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Attitude Towards Green Warehousing in El Paso, Texas: An Exploratory Analysis

Lynda Jeanette Macias
University of Texas at El Paso, ljmacias@miners.utep.edu

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LYNDA JEANETTE MACIAS

Department of Civil Engineering

APPROVED:

W. Shane Walker, Ph.D., Chair

Ruey Long Cheu, Ph.D., Co-Chair

Heidi A. Taboada, Ph.D.

Salvador Hernandez, Ph.D.

Benjamin C. Flores, Ph.D.
Dean of the Graduate School

Dedication

To my three greatest inspirations of all
To my parents, Jorge and Imelda, and my brother George

ATTITUDE TOWARDS GREEN WAREHOUSING IN EL PASO, TEXAS: AN EXPLORATORY ANALYSIS

by

LYNDA JEANETTE MACIAS, B.S.

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Abstract

The increasing reliance on fossil fuels by today's emerging economies has a profound implication on the sustainability of many warehousing and distribution logistical systems worldwide. This research attempts to fill the gap in current green warehousing literature by investigating how warehousing and distribution facilities view greener strategies as a way to increase operation efficiency through a stated preference approach. A survey instrument was developed, and the survey was conducted to identify warehousing characteristics, green practices, and current green views of warehouse managers in El Paso, Texas. The survey results found a balanced outlook within the environment and business needs. Companies revealed the importance of investing for the sake of the environment, while also improving operational efficiencies and lowering costs, in spite of an economic downturn. Others showed indications of incorporating green strategies for the purpose of benefiting the company, if these investments are not too costly.

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Chapter 1: Introduction

The increasing reliance on fossil fuels by today's emerging economies has a profound implication on the sustainability of many warehousing and distribution logistical systems worldwide. Countries such as China and India with accelerating growth and energy consumption are straining an already limited energy reserve. With no end in sight for the economic prosperity and increasing need for energy resources of these nations, energy conservation and efficiency of use becomes of pivotal importance to the whole world. The vast majority of logistical systems depend heavily on fossil fuel derivatives to sustain operations and future expansions. With the ever-increasing fuel prices, due to the increase in demand by emerging economies and their scarcity, these logistical systems, which already operate inefficiently, will either cease to exist or suffer further service level decline; thereby comprising the competitiveness of the U.S. economy and its warehousing and distribution system.

Many of today's logistical operators are looking for new and innovative approaches to lessen their dependency in fossil fuels, solid waste disposal, and energy and power. Since much of what is transported goes by ground and through some warehousing and distribution facility, increasing fuel and energy prices are raising the costs of their operations. For example, for commodity-based logistical systems (food items, etc.) the increasing costs of operations are further reducing an already slim profit margins causing an adversarial ripple effect across other industries—even playing a factor in increasing food prices across the globe. For such firms, more efficient warehousing and distribution facilities would greatly reduce operational costs. However, the design of such warehousing and distribution facilities and introducing them to the market alone will not likely solve the imminent energy crisis. This is because of the lengthy process and the development of the necessary technologies to get these facilities running at maximum efficiency; the research for alternative energy sources and the technology needed to make those sources usable are only in their infancy stages, thereby it may take decades to have such energy efficient facilities and supporting infrastructure in operation.

Actions towards creating greener warehouses are evolving due to the increased concern as found hereunto and the need to minimize negative impacts created on the environment. With the world population increasing, the demands for goods are growing, as well as the need to create larger and additional storage facilities for these goods. With the increasing energy consumption as expressed earlier and increasing carbon emissions, implementation of green strategies to reduce these harmful effects is imperative. With this in mind, this research attempts to fill the gap in current green warehousing literature by investigating how warehousing and distribution facilities view greener strategies as a way to increase operation efficiency.

1.1 Background

Scientists postulate that greenhouse gas (GHG) emissions (especially the emission of carbon dioxide (CO_2) from the burning of fossil fuels for energy production and transportation), is affecting global climate change. This global climate change may be observed through increases in frequency and intensity of extreme events, such as intense droughts affecting water and food cultivations, severe rainstorms causing floods, rising sea level, risk of human health due to heat waves, and threatening animal species (NRDC 2011). Current reports from the Intergovernmental Panel on Climate Change (IPCC) have increased their confidence level to 95 percent, indicating climate change to be human related (IPCC 2013).

Significant contributions of GHG emissions may occur within the supply chain of food and goods, including manufacturing, warehousing, and transportation. Conversely, methods to reduce carbon footprints can be implemented by replacing consumption of energy produced from fossil fuels to renewable energies, such as wind or solar, as well as improving warehousing efficiencies. For example, a refrigerated warehouse could be improved by installing CO_2 sensors, high roof and wall insulation, natural lighting, motion lighting sensors, fluorescent lighting, efficient heating and cooling systems, and low-flow plumbing fixtures (Martin 2010). This

example facility was expected to have payback return investment for energy efficiency costs in less than three years.

The *Paso del Norte* region, including the City of El Paso, Texas and Ciudad Juarez, Chihuahua, Mexico, shown in Figure 1.1 (Baumbach, et al. 2008), is a significant region with respect to manufacturing, warehousing, and transportation. The *Paso del Norte* region is especially significant for international trade across Mexico, the United States, and Canada, formally recognized through the North American Free Trade Agreement (NAFTA). Exports and imports on behalf of goods and trade in services in the U.S. with Mexico and Canada amounted to $1.6 trillion in 2009 (Office of the United States Trade Representative n.d.). The *Paso del Norte* region is also significant with respect to interstate trade across the U.S., as Interstate Highway 10 is a significant route for east-west transportation from the Pacific coast to the Atlantic coast. This study is aimed to increase understanding in current warehousing practices in this region, and emphasize the need and methods for more systematic implementation of green warehousing.

Figure 1.1: Map of the *Paso Del Norte* Region

Source: (Baumbach, et al. 2008)

1.2 Objectives

This research seeks to understand current views and warehousing practices with regards to green initiatives in El Paso, Texas. To do so, this research seeks to develop a stated preference approach to characterized current warehousing practices, corporate responsibility towards mitigating environmental impact, and awareness of improving warehousing operational efficiencies for decreased energy, and increased revenue.

The basic objectives are:

1. Review the current state of the art with regards to warehousing and distribution, green initiatives, and implementation.

2. Develop a state preference survey. The purpose of the survey is to characterize current warehousing operations and practices, as well as identifying opportunities for future improvement for the warehousing and distribution industry in El Paso, Texas. In addition, to identify manager's influences in applying environmental incentives may help guide research in developing methods that integrate a company's beneficial gain to go green.
3. Provide statistical backed inferences with regards to green initiatives found through the stated preference survey.

To the best of our knowledge these are the first attempts at collecting warehousing attitudinal responses to green initiatives through a state preference approach.

1.3 Thesis Organization

Chapter 2 of this thesis presents a literature review, with an introduction to warehousing and "green" practices. The chapter then presents the current state of green supply chain through previous research, followed by related studies on green, efficient warehouses and earlier studies that have used survey based methods. Chapter 3 describes the methodology used to conduct this research, development of the survey with targets in mind, purpose, description of the survey, and how the data was collected. Chapter 4 presents the results of the survey with an evaluation of warehouse operations. Chapter 5 concludes with the summary of the keys findings and contributions of the study, along with recommendations and possible future work.

Chapter 2: Literature Review

This chapter develops the concepts of warehousing and green practices, including green supply chain and evaluation of warehouse efficiency.

2.1 What is Warehousing?

A warehouse is a building used for the handling and storage of raw and finished products, between critical points in the supply chain. Some commodities are shipped and can be stored for long periods of time, while other goods can be shipped to the warehouse and transported in the same day.

The generalized product flow through a warehouse, shown in Figure 2.1, begins with the shipment received, either from a manufacturing company or other sources. The warehouse personnel then unload the cargo to be verified and some instances scanned, subsequently assigned to a certain location to be stored. The use of technology or software is used to keep track of shipment orders and placement. Once the customer places the order, the order picking is engaged. After the shipment is picked at the indicated rack location, forklifts are used to take and place the commodities in trailers where they will be shipped and delivered. Included in the warehouse are racks, pallets, forklifts, conveyors, and cranes for larger shipments. The size of the warehouse varies on the type of services that will be provided and the amounts of moving goods that are to be projected. Warehousing location is a major aspect in transportation, where costs, emissions and time are greatly impacted, therefore it should be carefully considered. The following figure is an example of a generalized shipment process through a warehouse from receiving to the shipping of the commodity.

Figure 2.1: Generalized shipment flow through a warehouse

The following are examples of the types of warehouses that can be found (Eclipse Systems Pvt. Ltd. 2004):

- Distribution
- Fulfillment
- Consolidation
- Value-added Services
- Cross Docking and Trans-loading
- Break bulk
- Storage
- Climate controlled
- Automated

Warehouses can also be found in combination of the types listed above. For example, a distribution warehouse, where large shipments are usually received and stored for a short period, can be used to refrigerate goods and also provide fulfillment and consolidation services. Fulfillment warehouses generally offer a variety of services that are needed to deliver a shipment, and are commonly used for e-commerce, in which a package may need to be stored, picked, packaged, shipped, and provided confirmation of delivery to their customers. On the other hand a consolidation warehouse concentrates on shipping out small commodities and grouping them efficiently to improve shipping rates. A warehouse can additionally incorporate

added value services that can range from specialized technology to systems of operations such as reverse logistics, which will be covered in more detail in section 2.3. Instances where shipments are received and are placed from one truck to another to be sent to specified locations with minimal or no storage needed is known as cross docking. This process can also be done through trans-loading, where intermodal transportation is taking place, for instance, a cargo in a container brought by a boat is unloaded and placed on a train, then transferred to trucks to be distributed. A distribution warehouse can also operate with large bulk shipments and breaking them down to be dispersed, which is known as break bulk. Warehouses that operate with large bulk or wholesale goods include Sam's Club and Costco, where the customers take advantage of buying bulk items for decreased costs.

According to the type of warehouse, they can be privately, publicly, or government owned (Chavan 2010). An example of a publicly owned warehouse operator is a third party logistics (3PL) provider, providing diverse warehousing and transportation services for their customers. Retailers, and e-commerce (Barthholdi and Hackman 2011) are other examples of entities which use warehouses, each having their individual purpose and needs. Goods can be traced by stock keeping units (SKU) where they are usually received in pallet loads at the warehouse.

2.2 What is Green?

Phrases such as "green", "eco-friendly" or "sustainability" are commonly used to interpret a way of preserving the environment and its surroundings by eliminating or minimizing the affects in which it can be damaged. This can be implemented into practices, design, regulations, and everyday activities such as recycling, reducing pollution, being energy efficient, or by managing amounts of waste being produced. High concerns of climate change and the negative effects of GHG on the atmosphere promote modifications to improve the quality of the environment. Figure 2.2 (U.S. EPA 2013) illustrates the main types of GHG such as carbon

dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) and the amount they emit based on the amount of carbon dioxide equivalence in the United States. It is evident that more than 5,000 million metric tons of carbon dioxide has been emitted every year from 1990 to 2011, and has shown a minor decrease from the year 2007.

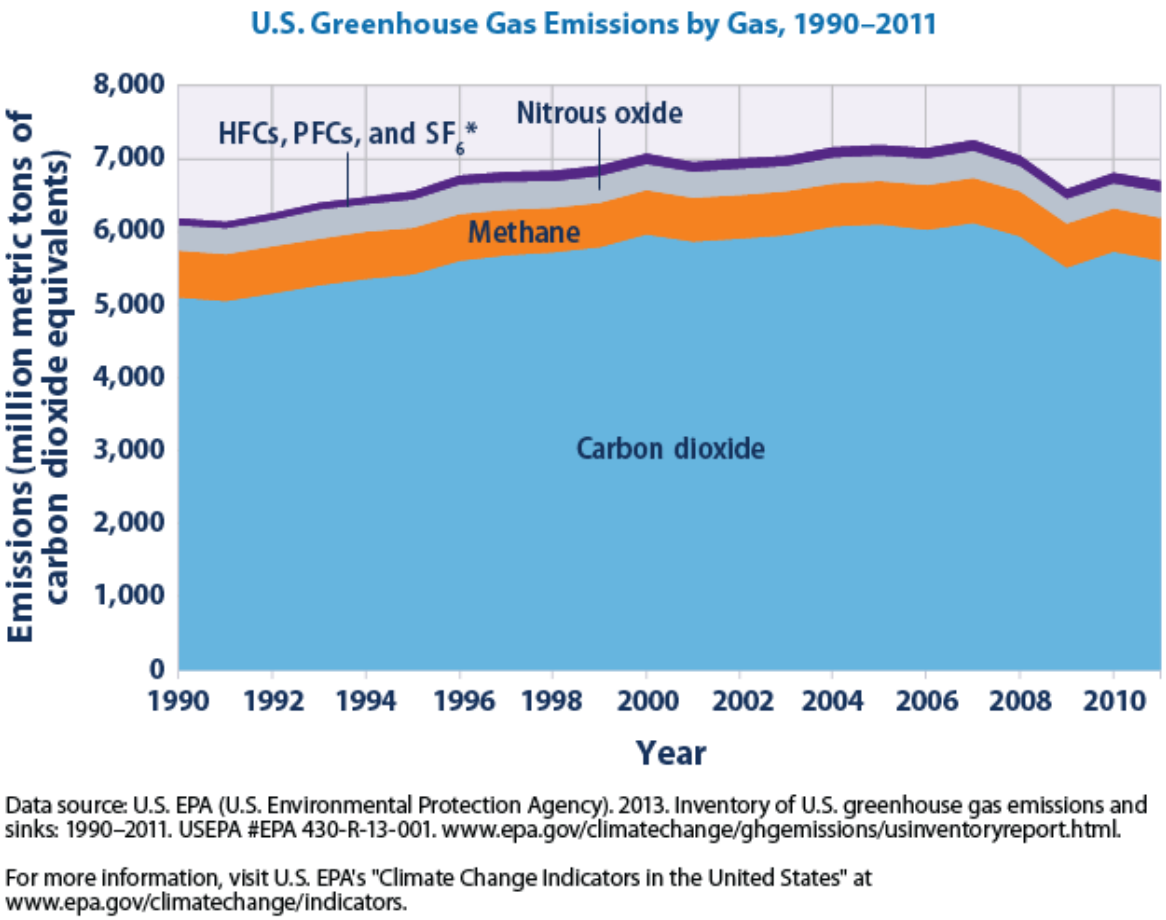

Figure 2.2: Greenhouse Gases in the U.S. from 1990-2011

Source: (U.S. EPA 2013)

Additionally, in Figure 2.3 (U.S. EPA 2013) we can see the major sources in which the GHG are produced in the United States. The largest component of GHG contribution is electricity generation, followed by transportation, industrial, agriculture, commercial, and

residential. At the bottom of the graph we can see land use, and forestry is below zero and account for about -1,000 million metric tons of CO_2 a year. This is because land and forestry absorb CO_2, but if we take into account the average of 6,500 metric tons of carbon dioxide per year from the greenhouse gases produced by the economic sector and subtract it from the land and forestry, there is still an unbalanced amount of about 5,500 metric tons of carbon dioxide per year.

