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# Sustainability in Industrial Logistics Operations

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# SUSTAINABILITY IN INDUSTRIAL LOGISTICS OPERATIONS

Directed Project Report

Submitted to the Faculty

Of Purdue University

By

Vishnu Siddharth Somanur Paramasivam

In Partial Fulfillment of the

Requirements for the Degree

Of

Master of Science in Industrial Technology

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## SECTION 1. INTRODUCTION

### 1.1. Statement of the Problem

Automotive CO<sub>2</sub> emissions from transportation contribute to 30% of the global CO<sub>2</sub> emissions and has been increasing rapidly says Raux. (2009) (p. 36). Vehicles used by companies to transport goods run on fossil fuels and emit CO<sub>2</sub> that is a green-house gas, which is partly responsible for global warming that can lead to many environmental impacts such as increase in planet's surface temperature, melting of arctic ice caps and increase in sea level (Hansen et al. (2012) (p.36). Neglecting to take actions on this front can be catastrophic to our planet Earth. Companies have to take initiatives to reduce the emissions from the transportation part of their operations to ensure a better future for the people and the planet.

### 1.2. Significance of the Problem

In the recent decades the content of atmospheric CO<sub>2</sub> has been on the rise due to automotive emissions. CO<sub>2</sub> is a greenhouse gas and it causes global warming. Scientists in WWW.CO2NOW.ORG claim that 350 parts per million (ppm) is the safe upper limit for the atmospheric CO<sub>2</sub> content. But currently the number has reached 397.34ppm (WWW.CO2NOW.ORG) and will continue to rise if no counteractive measure is taken. Companies are stepping forward to reduce the CO<sub>2</sub> emissions by implementing sustainability practices. Companies rely on vehicles that run on fossil fuels to transport goods from one place to

another. Trying to reduce CO2 emissions by cutting down the number of vehicles without a strategy or solution can cause serious impact to the business.

Companies are being innovative by incorporating sustainability practices in their logistics operations to reduce the CO2 emissions.

### 1.3. Research Question

What are the sustainability practices that the companies are following in the logistics operations to reduce the CO2 emissions from the vehicles used for transportation?

### 1.4. Statement of Purpose

Companies should start taking accountability for their contribution to CO2 emissions and find means to reduce the same. The researcher explored the means by which the companies are reducing CO2 emission from the vehicles used for transportation and found that the companies are implementing sustainability practices in the logistics operations as one of the ways to reduce the emissions. Through literature review of the sustainability information provided by the Wal-Mart, Honda, Mazda, Apple and UPS, the researcher documented the best sustainability practices followed by the aforementioned companies right now in an aim to reduce the CO2 emissions. For those companies which are looking for initiatives to reduce emissions from transporting vehicles, this report can guide them to identify the current sustainability practices and help them choose a practice for their own operation.

### 1.5. Definitions

Global Warming: “Global warming refers to climate change that causes an increase in the average temperature of the lower atmosphere.” as per Kim, Y et al. (2010)

Logistics: Coyle, J et al. (2008) in their book define logistics as “Logistics is the process of anticipating customer needs and wants; and acquiring the capital, materials, people, technologies and information necessary to meet those needs and wants; optimizing the goods or service-providing network to fulfill customer requests; and utilizing the network to fulfill customer requests in a timely manner”.

Sustainability: Ross et al. (2011) mentioned “in general, the most frequently cited definition of sustainability, adopted by the World Brundtland Commission on Environment and Development, is "to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs””.

### 1.6. Assumptions

The project was completed with the following assumptions:

- Companies were aware of the environmental impacts due to the CO<sub>2</sub> emissions
- Companies were aware that the vehicles used for transportation emit CO<sub>2</sub> into the atmosphere



- Companies under study were trying to reduce the CO2 emissions
- Companies were trying to implement sustainability in an aim to reduce the CO2 emissions

### 1.7. Limitations

The project involves the following limitations:

- The companies under study may not have published all their best sustainability practices information
- The companies under study may follow sustainability practices in other part of the operations to reduce CO2 and not in the logistics
- The companies under study may not divulge information on sustainability and projects related to sustainability as a result of company policy

### 1.8. Delimitations

The project involves the following delimitations:

- The project was based on the environmental impacts due to CO2 emissions
- The project considered only the practices that were listed or mentioned under the topic sustainability and that aimed at reducing the CO2 emissions from the vehicles used by the companies for the transportation of products or services

- The sustainability practices studied in this project aimed at reducing CO2 emissions from the vehicles used by companies for transportation purposes only
- The companies under study have their own fleet for transportation of parts, finished or services
- This project did not cover the social or economic impacts due to sustainability
- The project did not involve the cost or any other financial aspects related to the sustainability practice
- The project did not cover the magnitude of reduction through the sustainability practices
- The project did not include any tool to measure the impact of the best practices

## SECTION 2. LITERATURE REVIEW

### 2.1. Introduction

In this section, through review of literature, the author establishes credibility to the topic of the project. As this project focuses on what the companies are doing in order to meet the sustainable goals by reducing the CO2 emission, it is vital to understand how sustainability gained attention from the industry, why the companies are trying to incorporate sustainability practices and what are the some of the challenges the companies face to implement sustainability.

### 2.2. Methodology of Literature Review

The review of literature was carried out in the following order.

- First the researcher reviewed the literature pertaining to topics global warming and CO2 emissions in order to understand the environmental impact of CO2 and how it gained attention.
- Once that was understood, the researcher proceeded to the topic of sustainability in order to understand how sustainability helps in reducing environmental impacts.
- Then the researcher moved on to the topics such as sustainability in logistics, supply chain and transportation in order to understand why and how logistics companies are trying to follow sustainability practices.

