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Green Logistics in E-Commerce Industry: A Case Study on Daraz Nepal Pvt. Ltd.

by

Sujan Kharel

A THESIS

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The undersigned certify that they have read, and recommended to the Institute of Engineering for acceptance, a thesis entitled "**Green Logistics in E-Commerce Industry: A Case Study on Daraz Nepal Pvt. Ltd.**" submitted by Sujan Kharel in partial fulfilment of the requirements for the degree of Master of Science in Energy System Planning and Management.

Supervisor, Dr. Sanjeev Maharjan
Assistant Professor
Department of Mechanical and Aerospace Engineering

External Examiner, Mr. Kishor Kumar Maharjan
Senior Case Processing Manager,
International Rescue Committee (IRC)
Kuala Lumpur, Malaysia

Committee Chairperson, Dr. Sudip Bhattarai
Head of Department
Department of Mechanical and Aerospace Engineering

Date: 30th November, 2023

ABSTRACT

This study explores the important role of last-mile delivery in the logistics sector, with a particular focus on the e-commerce sector. The last mile, often considered the most important customer touchpoint, requires optimal vehicle allocation and route planning. Daraz Nepal Pvt. Ltd., a leader in e-commerce, currently relies on two- and four-wheeled gasoline-powered vehicles for last-mile deliveries, using a hub-based model spread across nine locations across the Kathmandu valley. In line with its commitment to environmental sustainability, Daraz aims to convert its entire fleet of gasoline-powered vehicles to electric alternatives, thereby contributing to the global effort to reduce the carbon emissions.

Our research yields compelling findings that highlight the significant benefits of transitioning from ICEs to electric vehicles in the context of e-commerce last-mile delivery. This conversion promises significant fuel savings, significantly improved fuel efficiency and an extremely short payback period of less than 5 years. We recommend that organizations involved in last-mile delivery, especially in e-commerce, carefully consider the use of electric vehicles as a financially prudent and environmentally friendly option. Additionally, our research highlights the importance of data-driven insights, using advanced data visualization tools, including sophisticated cash flow diagrams and infographics created by Python created, to improve decision makers' understanding of financial drivers and highlight the value of data-driven decisions which helps in promoting resilience and sustainability in the logistics and transport sector.

In addition to these findings, our research also examines the transformative potential of energy consumption and emissions reduction in last-mile logistics. We reveal a stark disparity between petrol and electric vehicles, with petrol two- and four-wheelers showing significant energy consumption and emissions. However, our research offers the possibility of significantly reducing emissions. Additionally, our economic analysis demonstrates that investing in emissions reduction, which represents a cost of $357.15 for two-wheeled vehicles and $171.48 for four-wheeled vehicles, survive financially while contributing to reducing social and environmental impacts. In summary, our research makes a compelling case for a cleaner, more sustainable and more economically viable future in last-mile logistics through the adoption of electric vehicles and other innovations.

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LIST OF ABBREVATIONS

BEV: Battery Electric Vehicle

CO2: Carbon dioxide

CO: Carbon Monoxide

EV: Electric Vehicle

FDI: Foreign Direct Investment

GDP: Gross Domestic Product

ICE: Internal Combustion Engine

JIT: Just In Time

kWH: Kilo-Watt Hour

L&T: Logistics and Transportation

MoEST: Ministry of Environment, Science and Technology

NAAQS : National Ambient Air Quality Standards

NEA: Nepal Electricity Authority

NOC: Nepal Oil Corporation

OR: Operations Research

PM: Particulate Matter

TCO: Total Cost of Operation

CHAPTER ONE: INTRODUCTION

1.1 Background

The media, political agendas, scholarly publications, and the general public have all shown an increasing concern in recent years about the environmental impact of human activity on the earth. Companies are coming under increasing pressure from stakeholders to accept accountability for any negative consequences that may arise from their operations. As a result, companies are thinking about incorporating environmental factors into their business plans. Logistics is a major source of pollution and resource consumption, hence there is a greater emphasis on ecologically friendly solutions in this area.

In the past, logistics has typically been linked to cutting expenses and increasing revenue, especially in the context of business and financial reporting. But then the phrase "Green Logistics" appeared, denoting an emphasis on social and environmental issues while preserving economic viability. The term "green logistics" refers to supply chain management techniques and policies that minimize the energy and environmental impact of freight distribution, with an emphasis on material handling, waste management, packaging, and transportation. (J.P. Rodrigue, 2017).

Transport and logistics are responsible for a large proportion of greenhouse gases. So, it's vitally important to make logistics practices greener and more sustainable. Fortunately, there's a wide range of steps to be taken. As well as benefitting the planet and the human race, we may be surprised to learn that many of these changes will actually benefit the bottom line. And of course, all will please increasingly eco-conscious customers. (DHL, 2022).

Online sales reached an all-time high during the COVID epidemic, with 55 million parcel deliveries each day in the US alone jumping by 37% between 2019 and 2020. (Pitney Bowes, 2021). Customers anticipating deliveries in a day or sometimes simply a few hours added to the logistical strain caused by the Amazon Effect. This implies that products can no longer be distributed across the country from a single warehouse. Products must be kept in nearby distribution facilities before being hurried to customers in smaller batches in order to accomplish such rapid delivery times. Larger fleets of smaller cars are required for this. (SAP , 2022).

Figure 1.1: Logistics Wing of E-commerce at Sort Center, Tashikhel

Approximately 90% of all travels conducted throughout the country in Nepal are made by road, which dominates the transportation sector (Acharya, 2015). Although compared to other countries, Nepal is still in the early stages of motorization, the country's growth rate for car registration has exceeded 16% annually over the past ten years. The world's largest source of GHG emissions and the primary consumer of petroleum-based products, which contributes to the global depletion of fossil fuels, are petroleum vehicles. The solution to the issues of GHG emissions and the depletion of fossil fuel resources is thought to be electric automobiles. The electric vehicle (EV) is propelled by a motor, which in turn is propelled by energy from the battery cells, which serve as the driving source. It can be argued that the majority of Nepal's electricity comes from clean hydropower as this is what is reported to be the case (Trading economics, 2022). Therefore, using an electric car in

Nepal lessens the country's reliance on foreign oil and substantially lowers its GHG emissions. Approximately Rs. 155.43 billion worth of diesel and gasoline were imported into Nepal for the 2018/2019 fiscal year, which is an increase of almost 30 billion rupees from the prior fiscal year, according to data from the department of customs (Lama, 2019).

The primary forces behind the need for energy in the transportation industry are thought to be economic expansion, fast urbanization, and rising population. Energy use for transportation in emerging nations is rising and is anticipated to increase quickly in the future (U.S. Congress, Office of Technology Assessment, 1991). According to projections, developing countries will have more vehicles than developed ones by 2030 (Wright, 2004). In Nepal, the transportation industry consumes 5.2% of primary energy, which is second only to residential energy use, and 63.2% of all petroleum fuel imported. It follows an upward trend. Petroleum fuel accounts for nearly all of the sector's output. This industry's yearly average growth rate for energy consumption is 8.9% (Government of Nepal, 2010). Road transport, which accounts for 86.5% of Nepal's total sectoral consumption and is the primary mode of transportation in terms of CO2 emissions, also dominates the energy usage pattern (Government of Nepal, 2010). After 1991, the number of automobiles increased significantly, with the majority being based in Kathmandu and other major towns in Nepal. This accelerated automobile increase has led to environmental issues in Kathmandu. According to studies, the transportation industry is one of the main contributors to air pollution in the Kathmandu Valley (Shrestha & Malla, 1996). The total suspended particles (TSP) caused by vehicle emissions grew by approximately four times, from 571 ton/year to 1971 ton/year between 1993 and 2001, according to the Ministry of Environment, Science and Technology (MoEST). Similarly, between 1993 and 2005, the amount of PM10 caused by vehicle emissions increased by approximately six times, from 570 tons per year to 4708 tons per year, accounting for 38% of all PM10 emissions in the Kathmandu Valley (C., 2006). These emission levels are significantly higher than the NAAQS (National Ambient Air Quality Standards) (Dhakal, 2006).

As things stand, the cost of imported petroleum is expected to roughly double from the 2018–2019 fiscal year, and it has recently increased to a significant amount with price increases forecast in the years 2022–2023. Kathmandu is among the most polluted cities in the world as a consequence of Nepal's dramatic 32-fold rise in carbon emissions over the course of 15 years, from 2000 to 2015 (Joshi, 2003). According to K. Zhang and S. Batterman, the following spike in the number of vehicles in the valley is considered to be the primary cause of the rise in pollution, particularly private vehicles (K. Zhang and S. Batterman, 2013). Therefore, in the case of Nepal, the hunt for a clean alternative vehicle is currently necessary. More than 99% of the moving vehicles in Nepal are fueled by petroleum, which increases carbon emissions and causes pollution (GON Ministry of Forests and Environment, 2021).

1.2 Statement of problem

As the research starts with the problem to be solved, it is a very important part of the study to define the problem statement. The modern world faces several global challenges, one of which is sustainable development. Degradation of ecosystems disrupts the socioeconomic system, contributes to climate change, and hinders the advancement of several sectors. Among the first-mile, linehaul and last-mile steps in logistics, last-mile has the most exposure with customers as because it is associated with door-to-door delivery. The last mile of package deliveries is becoming more complicated, with negative effects on the environment and quality of life. This is due to the growing urban population and the growth of e-commerce. Emerging nations find it challenging to create and execute alternatives to the traditional scope of fossil-based operations, despite their significance. This study focuses on the impact of green logistics in ecommerce and the cost and emission analysis of transforming all fleet vehicles for last-mile delivery to BEV in an e-commerce company for Tier-1 Cities (Kathmandu, Bhaktapur and Lalitpur).

1.3 Objective

1.3.1 Main Objective

The main objective of the study is to examine the effectiveness of Green Logistics inside the Kathmandu Valley for an e-commerce-based company Daraz Nepal.

1.3.2. Specific objectives

1. To examine the last-mile delivery of a logistics company.
2. To measure the cost effectiveness of an e-commerce company switching to green logistics.
3. To analyse energy usage, emission impact on delivery following the Green Logistics.

1.4 Significance of the study

This research is aimed at analyzing the adoption of electric vehicles used for freight transportation and finding their effectiveness in an e-commerce company. This study has been undertaken to understand about the savings in terms of emission and also cost of logistics. This study will focus on finding the various factors involve to perform a last-mile delivery with the use of BEV's compared to ICE's. The findings of this thesis will help e-commerce and logistic company to understand the importance of switching to green logistics. Also, this thesis will also aid new comers to gain insights on the cost analysis of choosing the greener option in logistics. This will also help the innovators and regulators for drafting future action plans and policies. Hence, the study and findings from this research will be helpful for the logistics team of any company to consider the findings for increasing its effectiveness and impact of greener options in logistics.

1.5 Scope and Limitations of study

The dimension of Green Logistics system is very vast which includes green packaging, green warehousing, green transport and waste minimization. This study is based only on analyzing effectiveness of green transportation model. There are various limitations of the study which are as follows:

- The study had to be completed within a prescribed time frame.
- The study is limited only in Kathmandu Valley (Kathmandu, Lalitpur and Bhaktapur) due to limited resources, geographical and time constraints.

- This research was conducted using both primary and secondary data as per the availability.
- This findings is based on a study performed at only one of the largest e-commerce company in Nepal.

CHAPTER TWO: LITERATURE REVIEW

Finding the causal factors influencing the adoption of greener logistics (electric bikes and vans) was the primary goal of the literature review. These findings were relevant to the study of the last-mile e-commerce system that accounts for the success of the green logistics systems in Nepal. The purpose of this exercise was to design the research questions, prevent information duplication, and create the theoretical foundation for the study. Journals, articles, books, corporate and governmental reports, newspapers, theses and dissertations, and online publications are the information sources used for this study. Literature review is based on any studies related to green logistics, its implementation, challenges, adoption and effectiveness.

Generally speaking, the goal of logistics is to increase profits while minimizing costs. The phrase was primarily used in financial reports and in sections that were solely business and displayed corporations. However, for a long time, the word "green" and "logistics" were combined to create "Green Logistics," a term that included expenditures but did not show up in financial reports or in discussions of the environment or society.

The expansion of the world economy and the global network of supply chains have made the logistics network increasingly intricate and dispersed. Longer travel lengths typically result in higher emissions and more severe environmental issues. "Green logistics" refers to the process of organizing, managing, and carrying out the flow of goods by utilizing contemporary logistics methods in an effort to reduce environmental risks. (Qin, 2008). Along with achieving the organization's objectives and customer pleasure, this logistical flow should also attempt to lessen the impact of these actions on the environment. (J.P. Rodrigue, 2017). According to this perspective, green logistics refers to an organization's capacity to transport goods and services in an economical and environmentally responsible manner. Green logistics include an organization's capacity to maintain resources, reduce waste, boost productivity, and meet the need for ecological reinforcement in society.

The research focused on Italy showed that the energy transition even though there are co-provision to induce the transition the change in socio organizational change was observed to be patchy because if there is no greater monetary benefit the change is not generally welcomed by the masses (Carrosio, 2019). As observed in the research EV has helped in reduction of CO2 emission and petroleum product dependence of any nation. Under different scenarios of production of electricity, the societal impact of the EV use was observed and the emission was largely reduced on smaller nations and the country using low emission fuel are bound to gain millions of euros per year in the avoidance of external cost in case of countries in EU (Buekers, 2014).

Table 2.1: Green Logistics Impact

Economic	**Social**
Enhanced contentment among clients	Diminished effects on the environment (such as CO2 emissions and noise levels)
Positive interactions with stakeholders	Improved use of natural resources (fuel, packaging, etc.)
Green image	Growth in line with the resources and cultural norms
Increased delivery dependability via more efficient route planning and less downtime	Decreased societal cost (such as community health issues)
Increased productivity as a result of increased employee motivation	Enhanced quality of life
Reduced taxes	
Improved financial performance	

2.1 Existing Logistics of Daraz Nepal

Daraz has its own logistics wing called Daraz Express which is currently serving for last-mile delivery all over the country. But, it also takes help from other third-party logistics for the delivery to customers doorstep. The logistics wing of Daraz contains three different categorizations.