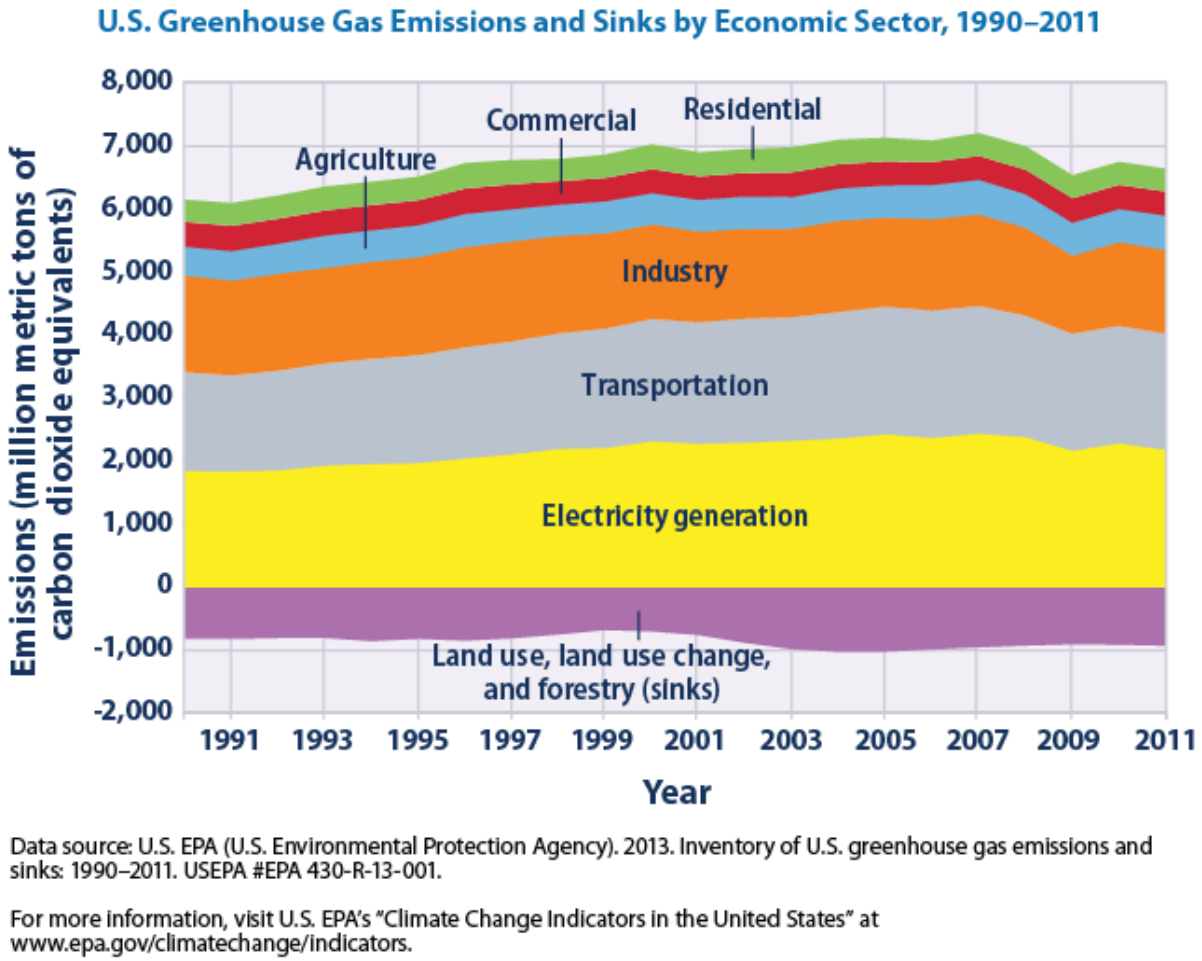

Figure 2.3: Causes of Greenhouse Gases in the U.S. from 1990-2011

Source: (U.S. EPA 2013)

Due to the increase in greenhouse gases, more heat from the sun is trapped (EPA 2013). Temperature in the United States is represented from the year 1880 to 2012 in Figure 2.4 (NASA Goddard Institute for Space Studies 2013). An average temperature is taken from 1951 to 1980 and is represented as zero. The dotted line represents the annual mean, while the red line characterizes a 5-year mean. A change in temperature at about 2 degree increase from the mean of 1951 to 1980, to the present annual mean of 2012 is displayed. Although there are fluctuations throughout each year, there is a visible increase in temperature in the 5-year mean line, with the highest of about 1.5 degree change since 1880 to 2000.

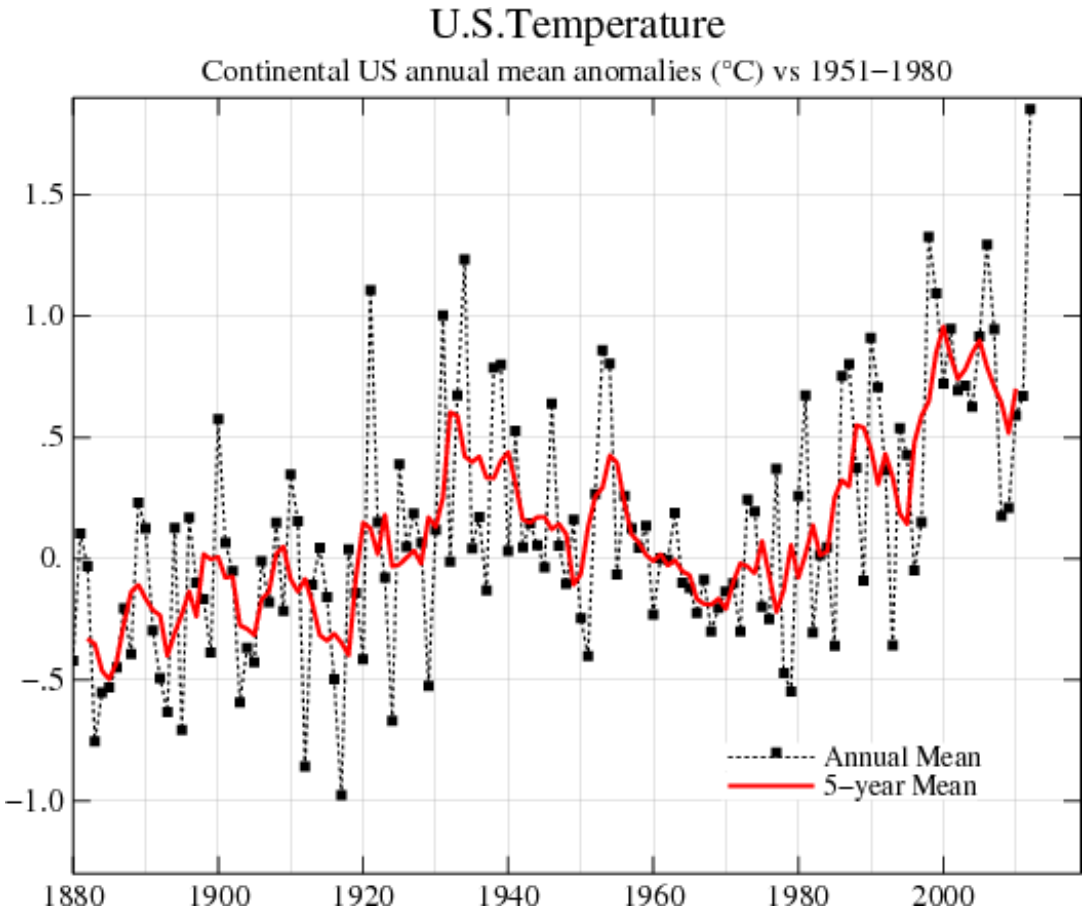

Figure 2.4: Temperature Mean in the U.S. from 1880-2012

Source: (NASA Goddard Institute for Space Studies 2013)

Population growth is also a contributing factor not only to GHG, but also to the depletion of non-renewable sources. In GHG, more CO_2 gases will be emitted with the increase of people burning fossil fuels such as petroleum for transportation, coal and natural gas for energy consumption, or methane produced by waste. An example of non-renewable resources include fossil fuels, rocks, concrete, steel, plastics, and other types of materials that are derived from nature and being consumed at a faster rate than are being harvested. Certain rocks and minerals used for concrete or building materials have taken several million years to form, and cannot be renewed but can be recycled. Therefore, greater use of renewable resources should be considered by means of renewable energy or renewable materials. Instances of renewable energy include wind, solar thermal, biomass, or solar photovoltaic (Mckinnon et al. 2010). Recycling and reusing materials are a couple of ways to be "green" and contribute to the conservation of nature.

Sustainability can be explained as a way of preservation or making something last, whether it be materials, buildings, roadways, or even life. Sustainability is defined as a triple bottom line where the environment, society and economy are taken into consideration (Melaver and Mueller 2009), shown in Figure 2.5.

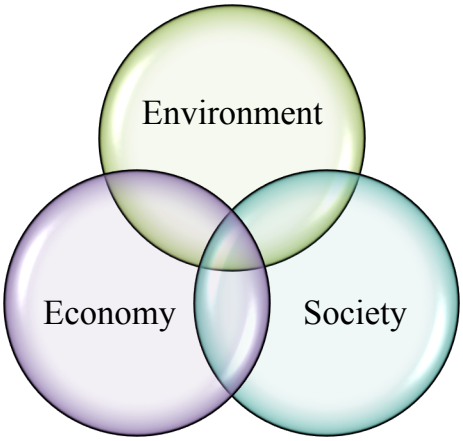

Figure 2.5: Sustainability in terms of Environment, Economy and Society

When thinking of being green the well-being of those who are surrounded by the environment and the economy should be considered in addition to the environment. Pollution, for example, is considered a threat to the health of humans, exposing individuals to respiratory illness, lung cancer, and heart disease. Eliminating the risk of harming the population is a high priority when considering sustainability. There are a few organizations that try to implement green and sustainability, for example U.S. Green Building Council (USGBC), which established a program known as Leadership in Energy and Environment Design (LEED). LEED rates and certifies a building according to the level of green incorporation and is categorized in rating a building according to specified categories, with the five most prominent as follows (USGBC 2013):

- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Environmental Quality

Each category is precisely examined and granted points depending on how significant the building meets those standards. The higher the points on the building the higher the certification, ranking from platinum, followed by gold, silver, then certified. LEED encourages all different types of buildings to incorporate green into their buildings and act as a profitable outcome with the given framework. Other organizations that help guide companies in managing environmental impacts include: International Organization for Standardization (ISO) 14001, (International Organization for Standardization n.d.), Environmental Protection Agency (EPA) climate leaders program, World Resource Institute's (WRI) publication, *A Service Sector Guide to Greenhouse Gas Management,* (Melaver and Mueller 2009).

2.3 Current State of Green Supply Chain

The process or management of a product that undergoes extraction, manufacturing, warehousing, transportation, and retail until it is received by the consumer is known as supply chain (Tan et al. 2009). Current supply chain management (SCM) focuses on going green and being more efficient in order to reduce transportation cost, pollution, energy consumption, and increase profit. Research such as that done by Halldórsson and Kovács (2010) investigates the importance of energy efficiency through logistics and its mutual dependency on the supply chain management to improve environmental concerns and rising gas prices. Their methodology includes a framework that involves the demand of energy reduction by implementing supply chain strategies and structures, and reducing greenhouse emissions of gasoline with alternative fuels. They accentuate the importance of energy efficiency, research and practices that can further help the economy and environmental impacts. Rahimifard, Seow, and Childs (2010) also emphasize the importance of measuring energy exerted in certain segments of the supply chain, such as manufacturing. They provide a modeling framework to measure the embodied product energy through the process of production. Manufacturing companies are capable of using the energy simulation model to view how much, and where the energy is being used. The model can consequently help to remove any unnecessary energy generation, consequently decreasing energy consumption and greenhouse gasses.

Reverse logistics is also another form of current green logistics that is taken place in the green supply chain. Through the use common applications adopted by companies that use three R's, i.e., reusing, reducing and recycling, used material can be recovered and the amount of waste can be reduced. Rodrigue, Slack, and Comtois (2001) also reasoned that the government should provide regulation, enforcement and support for green logistics. Bio-fuels are also a growing subject as a replacement for fossil fuels and can lower the impact to the environment, remove the dependency for foreign oil, and derive from renewable resources. Gold and Seuring (2011) target specific problems having to do with bio-energy, such as production, resources, supply chain management, and technologies for converting biomass into energy and

incorporating it in transportation. Their methods include an overview of previous research papers on bio-energy and a breakdown on the supply chain production of bio-energy in the course of harvesting, collecting, storage, transport, pre-treatment, and design, and they underline issues and ways to improve production. The benefit of this approach is the reduction of CO_2 emissions.

Technology and education are important factors when considering sustainability in the supply chain. Garetti and Taisch (2012) emphasize methods such as Life Cycle Assessment (LCA) to facilitate in identifying the environmental impact from beginning to end of a products lifespan. LCA can be used from the extraction of the material and measuring the emissions produced from its manufacturing stage to transportation, storage, maintenance, and the end of disposal or recycling, encouraging green services within the supply chain from efficient technologies, practices, design, to renewable energy. LCA can distinguish between a green (low environmental impact) material to a material that can be marketed as "green" solely based on the fact that it is a renewable resource, yet its high environmental impact through high transportation emissions informs us otherwise. Winter and Knemeyer (2013) examined 456 articles ranging from the year 1995-2010, highlighting the development of sustainability in the SCM throughout those years. They focused in three major topics, logistics and SCM, operations and production, social and environmental, which also incorporated triple bottom line (environment, social and economic) for sustainability mentioned in section 2.2. Sustainability topics such as carbon footprint, green logistics, recycling, reducing emissions, fare trade, human rights, social, labor practices, reducing costs and economy, were several that were considered. Additionally, reverse logistics, remanufacturing, demand forecasting, network configuration, systems design, network optimization, organizational structures, and controlling methods for supply chain management were also considered. Their studies found that growing interest of research was emerging for environmental concern. Few articles investigated the integration from all sustainability aspects (environmental, social and economic) and SCM (processes, network structure, and components) (about 3% from the 456 articles). Carter and Rogers (2008) also merged environment, social, and environment in their framework with the addition for the supply chain managers on considering

risk management, transparency within the company, and having an organizational culture and strategy. They define risk management through a series of literature reviews, by managing short and long term issues such as the environment, financial outcomes, human safety, poor supply demand, and energy costs. Transparency is then described as removing secrecy from the company and involving the stakeholders. Next, having a strategy in incorporating sustainability to their company and having a culture base in which their values are for the good of the people. Carter and Easton (2011) use the same framework in their study of literature reviews from the year 1991 to 2010. Their finding also encountered a larger percentage focusing on the environment review trends, followed by safety, human rights, sustainability (increasing percentage over the years of 1991 to 2010) and diversity (shown decrease percentage over the years). Type of industry was also interpreted in the research that showed multi-industry to be the highest in literature reviews, although a slight percent decrease from 1991-2000 to 2001-2010 is presented. Transportation is the next highest rated, with increasing percentage over the years, next being consumer products, other types of commodities such as automotive, food, and beverage. They also examined theoretical lenses, validity, social bias, unit of analysis, methodology, type of analysis, and moderation.

