BLUE YONDER'S
SUSTAINABLE SUPPLY CHAIN

Closer step towards Carbon Neutrality

TEAM 14

EXECUTIVE SUMMARY

Carbon Emissions in CPG Supply Chain (SCOR)
- Carbon Footprint Distribution

Packaging
- Analysis of Current Packaging Problems
- E-Commerce Survey
- Solution 1: Oriented Strand Board (Reusable Packaging)
    - About
    - Implementation Strategy
    - Impact
    - Guesstimate Financials
- Solution 2: Carton Optimization (Oversized Packaging)
    - About
    - Solution Model
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    - Impact
    - Financials
- Solution 3: T-LOC System (Innovative Packing Mechanism)
    - About
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Transportation
- Analysis of Current Transportation Problems
- Solution 1: Relay as a Service (RaaS)
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    - Why CCUS over EV?
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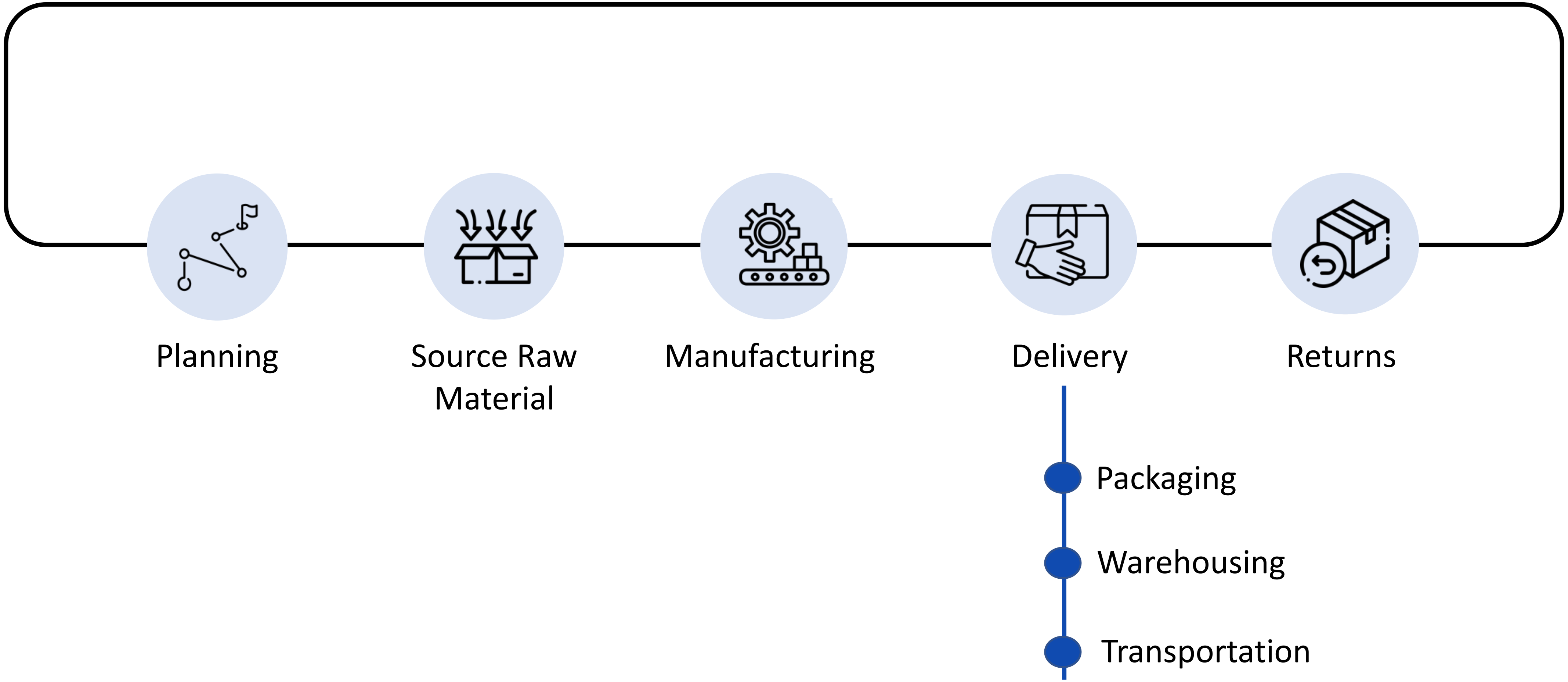
Returns
- About
- Reasons
- Financials
- Impact

Supply Chain Operations Reference (SCOR)

Modern and widely studied **Supply Chain Operations Reference (SCOR)** model used for analysis



Supply Chain holds 80% out of 33 gigatons of Greenhouse emissions from Consumer packed goods

CPG emissions

Consumer-packaged goods (CPG) companies are responsible for roughly **33 gigatons of CO_2.**

Supply chain emissions

More than 90% damage caused to environment by CPG comes from Supply Chain, including **80% of GHG emissions**

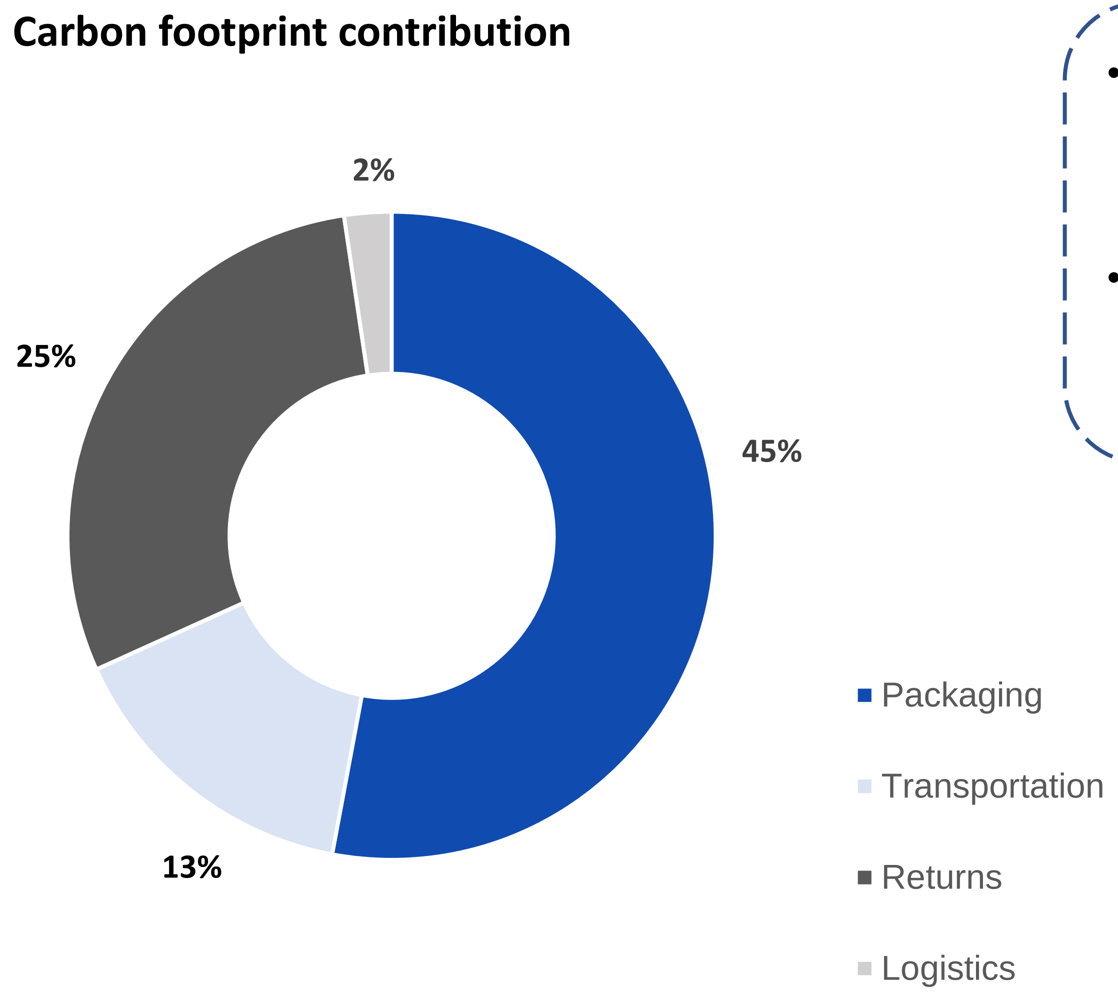
Reduction Required

A massive reduction of **one metric ton of CO_2** per $1000 revenue of CPG resource intensity is required

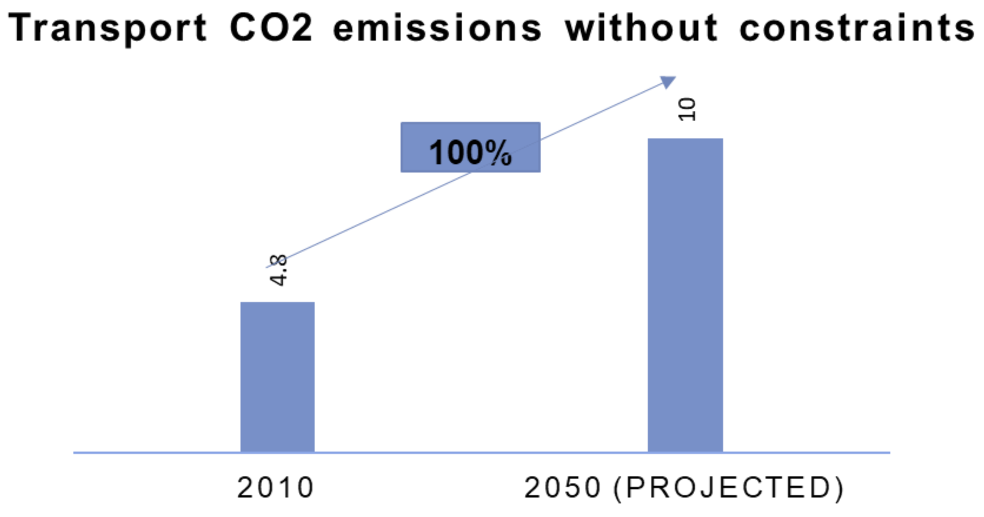
Environmental Goals

To achieve the 2050 targets, CPG companies must **reduce emissions by 92%** relative to their revenues.

Increased packaging and last-mile distribution led to significant rise in carbon footprint of the e-commerce industry



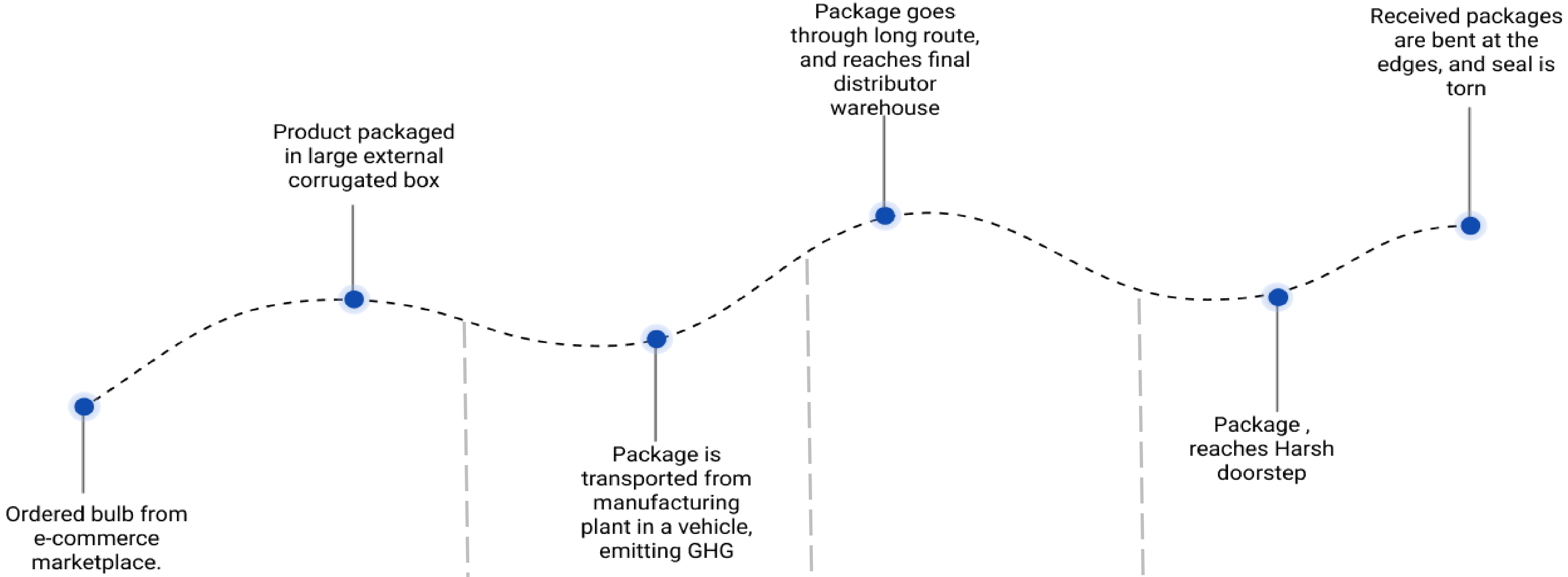
- In recent times, Carbon footprint from supply chain has gone up significantly due to increased packaging, faster last-mile distribution
- For **current scope** of our PS, we focus on later stages of delivery and return, specifically **packaging** and **transportation.**



Behind the scenes of the e-commerce supply chain :

Harsh Shah
25 years
lives in Agra

“I ordered a bulb through online”



Observations:

- External packaging of the product could have been smaller
- The Emissions produced by vehicle could be reduced
- Vehicle could take an easier route reducing carbon emission
- Lack of durability of packaging and improper handling raised suspicion in the consumer's mind

PACKAGING PROBLEMS

Packaging | Transportation | Returns

With oversized packaging and unsustainable material, packaging accounts for 45% emissions

Current Situation

45% — Packaging level emissions constitute 45% of the total e-commerce emissions

56.8 — Indian e-commerce industry produced 56.8 million kilograms of packaging plastic waste in 2020

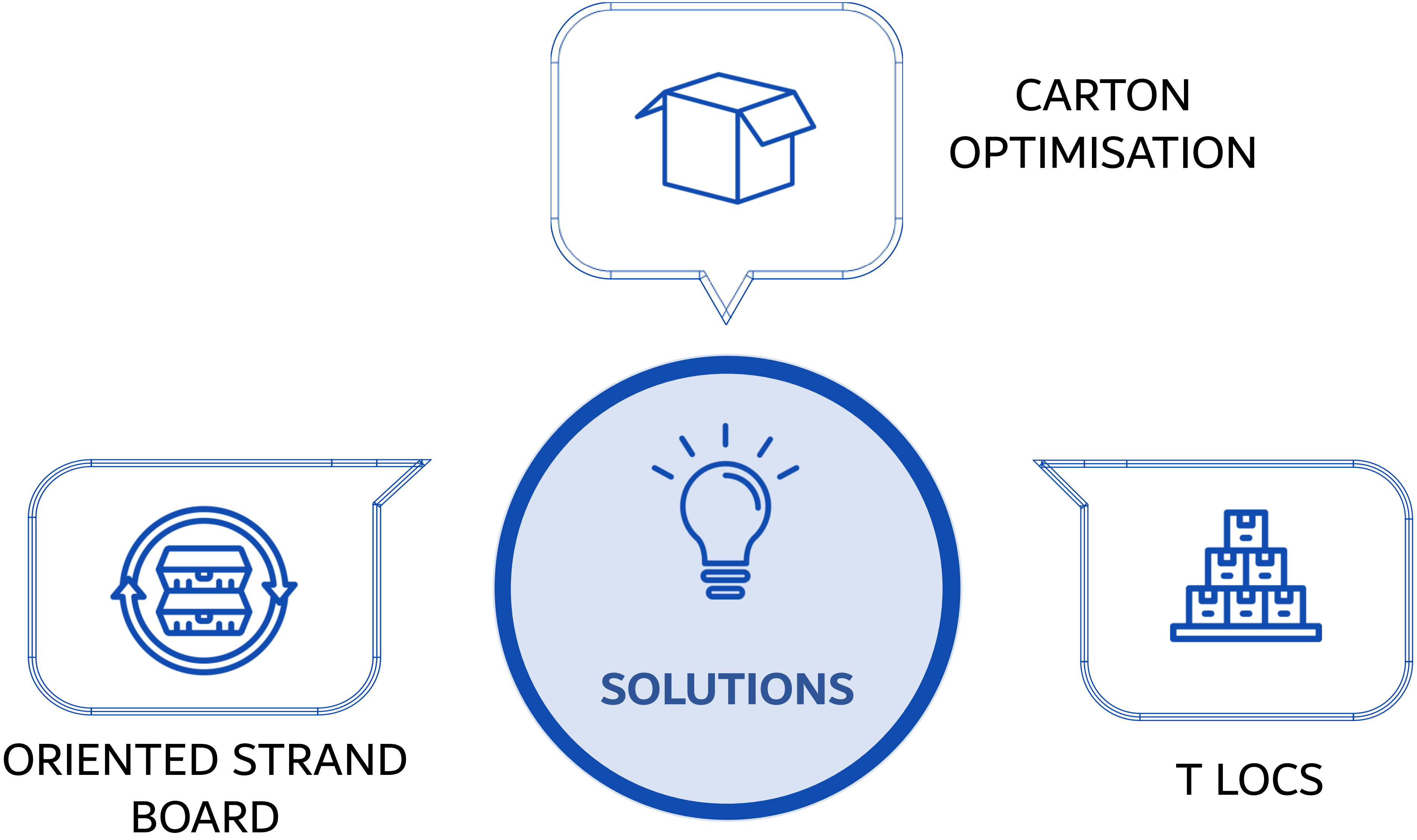
700 — Cardboard produced from 700 M trees, equivalent to **329.4 M metric tons**, goes waste every year.

