Driving Towards a Sustainable Future: Optimizing Electric Vehicle Utilization in Last-Mile Supply Chain Operations

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Received Jul 11, 2024, **Revised:** Jul 17, 2024, **Accepted:** Aug 20, 2024, **Published Online:** Aug 28, 2024
Reviewers: Anonymous Peer Review
Citation: Chandra, S. (2024). Driving Towards a Sustainable Future: Optimizing Electric Vehicle Utilization in Last-Mile Supply Chain Operations. *International Journal of Supply Chain Management, 13*(4), 21-33, https://doi.org/10.59160/ijscm.v13i4.6254

***Abstract*— This is an era where environment has become one of the key concerns due to progressive deterioration caused by human activities that generate pollution. Hence it has become imperative for businesses to alter their strategies pertaining to operation and transport logistics and chose and implement more environment friendly options. Almost without exception, the logistics sector of any enterprise is the one with a significant carbon footprint, if not the largest. The growing gravity of the environmental damage has urged the enterprises to initiate a significant move towards choosing an alternative method of operation that is not only less polluting but is also a more sustainable option. This article evaluates the use of EV as a sustainable green alternative for last mile logistics and creates the scope for further research on possible alternatives.**

***Keywords*—** *E-commerce, delivery, last mile, last mile delivery, EV, electric vehicle, sustainable, environment, emission, pollution*

1. Introduction

Last Mile delivery may be defined as the delivery of the finished product from the transportation hub to the address provided by the final customer. In other words, it is the final journey of the goods from transportation hubs to their final destinations which typically is the consumer's residences. With more and more consumers shopping online and expecting swifter delivery, last mile delivery has progressively turned into a more significant leg of a company's logistics as it has substantial bearing on the costs as well as final customer satisfaction [1]. This final phase of the supply chain generally has very high shipping costs associated with it [2]. Modern last-mile delivery is a key function that is undertaken by modern commercial companies as an important initiative to provide superior consumer experience and goes a long way in building consumer loyalty, retaining old customers and adding new ones. In the current scenario, therefore, companies are measured, among other parameters by their prompt and efficient last-mile delivery. Logical and balanced process management contributes towards the distribution of goods reliably and ensures achievement of the necessary service levels as per the broader organizational commitment. The choice of methods pertaining to last-mile delivery is an outcome of the influence of several factors such as product pricing, logistics tools at the disposal of the organization and demand requirements forthcoming from the customers, which in turn dictates their logistical processes and hence their overall efficiency [3].

Owing to the changing face of online retail, Supply Chain Management (SCM) today has undergone sea change. Contemporary consumers now want speed with efficiency. With the massive development of ICT, there has been significant changes in the nature of consumer demand, consumers' psychology besides growing need for instant gratification. This has led to the huge expansion of diesel driven delivery vehicles, from 2-wheelers to delivery trucks, that has magnified the deterioration of the already heavily polluted environment, further adding to the problem of global warming. Mandates and incentives from the governments and local authorities now encourage adoption of green transport to fight the environmental degradation. While today's

consumers insist on better and faster deliveries, they are aware of the environment situation and hence show an inclination to buy from retailers and brands which use processes to reduce their carbon footprint. Green logistics is not just a subject for discussion any more – it has turned into an essential element for survival and sustenance. An IBM Research Insights report states that 57% of consumers are ready to shift their online buying habits inn a manner that will reduce the adverse environmental impact caused by emissions from delivery vehicles [4]. Enterprises, taking the cue, are slowly but steadily adjusting their supply chains and logistics so as to make a conscious effort towards in reduction of net carbon footprint of the organization simultaneously with meeting the emerging consumer expectations. This transformation is gaining focus as an increasing number of CEOs are putting environmental factors higher in their list of corporate priorities. This article focuses on the use of electric vehicles (EVs) in last mile delivery and its potential in driving e-commerce logistics towards a sustainable future.

2. Literature review

The whole world is facing consequences of climate change and environmental hazards, and it has become imperative to find sustainable solutions. Infamous for its very function, the logistics industry contributes significantly to greenhouse gas emissions and generation of waste and effluent [5]. The massive increase in use of diesel-driven delivery vehicles has been one of the key reasons behind the rise in pollution and hence worsening global warming. It has, therefore, become essential for modern logistic companies to initiate less harmful alternatives. In a bid to seek eco-friendly alternatives, these companies are now turning to delivery vehicles that are battery driven and hold the promise to become an effective solution to the problem of green and sustainable growth and expansion.