Furthermore, Mollenkopf et al. (2010) introduce lean supply chain in accordance to globalization, and green supply chain by extensive research on literature reviews. They define each supply chain and find connections and conflicts between them, for instance, global supply chains are known for expanding their business into other countries to decrease costs. Although creating businesses in different parts of the country can produce more emissions, caused by added miles in transportation, green supply chains try to minimize the environmental impacts thus lowering emissions and pollution. Global supply chains as with green supply chains could incorporate global green strategies such as recycling, reducing pollution and reducing materials. Lean supply chains on the other hand attempt to optimize and eliminate unnecessary operations, as just in time (JIT) services that depend on demand forecasting to foretell what goods will be needed during that period of time therefore reducing costs for holding or storing that item

(Investopedia 2013). Lean and green supply chains can also be associated through the reduction of waste, consequently reducing negative environmental effects.

2.4 Related Studies

When considering warehousing operations and building inefficiencies, there are a few approaches to consider in making a warehouse more efficient, in addition to supporting environmental benefits.

2.4.1 Efficient Warehousing Operations and Layout

There have been several literature reviews that incorporate efficiency into warehousing to greater benefit the company. Dharmapriya and Kulatunga (2011) focus on lean warehouse by removing any types of unnecessary operations throughout the warehouse. Picking costs account for about 55% of operating cost in the warehouse (Barthholdi and Hackman 2011). Their method of improving the warehouse layout found that selecting optimized suitable paths decreased traveling distances and costs based on storage location and order picking. Numerous case studies were examined to decrease travel distances with respect to demand and traveling cost according to rank, distance, and weight on the items using a Simulated Annealing Heuristic approach. Dukic et al. (2010) also discuss layouts such as the Flying-V and the Fishbone layouts, decreasing travel distances in connection to the reduction of energy and reducing the impact to the environment, although results are dependent on the size of the warehouse. Cross-isle should also be taken in to consideration when performing order picking to maximize efficiency and decrease costs. Berglund and Batta (2012) compared the optimal cross-isle (i.e., the storage isles layout in the warehouse) placements with the application of an algorithm for diagonal, across-aisle, and within-isle storage policies and computed the position best suited for a single cross-aisle. Batch-picking (grouping several orders), planned routing and storage, are algorithmically compared to single order picking and unplanned storage, and found to save about 80% or more on traveling distance (Dukic, et al. 2010). Order picking should also consider congestion in

warehousing, which can cause an increase of cost per order if congestion is increased, such as blocking, extra walking and other travel related issues (Heath et al. 2012). Their approach consisted of using an agent based simulation model approach (ABM).

2.4.2 Lean Warehousing

Lean concept as mentioned in Section 2.3, where cutting out waste in operations are deliberated to remove costs that create no value, are considered in distribution centers through the process of consolidation, distributing, storing, picking, packaging, and shipping (Villareal et al. 2012). Their methods include, applying Value Stream Mapping on processes and Automated Storage Retrieval System (AR/RS) for analyzing performance and availability efficiencies through the losses of capacity, speed and distance. A methodology used by Garza, Lopez and Guerra (2011) takes account of availability losses by the means of non-scheduled time, and scheduled maintenance to obtain administrative availability efficiency, and operator breaks, breakdowns, unscheduled maintenance and waiting time to obtain availability efficiency. It also account for capacity losses that accounts for volume, speed, and excess distance losses to evaluate for performance efficiencies. Quality losses such as truck waiting time, percent demand not met, and percent product defects are also measured in order to attain quality efficiency.

2.4.3 Eco-Efficient Warehousing

Added considerations for increasing efficiencies in supplement to lowering the environmental impact include the following (Dukic et al. 2010):

- Lighting
- Sensors (doors and lighting)
- Wind turbines
- Solar Energy
- Ventilation
- Building Materials (insulation)
- Recyclable Materials (containers, packaging)

- Warehouse Management System (paperless)

Warehousing Management Systems (WMS) are used to help the efficient flow of goods, keep track of stored goods and their specified location, and other additional features (Barthholdi and Hackman 2011). The type of facility also depends on what kind of green strategies are being applied, for example, temperature controlled warehouses need more energy to heat, cool, or keep at a specific humidity level. Therefore, proper higher insulation levels are needed to keep heat/cool from escaping, and help contribute in energy savings. Richman et al. (2009) analyze how roofing insulation can reduce costs and cooling energy, needed for a cold storage building. They discuss that several temperature-controlled buildings with no considerations in roof insulation increased the use of energy to cool the building with air leaks found throughout the building. Results from two cold storage buildings, using extruded polystyrene insulation, exemplified lower energy consumption and lower pollution emissions when higher levels of insulation were added. Suggested levels of insulation should, however, be carefully considered depending on the type of climate in that region, as cold and warm regions will vary and excess insulation will have no economic benefit.

2.4.4 Warehousing Technologies

Applying economic, social and environmental concerns is imperative in warehouse operations. Tan et al. (2009) executes a model processes diagram using iThink modeling software to create a user interface prototype, which includes sustainability meters that measure revenue, job satisfactions and carbon emissions. Revenue and carbon emission measuring meters, offered on the model, help reduce unnoticed spending costs. The model also supports environmental benefits by considering carbon credits, planting trees, and up keep truck maintenance. Warehousing decision support system (WDSS) model is used in a case study for an emerging cable company with demand of warehouse space (Min 2009). WDSS presented benefits in improving the flow, and tracking of inventory, layout, labor productivity, forecasting,

activity visibility, and warehousing decisions. The model includes: database management subsystems (DBMS) and On-line Transaction Processing (OLTP) for data filtering, simulation models such as computer aided design (CAD) to visualize flowing goods through the warehouse, a forecasting model, and an analytic hierarchy process (AHP) model for assistance in decision making, given certain cost and warehousing data. Dukic et al. (2010) presents technologies that increase efficiency. One includes Pick-to-Light system, resulting in 40% more productivity than paper-based picking and 99.90% accuracy. Additionally, radio frequency (RF) scanning technology resulted in 15% more productivity and 99.90% accuracy. Voice technology also presented more productivity than paper based picking at 25% and a higher accuracy at 99.99%. Warehousing decisions can either assist or impede sectors of the supply chain such as logistics (Marco and Mangano 2011). Data involving 78 warehouses and their linear regression model exemplified that there is a correlation to decreasing the number of late deliveries to increasing maintenances costs.

2.4.5 Warehouse Location

Increased transportation costs, air pollution, and emissions can be expected when random selection of site location is considered. Decision on placement or choosing a suitable warehouse, according to location, can be considered by a framework concluded by Korpela and Tuominenb (1996). An analytic hierarchy process (AHP) approach is formed to assist on warehouse location according to a set of carefully considered alternatives based on benefit/cost through a qualitative and cost analysis. Warehouse with the highest calculated benefit/cost ratio and overall importance of reliability would be considered the appropriate site location of the warehouse. Recent studies evaluate costs, labor, transportation, environment, and geographical location when considering selecting a warehouse location (Uysal and Tosun 2012).

2.4.6 Previous Surveys

Similar studies through a series of warehousing surveys include Hilmola and Lorentz (2011), which investigate warehousing companies in Finland and Sweden on the significance

that they place in the process of site selection, size, and illustrate the differences between them. Their methods included three online surveys sent to 750 companies, through e-mail, in the year 2006. Of these, only 67 responded. In the year 2009, 680 companies were contacted, but respondents decreased to 35. Finally, in 2010, 570 companies were surveyed, resulting in a greater decrease in respondents to 25. The percent response rate of web-based surveys of 8.9%, 5%, 4.4% in the years 2006, 2009, and 2010 respectively (Hilmola and Lorentz 2011). All e-mails that were sent were searched through the web, responding highest of all three years involved manufacturing companies (62%), followed by service at 13%, retail at 12%, wholesale at 8%, electricity distribution at 3% and construction at 2%. Their survey responses on warehouse site selection depended mostly on low distribution costs, averaging all three years, followed by others such as road transportation connection, assembly/manufacturing proximity, inbound logistics connection, intermodal transportation support, and 3PL availability. The surveys also indicated that warehousing size would gradually grow but a variety of warehousing sizes still exist.

A business perspective on sustainability is also a large contributor to regulating environmental impact. Whether managers or owners are implementing an environmental concern has a great influence on how they rank their priorities in order of importance. Ditlev-Simonsen and Midttun (2011) investigate corporate responsibility amongst the opinions of three groups of stakeholders: corporate leaders (board members, CEO's, corporate lawyers, and consultants), students in master's programs (taking a corporate responsibility course), and employees of NGO (Non-Governmental Organizations), such as World Wide Fund for Nature Norway and Amnesty International Norway, as to what they think encourages and what they believe "should" encourage a manager's perspective. Their surveys found that all three groups of stakeholders believed that a manager's highest motivation for corporate responsibility runs on enhancing a company's image/brand and placing profitability above sustainability. However, when asked what "should" be the main priority, all groups ranked sustainability as the most important.

When surveying more than 1,500 executives and managers, and interviewing more than 50 leaders, Berns et al. (2009) found that about 92% of the companies were implementing some form of sustainability, although 70% of companies did not have a solid environmental strategy in place. The survey showed that long-term investments, difficulty in measuring and regulating social and environment impacts, and unpredictability, are the main issues that cause difficulty for companies to implement sustainability. Results of an economic downturn showed that most of the companies had no effect in applying sustainability (more than 30% of respondents), while other companies roughly reduced (about 17%), others roughly increased (about 15%), others considerably increased (10%), and others considerably decreased (about 8%). The survey also demonstrated a large percentage of profitability towards the company brand image when integrating sustainability, followed by cost savings, competitive advantage, employee satisfaction, product/service improvement, business process improvements, added revenue sources, risk management, stakeholder relations, and other elements.

2.5 Summary

Much research focuses on creating a greener efficient warehouse, where little attention is placed on existing warehousing practices and manager's motivations in going green. Previous research conducted on companies through survey analysis, does not consider specific types of companies. This research not only helps better understand strategies in warehousing companies in El Paso, TX but also aims to discover manager's incentives towards green warehousing. By understanding manager's views one can shape green strategies to be further implemented into companies policies.

Chapter 3: Research Methodology

Including green strategies into warehousing operations or through building efficiencies can be quite broad, from arranging the warehouses layout to increase storing and picking efficiencies, to considering types of lighting for energy savings to increase cost savings. There are many techniques that can be considered in benefiting warehousing companies yet also have a progressive advantage in lowering environmental impacts. Questions regarding the company's costs and benefits impede merging green initiatives due to the perception of green being a long-term investment rather than an initial profit.

3.1 Survey Based Framework

This section presents a framework developed to assist with the process of collecting and analyzing data through a survey based method. The survey was developed for warehousing managers in El Paso, Texas in order to understand what type of approaches are implemented in their warehouse that are considered to be environmentally friendly, cost effective and bring notable benefits towards the company. Warehousing managers are chosen participants in the study due to their knowledge and expertise in warehousing operations. Owners of the companies were also considered for participation in the survey, however it was assumed they did not have enough comprehension in warehousing activities, therefore were excluded. Figure 3.1 demonstrates the surveys process from the beginning of designing the survey, distributing the survey, analyzing the data and ultimately understanding the key aspects of green warehousing strategies in El Paso.

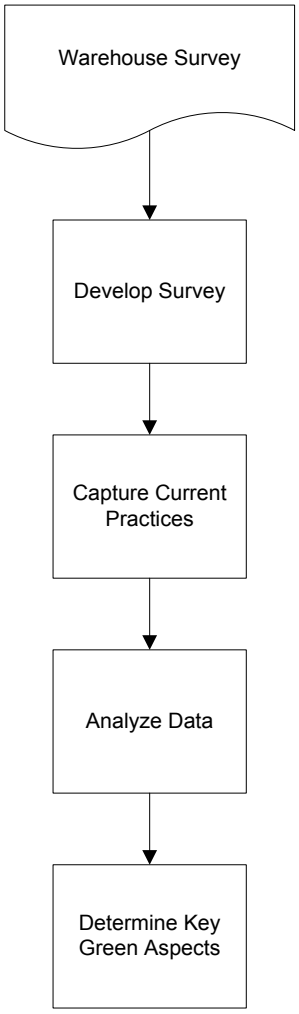

Figure 3.1: Warehouse Survey Flowchart Process

The framework provided can be broken down further from each process to better understand each in detail. When developing a survey, questions that targeted different properties of warehousing such as size, location, and type of facility were considered in order to associate the differences and similarities in warehouses and get a broad vision on warehouses in the El Paso area. The rest of the questions considered green views with respect to warehousing; section 3.2 will describe the questions in detail. Second, we define the purpose of the survey and acquire current green strategies, by conducting e-mail (using Qualtrics), phone, and in-person surveys to different companies in El Paso. Although focusing in one warehouse, one can also observe current operations; the survey would not capture a wide range of opinions and methods used by

different warehouses. Third, where one company can express concern towards the environment, another company might only focus on their own profitability. With the data obtained we can compare the differences between these companies, capture a variety of practices, and analyze any connections, which overall captures key components that formulate green warehousing.