Most of the literature reviewed by the researcher was found on the internet through internet search. The search strings used for finding the literature were as follows:

1. Global Warming
2. Green House Effect
3. CO2 Emissions
4. Atmospheric CO2
5. Sustainability
6. Sustainability in Logistics
7. Sustainability in Supply Chain management
8. Green Logistics
9. Sustainable Logistics
10. Sustainability in Transportation

### 2.3. Environmental Issues

The concept of sustainability came into existence only after the realization of the environmental issues. The environment is being constantly affected due to man by various means. In sustainability terms, this phenomenon of impact on environment due to man is called anthropogenic. The modern lifestyle of man involves actions and materials that are not friendly to the planet earth. Industries are setup to provide products and services to satisfy the needs and wants of humans. And these industries contribute significantly to the pollution of

environment in the forms of emissions, effluents and wastes. When talking about logistics industry in specific, the most of the environmental impact is caused due to emissions.

The main component in the emission is CO<sub>2</sub>, which is a greenhouse gas. Geologists and environmental experts have been studying the impacts of such emissions for decades. Hiramatsu, Mimura and Sumi (2008) say “research activities on climate change and global warming have experienced a remarkable worldwide increase in recent years” (p. 36).

Over the past many decades the CO<sub>2</sub> level in the atmosphere has been rising, causing the planet’s temperature to rise and this phenomenon is termed as global warming. Hansen et al. (1981) claims “atmospheric CO<sub>2</sub> increased from 280 to 300 parts per million in 1880 to 335 to 340 ppm in 1980, mainly due to burning of fossil fuels” (p. 36). The vehicles that burn fossil fuels are used by the logistics companies for transportation. Raux (2010) states “transport currently accounts for around 25–30% of global CO<sub>2</sub> emissions and this contribution is growing rapidly” (p. 36).

The even more threatening fact is the rate at which the transportation alone is contributing to the increase in CO<sub>2</sub> levels. “Moreover, emissions from transport have increased sharply by 31% in the world between 1990 and 2003” says Raux (2010) (p. 36).

## 2.4. Sustainability in Logistics

### 2.4.1. Reasons to Practice Sustainability

The numbers mentioned in the section 2.3 raised an alarm and made the logistics industry take serious steps to reduce the environmental impacts. A viable solution to this problem was sustainability. Before entering into the details of sustainability it is necessary to define it. Ross et al. (2011) mentioned “in general, the most frequently cited definition of sustainability, adopted by the World Brundtland Commission on Environment and Development, is "to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs”” (p. 36).

Logistics companies have gone an extra step and started following sustainability practices not just as an additional practice, but as a way to do business. Lieb and Lieb (2010) reported after surveying 29 top third party logistics (3PL) companies that, the top reason why the companies implemented sustainability was “a corporate desire to do a right thing” (p. 36).

### 2.4.2. Ways to Incorporate Sustainability

For the logistics industry, when it comes to transportation, the phrase incorporating sustainability can be simply rewritten as reducing emissions. The first step in reducing emissions is to identify the factors that account for the increase in emissions. Raux (2010) claims that there are two factors that contributes to emissions from transport

#### 2.4.2.1. The vehicle's engine:

Internal combustion engines used in the vehicles run on fossil fuels. Considering the volume of vehicles that are used for transportation, if every vehicle used a more fuel efficient engine or engines that ran on other energy source like electrical, the emission will be greatly reduced. Also governments have started structuring policies like offering subsidies, tax cuts and other allowances for companies that used efficient vehicles. Companies can make use of such opportunities which will not only ensure reduced emissions but can also save money. Hoffman (2008) commented on Wal-Mart's sustainability measures:

The world's largest retailer has one of the world's largest private fleets, with almost 7,000 trucks. The company hopes to use more efficient engines and tires, hybrid drive systems and better transportation network utilization to reduce carbon monoxide emissions and increase vehicle efficiency 25 percent by 2012 (p. 36).

#### 2.4.2.2. The distance travelled by the vehicles.

It is a direct relationship where, by reducing the travel distance, the emissions can be reduced. One aspect of logistics deals with reducing the travel distance and time and optimizing the transportation network. Although it targets to maximize the profits and reduce costs, it indirectly addresses a part of the environmental issue. And it is this remaining part

of sustainability that the logistics companies are trying to embrace. Raux (2010) explains:

Emissions from travel may be reduced by various means: changing driving style, reducing vehicle kilometers of travel (by increasing the number of passengers in the vehicles, reorganizing trips or changing the locations of activities); by changing one's vehicle or changing mode in favor of one which consumes less energy (p. 36).

By designing more robust and efficient transport networks, the companies can greatly reduce the emissions. But these networks are driven by the customer needs. Conducting business with customers who are equally interested in sustainability can lead to a win-win situation. Lieb and Lieb (2010) after their survey from 29 top 3PL companies concluded that "pressure from the customers" as the second biggest reason the companies wanted to incorporate sustainability (p. 36).

Anderson (2012) says "more than 70 percent of the private companies surveyed said their chief executives were actively involved in sustainability policy and strategy development, and almost 60 percent of publicly traded companies reported board engagement" (p. 36).

#### 2.4.3. Benefits of Incorporating Sustainability

Benefits of sustainability for logistics can be three-fold: 1.) Reduction in environmental impact 2.) More customer recognition by incorporating sustainability practices which results in better quality of products and services



and 3.) Financial profit. Other accompanying benefits can encourage companies to implement sustainability in their business. Hoffman (2008) claims “logistics executives say there is still plenty of low-hanging sustainability fruit” (p. 36). In the same article he also quotes Randall Boeller’s (Packaging and engineering programming manager at Hewlett Packard) statement “The good news is if you can reduce logistics costs you can write an environmental story about it” (p. 36).

Customers have become more aware of the environmental issues and have started choosing suppliers and partners who have common goals when it comes to sustainability. Lieb and Lieb (2010) state that “6 CEOs reported that company sustainability efforts led to increase business not only with the existing customers but also with new customers” after surveying 29 top 3PL companies (p. 36).