2.2 Growth in ICE Vehicles in Last Mile Delivery

In the present-day world, the task of a logistic team or logistics company is the effective delivery of the product from the manufacturer to the final consumer. Population growth in combination with a transformation in the patterns of retail consumption like online purchases and variable delivery methods [6] has resulted in the market gradually becoming customer oriented and this change is very relevant to developing countries leading to new stereotypes and evolution of traditional behavior. The most perceivable fallout of this change is the modern buyers demanding superior services but for lower costs. A clear trend towards decrease in the stock of household items can be deciphered [7]. The impact of increased automobilization is evident from the transformation in buyers' behavior so far as going into retail shops is considered [6]. The high level of penetration of computer into each household has made transmission and processing of data possible and easier than earlier which in turn helps to search and order products from the comfort of one's own residence. Due to this change in consumer buying patterns we see refusal for traditional shop purchases and a rise in online e-shopping. Consumers have been pampered with easier and faster delivery of their purchases to their doorsteps; so much so that it has now become a practice and the consumers now want instant gratification. These changes have also made logistics companies rethink their processes and innovate them to mixed and omni channel routes. This change brings along different efficiencies from doorstep return of damaged goods to delivery of sophisticated electronic systems being delivered and company technicians installing the product for use [8].

2.2.1 Impact on Environment

The urban areas have seen a steady rise in the employment of LCV or light commercial vehicles for the speedier delivery of parcels to the consumers, thanks to the exponential growth in e-commerce over the last decade or so [9]. According to the forecasts made by the World Economic Forum, there has been a magnificent surge in e-commerce demand and to address this humongous growth in demand, by the end of this decade, there could be 36% rise in the number of e-commerce delivery vehicles that drive around within the modern cities. This would translate into an equivalent rise in the environmental pollution (both air and noise pollution) due to scaling of pollution caused by emissions from these vehicles that are predominantly diesel driven, disposal of toxic waste, and congestion in these cities which will get overcrowded by traffic [10].

The volume of delivery vehicles plying the streets has increased rapidly over the last few years triggered by the global pandemic and so has the frequency of their engagement. This invariably adds to the already escalating issue of pollution in the cities and hence magnifies global pollution. The majority of these commercial vehicles that are used for last mile delivery have diesel engine. Of all the commercial trucks in use 75% are powered by

diesel [11]. Besides being a traffic nuisance, these vehicles are responsible for noise pollution and emit higher volume of air pollutants. The entire doorstep delivery process is a very rapid one involving loading, travelling, alighting and, delivering, which makes the driver of the diesel engine inclined towards idling the vehicle rather than turning the ignition on or off at quick intervals. Besides adding to noise pollution this is also the cause behind the limited possibilities of shifting deliveries to overnight periods. These vehicles release pollutants that are responsible for such health issues as blood pressure, heart disease, and sleeping disorders [12].

According to the World Economic Forum, at the present rate of expansion, if there is no appropriate measures in place to check and balance, vehicle emissions is likely to increase by nearly one third of its present volume in the top 100 cities of the world by 2030 [10]. The need of the hour is to draft stronger policies and implement them so as to dissuade the logistic operators from using diesel-run vehicles is an urgent bid to cut down on carbon emissions. Delivery vehicles are responsible for releasing as much as 50% of Nitrogen oxide discharge into the atmosphere in the U.S. [13] a key pollutant coming from vehicular emissions with the capability of doing substantial damage [14]. Vehicles that are employed in the distribution of goods to the end-consumers of products sold online account for just 4 in a hundred vehicles on U.S. roads but contribute to at least 50% of the nitrogen oxide emissions, nearly 60% of the fine particulates from all vehicles, and almost 7% of all greenhouse gas emissions (GHG) in the country [15]. It is very easy for particulate to infiltrate the human body and affect vital organs such as the lungs and even the heart. By virtue of its tiny size, it can even infiltrate the respiratory system causing severe respiratory disorders. Prolonged exposure can cause damage to the skin, infect blood stream and even the muscle tissue. The health implications are serious and in several of the cases most life threatening. Such adverse environmental effects would cause an estimated 18,000 deaths, annually, by 2025 while the ozone layer continue to deplete at an alarming rate. The number of annual deaths is anticipated to scale by 25% or more within the next 6 years [16].