3.2 Survey Questions

A pilot test was conducted on a warehouse manager in order to get an evaluation of the pilot survey. The pilot was helpful in understanding whether questions were clear enough to be understood from a manager's perspective, the length of the survey was not too long that the respondents would now have enough time to finish, and any other inputs they thought was necessary to add to the survey. In conclusion, their thoughts on availability and being busy throughout the workday caused a concern on the length of the survey. Therefore, changes on shortening the survey and removing questions that were not relevant on green perspectives were made. The revised survey consists of 22 questions, which will take approximately 10-15 minutes to answer, as shown in Appendix A. The aim of the survey was to get about 15 participants, where enough information can be evaluated. Figure 3.2 shows the main goals that were considered for the survey. Five leading goals where incorporated to observe the warehouse's description, how and why they are going green, their thought of what is green, and rating the importance they place on the environment versus their business. By the "how", we want to see what they are incorporating into their warehouse to make it more efficient or green. The "why" can help us understand any benefits they acquired from going green, as well as their motivations. The "what" illustrates their views on what is green, showing their level of knowledge on the topic.

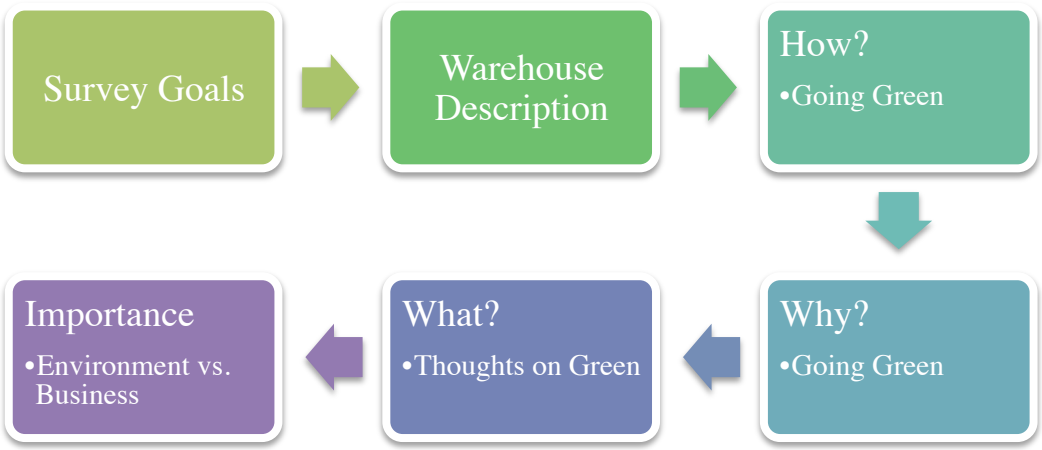

Figure 3.2: Goals incorporated into the Survey

We had begun the survey, as also seen in Appendix A, by asking the participant for the company's name and their position in the company (*Questions 1 and 2)*. In order to understand the warehouses that are surveyed, the first eight questions were to describe the different types facilities found in El Paso, Texas:

Question 3: Your company is considered a: This question was used to compare the different types of warehouses in terms of location. Four options were given to choose, the participants were able to check whether the warehouse is local, regional, national, or global company.

Question 4: How long has your facility been in operation?: This question illustrates a range from how long the warehouses have been in operation, and if newer facilities are incorporating green strategies compared to older facilities.

Question 5: Is your facility a: This question examines the types of facilities, showing the variability a facility can offer, and which are the most prominent. The participants were given the choice to select more than one because facilities can offer more than one service. Choices that were given included: public warehouse, contract warehouse, cold storage, distribution center/HUB, or other (participant stated what type of facility).

Question 6: What are the hours and days of operation of your facility?: This question allows to examine the operational hours from different types of warehouses gives us a better understanding on how long warehouses are in use.

Question 7: How many employees typically work at your facility?: This question shows the number of employees, which can better represent how many employees are needed to run a warehouse.

Question 8: What is the approximate square footage of your facility?: This question can be used to analyze the range in sizes of warehouses in El Paso. It can also be associated to types of facilities and locations.

Question 9: How many loading bays does your facility have?: This question demonstrates how much activity is taken place at the facilities with regards to the movement of goods to transportation mode. The more number of loading bays at a facility, the greater the flow of goods and greater the traffic experienced at that facility.

The following questions 10-22 are used to capture preferences of facilities with regards to operations and green initiatives.

Question 10: About what percentage (%) of your total operational costs would you say is attributed to energy consumption annually? This question allows us to capture how much energy is needed to operate a warehouse.

Question 11: How important would you say is the environment to your facility's strategy? This question allows the participant to rate the importance of the environment, using a Likert scale, from not at all important, very unimportant, neutral, very important and extremely important. Here we can begin to get a sense of how a company views environmental issues and their concerns to lessen the impact.

Question 12: Does your facility have an environmental strategy in place? This question, just like the previous question, we are able to understand their concerns towards the environment, but now we can also observe whether their concerns are followed through with their actions.

Question 13: If yes to, does your facility have an environmental strategy in place?, can you please elaborate: This question is a free response that allows the participant to explain what type of techniques they are applying; therefore, understanding their interpretation of what makes the warehouse green and efficient. We can also discover new techniques that they are implementing that were not read on previous research articles.

Question 14: Do you consider technology an important tool in mitigating environmental impacts? This question is a yes or no reply that would be given to the participants in order to understand the importance placed on technology in increasing efficiencies, and reducing emissions from energy reductions.

Question 15: In your opinion, what type of technology do you consider to bring most environmental benefits? This question is in connection to the previous question, we see their views on the importance of technology, using their understanding on how these systems function, in addition to what type of technology they consider to help the environment. Including transportation management systems, supply chain planning, freight forwarding software, warehouse management systems, or other to input what they believe is best.

Question 16: Do you measure your facility's carbon footprint? This question allows three responses that can be chosen; yes, no or don't know. The "don't know" was inputted in case the manager might not be informed measuring emission, and might be handled by other employees. This question exemplifies the efforts of a warehouse in contribution to trying to lower and managed their emissions, placing added attention towards the environment.

Question 17: In your opinion, how important is the environment as a driver in adopting more efficient processes? This questions is scaled of importance is also portrayed for the participants response from not at all important, very unimportant, neutral, very important or extremely important, using a Likert scale. Highlighting, not just the importance of warehousing, but also other influences that are affecting the environment.

Question 18: Has your company spent money on environmental initiatives for your facility? This question the participant will answer a yes or a no. Examples will be provided such

as efficient lighting, recycling, or proper insulation to support the meaning of environmental initiatives that promote on lowering negative environmental effects. This will also help us get a sense of how many warehouses are going green and are willing to invest.

Question 19: If so, have you experienced any benefit from doing so? A yes or no will also be provided. This question has a great level of importance, due to some uncertainty in bring profits to the company when integrating environmental gains. Here we are able to examine the percent average on companies benefiting from such investments.

Question 20: Which of the following statements most closely describes your personal views with regards to "Green" issues: This question goes more into depth on how green a company is willing to go, also answers many inquiries on why many warehouses are not going green due to only focusing on business needs rather than combining both. The participant will be asked to pick between three options, tackling the importance on business and the environment. First option incorporates if they should balance business and the environment, putting equal importance to both. Or, have a higher importance on the environment and be willing to pay more to reduce their impact. Lastly being their business as their only priority.

Question 21: If you were to select a more environmentally friendly facility: This question, similar to question 20, helps us understand the level of placement on the environment, but instead we emphasize on the importance on the buildings infrastructure and the effects it can have towards the environment. The significance of this question relies on how companies are eager to go beyond their production activities and focus on a green facility to assist in energy efficiencies, the production and incorporation of renewable resources, ultimately reducing emissions. This also helps in forecasting the construction of green facilities in the near future if warehousing expansion of these companies is needed, and how much they are prepared to invest. Three options will be given; the first will consist of their willingness to invest in a green facility with the preference of profiting their business with lower running costs. Second, a company is more on the neutral side where the cost of the green facility will cost no more than a regular warehouse, where a company is not willing to invest. Third, concentrates more on the

environmental benefit than the company, where they are willing invest and pay more to help the environment.

Question 22: In light of economic downturn, in your opinion will your company invest in environmentally friendly services? This question helps to evaluate the impact of the economy on green initiatives. Three questions will also highlight on business needs, environmental, or balancing on both. First question includes the environmental needs, which states: Yes, we will continue to pay more for an environmentally friendly facility. Second involves a business priority, stating: No, cost cutting will mean we will look for the lowest cost services or infrastructure. And lastly, a balance through business needs and environmental concern, stating: Invest in our environment initiatives will bring operational efficiencies and lower costs. We can uncover a company's motivation in up keeping the environment even with an economic decline. It can be observed that "going green" can bring more economical benefits through possible experiences, if participant considers choice three.

3.3 Data Collection

Once the survey design is completed, the online survey was sent to warehousing companies addressed to the manager, or conducted in person. A web search engine was used to contact warehousing companies. In this case, Google, and yellow pages were used to find phone numbers to call warehousing managers and asked to take an online survey. If they agreed, the participants provided an email address were they can be reached, and the online survey was sent. It is important to note that few limitations occurred during the method of collecting data. As a low response rate was predicted in applying an e-mail survey approach, other survey methods were applied in order to increase the rate response. Interviews through the phone, going in person to ask for e-mails, and in person interviews were also conducted, represented in Figure 3.2.

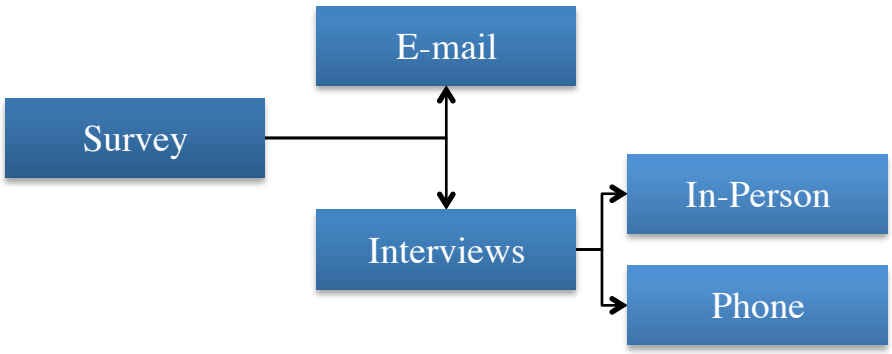

Figure 3.3: Survey Data Collection

It was assumed that when gathering e-mail addresses by person, more respondents would be willing to participate in the survey, considering more time and effort was taken to get in contact with them, unlike gathering them through phone. In-person and phone interviews were also considered instead of sending it through e-mail because of a faster response. Although conducting surveys through e-mails, can allow the participant to respond to the questions at their own convenience, it can also allow the participant to put aside, raising the probabilities of them forgetting to take it. Another limitation on all the types of surveys conducted was the participant availability, which also contributed to the total number of respondents. Other limitations on the survey involved is the possibility of the participant not having adequate understanding on what is green, which can cause the participants to ignore the survey or not give effective response information, which, in phone and in-person interviews can be explained.

3.4 Summary

An analysis on current warehousing practices towards minimizing environmental effects was taken into account when considering conducting a survey. Methods on data collection will be analyzed on how many participants were most responsive and what was believed to be the best method from e-mail, in-person, or phone interviews. The data collected will also be analyzed through series statistical analysis, where any connections, observations, and a

theoretical perspective can be made, which will be described in further details in the following chapter.

Chapter 4: Results

This chapter presents the outcome on data collected from the surveys performed in El Paso, Texas from October 2, 2013 to November 5 2013. The first section involves the analysis on the survey methods implemented. The second section contains the overall responses from the participants, including an evaluation of each of the questions. The third section covers survey challenges. The last section discusses observations made according to the findings.

4.1 Results of Survey Methods

Survey methods that were conducted included e-mails, in-person interviews, and phone interviews, shown in Table 4.1. The survey first began by calling companies, by web search, in order to ask for e-mail addresses with regards to completing an online survey. A total of 16 companies were contacted through phone, six of which were too busy or were not available (out, or in a meeting), and 10 managers accepted to give out their e-mails. In order to increase the response rate, in-person visits to the company to ask for e-mail addresses were considered. Of seven companies that were visited, six agreed to give out e-mails, although one did mention they had to check with their supervisors to see if they could partake in such surveys, and one company could not give out such information. Out of the six that agreed to give out e-mails only one company responded. Two other emails were additionally sent that were found in the web search engine. Seeing how a total of four had replied through e-mail (contacted by phone, in-person and web), and three opened the survey without answering any of the questions, within a three week span, a different survey approach was initialized. Instead of visiting warehouses to ask for e-mails, warehousing managers were asked to take an in-person survey. This was done for two weeks from Monday to Thursday, excluded Fridays considering might be too busy, from 9:00 a.m.-11:30 a.m. (omitting the possible lunch hours from 12:00 p.m.-1:30 p.m.) and from 2:00 p.m.-4:00 p.m. From the total of nine companies visited, four agreed to complete the survey, and the other five either rejected, or were either too busy or gone for the day. Phone interviews were also conducted during the two-week time frame, although the times were extended till 5:00 p.m.

A total of 13 companies were contacted and asked to speak with a warehouse manager, five accepted to answer the survey, and out of the eight rejected, two asked to call back a later specified time, and when contacted again there was no answer, others had a meeting to attend to, were in a meeting, or they weren't at their office.

Table 4.1: Number of Company Results according to Survey Method

Survey Method	Approached	Completed Survey
E-mail (Web)	2	1
E-mail (Phone)	16	2
E-mail (In-Person)	7	1
In-Person (Survey)	9	4
Phone (Survey)	13	5
Total:	**47**	**13**

From the 25 companies contacted through e-mail by web, phone and in-person, only 18 accepted to give out their e-mails, of which only four responded. Giving the e-mail a response rate of about 22%, an in-person survey a response rate of about 44%, and the phone survey of about 38% response rate. Figure 4.1 shows the response rates for using each method.

