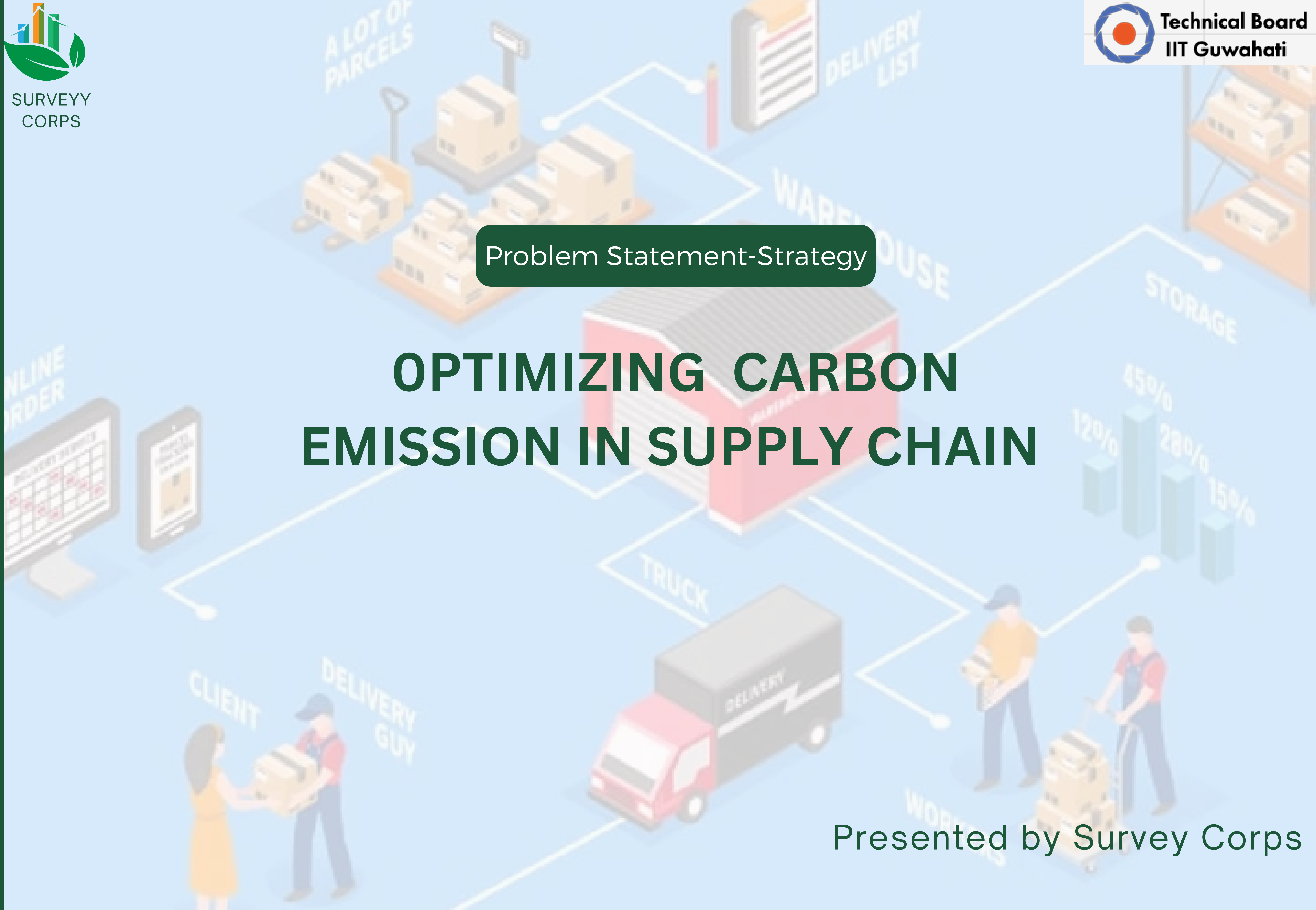
SURVEYY CORPS

Technical Board IIT Guwahati



Problem Statement-Strategy

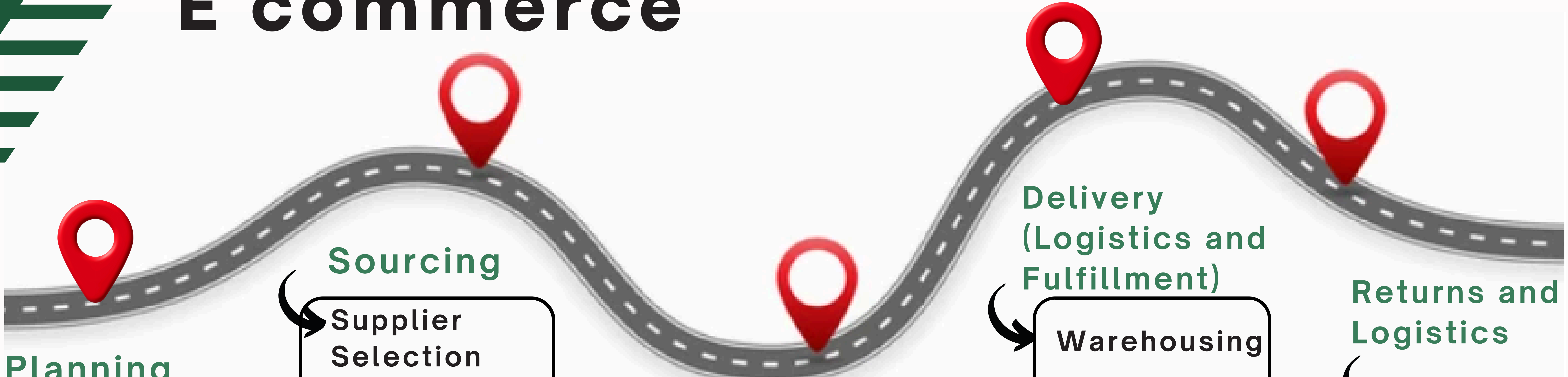
OPTIMIZING CARBON EMISSION IN SUPPLY CHAIN

Presented by Survey Corps

AGENDA

1. Analysis of supply chain of all industries
2. Why E-Commerce
3. Exhaustive supply chain analysis
4. Solutions in brief
5. Risk and Impact

E commerce



Planning

- Demand Forecasting
- Inventory Management
- Logistics Planning

Sourcing

- Supplier Selection
- Procurement of Raw Materials
- Supplier Management

Manufacturing

- Product Assembly
- Customization

Delivery (Logistics and Fulfillment)

- Warehousing
- Order Processing and Fulfillment Shipping

Returns and Reverse Logistics

- Returns Management
- Reverse Logistics
- Product Disposal or Recycling

Primary Sources of Emissions

- Data center energy consumption.
- Raw material extraction and long-distance transport.
- High energy use in production and packaging waste.
- Transportation, especially last-mile delivery.
- Additional transport and product disposal.

Carbon Emission

1. **PLANNING:-**

Data Centers: Demand forecasting and inventory management heavily rely on data processing. The energy used to run algorithms in data centers contributes to carbon emissions.
Cloud-based planning platforms add to the footprint depending on the energy source.
Energy Use: Planning processes rely on software tools, which consume significant electricity, often sourced from non-renewable sources, particularly in regions with carbon-intensive electricity grids
Mitigation Potential:Using renewable energy in data centers.
Implementing AI-driven predictive models to reduce overproduction and minimize waste.

2. **Sourcing :**

Supplier Selection: Choosing suppliers based on cost, quality, and geographical proximity. Procurement of Raw Materials: Raw materials needed for manufacturing are sourced globally.Supplier Management: Negotiations and contracts for continuous supply.

Carbon Footprint Contribution: Raw Material Extraction: Significant emissions are associated with mining, farming, or manufacturing raw materials. The carbon footprint depends on the resource extraction method, energy intensity, and geographical location.
Transport of Raw Materials: Shipping raw materials from suppliers to factories involves emissions from trucking, shipping, and airfreight. Overseas transport, especially by air, leads to high carbon intensity.
Primary Sources of Emissions: Raw material extraction and long-distance transport.
Mitigation Potential: Sourcing from local or regional suppliers to reduce transportation distances,Preferring suppliers that follow sustainable practices such as using renewable energy or minimizing resource use.