It consists of first-mile, last-mile and middle-mile. It is explained below:

- First-mile: The initial phase of shipping, known as first-mile delivery, marks the departure of goods from the production facility or supplier warehouse. It's crucial to note that the interpretation of the stage between the first mile and the middle mile can vary across industries. In the retail sector, first-mile delivery involves transporting goods from the supplier warehouse to the retailer's store. In e-commerce, the first mile may encompass the movement of goods from the retailer to the delivery courier responsible for delivering to the customer's residence, workplace, or another designated pickup point.

- Middle-mile: In many instances, middle-mile delivery involves the movement of goods from a distribution center to a fulfillment facility. It's noteworthy that, following the initial mile, there might be multiple stages of middle-mile delivery. Therefore, tracking becomes a vital tool for both customers and logistics providers to monitor the order's progress and location. Despite the substantial growth in online shopping, e-commerce businesses and other retailers continue to depend on physical sorting facilities to efficiently process and deliver goods to the intended customers.

- Last-mile: Following the initial and middle-mile phases, last-mile delivery represents the ultimate leg of the product's journey to the customer's doorstep. This stage is exceptionally crucial as it serves as the "customer-facing" aspect of the entire shipping process. Additionally, it stands out as the most costly stage, factoring in labor expenses, logistics software, and surcharges associated with unsuccessful deliveries. Ultimately, customer satisfaction hinges on the seamless and efficient execution of the first-to-middle-to-last-mile operations. Delays or damages during shipment can adversely impact the potential for future business collaborations. (Barra, 2022).

Daraz mostly uses two-wheelers (Motorbikes) and four-wheelers (Pickup Vans-Tata Ace) for its delivery purposes. Mostly for small sized packages two-wheelers (Motorbikes) are used whereas four-wheelers (Pickup Vans-Tata Ace) are used for big sized vehicles.

2.2 Sustainable Development through Green Logistics

Green logistics concerns are receiving a lot of attention in the fiercely competitive world of today. Due to the fact that it is a crucial component of supply chain management and helps to enhance the transportation system. Logistics makes it easier for customers to receive goods and services when and when they need them. Because it facilitates economic transactions, it plays a significant role in fostering the expansion of trade and commerce within an economy. "The process of organizing, carrying out, and managing the economical movement and storage of finished goods, in-process inventories, raw materials, and associated data from the point of origin to the point of consumption in order to satisfy client demands" is how the American Council of Logistics Management defines logistics. Modern technology advancements have reduced costs, increased effectiveness, and increased dependability of freight and passenger transportation networks. Simultaneously, the detrimental effects of transportation on the environment have come to light and are fundamental to sustainability concerns, particularly in metropolitan settings. The idea of "green logistics" emerged since it has been claimed that logistics should be environmentally friendly because its applications typically improve the effectiveness of transportation networks. (Kumar A. , 2015).

Figure 2.1: Illustration of Green Logistics

2.3 The green logistics evaluation standard

The following are the enterprise green logistics evaluation criteria, per the Logistics Link:

1. Green transportation: Green transportation involves utilizing low-pollution fuels to power various modes of transportation and implementing a multi-modal allocation approach. Properly organizing transportation allows for pollution reduction, cost savings, and improved allocation efficiency.
2. Green storage: Green storage involves incorporating mechanized operations in the goods-storing process to minimize labor costs, utilizing environmentally-friendly products for sterilizing stored goods, and implementing centralized stock methods to mitigate environmental impacts and minimize the damaging impacts of warehousing on the ecosystem.
3. Green packing: Green packaging means a type of product packaging which avoids causing environmental pollution. The packaging materials should be resource-efficient, minimizing waste, and designed for easy recycling and regeneration after use. Additionally, the packaging should occupy minimal land when disposed of, facilitating easy decomposition.
4. Reverse logistics: Reverse logistics, in contrast to the conventional chain of supply, focuses on the strategic planning, management, and control of raw materials,

intermediate inventory, final products, and associated information from the consumer's location back to the starting point, with the aim of responsible disposal or value recovery.

5. Green technology: Information and communication technology, biological technology, monitoring technology, and other specialized technologies are all included into green technology in logistics management. Using cutting edge technology enables businesses to effectively improve managerial efficiency.

Table 2.2: Green Logistics Outcome and Paradoxes

Dimensions	**Outcome**	**Paradoxes**
Cost	Cut costs by eliminating waste and enhancing packaging	Compared to packaging costs, environmental costs are substantially higher.
Time/Availability	The development of JIT and integrated supply chains results in an effective distribution system.	Improved sales, distribution, and production system requires more energy, more room, and produces more CO2 emissions.
Network	Enhancing the system's efficiency as a result of network modifications	Concentration of the environment along corridors and adjacent to major Huns, with an effect on nearby communities.
Reliability	A reliable and efficient transportation system.	The ecology is negatively impacted by trucks and airplanes.
Storage	Lowering the need for individual storage facilities.	Continuous usage of the roadways, which results in more traffic.
E-commerce	Expanding the quantity of commercial prospects and broadening the range of suppliers.	An increase in energy consumption results from modifications to the physical distribution.

According to the logistics environment, the evaluation criterions of city green logistics are as follows:

1. Green logistics policy: The green logistics policy encompasses a set of interconnected policies developed by the government during the implementation of green logistics. On one hand, it aims to regulate the behavior of enterprises, encouraging them to align with sustainable development goals. On the other hand, it serves to incentivize enterprises to adopt green management practices, contributing to the construction of a harmonious society.
2. The third-party logistics: Third-party logistics involves enterprises outsourcing their primary logistics activities to specialized service providers, allowing them to focus on their core business. Simultaneously, both parties maintain close communication through information systems to efficiently manage and control the entire logistics process.
3. Modern logistics human resource: In the context of modern logistics, the coordinated movement of goods, information, and funds requires meticulous preparation and execution. Only qualified logistics professionals, possessing a solid theoretical foundation and extensive practical experience, can effectively fulfill this integrated role. (Qin, 2008)

2.4 Green Logistics in last-mile delivery

Presently, consumers exhibit an increased awareness of the environmental repercussions associated with their purchases. Sustainable products alone no longer suffice; consumers are actively seeking brands committed to environmental preservation. According to a YouGov study, half of consumers in the Asia-Pacific region believe that businesses bear the responsibility of ensuring their supply chain does not contribute to environmental harm. Notably, last-mile deliveries, a significant carbon emitter in the logistics industry, underscore the pivotal role of transportation. Given consumers' expectations for sustainable practices in last-mile deliveries, it becomes imperative for all logistics companies to transition towards eco-friendly alternatives. Demonstrating environmental consciousness necessitates a tangible reduction in carbon emissions, making it the primary objective for achieving sustainability in the logistics last-mile delivery sector.

How Green Logistics can lower carbon footprint?

Opting for Green Logistics in the last-mile operation emerges as the optimal solution for reducing carbon footprint. Green Logistics is specifically designed to mitigate the environmental impact of delivery processes. By seamlessly integrating green logistics into overall business operations and sustainability efforts, organizations stand to enhance both aspects concurrently. The reduction in carbon footprint not only yields cost savings but also serves as a compelling factor for attracting customers. Beyond that, fostering customer loyalty becomes achievable, as evidenced by over 88% of consumers expressing a commitment to companies prioritizing sustainability. In essence, the capacity to diminish carbon footprint emissions not only contributes to environmental sensitivity but also has the potential to fortify relationships with consumers. (Swat Mobility, 2022).

2.5 Electric Automobiles in Transport and Logistics

The logistics and transportation (L&T) industry is vital to modern civilizations' social and economic progress, and it plays a major role in global economies. The industry's widespread presence is a consequence of its steady growth and significant contribution to the GDP of the surrounding region. Specifically, motorized vehicle-based road-based L&T activities have grown significantly due to the growing forces of globalization and international trade. Over the course of several decades, the Operations Research/Computer Science (OR/CS) groups have investigated L&T systems in great detail in an attempt to improve efficiency. The modeling and optimization of vehicle tour assignments is a recurrent issue in L&T literature that is particularly relevant to real-world operating circumstances. (Angel Alejandro Juan, 2016).

The transportation and logistics sector are experiencing rapid advancements, reshaping the standards for on-road delivery. Recently, there has been a notable shift in focus among companies toward enhancing the efficiency of their delivery vehicles. Electric vehicles (EVs) have revolutionized the automotive manufacturing process, emerging as a clean and efficient solution that is transforming the logistics industry. As the accessibility of EVs increases, their impact on supply chain distributions becomes more pronounced. Many logistics companies traditionally relied on vehicles with internal combustion engines

(ICEs) for their delivery fleets, contributing to additional carbon dioxide emissions, reduced air quality, and higher maintenance costs.

In response to these challenges, businesses are increasingly adopting electric vehicles for their delivery operations, recognizing them as a worthwhile investment in the evolving landscape where logistics and electric mobility are closely intertwined. Government subsidies and economic considerations have played a significant role in incentivizing the use of sustainable vehicles for transporting freight and goods. Electric vehicles demonstrate versatility and suitability for various types of freight transportation and parcel delivery, particularly excelling in last-mile delivery due to their high maneuverability and minimal carbon footprint. Beyond their operational benefits, EVs contribute to pollution-free circulation, substantial reductions in carbon emissions, and are well-suited for deployment in compact city centers, urban spaces, and indoor environments. (Express It Delivery, n.d.).

EVs offer companies the prospect of creating substantial added value by fostering ongoing savings in operation and maintenance, enhancing the efficiency of delivery service routes, and providing an avenue to strengthen the brand image of these services. In the pursuit of more effective, efficient, and reliable delivery operations, many logistics companies have recognized the advantages of EVs as an innovative and sustainable long-term investment.

The focus on electric vehicles (EVs) has intensified in recent years, experiencing a significant surge in popularity and demand over the last five years. Undoubtedly, EVs represent the future, given their eco-friendly nature, emphasis on reducing fuel consumption and pollution, and suitability for the forthcoming 100 smart cities in the country. According to a report by NITI Aayog and the Rocky Mountain Institute, India has the potential to reduce logistics costs by 4% of its GDP and save 10 gigatons of CO2 by 2030 through the implementation of clean technologies, including electric vehicles.

These goals seem attainable as logistics companies nationwide are placing substantial emphasis on adopting sustainability in transportation. The logistics industry is making substantial investments in electric vehicles (EVs) to ensure the cost-effectiveness and sustainability of their operations. The increasing convergence between the logistics industry and electric mobility underscores the value of EVs as a sound investment. Government subsidy programs and various economic considerations have significantly influenced the adoption of sustainable vehicles for the transportation of freight, goods, and packages. (TVS Supply Solutions, 2022).

As per the article the industries developed for fulfillment of need of electric vehicle also is the cause of environmental pollution so in case of India to reduce emission not only the switching to EV but also the energy mix has to improve with increment in renewable energy sources (Vidhi, 2018). EV has high initial cost and low per km cost hence the model with total cost of ownership and EV and that of ICEV were compared in case of India (Kumar P. &., 2020). For vehicle with usage above 110km per day only e-3W EV TCO per km is found lower than the ICEV and in case of the e-bus TCO per km of e bus is higher if the bus does not cover more than 264 km per day than that of ICE counterpart. The study of India shows different scenarios showing TCO per km high in case of lower consuming vehicle. The research (Palmer, 2018) is also taken into consideration for the comparison of TOC calculated with that of US, UK and Japan. In case of Nepal, it is observed that the two wheelers in case of Nepal is more economical than that of four wheelers considering present government policies of Nepal. The current policy has caused the TCO/ Km to rise by 20-30% in case of Nepal which was cheaper before the 2021 finance act. With annual kilometer travel of 7760 Km for SUV seen in Nepal (Pathak & Subedi, 2021).

2.6 GHG Emission and Carbon Pricing

Taking into account national circumstances, Nepal is committed to accelerating climate action in line with the shared but distinct obligations and individual capabilities, as specified in the Paris Agreement. The nation intends to transition from a phase of extremely low emissions to full net-zero status by 2045, with a goal of reaching net-zero emissions between 2020 and 2030. Furthermore, Nepal wants recognition for its international mitigation initiatives, especially in the trade of clean energy. Nepal's Long Term Strategy calls for the development of strong policies, social transformations, and technology breakthroughs to promote a future that is inclusive, carbon neutral, and resistant to climate change.

In the reference scenario, Nepal's total carbon dioxide (CO_2) emissions for 2019 were 23 $mMtCO_2$. It is anticipated that this amount will increase to 34 $mMtCO_2$ in 2030 and 79 $mMtCO_2$ in 2050. In 2019, the energy sector accounted for 54% of net CO_2 emissions, with non-energy-related emissions accounting for 46%. By 2050, non-energy emissions would progressively account for 32% of total emissions under the reference scenario. Estimated CO_2 emissions from land use, land use change, and forestry (LULUCF) were 8 $mMtCO_2$ in 2019 and are predicted to increase to 17 $mMtCO_2$ by 2050. (Government of Nepal, 2021).

Carbon pricing acts as a mechanism to restrain greenhouse gas emissions by imposing fees on emissions or providing incentives for emission reduction. This pricing strategy creates a signal influencing consumption and investment behaviors, aligning economic development with climate protection goals. The adoption of carbon pricing is gaining momentum globally, with an anticipated 25 percent of total global emissions falling under such mechanisms by 2020. Numerous non-Annex I countries, including South Korea, China, Thailand, Singapore, Bangladesh, and others, are actively pursuing carbon pricing initiatives. The V20, a coalition of 20 climate-vulnerable developing nations, has recently declared its commitment to implementing carbon pricing by 2025.