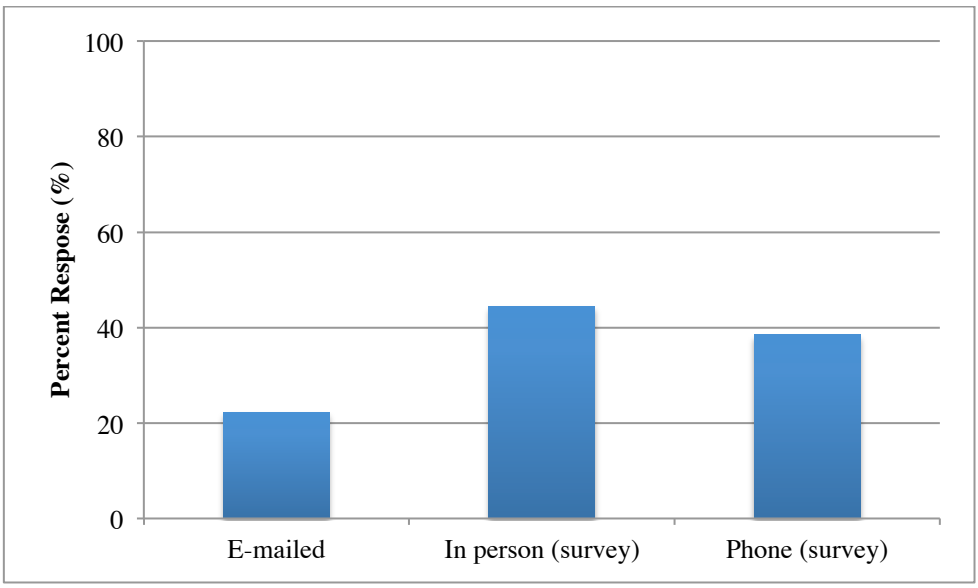

Figure 4.1: Response Rate according to Survey Method

A higher response rate was achieved with in-person surveys, followed by survey through phone, and the lowest response rate for e-mailed survey. Overall 47 companies were approached, but only 40 provided e-mails for contact. A total of 13 total surveys were completed, having a total response rate of approximately 33% of e-mailed, in-person, and phone surveys combined.

4.2 Results of Warehousing Survey

Of the total of 13 responses were received and analyzed in Excel spreadsheet. All the 13 surveys were completed except that two questions from a participant were left blank due to not having enough information to answer. The aim for the survey included contacting the facility manager from each company. Figure 4.2 indicates the types of managers that responded, these are: warehouse managers, accounting for more than 30% of respondents, followed by two operations managers, two logistics managers, and two general manager's, and one response from a transborder manager, office warehouse manager, and distribution warehouse manager.

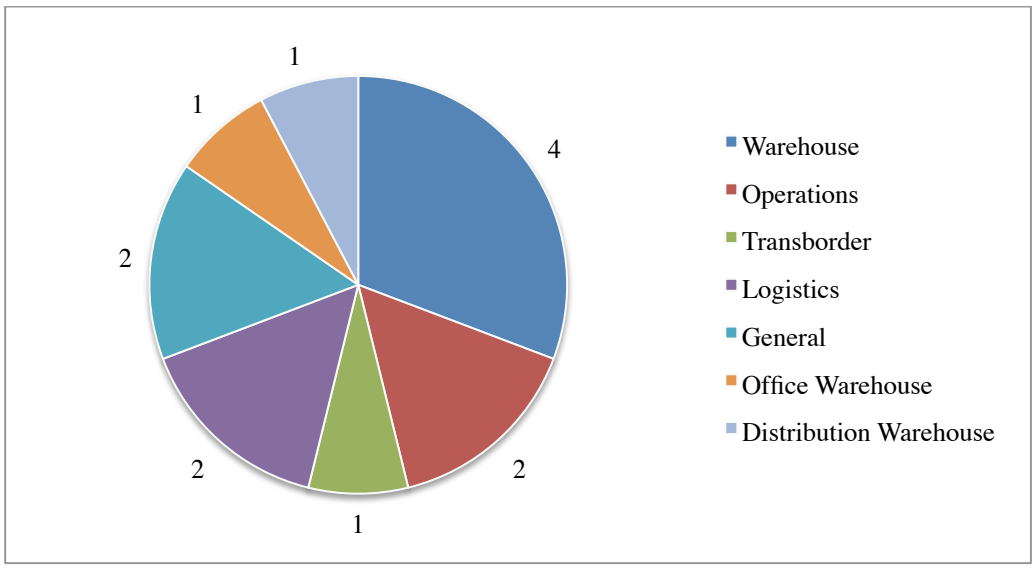

Figure 4.2: Type of Manager Positions Surveyed

The following results indicate the 13 warehouse descriptions from questions three to seven from the survey (Appendix A). The first question involved the type of facility according to location, as shown in Figure 4.3. The survey composed of seven global (about 54%), one national (about 8%), one regional company (about 8%), and four local in El Paso, Texas (about 31%). A larger selection of global companies can be seen.

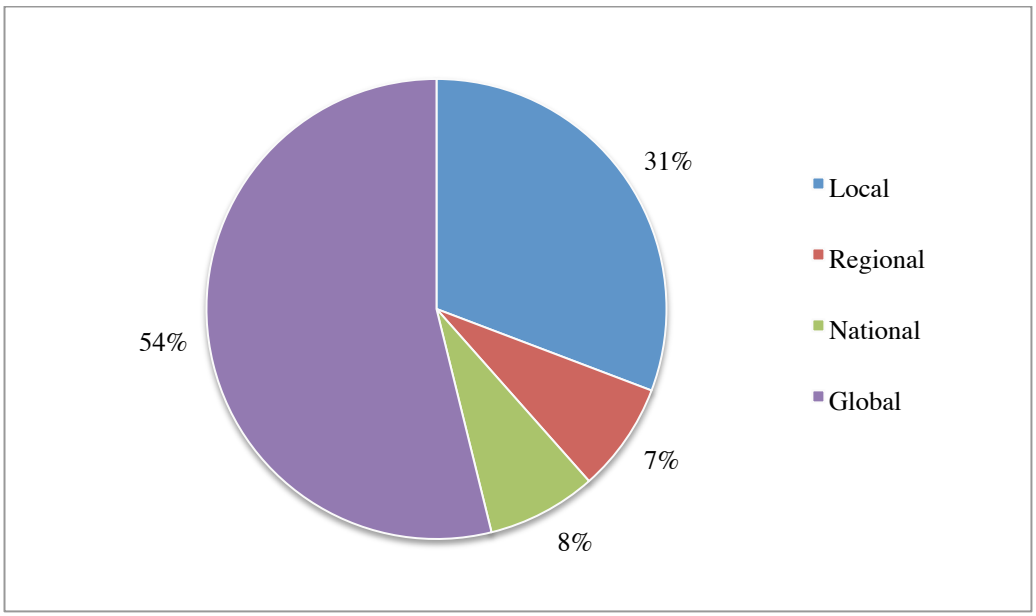

Figure 4.3: Type of Company Surveyed

In question 5, each participant was able to choose more than one type of facility, out of the 13 companies, total of 21 types of facilities were chosen. Where a company can chose public warehouse, contract warehouse, cold storage, distribution center/HUB, and other where given as options. Third party logistics (3PL), bonded warehouse and storage warehouse where replies, in placement of "other". Figure 4.4, exemplifies the largest selected type of facility in El Paso, Texas to be distribution center/HUB, totaling eight out of 21 making up 38% of the total responses. Followed by five types of contract warehouse's, three types of public warehouse's, two storage and one for each of the following: cold storage, bonded warehouse, and 3PL.

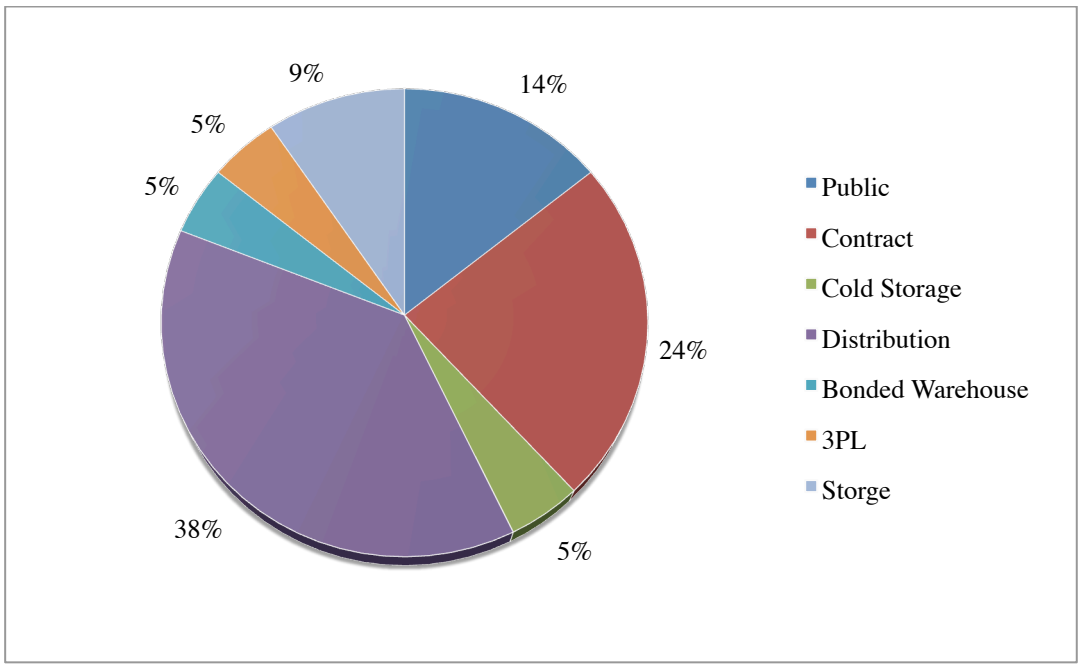

Figure 4.4: Type of Facility Surveyed

Results from question 6 can be seen in Figure 4.5, where the hours of operation were mostly from 8 a.m. to 5 p.m., and days of operation from Monday to Friday. Some companies did respond opening till later time and having two work shifts. The figure exemplifies the days and hours of operation according to the type of company. It can be seen that four companies open till later hours (most of them being global companies and the other being regional), with the longest duration of 17 hours occurring from 6 a.m. to 11 p.m. and the latest time till 12 a.m. It is also noted that most of local companies operated from the same hours from 8 a.m. to 5 p.m. The beginning and closing time was averaged, where average hours between the 13 companies were from 7:50 a.m. to 6:50 p.m., and duration of 11 hours.

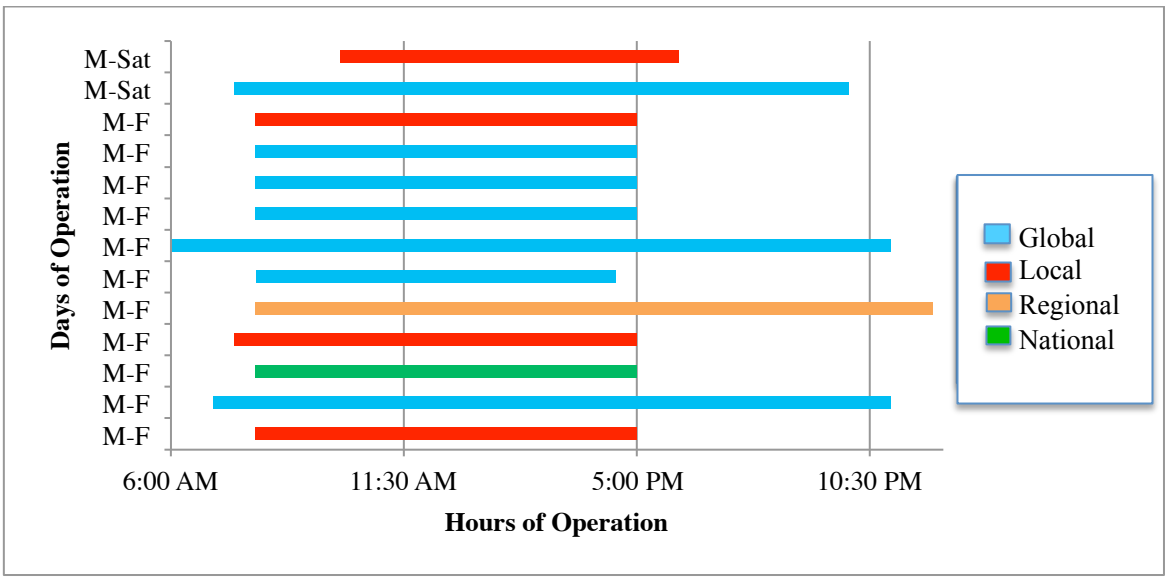

Figure 4.5: Times of Operation according to Company Type

From the results of question 8, the approximate square footage from the facilities is shown in Table 4.2, in comparison to company and facility type. From the 13 companies, one participant was not familiar with the size of the facility; therefore only 12 responses were noted. Large ranges in facilities sizes are noted. The minimum size of a facility found was 600 ft^2, being a local storage facility. The largest facility was about 282,000 ft^2, being a regional 3PL facility. The total facilities size averaged to be about 95,025 ft^2, with a median of 71,500 ft^2.

Table 4.2: Facility Size according to Company and Facility Type

Company Type	Facility Type	Size of Facility (ft^2)
Local	Storage	600
Global	Public	30,000
Global	Distribution	32,000
Local	Contract/Distribution	44,700
Local	Contract/Distribution	50,000
Global	Public	70,000
Global	Contract/Distribution/Bonded	73,000
Global	Distribution	120,000
National	Public/Contract/Cold Storage/Distribution	132,000
Global	Distribution	150,000
Global	Distribution	156,000
Regional	3PL	282,000
	Median:	**71,500 ft^2**

The results of questions 4, 7, and 9 were gathered in Figure 4.6 to illustrate how long a facility has been in operation, how many employees are working, and show how many loading bays are in the facility. The box-and-whisker plot shows the maximum, minimum, median, and quartiles. For instance, the maximum years a company has been open according to the responses is 120 years, and the minimum is three years. The graph also shows the median at 15 years, where 50 percent of the facilities were in the range from three to 15 years, and the rest of the 50 percent ranged from 15 to 120 years. With respect to number of employees, the median was 30, with a maximum of 100 and a minimum of three. The number of loading bays, according to the responses, averaged at 15 bays, with a maximum of 41 and a minimum of zero.