As mentioned earlier logistics addresses some of the environmental issues. And in turn sustainability addresses some of logistics issues. Better and efficient transportation networks can ensure better customer service level while simultaneously reducing the emissions and increasing the savings for the logistics company. Hoffman (2010) comments that “Wal-Mart projected savings of \$3.4 billion from the initiative, which it said would be equivalent to removing 213,000 trucks from the road” (p. 36). Savings is a desirable effect when it comes to business. And when it can be achieved while also saving the planet, it gives a stronger reason to the logistics to follow sustainability.

#### 2.4.4. Challenges in Implementing Sustainability

Although logistics companies benefit from sustainability, it is not an easy task to implement. There is an initial setup cost and other running costs that discourage many to enter into sustainability. Montreuil (2011) says “The global logistics sustainability grand challenge cannot be addressed through the same lenses that have created the situation. The current logistics paradigm must be replaced by a new paradigm enabling outside-the-box meta-systemic creative thinking” (p. 36).

Lieb and Lieb (2010) inferred from a survey taken from 29 3PL companies that the biggest challenge when it came to sustainability was “balancing sustainability efforts with customer expectations for low-priced 3PL services”. Although sustainability can save money for the company, it is not always the case. Following sustainability practices, such as full-truck deliveries can increase the delivery time but for the customer, time is of essence. Charging the customer extra for half trucks can also ruin customer’s desire to do business in the future. Montreuil (2011) from his study says that:

Vehicles and containers often return empty, or incur extra travel routes to find return shipments. Furthermore vehicles leaving loaded get emptier and emptier as their route unfolds from delivery point to delivery point. In the UK, the proportion of truck-kilometers travelled empty was reported in 2004 to be on the order of 27%. In 2009, the USA industry average was

20% of all miles are driven with a completely empty trailer with many more nearly empty (p. 36).

Logistics being a part of a supply chain network is affected by all the factors that affect the supply chain itself. Some can deteriorate not only the performance of the logistics but also impede the sustainability practices. Sanches-Rodriguez, Potter and Naim (2010) after their research on “The impact of logistics uncertainty on sustainable transport operations” found that “The findings indicate that the main drivers impacting the sustainability of transport operations are delays, variable demand/poor information, delivery constraints and insufficient supply chain integration. The consequence of these problems is to reduce the efficiency of transport operations.” (p. 37).

The uncertainties of logistics and supply chain are the biggest challenges even though there may be many good reasons and promotions to encourage sustainability practices. In this project I would like to study the impact of the logistics uncertainties faced by the logistics companies that pose a challenge to follow sustainability.

## 2.5. Summary

Although there are challenges that can hinder or prevent companies trying to be sustainable, many companies have stepped forward by taking initiatives in sustainability to reduce CO2 emissions and reap its benefits.

## SECTION 3. METHODOLOGY

This section describes the methodology of the research. This research followed a pure qualitative descriptive study that focused on documenting the existing best practices followed by the companies to reduce CO2 emissions in the logistics operations.

The methodology of the project is organized into three following sections

1. Data Collection
2. Data Analysis

### 3.1. Data Collection

The data collection process involved the following steps:

#### 3.1.1. Selection of Literature:

As this is a descriptive study of what companies were doing to reduce CO2 emissions through logistics, for accurate information, the researcher chose the sustainability reports and other sustainability information and news published by each company in their journals or website. Most of the literature was found on the internet through web searches.

#### 3.1.2. Selection of Companies:

Selection of companies involved the following steps:

1. 16 companies were first identified based on the researcher's prior knowledge about the company's product or services. They are:

- i. Wal-Mart
  - ii. Amazon
  - iii. UPS
  - iv. Apple
  - v. Fed-ex
  - vi. Honda
  - vii. Mazda
  - viii. Toyota
  - ix. Nissan
  - x. Walgreens
  - xi. Nike
  - xii. Sony
  - xiii. Pepsi-Co
  - xiv. Coca-Cola
  - xv. Chrysler
  - xvi. General Motors
2. A web search was performed to find out if the listed companies owned a fleet for transportation
  3. A web search was performed for the company's sustainability information, report or literature.
  4. 11 companies were eliminated due to two reasons. 1.) The company did not own a fleet for transportation and 2.) The company did not have sufficient sustainability information specifically required for this project.

5. A company with sufficient information on sustainability initiative in logistics The companies selected through this process were:

- i. Wal-Mart
- ii. Mazda
- iii. Honda
- iv. Apple
- v. UPS

#### 3.1.2.1. Web-Search Strings:

The researcher used the following terms to find the appropriate information and literature of the each company.

1. Company's name sustainability report
2. Company's name sustainability initiative
3. Company's name GHG reductions
4. Company's name logistics sustainability
5. Company's name CO2 reductions
6. Company's name GHG sustainability
7. Company's name CO2 sustainability
8. Company's name sustainability transportation
9. Company's name sustainability distribution

### 3.1.3. Review of Literature:

The researcher then performed a thorough review of the literature in order to extract data. The data used for this research was selected based on following aspect.

## 3.2. Data Analysis

Analysis of data involved the following steps:

1. Identification of sustainability practice
2. Identification of common methods

### 3.2.1. Identification of Sustainability practice

A practice was identified as a sustainability practice and was considered for the study if and only if it fulfilled the following criteria: 1.) The source of the information was the company's sustainability data; 2.) The practice aimed at reducing CO2 emissions and 3.) The sustainability practice was implemented in the logistics part of the company's operations.

### 3.2.2. Identification of Common Methods

In this step, the researcher identified that the sustainability practices followed three major methods through which it reduced the CO2 emissions. The following are the three methods:

1. Reducing the Number of CO2 Emitting Vehicles:

Reducing the number of CO2 emitting vehicles on the road eliminates the opportunity for the vehicles to emit CO2.

2. Reducing the distance travelled by the CO2 emitting vehicle:

Reducing the number of miles travelled by the CO2 emitting vehicles ensures that the vehicles do not travel longer distances and thus eliminating the opportunity for emission of CO2

3. Alternative transportation systems:

Switching to alternative transportation systems that have zero or low emissions of CO2 reduces the CO2 emissions compared to the regular CO2 emitting vehicles

### 3.3 Summary

The data was collected from the company's published sustainability information. The companies were selected if they had their own fleet for transportation and availability of sustainability information that pertained to this project. The collected data was then analyzed to identify the sustainability practices and the methods through which the practices reduced the emissions.



