a shorter delivery time, which are positive, ultimately, to the customer. The society itself also wins because of the decrease of the environmental footprint of the carrier.

The road transporter has much to gain in the implementation of a green logistics service. Besides being the only possible path to follow, it is the right thing to do, it is more efficient, more competitive and allows society to walk on the path of environmental sustainability in the benefit of all.

The problem is that, in general, small and medium enterprises (SMEs), in particular, do not measure, for example, their carbon footprint (one of the relevant KPIs) mainly because they do not have the necessary technologic means nor the technical knowledge. Therefore, how they can monitor adequately their activity in order to accomplish environmental EU directives and legislation? How they are capable of anticipate their environmental friendly actions and measures in order to try to obtain some competitive advantage from competitors, since customers are increasingly demanding green(ner) products?

The objective of this paper is twofold: (1) find out which aspects (e.g. informational and computational components) transportation SMEs consider the most important ones in order to monitorize and manage their activities; and, based on those, (2) purpose a general, institutional and across-companies, collaborative framework for performance their green logistics.

The remainder of this paper has the following structure. In Section 2 we overview the most relevant literature in the context of this work namely environmental and enterprises concerns, real problems that we can find to quantify the road transport activity impact, difficulties to implement a model and possible action strategies. Section 3 presents the current situation of the freight sector in Portugal, in particular the reality about the national carriers and the degree of involvement with green logistics activities along with and the perspectives of companies. In Section 4 we present our proposal of conceptual model, which is then discussed in Section 5. Finally, Section 6 is devoted to final remarks, conclusions and suggestions for further work.

2 Literature review

Carter & Rogers [2] defines green supply chain (GSC) as “the strategic, transparent integration and achievement of an organization’s social, environmental and economic goals in the systemic coordination of key inter-organizational business processes for improving the long-term economic performance of the individual company and its supply chains”.

GSC aims to minimize the wastes related to the environment and its sustainability needs to be seen as an imperative to all companies leading to the commitment of top management and subsequently extend this communication to all organizations level in order to develop processes and offer more sustainable products and services [3].

2.1 Green Logistics Strategies

Green logistics strategies intend to reduce the final costs to the customers and practice a more rational supply chain management (SCM) while respecting the environment and the efficiency of energy consumption.

Rodrigue, Comtois, & Slack [4] report five possible strategies that ensures the maximum efficiency and profit in logistics activity but also minimize the environmental impact:

1. Minimize shipments;
2. Use efficient packaging;
3. Transport programming
4. Modal shift (from road to intermodal means)
5. Select suppliers criteriously.

These strategies can be seen as a way to minimize the logistical final costs grounded by continuous improvement strategies [5].

The strategy of **minimizing shipments** (1) aims to creating a system that answer to customer's demand which creates a strict integrated supply chains which ensures that the quantity ordered is the same amount sent to the customers. If the customer service level is ensured it is easier to reduce the volume of returns.

An **efficient packaging** (2) method is a useful tool (as well as the package itself) that helps increasing the density of each transport and decreasing the number of trips.

One way to accomplish the previous strategies is to adopt and make sure that exists an efficient **transport programming** (3) which can guarantee an efficient use of the existing fleet as well as the goods stored in the warehouses. Thus, it is very important to consider, in the context of freight road transport, the periods of low transit congestion on highways and facilities and increase the level of service associated to the time frame close to the customers, thus trying to generate greater efficiency and decreasing environmental impact.

According to the same arguments, as before, the **modal shift strategy** (4) can be translated in the use of (real-time) dynamic information systems that helps route planners to opt for intermodal means and services with less environmental impact. In general, for long distances, the most appropriate transport modes are rail and maritime transport, whereas the short sea shipping (SSS) is the most suitable for coastal regions.

Periodically companies should implement evaluation procedures of their suppliers because there are some important factors (e.g. logistics costs) that are particularly related to environmental and energy issues. **Changing suppliers** (5) is sometimes the best way to maintain a good strategy. For example one supplier can offer a lower cost when compared to another suppliers. However some restrictions appear such high level of inventory in transit, failure to comply with time windows, freight insecurity or higher transportation costs.

