Economics of reuse

For street vendors in India

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Zero Waste Europe

National Hawker Federation

Searious Business

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Executive Summary

India's thriving street food sector, currently reliant on single-use plastics (SUP) for packaging, faces a pressing need for sustainable alternatives. This report delves into the economic feasibility of a novel reuse system tailored to Indian street food vendors. While SUP has long been affordable and accessible, it poses substantial environmental challenges, particularly concerning petrochemical production and post-use disposal. The report conducts a robust cost-benefit analysis to address these concerns, comparing the current SUP system with the proposed reuse system. The study's key objectives encompass an extensive evaluation of the financial implications, cost structures, and potential benefits associated with both systems, emphasising a focus on commonly used street food packaging items, including plates, bowls, cups, and takeaway containers.

The report does not overlook environmental concerns but primarily centres its efforts on the economic dimension of the issue. Its outputs include a well-defined and practical reuse system designed to replace SUP, an in-depth economic comparison shedding light on cost savings, revenue implications, and overall viability, a sensitivity analysis pinpointing influential parameters, and a city-level implementation comparison across five major Indian cities. Stakeholder perspectives are examined, encompassing street vendors, customers and policymakers. Notably, the report culminates in actionable recommendations grounded in practicality and economic viability, providing stakeholders with the necessary insights for informed decision-making.

Methodologically, the report adopts a cost-benefit analysis approach and relies on key performance indicators (KPIs) such as Return on Investment (ROI), Payback Period, and Investment Needed. Reliable input data forms the basis for the quantitative assessments, while key modelling parameters are categorised into packaging, reuse, and local parameters for comprehensive sensitivity analysis. By exploring the economic dynamics of implementing the proposed reuse system across five Indian cities (*Kolkata*, *Delhi*, *Mumbai*, *Nagpur*, and *Ranchi*), the report offers valuable insights into regional variations and considerations.

For the baseline case of *Kolkata*, the findings reveal a **compelling business case**, highlighting **reduced costs for vendors and customers**, a **significant reduction in packaging stock**, and a promising **21% ROI** with a **2.3-year payback period**. Sensitivity analysis underscores the significance of critical factors in optimising the system, like material choice, retention time, return rate, deposit amounts, government incentives, and others.

In conclusion, this report **advocates strongly for the adoption of a reusable packaging system in India's street food sector**. By presenting a synergy of economic viability and environmental sustainability, this system benefits all stakeholders and paves the way for a more resilient and sustainable future for Indian cities.

REUSE ADDS UP

Introduction

Background information and context

Single-use plastics, such as plates, cups, and takeaway containers, dominate street food vending across India. This can be attributed to several factors, including their current affordable pricing, accessibility, and the inertia of maintaining the status quo. While plastic serves its purpose by providing durability and safety for food consumption, it also poses **significant challenges** throughout its lifecycle.

The production of these plastics is inherently linked to petrochemical processes, a major source of **carbon dioxide (CO_2) emissions** contributing to climate change. Even if plastics were produced from bio-based sources, the issue of post-use disposal remains requisite. Typically, these plastics end up in one of three fates: landfilling, incineration, or recycling. The first two methods have detrimental environmental consequences. Landfills contribute to soil and groundwater pollution, and incineration generates harmful greenhouse gases. Even recycling, though a more sustainable option, still faces its limitations. Recycling infrastructure is still in its infancy, and only a small fraction of recycled plastics will re-enter the value chain. Recycling remains an energy-dependant form of waste management, not achieving overall waste reduction.

To address these challenges, exploring alternatives becomes imperative. One promising approach is adopting **reusable systems**, wherein items initially designed for single use are reimagined for durability and multiple applications. However, the successful implementation of such systems hinges on **resolving complex logistics**, including distribution, collection, cleaning, and redistribution of these items. The viability of these solutions varies depending on the specific use case.

This report narrows its focus to the **street food vending sector in India**, characterised by a high density of vendors and extensive reliance on single-use plastics operating within an open-loop system. This makes exploring a new reuse system particularly **impactful** and relevant in the Indian context.

FIGURE 1: TYPICAL WASTE MANAGEMENT SYSTEM (LANDFILLING, INCINERATION)

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Objectives and scope of the report

The primary objective of this report is to conduct a comprehensive economic assessment of the feasibility of implementing a reuse system for street food vendors operating in India.