## SECTION 4. FINDINGS AND REPORTING

This section discusses each of the sustainability practices identified from the data analysis. A total of 10 sustainability practices were identified. Under the discussion of each of the practice, the methods through which the practice reduces the CO2 emissions is also identified and are mentioned by the number associated to the method as given below:

1. Reducing the number of CO2 emitting vehicles
2. Reducing the distance travelled by the CO2 emitting vehicles
3. Alternative transportation system

### 4.1. Sustainability Practices and Methods:

#### 4.1.1. Modal Shift

Modal shift refers to changing the mode of transportation from the regularly followed mode of transportation to another. By shifting the mode of transportation to a mode that emits less CO2 per transported unit in the distribution network, CO2 emissions can be reduced. Wal-Mart said that it “shipped more goods by rail and fewer by truck, and were able to eliminate miles travelled” (p. 37). Honda stated that in order to reduce CO2 emissions it changes its modes of transportation from ground to rail and ships as the emissions for transporting the same volume of goods has reduced to one-eighth (p. 36).

From the above discussion it is clear that companies like Wal-Mart and Honda shift their mode of transportation from ground to rail or ships in order to

reduce the CO2 emissions. This practice uses an alternative transportation system that has lower emissions per volume of the transported goods, compared to regular mode of transportation. It also reduces the distance travelled by the vehicle that comparatively gives out more emissions.

This practice follows methods 2 and 3.

#### 4.1.2. Backhauling

Backhauling is the process in which an outbound truck after the delivering the products to its destination, is loaded in the same or nearby location with goods that needs to be shipped to the vehicle's starting point. This reduces the empty truck runs and makes use of a single trip to fulfill the same operation that would have required more than one trip. Wal-Mart stated that it saved more than 56,000 trips through backhauling in 2011 alone. (p. 37). By saving trips, Wal-Mart reduces the need of CO2 emitting vehicles. Honda in its sustainability report claimed that through backhauling the trucks to transport its cars between Suzuka, Saitamaarea and Saitama it reduces the number of miles travelled by trucks and thus reducing the CO2 emissions (p. 36). From these examples, it can be understood that companies, by practicing backhauling, not only reduce the no of vehicles but also reduce the distance travelled by them.

This practice follows method 1 and 2.

#### 4.1.3. Switching to Alternative Fuel Vehicles:

In recent years, usage of alternative fuel technology to drive vehicles has gained popularity. Alternative fuel vehicles either have low or zero emissions of CO<sub>2</sub>. Wal-Mart, in its sustainability website stated that it is working continuously to incorporate hybrid assist trucks into its operations in order to reduce the carbon footprint. It also said that it is making efforts to add more vehicles of such technology into its trucking fleet (p. 36).

And UPS in its 2011 Corporate Sustainability Report claimed that it is employing many vehicles that run on low emissions fuels and other technology driven vehicles such as all-electric vehicles into it's what it calls "the green fleet" in an effort to reduce the CO<sub>2</sub> emissions to a great extent. By doing so, companies can replace the CO<sub>2</sub> emitting vehicles and thus reducing the CO<sub>2</sub> emissions (p. 37).

By this practice, Wal-Mart and UPS are not only resorting to alternative transportation systems but also it replaces the regular CO<sub>2</sub> emitting vehicles thus reducing the CO<sub>2</sub> emitting vehicles.

This practice follows the methods 1 and 3.

#### 4.1.4. Switching to Non-Emissive Transportation Systems

Wal-Mart says it's regional distribution centers are more than 1 million square feet in size and it uses conveyor belts ranging from 5-12 miles in length to transport goods within its facilities (p. 37). Thus by using the non-emissive

transportation systems, the need for vehicles to transport goods is eliminated and thus reducing the use of CO2 emitting vehicles.

This practice follows the methods 1 and 3.

#### 4.1.5. Direct Shipments to the Customer

Directly shipping the products to the customer and not taking it to the company's own distribution center will avoid using another separate vehicle to carry the products to the customer. Wal-Mart in its sustainability information stated that it worked with one of its supplier to deliver products directly to Wal-Mart's distribution centers from the manufacturing facility rather than first taking it to the supplier's warehouse and then using another outbound truck to then ship it to Wal-Mart (p. 37). This method reduces the number of trucks needed for the operation from two to one.

This practice follows the method 1.

#### 4.1.6. Consolidated Shipping

Consolidating shipments into a single full-truck load rather than using multiple vehicles that carry less than truck load can reduce the number of vehicles needed to transport the same volume of goods. Wal-Mart published that it is using various technology to accommodate different kinds of merchandise in the same truck and claims that "these methods have the potential to reduce our number of outbound trucks, while lowering transportation costs by 25 percent" (p. 37). Apple in its sustainability webpage says "Making thinner, lighter, and more

material-efficient products not only reduces their carbon footprint, but it also means that we can ship them in smaller packaging.” (p. 36). This method enabled the company to ship the same number of units using fewer trucks. By consolidating the shipping the need for more vehicles is eliminated and thus reducing the CO2 emissions.

This practice follows the method 1.

#### 4.1.7. Consolidation of Operations:

By this practice the company localizes its multiple operations into a single facility. By doing so, usage of vehicles to transport parts between different facilities can be eliminated. Mazda, in its sustainability webpage states that some of its parts are manufactured and packaged at the same facility resulting in the elimination of transporting these parts using trucks between production and shipping locations (p. 36). Hence by consolidating operations into a single facility rather than having multiple locations for separate operations, usage of CO2 emitting vehicles can be reduced as the need for transportation is eliminated.

This practice follows the method 1.