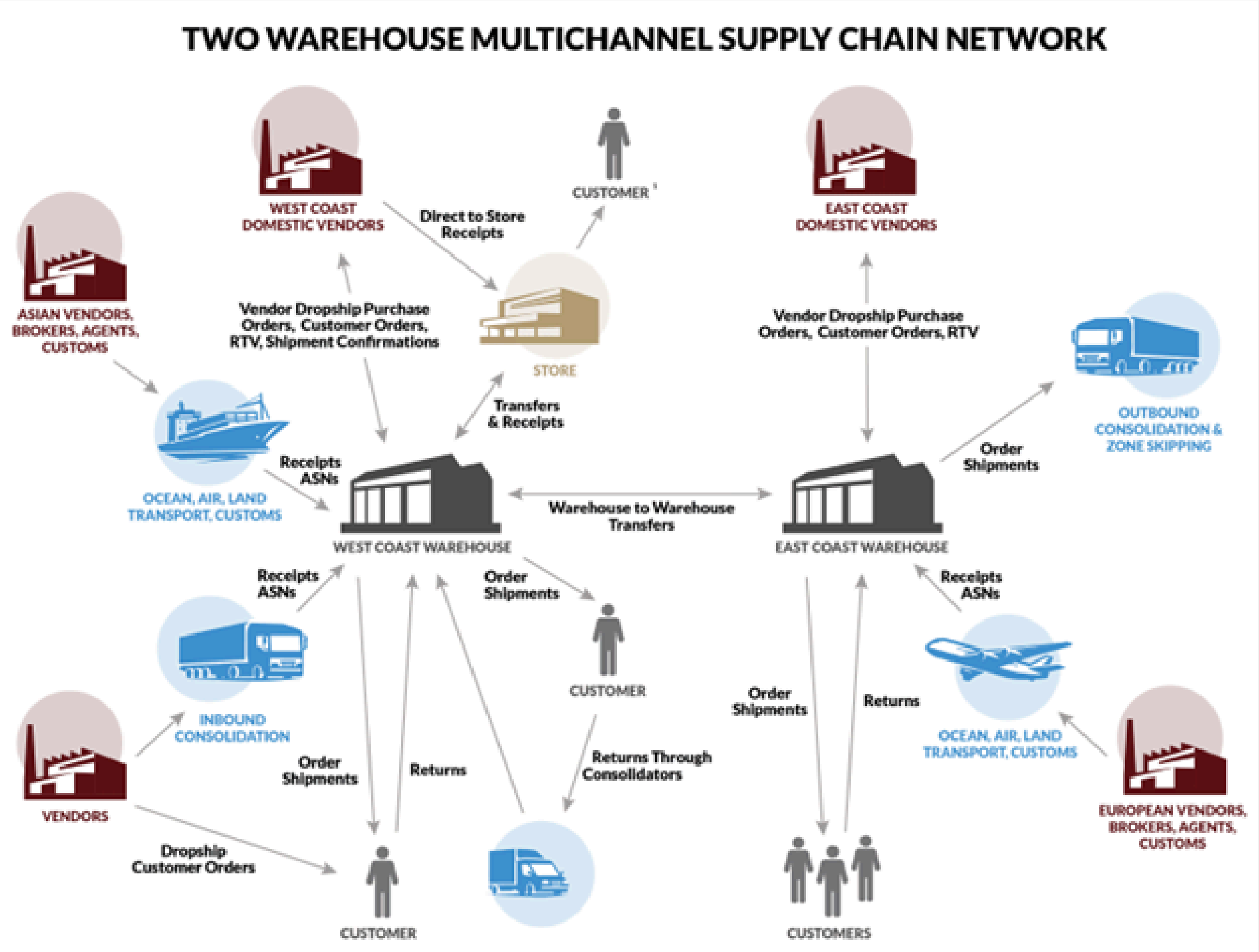
3.Manufacturing :

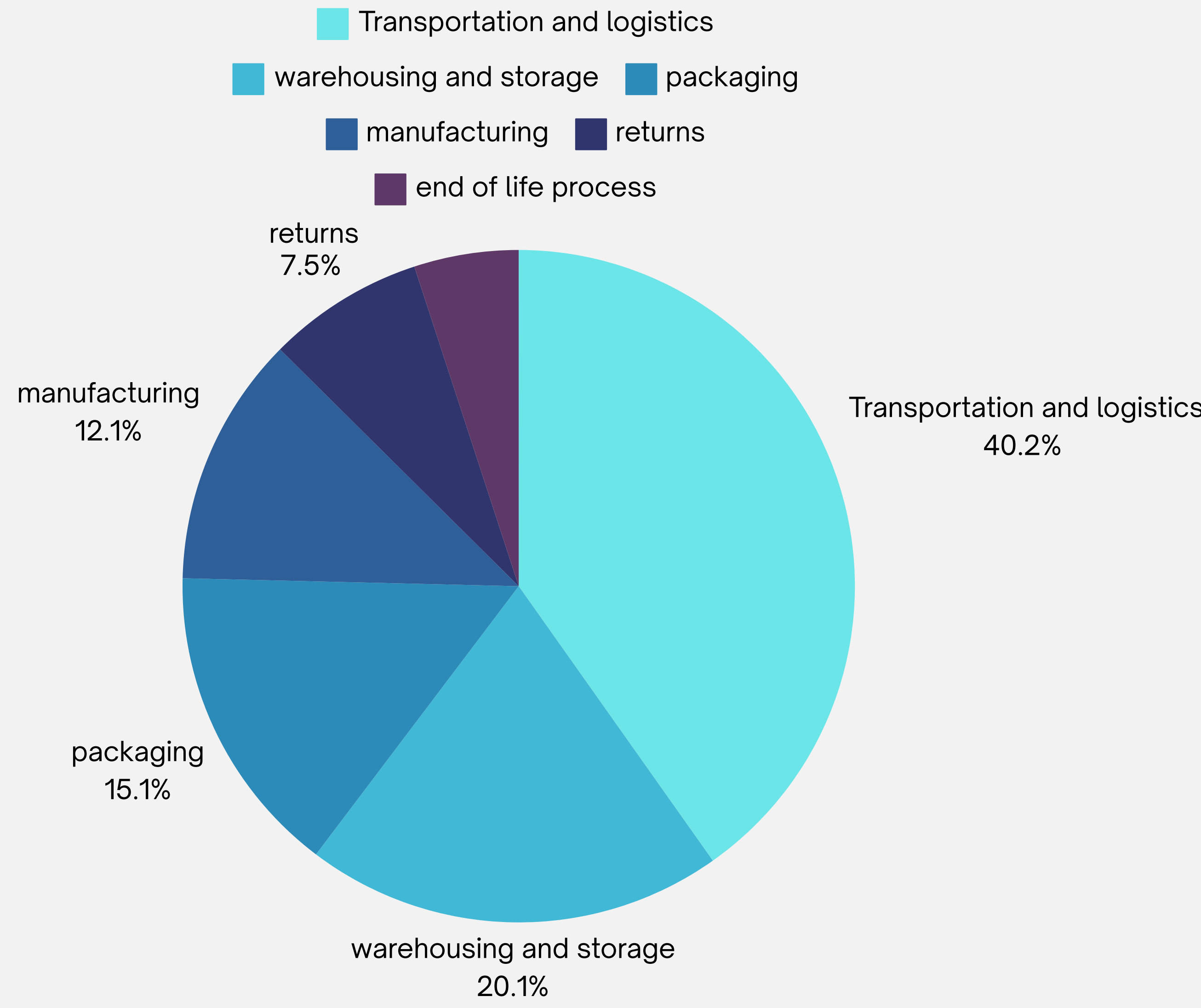
Energy Consumption: Factories often rely on non-renewable energy sources. Manufacturing processes such as electronics or plastic-based products are particularly energy-intensive.
Waste Generation: Waste material from manufacturing processes contributes to the carbon footprint if not managed sustainably.
Packaging Materials: Packaging plays a significant role in the e-commerce industry. Plastic and cardboard packaging have embedded emissions from production and disposal stages.
Primary Sources of Emissions: High energy use in production and packaging waste.
Mitigation Potential: Shifting to renewable energy in factories. Reducing packaging by using minimal, recyclable, or biodegradable materials. Implementing energy efficiency practices in manufacturing processes.

4.Delivering:

Warehousing: Products are stored in warehouses until ordered.
Order Processing and Fulfillment: Managing and fulfilling orders with packaging and labeling.
Shipping: Moving products from warehouses to distribution centers or directly to customers via trucks, planes, or ships.

Transportation: The most carbon-intensive phase, transportation by road, air, and sea accounts for a significant share of emissions. Last-mile delivery, especially, is highly inefficient due to individualized routes.
Packaging and Returns: Excess packaging material increases weight, which adds to emissions during transport. Return shipping adds another layer of transport emissions.
Primary Sources of Emissions: *Transportation, especially last-mile delivery.*
Mitigation Potential : Optimizing delivery routes and shifting to electric delivery vehicles. Reducing air transport and encouraging slower, more efficient modes of shipping.
Building fulfillment centers closer to key urban hubs to reduce the distance for last-mile delivery.
Returns Management: Handling customer returns, including inspection, refurbishing, or disposal.
Reverse Logistics: Managing the transport of returned products to the warehouse or disposal/recycling centers.
Product Disposal or Recycling: If products are damaged or unsuitable for resale, they are either disposed of or recycled.
Carbon Footprint Contribution:
Transportation: Returns involve transporting items back to the warehouse or another facility, doubling transport-related emissions.
Reprocessing: Refurbishing returned items for resale or recycling generates energy costs.
Waste Disposal: Non-recyclable products contribute to landfill waste, which emits methane, a potent greenhouse gas.
Primary Sources of Emissions: Additional transport and product disposal.
Mitigation Potential: Reducing the rate of returns by improving product descriptions and customer support. Encouraging product recycling and reuse over disposal. Developing efficient reverse logistics systems that reduce emissions through optimized routes and consolidated shipments.





Agriculture

Planning

- Deforestation
- pesticides and fertilizers planning

Sourcing

- Fertilizer production
- Water Pumping and Distribution

Manufacturing

- Methane from Livestock
- Energy Use in Irrigation and Harvesting

Delivery (Logistics and Fulfillment)

- Cold Chain Emissions
- Transportation

Returns and Reverse Logistics

- Returns Management
- Reverse Logistics
- Food Waste

Primary Sources of Emissions

- Land-Use Change and Deforestation
- Fertilizer and pesticide manufacturing
- Manure Management
- Cold storage and refrigerated transportation
- Recycling of Packaging Materials

Carbon Emission

1. **PLANNING:-**

Deforestation that is conversion of forests to farms and agricultural land :-
a) Deforestation contributes about 10-15% of global CO_2 emissions each year.
b)4-5 billion metric tons of CO_2 are emitted annually from deforestation and land-use changes.
c) Tropical deforestation is a major contributor, particularly in the Amazon, Southeast Asia, and Central Africa.
d) One hectare of deforestation can release 100 to 300 metric tons of CO_2, depending on the forest type.

