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The Ecological Efficiency of Green Fuel's Distribution in NAFTAL Laghouat Using Data Envelopment Analysis (DEA)

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Abstract:

This paper discusses the ecological efficiency of fuel Distribution practices in NAFTAL company. With the using the data envelopment analysis 'DEA' as a tool measurement.

The results show that technical efficiency under the variable scale yield, the values θ was less than 1, (0.204,0.299) in the stations, This implies that it is possible to increase other ways in fuel transportation assured the minimum of CO2 emission ratio.he minimum of CO2 emission ratio.

Keywords: Technical efficiency, Data envelopment analysis (DEA), Green distribution, Fuel.

(JEL) Classification: C140 ،C610 ، Q520 ، Q47.

1. Introduction:

Sustainability and green trends have the wherewithal to withstand shifting consumer interests. Most importantly, green marketing and the incorporation of sustainability within a business model allows for market adaptation and effective capturing of the consumer audience the by organization's efforts in producing, promoting, packaging, distributing with a manner that responsive to ecological concerns. (Mehdi et al., 2013)

The green distribution determines the supply chain cost and increased environmental awareness through his practices, which span from reducing the amount of fossil fuels and greenhouse gases used in. (Vaibhav & Anand, 2015)

This study aims to find the technical efficiency of the fuel distribution, and show the ecologic-efficiency factors, using the data envelopment analysis **(DEA)** method as a tool which helps making decision. (Djimasra, 2010)

To improve the road fuels transport of NAFTAL Company it indispensable to include all information about the traffic distances and the fuels consumed to reduce CO_2 emissions.

1.1. Research Problematic

Green Distribution is the sustainable distribution practices of goods and services through each Sustainable practice that reduce carbon dioxide, to assure a better quality of life for the earth's future inhabitants. (Wong & Rashad, 2015).

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1.2. Research Aims

Green distribution in NAFTAL Laghouat Campany, will analyse the different means of transport in the energy consumption–time ratio in each transportation station. (Vaibhav & Anand, 2015). This study therefore proposes that:

1.3. Research Hypothesis

H0: Green distribution practices do not have an ecologic-efficiency in NAFTAL Laghouat Campany.

2.Literature review

Green distribution is a very delicate operation in the marketing mix we try to spotlight some definitions.

2.1 Green distribution definition

Today's, the marketing Action programs are all marketing integrate actions trough the company's activities for each customer needs in order to achieve both objectives (Kotler et al., 2019, p. 28).
Green distribution includes two internal and external aspects. Internal aspect involves the internal environment of the corporation that must be a place in which managers and employees have a sense of tranquility besides observing the environmental issues in the internal corporation processes. The external aspect means any offering the products and services by the way which have the least harm for the environment (Vlosky et al., 2006).
Many clean distributions (or transportation) processes that taken in consideration through descriptive reconstruction of economic, financial political and technological factors, by companies as:(Traistaru, 2013)

A. Developing of centralized distribution method that creates environmental advantages such as decreased movement of vehicles and reduction of shipments;
B. Compiling a suitable policy and purpose to decrease the pollution of vehicles which is tribute the products;
C. Analysis of costs and utility for feasibility study of the recycling system of wastes and packaging;
D. Enhancement of environmental awareness both in the corporation and among the parties to the transportation contract (Sudhalakshmi & Chinnadorai, 2014, p. 110).

Green distribution is a very delicate operation, it must be guaranteed the 'Ecological nature' in the transportation of products. (Yazdanifard & Erdoo Mercy, 2011).

2.2 improving road transport of fuels: minimizing CO_2 emissions.

Fossil fuel and energy consumption in delivering the products to customers, is one of the basic environmental Challenges for most businesses. the activity of the freight sector is the source of an increasing share of GHG emissions, mainly road transport; transport, with the share of goods. Increased GHGs, including CO_2 emissions from transportation in general and freight transport in particular, contribute to global warming. (Quoc-Dat, 2017, p. 413).
The notion of CO_2 information about transport services includes the calculation of transport services and minimizing it, as much as possible to less polluting the environment when distributing

fuels.