#### 4.1.8. Centralized Distribution Centers

Having a centralized distribution center that serves multiple retailers in the locality will ensure lesser travelling distances compared to delivering goods to retailer from a distribution center that is relatively far. Wal-Mart in its sustainability report says that “every distribution center supports 90 to 100 stores in a 200-mile

radius” (p. 37) and so enabling the company to considerably cut down on long distance deliveries and thus reducing distance travelled by the vehicles.

The practice follows the method 2.

#### 4.1.9. Loading the Trucks in the Order of Delivery

Efficiently loading the trucks in the order of the delivery to customers ensures shorter routes and also saves time. Shorter routes will reduce the travelling miles and thus reduces CO2 emissions. UPS says “Loading vehicles most efficiently for the order of delivery, so that routes and miles driven can be kept to a minimum” (p. 37).

This practice follows the method 2.

#### 4.1.10. Efficient Route Selection

Efficient route selection is a good practice to reduce the number of travelling miles of the vehicles. UPS says “Selecting route options that minimize idling time spent waiting for lights and turns, thus reducing fuel use and emissions even if miles driven remain the same” (p. 37). In the same report UPS states that “Using telematics and routing technology also enable us to burn less fuel and emit less CO2 for every mile we drive” (p. 37). Companies can use such technologies to select better and efficient routes that will satisfy the requirements and simultaneously reduces the CO2 emissions through lesser travelling miles.

This practice follows the method 2.

## 4.2. Reporting

This section gives a consolidated report of the findings. The *table 4.2.1* lists all the 10 sustainability practices studied and the methods through which the practices reduced the emissions. Some practices reduced the emissions through more than one method. In certain cases both the methods were direct for example modal shift. And in few cases one of the methods was a resultant of another. For example switching to non-emissive transportation system followed the method of alternative transportation system but it also resulted in reducing the number of Co2 emitting vehicles. The table consists of four columns:

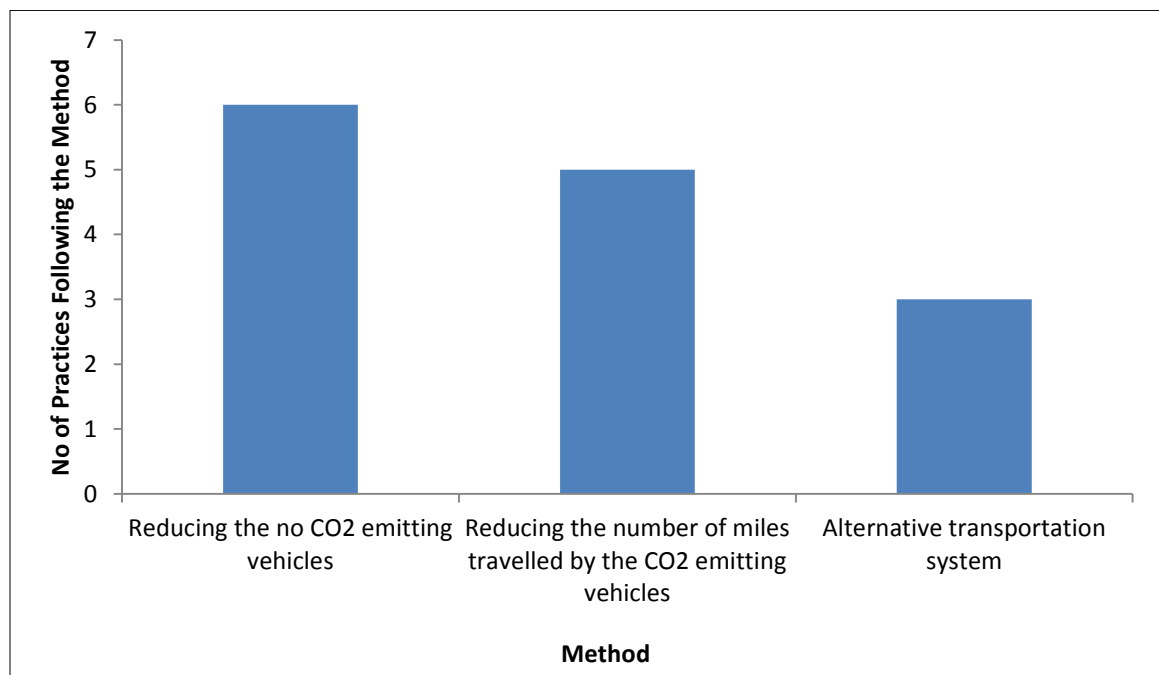
- i. Serial number
- ii. Sustainability practice
- iii. Methods
- iv. Companies (companies that follow the sustainability practice)

*Table 4.2.1 Current Industrial Sustainability Practices in Logistics Operations*

<b>S.No</b>	<b>Sustainability Practice</b>	<b>Method</b>	<b>Companies</b>
1.	Modal shift	<ol style="list-style-type: none"> <li>1. Reducing the distance travelled by the CO2 emitting vehicles</li> <li>2. Alternative transportation system</li> </ol>	Honda, Wal-Mart
2.	Backhauling	<ol style="list-style-type: none"> <li>1. Reducing the number of CO2 emitting vehicles</li> <li>2. Reducing the distance travelled by the CO2 emitting vehicles</li> </ol>	Wal-Mart, Honda
3.	Switching to alternative fuel vehicles	<ol style="list-style-type: none"> <li>1. Reducing the number of CO2 emitting vehicles.</li> <li>2. Alternative transportation systems</li> </ol>	Wal-Mart, UPS
4.	Switching to non-emissive transportation systems	<ol style="list-style-type: none"> <li>1. Reducing the number of CO2 emitting vehicles</li> <li>2. Alternative transportation systems</li> </ol>	Wal-Mart
5.	Direct shipment	<ol style="list-style-type: none"> <li>1. Reducing the number of CO2 emitting vehicles</li> </ol>	Wal-Mart
6.	Consolidated shipping	<ol style="list-style-type: none"> <li>1. Reducing the number of CO2 emitting vehicles</li> </ol>	Wal-Mart, Apple
7.	Consolidation of operations	<ol style="list-style-type: none"> <li>1. Reducing the number of CO2 emitting vehicles</li> </ol>	Mazda
8.	Centralized distribution center	<ol style="list-style-type: none"> <li>1. Reducing the distance travelled by the CO2 emitting vehicles</li> </ol>	Wal-Mart
9.	Loading trucks in the order of delivery	<ol style="list-style-type: none"> <li>1. Reducing the distance travelled by the CO2 emitting vehicles</li> </ol>	UPS
10.	Efficient route selection	<ol style="list-style-type: none"> <li>1. Reducing the distance travelled by the CO2 emitting vehicles</li> </ol>	UPS