2.3 The Move Towards Alternative Routes

The vehicular pollution has taken such grave shape and has emerged as the key contributor to global temperature rise and global warming. Every nation everywhere in this world is now recognizing the red flags and adopting various measures to do whatever they can to stop the situation from spinning completely beyond control. Luckily, there are evidences to indicate that an increasing number of countries and entrepreneurs are making conscious efforts at cutting down the usage of diesel delivery vehicles.

Efforts are visible from freight forwarders who are making attempts to alter the composition of their fleet for coping with the rising e-commerce demands. For instance, today freight forwarders are putting substantial amount of money into investment in small-sized trucks and trailers which are better suited for those last-mile deliveries that are short and have higher frequencies [17].

Governments are being persuasive – providing incentives for purchasing EVs for commercial usage. Where necessary, strong directives are being used to mandate the replacement of ICE vehicles by alternatives that run on cleaner energy. Electric vehicles are likely to be the much-needed solution. A lot of initiatives are visible towards transition to a green supply chain. Vendors and businesses are making conscious use of their resourcefulness to transition to EVs instead of using conventional ICE vehicles for last mile delivery due to their need to build and nurture their competitive edge, keeping in line with the sustainability trends, which also keeps them in the good books of customers who are choosy about environmentally conscious businesses. Such transition has significant positive impact not only on the distributors involved but also on the society as a whole conferring a wide range of benefits to the e-commerce businesses. EVs can prove to be beneficial for a host of delivery businesses but is specifically suited for last-mile delivery operations due to the nature of mobility required for last mile delivery - the need to travel fixed and constrained range [18]

3. EV Adoption

Green logistics refers to the function of finding alternate processes of delivery so as to reduce the adverse environmental impact of delivery logistics that is predominated by the use of diesel vehicles that cause more pollution than any other. With a larger number of modern customers having better insight into the environment, and opting for purchases from environmentally conscious and green companies, shipping enterprises see an increasing need to reduce the carbon dioxide emission, and improve their waste disposal as also waste management methodologies while using

more recyclable materials thereby increasing their Green impact [4].

All over the world, the focus on environmental sustenance through reduction in carbon footprint has increased manifold and has penetrated all aspects of transport and logistics operations which is a pivot for logistic companies who are taking care of movement of goods – from procuring raw material to shipping out finished goods. Conventional transport logistics relied heavily on fossil fuels and that too primarily on diesel powered trucks, which did quite a bit of damage to air quality by contributing copiously to the emission of pollutants such as the greenhouse gases. In contract, Eco-friendly alternatives reduce the environmental impact of logistics and transportation and makes the process more sustainable.

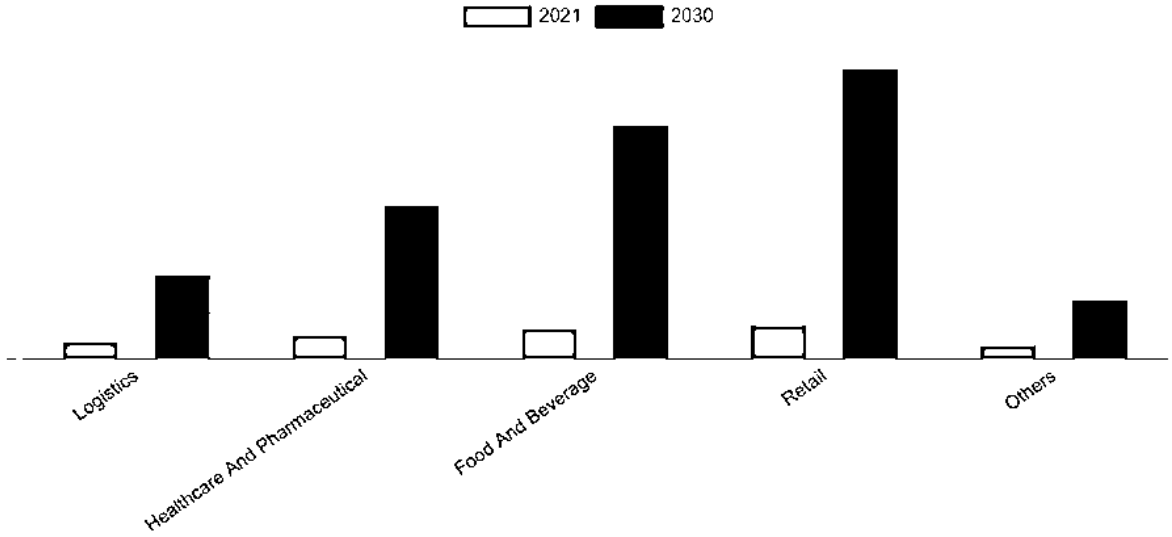

Figure 1: Projected EV adoption across sectors [21]

With an increasing number of enterprises infusing sustainable logistics practices into their business operations and thus moving closer to achieving their environmental goals of reducing their carbon footprint, the demand for electric vehicles has started increasing at an exponential rate. This, in turn, urges the actual business owners and suppliers to partner with green logistic firms and bring operations to an environmentally friendly standard [22].