Carbon pricing is prominently featured in two-thirds of the submitted Nationally Determined Contributions (NDCs) under the Paris Agreement, with around 100 countries exploring this strategy to achieve emission reduction targets. The World Bank suggests that widespread adoption of carbon pricing to meet NDC targets could potentially reduce the cost of climate change mitigation by 32% by 2030. While pricing carbon proves to be a cost-effective and efficient means to attain mitigation goals outlined in NDCs, its success hinges on the integration of complementary energy and environmental policies to fully unlock its potential. (UNFCCC).

A market-driven strategy called "carbon trading" aims to cut greenhouse gas emissions, especially the carbon dioxide that comes from burning fossil fuels, in order to slow down global warming. Under this system, businesses and individuals can buy carbon credits from organizations that are actively working to reduce or eliminate greenhouse gas emissions in order to offset their own emissions. After overcoming a number of legal obstacles and laying the groundwork for official carbon markets in 1997 with the Kyoto Protocol under the United Nations Framework Convention on Climate Change (UNFCCC), the acceptability of clean development mechanisms (CDM) and emissions trading systems has grown globally. Apart from the European Union Emissions Trading System (EU ETS), a lot of countries have either adopted or are in the process of constructing their own national or regional emissions trading systems, such as South Korea, China, Japan, South Africa, Canada, South Africa, New Zealand, and the United States.

Carbon Trade Deal of Nepal

Nepal is aggressively working to improve its forest carbon store, along with other developing countries, by minimizing deforestation and forest degradation. Nepal's notable agreement with the Forest Carbon Partnership Facility (FCPF) in 2021 marked a remarkable accomplishment, placing the nation sixth in the Asia-Pacific region and 12th globally for emission reduction efforts. Given that forests occupy a substantial 44.74% of its area, Nepal stands to gain a considerable amount of cash from carbon financing. With the help of the crucial Emission Reductions Payment Agreement (ERPA), Nepal hopes to aggressively cut its carbon dioxide emissions by 9 million tons.

Nepal is expected to get USD 5 under the terms of the ERPA for each ton of carbon dioxide emissions that are successfully reduced. Reserving about 23% of the expected carbon dioxide reduction, or 7.9 million tons, from forest cover in 13 areas is a preventative approach to mitigate potential releases of carbon dioxide from forest fires. Only 10 million tons of the 26 million tons predicted reduction are anticipated to be accessible for trading during the duration of the agreement, which is 2018 to 2025. Thus, 9 million tons of carbon dioxide emissions are traded as part of the current arrangement. However, two assessments of Nepal's carbon stock—one scheduled for 2021 and the other for 2025—are necessary to gauge the country's success in lowering carbon dioxide emissions and to generate income through carbon finance.

Carbon Trade Deal Benefits in Nepal

Nepal's strategic goals concerning forest landscapes and climate action heavily rely on the carbon trade agreement. This creative financing structure inspires and mobilizes communities across the nation while acting as a potent weapon to address the root causes of deforestation and forest degradation. This project prioritizes developing integrated land use planning, supporting alternative energy sources, strengthening the ability to manage protected areas, elevating community-based forest management, and granting local communities user rights over national forests. When taken as a whole, these actions seek to promote sustainable forest management and lessen the effects of Nepal's climate change.

Nepal stands to gain a number of advantages from the carbon trade agreement, some of the aspects are outlined below:

Environmental: Through a variety of strategies, carbon trading encourages environmental progress and lowers carbon emissions. These tactics include afforestation, attempts to reduce deforestation, sustainable land use management, and the use of renewable energy to reduce emissions. In addition to providing biological advantages like flood control and watershed protection, forests act as carbon sinks, stabilizing greenhouse gas concentrations. Carbon credits serve as a strong motivator for people and governments to safeguard this vital natural resource, thereby mitigating the growing threats of urbanization, industrial growth, and agricultural advancement in Nepal.

Economic: Rewards for community-based forest management initiatives that reduce carbon emissions and increase carbon stocks via a variety of forest governance activities are provided by the carbon trading agreement. By 2025, Nepal hopes to have raised USD 45 million in revenue by selling about 9 million tons of carbon dioxide equivalent (CO_2e) at a price of USD 5 per ton through the use of the carbon fund. In addition to immediate carbon finance, improved management of forest yield a number of long-term secondary benefits, such as increased earnings from ecotourism and other forest-related industries.

Social: Developing countries like Nepal can propel socio-economic progress while shifting to a low-carbon economy by taking part in carbon markets and earning incentives based on achieved emission reductions. Creative carbon finance could serve as a catalyst for the public and private capital needed to fund green and sustainable development projects, such as clean energy projects that electrify rural areas. Similar to Nepal, Ghana is a developing country that has pledged through its Nationally Determined Contribution to significantly reduce its greenhouse gas emissions by 64 metric tons of CO2 equivalent by 2030. As part of its strategy, Ghana is implementing a climate-smart agriculture program to train over 10,000 rice farmers, who produce 80% of the nation's rice, to embrace sustainable methods. This entails lowering methane emissions while preserving rice productivity, periodically drying paddy fields rather than continuously flooding them, and applying the alternating wetting and drying (AWD) approach. It is projected that these efforts will result in major advantages like lower methane emissions, higher crop yields, and better water efficiency.

Many nations and corporations have adopted aggressive carbon neutrality goals in response to the increased attention being paid to sustainability and environmental responsibility on a worldwide scale. A nation's commitment to attaining net-zero emissions makes it a desirable location for foreign direct investment (FDI) from businesses and nations looking to reduce their carbon footprints. By aggressively pursuing net-zero emission targets, Nepal may become the front-runner among developing nations in the shift to a low-carbon economy, drawing in both foreign and domestic investment.

Reaching the Net-zero Emission Goal Could Help Nepal Attract FDI

Foreign direct investment (FDI) is significantly impacted by the implementation of laws governing carbon emission trading, which are influenced by a number of factors. With well specified property rights exchanges, these rules maximize benefits for multinational firms while lowering transaction costs, which boosts foreign direct investment inflows. Another strategy is to tie FDI taxes to carbon emissions. This way, lower carbon footprints translate into lower tax burdens, which incentivizes low- or emissions-reduction-focused investments. By making green finance more accessible, governments can help these kinds of projects even more. Green finance is a sizable financial pool with trillion dollars in assets. We can accomplish this by using international procedures and development finance organizations to fund FDI initiatives that aim to attain carbon neutrality. A prominent example of how carbon emission trading policies work to reduce emissions and increase foreign direct investment inflows is the pilot program that China is now implementing. The aforementioned benefit serves to balance the advancement of both the environment and the economy, underscoring the beneficial effects of carbon emission trading regulations on investment and the promotion of sustainable development. (Mishra, 2023).

CHAPTER THREE: RESEARCH METHODOLOGY

A scientific way to solving research problems is provided by the research technique. It provides a foundational framework for the investigation, clarifies the reasoning behind the use of particular approaches or strategies, and aids in the evaluation of the validity, appropriateness, and correctness of research. This chapter describes the equipment used in data collecting, sampling strategies, research methodology, and research design. It provides the overall framework for the research, providing the framework around which the study is built.

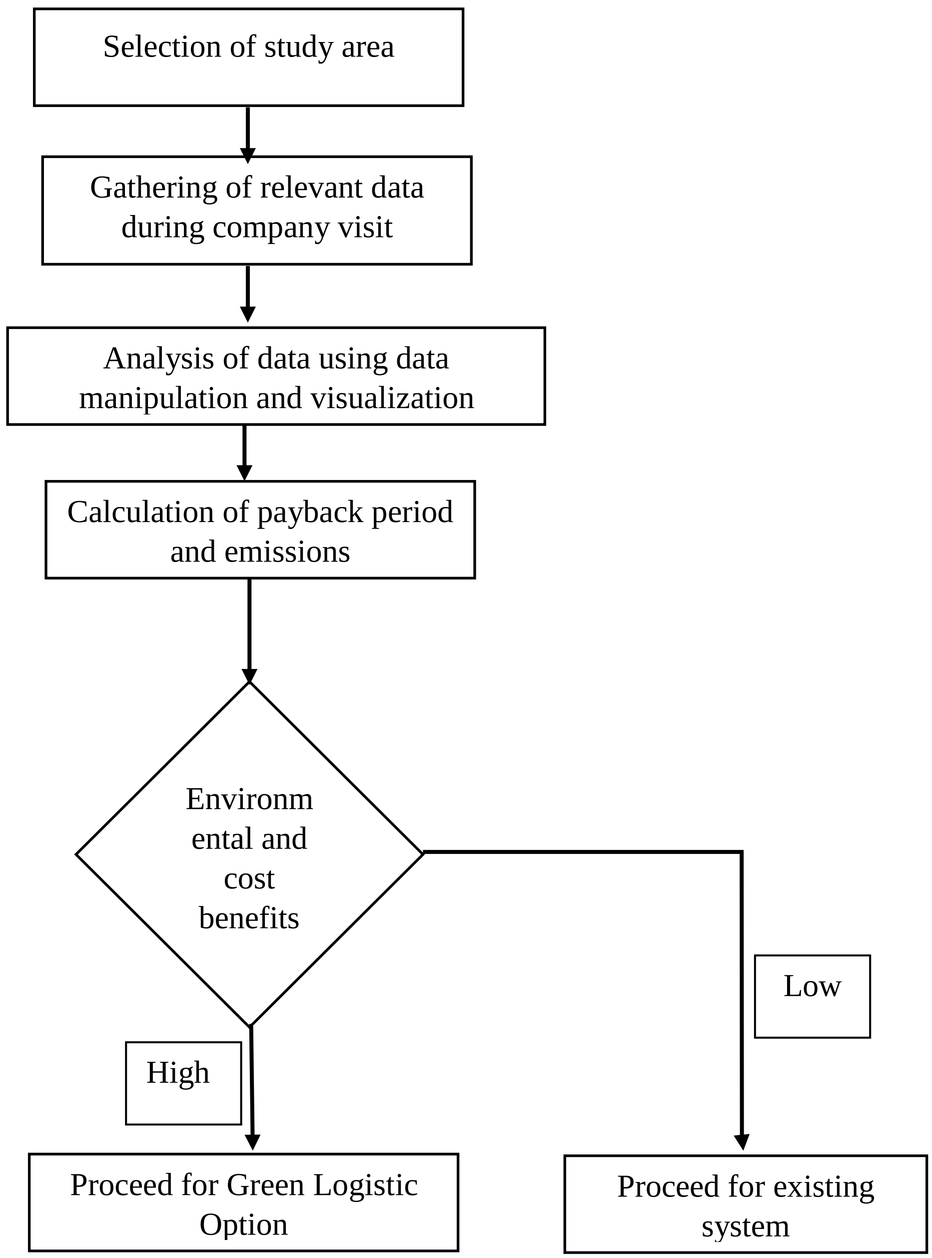

Figure 3.1: Research Methodology

3.1 Study Area

This particular research took done inside a well-known e-commerce company located in Nepal, and the topic of study that this particular investigation fell under is the broad area of green logistics. The Kathmandu Valley's urban areas came under close inspection, with Kathmandu, Lalitpur, and Bhaktapur being the three main targets. This study's main objective was a thorough analysis of every kind of vehicle, including both two- and four-wheelers, used in the last stage of cargo delivery for Daraz Nepal.

In essence, this study explored the vast field of green logistics but focused on a large Nepalese e-commerce company. It focused on Kathmandu Valley cities in particular, including Kathmandu, Lalitpur, and Bhaktapur, and examined the whole Daraz fleet of vehicles utilized for last-mile delivery.

3.2 Gathering of data

A conceptual framework that captures the main focus and the breadth of factors taken into account has been constructed in accordance with the study's aims and findings from the literature review. This study makes use of both primary and secondary data sources. While secondary one includes information that has already been gathered in other research projects, primary data is information that is gathered directly from the e-commerce company. Aside from acquiring technical information about electric vehicles from businesses like NIU and Tata, primary data acquisition also included counting the number of vehicles used at Daraz Nepal.

The main areas of concentration and the variety of variables included have been clearly summarized by a conceptual framework that has been formed by the study's aims and previous research discoveries. The research technique combines primary data, obtained directly from the online retailer, with secondary data, which draws on knowledge gathered from earlier research investigations. Additionally, primary data collection involved gathering technical information about electric vehicles from manufacturers like NIU and Tata in addition to characterizing the vehicles now in use at Daraz Nepal.

3.3 Analysis of data

Excel and other visualization tools were used to carefully process the primary and secondary data that had been gathered. After this data cleaning, a Python model was created to carry out an extensive analysis. With the use of this analytical method, the dataset was fine-tuned to enable the computation of important variables including the payback period and CO_2 emissions.

3.4 Calculation of payback period, energy consumption and emissions

After doing a data analysis, the study evaluated the financial and environmental benefits of using green logistics techniques. Using a Python model to determine the payback period, the financial viability of these activities was quantified and the findings were displayed graphically. Additionally, a bar graph was used to emphasize the differences between traditional diesel/petrol automobiles and electric vehicles when comparing their energy use.

Further, to assess the possible cost savings realized by carbon trading, the study calculated significant emissions, such as CO_2, CO, HC, NO_x, and PM_{10}. This in-depth research covers the benefits of moving to green logistics in great detail and accounts for both environmental and economic issues.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Last-mile delivery route

An established player in the e-commerce sector, Daraz is a widely known worldwide firm that enables online transactions and links customers to a wide range of goods. Daraz has created its own logistical infrastructure, including the first-mile, middle-mile, and last-mile portions of the supply chain, to assure effective and dependable delivery services. With this tactical move, Daraz is now better able to manage all aspect of the client experience, from order fulfillment to doorstep delivery.

Daraz has a sizable and varied consumer base, which has had a considerable impact on the e-commerce sector. Although the organization offers services all across the country, it's important to note that a sizable percentage of their business is concentrated in the Kathmandu Valley. The Kathmandu Valley, which includes the capital city of Kathmandu and the key cities of Lalitpur and Bhaktapur, is a center of economic activity and consumer demand. This area is the main focus of Daraz's logistical and operational strategy because it accounts for the majority of the company's transaction volume and client involvement. Daraz's position in the Nepalese e-commerce sector is further cemented by its ability to effectively service a densely inhabited and economically active region thanks to this specific focus.