Carbon emission due to **pesticides and fertilizers** *planning* :-
a) *Between 327 to 656 million tons of CO_2-equivalent (Mt CO_2-eq) from fertilizer application annually (based on current fertilizer usage and IPCC emission factors).*
b) *Field Application of Fertilizers: After application, fertilizers, particularly nitrogen-based ones, result in the release of nitrous oxide (N_2O), a greenhouse gas with 298 times the global warming potential of CO_2.*
c) *Emission Factor for N_2O: Approximately 1-2% of applied nitrogen fertilizer is emitted as N_2O. For example, applying 100 kg of nitrogen "fertilizer could release 1-2 kg of N_2O (equivalent to 298-596 kg of CO_2e).*
d) *Global Nitrous Oxide Emissions: N_2O emissions from soil account for around 1.3 billion metric tons of CO_2e annually, driven largely by fertilizer use.*
e) *Direct Emissions from Machinery Use: Estimated between 5.3 to 10.5 million tons of CO_2 per year due to the fuel consumed by equipment used in pesticide application.*

2. **Sourcing :**

- **Fertilizer production**, globally, contributes **around 500-630 million metric tons of CO_2** annually. Nitrogen fertilizers, especially those produced using the Haber-Bosch process, are responsible for the majority of these emissions.
- Pesticide Production Global Use: Around 4 million metric tons of pesticides are used globally each year. Based on emission factors, global pesticide production may emit approximately 40 to 100 million metric tons of CO_2e annually..

Water Pumping and Distribution: Sourcing water for irrigation may require energy, especially in regions that rely on electrically or diesel-powered irrigation systems.
- The total annual carbon emissions from irrigation water pumping (both electric and diesel systems) are estimated to be around 1.95 billion metric tons of CO_2.

3.Manufacturing :

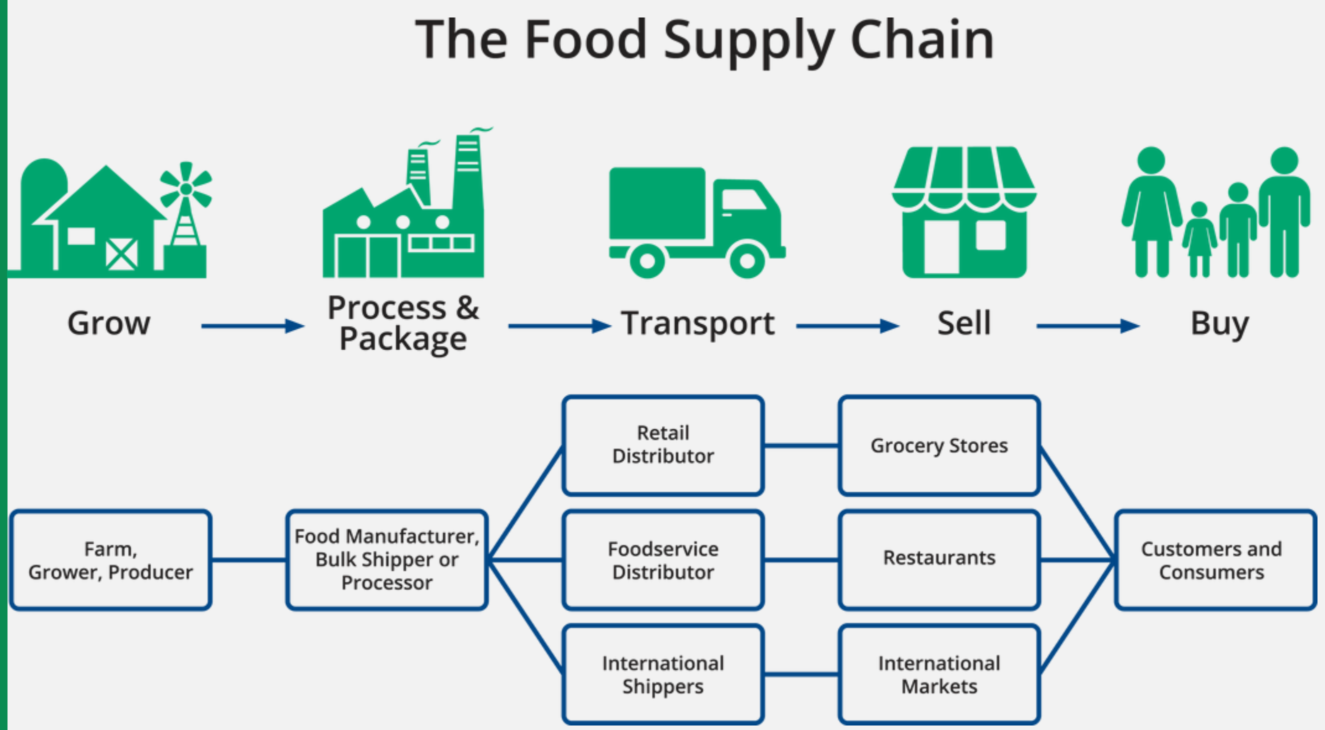
Methane from Livestock: Livestock farming (especially cattle) produces large amounts of methane during digestion and manure decomposition.CO_2e of Methane Emissions: Using an average GWP of 30, the 180-225 million metric tons of CH_4 emitted annually from livestock farming are equivalent to 5.4 to 6.75 billion metric tons of CO_2e annual.
Energy Use in Irrigation and Harvesting: Irrigation using electrically powered systems or diesel engines emits CO_2, especially in energy-inefficient setups. Mechanized harvesting also adds to emissions

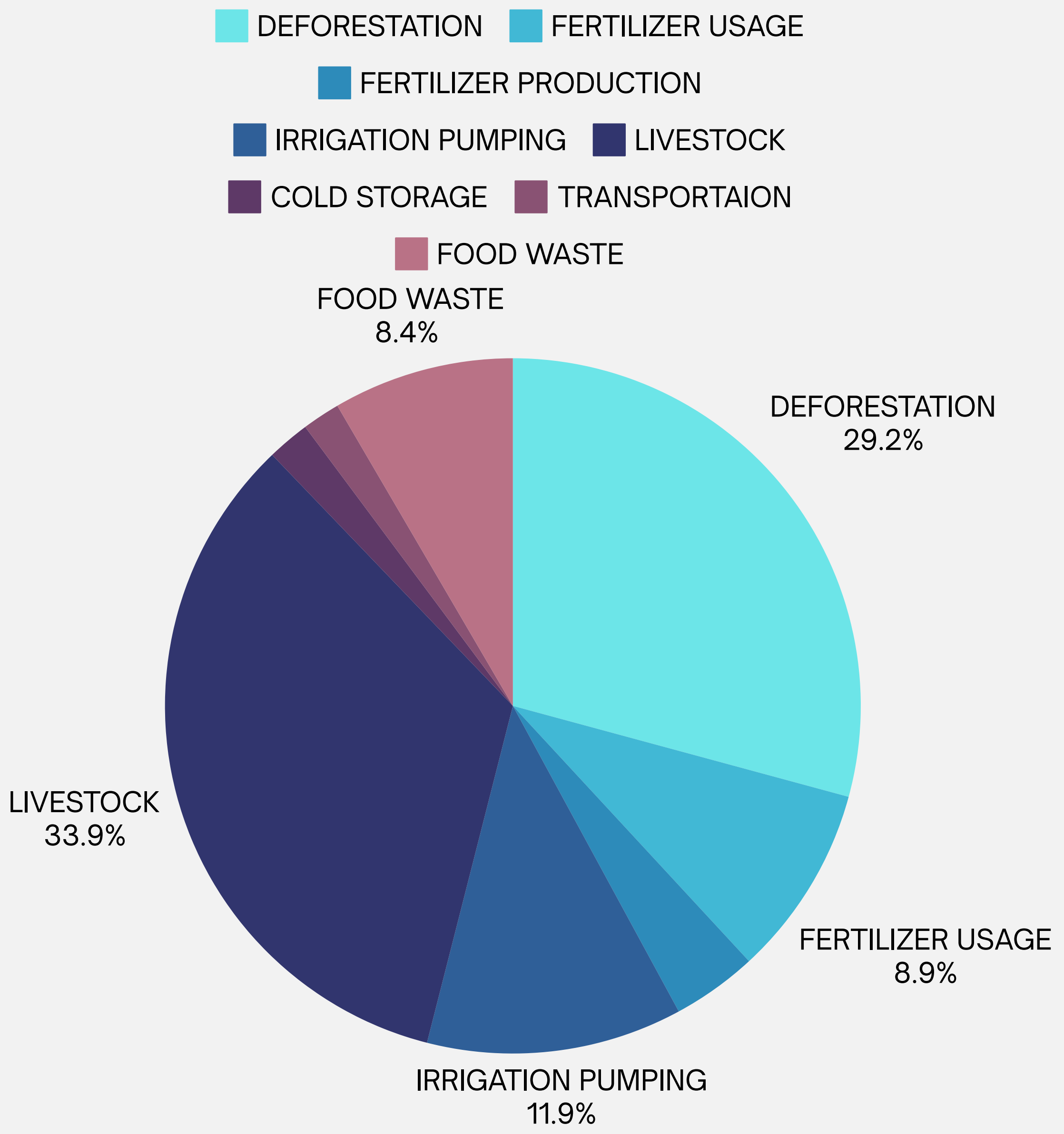
4.Delivering:

Cold Chain Emissions: Cold storage and refrigerated transport emit significant CO_2 if powered by fossil fuels.
- The global cold chain is estimated to emit around 260-280 million metric tons of CO_2 annually. This includes emissions from both cold storage and refrigerated transport.

Transportation: Long-distance shipping, especially air freight, greatly increases the carbon footprint of agricultural goods. Local food systems tend to have lower transport-related emissions.
Total Annual Carbon Emissions from Agricultural Goods Transportation:-
- Air Freight: Approximately 82.5 million metric tons of CO_2 annually.
- Road Transport: Approximately 120 million metric tons of CO_2 annually.
- Sea Freight: Approximately 112.5 million metric tons of CO_2 annually.
- Rail Transport: Approximately 7.5 million metric tons of CO_2 annually.