3.2 Need for Greater EV Adoption in Last-Mile Delivery

Last mile delivery is the costliest leg of the supply chain with modern customers preferring zero cost deliveries to their doorsteps. There are also demand for same day deliveries but at zero cost. Hence, besides being the most expensive, last mile logistics is also time intensive and accounts for almost 53% of the total shipping costs. Sometimes inefficiencies creep into the process of the last mile logistic which makes the cost of deliveries rise even further.

The proliferating growth in e-commerce is in part responsible for higher engagement of light commercial vehicles (LCV) for the delivery of parcels within cities and their suburbs [9]. These areas are already reeling under the menace of growing air and noise pollution coupled with clogging of the traffic. The fulfilment of the mammoth and ever-growing demand created since the global pandemic is predicted to send the number of e-commerce delivery vehicles driving around inner cities rising up by about 36% by the close of the present decade. This indicates that there is likely to be similar kind of expansion in the volume of carbon emissions, toxic waste generation and hence pollution and, needless to say congestion [10].

Vehicles used in last-mile delivery such as the mini trucks, 2 and 3 wheelers are responsible for causing large-scale traffic congestion all across the city and since majority of them use diesel to fuel them, they heighten the levels of GHG emission thus adding to the already elevated levels of pollution within modern cities and their surrounding areas. This, in turn, has further negative impact on the quality of city life making sustained city-dwelling in modern

times more of an ordeal aggravated by the plethora of such undesirable changes as the sustained increase in health hazards, rising instances of severe health problems specifically respiratory disorders in both children and adults resulting from the continued deterioration in air quality index thus putting adverse impact on the liability of modern urban and suburban areas [12].

According to forecasts, if the present rate of increase remains unabated and no efforts are made towards adopting any suitable measures aimed at arresting or at least managing the present levels of vehicular pollution, emissions are likely to increase by at least one third of what it is today inside the top 100 cities of the world in another 5 years or so. [10]. It has now become essential to undertake certain drastic measures and implement stricter policies in the earliest possible time. Delivery vehicles continue to remain the key perpetrators, pumping in more than half of the Nitrogen oxide discharge into the atmosphere of the USA [13]. Nitrogen oxide can and does increase the quantum of small particulate in the atmosphere that comes from vehicular emissions and is responsible for causing substantial damage to health of the masses [14]. Despite delivery trucks that are employed for the distribution of goods accounting for less than 4% of vehicles running on roads in the U.S.A., they contribute to nearly 50% of the nitrogen oxide emissions in the country besides being responsible for approximately 60% of the fine particulates emitted by all vehicles taken together, and about 7% of all greenhouse gas emissions (GHG) in the U.S [15].

During the recent past, especially in the post COVID era, global e-commerce has seen significant scaling up of transaction volumes along with the bulk of the volume in the total sales tipping towards fast-moving consumer goods or FMCG. The optimization of delivery operations becomes essential to handle explosive increase in the number of orders. The present situation also demands that e-commerce businesses be abreast of the latest technologies in in last-mile delivery and employ are able to deploy them and implement them effectively. The integration of these technologies into delivery operations can be facilitated through the adoption of electric mobility and use of EVs which have come to play a very crucial role in last mile delivery. The necessity to adopt and adapt to novel technologies has become apparently critical to the success of e-commerce enterprises while for the small enterprises it has become a survive tactic in the face of the ongoing technologies advances [23].

3.3 Benefits Of Adopting Electric Mobility

Lesser Carbon Footprint Due to Substantial Reduction in Greenhouse Gases (GHG) Emission: Delivery vehicles that run on Diesel are responsible for major portion of urban pollution. Hence, they contribute generously towards global warming and adding to the carbon foot prints of the organizations that employ them. Report published by the Union of Concerned Scientists suggest that switching over to electric mobility can make a significant difference in the positive direction in this respect. Beyond doubt, electric mobility can bring down the emission of greenhouse gases by almost eight tenth when compared to exhaust from ICE vehicle. The resulting comprehensive decline in vehicular emissions will make positive contributions towards the global agenda of battling an impending climate change and improve the situation if not abate. When EVs are used as last mile delivery vehicles, the carbon emissions are reduced by at least 55% in comparison to a standard diesel-driven ICE delivery van [24].