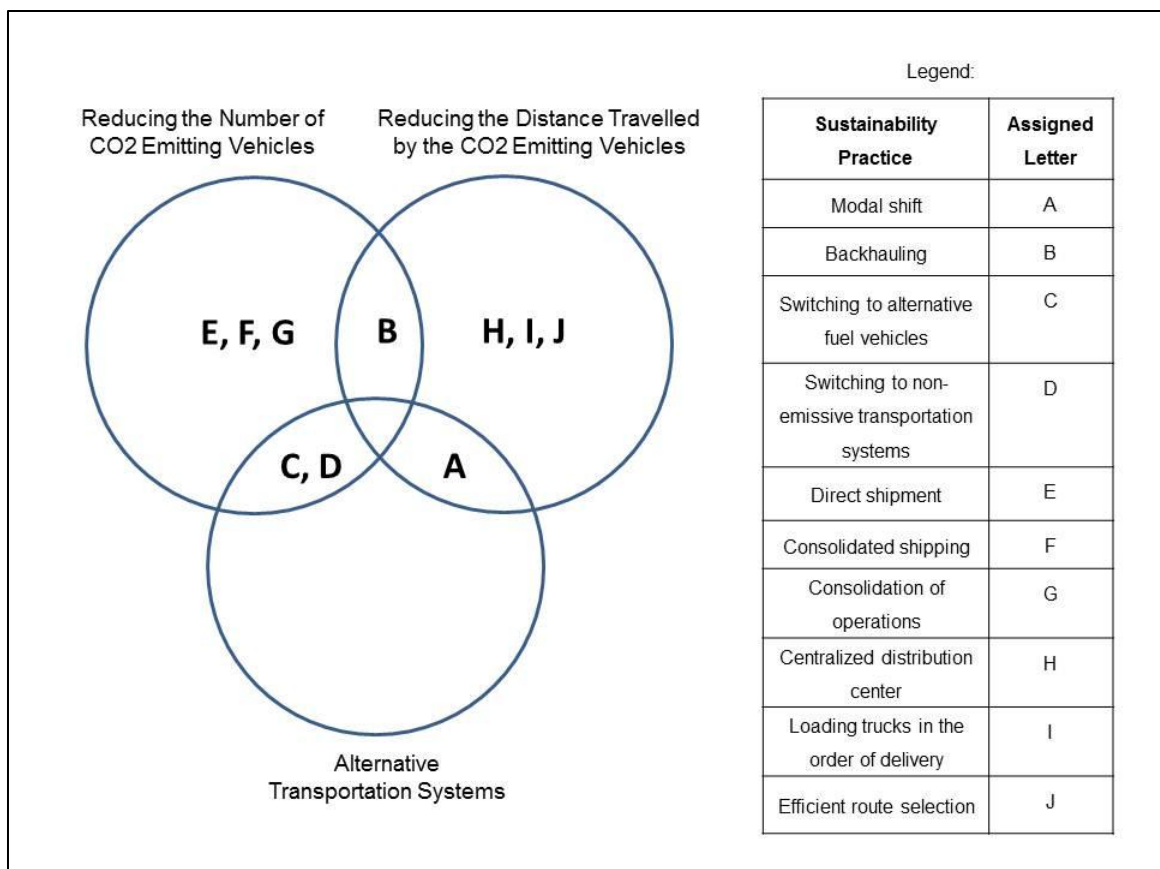
Each of the ten recorded sustainability practices reduced the CO<sub>2</sub> emissions through one or two of the listed methods. The *figure 4.2.1* is a bar chart that has the methods measured against the no of practices using the method. Seven out of ten sustainability practices reduced the emissions by reducing the number of CO<sub>2</sub> emitting vehicles. Five practices reduced emissions through reducing the number of miles travelled by the CO<sub>2</sub> emitting vehicles. While the least used method was to shift to alternative transportation system with only three out of ten practices falling under it.



*Figure 4.2.1 Commonly Practiced Methods*

As some practices reduced the emissions through more than one methods, the researcher used a Venn Diagram *Figure 4.2.2*, that shows the distribution of the ten practices among the three methods. Each circle in the figure represents each method. The intersection regions represent the