2.3 The definition of CO_2 information:

Greenhouse gases: are constituents of the atmosphere that absorb and return certain radiation lets emitted from the earth's surface, atmosphere and clouds. The exaggerated increase in these gases, due to human activities, is a factor responsible for global warming. The main greenhouse gas in the transport sector is carbon dioxide (CO_2), which is emitted during the production phase for electricity and during the production and operation phases for fuels (Energies, 2019) CO_2 information on transport services: is about the amount of carbon dioxide used by a transport means.

2.3.1. The usefulness of CO_2 information:

A. CO2 information on transport services is an important tool in implementing an environmental progress approach at the transport provider;
B. CO2 information responds to a need for awareness and the right to environmental information of individuals;
C. The CO2 information on transport services, aims to make all players in the transport chain aware of their contribution to greenhouse gas emissions.

The companies challenge is maximizing their profit and minimizing CO_2 emissions from vehicles used in distribution, and adopt the sustainable transport in the fuel distribution sector.

2.4 How we calculate the CO_2 emission in the transport field?

There are different methods to calculate CO_2 emissions, described as follows:

2.4.1 Life cycle analysis method (LCA): The life cycle analysis (LCA) method is a technical research tool to analyze the impact of a "product" (good, service or process) on the environment.

In transportation, this method takes the energy used in the vehicle's engine, the construction and maintenance of each vehicle.

2.4.2 The Carbon footprint method: it applied to quantify the sum of net greenhouse gas emissions (also including greenhouse gas absorptions) of a product system, expressed in CO_2 equivalents.

Both methods, Carbon footprint and ACV, cover the production and use of the product (France, 2018).

2.4.3 ADEM's Carbon Balance Method: It aims to prioritize the emission's position in organization, in order to enable a dynamic of emission reduction. Since 2000, ADEM has developed a new methodology for quantifying greenhouse gas emissions for organizations (or local authorities) called Carbon Balance.

2.4.3.1 The approach used by ADEM Carbon Balance Method: This method quantifies the emissions resulting from the processes required for the activity, including emissions from the transportation activity that is the subject of a particular tool. The Carbon Balance method has been precisely developed to convert this activity data into estimated GHG emissions, expressed in carbon equivalent.

2.4.3.2 Description of the steps of the method: There are four steps in this method:

A. The transport decomposition delivery into segments;
B. The calculation of the amount of energy source consumed for each segment;
C. The conversion of the amount of energy source into the amount of carbon dioxide for each segment is done through emission factors;
D. The carbon dioxide amounts addition of in the different segment.

2.4.3.3 The energy source emission factor: is calculating CO_2 emissions basing on the amount of fuel consumed (ecoscore, 2020).

Diesel:

1**liter** of diesel weighs 835 g. Diesel is made up of 86.2% carbon (C), which corresponds to 20g Carbon/l of diesel. To burn this C in CO_2, 1920 g of oxygen are needed. The sum 720+ 1920gives: = **2640** g CO_2/ liter of diesel.

A vehicle that consumes 5 liters/100km will therefore emit 5L * 2640 g/L/ 100 km: **132** g CO_2/km.

Gasoline (essence):

1 **liter** of weighs 750 gr. Gasoline is 87% carbon (C), which equates to 652g C per liter of gasoline. To burn this C in CO_2, 1740 g of oxygen is needed. The sum gives us 652 + 1740= **2392** g OF CO_2 / **liter** of gasoline.

Including:

E10: (It contains 10% bioethanol and 90% gasoline), made mainly from beets and wheat; in order to significantly reduce greenhouse gas emissions but also to increase the share of renewable energy in the transport sector; by amount of emission of :**2211g** Of CO_2/Liter.

E85: (It contains 85% bioethanol and 15% gasoline); **SUPERETHANOL** E85, consists of 65-85% bioethanol and 15-35% unleaded 95 (SP95).

Bioethanol is a green fuel made from plants and plants containing sucrose (e.g., sugar cane or beetroot) or starch (wheat or corn …) (total, 2019)

The CO_2 emission amount:**1610**g Of CO_2/Liter.

LPG: LPG refers to: **LIQUEFIED OIL GAZ**. These are blends of Butane (C_4) and Propane (C_3). LPGs can be obtained from a variety of hydrocarbon processing sources (Transport &Environment, 2018)

1 **liter** of GPL weighs 550 grams. The GPL is composed of 82.5% carbon (C), which corresponds to 454 g C /liter of GPL. To burn this C in CO_2, 1211 g of oxygen is needed. The sum gives us 454 + 1211 = **1665** g CO_2 /l of LPG.