Draw More Consumers as Consumers Prefer Eco-Friendly Companies: Modern consumers are much more environmentally conscious and are aware of the unsustainability of environmental deteriorations. E-commerce consumers are of the opinion that they are progressively better aware of the environmental impact of diesel-run vehicles employed in package delivery. According to Merchants Fleet, a New Hampshire-based fleet management company, at least 70% of consumers have deliberated on the environmental impact of last mile delivery, and almost 60% have confirmed that the environmental impact had some role to play in their decisions to have packages delivered to them [25]. Nielsen’s study concluded that approximately 66% of the customers are more in favor of buying products from those business organizations that demonstrate their commitment towards achieving sustainability goals. The transition to EVs with respect to last-mile delivery operations works as a powerful tool for the dispersion of a positive message regarding the organizational intent and stand on having operation

that are environment friendly [26]. Another recent consumer survey revealed that an overwhelming number of e-commerce consumers desire to witness accelerated transition of e-commerce to delivery companies to electric mobility in response to climate change and air pollution [27]. Almost 50%of the consumers in America say they would choose an e-commerce package carrier over another if they are convinced that it uses electric vehicles instead of traditional vans that burn fossil fuels for power, according to the survey conducted by Merchants Fleet. The exact statistic puts the count as 55% higher number of U.S. shoppers compared to the previous year, intended to purchase higher volume of goods online during the holiday season in 2022 than last year, despite the distresses caused by the rising inflation and a volatile stock market. [25].

Safer Deliveries with Low or No Noise Pollution: Electric vehicles are way less noisy compared to ICE vehicles [28]. The Electric delivery vans cause less noise pollution at the time of switching on the ignition and even during carrying out deliveries, EVs can actually remain more muted in comparison vans operating using the ICE technology, and hence causes least disturbance, especially in urban residential areas [26]. Electric vehicles are 30% less likely to cause deaths in comparison to fossil fuel powered internal combustion vehicles as stated by the American Lung Association. According to them, a countrywide changeover to EVs and other zero emission technologies will result in major health benefits for the masses through the reduction in air and noise pollution [29].

Operational Improvements: EVs entail zero re-fueling cost that is rampant in conventional ICE vehicles. This part of the expenses made on the delivery fleet is completely done away with. In the absence of refueling, the costs of labor is reduced by maximum of 30% as has been revealed by a recent study [26]. This translates to lower operational expenses which in turn leads to better margins and higher bottom lines as fuel costs find their way out of the total expenses incurred by the company. It is obvious that there exists a straightforward connection between the volume of consumption of fossil fuel and the complete cost of logistics, and since electric vehicles make do with lower amount of fuel, even the hybrid ones, they are in a position to reduce operational expenses [30]. In a way this enhances productivity. A study showed that EVs are able to deliver a product within the cities at 20% lesser time, thus enhancing productivity [31].

Overall Lower Cost of Ownership & Maintenance: In more than one country, vehicle owners are encouraged to adopt EVs through the provision of various grants and subsidies to help purchase an electric vehicle of their choice, thus trying to expedite the process at a larger scale [32]. According to the US Department of Energy, conventional internal combustion engine vans that are powered by fossil fuel and are used for last mile delivery, on an average expend about 40 cents on every mile travelled. There is significant cost differential when it comes to the use of electric vehicles. When EV is used, the average cost per mile reduces drastically to 5 cents. This translates to a almost 80% potential savings in terms of the cost of fuel only [26]. The fuel cost will, actually, stand at nil as no gasoline would be required to power these vehicles. Even for hybrid vehicles, the fuel cost would be significantly low as bulk of the power requirement would be met from electricity. In the long run, electric vehicles turn out to be much cheaper mobility option compared to EVs and also command better resale value [32]. Over a period of 3 years, it is estimated that an EV 2-wheeler is likely to be at least 30% cheaper on the pockets in comparison to a conventional ICE vehicle. Also, such incentives as subsidies also encourage EV adoption by reducing the cost of ownership [33]. The consumption of electricity for driving 15,000 miles per year in an Electric Vehicle would cost approximately $550 per year, which comes to around $45 per month. The amount of gasoline that will be consumed for driving the same distance is expected to cost you close to $1,300 on an annual basis [34]. Unlike vehicles running on petrol and diesel, there are lesser number of moving parts in EV engines which means the costs associated with wear and tear are also lesser and they also require much lesser maintenance. Rocky Mountain Institute carried out a study that showed that the maintenance costs for electric delivery vans were only 3 cents per mile on average, whereas roughly 10 cents per mile is the maintenance cost for their fossil fuel counterparts. This translates to a savings of practically 70% for the e-commerce companies using EVs as their delivery vehicles [26]. If maintained as per the recommendations of the particular EV manufacturer, on average electric