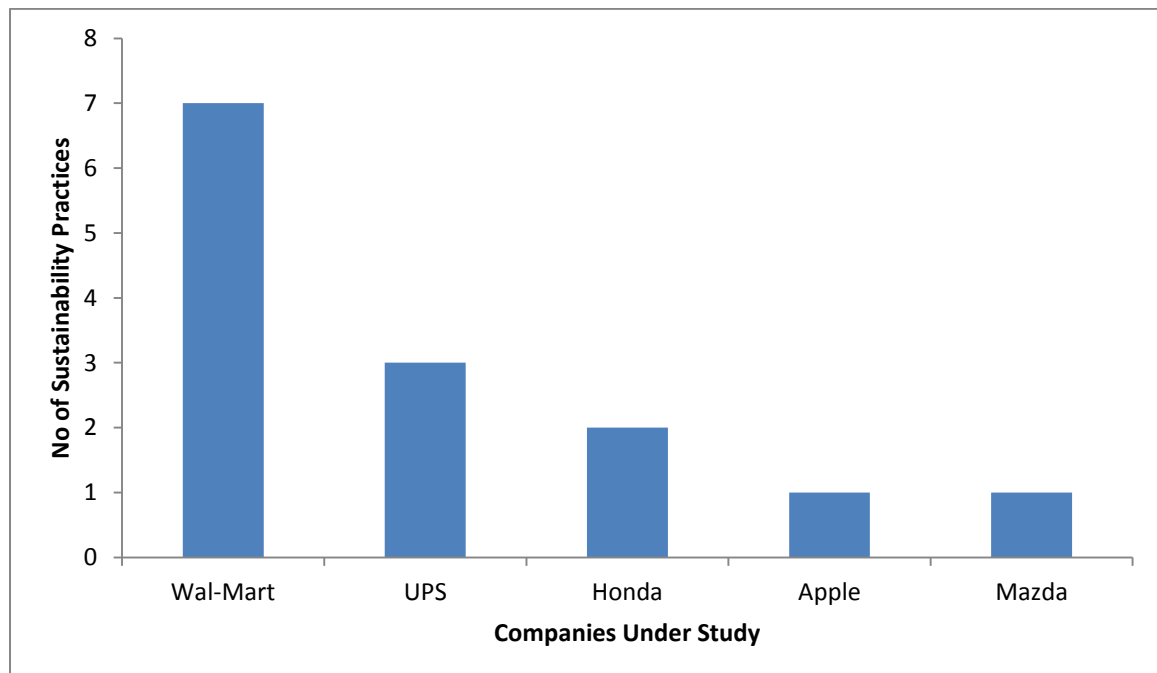
combination of, the methods that each of the intersecting circle represent. There were three practices that reduced the emissions by reducing number of CO2 emitting vehicles. Three practices reduced the emissions by reducing the distance travelled by the CO2 emitting vehicles. Two practices reduced by the combination of reducing the number of vehicles and alternative transportation system. One practice reduced the emissions by the combination of reducing the number of vehicles and reducing the distance travelled. And one practice reduced the emissions through the combination alternative transportation system and reducing the distance travelled by the vehicles.



*Figure 4.2.2 Distribution of Practices among the Three Methods*

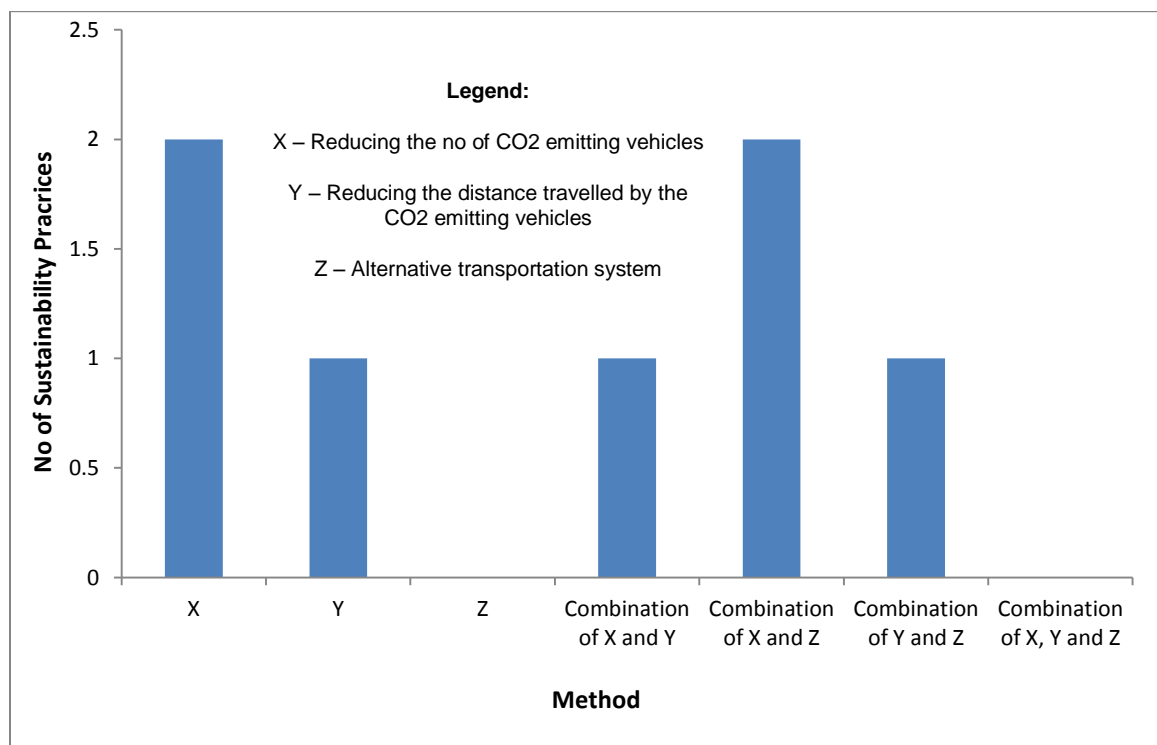
It was also evident that there were no practice that followed the method “alternative transportation system” exclusively. Following that method resulted in either one of the other two methods.

*Figure 4.2.3* is a bar chart that shows the number of practices that each of the five companies under study are using. This data is based on this project only and is subject to constraint as there may be other practices that the companies are following that were not a part of this project due to unavailability of information to the researcher as per the research methodology. According to the data, Wal-Mart had the most number of sustainability practices with a count of seven, followed by UPS with three. Honda had two practices. Apple and Mazda had one practice each.