Daraz's last-mile delivery operations, which use both two-wheeler and four-wheeler vehicles to carry products to customers' doorsteps, are an essential part of their logistics network. These trucks act as the last link in the supply chain, ensuring that goods purchased through Daraz are delivered effectively and on schedule to their intended customers. Daraz operates a network of distribution hubs that are placed both inside and outside the Kathmandu Valley strategically to help with this operation. These hubs act as key places from which products are delivered to their specific locations, whether those areas are inside the busy Kathmandu metropolitan area or farther afield throughout Nepal.

Daraz, Nepal's biggest e-commerce and logistics company, has expanded to serve more than 100 cities across the nation. They are able to serve a wide range of customers because of their enormous network, providing a variety of goods and services to clients from different geographical areas. Daraz also offers a flexible and customer-focused approach by making it convenient for individuals who choose to pick up their packages to do so at any of the business' sites inside the Kathmandu Valley. This adaptability improves the overall customer experience by enabling people to select the delivery option that best suits their needs and schedules. Nine areas in the valley, including Kathmandu, Lalitpur, and Bhaktapur, are owned by Daraz. These places are used for doorstep deliveries called the last mile. Due to the fact that one site cannot service all regions, hubs are developed for specialized last-mile delivery. Additionally, customers can pick up their packages from any of these locations if it is more convenient for them to do so.

The major parts of area where Daraz delivers is as shown in heatmap below:

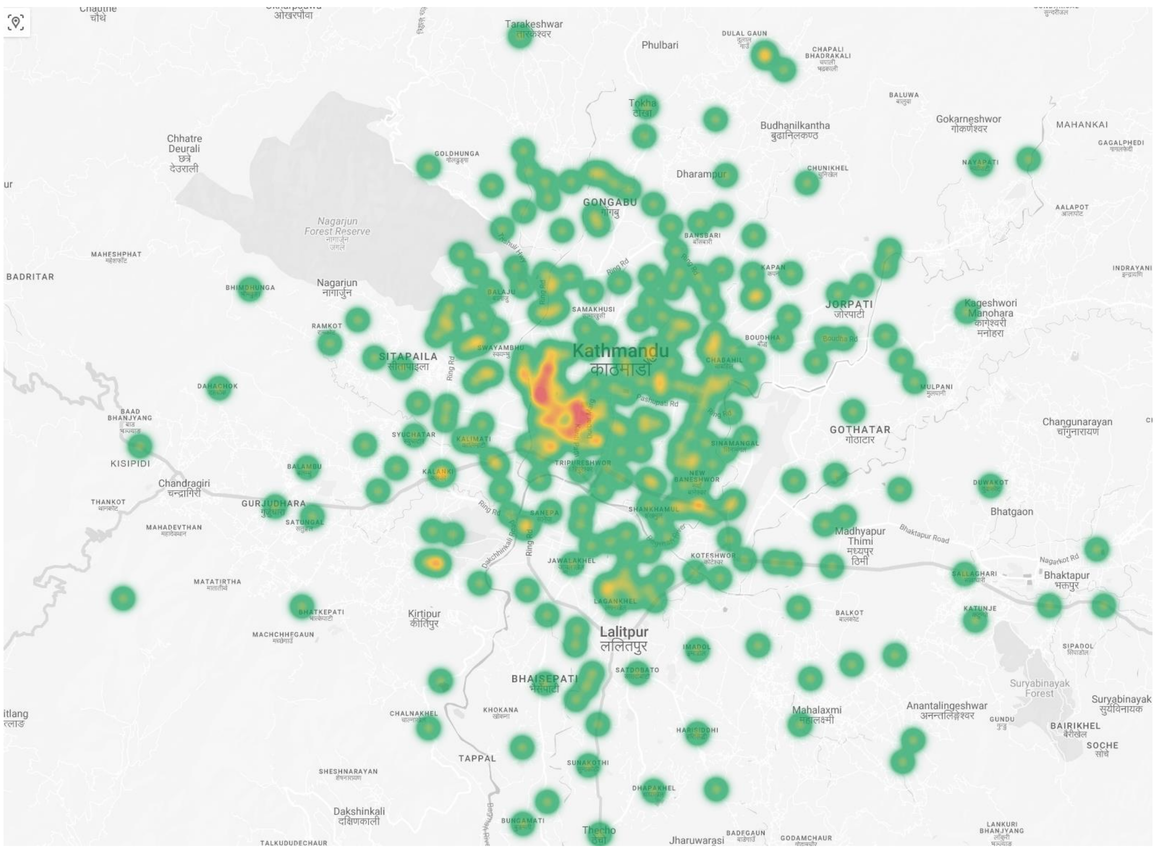

Figure 4.1: Heatmap of delivery location inside Kathmandu Valley

Table 4.1: Delivery Facilities of Daraz

Code	**Full_name**
BB1	Bhagwati Bahal Hub
BLJ	Balaju Hub
GKH	GopiKrishna Chabahil Hub
NXL	Naxal Hub
OBN	Old Baneshwor Hub
PUT	Putalisadak Hub
SAL	Sallaghari Hub
SOL	Soltimode Hub
THA	Thasikhel Hub

For last-mile deliveries of items to consumers, Daraz uses both two-wheelers (delivery bikes) and four-wheelers (delivery trucks). Two-wheelers (delivery bikes) are used to deliver small packages, while four-wheelers (delivery vans) are used to deliver larger packages. The delivery vans now in use all have internal combustion engines, however switching the entire fleet to electric vehicles is a possibility. The company now uses the following list of gasoline vehicles for logistics operations:

Table 4.2: Vehicle used with quantity

S.N.	**Vehicle Type**	**Quantity**
1	Two-Wheeler (Motorbike/Scooters)	221
2	Four-Wheeler	15

Table 4.3: Month Wise capacity and average kilometer travelled in Kathmandu valley by 2-wheelers

Month	No. of Heroes	Avg km/day/hero
Dec 2021	230.00	37.22
Jan 2022	200.00	37.58
Feb 2022	200.00	39.06
Mar 2022	210.00	38.49
Apr 2022	220.00	37.74
May 2022	210.00	39.31
Jun 2022	210.00	39.87
Jul 2022	211.00	36.82
Aug 2022	213.00	37.08
Sep 2022	215.00	38.64
Oct 2022	220.00	38.83
Nov 2022	333.00	38.44
Dec 2022	235.00	37.26
Jan 2023	210.00	39.32
Feb 2023	210.00	39.90
Mar 2023	210.00	39.18
Average	**221.06**	**38.42**

The aforementioned table offers helpful details on the month-to-month statistics of delivery heroes, as well as their typical daily trip distance. These KPIs are essential for the logistics operation's capacity planning and last-mile package delivery optimization. The corporation can allocate resources efficiently, make plans for times of peak demand, and guarantee effective and prompt delivery services by looking at these numbers.

The considerable increase in the number of delivery heroes throughout the month of November is a noteworthy finding in the data. This significant rise is mostly attributable to the 11.11 campaign, which is held annually on November 11th. The single largest sale of the year will take place at this time, attracting a sizable client base and spiking order volumes. To meet the increased demand during this busy shopping season, the company increases its personnel by hiring more delivery heroes. This tactical step guarantees that orders are delivered promptly to customers, especially during the hectic 11.11 shopping season, consequently raising customer happiness and increasing the company's brand.

When petroleum is burned, one liter yields about 2.3 kg of carbon dioxide (CO_2). (National Resource Canada, 2014). Most of the time, Nepal's power grid uses clean energy sources, except the purchase of electricity from India. We can easily help Nepal reach its net-zero target and lessen the effects of climate change if we can encourage fuel switching from petroleum to electrical sources. This will cut the huge share of emissions from the transportation sector. Additionally, hydroelectricity is regarded as an indigenous resource in the case of Nepal. It contributes to the country's improved energy security and energy balance. Additionally, because the cost of electricity in Nepal is estimated to be at most Rs. 12 (NEA, 2022) and the cost of gasoline to be at most Rs. 178 (NOC, 2023) ,the economic evaluation of cost per km for EVs is anticipated to be cheaper and more economical than that of IC engine cars. According to Nepal's plans and strategies, the population and GDP are both predicted to grow to some level between 2030 and 2050, which will have an impact on the demand prediction. The advantages of using electric vehicles (EVs) are anticipated to convince the general population in Nepal to make the changeover.

With the aim of reducing the GHG emissions and saving the cost of petrol used for operating these two-wheelers Daraz Nepal is planning to switch all these two-wheelers to electric option.

Figure 4.2: Electric Bikes Piloting at Daraz Nepal for Last-mile Delivery

4.2 Cost effectiveness of last-mile logistics, switching to Green Logistics

A striking finding was made after the creation of a complex Python model designed for both two-wheelers and four-wheelers: switching from Internal Combustion Engines (ICE) to electric alternatives might save considerable amounts of gasoline. This realization is particularly relevant in the last-mile delivery setting within an e-commerce-focused organization. Accepting the electric option resulted in observable fuel efficiency savings that were significant enough to produce a payback period that was remarkably short—less than five years. This conclusion highlights how adopting electric vehicles for the last leg of delivery operations is a financially sound and environmentally responsible decision.

Additionally, the creation of elaborate cash flow diagrams and instructive graphs, both painstakingly built through the use of several Python packages, increased the analytical depth of this study. These visualization tools made it easier to understand the intricate financial dynamics as well as the financial and temporal considerations involved in the switch to electric vehicles. By using Python libraries to create these graphics, decision-makers can better understand the potential financial rewards and viability of adopting electric options in the e-commerce sector. This highlights the value of data-driven insights. The python-generated cash flow diagram and graph are as shown below which shows that the payback period for two-wheelers is 3.03 years and for four-wheeler option is 4.34 years. All the libraries and model developed is mentioned in Annex section.

Table 4.4: Cash flow diagram for ten years for two-wheelers as modeled in Python

Details	Year0	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9	Year10
Purchase Cost	203000.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity Cost	0.0	3596.1	3596.1	3596.1	3596.1	3596.1	3596.1	3596.1	3596.1	3596.1	3596.1
Tax	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Servicing	0.0	4000.0	4200.0	4410.0	4630.5	4862.0	5105.1	5360.4	5628.4	5909.8	6205.3
Tyre Replacement	0.0	0.0	0.0	0.0	5000.0	0.0	0.0	0.0	5000.0	0.0	0.0
Insurance	0.0	4000.0	3600.0	3240.0	2916.0	2624.4	2362.0	2125.8	1913.2	1721.9	1549.7
Battery Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50000.0	0.0	0.0
Total Cost	203000.0	11596.1	11396.1	11246.1	16142.6	11082.5	11063.2	11082.3	66137.7	11227.8	11351.1
Petrol Fleet Cost	0.0	88704.1	88704.1	88704.1	88704.1	88704.1	88704.1	88704.1	88704.1	88704.1	88704.1
Saving	-203000.0	77108.0	77308.0	77458.0	72561.5	77621.6	77640.9	77621.8	22566.4	77476.3	77353.0
PV Factor	0.0	0.9	0.9	0.8	0.7	0.7	0.6	0.6	0.6	0.5	0.5
PV of Saving	-203000.0	71710.4	66863.7	62303.9	54279.8	54000.4	50232.9	46705.1	12627.7	40319.5	37437.5
Cash Flow Status	-203000.0	-131289.6	-64425.9	-2122.0	52157.7	106158.2	156391.1	203096.2	215723.9	256043.4	293480.9

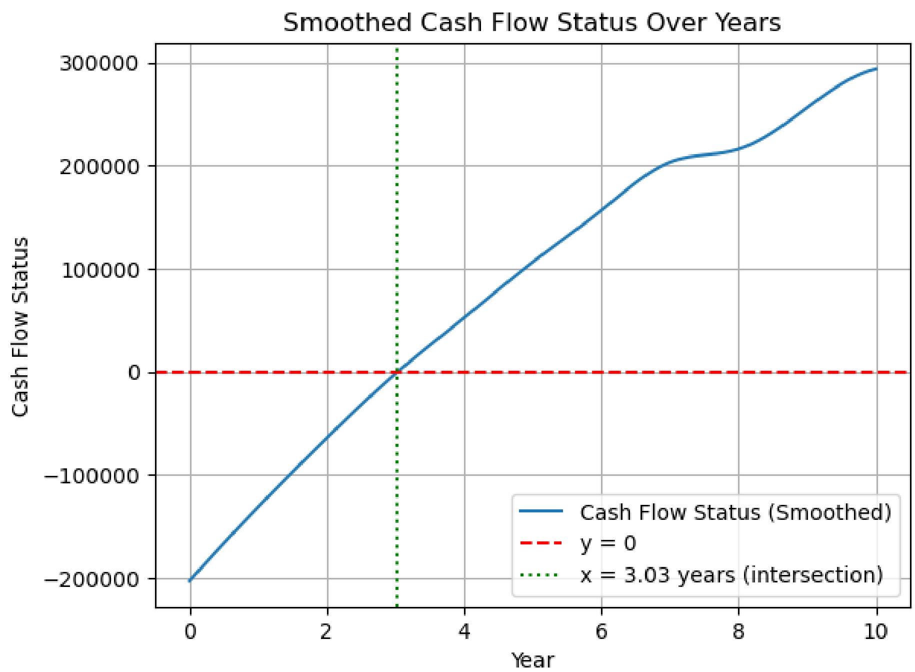

Figure 4.3: Cash flow diagram showing pay-back period of two-wheelers

Table 4.5: Cash flow diagram for ten years for four-wheelers as modeled in Python