25% — Only **25-30%** of the corrugated cardboard boxes in the e-commerce industry are **recycled**.

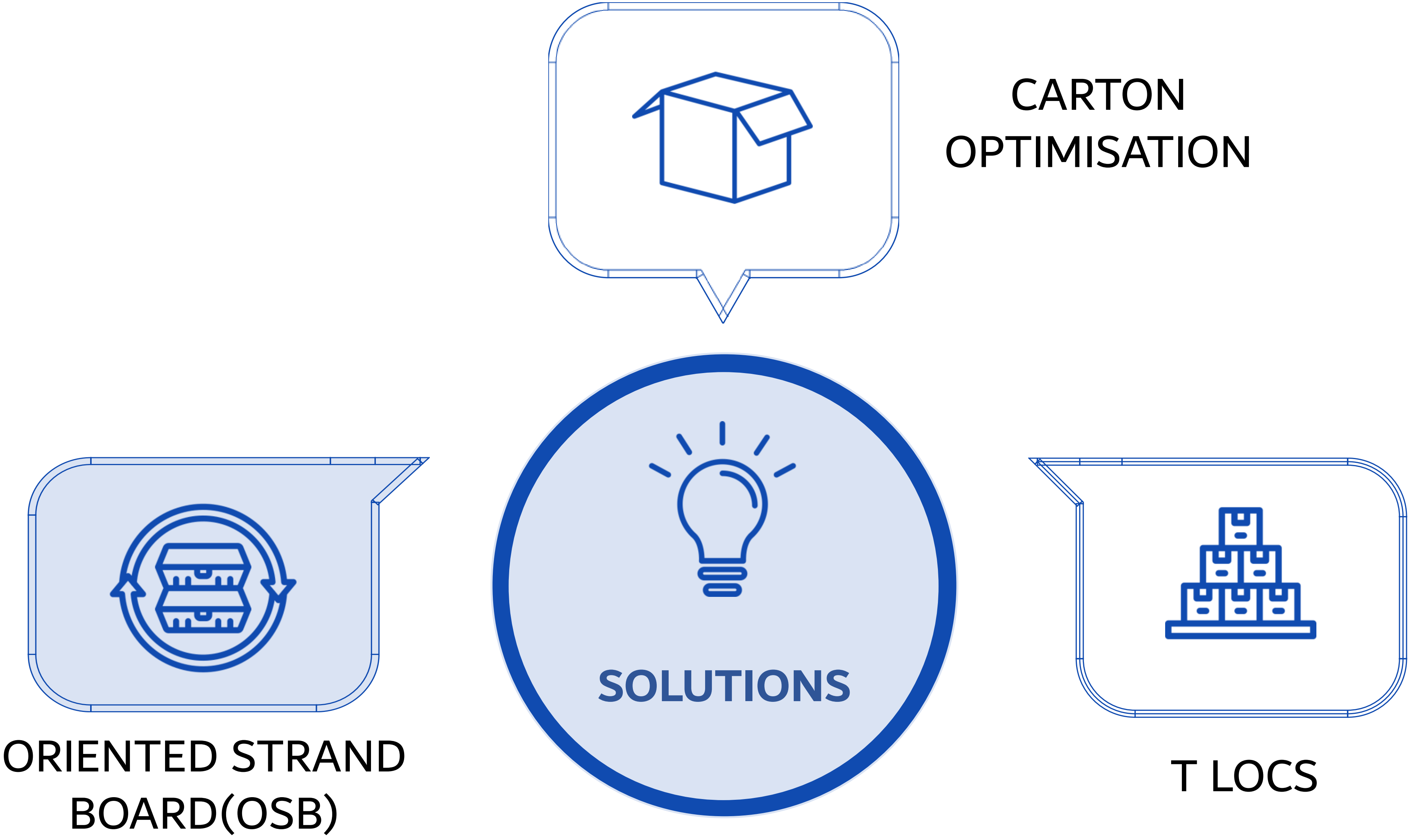
Underlying Problems

1. Oversized packaging leading to Inefficient space management and adds damage to the product.
2. Packaging size is greater than product size by up to 40%, leading to excessive use of fillers
3. Unsustainable material like plastic or cardboard is used, leading to carbon emission and lack of durability.
4. Damaged products due to lack of durability in packaging
5. Low rate of recycling packages is due to lack of recycling infrastructure and less return % from user.

PACKAGING


CARTON
OPTIMISATION
SOLUTIONS
ORIENTED STRAND
BOARD
T LOCS

PACKAGING


CARTON
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SOLUTIONS
ORIENTED STRAND
BOARD(OSB)
T LOCS

With 95% consumers in favor of eco-friendly packaging, there is huge scope to transition to a new sustainable material

Cardboard produced from over **700 million trees**, equivalent to **329.4 million metric tons**, goes to waste every year in India, so we conducted a survey to understand consumer preferences for the same

88%

Consumers in India are willing to **purchase a more sustainable product** once they are made aware of sustainability issues

57%

Consumers in 18-24 age group have **switched to lesser-known brands** because they were sustainable

95%

Consumers **demand eco-friendly packaging** from brands

30%

Consumers have **switched from fashion sector** due to lack of sustainability

Reusable Packaging OSB is 77.83% more sustainable with a 5.5x strength

About: Oriented strand board (OSB) durable, water-resistant, widely used, versatile engineered wood panel made from wood strands. With favorable mechanical properties, it is particularly suitable as a reusable packaging material

Features: Some of the very favorable features of OSB include High durability , Water resistant ,Shock resistant

A CORRUGATED	Metrics	OSB B	
✗	Durability	✓	
✗	Water Resistance	✓	
✗	Shock Resistance	✓	
0.987	Carbon Emission (kg CO2 per kg)	0.208	**77.83% Reduction**
1.48	Tensile Strength (MPa)	8.27	**5.5x Strength**

The problem no. 3,4 & 5 stated in "UNDERLYING PROBLEMS" has been solved by using Oriented Strand Board(OSB).

Implementation of Reusable Packaging Boxes

THE REUSABLE BOX POLICY

At a time, a customer will have just one reusable box with them.

PRODUCT DELIVERY

The delivery executive, delivering the product, will bring the products in one such reusable box.

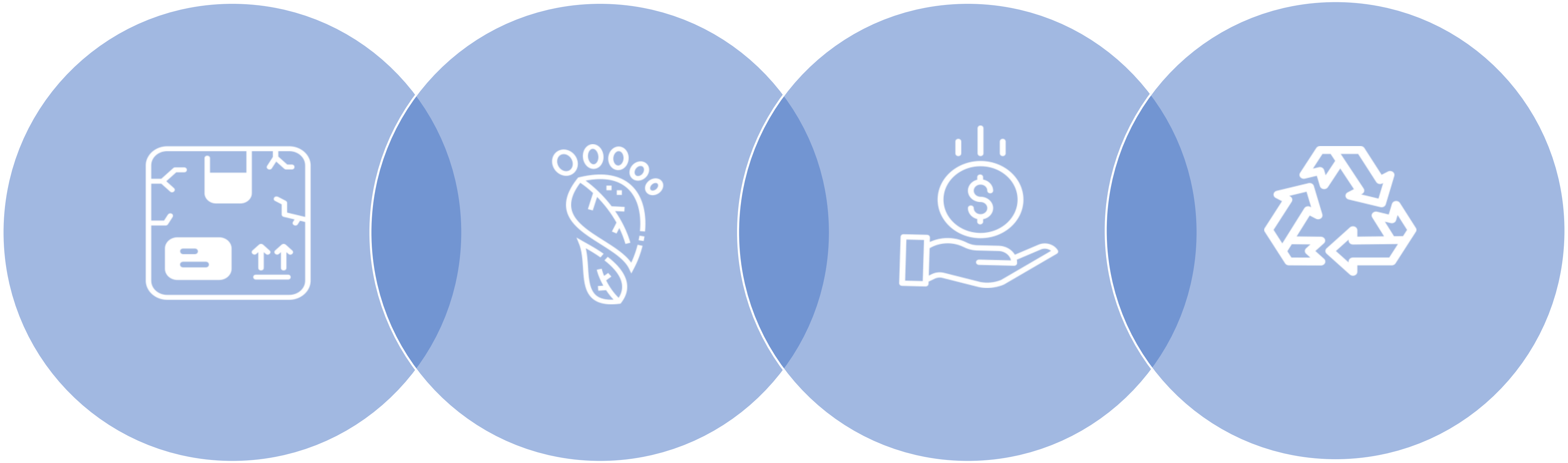
EXCHANGE OF REUSABLE BOXES

The old box will be returned by the customer when the next delivery arrives at their doorstep.

RETURN POLICY OF PACKAGING

If delivery executive is within a 100m radius of the customer’s house, the customer will be alerted, and have the option to return the box.

Impact: Sustainable OSB improves financials by 41% while reducing need for fillers and bubble wraps to reduce emissions



DURABILITY

More durable packaging means **safer transport and delivery of product**

SUSTAINABILITY

A more sustainable packaging material leading to **control in carbon emissions by over 77%**

REUSABILITY

Reusability of the box will lead to decrease in financials of packaging by **over 41%.**

AVOIDING UNNECESSARY FILLERS

Less bubble wrappers and fillers needed for shock resistance due to more durable packaging

With a box being used an average of 3.5 times, enough box production capital is saved to issue 6.57 billion carbon credits a year

REUSABLE BOX PRODUCTION COST		
	Corrugated Box	**OSB**
Cost of a general 8*7*5 box	8	9.3
Considering 9 million orders per day, so per day cost(in millions)	72	83.7
Cost per year(in millions) [considering average reusability of the box to be 3.5]	**26280**	**8730**

GUESSTIMATED CARBON CREDIT FINANCIALS

CARBON CREDIT SYSTEM	
No. of orders in India per day (in millions)	9
Carbon credits per order	2
Carbon credits per day (in millions)	18
Carbon credits per year (in millions)	**6570**

PACKAGING

CARTON OPTIMISATION

SOLUTIONS

ORIENTED STRAND BOARD

T LOCS

We devised a Machine Learning algorithm to solve the problem of 60% over-packaging

The mean packaging factor (product volume/package volume) for ecommerce packages is 0.4, i.e., packages are typically 60% oversized

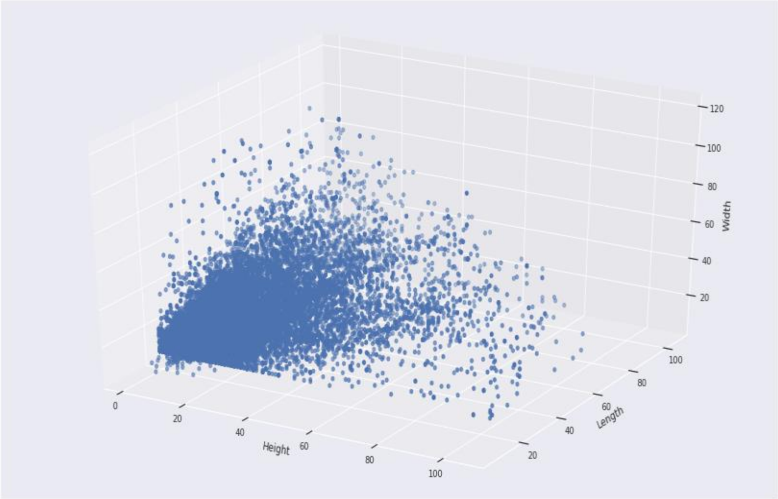
Solution Premise:

Aim: A machine-learning algorithm to determine the optimal sizes of boxes for packaging.

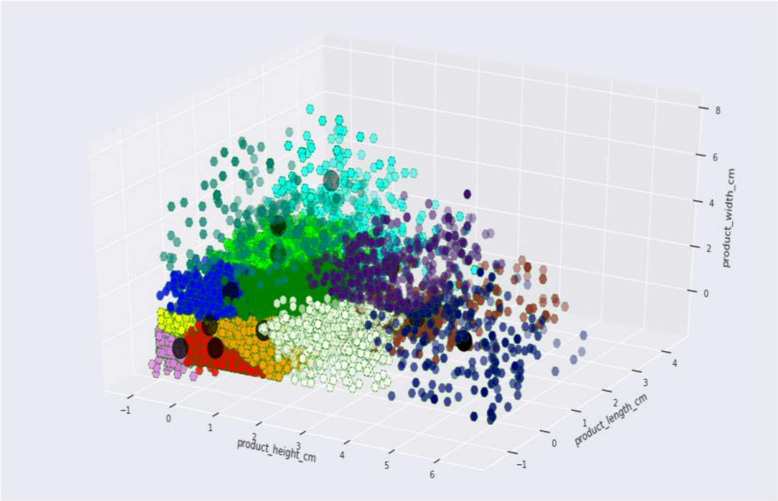
Goal: This algorithm is to iterate through all the products in the inventory and identify clusters based on height, width and product fit.

Result: As the algorithm clusters based on dimensions of products, boxes can be manufactured based on cluster sizes.
The number of unique boxes obtained will be equal to the number of clusters.