The report focuses on the following key aspects:

1. **Comparison of Single-Use vs. Proposed Reuse System**: The report rigorously compares the economic aspects of the existing single-use plastic system with a newly proposed reuse system. Specifically, it assesses the financial implications, cost structures, and potential benefits associated with both systems.
2. **Scope of System**: The analysis encompasses a specific set of products commonly used by street food vendors, including plates, bowls, cups, and takeaway containers. These items represent the core components of the street food service.
3. **Exclusion of Environmental Analysis**: It is important to note that this report does not include an in-depth environmental analysis beyond evaluating the quantity of plastic waste generated and managed within each system. While environmental concerns are significant, this study primarily focuses on economic factors.

Outputs of the report

This report aims to generate several key outputs and findings, including:

- **Proposed Reuse System**: The report presents a novel reuse system tailored to the specific needs and local realities of street food vendors in India. This system serves as a practical alternative to the existing single-use plastic system, considering the unique characteristics of the Indian street food sector.
- **Economic Comparison**: The report provides a comprehensive economic comparison, contrasting the financial aspects of the proposed reuse system with the current status quo. This analysis sheds light on the potential cost savings, revenue implications, and overall economic viability of adopting the new system.
- **Sensitivity Analysis**: Through a sensitivity analysis, the report identifies and prioritises the parameters within the proposed reuse system that significantly influence its economics. This insight guides the design and optimisation of the system to enhance its effectiveness.
- **City Implementation Comparison**: An evaluation of the economic feasibility and practical challenges associated with implementing the proposed system is conducted across five diverse cities in India. This comparative analysis highlights regional variations and considerations for successful adoption.
- **Stakeholder Perspectives**: The report delves into an examination of both the benefits and costs incurred by core stakeholders (street vendors, customers, dishwashing centre, municipality) involved in adopting the reuse system. This holistic view encompasses street food vendors, consumers, policymakers, and environmental considerations.
- **Conclusions & Recommendations**: Drawing upon the insights from the cost-benefit analysis and the real-world nuances of the Indian market, the report provides actionable recommendations for implementing the proposed reuse system. These recommendations are grounded in practicality and economic viability, ensuring their relevance to the local environment.

Methodology

Cost-benefit analysis approach

In this section, we outline the core component of our methodology: the cost-benefit analysis. This analysis serves as the foundation for comparing the economic viability of the existing single-use system with the proposed reuse system. To support this analysis, we develop an economic model that enables the comparison of various scenarios using Key Performance Indicators (KPIs) and cash flow diagrams.

Key performance indicators (KPIs) for comparison

- **Return on Investment (ROI)**: ROI measures the profitability of an investment by assessing the ratio of net gain or loss relative to the initial investment. It provides a clear picture of the financial returns generated by each system.
- **Payback Period**: The payback period represents the time required for the cumulative benefits of an investment to equal or surpass the initial investment. It indicates how quickly an investment can recoup its costs.
- **Investment Needed**: This metric quantifies the capital required to implement the proposed reuse system, helping stakeholders understand the financial commitment involved.

In our analysis, we calculate these KPIs by considering the following financial components:

- **Capital Expenses**: These encompass the upfront costs associated with transitioning to the proposed reuse system, including expenses related to infrastructure, equipment, and initial setup.
- **Operational Expenses**: These ongoing costs pertain to the day-to-day operations of both systems and include labour, maintenance, and utility costs.
- **Revenue**: Revenue generation is a critical component involving all the income streams.
- **Cashflow**: The cashflow analysis outlines the inflow and outflow of funds over time, reflecting the financial dynamics of each system.
- **Cumulative Cashflows**: This component illustrates the accumulation of cash inflows or outflows over time, enabling us to understand the financial trajectory of each system.

Furthermore, it's important to note that input data and parameters are integral to our cost-benefit analysis.

Input Data & Parameters

- **Input Data**: These data points are essential for the calculations within our analysis. They include information such as current prices of single-use plastics, utility costs, and material properties. It's worth highlighting that our partners in India generously provided our input data and serves as the foundation for the quantitative assessments in this study.
- **Parameters**: Parameters represent values that remain constant within a single case analysis but can be adjusted to explore their impact on the system's economics. Through our sensitivity analysis, we investigate the influence of these parameters to identify which factors have the most substantial impact on the feasibility and performance of the reuse system. This examination provides crucial insights for system design and optimisation.