Details	Year0	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9	Year10
Purchase Cost	2500000.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity Cost	0.0	39312.0	39312.0	39312.0	39312.0	39312.0	39312.0	39312.0	39312.0	39312.0	39312.0
Tax	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Servicing	0.0	10000.0	10500.0	11025.0	11576.2	12155.1	12762.8	13401.0	14071.0	14774.6	15513.3
Tyre Replacement	0.0	0.0	0.0	50000.0	0.0	0.0	50000.0	0.0	0.0	50000.0	0.0
Insurance	0.0	30000.0	27000.0	24300.0	21870.0	19683.0	17714.7	15943.2	14348.9	12914.0	11622.6
Driver's Salary	0.0	300000.0	306000.0	312120.0	318362.4	324729.6	331224.2	337848.7	344605.7	351497.8	358527.8
Fleet Manager's Salary	0.0	150000.0	153000.0	156060.0	159181.2	162364.8	165612.1	168924.4	172302.9	175748.9	179263.9
Battery Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	833333.3	0.0	0.0
Total Cost	2500000.0	529312.0	535812.0	592817.0	550301.9	558244.5	616625.9	575429.3	1417973.8	644247.3	604239.6
Petrol Fleet Cost	0.0	1248000.0	1248000.0	1248000.0	1248000.0	1248000.0	1248000.0	1248000.0	1248000.0	1248000.0	1248000.0
Saving	-2500000.0	718688.0	712188.0	655183.0	697698.1	689755.5	631374.1	672570.7	-169973.8	603752.7	643760.4
PV Factor	0.0	0.9	0.9	0.8	0.7	0.7	0.6	0.6	0.6	0.5	0.5
PV of Saving	-2500000.0	668379.8	615971.4	527001.0	521914.5	479854.9	408492.9	404686.4	-95114.2	314199.6	311568.7
Cash Flow Status	-2500000.0	-1831620.2	-1215648.8	-688647.7	-166733.2	313121.6	721614.5	1126300.9	1031186.6	1345386.2	1656954.9

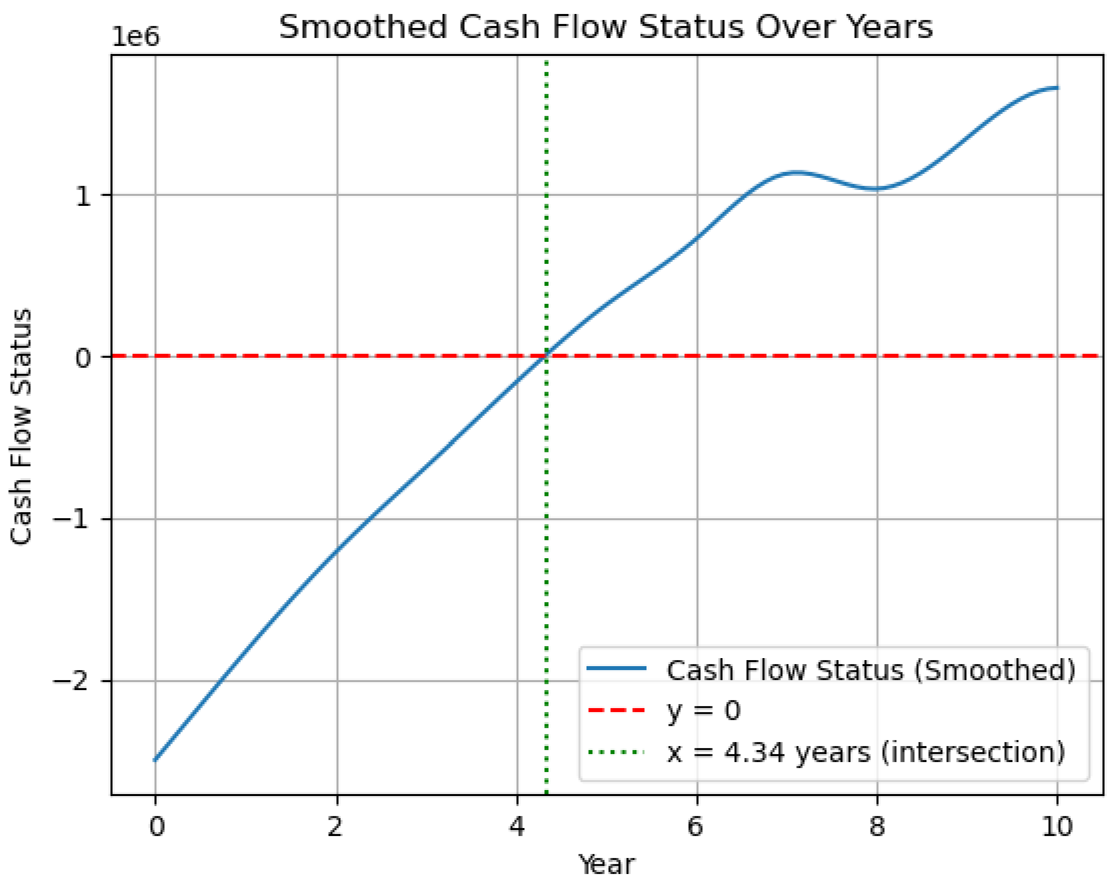

Figure 4.4: Cash flow diagram showing pay-back period of four-wheelers

An extensive strategy was used to evaluate the effectiveness and impact of integrating environmentally friendly methods, also known as Green Logistics, into the operations of the e-commerce company "Daraz Nepal." This strategy entailed creating a complex Python-based model that was tailored to the requirements of the company. This model's primary goal was to assess the viability of implementing Green Logistics practices, with a focus on the logistics procedures involving both two-wheelers (motorcycles) and four-wheelers (vehicles) in particular.

The primary objective of this model was to assess the financial and environmental implications of adopting green logistics practices. Costs associated with logistics and environmental impacts were calculated and contrasted to achieve this. These two criteria played a crucial role in conducting a comparative analysis, making it possible to thoroughly examine the implications for both the economy and the environment.

The logistics expenditures included a broad range of costs related to the shipping, distribution, and overall supply chain operations. This included expenses for things like employees, maintenance, fuel, and other operating costs. The ecological footprint left by these logistical activities was also included in the environmental costs. This environmental impact also included fuel use, greenhouse gas emissions, noise pollution, and other environmental effects.

Meaningful findings were reached by methodically contrasting these two crucial aspects—logistics costs and environmental costs. The conclusion of this thorough research confirms expectations: using Green Logistics solutions turns out to be the better choice. In other words, the research results proved that 'Daraz Nepal's' logistics operations' adoption of environmentally friendly techniques led to favorable outcomes in both the economic and ecological spheres.

4.3 Energy usage and Emission impact of last-mile logistics, switching to Green Logistics

4.3.1 Energy usage analysis of last-mile logistics

Our study into energy use starts with a thorough analysis of two different types of vehicles: 2-wheelers and 4-wheelers that are fueled by gasoline. The main focus of this analysis is a comparison of the energy consumption of these traditional gasoline-powered cars and the electric vehicles (EVs) used by Daraz for their important last-mile delivery services. We have standardized the measurement units for both sets of data, stating energy usage in kilowatt-hours (kWh), to provide a fair and meaningful review.

Our study's findings reveal an amazing tale of opposites. Gasoline-powered two-wheelers account for 296,027.24 kWh of annual energy use, which is a substantial amount. In stark contrast, the EVs used to supply 2-wheelers show an amazing break from tradition by using only 66,228.4 kWh. This astounding disparity highlights a significant decrease in energy use and highlights the revolutionary influence of electric 2-wheelers on energy efficiency.

This considerable disparity is illustrated visually in the accompanying bar graph by visualizing the comparison.

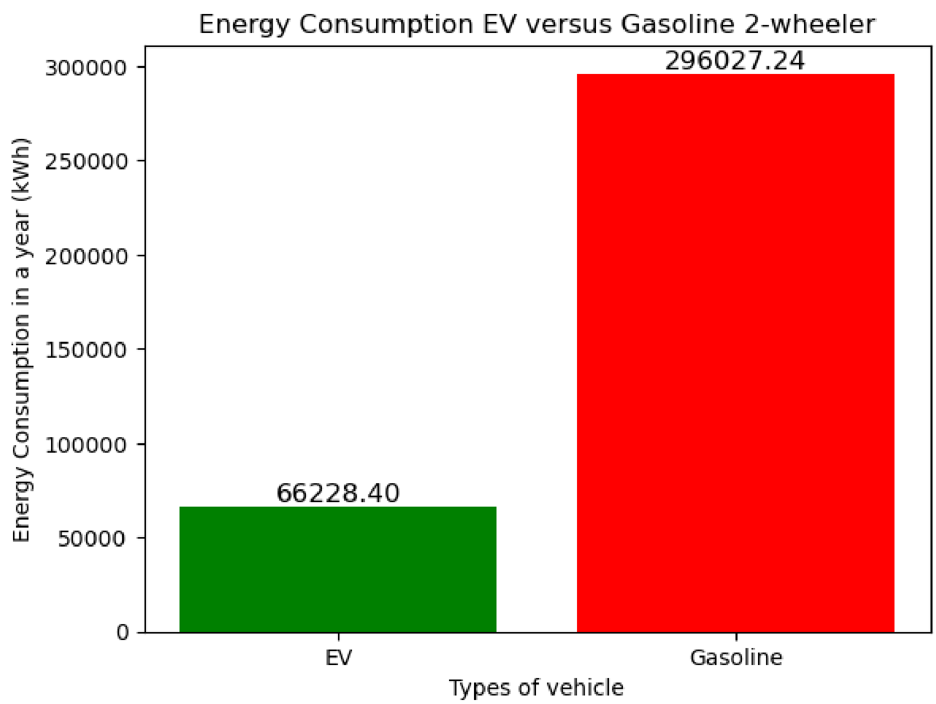

Figure 4.5 Energy Consumption of EV vs Gasoline (Two-Wheeler)

When we focus on 4-wheelers, a similar story of decreased energy use develops. An impressive number in itself, gasoline-powered 4-wheelers need 117,667.31 kWh of energy every year. The EVs in charge of the 4-wheeler delivery, however, accomplish a remarkable achievement by using only 58,968 kWh, which is a strong indication of their effectiveness. This discrepancy clearly highlights the significant decrease in energy consumption associated with electric 4-wheelers, as shown in the related bar graph.

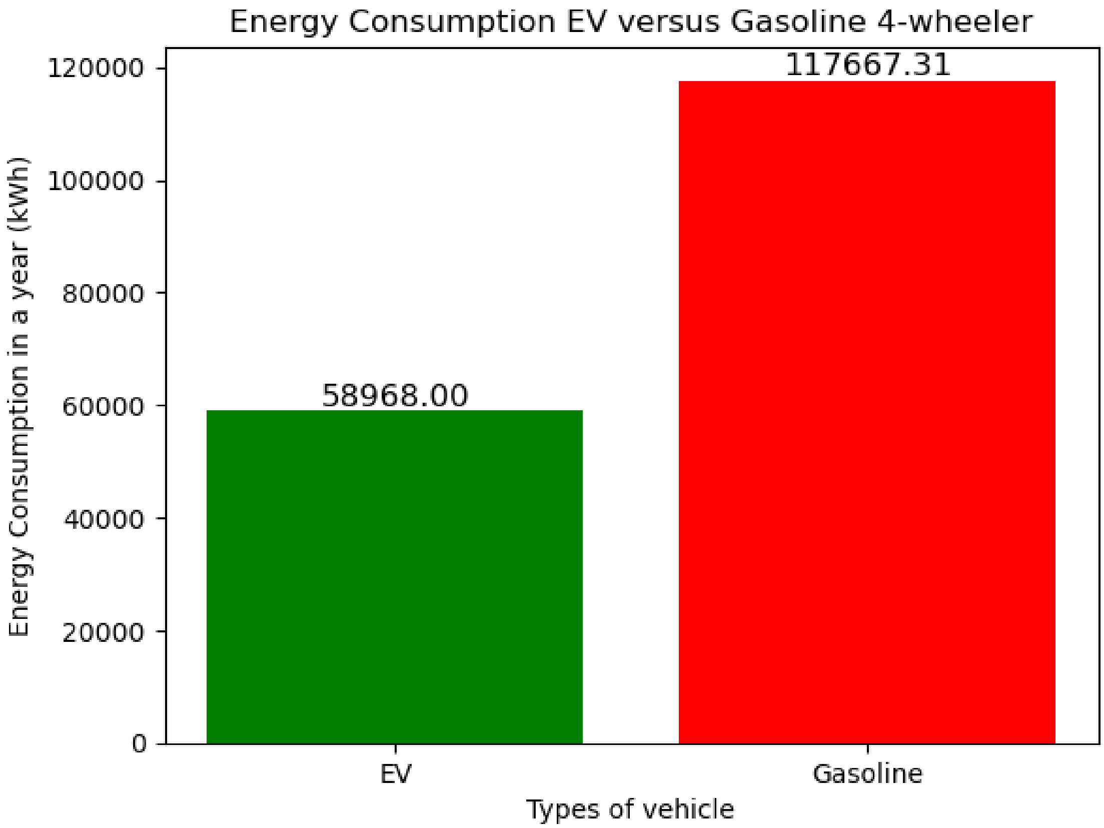

Figure 4.6 Energy Consumption of EV vs Gasoline (Four-Wheeler)

In conclusion, our findings highlight the significant energy savings made possible by the use of electric vehicles. Beyond the figures, these results demonstrate the potential contribution of EVs to the development of a more energy-efficient, ecologically friendly, and futuristic transportation system. They highlight the potential for electric vehicles to act as engines for a future of transportation and logistics that is more environmentally friendly and resilient.

The emission analysis describes the emissions data for a 4-wheeler and 2-wheeler vehicle used in the logistics industry when powered by gasoline as its fuel source.

4.3.2 Emission impact analysis of last-mile logistics

In this case, there are five types of emissions considered:

- CO2 (Carbon Dioxide): This is among the main greenhouse gases that cause global warming. It's measured in grams (g).