2.2 The particular importance of modal shift strategy

Generally speaking, it is obviously important to be able to determine, in each situation (e.g. a given cargo service), which is the best mode of transport taking in account distance, cargo type, the client and the expected environmental impact. The UE, in particular, recognizes that a low environmental impact is directly related to the sustainable mobility, which, in turn, has been at the heart of its transport policy. And, indeed, most UE programs has been translated into several funded projects that aim to (more or less) drastically produce a modal shift from road to intermodal transport integrating, as the main leg of journeys, less pollutant means such as rail and maritime. Some examples of such programmes and projects are: Marco Polo (I and II) programme, e-Freight (http://www.efreightproject.eu/), etc.

The quantity of greenhouse gas emissions diverge according to type of fuel used by each vehicle due their energy efficiency. There is some indicators that helps calculating the greenhouse gas emissions [6].

The CO2 emissions are computed by multiplying fuel consumption by fuel emission factor, or, alternatively, by multiplying the total tonnes-km of the company by the correspondent emission factor.

Table 1 shows the emission factors of the different transport modes. Biofuels are approximately 38% less pollutant than traditional fuels in terms of kg-CO2 per litre, so, whenever possible, transporters should use them in order to contribute for a greener logistics. Although this the vehicle brands does not disclaim under warranty any problems that occur through the use of such fuels. The air transport is the most pollutant but the quantity of freight transport is residual so it will not take part of the present study. Therefore the road freight transport appears as the second most pollutant transport mode and the most used to freight transport [7].

Table 1. Emission factor by transport type (adapted from [7]).

Transport mode	gCO_2/tonne-km	Notes
Airfreight	602	
Road transport	62	
Road/rail	26	Intermodal
Rail transport	22	
Road/short sea	21	Intermodal
Short sea	16	
Deep-sea container	8	
Deep-sea tanker	5	

Another overall green KPI is the ecological footprint. This is a concept that emerged in 1996, developed by Rees and Wackernagel, which intends to measure the amount of natural resources needed to sustain environmentally our lifestyle. It is an estimate of the impact of our actions on the planet in terms of resource use and waste treatment that we, in the sense that we can better protect the planet for future generations [8].

2.3 Analytical green models

There are several models [1,9,10-12] developed which use some algorithms that translate the importance of green practices into logistics processes. The general purpose of these models is to forecasting the environmental impact of alternative decisions and to developing of green processes that minimize such impact and reduce the final costs (production, transportation, waste treatment among others). This is seen as advantages to the companies. But there also some handicaps like the cost to acceptable infrastructures, lack of green laws and punishment to infringers, human resources without specific formation without guidance to “Green” activities.

Table 2 presents a synthesis of some recent and relevant analytical models for green logistics. In general, these models allow companies to understand their environmental impact by using green information system (powered with green information) and the cooperation between all supply chain actors.

The main drawback of the presented models is that, in general, they do not allow companies to quantify, in real time, some indicators like costs, the environmental impact of their activity and decisions and other relevant indicators (e.g. the drivers training impact on daily operations).

Table 2. Example of analytical models for green logistics.

Author and Article Title	Model description
(Iakovou, Vlachos, Chatzipanagioti, & Mallidis, 2011) **A comprehensive optimization framework for sustainable supply chains networks**	Studies the relationship between the environmental impact costs and the transport costs to customers throughout the manufacturing units.
(Goel, 2010) **The value of in-transit visibility for supply chains with multiple modes of transport**	Relates intermodality with some green indicators such as carbon missions, energy use, costs and damages
(Feng, et al., 2008)	Optimizes the location of distribution

Distribution center locations for green supply chain	centers considering transportation costs and emissions from transport and production processes
(Mallidis, Dekker, & Vlachos, 2012) **The impact of greening on supply chain design and cost: a case for a developing region**	Total costs optimization (including emissions costs) by selecting entry points, distribution centers and transport modes used (shared or dedicated)
(Wang, et al., 2011) **A multi-objective optimization for green supply chain network design**	Supply chain optimization considering transport, handling cargo to and from warehouses and future investments in green technologies and equipment
(W. Green Jr, J. Zelbst, Meacham, & S. Bhadauria, 2012) **Green supply chain management practices: impact on performance**	Hypothesis testing of several components such as green information systems, level of collaboration with customers, green purchasing and investment recovery with effects on the environmental performance

2.4 UE legislation

The European Union [13] has been committed for several years to tackling climate change in Europe and the rest of the world as we can observe from the statements of European climate change policies. These statements set several objectives such as "consuming less-polluting energy more efficiently, creating cleaner and more balanced transport options, making companies more environmentally responsible without compromising their competitiveness, ensuring environmentally friendly land-use planning and agriculture and creating conditions conducive to research and innovation."