vehicles cost $330 lower on an annual basis compared to the gas-imbibing counterparts. As per Consumer Reports, EV drivers pay 50% lesser money on repair and maintain on their vehicles. Those who own an electric car can expect an average saving of approximately $4,600 in terms of repair and maintenance costs over the life of their vehicle compared to a vehicle powered by fossil fuel [34].

3.4 Current challenges and barriers to widespread adoption

The adoption of EVs in every aspect of modern urban transportation and the transition to green transportation is not an easy process. Following are the key challenges that appear as impediments in EV adoption.

3.4.1 High Initial Cost

EVs generally have a significantly high purchase cost that acts as a huge deterrent for purchasing EVs, though overall cost of ownership may be lower [37].

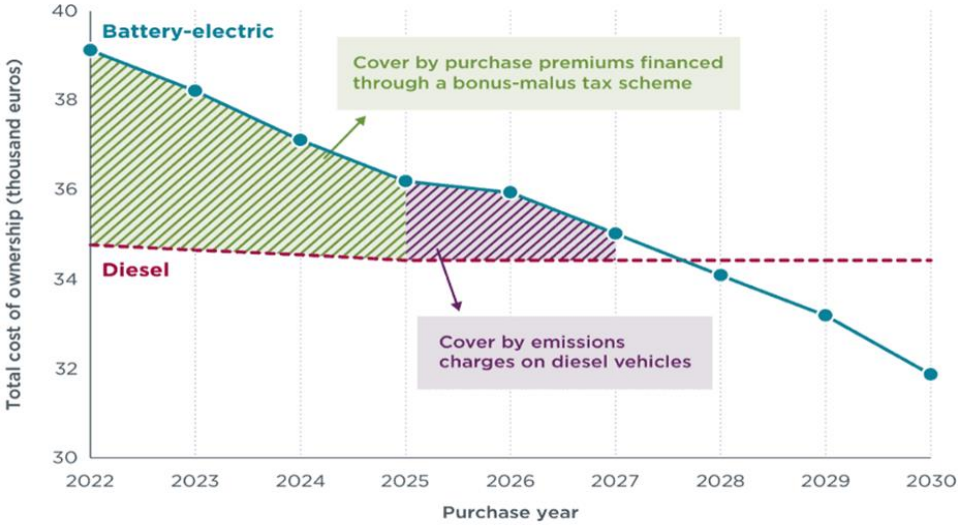

Figure 2: Cost of ownership of EV [37]

One of the key impediments in EV adoption, in last mile delivery, is the substantial upfront payment in the form of vehicle purchase cost [38]. EVs are more expensive than conventional ICE ones, essentially because of battery technology [39]. These batteries need to hold a enormous charge to be able to provide the minimum range for the owners. Hence the need of expensive inputs. Even without battery costs, EV are more expensive due to availability in miniscule quantities compared to huge supply of gas-powered vehicles in the U.S. Although overall operational cost of EVs are less than their gasoline counterparts, there are not many choices available in the market with a sticker price lower than $30,000 (excluding government tax credits). Used models may be half the price but they are also older models indicating less battery range [40].

3.4.2 Inadequate Infrastructure

The power source for EVs is batteries that need charging at regular intervals. There is acute shortage of charging infrastructure and inconsistent obtainability. The shortage of public charging infrastructure is particularly severe in emerging markets economies, whatever is available is mostly private charging (at home etc.). Comparative novelty of EVs in the emerging markets is responsible for extremely low number of charging stations. The available options are totally insufficient compared to EV demand making it harder for EVs to be fully employed in delivery logistics. Logistics companies depending on EVs for covering long distances need to do advance planning to avoid being stranded on the road in between 2 charging stations, which becomes quite painful.