- CO (Carbon Monoxide): When breathed in significant amounts, the colorless, odorless gas carbon monoxide can be deadly. It's also measured in grams (g).
- NOx (Nitrogen Oxides): Nitrogen oxides are a group of gases that contribute to air pollution and are a precursor to smog and acid rain. Measured in grams (g).
- HC (Hydrocarbons): Organic molecules with solely hydrogen and carbon atoms are known as hydrocarbons. They can contribute to the formation of ground-level ozone and smog. Measured in grams (g).
- PM10 (Particulate Matter): Particulate matter is made up of microscopic airborne particles or droplets that might cause harm to one's health if inhaled. Particles with a diameter of 10 micrometers or less are referred to as PM10. Measured in grams (g).

Quantity of Emission in Gram: The quantity of each emission type produced by the 4-wheeler and 2-wheeler vehicle during its operation is converted to same unit i.e.gram. These values represent the amount of each emission that the vehicle emits into the environment. The values are expressed in grams (g).

In summary, the table offers a snapshot of the emissions generated by a 4-wheeler vehicle and 2-wheeler vehicles operating in the logistics industry when using gasoline as its fuel source. It measures the effect on the environment in terms of several emissions, such as particulate matter, hydrocarbons, nitrogen oxides, carbon monoxide, and carbon dioxide, a significant greenhouse gas. Particularly in relation to logistics and transportation, these emissions have an impact on environmental sustainability and air quality.

Our investigation starts with a thorough evaluation of emissions coming from both two-wheelers and four-wheelers. We have calculated the annual emission quantities in grams by quantifying these emissions using validated emission factors. The next phase entails the visualization of this data using Python, a powerful program for making useful graphs.

The resulting graph offers an interesting contrast of 2-wheeler and 4-wheeler emissions before moving to more environmentally friendly logistical techniques, serving as a potent visual representation of the emissions landscape. Notably, the graph emphasizes distinct pollutant emissions, demonstrating how each of them contributes to the overall environmental impact.

A striking discovery emerged from this visual exploration: Carbon dioxide (CO2) emissions reign supreme among all pollutants. These emissions are especially notable because they are the dominant greenhouse gas (GHG), responsible for a significant portion of global warming and climate change. When looking at emissions from 2- and 4-wheeled vehicles, a harsh reality becomes clear. The use of gasoline as the main fuel source for last-mile deliveries in the logistics sector leads to significant emissions of various gases. This revelation highlights the environmental impact of conventional logistics practices and emphasizes the need for change.

However, there is a glimmer of hope in these results. Data shows that these emissions can be reduced significantly, even reaching net zero emissions. Achieving this ambitious target depends on implementing strategies and practices designed to reduce Minimize or completely eliminate emissions. These steps towards greener logistics not only promise a more sustainable and environmentally friendly future, but are also in line with global efforts to combat climate change and reduce environmental impact.

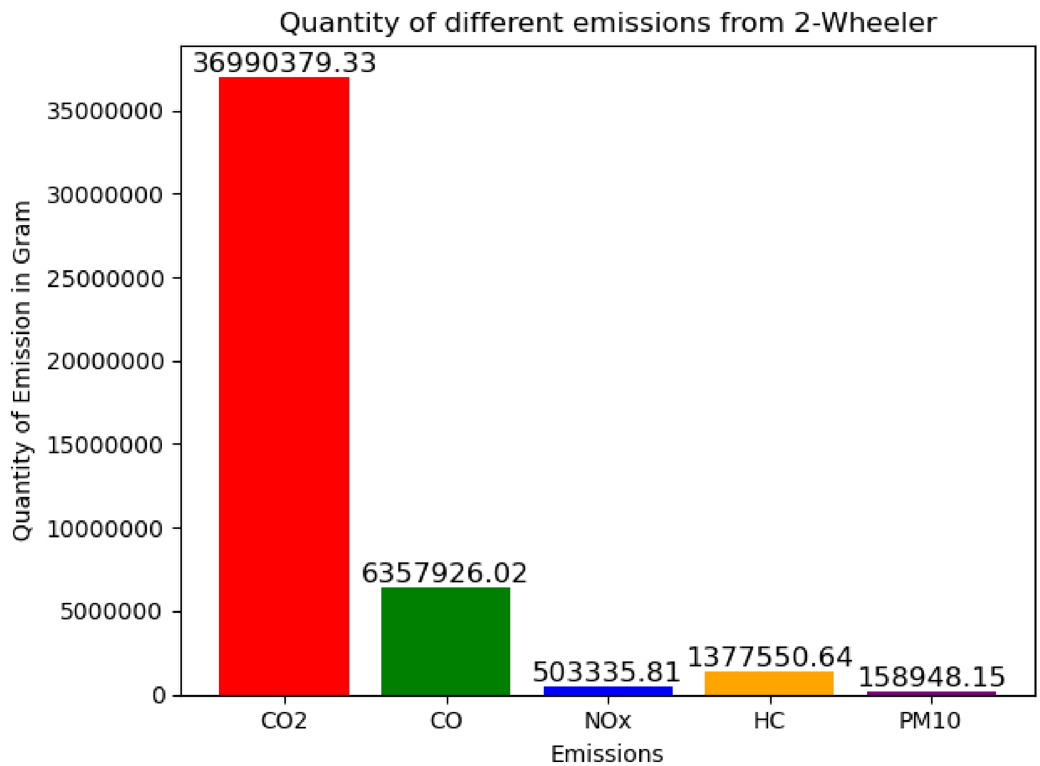

Figure 4.7 Quantity of Emission from different pollutants from two-wheeler

Table 4.6 Quantity of Emission from different pollutants while using Two-Wheeler

Emissions	Quantity of Emission in Gram
CO2	36990379.3
CO	6357926
NOx	503335.8
HC	1377550.6
PM10	158948.1

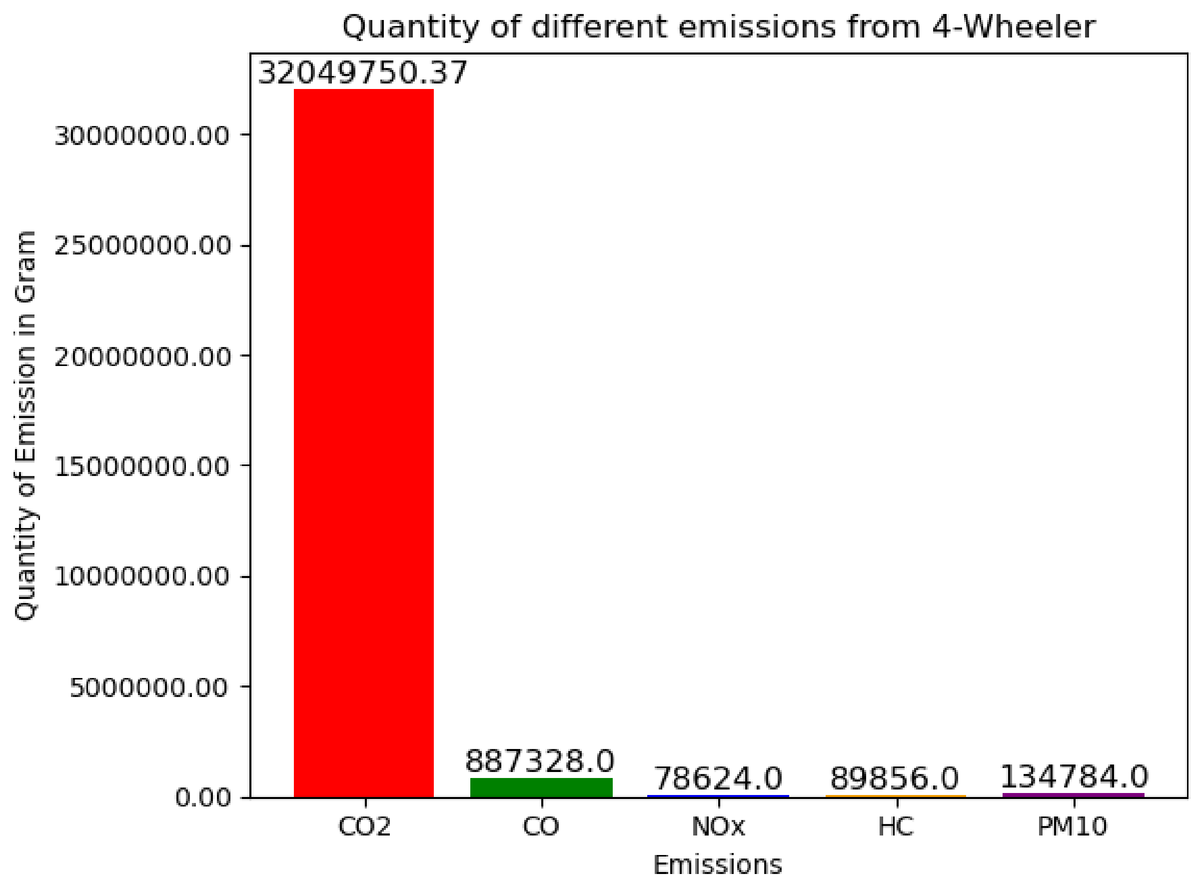

Figure 4.8 Quantity of Emission from different pollutants for Four-wheeler

Table 4.7 Quantity of Emission from different pollutants while using Four-Wheeler

Emissions	Quantity of Emission in Gram
CO2	32049750.4
CO	887328
NOx	78624
HC	89856
PM10	134784

The impact of various greenhouse gases on global warming was taken into account by converting emissions into CO_2 equivalents. The "Global Warming Potential" (GWP), a measurement of the amount of warming each gas contributes to the greenhouse effect, serves as the foundation for this conversion. The impact of one kilogram of CO_2 emissions is equal to one kilogram of CO_2. One kilogram of methane (CH_4) released is equal to 25 kilograms of CO_2, and one kilogram of nitrous oxide (N_2O) released is equal to 298 kilograms of CO_2. Fluorine gases have a wide range of GWPs and can have very high concentrations. One kilogram of sulfur hexafluoride (SF_6), for instance, is equal to twenty-eight thousand kilograms of CO_2 equivalent.

Air pollutants and greenhouse gases (GHGs) make up the specific air pollutants assessed from various sources.

Within each group, certain contaminants are mentioned as follows:

Criteria Pollutants:

- Nitrogen oxides [NOX],
- Carbon monoxide [CO],
- Particulate matter 10 micrometers in diameter or less [PM10]

GHGs:

- Carbon dioxide (CO_2),
- Hydrocarbons such as Methane (CH_4)

We primarily concentrate on two categories of greenhouse gases (GHG) in our emissions analysis: hydrocarbons and carbon dioxide (CO_2). To provide a more comprehensive assessment of environmental impacts, we use the concept of global warming potential (GWP). GWP allows us to express the impact of different greenhouse gases in terms of CO_2 equivalent levels, thereby facilitating a more unified and comprehensive view. Performing calculations, we see that the equivalent annual CO_2 emissions of existing 2-wheeled vehicles are 71.43 tons, while for 4-wheeled vehicles this figure is 34.3 tons. These values represent the cumulative environmental impact of CO_2 and hydrocarbon emissions, expressed as CO2 equivalent emissions. This approach allows us to more effectively assess the overall climate impact.

Additionally, our analysis delves deeper into the economics of emissions mitigation. We have calculated the expenses related to emissions, assuming that Nepal will receive $5 for each ton of carbon dioxide emissions effectively decreased. More specifically, we determined that the annual emissions trading cost is $357.15 for 2-wheeler vehicles and $171.48 for 4-wheeler vehicles. This cost represents an additional cost incurred when switching to greener last-mile logistics options. Importantly, this expenditure represents a valuable investment in sustainability as it helps to reduce the social and environmental impacts associated with emissions. The decision to switch from gasoline to electricity for transportation not only makes financial sense but also brings significant social and environmental benefits, ultimately aligning with broader goals of environmental responsibility and sustainability. In this context, emissions trading represents a step towards a cleaner, more sustainable and more economically viable transport ecosystem.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

The research conducted on green logistics at Daraz Nepal has thus been completed and following conclusions were drawn from the study which are listed below.

The last mile delivery route plays a central role in a logistics company's interaction with customers, serving as a key touchpoint. This requires deploying the appropriate number of vehicles depending on the volume of items to be delivered and the geographical area to be served during the delivery process. Daraz, as part of its logistics operations, is currently using two and four-wheeled petrol vehicles for last-mile deliveries. These deliveries are coordinated through a hub-based model, with operations covering nine separate locations in the Kathmandu Valley, each with its own designated route. In line with its commitment to environmental sustainability, Daraz has expressed its strong desire to convert all its gasoline-powered vehicles to electric alternatives. This strategic change demonstrates their proactive contribution to environmental conservation and is in line with the broader goal of reducing carbon emissions associated with last-mile logistics.

In summary, our research shows the significant benefits of transitioning from internal combustion engines (ICEs) to electric vehicles in the context of last-mile delivery for e-commerce operations. The potential for significant gas savings, along with significant improvements in fuel efficiency and a short payback period of less than five years, highlights the financial and environmental benefits of going electric. We recommend that organizations involved in last-mile delivery, especially in the e-commerce sector, seriously consider adopting electric alternatives as a financially and prudent choice. Additionally, the use of data visualization tools, such as complex cash flow diagrams and infographics created in Python, helps improve decision makers' understanding of financial dynamics. key and reinforce the value of data-driven information to make informed choices for a resilient and sustainable life and a productive future in the logistics and transportation sector.

Our results present a compelling story about energy consumption and emissions transitions in last-mile logistics. The stark contrast between gasoline and electric vehicles is evident in our results. Gasoline 2-wheeler and 4-wheeler vehicles show significant energy consumption and emissions, highlighting the environmental impact of common operations.