There are several UE policies (own policies and international adopted policies) that influence all economic sectors but with greatest incidence in road freight transport sector as we will see below in Table 3.

Table 3. Tackling climate change in Europe (source: [13]).

EU Climate change policy (and aims)	Programmes
1. **European Climate Change Programme (ECCP)** Actions to prevent temperatures from increasing to more than 2ºC above pre-industrial levels.	Strategy on climate change: foundations on the strategy. Strategy on climate change for 2020 and beyond.
2. Reducing in greenhouse gas emissions as priority objective Using a monitoring mechanism in place to keep regular track of emissions and the absorption of these gases. Greenhouse gas emissions trading scheme.	Reducing greenhouse gases by 2020. Greenhouse gas: reducing emissions by 20% or more by 2020. Mechanism for monitoring greenhouse gas emissions. Greenhouse gas emission allowance trading scheme. Reduction in fluorinated greenhouse gases.
3. Kyoto Protocol	Kyoto protocol on climate change.
4. Less polluting, more efficient energy Genuine common energy policy. This measures focuses the energy market more on sustainability, particularly by mean of tax measures.	An energy policy for Europe. Community framework for the taxation of energy products and electricity. Sustainable power generation from fossil fuels. Demonstration of the capture and storage of CO_2.
5. Clean better-balanced transport Better management of freight transport and harnessing technology.	Freight transport logistics in Europe.
6. Reconciling road and air transport with the environment A wide range of measures to reduce the impact of road and air transport.	Taxation of heavy good vehicles: Eurovignette Directive. Aviation and climate change. Framework for creation of the Single European

	Sky (SES).
7. Promoting transport by rail and waterways and intermodality To improve the balance between transport modes and to promote less polluting means of transport.	White Paper: A strategy for revitalizing the Community's railways. Promoting of inland waterway transport "NAIADES". Programme for the promotion of short sea shipping (SSS). Strategy to reduce atmospheric emissions from seagoing ships. The Marco Polo II programme.

In general, these EU policies are translated into environmental legislation in the area that transport carriers must meet at pre-established dates onwards.

3 Portuguese freight companies: current situation and perspectives

3.1 Official statistics

According with the study "Logistic Situation on Portugal" called by "Associação Portuguesa de Logística" [14] in relation to the years between 1987 and 2008 with forecasts to 2013 in Europe the transportation costs represents the largest percentage in logistics costs (in % of sales). After an accentuated decline between 1987 and 1998 (from 5.9% to 2.8%) this value can register once again an increase in 2013 to 3.8%.

The forthcoming analysis are taken from Statistics Portugal which is the official organization of statistical analysis [15].

In Portugal the road transport is the most used mode of transport. In 2011 were used 58288 vehicles to the transport of goods to travel a total of 32,226,492 thousand of km and to carry 219,808 thousand of tons. Fuel consumption in road transport decreased 6.6% in terms of tonnes of oil equivalent (toe) reaching 6,193,453 toe. There were also registered decreases in consumption of gasoline (-9%), LPG (-8.9%) and diesel (-5.8%). In other way biodiesel and natural gas increased 3.3% [15].

The diesel is the most used fuel in road transport with 4,654,280 toe in 2010 and a decrease in 2011 to 4,384,332 toe (5.79%). The next one is gasoline with 1,450,134 toe in 2010 and a decrease of 9.05% to a value of 1,318,959 toe.

It results on a tremendous pollutants emissions by the road transport sector. So it is important to adjust new measures to decrease the environment impact.

According with the INE [15] it is possible to conclude that the number of light freight vehicles are the main type of transport. There were a decrease of 1.18% between 2010 and 2011. The heavy trucks are the second largest type of transport used to freight transport with 65,236 units in 2010 and 61,482 units in 2011 (-6.10%).