Clustering an ecommerce dataset of over 30,000 products



Un-clustered data points



Clustered data points

Implementation: The algorithm clusters sizes based on product dimensions along with use of Reinforcement Learning to decrease the packaging factor

1. Generating the Initial Solution

- Make initial clusters of the product inventory based on dimensions and demand
- The ML model recommends a box size based on current cluster centroid which fits the products. Using K-means algorithm, clusters are distributed, the optimal size of boxes are predicted that needs to manufactured
- On implementing the entire sequence, we found packaging factor using our algorithm was around 0.5 for a 1000 clusters and 0.6 for 10,000 clusters

2. Utilization of Reinforcement Learning to minimize Packaging Factor (PF)

- We can further modify the algorithm using game theory and reinforcement learning (RL). Objective of the game is to decrease the packaging factor, and RL reward can be set accordingly
- The RL agent, while playing the game, will have two options,
  a. To play the game and modify the current box assortment
  b. To exit the game

Rewards shall be given to the RL accordingly

Generating a machine learning pipeline for the initial solution

Process

	Step 1	Step 2	Step 3
Process	**Data Preprocessing**	**Clustering**	**Scoring**
	• **Data Cleaning:** Drop the nan values • **Volume:** Add a volume field using dimension data • **Analyze:** Plot and visualize the unclustered data point.	• **Input:** Create an example set for number of clusters • **Algorithm**: Run Kmeans through each example • **Compute**: Find packaging factor (PF) for each of them.	• **PF vs Cluster Tradeoff:** Packaging factor increases with increasing number of clusters. • **Final Decision:** Choose the optimum no. of clusters based on PF tradeoff.

```
kmeans = KMeans(n_clusters=1000, random_state=0).fit(dfa)
labels = kmeans.labels_
dfa_wth_std = pd.DataFrame(data = dfa, columns = ['product_height_cm','product_length_cm','product_width_cm'])
dfa_wth_std['label_kmeans'] = labels
```

The problem no. 1 & 2 stated in "UNDERLYING PROBLEMS" has been solved by using ML algorithm for efficient space management.

Utilization of Reinforcement Learning to minimize Packaging Factor (PF)

Objective | To get Minimizing Packaging Factor (PF)

Approach | Through Reinforcement Learning in a box-sizing game

Step 1

Step-1

Feed the initial box sizes (S_0) determined from K-means to the RL Agent

Step 2

Step-2

At any time t, agent chooses

- Modify S_0
  - Positive reward if box sizes are decreased
  - Negative reward if box sizes are increased
- Quit the game

Step 3

Step-3

Keep repeating step 2 till reward is maximised i.e., PF is reduced to a minimum

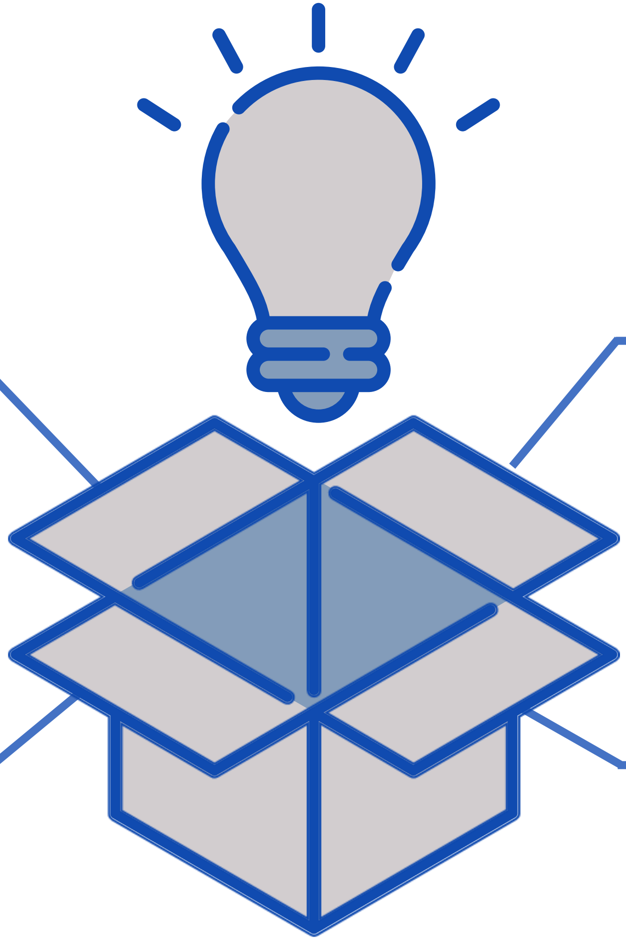
Impact: By reducing packaging size by 10%, carton optimization reduces emissions while saving significant capital

Streamlined Manufacturing

Manufacturing process of OSBs will be more streamlined as the algorithm predicts optimal number of box sizes required.

Fewer Trips, Lower Emissions

As volume decreases by more than 10%, more boxes can be fit in one shipping trip, reducing total number of trips and hence saving on carbon emissions.



Savings on Overheads

Fewer trips will reduce overhead costs and hence, increase profit margins for each product sold.

Lesser Material Requirement

Since boxes manufactured are smaller by a factor of 0.1, it saves on OSB manufacturing material.

Sources-

Financials of carton optimization

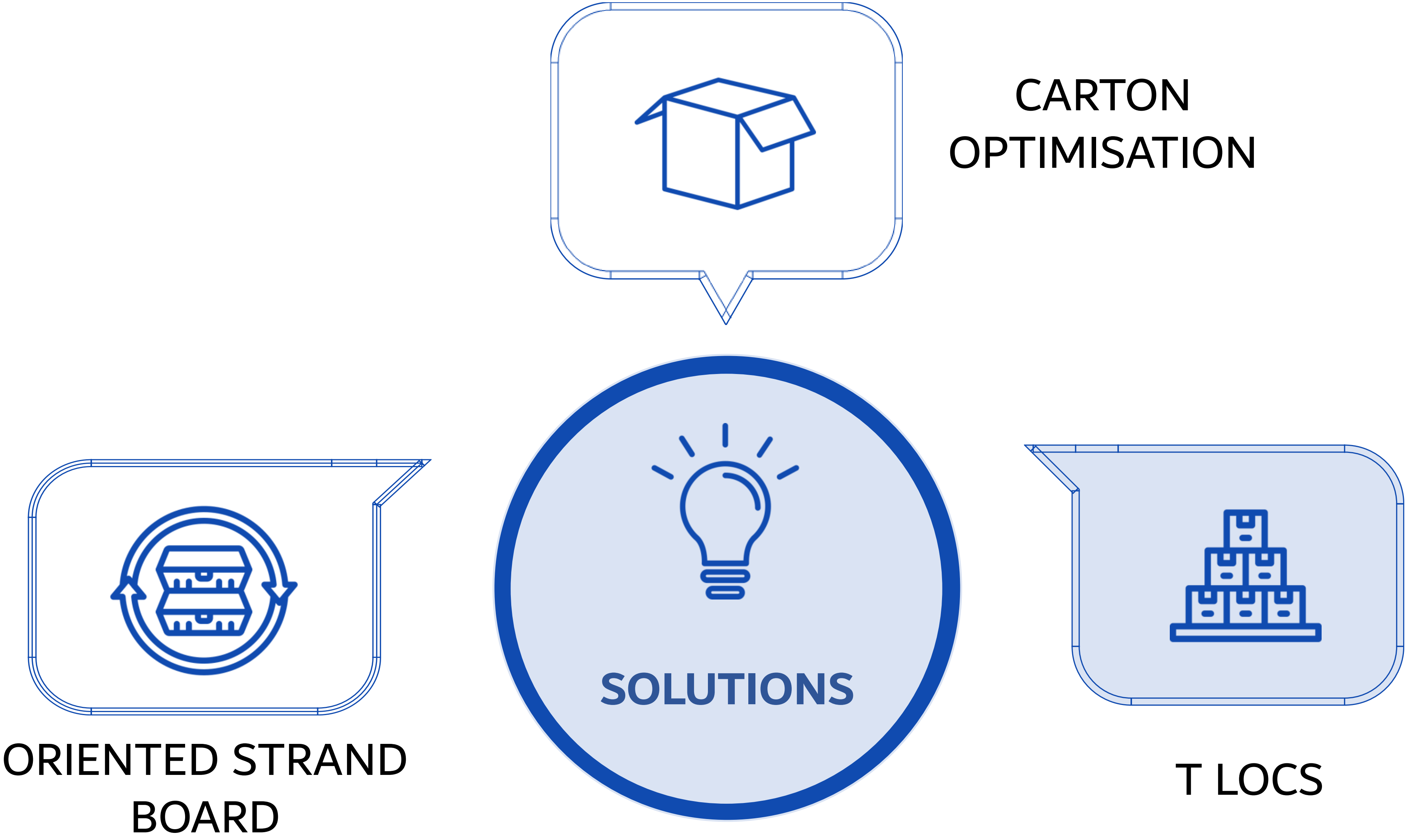
SHIPPING COSTS				
Height (cm)	Width (cm)	Length (cm)	Cost (INR)	Net Volume (cm3)
10cm	100cm	100cm	17511	100000
10cm	10cm	10cm	1831	1000

Change in Cost After Optimization			
Net Increase in Volume (L)	99	New Net Volume Increase After Optimization	79.2
Net Increase in Cost	15680	New Net Cost Increase After Optimization	12544
Increase in Cost per Unit Volume (INR per L)	158.38	Cost Savings After Optimization	3136

Current Box Negative Space		60%
Current Packaging Factor (Produce Volume/Package Volume)		0.4
Packaging Factor From ML Model	1000 Clusters	0.5
	10000 Clusters	0.6
Packaging Factor Increase	Worst Case	0.1
	Best Case	0.2

Truck Spare Volume Increase Percentage	20

PACKAGING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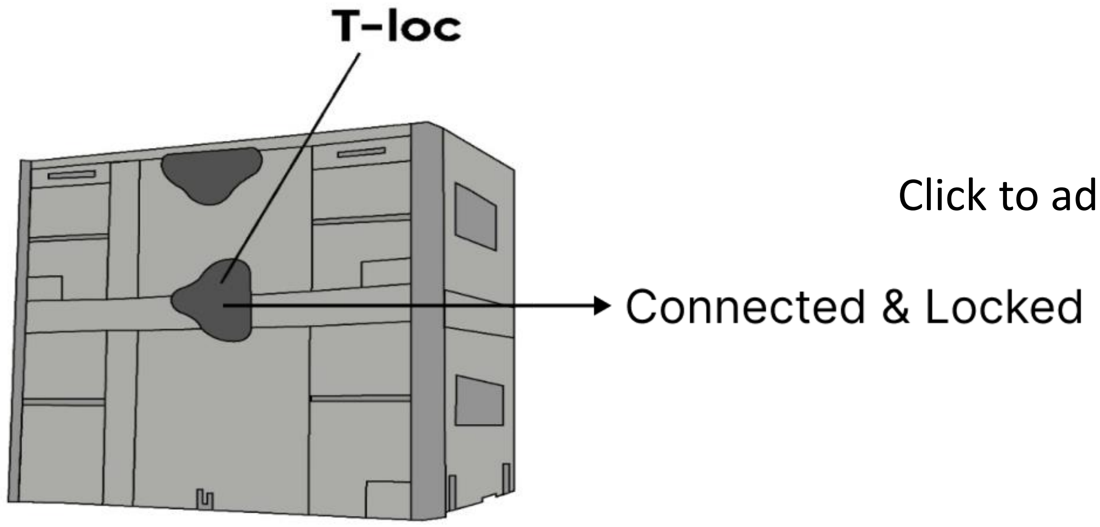
T-LOC System: An Innovative Packaging Mechanism

Schematic Representation of OSB boxes integrated with T-LOC system



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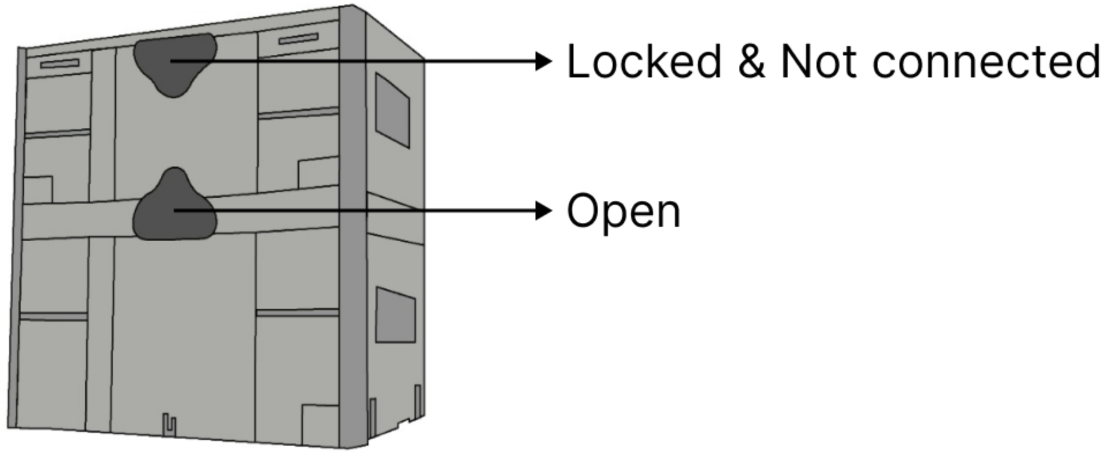


T-shaped central control element

Lock | Open | Connect

T-LOC System allows boxes to be stacked without extra packaging

Why is optimally stacking boxes important?

Reason 1: Freight Density

Freight density is the **space an item occupies in relation to its weight** and is determined by dividing the weight of the item by its volume.

1. Influx of E-commerce
2. Driver Shortage

→ Increase in demand for Freight Shipping

→ Freight Pricing is shifting from **Weight to Freight Density**

Reason 2: Space Optimisation

To make sure that stacked boxes remain intact and do not fall, we **use another layer of packaging**, usually made of cardboard or stretch-wrapping, made of plastic.

Interlocking System

→ Stacked Boxes are well connected

→ Extra layer of cardboard covering can be omitted

→ Reduction in Packaging cost and emission

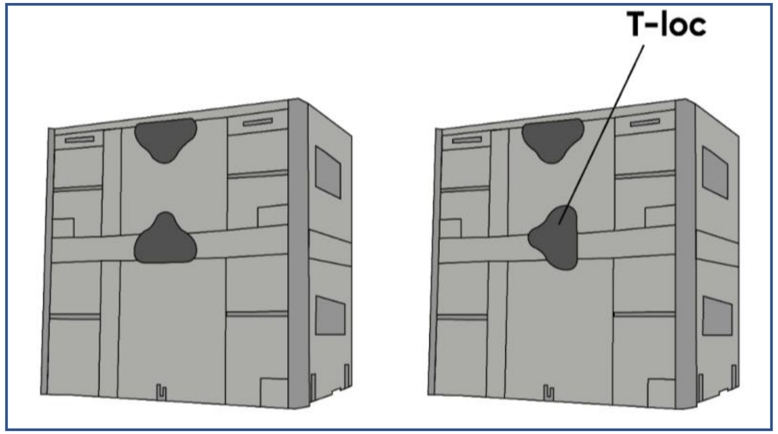
T-LOC System allows 33% more boxes to be stacked with more stability

Impact

As most stacks are erected by visual alignment, a slight error in calculation near the base can easily result in a barely noticeable overhang, with a resultant loss of stability.