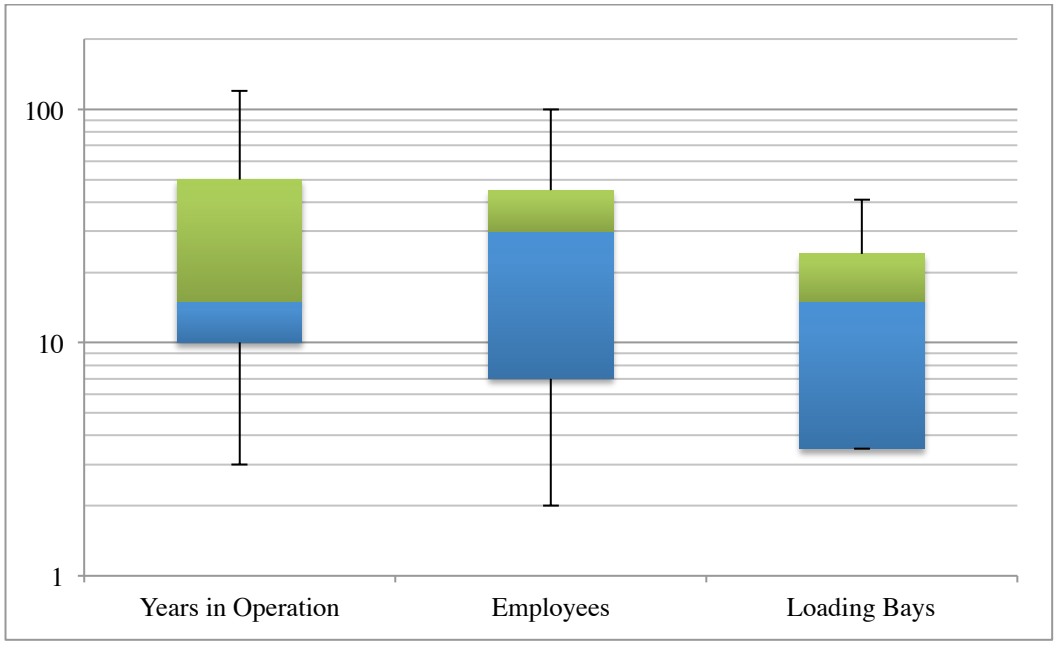

Figure 4.6: Facilities Years in Operation, Numbers of Employees and Loading Bays

The following results are questions from the survey pertaining facilities operations and views on green initiatives. Question 10 asked for the approximate percent of total operational costs due to energy consumption annually. The amount of responses was limited to 12 participant, were one wasn't aware of certain costs. Seen on Table 4.3, the top is ranked from the

highest percent to the lowest percent, in comparison to the type of facility. A wide range can be seen in companies, where both maximum and minimum, of the companies were a contract and distribution facility. The total average was of 25 percent, where maximum was 80 percent and minimum of less than two percent of operational costs are attributed to energy consumption annually.

Table 4.3: Annual Operational Costs due to Energy Consumption

Type of Facility	**Operational Costs due to Energy (%)**
Contract/Distribution	80%
3PL	75-80%
Public	35-40%
Distribution	25%
Public/Contract/Cold Storage/Distribution	15%
Contract/Distribution	10%
Public	10%
Distribution	10%
Storage	5%
Distribution	3%
Contract/Distribution/Bonded	< 2%
Average:	**25%**

The survey participants rated the importance of the environment to the facility's operating strategy according to five choices, seen in Figure 4.7. According to the results of nine out of 13 (about 69%) participants showed that the environment is ''very important'" to the facility. Next to "extremely important" receiving two out 13 (about 15%) replies. Furthermore, one out of 13 (about 8%) for "neutral", and one out of 13 (about 8%) for "not at all important".

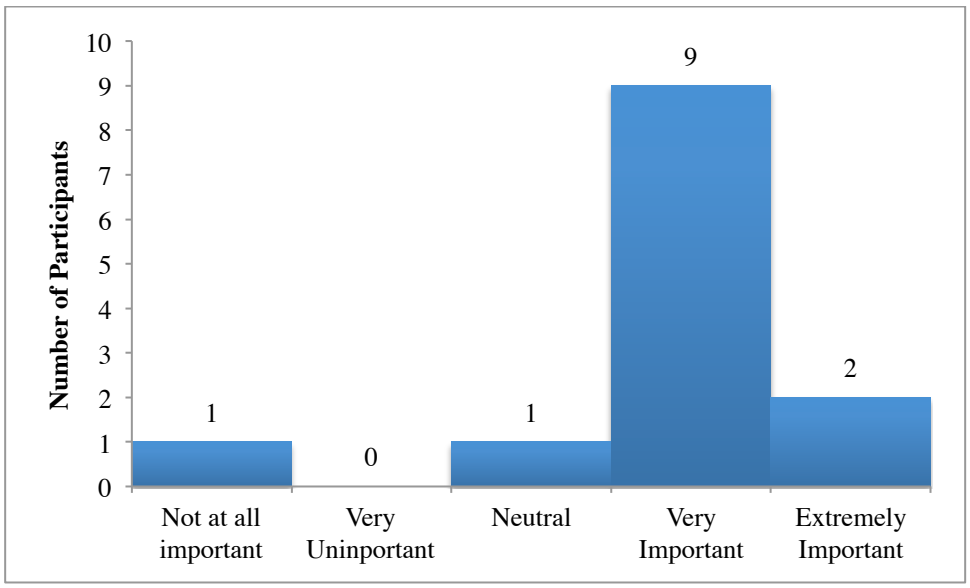

Figure 4.7: Importance of the Environment to Facility's Strategy

The results for question 12 are summarized in Figure 4.8. Of all the 13 participants who responded, nine of which responded to having an environmental strategy in place, three of which had none, and one did not know.

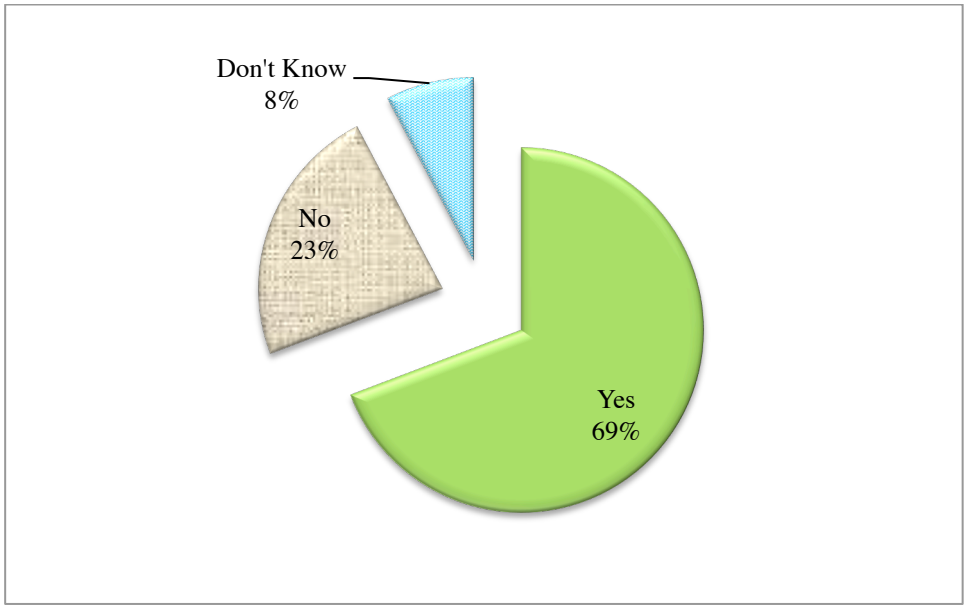

Figure 4.8: Companies with an Environmental Strategy in Place

Question 13: The participant then elaborated on how they are implementing green strategies, the following are the responses:

- "We use recycled water for some of the cleaning and all evaporative coolers. We turn off office lights when in the warehouse but not in the offices. We illuminate only the part of the warehouse on which we are working."
- "Environmental goals regulated by internal department called (QSHE)."
- "We separate all recycled items/ our company is small company we have no big trash bins were we actually separate card board and trash, we have a single small trash bin."
- "Energy Efficient Lighting on parts of the Warehouse, reduce paper consumption using EDI."
- "Recycling (plastics, pallets), motion sensors, bay lighting, LED bulbs, and buy recycled material (paper towels)."
- "Recycling, returnable containers, change warehouse layout, recycling trash, consider lights to save energy."
- "Efficient lighting and recycle."
- "Recycle wood and plastics."
- "Consider lighting to reduce energy consumption, work with EP electric company for when there is a spike, we shutdown."

Out of the nine participants who answered to "yes", having an environmental strategy in place, all responded in explanation on their strategies. Out of the nine, seven companies recycle, six consider in managing lights, one buys recycled materials, and one uses a plan on quality, safety, health, and environment (QSHE), and one uses electronic data change (EDI) technology as a form to reduce paper.

Results on question 14, whether the surveyor considers technology as a method to lessen environmental impacts, Figure 4.9. From 13 participants, twelve believe that technology can mitigate the environmental impressions, and one thought other wise.

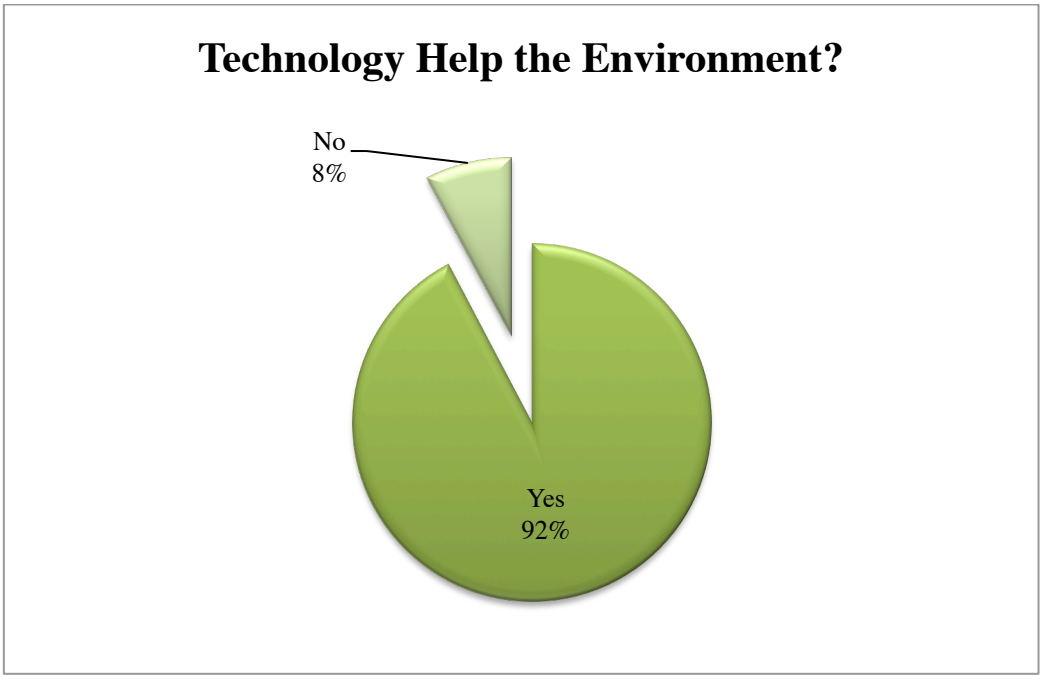

Figure 4.9: Survey Result on Technology mitigating Environmental Impacts

Question 15 asked the opinions of the surveyors on what type of technology they believed to bring the most benefit to the environment, result are shown in Figure 4.10. It is evident that warehouse management systems are thought to bring more assistance to the environment. As there was given the option of selection "other", then describing the type of technology, one company chose all types to be important. While four considered supply chain planning, and two believed transportation management systems to be the most beneficial.

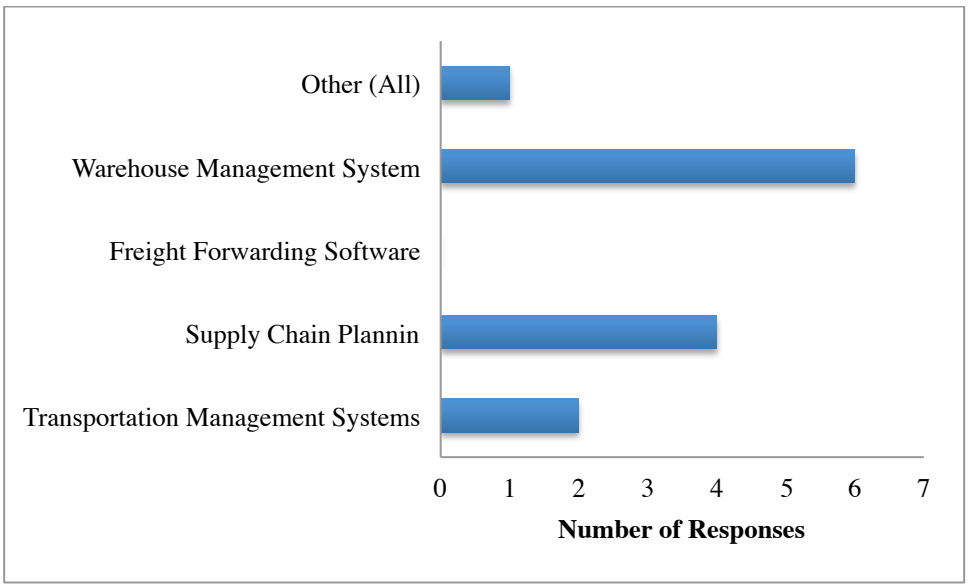

Figure 4.10: Response on Type of Technology to bring Environmental Benefits

Next, the survey results on a company's awareness in the amount of emissions they produce by measuring their carbon footprint are shown in Table 4.4. As shown, only one company measures the quantity on CO_2 emissions generated, followed by ten companies not implementing it, and two companies that are not sure.

Table 4.4: Measuring a Facility's Carbon Footprint Response

Survey Choices	Number of Responses	Percent Response
Yes	1	8%
No	10	77%
Don't Know	2	15%

The importance of the environment in regards to a driver adopting greater efficient processes survey results is shown in Figure 4.11. The participant is asked to rate the importance from not at all important, very unimportant, neither important not unimportant (neutral), very important, and extremely important. The radar graph shows a larger inclination on "very important" where seven out of the 13 participants (about 53.8%) thought driving efficiencies are very important to the environment. The graph also shows a pull on "extremely important", where

three companies chose on type of importance. Following one company choosing “neutral”, another company selecting “not at all important”, and the other “very unimportant”.