The road freight transport distance in Portugal is declining for at least the last four years. In 2009, the value situated near the 2,315 million km to 1,748 million km in 2011. In the opposite direction, the international transport distance is increasing since 2009 to values in 2011 near 1,360 million km. This is due to the increase of SSS and the increase of logistics performance, such us of the vehicle routing planning, fleet management, usage of integrated information systems and so one.

It is possible to understand the importance of using diesel engines because. There is at least 1,301,633 light freight vehicles using diesel and only 16,309 with gasoline engine and 754 with GPL. Concerning the heavy trucks there are about 61,456 vehicles equipped with diesel engines and only 9 with gasoline engine and 4 with GPL. This can be easily be supported with Portuguese difference of sales value cost of each type of fuel and taxes policy for vehicle acquisition.

There is a lack of official information about route planning in Portugal, so it is impossible to understand without specific studies to understand how companies select their routes.

3.2 Inferred statistics from interviews

For this study it was decided to carry out a set of semi-structured interviews. These interviews were conducted with four companies representing approximately 80% of turnover in the sector. So this subset of a statistical population accurately reflects the entire sector. The main aspects approached during the

interviews are related with environmental aspects, routes planning, drivers training (about environmental concerns and security) and vehicles properties. Companies are identified by A to D.

The road transport sector represents a huge responsibility on society's life quality and their development because it takes easy to move people and freight always considering a sustainable development.

Portugal is no exception in the European community and the geographic location contributes to the dependence of road transport in the commercial transactions. Therefore it is important that the road transport sector to be efficient, effective, sustainable and flexible.

After analysing the Portuguese reality it's important to evaluate with detail the actuality near road shippers and what actions they take to ensure economic viability but also important the environmental sustainability. The developed model tries to cover the most important aspects enterprises need to be aware.

To emphasize the company's importance it is important to regard the number of vehicles they have as we can see in Table 4.

Table 4. Quantity of vehicles by company

Company	Number of vehicles
A	156
B	278
C	178
D	1150

Each one works with the same number of subcontract vehicles and all companies are certified with certified with ISO standards particularly NP ISO 9000:2005, NP ISO 9001, NP EN ISO 14001, OHSAS 18001/NP 4397 and HACCP.

To the interviewees is important that companies use internal information systems to get a network with the different clients and access to a lot of important information that can be handled to measure important environmental and economic indicators. All companies use internal I.S. to easily support the management of all vehicles, control the empty km, load factor, average fuel consumer and €/ton-km. Concerning the empty km travelled the companies have good results as we can see in Table 5.

Table 5. Empty km travelled in road freight transport.

Company	Empty km	Notes
A	50%	Every vehicles with tanks trip
B	5%	
C	10%	
D	NA	

Following the importance to reduce the empty km travelled the companies responsible have the opinion that is important a collaborative platform to guarantee access to significant information like supply of transport services (helps to decrease of empty km) and a real time KPI evaluation. Concerning the same idea load factor and cargo consolidation are important aspects indicated but none of the company determine €/ton-km (only company B demonstrate interest to measure this KPI).

Intermodality can be an important alternative to reduce transport costs, emissions and empty km and the data collected within the interviews are in Table 6.

Table 6. Intermodality.

Company	Number of vehicles (y)	Total %
A	No	
B	Yes	1% - SSS
C	No	
D	Yes	Less than 20% - Railway

The responsible for company C believes that SSS (short sea shipping) partnerships affects the road freight sector and business itself.

The vehicles characteristics are important to their selection and route planning. As we know some countries impose harsh restrictions and penalties to vehicles with a high rate of pollutants emissions.

Older vehicles generate (much) higher CO2 emissions. In Table 7 is presented vehicles average age in companies.

Table 7. Vehicles average age.

Company	Number of vehicles (y)
A	5,5
B	4,3
C	4
D	3 – 5

This parameter is related with the Standard Emissions and CO2 emissions so it is relevant to approach this points. The information collected in the interviewers is demonstrate in Table 8.

Table 8. Vehicles Standard Emissions.