3.4.3 Range Anxiety and Predictable Delivery Patterns

Range anxiety is a key factor that acts as a deterrent to EV adoption. Typically, the EVs that are available at present, on an average, can travel, on a single charge in temperate weather conditions, between 200 to 300 miles. short driving range resulting from battery capacity and limited availability of charging infrastructure are key hurdles to EV adoption [41]. A little less than 80% of the public charging stations are Level 2, which means that the time taken to charge up the EVs for the next 3-4 hours drive can take up almost 4-6 hours and even longer. However, logistic businesses are concerned about the distance that their delivery vehicles will be able to travel before finding a charging station and then having to wait through a long charging session. This becomes especially challenging during the winter when an EV's regular battery range reduces significantly due to temperatures declining below freezing point [40]. Compared to traditional ICE vehicles, EVs typically face range anxiety for a number of vehicle owners and users [42]. This can potentially cause delivery delays. However predictable routes and delivery frequencies will ease this pressure. For e-commerce last mile delivery businesses where the trave is along known routes and not a very long distance EVs can prove to be a convenient option, however for long-distance travel and unfamiliar routes EVs can't be a very practical option. Generally, EVs battery range is good for last-mile deliveries since they usually focus on a limited area to cater to. For shipping and delivery interstate use of EV is impractical and more of a hassle given the severe lack of charging infrastructure [32].

3.5 Strategies and incentives to promote EV adoption in the logistics industry

The Government policies (various initiatives and schemes) have a crucial role to play in fostering a conducive environment for EV adoption. The benefits of transitioning to EVs in the logistics and delivery domain are manifold. The Inflation Reduction Act (IRA) is the most noteworthy investment in in U.S. history for fighting climate change [43]. Apart from playing its part in sustainability and addressing climate change, the IRA is also working towards updating the existing electrical infrastructure which has remained principally unchanged since it inception and installation that happened decades ago. As part of a wider program to transform mobility and establish the energy infrastructure required for fueling an electric vehicle of the future, the IRA also initiated measures intended to increase electric mobility adoption rates, support installation of EV chargers, and incentivize the transition to form of transportation that has higher sustainability [44]. Apart from the Government incentives, stakeholders' collaboration crucial to stepping up EV charging infrastructure. The e-commerce companies and their logistic service providers (in case the logistic facilities are not available in-house) need to collaborate and concur on the adoption of EVs in the last mile delivery process. Regulatory changes are on their ways with various states making their own efforts at it. For instance, California is phasing out larger trucks with its EV Acceleration Challenge and is now the state with 40% share in EV sales in US [45, 46].