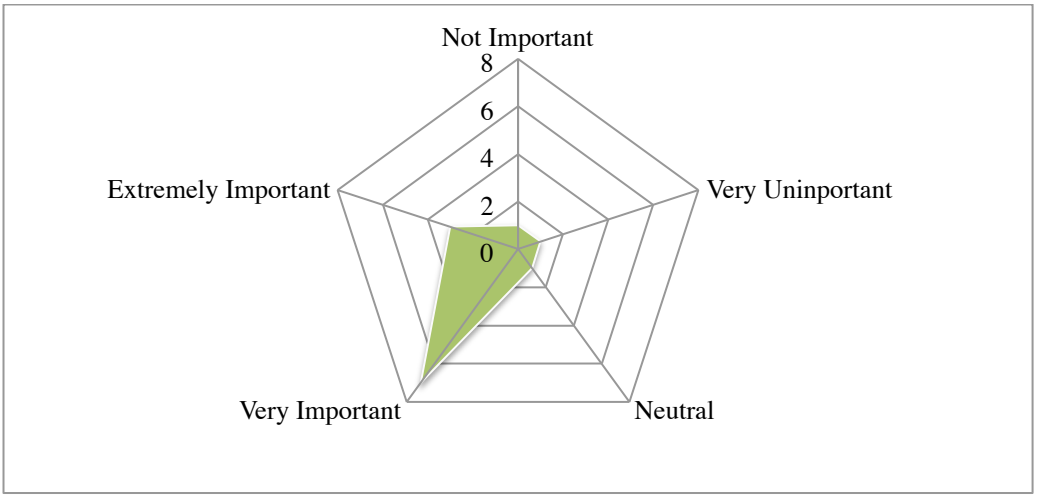

Figure 4.11: Environmental Importance as a Driver Response

Question’s 18 and 19, where the companies are asked if they havae spent money on environmental initiatives in their facilities, such as efficient lighting, recycling, and if there has been noticeable benefits in doing so. The results are combined in Figure 4.12, which illustrate the correlation for those who answered yes. It is shown that 92 percent (12 out of 13) of companies are spending money on green resources, while eight percent (1 out of 13) are not. The graph on the right represents those whom experienced any benefits from utilizing these green initiatives. From the twelve that answered yes to the previous question, nine (75%) replied that there have been notable benefits, whereas three (25%) of companies have not.

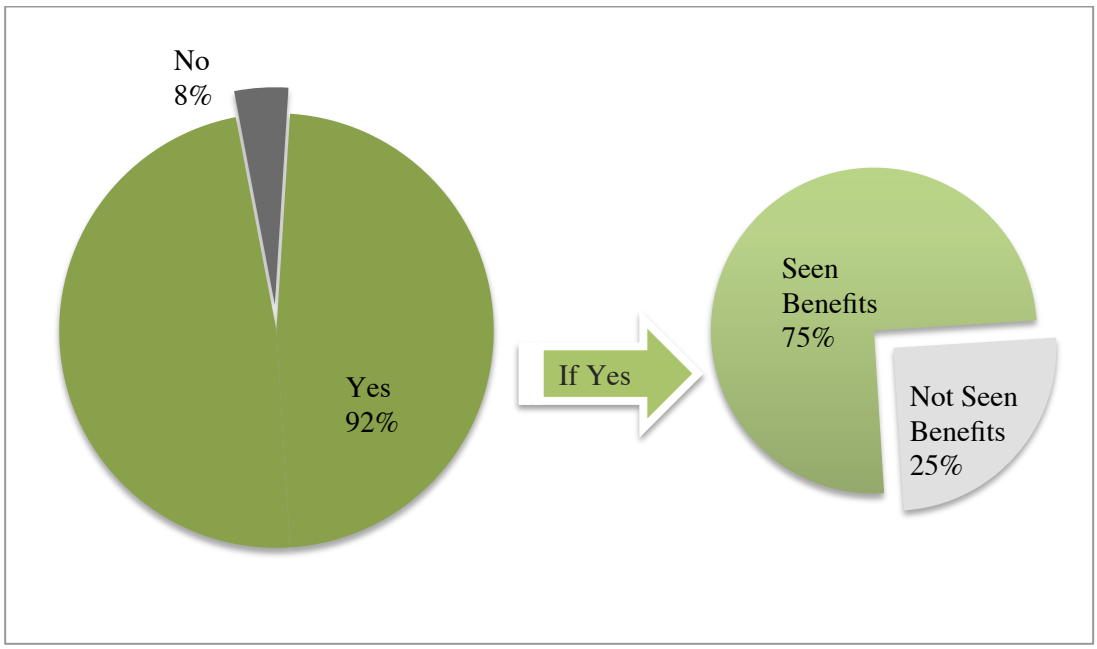

Figure 4.12: Percent Response on Environmental Initiatives and Observed Benefits

The outcome from companies stating their views of green issues are represented on a bar graph, seen in Figure 4.13. Results display larger viewpoints, at 61.5 percent, on balancing environmental initiatives and costs with business needs, graph shows the eight companies' responses out of 13. Business needs as their only priority, with a result of 30.8 percent (4 out of 13), was also prevalent over reducing the environmental impact at all costs even if the company is less competitive, resulting in 7.7 percent (1 out of 13).

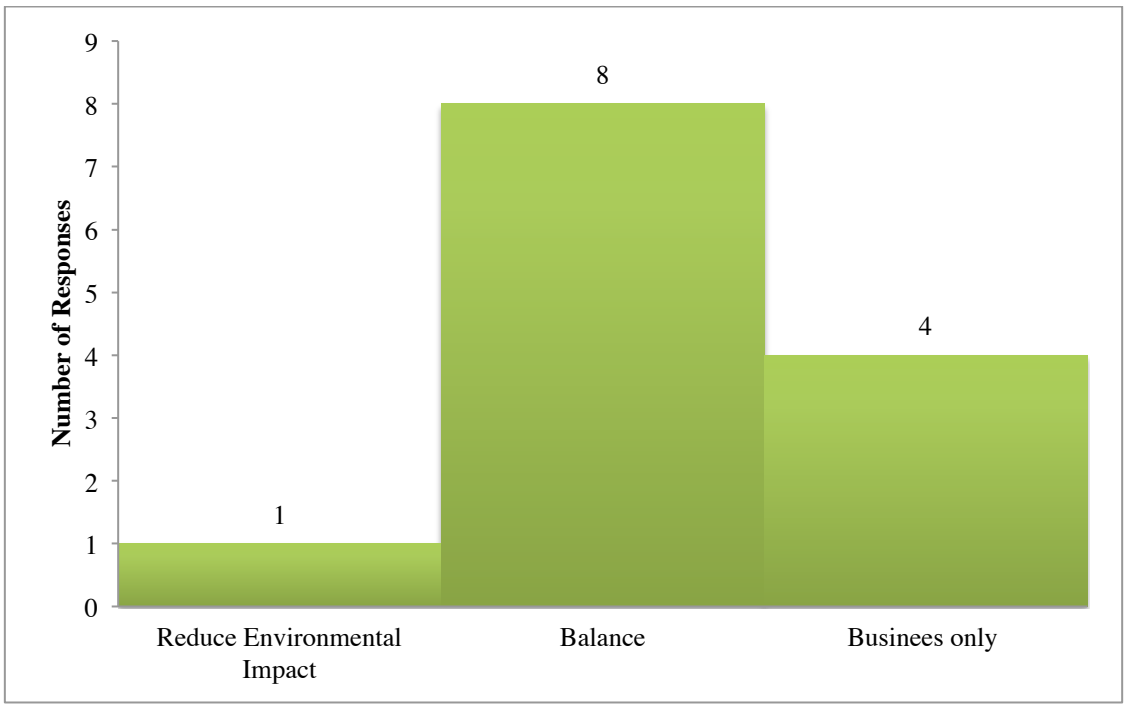

Figure 4.13: Views on Green Issues Response

Question 21 pertains on companies' views on selecting an environmentally friendly facility. As seen in Figure 4.14, a green facility costing no more than a traditional facility was most predominant choice amongst companies. From the twelve that answered (where one company was not sure, had no respond), eight companies chose to have an equal cost of a green facility to a regular facility (66.7%). The other 25 percent (3 out of 12) chose to invest and pay more initially if operating costs are lower. And one company (1 out of 12) would be happy to pay more to gain environmental benefits.

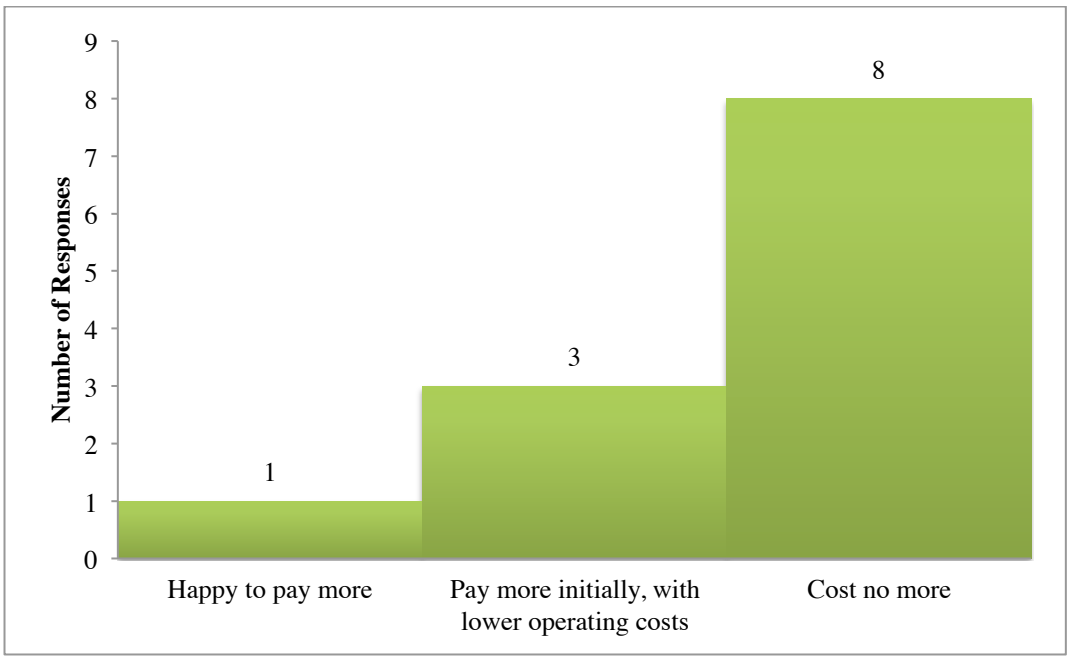

Figure 4.14: Views on Green Facilities Responses

Below, Figure 4.15, the companies responses in investing in environmental services in concern with the effects on an economic downturn are recorded. As can be seen, three of the 13 (23%) companies that responded will not continue to invest in green resources and will search for low costing services or infrastructure. Seven (54%) of the companies interviewed said they would invest, with the belief that it will lead to decreased costs and increase operational efficiencies to the company. The final three (23%) companies said they would continue to pay whatever it costs to keep their company green.

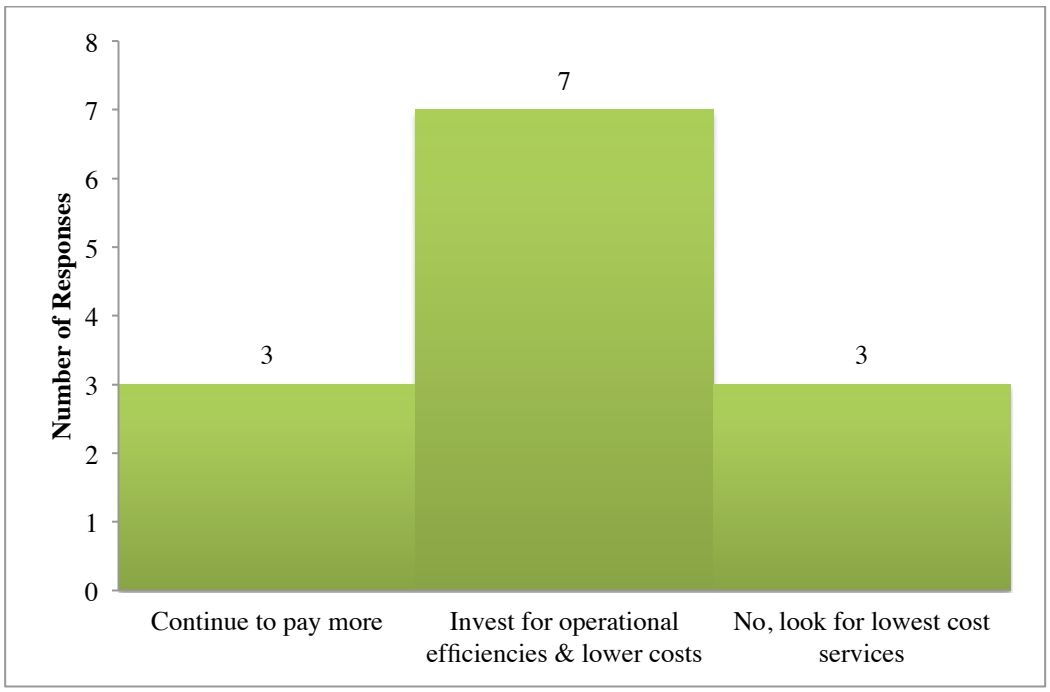

Figure 4.15: Investing in Environmental Services with an Economic Downturn Response

4.3 Survey Challenges

The survey results from responses of warehouse managers in El Paso, Texas on green evaluations were recorded. It was determined that surveys through e-mail had a low response, similar to the previous research conducted in literature review. Considering the low response rate, other forms of survey were introduced to have a higher number of responses. As the in-person survey generated the largest response rate compared to phone and e-mails, the following aspects should also be considered in terms of selecting the optimum survey approach: time, money and fuel emissions to drive from point A to point B. Seeing that in-person interviews proceeded in vehicle utilization, added money and emissions to the equation, as well as time to traveling from warehouse to warehouse. Although e-mails did not take into account money or emissions such as in-person surveys, time was a major factor. Waiting for the participant to fill out the survey at their own convenience did not allow obtaining immediate results. It also restricted further explanation on free response questions that were unclear. Surveys done by

phone were found to be the best survey method, which allowed for immediate results, savings time, money and emissions from traveling to the warehouse.

4.4 Discussion

The warehouses found in El Paso showed to have a wide variation on types of facilities and attributes, including global companies and distribution warehouses. Differences in range were found on facilities size, years in operation, number of employees, number of loading bays and percentage operational costs from energy consumption. Previous research, such as Ditlev-Simonsen and Midttun (2011) which several surveyed stakeholders opinionated that managers priorities where more on business profits rather than sustainability. This can also be associated with the results of this research in which a majority of the managers surveyed believed in balancing business needs with the environment, rather than placing sustainability as their highest concern. Similar results pertaining to the effects on a economic downturn, Berns et al. (2009), their results had companies still continuing to implement sustainability. This research found that more managers were selecting to invest in the outcome of operational efficiencies and decreased costs, with lower responses in cost cutting and paying more to benefit the environment. Many companies were also opposed to spending more money for an environmentally friendly facility, and believed it should cost no more than a regular facility. Most companies, according to the survey results, placed the environment as very important in their facility strategy, while 69% had an environmental strategy in place and 92% had spent money on environmental initiatives. Methods of an eco-efficient warehouse mentioned in the literature review, such as lighting, sensor lighting, recycling, using technology to go paperless, use of recycled materials, and consideration of warehousing layout are ways warehouses in El Paso, Texas are going green. While familiar techniques were observed, an environmental strategy was presented, known as ISO 14001, to help manage environmental systems. Although most of the companies did not measure their carbon emissions, or were not sure if they did, there was only one company that responded in doing so. And another innovative method, brought upon a different company,

which works with the El Paso Electric Company to reduce electricity consumption by shutting down when there is a large spike in energy consumption. While some companies add green strategies, only two companies go beyond to lessen the environmental impact. Possibilities why companies don't implement additional green resources, such as renewable energy (wind or solar), because of high costs and profits might not be seen right away. Other possibilities could be that companies are not aware of certain operational efficiencies that can help the environment and their business. Also, time in changing or finding ways to go green could take time and time could mean money, companies do not have the time to invest.