Food Waste: Spoilage during storage and transport can result in food waste. If wasted food decomposes anaerobically in landfills, it produces methane, a potent greenhouse gas.
Estimated Global Methane Emissions from Food Waste:
- Annual global food waste: 1.3 billion tons.
- If 30% of global food waste (around 400 million tons) ends up decomposing anaerobically in landfills:
- Methane emissions = 400 million tons × 0.09 tons CH_4/ton = 36 million tons of methane (CH_4).
- CO_2-equivalent emissions = 36 million tons of CH_4 × 28 = 1 billion metric tons of CO_2e annually.





Healthcare

Planning

- Hospital Operations
- R&D Labs
- Pharmacy Operations

Sourcing

- Raw Material Extraction
- Office Supplies
- Catering and Cleaning Staff

Manufacturing

- Pharmaceutical
- Medical devices

Delivery (Logistics and Fulfillment)

- Warehousing Cold chain
- Patient Travel

Returns and Reverse Logistics

- Medical Waste Management
- Medical Waste Recycling
- Biomedical Engineering Maintenance

Primary Sources of Emissions

- Production and procurement
- Energy Consumption
- Clinical Procedures
- Transportation
- Waste Mnaagement

Carbon Emission

1.Planning
Forecast demand for medical supplies and pharmaceuticals.
Plan inventory, resources, and capacity to meet patient needs.
Coordinate with manufacturers, suppliers, and healthcare providers.

1-2% of total healthcare emissions, mostly from digital tools, remote communication, and administrative functions.

2. Sourcing
Select approved suppliers for raw materials or finished products.
Ensure regulatory compliance for pharmaceuticals and medical devices.
Manage supplier relationships and contracts.

Sourcing contributes approximately 5-10% of the total emissions in the healthcare sector, translating to around 0.1 to 0.2 $GtCO_2e$ annually

3. Manufacturing
Produce pharmaceuticals, medical devices, and equipment.
Use specialized production processes (e.g., chemical synthesis, biotech).
Maintain strict quality control and adhere to regulatory standards.
E-commerce: Typically does not involve manufacturing, but exceptions include specialized items like 3D-printed medical devices.

50% or more of the healthcare sector's total carbon emissions, particularly from pharmaceutical production and medical device manufacturing.
Emissions stem from raw material extraction, chemical synthesis, and energy use in factories.

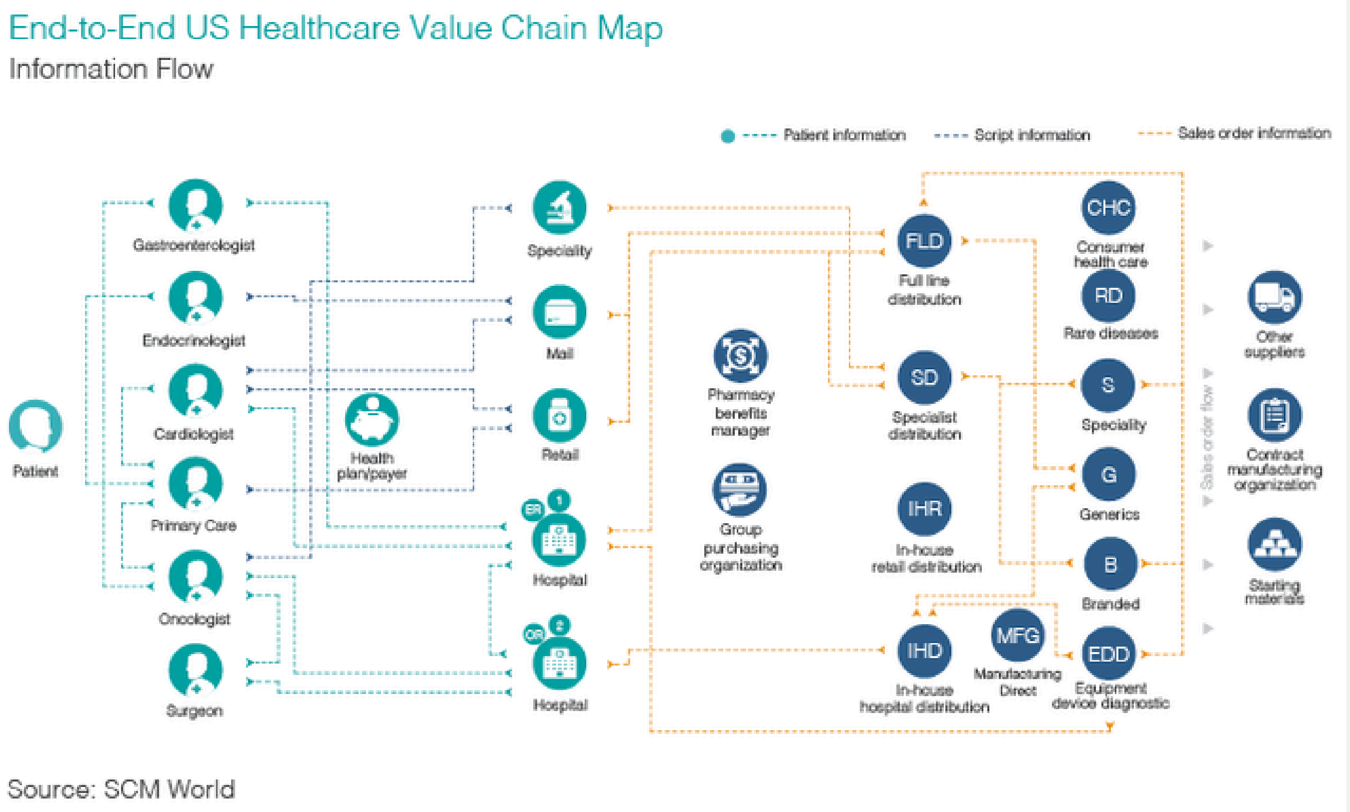
4. Delivery
Distribute products to hospitals, pharmacies, clinics, and patients.
Ensure cold chain logistics for sensitive items like vaccines.
Use third-party logistics (3PLs) for efficient distribution.

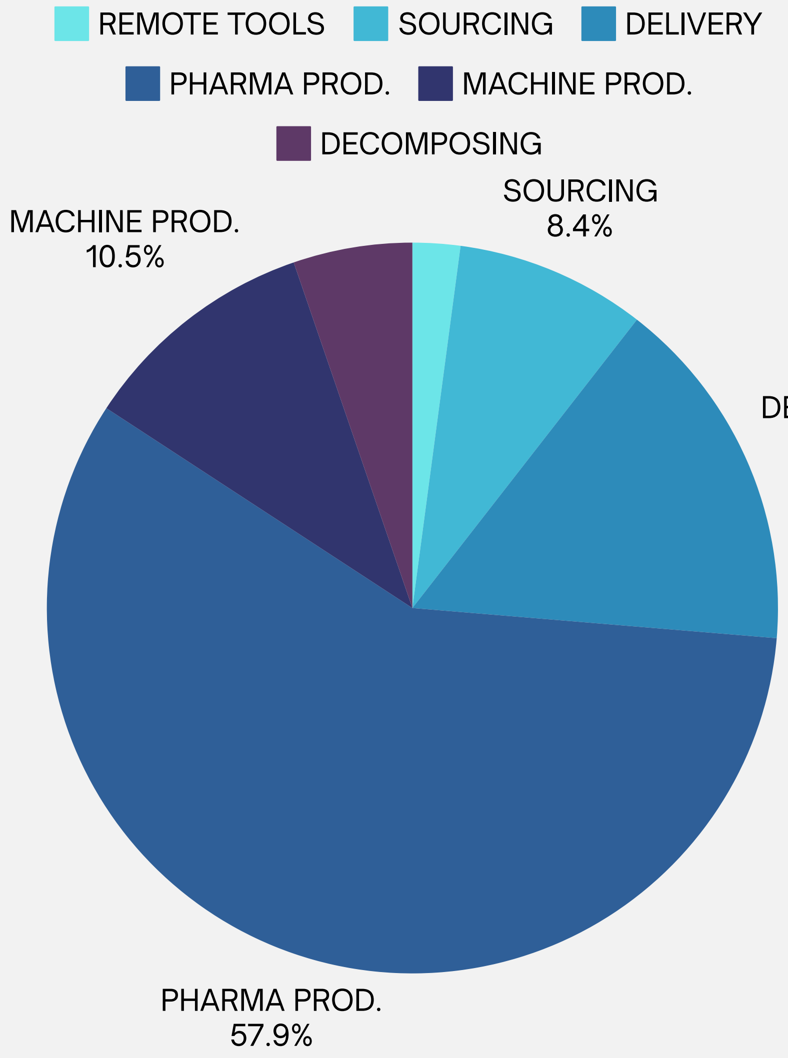
Around 15-20% of total emissions in healthcare come from logistics. Efficient distribution and third-party logistics help, but transportation remains a major source of emissions.

5. Return Logistics (Reverse Logistics)
Handle returns of defective, expired, or recalled products.
Follow regulatory guidelines for disposing of medical waste or hazardous materials.
Manage product recalls and returns efficiently.

A smaller but important source of emissions, accounting for around 5% of total emissions. Handling hazardous materials and medical waste adds complexity and carbon footprint, especially in disposal processes.

The global healthcare sector emits approximately 2 gigatons of CO_2 equivalent ($GtCO_2e$) annually. This accounts for about 4-5% of global greenhouse gas emissions.





Why E-Commerce ?

About carbon emission

The global e-commerce industry is estimated to generate approximately 1.4 billion metric tons of carbon dioxide equivalent (CO2e) emissions annually, which represents about 3-4% of total global greenhouse gas emissions. Currently it is not the highest among another industries but the growth rate of this is industry is so high that will indeed effect the future carbon emission projections also therefore we think that this industry require higher amount of attention .