	Company A		Company B		Company C		Company D	
Standard Emissions	Vehicles	%	Vehicles	%	Vehicles	%	Vehicles	%
EURO 1	NA	NA	0	0	0	0	NA	NA
EURO 2	NA	NA	0	0	0	0	NA	NA
EURO 3	NA	NA	64	36	50	25	NA	NA
EURO 4	NA	NA	94	52,8	50	25	NA	NA
EURO 5	100	100	20	11,2	100	50	NA	NA
TOTAL	100	100	178	100	200	100	NA	NA

All companies calculate CO2 Emissions according with the emission factor provided by vehicles manufacturers and fuel consumption.

The recycle costs is other important way to understand the company environmental impact. All companies prove this importance in their decisions. The waste resulting from maintenance operations on Company A are forwarded to operators properly qualified. The vehicles tires will be always retreated until it's possible to practice. At this time the tires are taken by contracted providers from company installations. The tires maintenance service happens directly at company premises. On company B the vehicles maintenance is performed by vehicles suppliers into company's facilities. The waste generated by maintenance activities is carried by the brand to its facilities. Thereafter this garbage is collected by a certified "ECO company", that delivers a proof that the material was treated according with the existing standards. Oils and scrap go through a similar process but these are lifted in a regular way. The tires are totally controlled by an external enterprise with a covenant on km. All waste generated by Company C are placed on a segregation machine (including filters, brake shoes, absorbents and even waste from employees). The tires selection is done according with characteristics that allows the maximum noise reduce and disc brake shoes not constituted with asbestos. Company D performs vehicles maintenance strictly according with the vehicle original plan of maintenance. There wasn't possible to identify how company manage their vehicles and activities wastes.

Other important aspect discussed during interviews was drivers selection and training. Regarding the drivers training all companies have specific formation areas and hours (Table 9).

Table 9. Drivers training criteria.

Company	Criteria
A	NA
B	Variable per driver depending due to the need (individual evaluation
C	3000h/year (total drivers)
D	< 10 h per driver

There is generally acuity towards drivers training so that can adopt a correct driving and a preventive vehicles maintenance.

4 Proposed conceptual model

After analyzing the previews models it was decided to develop a model (Fig. 1) that allows companies to understand the real impact of their activity, which can be changed or improved, taking into consideration ratios or KPI. So this is an advantageous tool to company's because it allows the easy access to some target indicators in a simple unique tool. In a simple way an evaluation can be connected to the different departments and responsible in order to join the necessary efforts to make their activity more competitive and more environmental respectful.

The model deals with five critical levels 1) Integration of different information systems (on web) 2) Integration of different information systems (intranet) 3) Vehicles selection 4) Drivers selection and 5) Routes planning.

The model is structured to assess the level of commitment with national and international regulations and connects two major groups: 1) road shippers and 2) customers/sector companies. Road shippers are all companies that receive requests for freight transport and customers/sector companies the entities that receive the good transported and all transported companies that haven't responsiveness or capacity to cargo consolidation and requests partnerships.

The model expects a cooperation between this groups with their information systems that support decisions based on a common database resulting in a win-win partnership so that costs can be reduced and gains shared, develops partnerships in exceptions situations, fulfillment the time of customers' requests to thereby keeping high service level near customers.

Therefore we propose the inclusion of the concept of green logistics, thus road freight transporters load the vehicles in destination countries so the return trip towards Portugal happens with vehicles with high load occupancy. Thus the supply chain ensure a more greener activity with a high efficiency since the cost per ton transported is less according the quantity transported increases [2,3,16). Below we will present the five critical levels.