Chapter 5: Conclusions and Future Work

This chapter is divided into three sections; the first section concludes the major findings, while the second section highlights the significance of this research. The third section includes suggestions for future work based upon the results. Lastly, section four recommends the capacities for future advancements.

5.1 Conclusions

The purpose of this research study was to capture the attitudinal preferences of the warehousing industry in El Paso, Texas with regards to green practices. A survey was developed and conducted to identify warehousing characteristics, green practices, and current green views of warehouse managers in El Paso. The survey discovered a balanced outlook within the environment and business needs. Companies also revealed the importance of investing green practices for the sake of the environment, while also improving operational efficiencies and lowered costs, in spite of an economic downturn. Although most of the companies are undertaking green initiatives, only a few expressed a higher concern towards the environment by incorporating a solid environmental plan. Others showed indications of incorporating green strategies for the purpose of benefiting the company, if these investments are not too costly.

5.2 Contributions

Although the survey was limited to the warehousing and distribution industry in El Paso, Texas, the results are believed to be representative of green initiatives being incorporated in the design and operation of warehouses in the *Paso del Norte* region. This research has provided information with regards to how the warehousing industry views the impact of negative environmental consequences caused by high emissions in warehousing and distribution, green strategies and efficiencies that can be applied by the warehousing and distribution industry to be more environmentally aware.

5.3 Recommendations

As few companies surveyed have a strong environmental strategy in place, an implementation plan is needed for many of the companies. With today's concern on climate change, there are different organizations that provide guidelines, such as LEED and ISO 14001, for companies to follow in order to be more eco-friendly. Aside from applying LED lighting or sensors to reduce electricity, technologies that measure energy consumption in the facility can be considered in order to monitor, control, and decrease unnecessary energy consumption. The use of renewable energies were not found to be incorporated in any of the warehouses surveyed, and considering El Paso is a sunny city, it can be beneficial in incorporating solar energy. Most of the companies are willing to invest in eco-friendly alternatives if they can profit from it in the long term. Companies should consider small investments, such as layout efficiencies, that can bring immediate benefits, and slowly increase to larger investments.

Questions by several warehousing managers regarding how carbon footprint is measured raised speculations on the companies' knowledge of current environmental strategies, and how well they are informed about the effects caused by climate change. Increasing awareness and understanding through seminars for companies, warehouse managers, and employees on climate change, importance of going green, and innovative green strategies, could help in applying green practices within the company, and possibly in their homes, as well.

5.4 Future Work

Further research on a larger scale evaluation, and surveying different types of warehouses in different geographical areas can capture a greater sense of green practices. In addition, this study has established a foundation on how warehousing managers are motivated by company profits in balance with environmental needs. Future research on a cost/benefit analysis from small to gradual investments can be used to convince companies on the advantages in applying green strategies. This research should also be extended to analyze current green practices that are being applied in the supply chain, such as manufacturing, transportation, and retail companies.

Understanding companies motives and views throughout the green supply chain management may help future research shape strategies, to further expand the decrease in carbon emissions.

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Appendix A: Green Warehousing Survey

The University of Texas at El Paso (UTEP) and Oregon State University (OSU) are seeking improved methods to address freight transportation needs. They are now seeking information with regards to "GREEN" logistics, specifically with regards to warehousing and distribution. This information will help UTEP and OSU to better understand the needs of the Warehouse and Distribution Center industry and plan for improvements that will benefit the freight transportation industry. About 15 participants will be enrolling in the survey, and will take about 10-15 minutes to complete. The data you provide will NOT be identified with your firm. It will be averaged with other survey responses to help provide UTEP and OSU with a more accurate picture of Warehouse and Distribution Center industry with regards to "green" logistics. Please provide the information requested below, we thank you for you participation. If you have any questions feel free to contact Lynda Macias or Dr. Salvador Hernandez at: Lynda Macias: ljmacias@miners.utep.edu Salvador Hernandez: sal.hernandez@oregonstate.edu

Q1 Company Name:

Q2 Job Position of Person Completing Survey:

Q3 Your company is consider a:
- ❍ Local company (1)
- ❍ Regional company (2)
- ❍ National company (3)
- ❍ Global company (4)

Q4 How long has your facility been in operation? (In Years)

Please answer the following question regarding TYPICAL freight activity at this location

Q5 Is your facility a: (Check all that apply)
- ❑ Public Warehouse (1)
- ❑ Contract Warehouse (2)
- ❑ Cold Storage (3)
- ❑ Distribution center/HUB (4)
- ❑ Other (Please describe) (5) _____

Q6 What are the hours and days of operation of your facility? (e.g., 8 a.m. - 5 p.m., Mon. thru Fri.)
- ❑ Hours: (1) _____
- ❑ Days: (2) _____

Q7 How many employees typically work at your facility? (Employees)

Q8 What is the approximate square footage of your facility? (Sq. Ft)

Q9 How many loading bays does your facility have? (Bays)

Please answer the following questions regarding Warehouse/ Distribution operations.

Q10 About what percentage (%) of your total operational costs would you say is attributed to energy consumption annually?

Q11 How important would you say is the environment to your facility's strategy?
- Not at all Important (1)
- Very Unimportant (2)
- Neither Important nor Unimportant (3)
- Very Important (4)
- Extremely Important (5)

Q12 Does your facility have an environmental strategy in place?
- Yes (1)
- No (2)
- Don't know (3)

If Yes Is Selected, Then Skip To If yes, can you please elaborate

Q13 If yes to Does your facility have an environmental strategy in place?, can you please elaborate

If If yes, can you please elab... Is Equal to, Then Skip To Do you consider technology an importa...

Q14 Do you consider technology an important tool in mitigating environmental impacts
- Yes (1)
- No (2)

Q15 In your opinion, what type of technology do you consider to bring most environmental benefits?
- Transport Management Systems (1)
- Supply Chain Planning (2)
- Freight Forwarding Software (3)
- Warehouse Management Systems (4)
- Other (Please describe) (5) _____

Q16 Do you measure your facility's carbon footprint?
- Yes (1)
- No (2)
- Don't know (3)

Q17 In your opinion, how important is the environment as a driver in adopting more efficient processes?

- ❍ Not at all Important (1)
- ❍ Very Unimportant (2)
- ❍ Neither Important nor Unimportant (3)
- ❍ Very Important (4)
- ❍ Extremely Important (5)

Q18 Has your company spent money on environmental initiatives for your facility? (e.g., efficient lighting, Recycling, insulation, etc)

- ❍ Yes (1)
- ❍ No (2)

If Yes Is Selected, Then Skip To If so, to has your company spent mone...

Q19 If so, to has your company spent money on environmental initiatives for your facility? (e.g., efficient lighting, Recycling, insulation, etc), have you experienced any benefit from doing so?

- ❍ Yes (1)
- ❍ No (2)

If Yes Is Selected, Then Skip To Which of the following statements mos...

Q20 Which of the following statements most closely describes your personal views with regards to "Green" issues?

- ❍ We must balance environmental initiatives and costs with business needs (1)
- ❍ We must reduce our impact on the environment at all costs, even if my company is less competitive (2)
- ❍ Our business needs are our only priority (3)

Q21 If you were to select a more environmentally friendly facility ... ?

- ❍ Our company would be happy to pay more in an initial investment if running costs are lower (1)
- ❍ The 'green' alternative must cost no more than a traditional warehouse/distribution center (2)
- ❍ Our company would be happy to pay more to gain environmental benefits (3)

Q22 In light of an economic downturn, in your opinion will your company invest in environmental-friendly services?

- ❍ Yes, we will continue to pay more for an environmentally friendly alternatives (1)
- ❍ No, cost cutting will mean we will look for the lowest cost services or infrastructure (2)
- ❍ Investment in our environmental initiatives will bring operational efficiencies and lower costs. (3)

Once again thank you for your participation in this survey. If you have any questions or comments feel free to contact us at: Lynda Macias: ljmacias@miners.utep.edu Salvador Hernandez: sal.hernandez@oregonstate.edu Thank you!

Appendix B: Green Warehousing Survey Responses

Questions 2-22

Finished	Q:2	Q:3	Q:4
1	LOGISTICS MANAGER	1	MORE THAN TEN YEARS
1	Warehouse Manager	4	3 years at this building
1	Transborder Manager	4	15
1	MANAGER	4	OVER 120 years
1	Warehouse Manager	1	51 years
1	Senior Operations Manager	2	51 years
1	Logistics Manager	4	10 years
1	Distribution Warehouse Manager	4	12 years
1	Warehouse Manager	1	60 years
1	Operations Manager	1	25-30 years
1	Office Warehouse Manager	4	5 years
1	Manager	4	12 years
1	Warehouse General Manager	3	20 years

Q: 5 (Check all that apply)-Public Warehouse	(Check all that apply)-Contract Warehouse	(Check all that apply)-Cold Storage	(Check all that apply)-Distribution center/HUB	(Check all that apply)-Other (Please describe)	Is your facility a: (Check all that apply)-Other (Please describe)-TEXT
0	1	0	1	0	
0	0	0	1	0	
0	1	0	1	1	Bonded Warehouse
0	0	0	1	0	
0	1	0	1	0	
	1			1	3PL
			1		
1					
				1	Storage
				1	Local Storage
1					
			1		
1	1	1	1		

Q:6	Q:6.2	Q:7	Q:8	Q:9	Q:10	Q:11	Q:12
8 am - 5 pm	M-F	4	50,000	10	10%	4	3
7 am - 11 pm	M-F	32	150000	32	25	3	2
7:30 am - 10 pm	M-Sat	45	73000	16	-2%	5	1
8 am- 5 pm	M-F	6	32000	4	16000	4	1
7:30 am - 5 pm	M-F	30	44700	2	80%	4	1
8am-12am	M-F	100	282000	41	75-80%	4	1
8 am-4:30 pm	M-F	30	156000	30	3%	4	1
6am-11pm	M-F	52	70000	15	35-40%	4	1
10am -6pm	M-Sat	45	-	3	5%	4	1
8 am-5pm	M-F	2	600	0	-	4	2
8 am-5pm	M-F	10	30000	6	10%	4	1
8 am-5pm	M-F	8	120000	16	10%	1	2
8 am-5pm	M-F	20	132000	18	15%	5	1

Q:13
We use recycled water for some of the cleaning and all evaporative coolers. We turn off office lights when in the warehouse but not in the offices. We illuminate only the part of the warehouse on which we are working.
-
Environmental goals regulated by internal department called (QSHE)
We separate all recycled items / our company is a small company we have no big trash bins were we actually separate card board and trash, we have a single small trash bin
-
Energy Efficient Lighting on parts of the Warehouse, reduce paper consumption using EDI
Recycling (plastics, pallets), motion sensors, bay lighting, LED bulbs, buy recycled materials (paper towels)
Recycling, returnable containers, change warehouse layout, recycling trash, consider lights to save energy
Efficient lighting, recycle
-
Recycle wood and plastic
-
Consider lighting to reduce energy consumption, work with EP electric company for when there is a spike, we shutdown

Q:14	Q:15	Q:16	Q:17	Q:18	Q:19	Q:20	Q:21	Q:22
1	2	2	4	1	1	1	2	2
1	2	2	2	1	1	3	1	3
1	4	1	5	1	1	1	1	1
1	2	3	3	1	2	3	2	2
1	2	2	4	1	1	2	1	1
1	4	2	4	1	2	1	2	3
1	1	2	4	1	1	1	2	1
1	4	2	4	1	1	1	2	3
1	4	2	4	1	1	1	2	3
1	4	2	4	1	1	1	-	3
1	1	2	5	1	2	3	3	3
2	4	2	1	2	2	3	2	2
1	ALL	3	5	1	1	1	2	3

Survey Response Rates

Survey Response Rate					
	Contacted	Accepted (Contacted)	Rejected (Contacted)	Opened Survey (Email)	Responded
Email	2	2	-	1	1
Phone (for Email)	16	10	6	5	2
In-Person (for Email)	7	6	1	1	1
In-Person (Interview)	9	4	5	4	4
Phone (interview)	13	5	8	5	5
Total	47	27	20	16	13
Email	25	18	7	9	4
In Person (interview)	9	4	5	4	4
Phone (interview)	13	5	8	5	5
Total	47	27	20	18	13

Overall Response Rate			
	Contacted	Responded	Response Rate (%)
Emailed	18	4	22.22
In person (survey)	9	4	44.44
Phone (survey)	13	5	38.46
Total	40	13	32.50

Calculations for Box Plot

Column1	Years in Operation	Employees	Loading Bays
Average	30.35	29.54	14.85
Min	3	2	0
Q1	10	7	3.5
Med	15	30	15
Q3	50	45	24
Max	120	100	41
25th	10	7	3.5
50th	5	23	11.5
75th	35	15	9
Min	7	5	3.5
Max	70	55	17

Vita

Lynda Macias was born in El Paso, Texas. She is the second child of Jorge Macias and Imelda Macias. She attended J.M. Hanks High School, in El Paso Texas, where she graduated early in the Fall of 2005, and walked with her class in the Spring of 2006. While pursuing her Bachelor's of Science in Civil Engineering, she worked as an intern at Conde, Inc., in the summer of 2011. She was a part of the winning team for the Best Senior Design Award from the Department of Civil Engineering at The University of Texas at El Paso. She received her bachelor degree from The University of Texas at El Paso, in the Fall of 2011. In the Summer of 2012, she enrolled in Graduate School to continue her Master's of Science in Civil Engineering at UTEP, where she also began working as a research assistant under the supervision of Dr. Salvador Hernandez. The following year, she worked as an intern for the USDA-ARS in Temple, Texas, in the summer of 2013. She and other team members from UTEP traveled to Irvine, California to compete in the U.S Department of Energy Solar Decathlon in the Fall of 2013, representing Team Texas.

Permanent address: 1705 Dale Douglas
El Paso, Texas, 79936

This thesis was typed by Lynda Macias.