A car that consumes 5 liters/100km will therefore emit 5L *1665 g/L 100/km): **83**g CO2/km.

CNG: **Compressed Natural Gas** the **NMC** is a gaseous fuel (natural gas) that is stored under high pressure. Consumption is therefore expressed in m^3/100km. Nm^3 corresponds to one m^3 in normal condition (1 a t m and 0^oC).

1N m^3 CNG weighs 717 gr. The NMC is composed of 69.2% carbon (C), which corresponds to 496 g of C / Nm^3 of NNG. To burn this C in CO_2, 1323 g of oxygen is needed. The sum gives us 496+ 1323 = **1819** g CO_2 / Nm^3 of NNG.

A vehicle that consumes 5Nm^3/100km will therefore emit 5Nm^3 * 1819 g/Nm^3 / 100 km: 91g CO_2/km (ecoscor, 2020).

There is a direct relationship between a car's consumption and its carbon dioxide (CO_2) emissions, the more one consumes and the more one rejects, this ratio is quasi-fixed. (motor nature, 2020)

A. The season weather

Oil tankers adapt their products, and do not sell the same gasoline, or diesel, in summer as in winter.

B. vehicle-related factors

It's about the engine features which, depending on its design, an engine will produce combustion that will generate more or less impaired, but an exhaust recirculation system (EGR) will be able to reduce them.

C. The clean-up system

the catalyst reduces emissions of **NO** nitrogen oxides and **CO** carbon monoxide, its main effect is to turn them into water vapor and CO_2.

D. Factors related to the environment of use: that includes:

Altitude:

The density of the air, compressing, varying according to altitude, an engine will not absorb the same air mass to burn its fuel, and CO_2 emissions will vary accordingly.

Temperature:

Because of warm, air is less dense, then cold air, an engine will not absorb the same air mass to burn its fuel according to the outside temperature, and CO_2 emissions will vary accordingly.

Hydrometrics:

The amount of H_2o water in gas in the ambient air, varied at density air, which alters combustion conditions, with exhaust effect.

Table (01): CO_2 Emission with energy source

Energy source type	measuring Unit of the energy amount source	Emission factor (kg of CO2 /liter)
Diesel	1.Liter	2.64
Gasoline	1.Liter	2.392
SuperGas B85	1.Liter	2.211
SP95 E10	1.Liter	1.610
Liquefied Oil Gaz lPG	1.Liter	1.665
Compressed Natural Gas CNG	1.Liter	1.819

Source: Canada, M.o, 2014, p. 2**.**

2.5 Algeria efforts in maximizing energy consumption and reducing CO_2 in the fuel distribution emissions

Algeria is making efforts to make clean energy such as natural gas available for our various domestic and industrial needs, which puts it in an advantageous position in terms of GHG emissions and air pollution. It is well known that associated with natural gas are reduced when compared to other fossil fuels (Ministry of Environment and Renewable Energies, 2019).

Despite this relatively advantageous position, Algeria has for many years taken various measures to optimize energy consumption and thereby reduce GHG emissions. These measures are both

legislative and regulatory, but also cover the development of national renewable energy and energy efficiency programs.