However, electric alternatives, demonstrated by reduced energy consumption and emissions, offer a promising path to sustainability. The primary greenhouse gas, carbon dioxide (CO2) emissions, predominate the emissions landscape, underscoring the pressing need for change. However, our results also offer hope, showing that emissions can be significantly reduced or even reach net zero with the right strategy. Additionally, our economic analysis shows that investing in emissions reduction is not only financially viable, but also helps reduce social and environmental impacts. In summary, our research highlights the potential for a cleaner, more sustainable and more economically viable future in the last-mile logistics sector through electric vehicle adoption and emission reduction strategies.

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ANNEX ONE: PYTHON MODEL

All the codes and libraries used are as below:

<u>For two-wheeler</u>

```
import pandas as pd

import matplotlib.pyplot as plt

import numpy as np

from scipy.interpolate import interp1d

vehiclePuchasePrice = 203000 ## Rs

vehicleFullChargeDistance = 80 ## km

vehicleMotorCapacity = 25 ## kW

fullChargeConsumption = 2 ## Unit

fullChargeElectricityCost = 24 ## Rs

electricityPricePerUnit = 12 ## Rs

dailyOperation = 38.42 ## km

workingDaysInAMonth = 26 ## days

servicingFrequency = 4 ## times a year

servicingCost = 1000 ## Rs per time

servicingCostIncrement = 5 ## yearly in percentage

batteryWarranty = "5years"

batteryLifetime = 5 ## years

batteryReplacementCost = 50000 ##Rs

tyreReplacementCost = 5000 ## Rs

tyreLifeTime = 50000 ##km
```

```
# driverSalary = 25000 ## Rs/month

# fleetManagerSalarly = 12500 ##Rs/month

petrolReimbursementCost= 7.40 ##Rs/km

dailypetrolCost=petrolReimbursementCost*dailyOperation

# salarlyIncrement = 2 ## in percent yearly

# dailyHiringCost = 4000 ## Rs

discountRate = 7 ## in percent

annualInsurance = 4000 ## Rs

depreciation = 10 ## in percent yearly

co2Emission = 2.69 ## kg/lt


yearlyElectricityCost = ( fullChargeConsumption / vehicleFullChargeDistance) * dailyOperation * workingDaysInAMonth * electricityPricePerUnit * 12


distanceTravelledInYear = dailyOperation*workingDaysInAMonth*12


timeToReplaceTyre = round(tyreLifeTime/distanceTravelledInYear,0) ## year

timeToReplaceBattery = 8 ## year


data = {

   'Details': ['Purchase Cost', 'Electricity Cost', 'Tax','Servicing','Tyre Replacement','Insurance','Battery Replacement'],

   'Year0': [0,0,0,0,0,0,0],
```

```
    'Year1': [0,0,0,0,0,0,0],
    'Year2': [0,0,0,0,0,0,0],
    'Year3': [0,0,0,0,0,0,0],
    'Year4': [0,0,0,0,0,0,0],
    'Year5': [0,0,0,0,0,0,0],
    'Year6': [0,0,0,0,0,0,0],
    'Year7': [0,0,0,0,0,0,0],
    'Year8': [0,0,0,0,0,0,0],
    'Year9': [0,0,0,0,0,0,0],
    'Year10': [0,0,0,0,0,0,0],
}

df = pd.DataFrame(data)
df.set_index('Details', inplace=True)

df.loc['Purchase Cost','Year0']=vehiclePuchasePrice
df.loc['Electricity Cost',1:] = yearlyElectricityCost
df.at['Servicing', 'Year1'] = servicingCost * servicingFrequency
df.at['Insurance', 'Year1'] = annualInsurance
# df.at['Driver\'s Salary', 'Year1'] = driverSalary *12
# df.at['Fleet Manager\'s Salary', 'Year1'] = fleetManagerSalarly *12
```

```
# Increasing Servicing value by servicingCostIncrement
for i in range(1, df.shape[1] - 1):
    prev_year = f'Year{i}'
    curr_year = f'Year{i+1}'
    df.loc['Servicing', curr_year] = df.loc['Servicing', prev_year] * (servicingCostIncrement+100)/100
    df.loc['Insurance', curr_year] = df.loc['Insurance', prev_year] * (100-depreciation)/100
#     df.loc['Driver\'s Salary', curr_year] = df.loc['Driver\'s Salary', prev_year] * (100 + salarlyIncrement)/100
#     df.loc['Fleet Manager\'s Salary', curr_year] = df.loc['Fleet Manager\'s Salary', prev_year] * (100 + salarlyIncrement)/100

    if i % timeToReplaceTyre == 0:  # Check if it's time to replace tyre
        df.loc['Tyre Replacement', prev_year] = tyreReplacementCost

    if i % timeToReplaceBattery == 0:  # Check if it's time to replace battery
        df.loc['Battery Replacement', prev_year] = batteryReplacementCost

df = df.T
df['Total Cost'] = df.sum(axis=1)
df['Petrol Fleet Cost'] = [dailypetrolCost * workingDaysInAMonth *12 if i != 0 else 0 for i in range(df.shape[0])]
df['Saving'] =  df['Petrol Fleet Cost'] - df['Total Cost']
df['PV Factor'] = [ (100-discountRate)/100 if i == 1 else 0 for i in range(df.shape[0]) ]
```

```
df = df.T

for i in range(1, df.shape[1] - 1):
    prev_year = f'Year{i}'
    curr_year = f'Year{i+1}'

    df.loc['PV Factor', curr_year] = df.loc['PV Factor', prev_year] * (100 - discountRate)/100

df = df.T
# df['PV of Saving'] = df['PV Factor'] * df['Saving']
df['PV of Saving'] = df.apply(lambda row: (row['PV Factor']*row['Saving'] if row['PV Factor'] > 0
                                     else row['Saving']),axis=1 )
df['Cash Flow Status'] = [0 for i in range(df.shape[0])]
df = df.T

df.loc['Cash Flow Status', 'Year0'] = df.loc['PV of Saving','Year0']
for i in range(0, df.shape[1] - 1):
    prev_year = f'Year{i}'
    curr_year = f'Year{i+1}'
    df.loc['Cash Flow Status', curr_year] = df.loc['Cash Flow Status', prev_year] + df.loc['PV of Saving', curr_year]
```

```
pd.options.display.float_format = '{:.1f}'.format

df

# Plot graph for 'Cash Flow Status'

cashFlowStatus = df.loc['Cash Flow Status']

years = np.array([int(col.replace('Year', '')) for col in cashFlowStatus.index])  # Convert to
int


# Perform cubic spline interpolation

f = interp1d(years, cashFlowStatus.values, kind='cubic')

smooth_years = np.linspace(min(years), max(years), num=100)  # Increase the number of
points for smoother curve

smooth_cashFlowStatus = f(smooth_years)


# Plot the smoothed curve

plt.plot(smooth_years, smooth_cashFlowStatus, label='Cash Flow Status (Smoothed)')

plt.xlabel('Year')

plt.ylabel('Cash Flow Status')

plt.title('Smoothed Cash Flow Status Over Years')


# Draw a horizontal line at a certain y-value

y_value = 0  # Adjust this value as needed
```

```
plt.axhline(y=y_value, color='r', linestyle='--', label=f'y = {y_value}')


# Find the exact corresponding x-value for the drawn line

closest_y_value = min(smooth_cashFlowStatus, key=lambda x: abs(x - y_value))

x_value = smooth_years[np.where(smooth_cashFlowStatus == closest_y_value)][0]


# Draw a vertical line at the intersection point

plt.axvline(x=x_value, color='g', linestyle=':', label=f'x = {x_value:.2f} years (intersection)')


plt.grid(True)

plt.legend()

plt.show()

# noOf4Weelers = 15

noOf2Weelers = 221


energyConsumptionInAMonth = noOf2Weelers * workingDaysInAMonth * dailyOperation * fullChargeConsumption / vehicleFullChargeDistance

energyConsumptionInAYear = energyConsumptionInAMonth * 12

mileage = 30 # km/L

energyOfOnegallonPetrol = 12.69 # kWh/gallon

petrolLitrePerGallon = 3.78541

energyOfOneperLitre = energyOfOnegallonPetrol / petrolLitrePerGallon
```

```
petrolConsumedInOneDay = dailyOperation / mileage

monthlyPetrolConsumptionInLitre = noOf2Weelers * workingDaysInAMonth * petrolConsumedInOneDay

monthlyEnergyConsumption = monthlyPetrolConsumptionInLitre * energyOfOneperLitre

yearlyEnergyConsumption = monthlyEnergyConsumption * 12

totalDistanceInAYear = noOf2Weelers * dailyOperation * workingDaysInAMonth * 12

yearlyEnergyConsumptionInGj = yearlyEnergyConsumption * 0.0036

#Emission_factors

COtwo = 34.71 # KG/Gj

CO = 2.4 # g/km

NOx = 0.19 # g/km

HC = 0.52 # g/km

PMten = 0.06 # g/km

yearlyCO2Emission = COtwo * yearlyEnergyConsumptionInGj * 1000

yearlyCOEmission = CO * totalDistanceInAYear

yearlyNOxEmission = NOx * totalDistanceInAYear

yearlyHCEmission = HC * totalDistanceInAYear

yearlyPM10Emission = PMten * totalDistanceInAYear

print(yearlyCO2Emission,yearlyCOEmission,yearlyNOxEmission,yearlyHCEmission,yearlyPM10Emission)

plt.bar(["CO2","CO","NOx","HC","PM10"],
[yearlyCO2Emission,yearlyCOEmission,yearlyNOxEmission,yearlyHCEmission,yearlyPM10Emission])
```

```
# Add labels and a title
plt.xlabel('Emissions')
plt.ylabel('Quantity of Emission in Gram')
plt.title('Quantity of different emissions from 2-Wheeler')

# Display the graph
plt.show()
plt.bar(["EV","Gasoline"], [energyConsumptionInAYear,yearlyEnergyConsumption],color=['green','red'])

# Add labels and a title
plt.xlabel('Types of vehicle')
plt.ylabel('Energy Consumption in a year (kWh)')
plt.title('Energy Consumption EV versus Gasoline 2-wheeler')

# Display the graph
plt.show()
import matplotlib.pyplot as plt

# Define emissions and their corresponding yearly values
emissions = ["CO2", "CO", "NOx", "HC", "PM10"]
yearly_values = [yearlyCO2Emission, yearlyCOEmission, yearlyNOxEmission, yearlyHCEmission, yearlyPM10Emission]
```

```
# Round off the values to two decimal places
rounded_values = [round(value, 2) for value in yearly_values]

# Define colors for each emission (you can customize the colors as needed)
colors = ['red', 'green', 'blue', 'orange', 'purple']

# Create a bar plot with data values and different colors
plt.bar(emissions, rounded_values, color=colors)

# Add data labels on top of the bars with the original values
for i, value in enumerate(rounded_values):
    plt.text(i, value, str(value), ha='center', va='bottom', fontsize=12)

# Add labels and a title
plt.xlabel('Emissions')
plt.ylabel('Quantity of Emission in Gram')
plt.title('Quantity of different emissions from 2-Wheeler')

# Disable scientific notation on the y-axis
plt.ticklabel_format(axis='y', style='plain')

# Display the graph
```

```
plt.tight_layout()
plt.show()
import pandas as pd

# Define emissions and their corresponding yearly values
emissions = ["CO2", "CO", "NOx", "HC", "PM10"]
yearly_values = [yearlyCO2Emission, yearlyCOEmission, yearlyNOxEmission, yearlyHCEmission, yearlyPM10Emission]

# Round off the values to two decimal places
rounded_values = [round(value, 2) for value in yearly_values]

# Create a DataFrame
data = {'Emissions': emissions, 'Quantity of Emission in Gram': rounded_values}
df = pd.DataFrame(data)

# Print the DataFrame with better formatting
print("\nQuantity of different emissions from 2-Wheeler:")
print(df.to_string(index=False, justify='center'))
# Define emissions and their corresponding yearly values
emissions = ["CO2", "CO", "NOx", "HC", "PM10"]
yearly_values = [yearlyCO2Emission, yearlyCOEmission, yearlyNOxEmission, yearlyHCEmission, yearlyPM10Emission]
```

```
# Round off the values to two decimal places
rounded_values = [round(value, 2) for value in yearly_values]

# Create a DataFrame
data = {'Emissions': emissions, 'Quantity of Emission in Gram': rounded_values}
df = pd.DataFrame(data)

# Print the DataFrame
print("\nQuantity of different emissions from 2-Wheeler:")
print(df)

# Create a bar plot with data values and different colors
plt.bar(emissions, rounded_values, color=colors)

# Add data labels on top of the bars with the original values
for i, value in enumerate(rounded_values):
    plt.text(i, value, str(value), ha='center', va='bottom', fontsize=12)

# Add labels and a title
plt.xlabel('Emissions')
plt.ylabel('Quantity of Emission in Gram')
plt.title('Quantity of different emissions from 2-Wheeler')
```

```
# Disable scientific notation on the y-axis
plt.ticklabel_format(axis='y', style='plain')

# Save the plot as an image (e.g., PNG)
plt.savefig('emissions_chart.png', dpi=300, bbox_inches='tight')

# Display the graph
plt.tight_layout()
plt.show()
import matplotlib.pyplot as plt

# Define types of vehicles and their corresponding yearly energy consumption values
vehicles = ["EV", "Gasoline"]
yearly_energy_values = [energyConsumptionInAYear, yearlyEnergyConsumption]

# Round off the values to two decimal places
rounded_values = [round(value, 2) for value in yearly_energy_values]

# Define colors for each vehicle (you can customize the colors as needed)
colors = ['green', 'red']

# Create a bar plot with data values and different colors
```

```
bars = plt.bar(vehicles, yearly_energy_values, color=colors)


# Add data labels on top of the bars with the rounded values
for bar, value in zip(bars, rounded_values):
    plt.text(bar.get_x() + bar.get_width() / 2, bar.get_height() + 0.1, f'{value:.2f}', ha='center', va='bottom', fontsize=12)


# Add labels and a title
plt.xlabel('Types of vehicle')
plt.ylabel('Energy Consumption in a year (kWh)')
plt.title('Energy Consumption EV versus Gasoline 2-wheeler')


# Display the graph
plt.show()
# Define emissions and their corresponding yearly values
emissions = ["CO2", "CO", "NOx", "HC", "PM10"]
yearly_values = [yearlyCO2Emission, yearlyCOEmission, yearlyNOxEmission, yearlyHCEmission, yearlyPM10Emission]


# Round off the values to two decimal places
rounded_values = [round(value, 2) for value in yearly_values]


# Create a DataFrame
```

```
data = {'Emissions': emissions, 'Quantity of Emission in Gram': rounded_values}

df = pd.DataFrame(data)


# Print the DataFrame as a table

print("\nEmissions Data (Tabular Format):\n")

print(df.to_string(index=False))

# Converting to CO2 equivalent

# conversion factors

# 1 KG GHGs equals how much CO2 Equivalent

CH4toCO2=25 #1kg ch4 equals 25kg CO2 eq.

Total_Co2_eq= (yearlyHCEmission*CH4toCO2)+yearlyCO2Emission #Total CO2 equivalent in Gram

print(Total_Co2_eq)

# Cost of CO2 equivalent

# Nepal will receive USD 5 for every ton of carbon dioxide emission successfully mitigated.

TontoDollar=5 #1ton=5USD

Yearly_Cost_saving_by_trading=(TontoDollar*Total_Co2_eq)/1000000

print(Yearly_Cost_saving_by_trading)
```