Carton Boxes
(Stacked **WITHOUT** Interlocking)

Maximum
Height to Base Ratio
3:1



OSB Boxes
(Stacked **WITH** Interlocking)

Maximum
Height to Base Ratio
4:1

33%
increase
in volume
of boxes
stacked

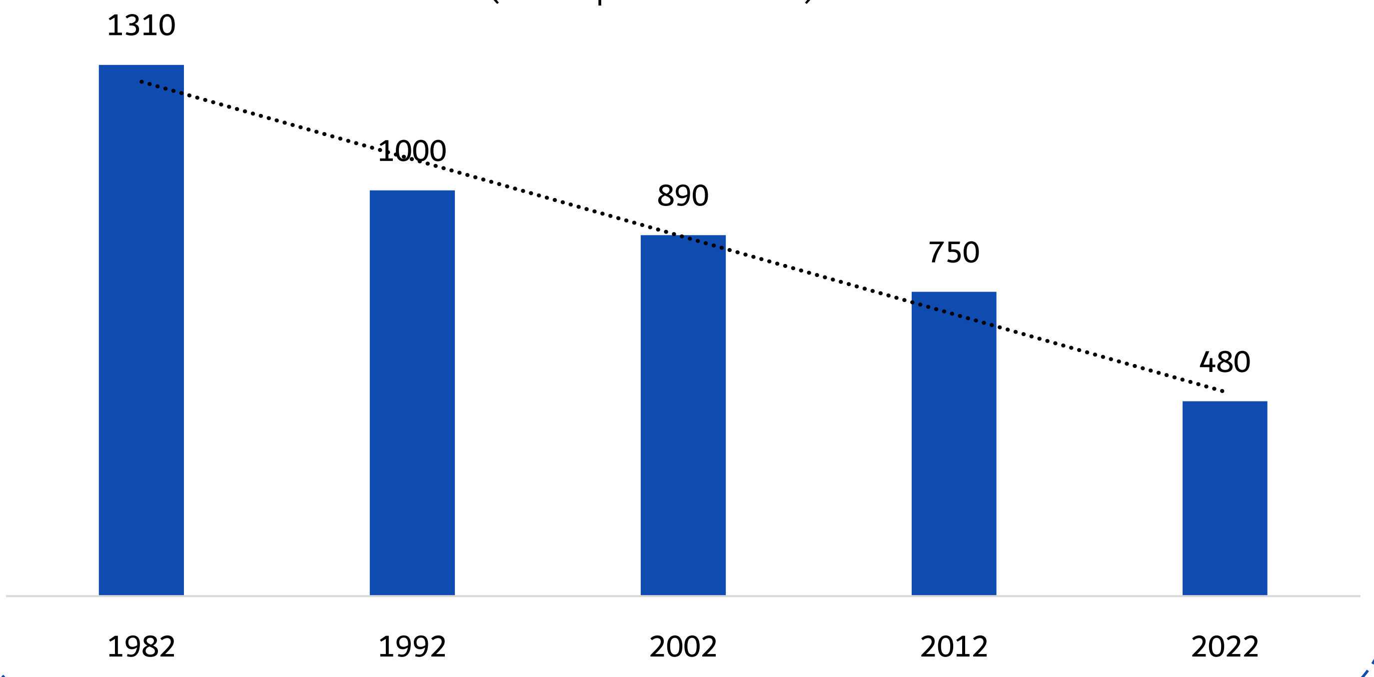
TRANSPORTATION PROBLEMS

Packaging | **Transportation** | Returns

Scarcity of drivers paired with fragmented nature of the market lead to 51.7% under-utilization of assets owned by fleet owners

Severing problem of driver scarcity in India from 1982 to 2022

(drivers per 1000 trucks)



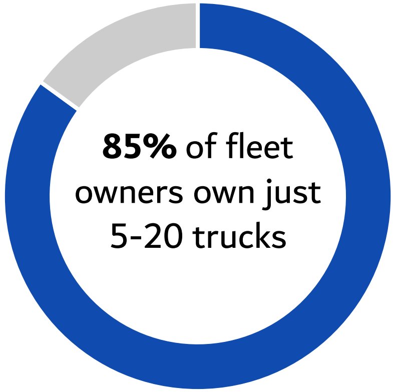
The scarcity of drivers, primarily caused due to **bad working conditions**, has caused various issues in the Indian logistics ecosystem:

- There is a **22% shortage** of drivers in India i.e., at least 22% of the fleet stays idle at any given time
- The load factor is Indian trucks is typically **above 100%**, while the same is just 50-80% on average in European countries

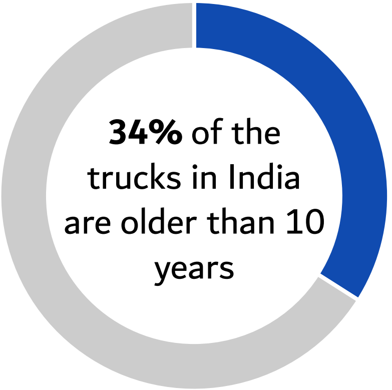
[1] Vehicle loading capacity that is productively used

Fragmented transportation industry, 51.7% under-utilization of assets, 37% empty running trucks, and fuel theft plagues the finances of fleet owners

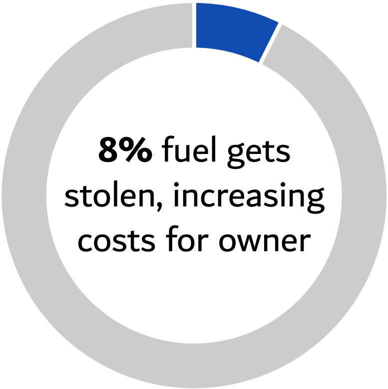
1. Fragmented Market



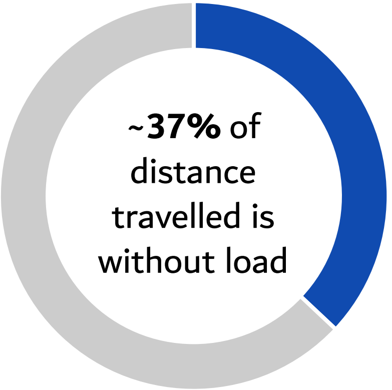
2. Ageing fleet



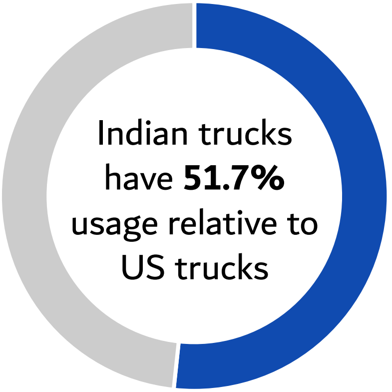
3. Fuel Theft



4. Empty Running



5. Under-utilized assets

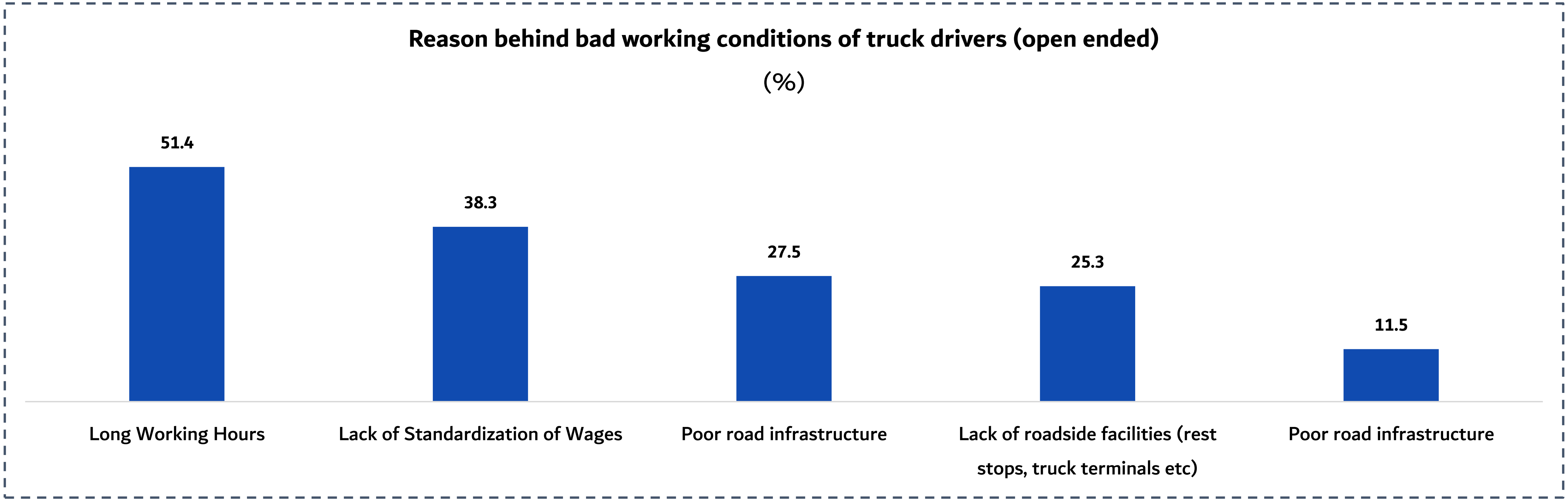


[1] Vehicle loading capacity that is productively used

Long working and unstandardized wages plague drivers' working state

- **12 hours** of driving in a day
- **Away from home** for more than **30 days** at a time
- Lack of standardization of wages due to fragmented nature of the industry

The drivers speak



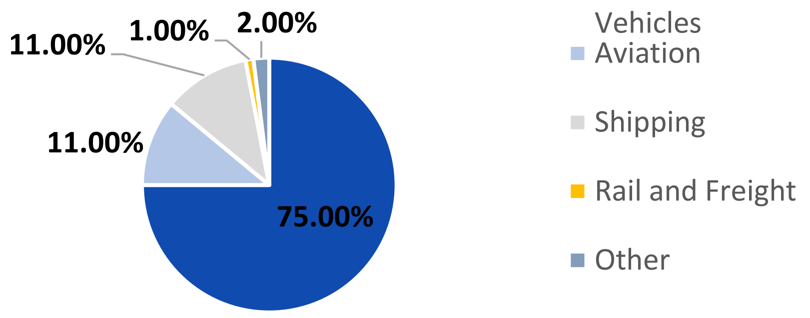
Thus, the job of a truck driver can be humanized by standardizing wages, limiting working hours and allowing them to operate locally. This shall help address the shortage of truck drivers in India.

The freight vehicles with carbon footprint – 104 Million Tones, accounts for 38% of total road carbon emissions

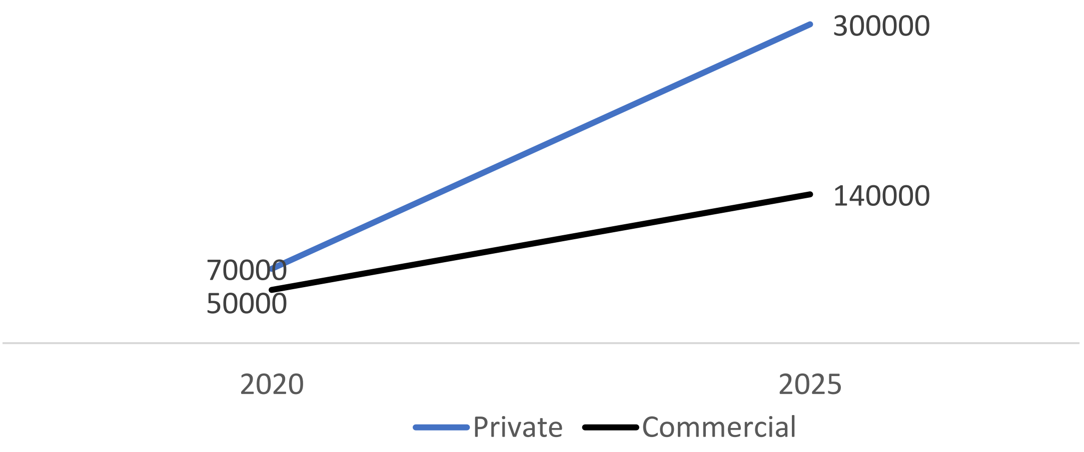
- The official service centers haven't incentivized the customers to use their expensive services (because of usage of good quality replacements) making the after-service industry extremely unorganized

- OECD Outlook: The CO_2 emissions from transport are projected to **double** from 2010 to 2050

Transport sector CO2 emission by mode



Total growth in Environmentally harmful vehicles

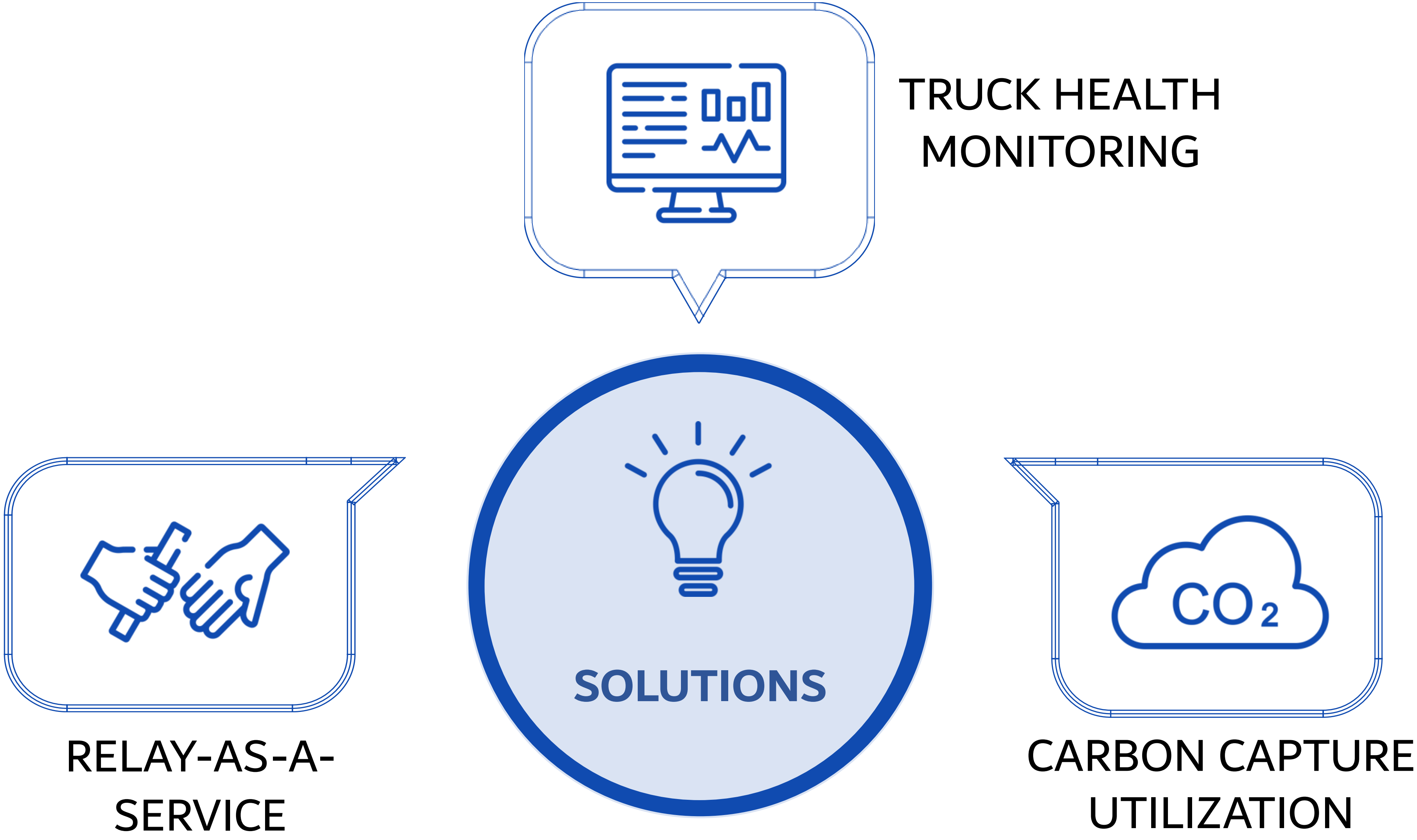


Consumer: Consumers are not aware of best time to **repair/resell** truck parts making it too late to **recycle and reuse** them