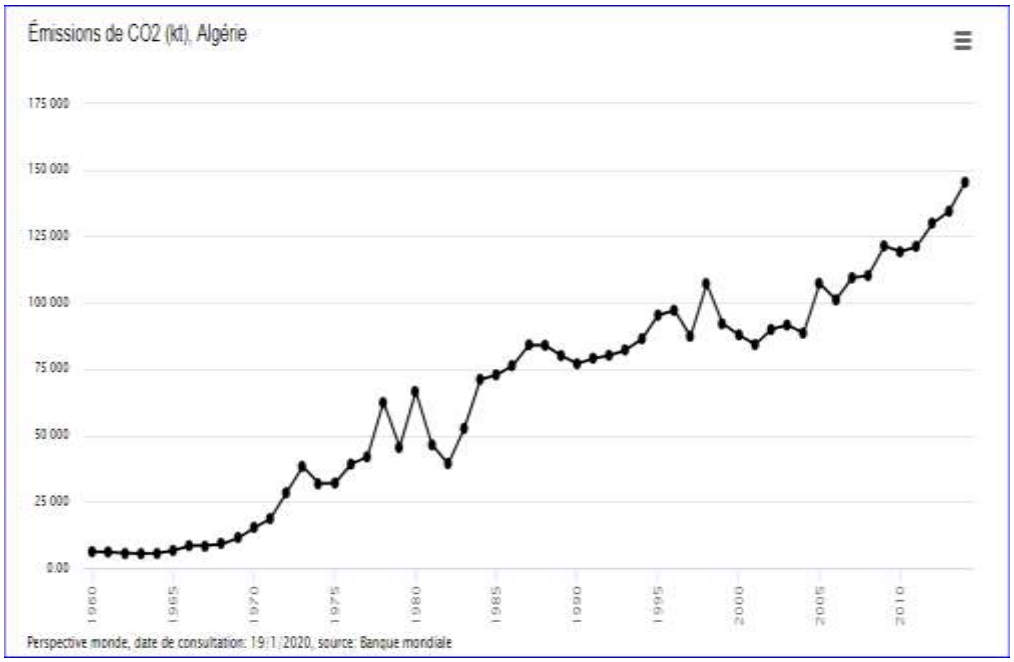
Regarding the energy sector, it takes action to reduce greenhouse gas emissions and air pollution and continues to put policies and strategies in place to preserve the environment.

These actions and policies undertaken by the energy sector are mainly focused on the development of clean energy particularly renewable one, whose production capacity will revise upwards to 27 % by 2040 of the total electricity generation.

Many Policies and strategies are in place to reduce CO_2 emissions and promote the least CO_2-emitting energies such as the regulations on the prohibition of flaring, which are permitted on exceptional authorization. Gas discharges from facilities must meet regulatory discharge standards and regulation of the 1% tolerance of flaring will be applied from 2020.

These actions have led to a significant reduction in GHG emissions. Since 1973, the rate of flaring has increased from 78.6% in 1970 to 8% in 2016. This reduction effort will sustain, through the new gas recovery projects to reduce the gas flaring to less than 1% as envisaged in Algeria's National Determined Contribution. (NDC) (Energies, Air pollution Information and Assesement, 2019, p. 04).

Fig (01): CO_2 gas Emissions in Algeria



Source: (world bank, 2019)

Table (02): Energy consumption rate for each type of transport vehicle and his CO_2 emission rate transported in Algeria

Description (Kind of the vehicle and the type of transport carried out with indication of the source energy used	**Rate of energy source consumption by the means of transport (unit of measurement of the energy amount source by kilometer**	**CO_2 emission rate transported unit by /t.km**
Carrier 7.5 tones PTAC - **Merchandise's** goods- Road diesel	0,220 ℓ / km - Road diesel	750g CO_2/t.Km
Carrier 12 tones PTAC - various Merchandises - Road diesel	0,240 ℓ / km - Road diesel	409g CO_2/t.Km
carrier 26 tons PTAC - - Road diesel	0,305 ℓ / km - Road diesel	156g CO_2/t.Km
articulated set -35 tons PTRA /long distance Diesel road	0,342 ℓ / km - Road diesel	189g CO_2/t.Km
articulated set 40-ton PTRA - merchandise. / - Diesel road	0,338 ℓ / km - Road diesel	84.0g CO_2/t.Km
articulated set - 40-tonne PTRA merchandise/various - Diesel road	0,379 ℓ / km - Road diesel	83.0g CO_2/t.Km
Articulated set 40 tones PTRA - Citerne -	0,353 ℓ / km - Road diesel	86.7g CO_2/t.Km

Source: (Zeddam & Menaa, 2018, p. 77)

3. Research background

New approach, strategy for sustainable transportation in NAFTAL Telemcen Company was proposed, through a multi-objective optimization model maximizing profit and minimizing CO_2 emissions; the results obtained were solution in making decision to choose between multi-compartment and multi-product vehicle touring. (Zeddam & Menaa, 2018)**.**

To evaluate the input–output performance of the manufacturing industry, Zaiwu use the DEA model of constraint the environmental pollution in the Yangtze River Delta (YRD) region in China. He took the distribution characteristics in the interval data (Based normal distribution) (Zaiwu & Xiaoqing, 2017)

The effect of green distribution technology, is significantly influenced the using of the internet distribution network, and increasing the competitiveness of Kenya's food manufacturing. (Anne et al., 2016)

We can resume all that to indicate the ecologic-efficiency of distribution we have to control the positively adoption of green distribution practices to enhance environmental sustainability.