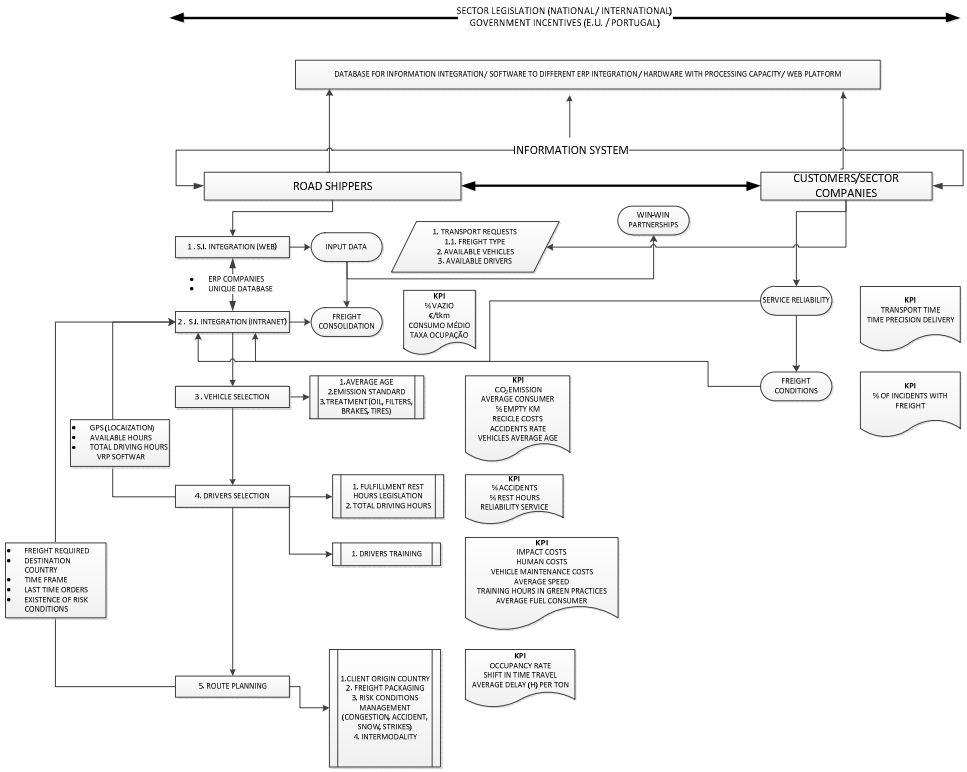

Figure 1. Green model developed.

5 Discussion

It is important to create and use a common database based on a web resource that allows the integration of the different information systems from road shippers and customers/sector companies. This allows an important strategic position that business partners must have to create win-win partnerships [17] to split costs and share profits. This level can be adopted by each company if they understand that this strategy can reveal an important strategic position in the market.

The road shippers insert important information respect to vehicles and drivers availability and possible routes. On the other hand, customers/sector companies enter information about their cargo transport necessity (visualized by road shippers and posteriorly approached) or they see the availability from road shippers and decide the different alternatives.

The information systems are vital in all companies, and the road shippers are not an exception. IS supports their all operational activities, decision-making and strategies developing.

The performance evaluation should occur through the analyzing of performance indicators in order to facilitate decision-making, simplifying the management of Human Resources and vehicles fleet (location, cargo, average speed, locals and times of starting and stopping routes, among others). The IS are important in order to receive customers' requests on an easy mode [18].

There are some green KPI that can be calculated as show below.

$$\%\ \text{empty km travelled} = (\text{empty km travelled})/(\text{total km travelled}) \times 100 \quad (1)$$

$$\text{Average fuel consumer} = (\text{Total fuel consumer})/(\text{standard consumer}) \quad (2)$$

$$\text{Load factor} = (\text{capacity occupied})/(\text{total capacity}) \times 100 \quad (3)$$

The vehicle allocation to a specific route is subject to several decision variables so it's extremely important to make a careful analysis to IS data. Some factors involved the final freight destination (careful vehicle selection due Standard emission gases like EURO 4 or EURO 5 as we can see in equation 8) or freight type. There are some aspects that should be taken into account in order to minimize vehicles environmental impact as shown next.

$$\text{Average vehicle age} = (\sum \text{vehicles age})/(\text{Total vehicles}) \times 100 \quad (4)$$

$$\text{Accidents rate} = (\text{accidents number})/(\text{Total trips}) \times 100 \quad (5)$$

$$\text{g/tonne.km} = \text{fuel emision factor} \times (\text{energy consumer})/(\text{load factor}) \quad (6)$$

The drivers are one of the main pillars to acquire a green supply chain because they are the responsible in several decision-making. Therefore their training is very important in several aspects like road and freight safety, speed adaption, cargo accommodation and performs preventive maintenance. There are some performance indicators that can be used to measure the impact of drivers and their training to ensure green practices in the supply chain listed below.