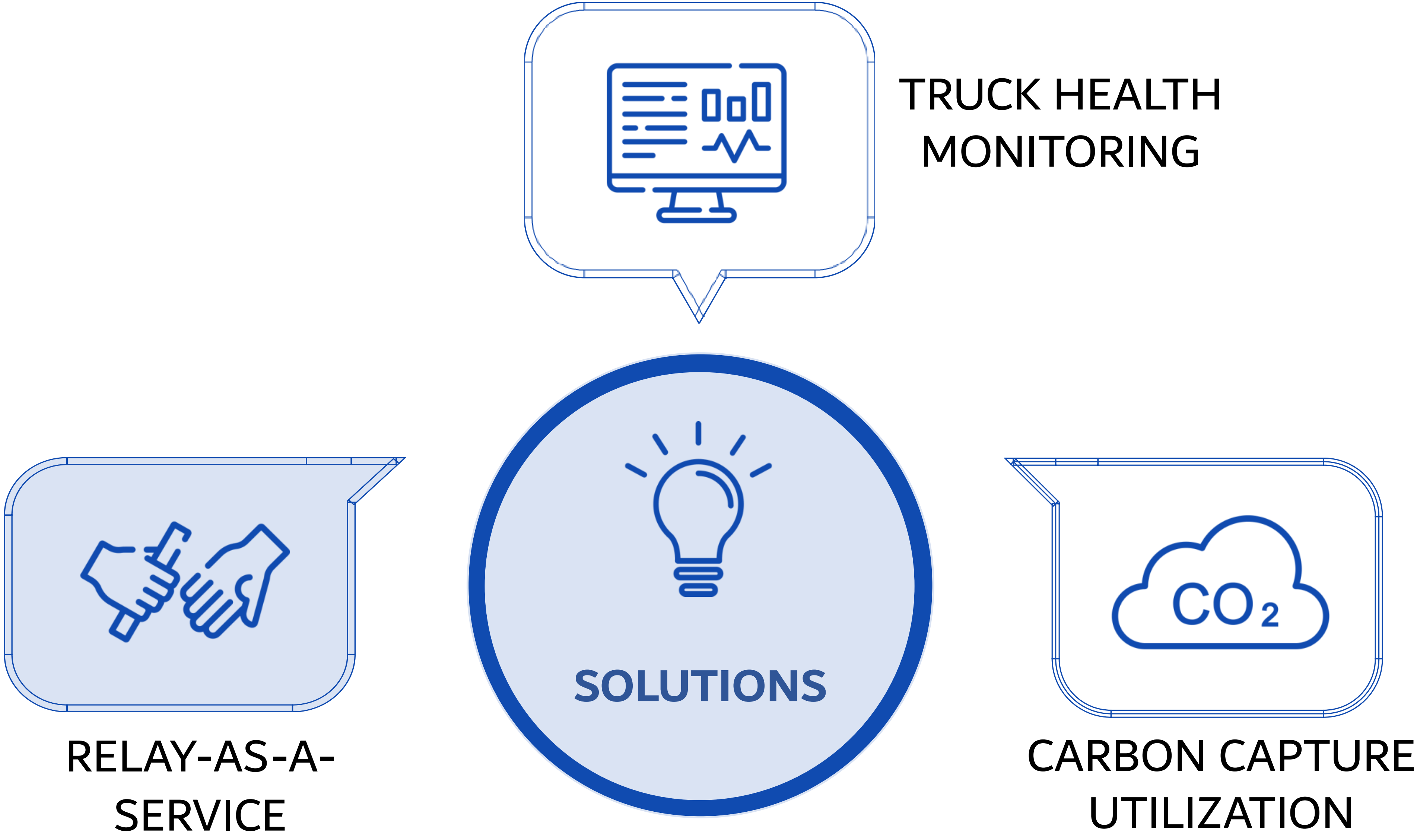
Environment: **2.5 million** vehicle parts are wasted every year, causing immense **environmental** and **socio-economic** problems

Official Service Centers: Majority of the sector is **unorganized** and third-party garages operate on cheaper prices and **forcefully push the lifetime** of the vehicle

TRANSPORTATION



TRANSPORTATION



Relay-as-a-Service allows trucks to run 8.97 hours more in a day by relaying trucks between drivers

Truck A **begins from Delhi**, destined for Kolkata. A driver travels to a **pit stop in Agra** and leaves Truck A there

The driver then takes a mandatory rest, hops into Truck B headed for Delhi at the pit stop and **drives back to Delhi**.

Similarly, another driver from Jhansi reaches the pit stop, leaves the truck at the pit stop, takes a rest, and then hops into Truck A to take it to Jhansi, towards its destination: Kolkata

Relay-as-a-Service Pipeline

01 — 02 — 03 — 04 — 05 — 06

01 IoT-enabling of Truck

Attach IoT enabled sensors in the trucks

02 Add Pit Stops

Establish 90-100 pit stops, separated by 200-250 km on avg

03 Truck Begins Journey

First driver takes the truck towards the 1st pit stop in Agra

04 Truck Relaying

Drivers in Agra get notified when the truck is near along with job information

05 Pricing of Job

Fleet owners quote a price rate (Rs./km) they'll pay for the job

06 Feedback

Fleet owner and drivers are rated by NAWCI corporations based on quality of service

We start by establishing pit stops between **metropolitan cities** to start with the establishment of the RaaS network. Eventually, we shall expand the network to **90-100 pit stops** across the country, **separated by 250 km each**

Busy transportation and warehousing hubs will be equipped with **more pit stops** to facilitate smooth transferring of trucks between the drivers

Case study: How a Pharmaceutical company freed INR 150cr in working capital by adopting RaaS for logistics

We assess the case of a leading Indian pharmaceuticals manufacturing company, engaged in pharma ingredients, branded and generic drugs. The company status initially was as follows:

- Operated through **6 manufacturing facilities**
- Each manufacturing facility specialized in different kind of products and **each aggregating at 5 different warehouses** spread across the country
- Distributed products through **30 self-owned depots** via **300 localized and small-sized distributors**
- The consignments were transported by multiple logistics partners at various distribution points and delivered through a combination of direct and subcontracted delivery partners – which led to up to 5% of consignments getting damaged
- The complex nature of the network forced the company had to maintain **70 days' worth of inventory**
- All this impacted the company's financials, with **INR 150cr** blocked in safety stocks

The problem no. 3,4 & 5 stated above has been solved by using Relay-as-a-Service(RaaS).

Case Study: RaaS reduced inventory needs by 57.1% to reduce depot emissions and costs associated with its operations

The company solved its working capital problem by reimaging its distribution model by consolidating its requirements under a single platform of truck relaying and integrating it with inventory management system

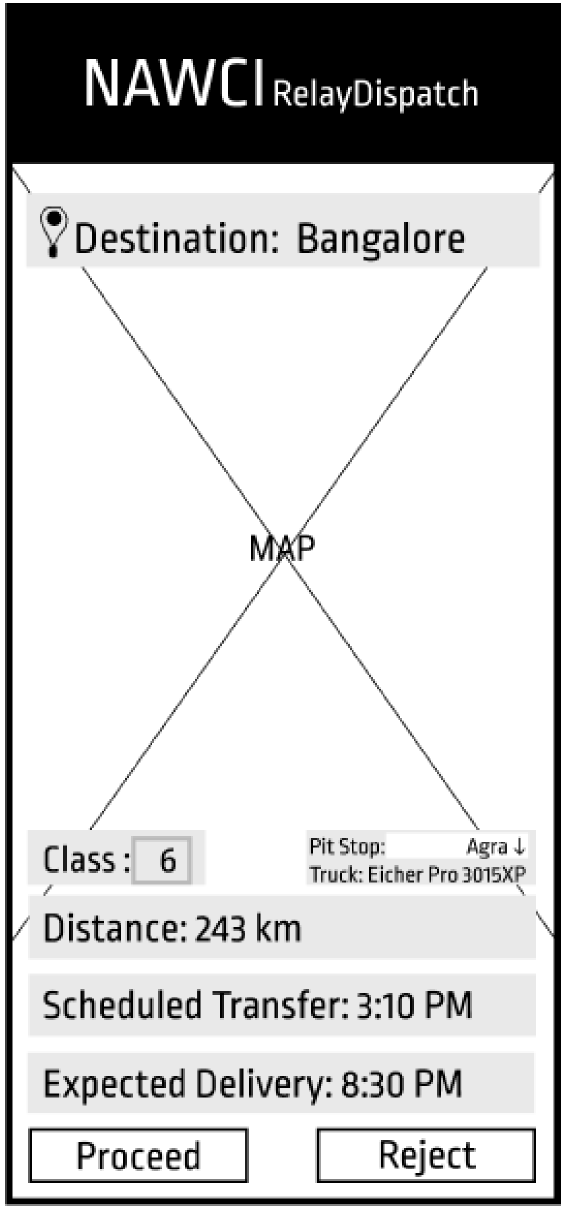
Before		After
Multiple, localized partner	Delivery partners	Single partner
70 days	Inventory Holding Time	30 days
30 depots	No. of short haul depots	20 depots
Risk of going out of stock	Stock availability	98% adherence to stock availability
Up to 5% of products	Damages and defects	Near 0 damages

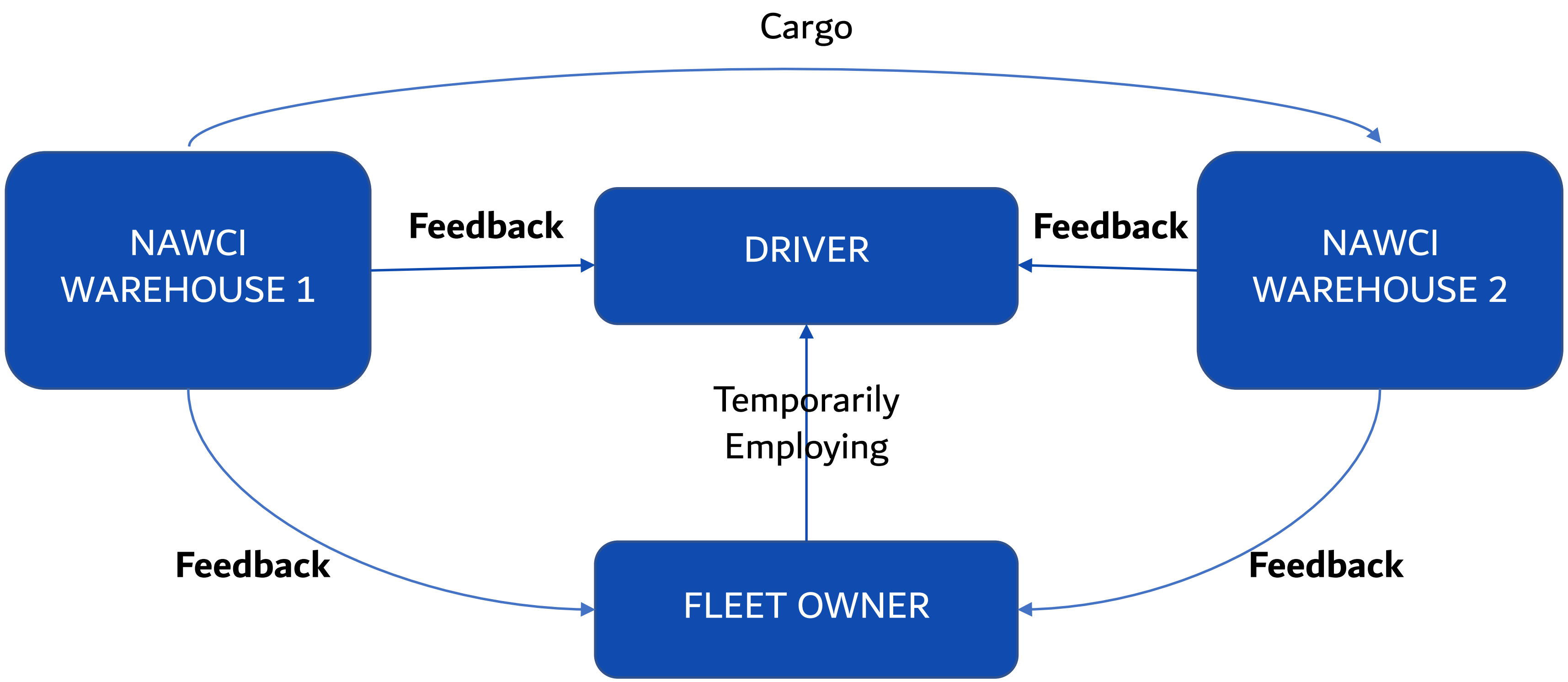
INR 150cr
Working capital unlocked

57.1%
Reduction in inventory

33%
Reduction in no. of depots and carbon emissions

Implementation: Ensuring adherence to SLAs by drivers and fleet owners through a feedback process





A feedback process shall overlook the relaying service, affecting the price that driver and fleet owner shall earn and pay, respectively, to ensure timely deliveries and quality adherence

Impact: Relay-as-a-Service raises asset utilization by 139% while reducing daily driving time by 12.3%

139%

Increase in daily trucking distance from 417 km to 1000 km and hence, reducing transit time by up to 70%

70%

Reduction in need for depots due to quicker transportation of goods across the country, freeing up working capital

46.6%

Increase in driver salaries from Rs. 15,000 to Rs. 22,000 per month funded by the freed up working capital

12.3%

Reduction in daily driving hours from 11.9 hours to 10.4 hours along with significant reduction in journeys far away from drivers' home cities

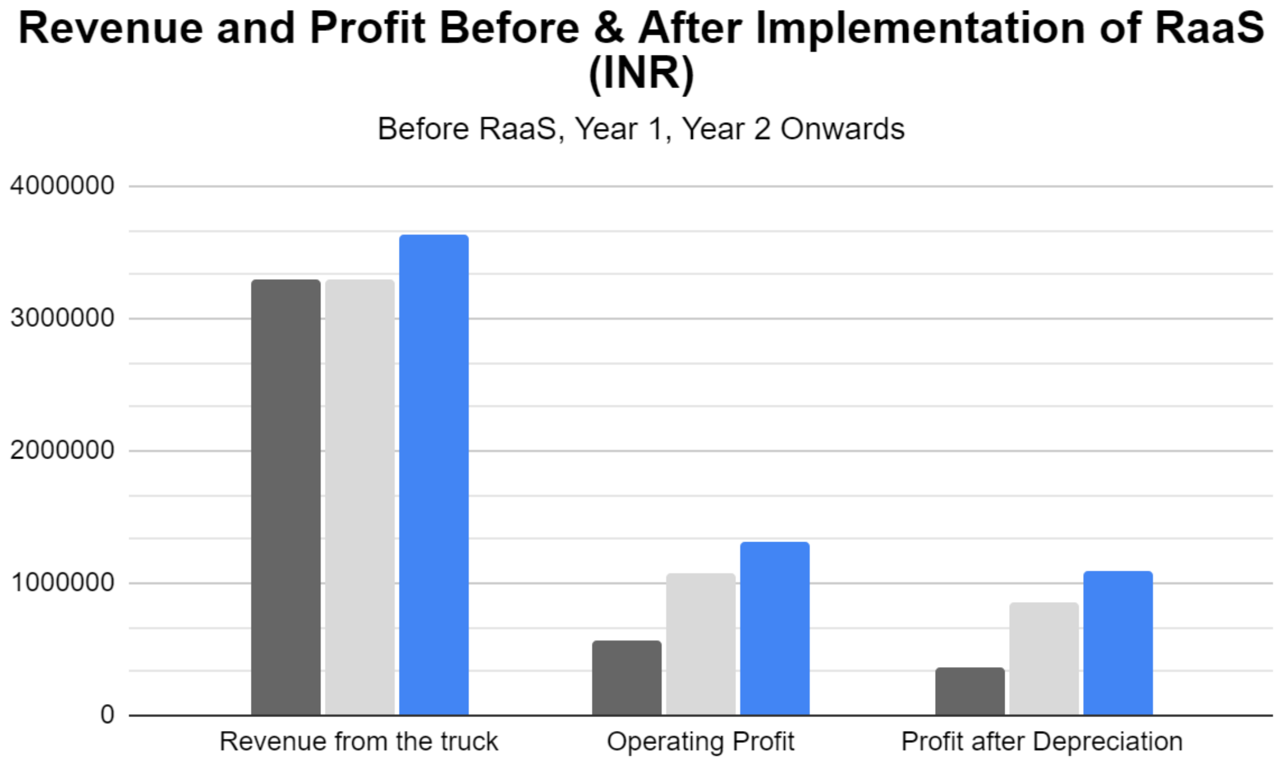
Thus, RaaS frees working capital for the company while improving the working conditions of the drivers, easing the process of acquisition for the RaaS platform