GROWTH RATE

HEALTHCARE- 9.07%
E-COMMERCE-18.90%
AGRICULTURE-3.85%

Branding

For decreasing the carbon emission there will be cost required for example we have solutions like green delivery , green packaging, etc. so for another two industries green solutions would be less appealing and customers wont give any extra for this while in E-commerce first of all most of the consumer market is middle or higher class so it wont be problematic aur conversion rate will not be effected if we charge some extra amount on the name of sustainability so our model will be profitable also .

Less available solutions

Another reason to choose this industry is the significant gap in solutions available compared to other sectors, however we believe that there are solutions which will not only reduce the carbon footprint but also have the potential to generate profit hence companies can implement these solutions in real life scenarios without significant concerns regarding costs

PLANNING

This section focuses on activities related to forecasting, demand planning, IT infrastructure, and energy use in connection with operational strategies. The table outlines different stages in planning and their corresponding carbon footprints.

Demand Forecasting & Planning:
This stage involves the use of data analytics to predict customer demand and manage inventory. The estimated carbon footprint associated with this activity ranges from **1 to 2 kg of CO_2 equivalent per forecast**.

IT Infrastructure (Cloud & Data Centers):
This encompasses cloud-based services, data management, and transaction processing. The estimated carbon footprint for IT infrastructure is between **0.5 and 1.5 kg CO_2** equivalent per transaction.

Digital Marketing & Advertising:
Activities such as online promotions, targeted ads, and product photography fall under this category. The estimated carbon footprint ranges from **0.5 to 1 kg CO_2 equivalent per marketing campaig**n.

Warehouse & Logistics Planning:
This involves optimizing routes and inventory to reduce energy consumption and emissions. The carbon footprint for this process is estimated between **0.5 and 1 kg CO_2 equivalent per optimized plan**.
Warehouse Site Selection:

This stage focuses on selecting warehouse locations based on their proximity to demand centers. Although no direct carbon figure is provided, the main impact is on transportation emissions.

SOURCING

The section on sourcing focuses on activities related to raw material extraction, packaging materials, procurement of goods, and initial transport to manufacturing or warehouses. The carbon footprint varies depending on the material and process involved. Below are the key stages and their estimated carbon footprints:

Raw Material Extraction:
This includes the extraction of plastics, metals, and textiles for both products and packaging. The carbon footprint for plastic extraction ranges from 2 to 5 kg of CO_2 equivalent, while metal extraction is significantly higher, ranging from 10 to 30 kg of CO_2 equivalent.
Packaging Material Production:
The production of packaging materials like cardboard, plastic, bubble wrap, and tapes generates emissions as well. The carbon footprint for plastic packaging is between 1 and 5 kg CO_2 equivalent per kilogram, and for cardboard, it's between 0.5 and 1 kg CO_2 equivalent per kilogram.
Supplier Procurement:
This stage involves the selection and transportation of raw materials and goods from suppliers. The carbon footprint for transportation varies by mode, ranging from 0.4 to 1.5 kg CO_2 equivalent per ton-kilometer.
Procurement of Electronics & Goods:
This covers the purchase of electronics, apparel, and consumer goods. The carbon footprint varies depending on the complexity of the product, ranging from 2 to 20 kg CO_2 equivalent per unit.
Cold Chain Storage (Sourcing Stage):
Cold chain storage refers to the refrigeration of perishable raw materials such as food and pharmaceuticals. The emissions associated with this process are 25 to 40% higher than those of standard logistics due to the energy required for refrigeration.

DELIVERY

carbon footprint associated with various stages of the delivery process, which includes transportation, warehousing, and waste disposal. Below is a descriptive breakdown of each stage:

Transportation to Warehouses:
This involves shipping products from manufacturers to distribution centers. The carbon emissions range between **0.5 to 2 kilograms of CO2 equivalent (kg CO2e)** per ton-kilometer, depending on the transportation method.
Order Fulfillment & Sorting:
At the distribution centers, products are picked, packed, and sorted for delivery. This process has an estimated carbon **footprint of 0.7 to 2 kg CO2e per order**.
Last-Mile Delivery (To Customer):
This refers to the final stage of delivering goods to customers, typically by trucks, vans, or electric vehicles. For diesel-powered vehicles, the carbon footprint is estimated at **0.25 to 0.4 kg CO2e per kilometer**. In contrast, electric vehicles significantly reduce this footprint, emitting only **0.05 kg CO2e per kilometer**.
Packaging Disposal (Customer):
After receiving the products, customers generate waste from packaging materials. Plastic packaging waste results in 3 to 5 kg CO2e per kilogram, while **cardboard generates 1 to 2 kg CO2e per kilogram**.

Retail Packaging Waste:
This refers to the customer's disposal of product packaging from home deliveries. The carbon emissions for this disposal are estimated to be **0.5 to 1 kg CO2e per delivery**.

Delivery Route Optimization:
By implementing AI or machine learning (ML) systems to optimize delivery routes, companies can reduce their emissions by **10% to 15% on average,** improving efficiency and lowering their carbon footprint.

This detailed description provides an understanding of the environmental impact at each stage of the delivery process, highlighting opportunities for carbon emission reduction through efficient practices like route optimization and electric vehicle usage.

RETURN LOGISTICS

Return process in the logistics sector and provides an estimate of the carbon footprint associated with each stage. Here's a detailed breakdown:

Returns & Reverse Logistics:
This involves the handling of product returns, including restocking or recycling activities.
The estimated carbon footprint for this stage is about 25-30% of the original delivery emissions.
Return Packaging Waste Management:
This includes the disposal and recycling of packaging from returned goods.
The carbon footprint for this process is estimated to be **2-4 kg of CO_2 equivalent per return**.
Returns Processing (Restocking):
This stage refers to refurbishing, restocking, or disposing of returned products.
The carbon footprint for these activities is **estimated at 0.5-1.5 kg of CO_2 equivalent per item**.
Reverse Transport to Warehouse:
This stage involves the transport of returned goods back to fulfillment centers.
The estimated emissions range from **0.4-1.5 kg of CO_2** equivalent per ton-kilometer.
Waste Disposal (Returned Unsellable Goods):
This covers the disposal of unsellable or defective products. The waste is either sent to a landfill or recycled.
The carbon footprint for landfill disposal is **4-7 kg of CO_2 equivalent per kg**, while recycling produces 2-3 kg of CO_2 equivalent per kg.
Return Quality Control:
This involves energy usage for inspecting and processing returned products.
The estimated carbon emissions for this stage range from **0.5-1 kg of CO_2 equivalent per product**.
These stages highlight the environmental impact involved in the return and reverse logistics process, focusing on emissions from transportation, disposal, and energy consumption related to returned items.

SOLUTIONS AND PROFITABILITY

Solutions were mainly required for packaging and delivery services in this industry so we focused on providing solutions about them.

ADAPTATION TO START/STOP AND ECO

The analysis compares the performance of three types of delivery vehicles —diesel, CNG (Compressed Natural Gas), and electric (E)—for parcel delivery operations in a large urban area. Key assumptions include a 10-hour maximum working day for drivers, with 1 hour for loading and debriefing, and a maximum distance of 18 km between the depot and destinations.

1. **Diesel Vans (No Start-Stop Technology)**: Used as the reference scenario. Fuel consumption and CO_2 emissions are highest in this case. Start-stop technology (optional for diesel) can significantly reduce emissions during idle times but has little impact on overall costs.

2. **CNG Vehicles**: These reduce CO_2 emissions further compared to diesel and bring NOx emissions near zero, making them environmentally favorable. Costs remain stable compared to diesel.

3. **Electric Vehicles (E-double)**: Electric vehicles with quick-charging capability allow for two delivery routes per day. While costs slightly decrease, using E-double vehicles requires 25% more vehicles, making them less practical.
   Electric Vehicles (Single-Route): These vehicles prove both ecologically and economically beneficial. They match the delivery capacity of diesel vans while offering significant reductions in CO_2 emissions and operational costs.

Table 3 Vehicle properties for the ECO-vehicle experiments

	Diesel	Diesel S/S	CNG S/S	E-single	E-double
Speed	30 km/h	30 km/h	30 km/h	30 km/h	30 km/h
Range[a]	300 km	300 km	300 km	140 km	112 km
Max route time	9 h	9 h	9 h	9 h	4 h
Routes per day	1	1	1	1	2
Start/Stop	No	Yes	Yes	Yes	Yes
CO_2 emission[b]	3140 g/l	3140 g/l	2532 g/kg	278 g/kWh	278 g/kWh

[a]Ranges for the Diesel, Diesel S/S, and CNG vehicles are adjusted to reflect the limits imposed by vehicle speed and maximum route time

[b]Electric vehicles do not produce emissions while driving, but the reported emissions are those corresponding to the production of the required electricity, assuming that the average values reported by the EU (European Commission 2011)