$$\text{Fulfillment rest hours} = (\sum \text{rest hours})/(\text{Total rest hours}) \times 100 \quad (7)$$

$$\text{Consumer reduction rate} = (\text{inicial consumer (l)})/(\text{consumer after training (l)}) \times 100 \quad (8)$$

$$\text{Accidents reduction rate} = (\text{Total accidents before training})/(\text{Total accidents after training}) \times 100 \quad (9)$$

The routes planning are subject to several decisions which are reflected in a green supply chain. Firstly it is important to take into account the freight destination and the vehicle selection (Standard emission) as described in equation 8. Second it is imperative to obtain a high rate of load factor (equation 5). It is also important a correct risk conditions management to avoid the vehicles travels occur on congested roads, road with traffic bottlenecks due accidents, roads constructions and strikes. Usually this conditions can result in a high fuel consumer, reliability decrease, road safety decrease and high attrition vehicle [19].

$$\text{shift time} = (\text{time travel (h)})/(\text{standard time travel (h)}) \quad (10)$$

The customers are an important element in supply chain and their decisions and behaviors can also help to ensure a green supply chain. So it's also important that the two major groups use I.S. to integrate their efforts [17].

The reliability of the road freight transport can be an important performance indicator as indicated on equation 12. Also it is possible to use other KPI such as:

$$\text{Service level} = (\text{n}^{\text{o}} \text{ services satisfied})/(\text{Total services}) \times 100 \quad (11)$$

$$\text{Freight conditions} = (\text{Number incidents})/(\text{Total ton shipped}) \times 100 \quad (12)$$

6 Conclusions and suggestions for further work

The issues related to the environment are on the agenda. Meanwhile, the road will face a number of setbacks in the coming years. Not only will the customer ask the supplier to measure the carbon footprint of its business, but also will the European Union issue a considerable amount of environmental legislation in the area that the carrier must meet.

This work addresses concepts such as green logistics and environmental footprint and applies them to the design of a conceptual model to aid SME road transport companies to undertake their green logistics. The changing of attitudes, the awareness of environmental issues and the implementation of a set of steps encourages companies to be able to provide an innovative green service to their customers. This service also involves the execution of part of the usual routes by sea, using the existent motorways of the sea and helping to reduce the environmental footprint of the supply chain, of the truck company, to reduce costs and delivery times to the customer. Thus, the carrier meets the rules, improves his service to his customer and manages the problem of external costs, which is always beneficial to his business.

The result of applying a strategy for green logistics to a road transport operator is a cost reduction and a shorter delivery time, which are positive, ultimately, to the customer. The society itself also wins because of the decrease of the environmental footprint of the carrier.

The road transporter has much to gain in the implementation of a green logistics service. Besides being the only possible path to follow, it is the right thing to do, it is more efficient, more competitive and allows society to walk on the path of environmental sustainability in the benefit of all.

When analyzing the reality of companies in Portugal using the interviews and survey data, it can be concluded that companies generally meet with policies and environmental issues in general. As an example may be mentioned the concern about the use of vehicles whose emissions standards are the most technologically advanced like EURO 5 standard. It would also be expected that the Portuguese government and E.U. create incentives to slaughter vehicles in end cycle of live with high pollution emissions rate or lower standard emissions thus leading to a sustainable and cleaner/greener logistics activities.

Thus, it is explicit that for Portuguese firms are important the environmental concerns which demonstrates the constant preoccupation with the use of vehicles with higher standard emissions (like EURO 4, EURO 5 and in the future EURO 6) for lower pollutants emission, with driver training so that they adopt sustainable decisions along the paths and their mode of driving as well as the importance of intermodality to reduce logistic costs and improve environmental performance throughout the supply chain (including production processes and / or vehicles maintenance).

Although a deep reflection is still lacking, study and development it is important to the creation of a common platform in order to meet clients needs complying the logistics and supply chain premise.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the financial support provided by the European Union through FEDER–"Programa Operacional Factores de Competitividade" (POFC) and by the Portuguese Government through FCT–"Fundação para a Ciência e a Tecnologia" under project FCOMP-01-0124-FEDER-022674.

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