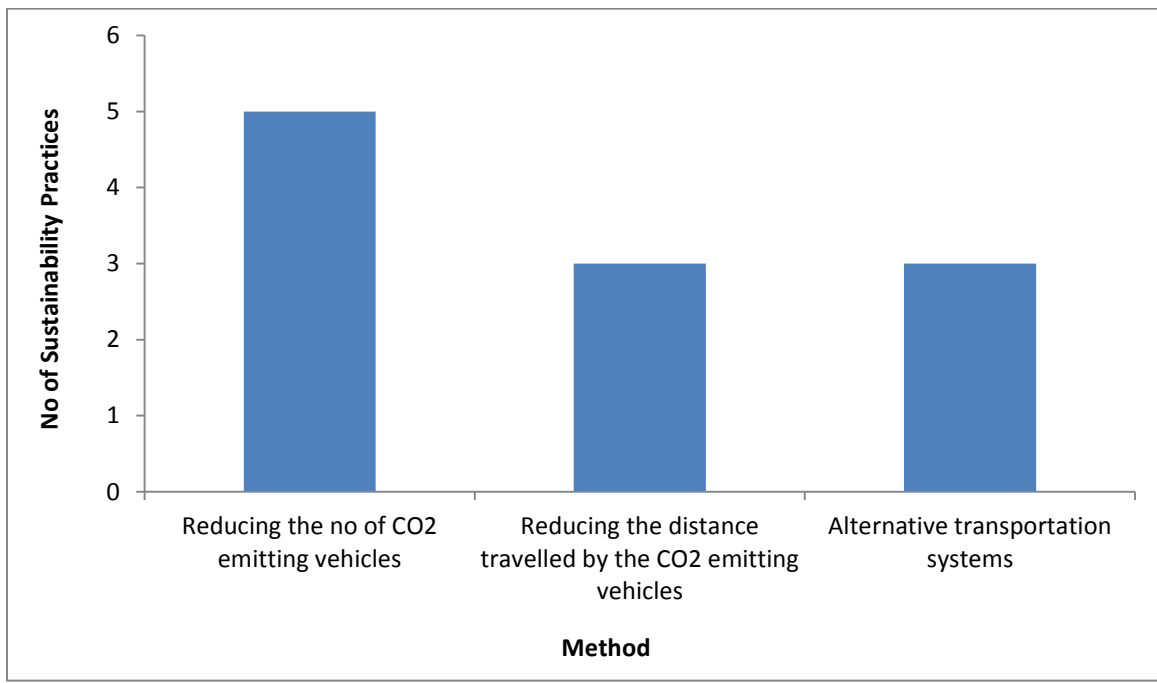
*Figure 4.2.3* Number of Sustainability Practices Followed by the Companies

Since Wal-Mart had the most number of recorded sustainability practices, The researcher plotted a bar chart *Figure 4.2.4* to find out which was the most common method used by Wal-Mart to reduce the emissions. Wal-Mart reduced emissions through two practices that followed the method 'reducing the no of CO2 emitting vehicles' and two practices that followed a combination of 'reducing the distance travelled by the CO2 emitting vehicles' and 'alternative taransportation system'. It had one practice that follwed each of the following: i.) Reducing the distance travelled by the CO2 emitting vehicles; ii.) Combination of reducing the number of CO2 emitting vehicles and alternative transportation system and iii.) Combination of reducing the CO2 emitting vehicles and the distance travelled by the same.



*Figure 4.2.4 Wal-Mart's Methods of Reducing Emissions*

If the methods were considered individually *Figure 4.2.5* then, five of the practices used by Wal-Mart reduced the emissions by reducing the number of vehicles. Three of the practices reduced it by reducing the number of distance travelled by the vehicles. And three of the practices reduced it by switching to alternative transportation system.



*Figure 4.2.5 Wal-Mart's Individual Methods of Reducing Emissions*

From the study, it is quite evident that reducing the number of CO2 emitting vehicles is the most sought method of reducing emissions.

### 4.3. Summary

From the study based on the five companies, there were ten sustainability practices found that were found to follow one or two methods from the listed three methods of reducing the emissions. The method “alternative transportation system” was not exclusive as it always led to one of the other methods. Reducing the number of CO<sub>2</sub> emitting vehicles was the most common method as it had six practices that followed it. As per the study Wal-Mart had the most number of sustainability practices in use to reduce the emissions of which five practices reduced the emissions through reducing the number of CO<sub>2</sub> emitting vehicles.

## SECTION 5. CONCLUSION

Five companies were considered for the study and a total of ten sustainability practices were followed by these companies in their logistics operations in order to reduce the CO<sub>2</sub> emissions. The practices followed three common methods to reduce the CO<sub>2</sub> emissions. There may be more practices that are currently followed but were not covered due to lack of availability of the information. Some practices actually followed more than one method. The most common method was reducing the number of CO<sub>2</sub> emissions which had six practices following it. The method “alternative transportation system” was never exclusive as it led to one of the other two methods.

As per the study, Wal-Mart was following seven of the ten practices of which five practices reduced the emissions through reducing the number of CO<sub>2</sub> emitting vehicles. May be the other companies have many other practices that were not published due to proprietary laws of the company.

The described methods can be used as a fundamental blue print to design a practice that can best suit the company. A certain practice followed by one company may not benefit another. A company must adopt a practice that aligns with its own operations that cannot only benefit the environment but also its business. An effective sustainability practice is the one that significantly reduces the CO<sub>2</sub> emissions while at the same time does not compromise on the required logistics function.

This project only explored the existing the sustainability practices used in industry. It did not include the cost component which is a very important aspect when it comes to business. Companies will not implement a practice if it just reduced the CO2 emissions. The practice should also be able to benefit the company as well in other ways such as financial and customer recognition. The validity of a practice is questionable if the cost to implement it exceeds the purpose of implementing the practice. The project neither included the magnitude of the reduction of CO2 emissions for the practice which is essential to understand nor the possibilities of other kind of environmental impacts due to the practice.

A tool can be developed to measure and compare the cost used to implement a practice and the level of reduction in CO2 emission through that practice. Though, it lays new scopes for future research in the field of sustainability in logistics. Further research needs to be done in this field in order to measure and evaluate the benefit of each of the practices and also the effect of the same over a prolonged period of time.

If more companies can step forward to publish their sustainability practices, many more companies can become more aware of those practices and can help them to take a giant leap by implementing those practices. This is our planet and it is our responsibility to take all measures possible to save it.



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