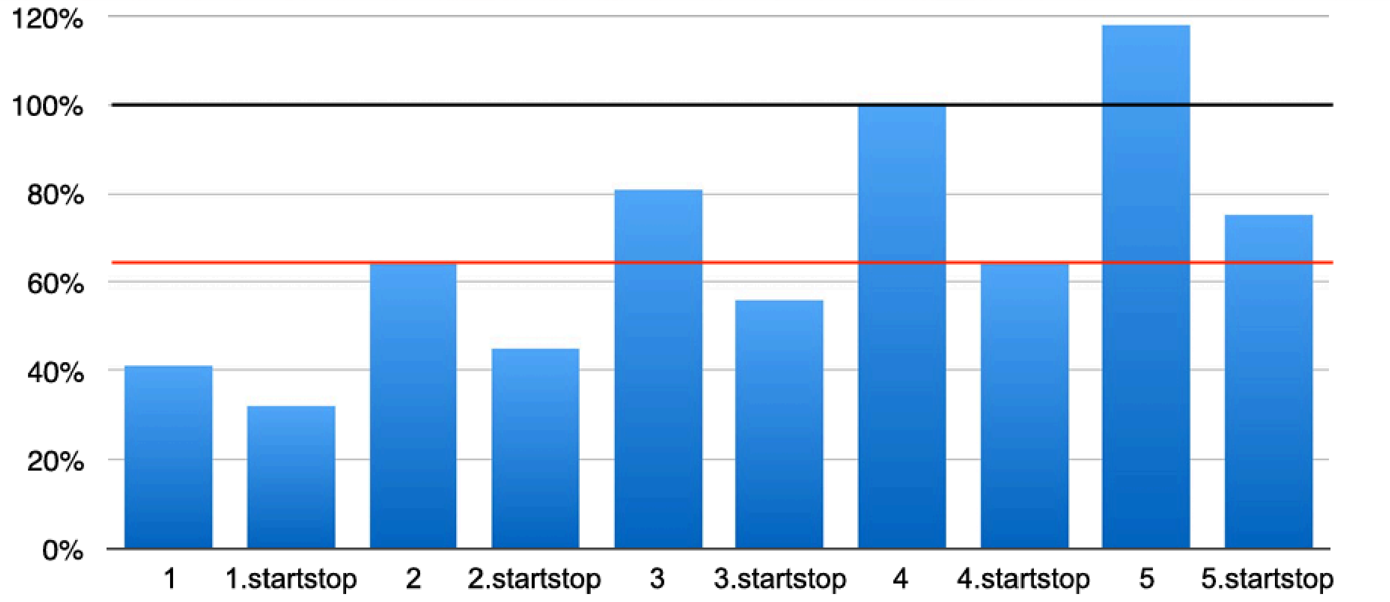


Fig. 12 Influence of service times [horizontal (min)] and start–stop technology (start–stop) on emissions (vertical). The reference scenario considers 4 min service time for standard vehicles without start–stop technology

Key Findings:

Start-stop technology reduces emissions but doesn't significantly affect other KPIs.
CNG vehicles are an eco-friendly alternative, reducing both CO_2 and NOx emissions.
Electric vehicles are the most ecologically sound option, with single-route electric vehicles also being economically viable for urban settings. However, E-double vehicles are less practical due to the need for more vehicles to cover deliveries.
Switching to electric vehicles offers the greatest long-term advantages in urban parcel delivery.

Results for ECO vehicles

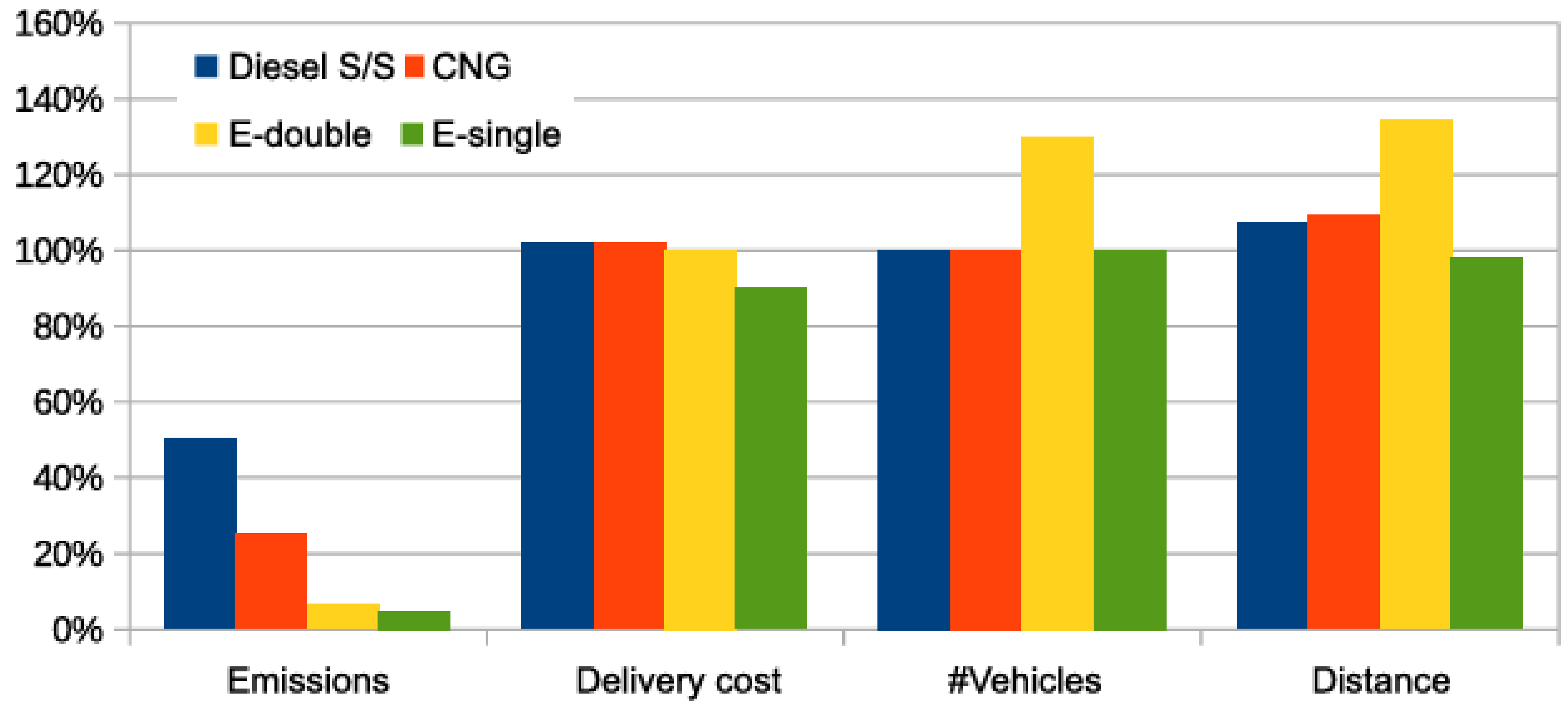


Fig. 7 Percentual gain (vertical) of employing ECO vehicles on the different KPIs (horizontal)

Quantifiable Cost Reductions:

Although specific numerical figures are not provided in the excerpt, the use of ECO vehicles can lead to a notable reduction in delivery costs:
For instance, companies can save up to 15-25% on fuel costs annually by switching to electric vehicles, depending on fuel prices and usage patterns.
Further, costs related to emissions (like potential carbon taxes or penalties for exceeding emissions thresholds) would also decrease as emissions from ECO vehicles are significantly lower.

Overall, the implementation of ECO vehicles in delivery operations leads to substantial carbon emission reductions, often estimated at up to 80% compared to traditional diesel vehicles, alongside significant cost savings on fuel and maintenance. The combined environmental and economic benefits make ECO vehicles a compelling choice for sustainable delivery solutions.

GREEN DELIVERY: During checkout we can provide the customer an option whether he wants the delivery to be eco friendly we will charge 3 to 5 more rupees per order for eco friendly delivery out of which we will provide some margin to the delivery person who is using a green vehicle which will motivate more delivery drivers to shift to EV's. For better results we will keep the green delivery option already checked so that there would not be an issue of low conversion rates

COLLECTION CENTRES

Most online stores default to home delivery, despite it being costly for both carriers and stores, especially when delivery fees are waived for large orders. Home deliveries often result in high failure rates because many customers are not home during the day, requiring multiple delivery attempts. This increases costs for carriers and causes inconvenience for customers due to delayed deliveries.

Offering financial incentives for customers to choose delivery to a collection point could solve these issues. Customers would benefit from picking up their items at their convenience, while stores and carriers would reduce costs and avoid the risks of failed deliveries. Despite these advantages, stores are reluctant to offer alternative delivery options, as adding more steps to the checkout process can reduce the conversion rate (the percentage of item views leading to sales).

Cost and Risk

Implementing collection centers for eCommerce can have intial costs , including setup and staffing. However, companies can save 15-25% on last-mile delivery costs by consolidating deliveries. Over time reduction in fuel consumption, can make the initiative profitable within 2-3 years. Additionally, collection centers can enhance customer satisfaction, boosting repeat purchases.