<u>For four-wheeler</u>

```
import pandas as pd

import matplotlib.pyplot as plt

import numpy as np
```

```
from scipy.interpolate import interp1d

# vehiclePuchasePrice=int(input("Enter purchase price of vehicle "));

vehiclePuchasePrice = 2500000 ## Rs

vehicleFullChargeDistance = 100 ## km

vehicleMotorCapacity = 25 ## kW

fullChargeConsumption = 21 ## Unit/kWhr

fullChargeElectricityCost = 252 ## Rs

electricityPricePerUnit = 12 ## Rs

dailyOperation = 60 ## km

workingDaysInAMonth = 26 ## days

servicingFrequency = 2 ## times a year

servicingCost = 5000 ## Rs per time

servicingCostIncrement = 5 ## yearly in percentage

batteryWarranty = "8years / 50,000 km"

batteryLifetime = 10 ## years

batteryReplacementCost = vehiclePuchasePrice/3

tyreReplacementCost = 50000 ## Rs

tyreLifeTime = 40000 ##km

driverSalary = 25000 ## Rs/month

fleetManagerSalarly = 12500 ##Rs/month

salarlyIncrement = 2 ## in percent yearly

dailyHiringCost = 4000 ## Rs

discountRate = 7 ## in percent
```

```
annualInsurance = 30000 ## Rs

depreciation = 10 ## in percent yearly

co2EmissionPerLitre = 2.69 ## kg/lt


yearlyElectricityCost = ( fullChargeConsumption / vehicleFullChargeDistance) * dailyOperation * workingDaysInAMonth * electricityPricePerUnit * 12


distanceTravelledInYear = dailyOperation*workingDaysInAMonth*12


timeToReplaceTyre = round(tyreLifeTime/distanceTravelledInYear,0) ## year

timeToReplaceBattery = 8 ## year

data = {

    'Details': ['Purchase Cost', 'Electricity Cost', 'Tax','Servicing','Tyre Replacement','Insurance','Driver\'s Salary','Fleet Manager\'s Salary','Battery Replacement'],

    'Year0': [0,0,0,0,0,0,0,0,0],

    'Year1': [0,0,0,0,0,0,0,0,0],

    'Year2': [0,0,0,0,0,0,0,0,0],

    'Year3': [0,0,0,0,0,0,0,0,0],

    'Year4': [0,0,0,0,0,0,0,0,0],

    'Year5': [0,0,0,0,0,0,0,0,0],

    'Year6': [0,0,0,0,0,0,0,0,0],

    'Year7': [0,0,0,0,0,0,0,0,0],
```

```
    'Year8': [0,0,0,0,0,0,0,0,0],

    'Year9': [0,0,0,0,0,0,0,0,0],

    'Year10': [0,0,0,0,0,0,0,0,0],

}


df = pd.DataFrame(data)

df.set_index('Details', inplace=True)


df.loc['Purchase Cost','Year0']=vehiclePuchasePrice

df.loc['Electricity Cost',1:] = yearlyElectricityCost

df.at['Servicing', 'Year1'] = servicingCost * servicingFrequency

df.at['Insurance', 'Year1'] = annualInsurance

df.at['Driver\'s Salary', 'Year1'] = driverSalary *12

df.at['Fleet Manager\'s Salary', 'Year1'] = fleetManagerSalarly *12




# Increasing Servicing value by servicingCostIncrement

for i in range(1, df.shape[1] - 1):

    prev_year = f'Year{i}'

    curr_year = f'Year{i+1}'

    df.loc['Servicing', curr_year] = df.loc['Servicing', prev_year] * (servicingCostIncrement+100)/100

    df.loc['Insurance', curr_year] = df.loc['Insurance', prev_year] * (100-depreciation)/100
```

```
    df.loc['Driver\'s Salary', curr_year] = df.loc['Driver\'s Salary', prev_year] * (100 + salarlyIncrement)/100
    df.loc['Fleet Manager\'s Salary', curr_year] = df.loc['Fleet Manager\'s Salary', prev_year] * (100 + salarlyIncrement)/100

    if i % timeToReplaceTyre == 0:  # Check if it's time to replace tyre
        df.loc['Tyre Replacement', prev_year] = tyreReplacementCost

    if i % timeToReplaceBattery == 0:  # Check if it's time to replace battery
        df.loc['Battery Replacement', prev_year] = batteryReplacementCost

df = df.T
df['Total Cost'] = df.sum(axis=1)
df['Petrol Fleet Cost'] = [dailyHiringCost * workingDaysInAMonth *12 if i != 0 else 0 for i in range(df.shape[0])]
df['Saving'] =  df['Petrol Fleet Cost'] - df['Total Cost']
df['PV Factor'] = [ (100-discountRate)/100 if i == 1 else 0 for i in range(df.shape[0]) ]
df = df.T

for i in range(1, df.shape[1] - 1):
    prev_year = f'Year{i}'
    curr_year = f'Year{i+1}'
```

```
    df.loc['PV Factor', curr_year] = df.loc['PV Factor', prev_year] * (100 - discountRate)/100


df = df.T
# df['PV of Saving'] = df['PV Factor'] * df['Saving']
df['PV of Saving'] = df.apply(lambda row: (row['PV Factor']*row['Saving'] if row['PV Factor'] > 0
                                     else row['Saving']),axis=1 )
df['Cash Flow Status'] = [0 for i in range(df.shape[0])]
df = df.T


df.loc['Cash Flow Status', 'Year0'] = df.loc['PV of Saving','Year0']
for i in range(0, df.shape[1] - 1):
    prev_year = f'Year{i}'
    curr_year = f'Year{i+1}'
    df.loc['Cash Flow Status', curr_year] = df.loc['Cash Flow Status', prev_year] + df.loc['PV of Saving', curr_year]



pd.options.display.float_format = '{:.1f}'.format
df
# Plot graph for 'Cash Flow Status'
cashFlowStatus = df.loc['Cash Flow Status']
```

```
years = np.array([int(col.replace('Year', ")) for col in cashFlowStatus.index])  # Convert to int

# Perform cubic spline interpolation
f = interp1d(years, cashFlowStatus.values, kind='cubic')
smooth_years = np.linspace(min(years), max(years), num=100)  # Increase the number of points for smoother curve
smooth_cashFlowStatus = f(smooth_years)

# Plot the smoothed curve
plt.plot(smooth_years, smooth_cashFlowStatus, label='Cash Flow Status (Smoothed)')
plt.xlabel('Year')
plt.ylabel('Cash Flow Status')
plt.title('Smoothed Cash Flow Status Over Years')

# Draw a horizontal line at a certain y-value
y_value = 0  # Adjust this value as needed
plt.axhline(y=y_value, color='r', linestyle='--', label=f'y = {y_value}')

# Find the exact corresponding x-value for the drawn line
closest_y_value = min(smooth_cashFlowStatus, key=lambda x: abs(x - y_value))
x_value = smooth_years[np.where(smooth_cashFlowStatus == closest_y_value)][0]
```

```
# Draw a vertical line at the intersection point
plt.axvline(x=x_value, color='g', linestyle=':', label=f'x = {x_value:.2f} years (intersection)')


plt.grid(True)
plt.legend()
plt.show()
co2EmissionSavedInYear = co2EmissionPerLitre * dailyOperation * workingDaysInAMonth *12 ## Kg
co2EmissionSavedInYear
noOf4Weelers = 15
noOf2Weelers = 221


energyConsumptionInAMonth = noOf4Weelers * workingDaysInAMonth * dailyOperation * fullChargeConsumption / vehicleFullChargeDistance
energyConsumptionInAYear = energyConsumptionInAMonth * 12
mileage = 8 # km/L
energyOfOnegallonPetrol = 12.69 # kWh/gallon
petrolLitrePerGallon = 3.78541
energyOfOneperLitre = energyOfOnegallonPetrol / petrolLitrePerGallon
petrolConsumedInOneDay = dailyOperation / mileage
monthlyPetrolConsumptionInLitre = noOf4Weelers * workingDaysInAMonth * petrolConsumedInOneDay
monthlyEnergyConsumption = monthlyPetrolConsumptionInLitre * energyOfOneperLitre
```

```
yearlyEnergyConsumption = monthlyEnergyConsumption * 12

totalDistanceInAYear = noOf4Weelers * dailyOperation * workingDaysInAMonth * 12

yearlyEnergyConsumptionInGj = yearlyEnergyConsumption * 0.0036

COtwo = 75.66 # KG/Gj

CO = 3.16 # g/km

NOx = 0.28 # g/km

HC = 0.32 # g/km

PMten = 0.48 # g/km

yearlyCO2Emission = COtwo * yearlyEnergyConsumptionInGj * 1000

yearlyCOEmission = CO * totalDistanceInAYear

yearlyNOxEmission = NOx * totalDistanceInAYear

yearlyHCEmission = HC * totalDistanceInAYear

yearlyPM10Emission = PMten * totalDistanceInAYear

print(yearlyCO2Emission,yearlyCOEmission,yearlyNOxEmission,yearlyHCEmission,ye
arlyPM10Emission)

plt.bar(["CO2","CO","NOx","HC","PM10"],
[yearlyCO2Emission,yearlyCOEmission,yearlyNOxEmission,yearlyHCEmission,yearlyP
M10Emission])


# Add labels and a title

plt.xlabel('Emissions')

plt.ylabel('Quantity of Emission in Gram')

plt.title('Quantity of different emissions from 4-Wheeler')
```

```
# Display the graph

plt.show()

plt.bar(["CO2","CO","NOx","HC","PM10"],
[yearlyCO2Emission,yearlyCOEmission,yearlyNOxEmission,yearlyHCEmission,yearlyPM10Emission])


# Add labels and a title

plt.xlabel('Emissions')

plt.ylabel('Quantity of Emission in Gram')

plt.title('Quantity of different emissions from 4-Wheeler')


# Display the graph

plt.show()

import matplotlib.pyplot as plt

from matplotlib.ticker import FuncFormatter


# Define emissions and their corresponding yearly values

emissions = ["CO2", "CO", "NOx", "HC", "PM10"]

yearly_values = [yearlyCO2Emission, yearlyCOEmission, yearlyNOxEmission, yearlyHCEmission, yearlyPM10Emission]


# Round off the values to two decimal places
```

```
rounded_values = [round(value, 2) for value in yearly_values]

# Define colors for each emission (you can customize the colors as needed)
colors = ['red', 'green', 'blue', 'orange', 'purple']

# Create a bar plot with data values and different colors
plt.bar(emissions, rounded_values, color=colors)

# Add data labels on top of the bars
for i, value in enumerate(rounded_values):
    plt.text(i, value, str(value), ha='center', va='bottom', fontsize=12)

# Add labels and a title
plt.xlabel('Emissions')
plt.ylabel('Quantity of Emission in Gram')
plt.title('Quantity of different emissions from 4-Wheeler')

# Define a custom y-axis tick formatter to display non-exponential numbers
def non_exponential_tick_formatter(value, _):
    return '{:.2f}'.format(value)  # Format to two decimal places

# Apply the custom y-axis tick formatter
plt.gca().yaxis.set_major_formatter(FuncFormatter(non_exponential_tick_formatter))
```

```
# Display the graph

plt.tight_layout()

plt.show()

import pandas as pd


# Define emissions and their corresponding yearly values

emissions = ["CO2", "CO", "NOx", "HC", "PM10"]

yearly_values = [yearlyCO2Emission, yearlyCOEmission, yearlyNOxEmission,
yearlyHCEmission, yearlyPM10Emission]


# Round off the values to two decimal places

rounded_values = [round(value, 2) for value in yearly_values]


# Create a DataFrame

data = {'Emissions': emissions, 'Quantity of Emission in Gram': rounded_values}

df = pd.DataFrame(data)


# Print the DataFrame as a table

print("\nEmissions Data (Tabular Format):\n")

print(df.to_string(index=False))

# 1 KG GHGs equals how much CO2 Equivalent

CH4toCO2=25 #1kg ch4 equals 25kg CO2 eq.
```

Total_Co2_eq= (yearlyHCEmission*CH4toCO2)+yearlyCO2Emission #Total CO2 equivalent in Gram

print(Total_Co2_eq)

Nepal will receive USD 5 for every ton of carbon dioxide emission successfully mitigated.

TontoDollar=5 #1ton=5USD

Cost_saving_by_trading=(TontoDollar*Total_Co2_eq)/1000000

print(Cost_saving_by_trading)

ANNEX TWO: PLAGIARISM REPORT

Green Logistics in E-Commerce Industry: A Case Study on Daraz Nepal Pvt. Ltd.

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