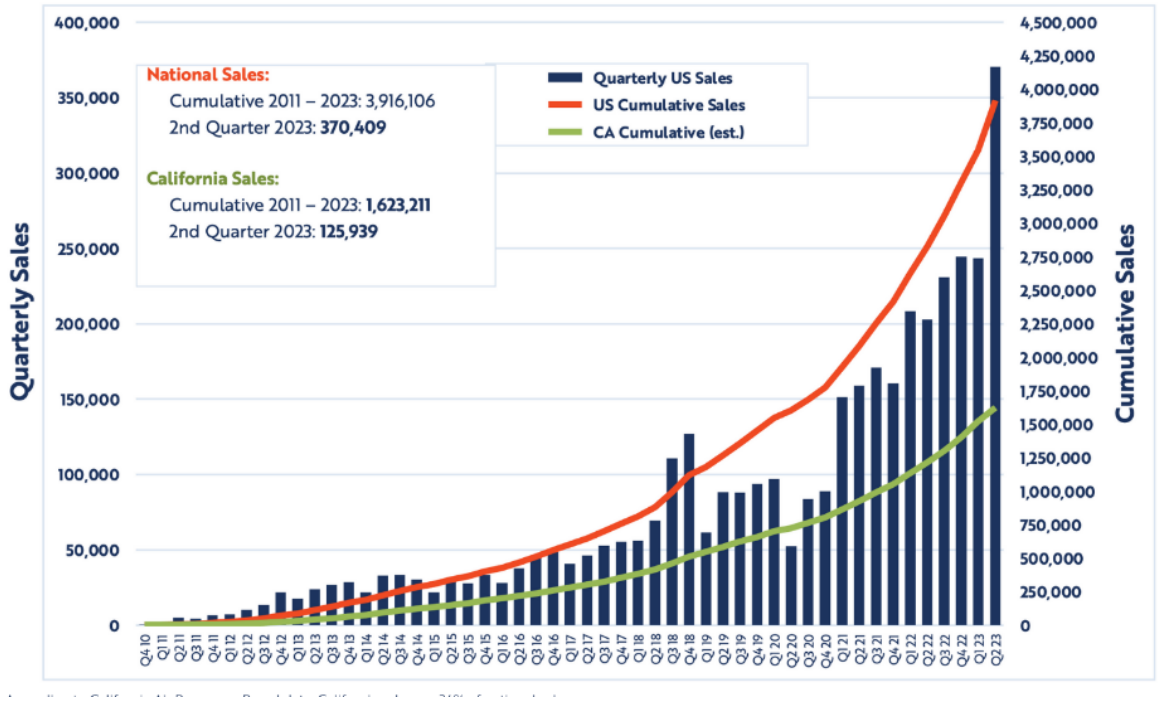

Figure 2: *EV sales growth - The US and California [47]*

4. Alternative Methods of Going Green

EV ownership models are a lot different than ICE, with lower ownership by driver owners. The primary reason being higher upfront costs involved in the purchase of the vehicle, perceived uncertainty pertaining to the technology, range anxiety, and restricted knowledge regarding the TCO benefits. This has created the huge opportunity for the EV asset operators who buy these vehicles and offer their e-fleets on rental contracts [33].

First, middle and last mile logistics are essential parts of any supply chain and hence form parts of a green supply chain. It is possible for any and every stage of logistics operations to go green easily with the help of digitization. This can be used from elimination of the paper trail to reding energy consumption by choosing the most optimum route in a day's delivery and using alternative fuels and thereby increase efficiencies. For any and every stage of logistics operation, the process of going green can be achieved with a lot of ease by going digital through digitization of the processes. For starter, digitization can be effectively used to do away with the paper trail, and cut down energy consumption using alternative fuels and higher efficiencies [4].

5. Conclusion

The e-commerce and the last-mile delivery operations have already recovered from the influence of the global pandemic. It has not only bounced back with greater positive energy but is also expected to grow further in the times to come. This has increased the number of vehicles doing last-mile delivery, which is likely to scale up the fuel consumption which in turn would increase the carbon emissions. The engagement of EVs for last-mile delivery is expected to contribute significantly towards the implementation of green supply chain logistics practices – a key step towards sustainable green initiatives to contribute positively towards steps taken to better the global warming situation. During 2023-28, U.S. EV market in last-mile deliveries is estimated to grow at a robust 16% CAGR as industry giant CEVA Logistics is working towards expanding its EV fleet to 1,450 by the 2025-end, a testimony to collective commitment towards sustainable last-mile deliveries [49].

While e-commerce offers the convenience of shopping from home and economic opportunity, its environmental impact needs to be addressed without much delay. Undoubtedly, the adoption of electric goods vehicle in last-mile delivery logistics is the only logical way forward, as of now, for businesses across the globe. From reducing carbon footprints, to cutting down fuel expenses, and improving air quality, EVs have a lot to offer.

Transitioning to electric vehicle fleets help curb emissions, reduce pollution, and decrease resource consumption and when combined with renewable energy, electric fleets has the capacity to provide a sustainable solution for the future of last mile delivery. Overall, the transition towards electric vehicles in last-mile delivery has a crucial part to plays in the creation of a more sustainable and healthier environment. The adoption of electric goods vehicle for last-mile delivery is the way forward for businesses across the world.

Despite the fact that a host of consumers are still skeptical about purchasing EVs, because of high initial cost, limited range, and lack of charging infrastructure, it is less likely to be the same with the organizations involved with last-mile delivery and are believed to be significant contributors to modern urban pollution. Major retail firms in the US are investing heavily in EVs for last mile delivery. Even the US Postal Service is making the transition [45]. The reduction in the TCO over the years may turn to be beneficial to them by providing the required competitive edge of cost. With states such as California investing heavily in EV infrastructure and incentivizing EV adoption, complete transition of last mile delivery to zero emission EVs would soon be a reality [50]. Other states will also follow making a marked difference to the air quality and to sustainable green existence. While the use of EVs in last mile delivery is most likely to deliver on the desired environmental goals the paucity of infrastructure makes it necessary to research for alternative avenues suggested. The goal remains, undeniably, the achievement of superior customer satisfaction through the use of sustainable measures that reduce environmental footprint.

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