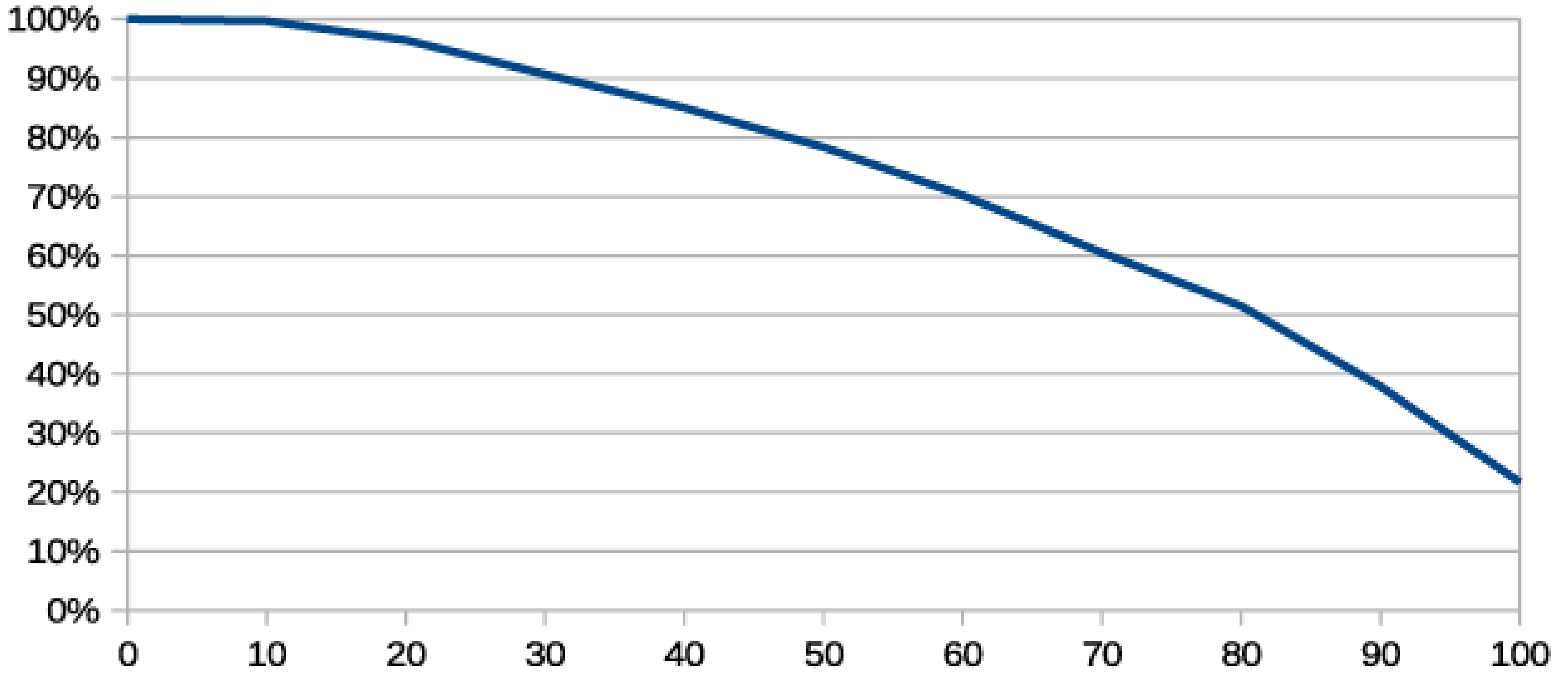
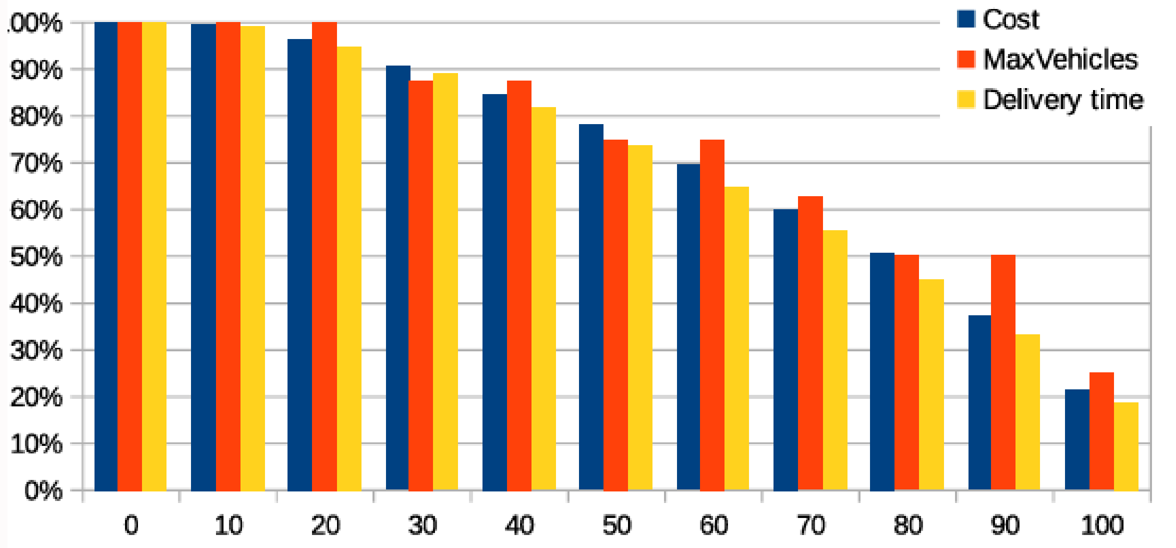


Fig. 8 Influence of the percentage of parcels delivered at collection points (horizontal) on emissions (vertical)



ig. 9 Influence of the percentage of parcels delivered at collection points (horizontal) on three KPIs ertical)

able 4 Vehicle properties for e default diesel van

	City	Rural
Speed (diesel van)	30 km/h	50 km/h
Range	300 km	500 km
Max route time	10 h	
CO_2 emission	3140 g/l	
Stop duration	4 min	
MultiStop duration	0.4 min per parcel	

The vehicle's range is adjusted to reflect the speed limits and maximum route duration

How Genetic Algorithm Reduces Carbon Emissions

1.

Efficient Route Optimization:GA helps find the most optimized routes for delivery vehicles by evaluating thousands of route combinations and selecting the shortest or most fuel-efficient ones.By minimizing the total distance traveled, carbon emissions are reduced because vehicles use less fuel (or energy in the case of electric vehicles).On average, using GA can lead to a 15-25% reduction in distance traveled, leading to a proportional decrease in emissions.

2.

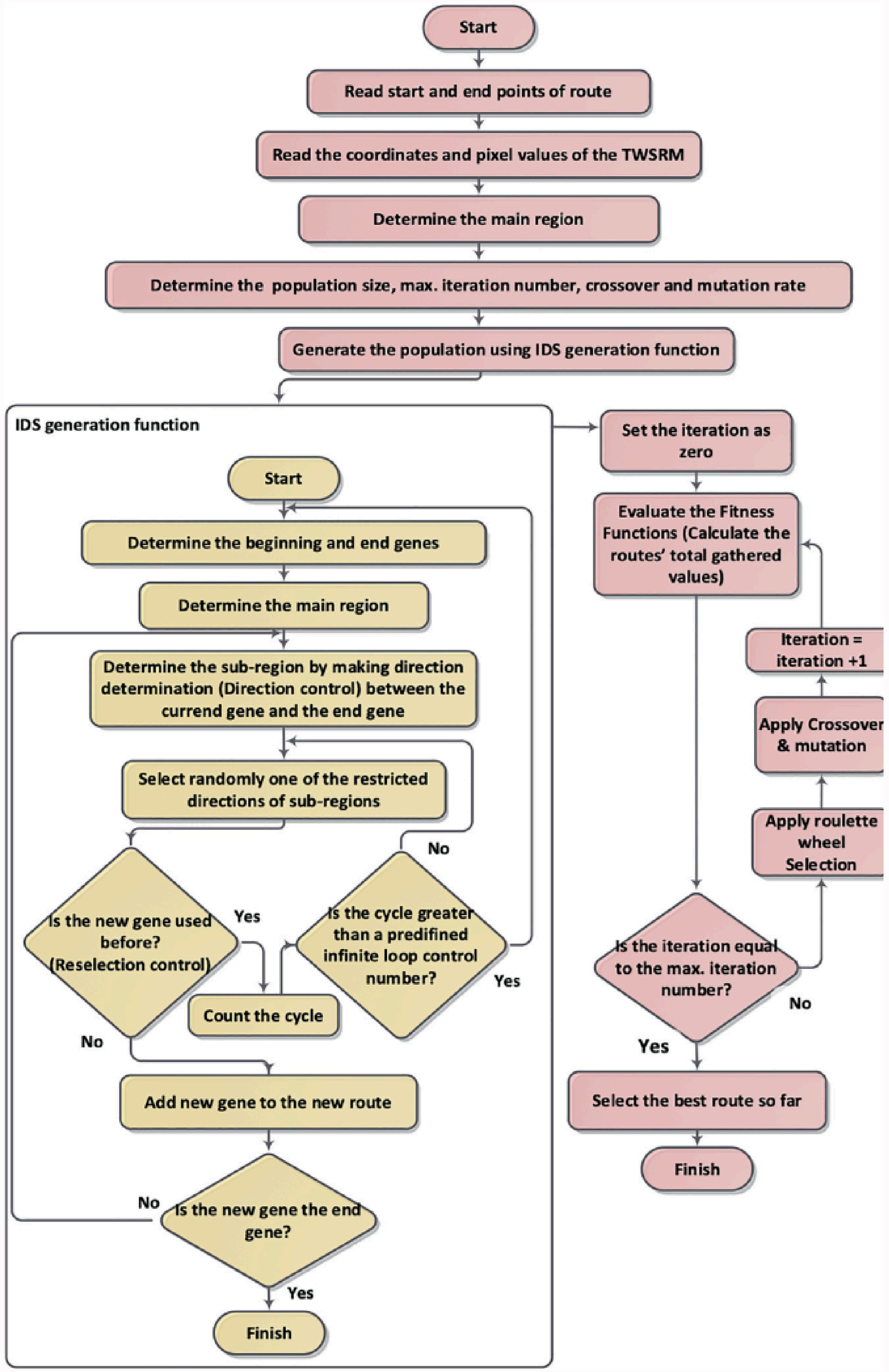
Better Vehicle Allocation: The algorithm considers the best combination of vehicle types (diesel, electric, CNG) based on delivery distance and parcel size.Electric vehicles, which produce zero tailpipe emissions, are prioritized for shorter, urban deliveries, leading to a 50-70% reduction in emissions for city routes where EVs can be deployed.

3.

Reduction in Number of Routes:GA helps reduce the total number of routes needed by consolidating deliveries more efficiently. Fewer routes mean fewer vehicles on the road, directly decreasing emissions.
Emission reductions can reach 10-15% simply by optimizing the number of vehicles and routes used.

RISK

Optimizing delivery routes and using electric vehicles can help reduce emissions, but high initial costs for infrastructure and electric vehicle fleets may deter adoption. Additionally, reliance on air transport remains a substantial source of emissions.