4. Methodology

The data envelopment analysis DEA is benchmarking technique assesses the performance of organizations through an efficiency score, which was calculated against a border of efficiency of 1 (100%), (it's called decision-making units) that transform (inputs) in benefits (outputs) (Huguenin, 2012).

The concept economic efficiency is becoming increasingly important in our research, it provides ability indication, which refers to the use of inputs in optimal proportions, taking into account their respective costs, the technical efficiency operates with adequate scale performance scale elasticity"**1**" (Domenique, 2006, p. 51)

The data envelopment analysis DEA method is an analysis tool for decision-making area by: (Charnes et al., 1978)

A. calculating an efficiency score, it indicates whether an organization has room for improvement;
B. setting target values, it indicates how much inputs, outputs must be reduced and outputs increased efficiencies;
C. identifying the type of scale yields;
D. Identifying the reference peers, it identifies which organizations have the best practice to analyze (Sherman & Zhu, 2006).

5. Variables

The study used statistics and formal data which was collected through the company reports in their six 06 distribution stations and analyzed by data The data envelopment analysis DEA using 'frontier4' software program

Table (03): truck consumption by rotations

truck Type	Nbr of trucks	Fuel using in transportation	price unit L »	Number of rotation/ per day (200km/day)	Full fuel consumption/ per Km
ligide truck 12k m^3 (12000m^3)	2	diesel	23.06da	2/day	300 Km
Tank truck 27k m^3	1	Diesel	23.06da	2/day	700Km
tank truck 30k m^3	2	diesel	23.06da	3/day	700Km

Source: Company documents

Rotation (back and forth) = 100*2=200 Km
Rotation number per /month = 60
Average distance = 200Km/day

NAFTAL Laghouat uses five (05) trucks for the fuel transportation distribution namely: 2 12k m^3 rigid trucks, 1 27km3 tanker truck and 2 30km3 tanker trucks. The objective of this analyze, is to verify the ecological efficiency mentioned in the research hypothesis

H_0: Green distribution practices do not have an ecologic-efficiency in NAFTAL Laghouat Campany.

Of this distribution channel and this by minimizing the CO_2 emission compared to the fuel consumption (mainly Diesel) and the number of rotations of the trucks. The figures presented below represent the month of December 2019.

The variables used to measure ecological efficiency are defined as follows:

Y: the CO_2 emission for each type of truck (gram per kilometer)

X1: fuel consumption of each type of truck (liter / month)

X2: the rotation of each type of truck (kilometer / month)

6. Results and discussion

To calculate the coefficients of technical efficiency θ we used "Frontier 4.1". In addition, the CO_2 emission values are calculated according to the meta-heuristic method.

Table (04): Coefficient values

Truck types	CO_2 emission(y)	Fuel consumption(X1)	Truck rotation (X2)	Coefficients θ
12km^3 ligide truck (2)	7362000	276720	18000	**0.299**
27km^3 tanker truck	6552000	276720	42000	**0.204**
30 km^3 (2) Tanker truck	6552000	276720	42000	**0.204**

Source: Illustration personnel by "fontier4" software

According to the results presented in the table above, we Prove

H_0: NAFTAL Laghouat Campany do **not have an ecologic-efficiency** in their Green distribution practices, through the type of truck showed ecological efficiency (the values θ less than 1), namely the respective coefficients were: 0.299, 0.204 and 0.204. In order to increase their ecological efficiency while keeping the same turnover should invest in greener trucks as this will allow them to reduce fuel consumption as well as the environmental tax. So, to reduce the number of rotation and make the supply chain more efficient, it is necessary to choose strategic sites for future stations.

7. Conclusion

In this paper we have detailed the use of DEA as a decision tool for distribution systems. DEA provides a number of opportunities, which seem to justify its use. This includes the usage of minimal a priori assumptions, objectifying characteristics, system without losing the possibility of global optimization. This important aspect is often neglected in more complex systems and local solutions or heuristics are treated as the global optimizers.

Another aspect to mention is that DEA does neither require specifying the relation between inputs

and outputs nor does these hidden functional dependencies has to be equal among all alternatives.

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