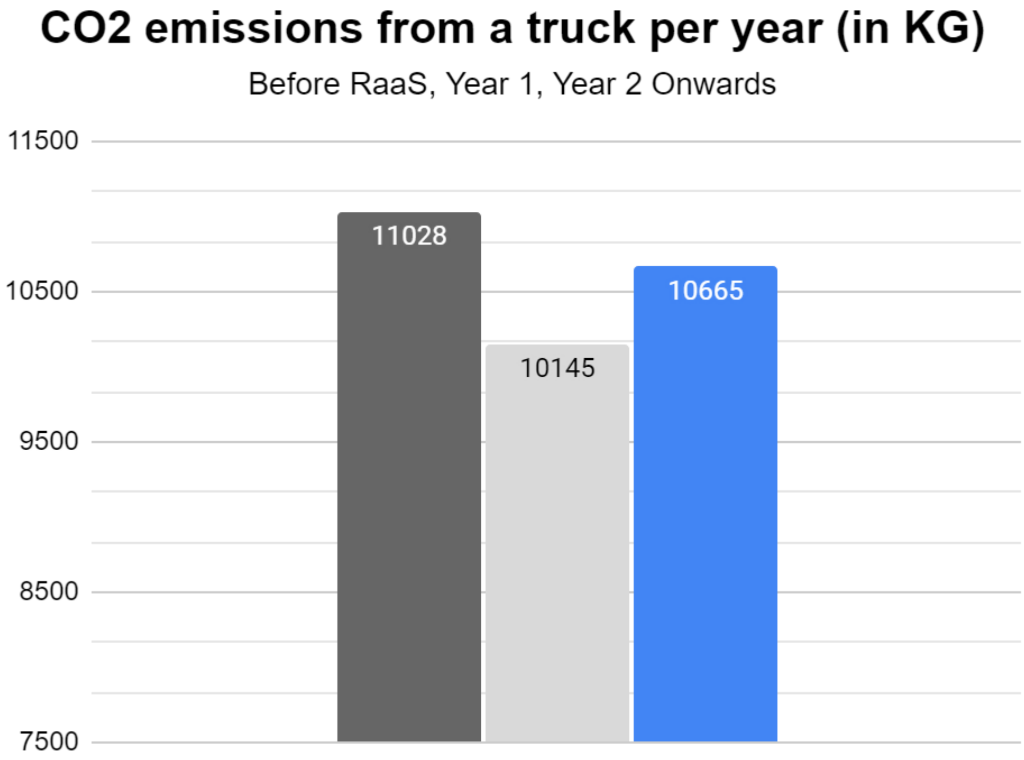
Relay-as-a-Service shall reduce direct carbon emissions from transportation by up to 8.01% with rise in profit margins from 11.02% to up to 30.2%

		Before RaaS		Year 1		Year 2 & Onwards	
Bracket	Task	P&L (INR) per km	P&L (INR)	P&L (INR) per km	P&L (INR)	P&L (INR) per km	P&L (INR)
OPERATING COST	Fuel	-20.3	-1217976	-18.67	-1120392	-18.67	-1177849
	Permits, Insurance, Tolls, Tax etc	-11.3	-678072	-11.3	-678072	-11.3	-712845
	Loading and Unloading	-1.4	-83904	-1.4	-83904	-1.4	-88207
	Driver Salary and Expenses	-4.5	-269952	-6.57	-393984	-6.57	-414188
	Maintenance	-6.8	-408120	-6.9	-414048	-6.9	-435281
	Tyres	-0.9	-53808	-0.9	-53808	-0.9	-56567
	Total Operating Cost	-45.2	-2711832	-36.91	-2214576	-36.91	-2328184
ASSET DEPRECIATION	Depreciation of trucks over 15 years	-3.5	-212496	-3.5	-212496	-3.5	-212496
	Total Operating Cost + Depreciation		-2924328		-2427072		-2540680
REVENUE	Revenue from the truck	54.8	3286848	54.78	3286848	57.59	3632800
PROFIT	**Operating Profit**		**575016**		**1072272**		**1304616**
	Profit after Depreciation		**362520**		**859776**		**1092120**

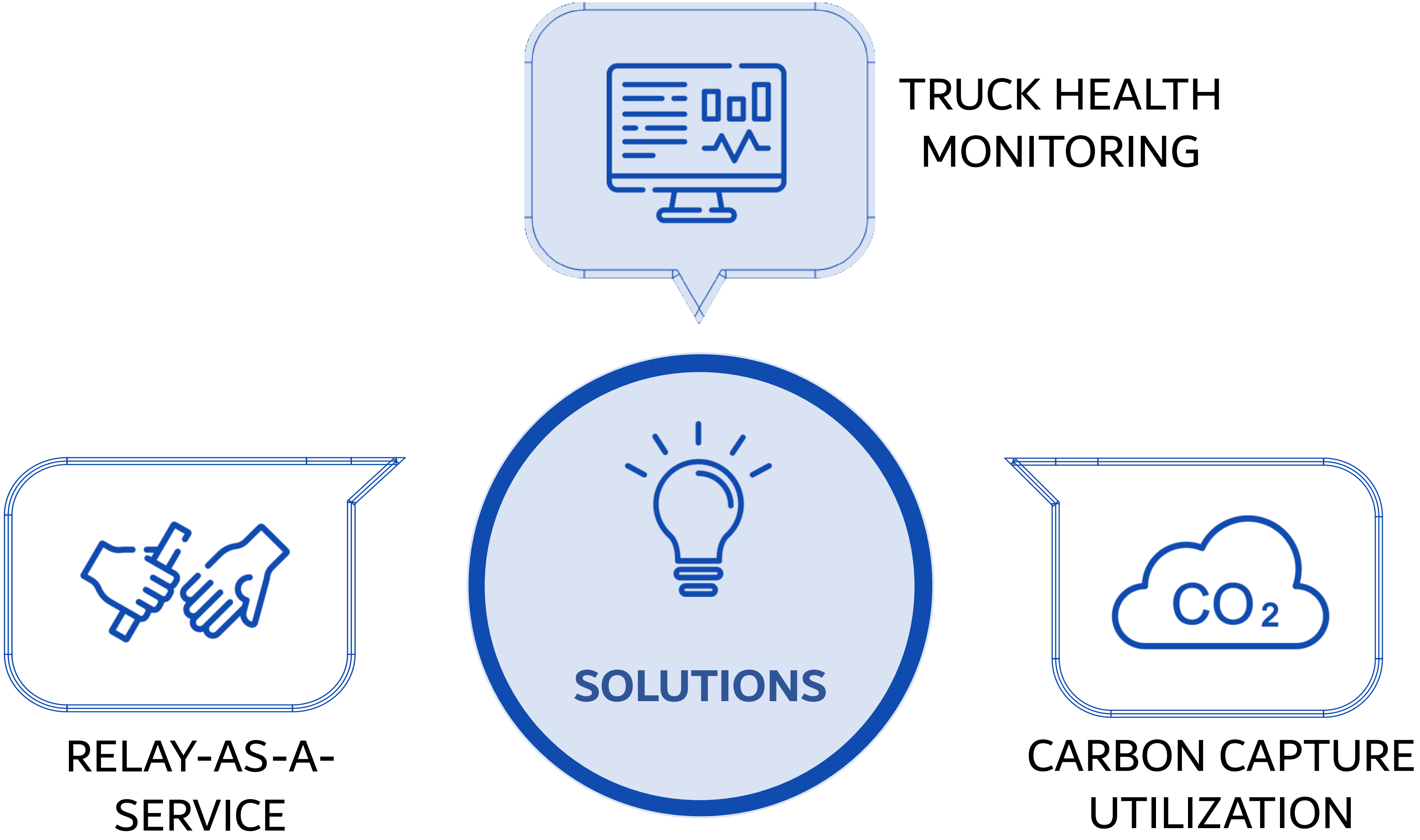
After adoption of RaaS, profit margins shall increase from **11.02%** to **26.3% in Year 1** and to **30.2% In Year 2 and onwards**
Moreover, this shall be fulfilled with an **8.01% fall in emissions in Year 1** and a **3.29% fall in emissions in Year 2 and onwards**

Relay-as-a-Service allows transportation to be more profitable while reducing carbon emissions





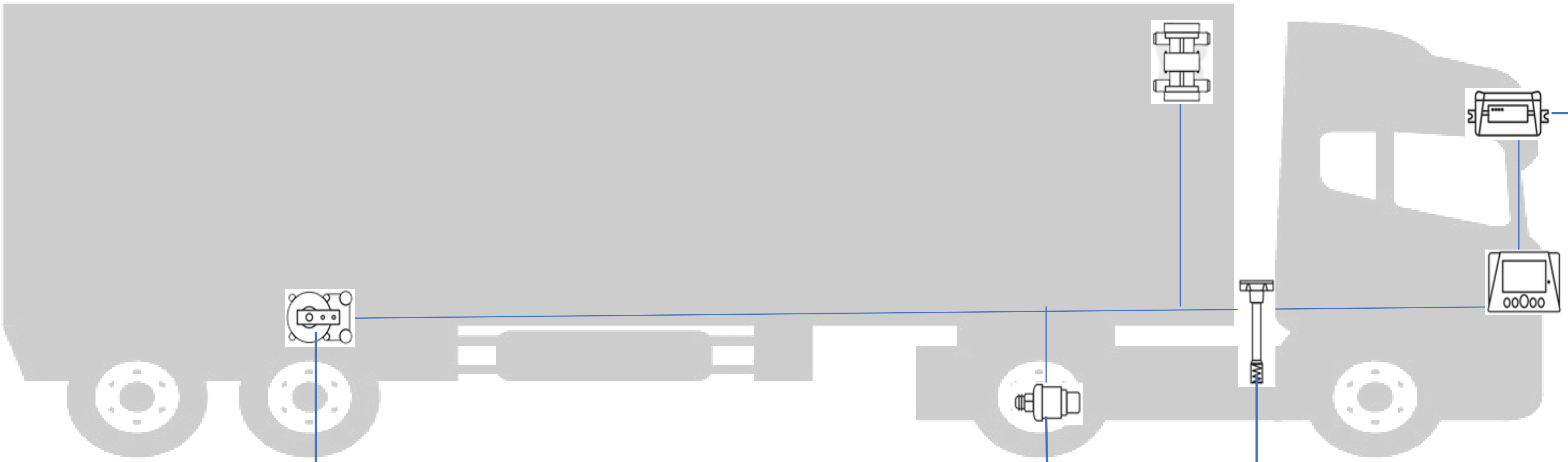
TRANSPORTATION



IoT-enabling of trucks to facilitate truck health monitoring and RaaS

A combination of IoT devices, assets, workflows, and analytics, providing a centrally consolidated monitoring of truck cargo load, pressure, fuel level, location, temperature etc. of the fleet's trucks reducing maintenance costs as well as increasing productivity.

Asset Monitoring:
- Temperature & Humidity Monitoring
- Trailer Monitoring
- Vehicle Security Management



GPS/GLONASS:
- real-time location tracking
- route optimization
- Navigation, route deviation alerts, mileage reports

Master Display:
- display information from various sensors and other devices used in the vehicle.

Axle Load Sensor:
- measuring axle and cargo load on vehicles
- Real time weight monitoring
- Vehicle axle monitoring

Pressure Sensor:
- measures the pressure in the vehicle pneumatic system
- Driver monitoring, no underhand cargo
- Avoid overloads and paying off traffic fines; reduce depreciation

Fuel Level Sensor:
- measure the volume of fuel in the tank.
- Control of fuel consumption in the tank
- Prevention of theft of fuel from the tank

Implementation: The proposed health monitoring system can leverage existing sensors and features in a truck and reduce the number of additional sensors

Sensors already present in trucks: Mass airflow sensor, Engine Speed Sensor, Oxygen Sensor, Spark Knock Sensor, Coolant Sensor, Manifold Absolute Pressure (MAF) Sensor, Fuel Temperature Sensor, Voltage sensor, Camshaft Position Sensor, Throttle Position Sensor, Vehicle Speed Sensor

Engine

In the status quo, some sensors are already being used for the engine, in our model we would need to add 3 more sensors for the engine.

Transmission and Braking

The additional sensors to check the health would be to determine the angular velocity and brake torque of each wheel.

Tires

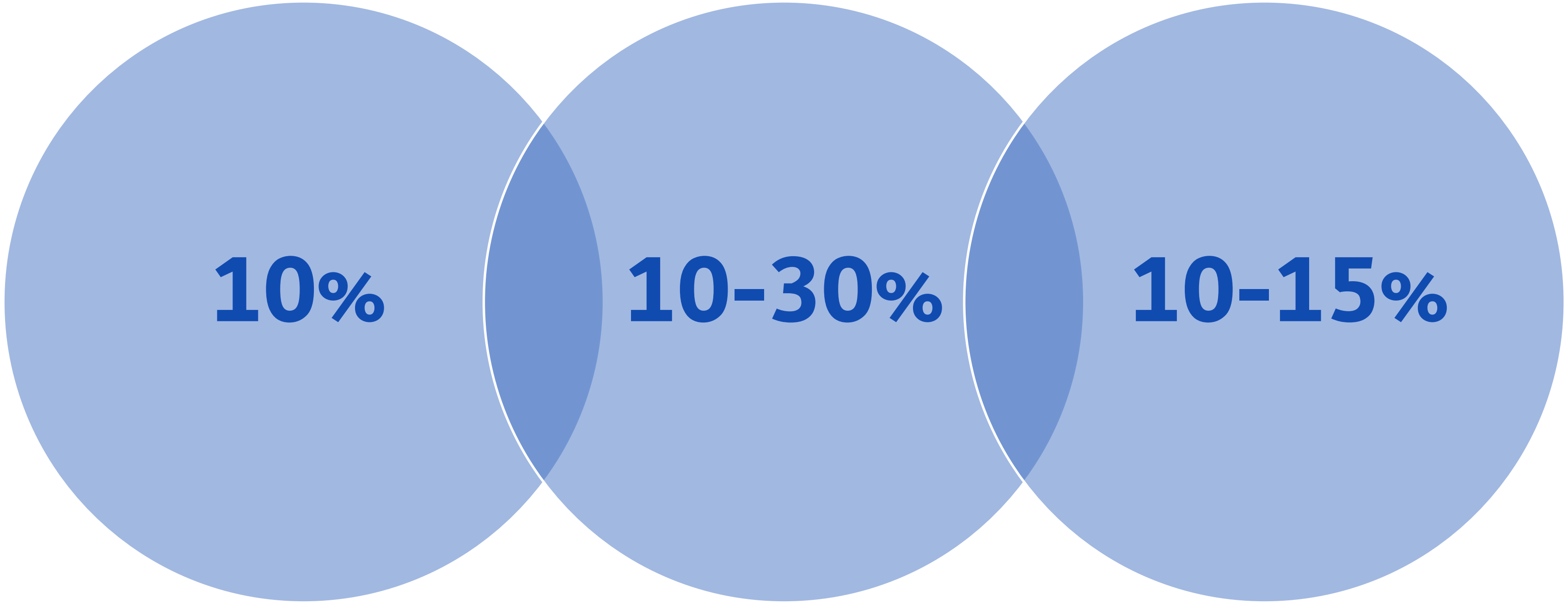
Data for power input and speed is already available. We would have to put sensors in to estimate tire pressure (only available in niche trucks right now)

Battery

The additional sensors to check the health would be to determine the angular velocity and brake torque of each wheel.