Benefits of Genetic Algorithm

Cost Impact

Impact on Costs (in Numbers and Percentages):Lower Fuel Costs:Reducing the total distance traveled by 15-25% results in a proportional decrease in fuel consumption.
For diesel vehicles, this translates to significant savings, as fuel is one of the largest cost components.
Cost savings from fuel can be 10-20% across the fleet.
Efficient Use of Electric Vehicles (EVs):
EVs, despite having higher upfront costs, are cheaper to run due to lower energy costs compared to diesel. GA optimizes routes to maximize the use of EVs where possible.
The cost per kilometer for electric vehicles is about 30-40% lower than diesel, contributing to overall cost reductions, especially in urban deliveries.

Climate Impact

Reduction in Vehicle Maintenance Costs: Fewer vehicles used, thanks to route optimization, reduces overall fleet wear and tear.
Maintenance costs can drop by 10-15%, particularly for electric vehicles, which have fewer moving parts and require less servicing.
Total Estimated Impact: Carbon Emission Reduction: 20-30% decrease across the delivery network.
Cost Reduction: Overall delivery costs reduced by 15-25%, mainly through fuel savings, optimized vehicle usage, and fewer required routes.
By utilizing GA, the e-commerce delivery network becomes not only more environmentally friendly but also more cost-efficient. This algorithm-driven approach makes it feasible to meet sustainability goals without incurring significant additional expenses .

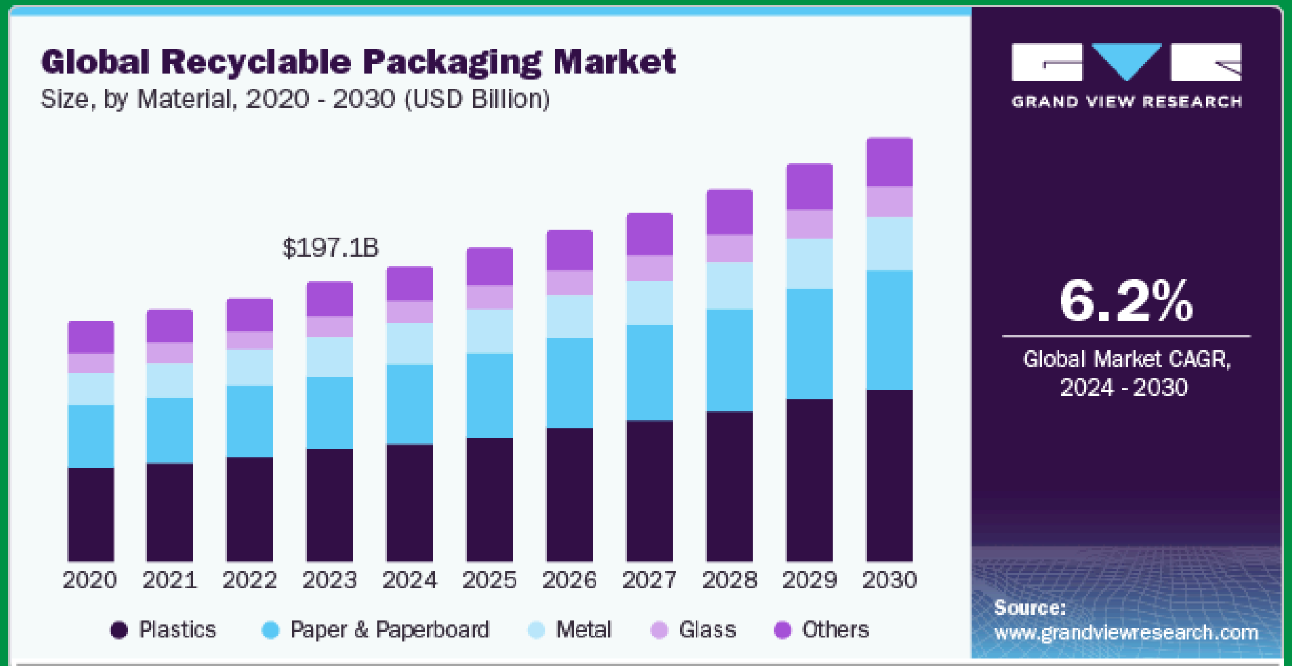
Packaging

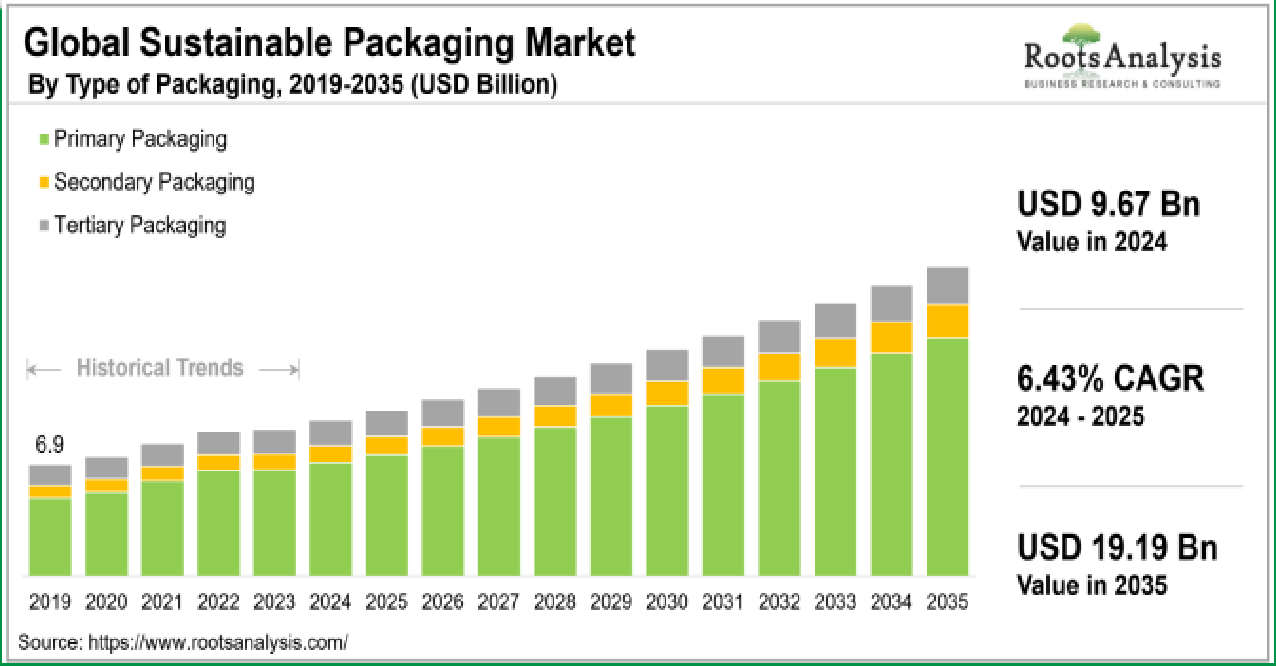
- Using single-layer packaging that's ready to ship without requiring additional layers.
  Using eco-friendly materials like biodegradable plastics or cornstarch-based packaging
  Single-step cardboard packaging can be used to prevent product movement within the box, reducing damage risks during transit.

- Switching to 100% recycled packaging can reduce carbon emissions by up to 60%.Industry-wide adoption could reduce emissions by 150-300 million tons of CO2 yearly—equivalent to taking 30-60 million cars off the road. Sustainable packaging can reduce greenhouse gas emissions by up to 25%

- **Recommendations**
  While fully eliminating plastic may not be practical, reducing single-use plastics and incorporating more sustainable alternatives is a crucial strategy.
- **Risks**
  Corrugated cardboard packaging is strong, customizable, and made from recycled materials. It also offers excellent protection and can be tailored to fit various product sizes reducing layer is inversely proportional to safety

Global Trends and Adoption





Cost

Switching to biodegradable packaging can increase packaging costs by 10-30%, . However, long-term savings come from reduced waste disposal fees, With growing consumer demand for sustainable products, companies could see boost in customer loyalty and repeat purchases, helping to offset the initial cost increase and driving long-term profitability

A report by Ellen MacArthur Foundation highlights that companies adopting circular packaging systems (recycling, reuse) often see 5-10% lower material costs across their supply chain.
Recycled materials are typically 30-40% cheaper than virgin materials, reducing procurement costs.

OTHER SOLUTIONS

CIRCULAR ECONOMY

Adoption of circular economy practices in e-commerce is expected to result in a 30% reduction in carbon emissions across the sector. This will be driven by increased use of recycled materials, localized production, and innovative business models such as product-as-a-service (PaaS).

HYPERLOCALISATION

Solution: Shift towards hyper-local sourcing for products, especially perishables. Partner with small, local producers for goods sold within specific regions, cutting down the need for long-distance shipping and allowing for same-day delivery via low-emission methods like electric bikes.

Impact: Reduces long-distance transportation emissions and supports local economies. Shorter shipping routes mean a smaller carbon footprint for each product sold.

Profit Angle: Higher customer satisfaction due to faster deliveries, fresher products, and the feel-good factor of supporting local businesses. It also cuts long-haul transportation costs.

Gamification of E-commerce sites and applications

Solution: Use gamification to encourage customers to reduce their carbon footprint. Create a rewards system where customers earn "eco-points" for purchasing carbon-neutral or eco-friendly products, selecting green delivery options, or participating in recycling programs. These points can be redeemed for discounts or exclusive sustainable products.

Impact: This increases customer engagement and encourages sustainable behavior, indirectly lowering the platform's overall carbon footprint.

Profit Angle: Gamification drives repeat purchases, increases user interaction with the platform, and offers an emotional reward for eco-friendly shopping. Exclusive rewards can also be offered as a premium option

Risk- however gamification of e commerce sites and applications won’t include any significant additonal costs. One potential risk could be continous ubgradation to get engagement from customers.