We would need 5-6 additional sensors for the system

Impact: Preventive Maintenance reduces GHG emissions by 10% by improving fuel efficiency by 10-15% and cutting spending by 10-30%

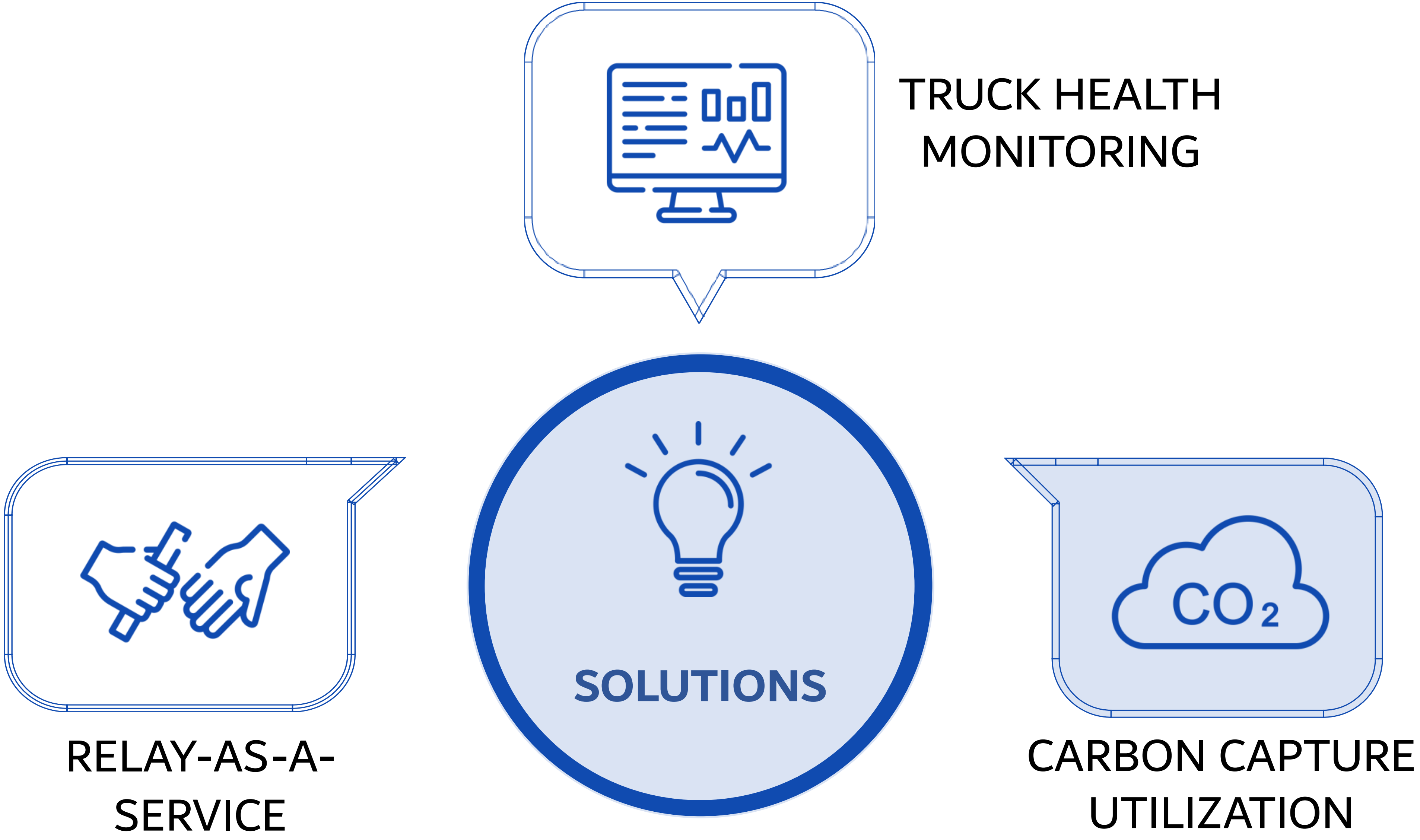


Greenhouse Gas Emissions can be reduced. In its 1st year, a new vehicle is responsible for 15.25 tons of CO2. That's about 3.5 years of using the old vehicle at 30 mpg, in terms of carbon emissions.

Vehicle spending can be cut. The optimized replacement and recycling will allow the auto parts to work efficiently and prevent spendings on serious vehicle malfunctions.

Fuel consumption can be reduced. An older vehicle develops faulty engine components which in turn adversely affects its fuel economy.

TRANSPORTATION

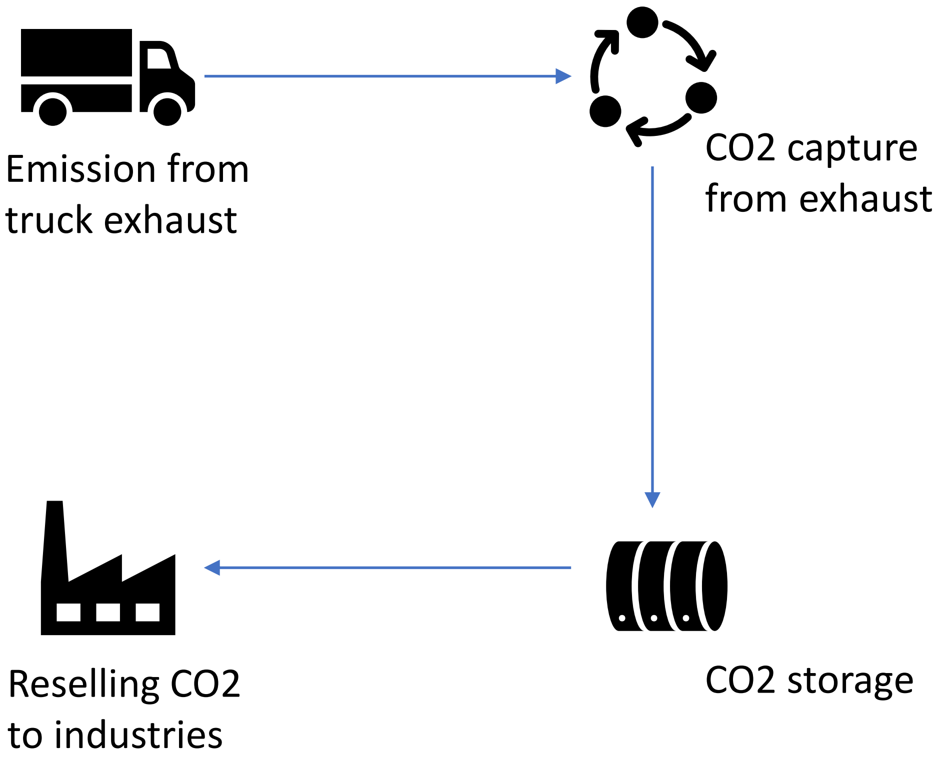


Carbon Capture Utilization Technology

What is CCUS Technology

- **Carbon Capture Utilization and Storage** (CCUS) is a combination of technologies designed to prevent the release of CO_2 generated from conventional industries and internal combustible engine vehicles.

- It involves the capture, transport and storage of CO_2 or its utilization as valuable resource in the production of ink, plastic, concrete etc.



How does Mobile CCUS work?

01 Installation of a Truck

A retrofit device to capture the exhaust gas and process it to segregate CO2 along with a tank to store the captured CO2 is attached to the truck.

02 Cooling and Drying Captured Exhaust

The exhaust gases are captured and then, the exhaust is made cooler and drier, and passed over a zeolite that selectively absorbs CO2

03 Separating of CO2 through selective absorption

Zeolite separates out CO2 and is typically used to remove excess CO2 emissions caused by human activity in spaceships and submarines

04 Release of CO2 captured

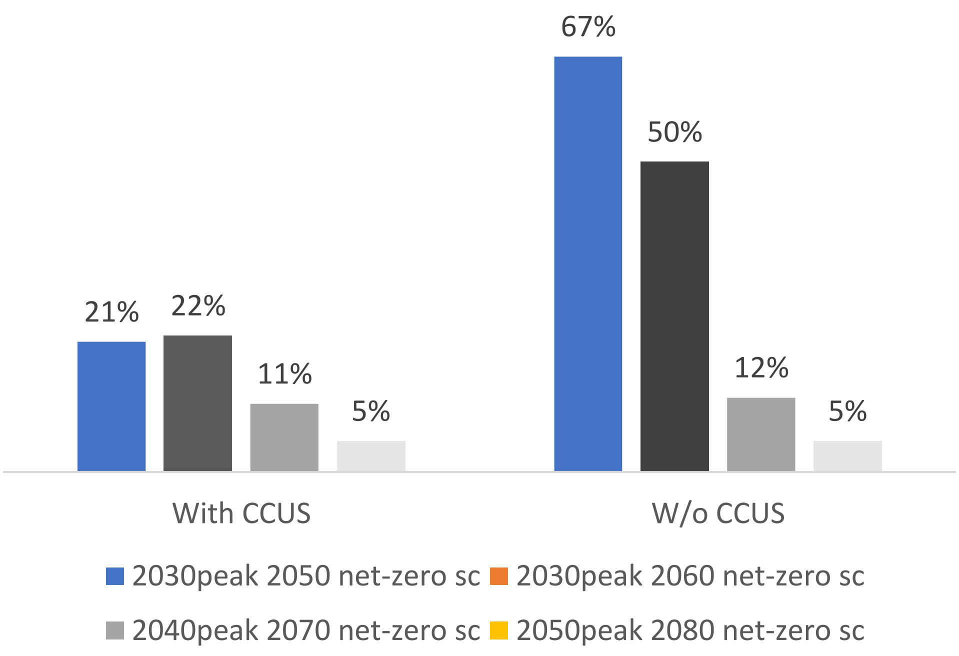
After the CO2 is captured, it can be released by applying heat, much of which comes from the exhaust itself. In this sense, the technology is making productive use of an otherwise wasted resource

05 Offloading at nearby pitstop

Once full, the tank can be offloaded at specific locations like warehouses or pit stops.

CCUS is indispensable for deep decarbonization and to achieve the climate goals, as stated in COP 26 summit

Share of electric trucks in freight truck sales



- CCUS are technologies which can prevent more than **90%** of CO2 emissions produced from stationary energy sources.
- CCUS is needed to achieve the goal of net-zero emissions, according to the IPCC and the IEA. The global capture capacity was about **50 Mt** CO2 per year in 2020.
- Meeting long-term climate goals without applying CCUS technologies in the power sector requires immense stress on the **virtual elimination of coal-fired power.**
- To achieve its ambitious target of carbon-neutral production, **Dalmia Cement** has announced the installation of a large-scale CCUS facility of capacity 0.5 MtCO2 per annum

Implementation of CCUS in the Indian economy across net-zero scenarios relaxes the pace of transition required across progress variables significantly

"Without CCUS, 140% more costs will have to be incurred to realize the climate goals"

-IPCC

Carbon utilization can in turn reduce emissions of other industrial activities through EOR, ECBM, Urea Yield Boosting

Direct End-Uses

- **Enhanced Oil Recovery(EOR)**:

The mature and depleted oil and gas fields have **5-10 Gt** CO_2 storage potential. **1** ton injected CO_2 leads to recovery of additional **2-3** barrels of oil.

- **Enhanced Coal Bed Methane Recovery(ECBM)** :

The deep coal seams have **354 Mt** CO_2 storage potential. Methane recovery from beds can be increased from **45%** to **95%**

- **Urea yield boosting**:

Around **130-140 Mt** CO_2 per year is used in urea manufacturing, and this is a **proven technology** to better the existing yield

Indirect End-Uses

- **Cement Industry** :

CO_2 can be used in production of concrete. CO_2-cured concrete have superior performance, lower manufacturing costs, and **reduce CO_2 footprint** by **80%**

- **Building materials from waste and CO_2**:

Reacting CO_2 with waste materials industrial processes produce construction aggregates. **5kt/year** of CO_2 can be used to convert **60 kt** of waste residue

- **Polymer Processing with CO_2** :

polymer containing **20%** CO_2 by weight shows life cycle CO_2 emissions reductions of **15%** relative to the conventional production process

Mobile CCUS is the least energy-intensive method to reduce emissions in an effective way

How does Mobile CCUS compare to alternatives like EVs or hydrogen fuel cell trucks?

Mobile CCUS is the **cheapest alternative** we have right now. If we compare it to EVs, it's much simpler and cost-effective to implement because you don't need to build the required infrastructure for it or manufacture new cars altogether, it can be simply retrofitted onto an existing vehicle. A hydrogen fuel cell powered truck or EVs typically cost **5-10 times** more

What do you think about other contemporaries of CC Tech like static Direct Air Capture (DAC) units?

In comparison to its static alternatives like DAC, Mobile CCUS can function on **1/4th** the amount of energy, which makes it extremely feasible in energy terms. Additionally, in the exhaust there is **10-12%** CO_2, which makes it a significantly more potent source of CO_2 than the air which has **0.04%** CO_2. To paint a picture, **28** trucks with Remora's device that run one shift a day captures more than the largest DAC

What are your plans of expanding into the Indian Market and by when do you see Mobile CCUS foray into India. What are the industries that Remora targets?

Around **75%** of fleet owners in the Indian market, own **4-5** trucks which is roughly similar to the US market and that won't be an issue for us. Given the difference in Indian and American trucks, we can foray into the Indian market in **2** years and cheap labour in India will make it more profitable. Remora typically targets **ink, cement, and plastic**

Eric Harding

Chief Engineering Officer
Remora Carbon

"The growth of CCUS in India is going to be exponential in upcoming years due to readily available cheap labor and vast presence of industries which use CO_2"

Impact: CCUS can capture up to 50 million tons of CO_2 and generate INR 26.1 lakhs in revenue per year, paying itself off in 2.75 years

INR 26.1 lakh

In **revenue generated** by reselling the captured CO_2 using the CCUS device in the truck fleet

50 million tons

CO_2 emissions captured from exhaust emissions of the truck per year considering only 50% carbon capture

90%

of the emitted CO_2 can be captured using the Remora's carbon capture device on the trucks

2.75

Years, the device takes to pay-off its cost by selling back the captured CO_2 from exhausts

5-10x

Cost reduced by dispensing away with construction of electric grid infrastructure required for electrification of the fleet

EV demands 4 times higher energy for equivalent carbon capture and its fuel, electricity, is sourced 61% from non-renewable sources

EV Trucks is a major challenge- Electrification seems like a viable option to reduce carbon emissions but long distance trucking and cargo transport are poorly suited to electrification.

- **Batteries are not a viable solution** : Required battery would add significant weight and a substantial charging time.
- **Limitations of an EV truck** : Even if we develop a feasible EV truck it will have less payload capacity and very less range
- **Electricity in India is not green**: 61% of electricity in India comes from non-renewable sources.

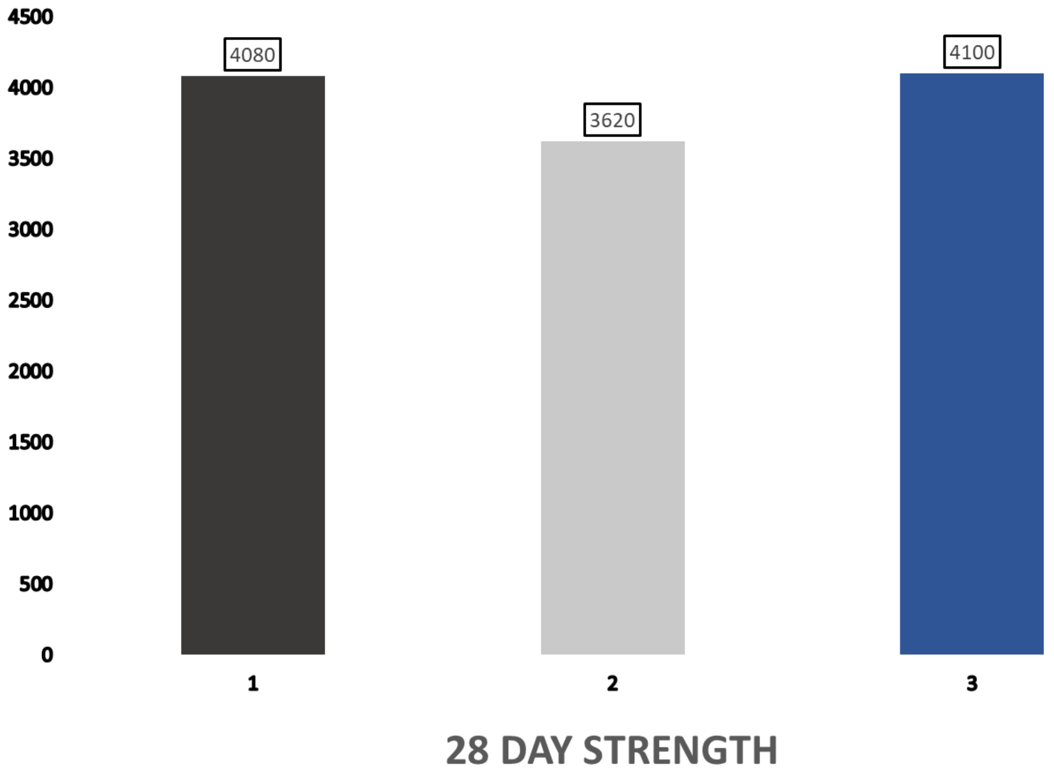
CCUS is better than Direct Air Capture(DAC) - Direct Air Capture removes CO2 from atmosphere while carbon capture technology prevents the release of CO2 from the source itself.

- **Low energy requirement** : CCUS consumes **1/4th** the amount of energy that a DAC CO2 capture facility operates
- **More efficient**: **28** long distance trucks with a carbon capture device that run one shift a day captures more than the largest DAC that currently exists.
- **Retrofitting** : Carbon capture technologies can be easily retrofitted in existing carbon emission sources.

"Even with big breakthroughs in battery technology, electric vehicles will probably never be a practical solution for things like 18-wheelers, cargo ships, and passenger jets. Electricity works when you need to cover short distances, but we need a different solution for heavy, long-haul vehicles."

- Bill Gates

Case Study: CarbonCure – CCU in the Concrete Industry



Design Strength : 3000 PSI

50% OPC 20% Fly Ash 30% Slag

Control Mix 4080psi
✓ Meets Strength Criteria

Cementitious material reduced from mix 3620psi
✗ Strength Reduced

Cementitious material reduced from mix 4080psi
✓ Meets Strength Criteria with reduced cementitious material

The graph shown above compares the **strength** of the concrete with and without CO2 and cementitious material. As is evident, the strength of the mix with CO2 is **more** than the strength of the mix without CO2, thereby we can corroborate the fact that the **addition of CO2 increases the compressive strength** of the concrete.

Case Study: Impact of CarbonCure on the Concrete Industry

4800

Cubic yards of concrete made with CO_2 diverts **1.5 million pounds** of CO_2 from the atmosphere

7%

Reduction in cementitious content in the concrete leads to **significant cost savings**

800

Years of sequestering CO_2 in a US forest would have the same impact as that of 1 concrete project

1.5 M

Tonnes of CO_2 emissions will be reduced if **CCU is applied for all residential concrete**

50%

Emissions of the concrete sector are **process emissions** and CO_2 cured concrete stands as the **only potent solution** to address that

*"We noted a **7.5%** return on investment on our original target of just 1%, upon CO2 curing through CarbonCure"* - Jason Blasé, President, Conewago Manufacturing

Finances of Carbon Capture, Utilization and Storage

Bracket	Task	P&L (INR) per km	P&L (INR)
REVENUE	Revenue from the truck	57.5928	3632800
CAPITAL DEPRECIATION	CCUS Device	-1.0108	-63758
	Truck (HDV)	-3.3668	-212344
	Total Capital Depreciation	-4.3776	-276108
OPERATING COST	Fuel	-20.3	-1177848
	Permits, Insurance, Tolls, Tax etc	-11.3	-712880
	Loading and Unloading	-1.4	-88236
	Driver Salary and Expenses	-4.5	-414200
	Maintainence and Others (Inclusive of IoT-enabled sensors)	-6.8	-435252
	Tyres	-0.9	-56544
TOTAL COST OF OWNERSHIP	Total Cost of Ownership (per km)	-41.2908	-2604520
	Profit Before Installation of CCUS	17.3128	**1092044**
EARNINGS FROM CCUS DEVICE	Earnings from CCUS (per km)	1.8392	115976
TOTAL REVENUE	Revenue from the truck and CCUS	59.432	3748776
PROFIT	**Profit After Installation of CCUS**	18.1412	**1144256**

CAPITAL EXPENDITURE and REVENUE STRUCTURE for CCUS	CAPEX (INR)	STAKE (%)
Cost of CCUS Borne by Fleet Owners in INR (draw from CSR Fund)	318578	66.54
Cost of CCUS Borne by Firms in INR	160222	33.46
Revenue from CCUS for Fleet Owners in INR	115976	66.54
Revenue from CCUS for Firms in INR	58319	33.46

APPENDIX and ASSUMPTIONS	
Life of truck (years)	15
Average Distance Run in a Year by truck	63077
Total distance run by a truck over lifetime	946155
Earnings from CCUS (annual)	$10,125
Over lifespan of the truck	$151,875
Earnings per km	0.16875
Cost of an HDV truck in India (INR)	3187000
Cost of CCUS (USD) (approx.)	6300
Cost of CCUS (INR) (approx.)	478800
Current Profit Margin on Trucks	30.06%
New Profit Margin on Trucks after installation of CCUS	30.52%
Profit Before CCUS	1092044
Profit After CCUS	1144256
Rise in profits (%)	4.78
Earnings from end use of CO2	
Cost of CO2 (INR per kg)	30
HDV Truck emissions (g/km)	183.8
Efficiency of CCUS (%)	50
Earnings from end use of CO2 per km	2.76
Total emissions in a year (kg)	10666.07
Emissions Reduction per truck per year (kg)	**5333.04**
Total earnings per truck per year	174295
Total earnings over lifetime of a truck	2614425
Payback period for CCUS (in years)	**2.75**

RETURNS

Packaging → Transportation → **Returns**

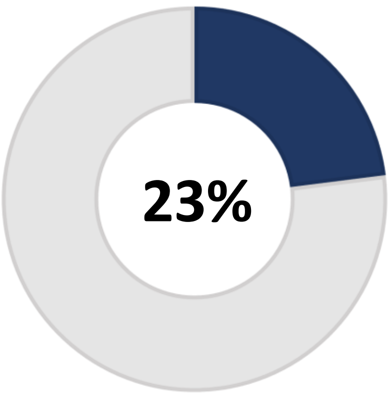
25% of Carbon Emissions of the CPG Supply Chain are caused by Returns.

20% of the Cash on Delivery Orders in 2020, were returned.

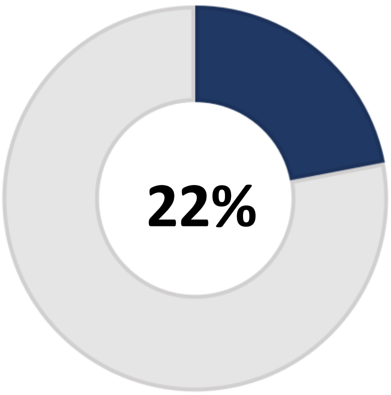
62% of Online Shoppers order only if Returns are free and available

49% of Retailers offer Free Shipping

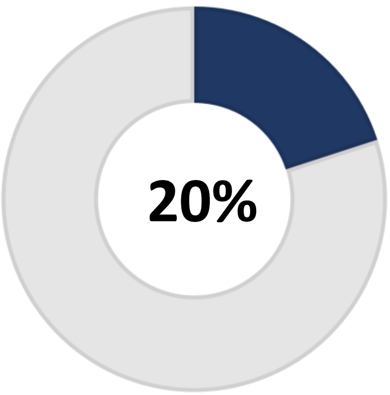
Reasons for Returns



Received Wrong Item



Product Received Looks Different



Received Damaged Product

Implementation of Return Strategy

THE REUSABLE BOX POLICY

At a time, a customer will have just one reusable box with them.

PRODUCT DELIVERY

The delivery executive, delivering the product, will bring the products in one such reusable box.

EXCHANGE OF REUSABLE BOXES

The old box will be returned by the customer when the next delivery arrives at their doorstep.

RETURN POLICY OF PACKAGING

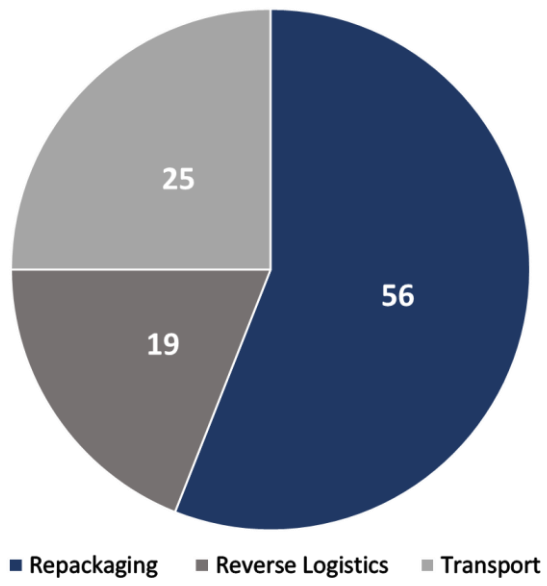
If delivery executive is within a 100m radius of the customer's house, the customer will be alerted, and have the option to return the box.

Guesstimated Financials for Returned Orders (India vs US)

GUESSTIMATE FOR RETURNED ORDERS (BASED ON DATA ABOUT RETURNED ORDERS)		
	USA	INDIA
No of orders per day(in millions)	12.8	9
Return rate	16.6%	17%
Orders returned per day(in millions)	2.1248	1.53
Net Carbon emission (in million tons)	**15**	**10.8**

15 million tons of net carbon emission in 2021 from US being given, the guesstimate is an analysis to find net emission from India in 2021. The return rates and the number of orders for India and US is given and used to find net emission in India, which comes out to be 10.8 million tons.

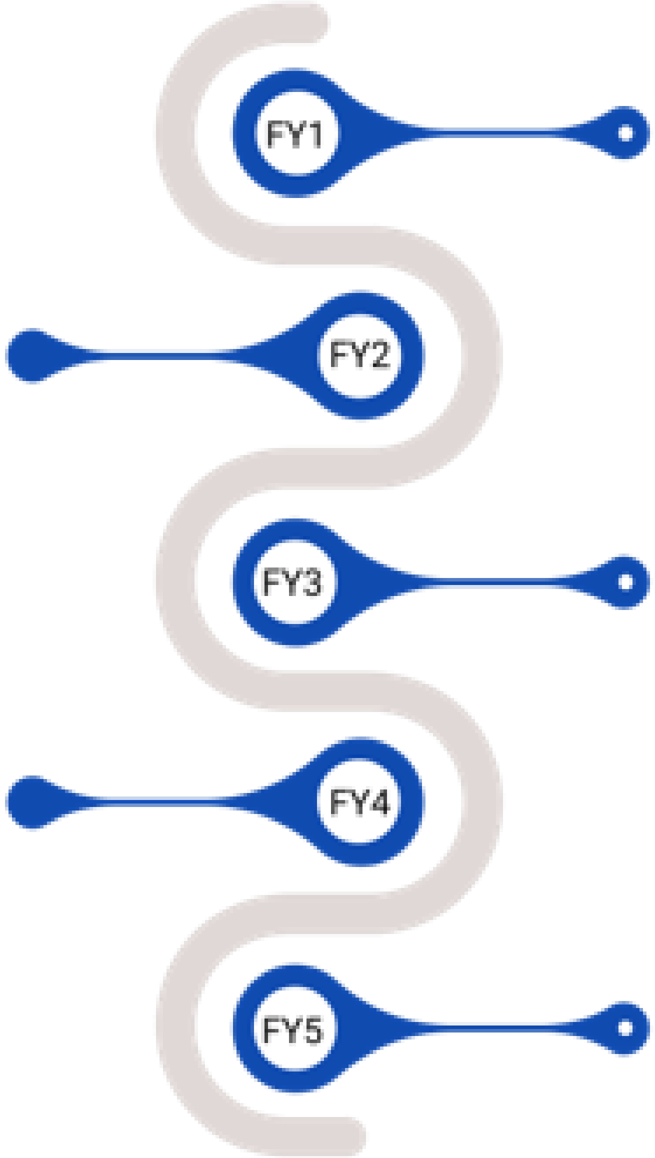
Impact of Returns on Carbon Footprint



- The reusability of OSB boxes for around 10 orders can directly impact around 56% of Carbon Emissions.
- The Strength & Durability of OSB boxes protects the products from Damage that cause 20% Returns.

ROADMAP

Packaging Roadmap



FY1

Gather purchase data, frequency of product dimensions in current inventory.
Start manufacturing OSBs for gradual shift from corrugated cardboard boxes, levied to tier 1 city starting with Premium users.
Offer benefits in terms of Green Cash every time user return OSB boxes.

FY2

Implement ML algo to optimize size of boxes to be manufactured
Introduce interlocking system to the reusable boxes. Start production of OSB boxes with T-loc initially to tier 1 city, from Premium users

FY3

Assess the data from tier 1 cities, rollout OSB boxes with T-loc to tier 2 cities.

Gradual roll out, due to large user base, starting from premium users.

FY4

Analyse the use of forklifts in warehousing to reduce accidents and product damage
Use ML model to further optimize boxes.

FY5

With increasing product usage and OSB return data, optimize algorithm, for efficient results.

Based on analysis of OSB, R&D for finding further efficient materials, smart boxes can be done.

Transportation Roadmap

FY1

NAWCI partners with fleet owners to set up infrastructure for RaaS model freeing up working capital and reduce inventory needs across warehouses and depots.
Introduction of truck health monitoring systems
Profits are earmarked for outsourcing large-scale production of CCUS units.

FY2

RaaS expands by 5.12% to further the profitability.
A section of the profits are earmarked for outsourcing the development of CCUS units.

FY3

CCUS tech deployment in trucks begins, capturing 60% of CO2 emissions in mobile transport.
carbon captured at pitstops are sold to potential buyers, with revenue of INR 30 per kg sold.

FY4

Large-scale CCUS tech deployment ramps up.
Consolidation of more truck fleets with NAWCI is undertaken.
Deploying CCUS in more truck fleets increase profitability and consumer satisfaction along with reduction of 2.5-4% of CO2 emitted by the entire transport industry.

FY5

Re-evaluate the entire situation and pivot to inland waterways transportation.
Scale up CCUS tech installation and explore more industries for selling captured carbon.

Impact: Overall carbon emissions reduction along the supply chain

Carton Optimization and T-locks

53%

Increase in truck spare volume after Carton Optimization.

Oriented Strand Boards

20%

Returns impacted due to damaged goods because of durable OSBs.

Consumer Engagement

88%

Increase in awareness created due to holistic solutions, green cash and so on.

Profitable Initiatives

145%

Increase in profits due do decrease in fuel, overhead, shipping and return costs.

Impacting Carbon Footprint

92%

Decrease in carbon emissions due to truck health monitoring, carbon capture and reduce in trips per volume.