Description of key modelling parameters

Through the comprehensive sensitivity analysis, we aim to identify the critical factors and scenarios that have the most significant impact on the feasibility and performance of the proposed reuse system. These insights will guide system design, optimisation, and decision-making in real-world implementation. The key modelling parameters of the analysis have been structured in three core categories:

A. Packaging parameters:

1. **Material**: The reusable packaging items can be made from different materials. For the scope of this study, plastic and metal materials will be compared. The focus here is on costs related to acquiring these items and the annual waste generation, which the municipality must manage.
2. **Packaging Types**: Different types of packaging items are being used by street food vendors. In this study, plates, cups, bowls, and takeaway containers will be examined.
3. **Cleaning Cost**: Cleaning reusable items is a significant operational expense. Analysing variations in cleaning costs can help optimise the overall cost structure of the system.
4. **Deposit (No-Return Fee)**: The deposit amount or any associated no-return fees can influence customer behaviour and incentive to participate in the reuse system.

B. Reuse parameters:

1. **Rotation Cycles before End-of-Life (EOL)**: This parameter is essential for understanding the lifespan of reusable items before they reach their end-of-life. It has direct implications for replacement frequency and costs.
2. **Return Rate**: Examining the rate customers return reusable items after use is crucial for calculating the system's efficiency and evaluating its impact on waste reduction.
3. **Retention Time**: The duration customers retain reusable items before returning them to the system affects the operational logistics and the frequency of item replenishment.

C. Local parameters

1. **Transportation Vehicle**: The choice of transportation vehicle for collecting and distributing reusable items plays a pivotal role in the efficiency and cost-effectiveness of the reuse system.
2. **Tax Rate**: Taxation policies, including the taxation of single-use plastics (SUP), can affect the financial landscape for both the existing single-use system and the proposed reuse system.
3. **Number of Vendors**: The total number of street food vendors in a given area directly affects the scale and scope of the reuse system.
4. **Demand per Vendor**: Understanding the demand for reusable items per vendor is crucial for resource allocation and inventory management.
5. **Vendor Density**: Vendor concentration in an area can impact the system's logistics, such as collection and distribution.
6. **Distance from Dishwash Centres**: The proximity of vendors to dishwasher centres influences transportation costs and operational efficiency.

Implementation in 5 cities in India

It is imperative to anchor our analysis in the **realities of specific cities** to gain a comprehensive understanding of the economic dynamics at play. To achieve this, we will undertake a comparative analysis encompassing five diverse cities in India (*Kolkata*, *Delhi*, *Mumbai*, *Nagpur*, *Ranchi*). This comparative approach allows us to evaluate the economics of the proposed reuse system under various scenarios and across different urban landscapes.

Full Implementation Exploration: It is important to emphasise that our analysis will consider a full-scale implementation of the system in each city. While real-world implementation may occur progressively and incrementally, a comprehensive comparison at full capacity enables us to grasp the complete economic picture and scale of the proposed reuse system.

By examining the economic viability and practical challenges across these diverse urban settings, we can provide more nuanced insights and recommendations that cater to the varying dynamics of each city, ultimately facilitating informed decision-making for stakeholders and policymakers.

Proposed reuse system

This section explains the current system, that is being used by street food vendors in India, as well as the proposed reuse system.

Current system

Under the prevailing system, street food vendors in India engage in *a linear packaging distribution, utilisation, and waste disposal process*. The key facets of this system include:

- **Acquisition of Single-Use Plastics (SUP):** Street food vendors procure single-use plastic items, encompassing plates, bowls, cups, takeaway containers, and related items, through established distribution channels.
- **Distribution to Customers**: These single-use plastic items are then handed to customers alongside their meals as part of the street food service.
- **Disposal**: Customers subsequently dispose of the SUP in designated collection systems, often managed by local municipalities.

In the current market, plastic products follow a linear journey from production to waste management, with minimal integration of a robust reuse system that could potentially reduce the need for new items. The absence of effective reutilization mechanisms perpetuates the cycle of plastic consumption, contributing to environmental challenges associated with waste disposal and the depletion of finite resources.

New system

The proposed reuse system introduces a comprehensive shift in the approach to packaging for street food vendors in India. Key components of this new system include:

- **Reusable Packaging**: A fundamental aspect of the new system involves the introduction of reusable packaging items designed to withstand multiple uses and washing cycles. These items, such as plates, bowls, cups, and takeaway containers, are engineered to ensure durability and safety for food consumption.

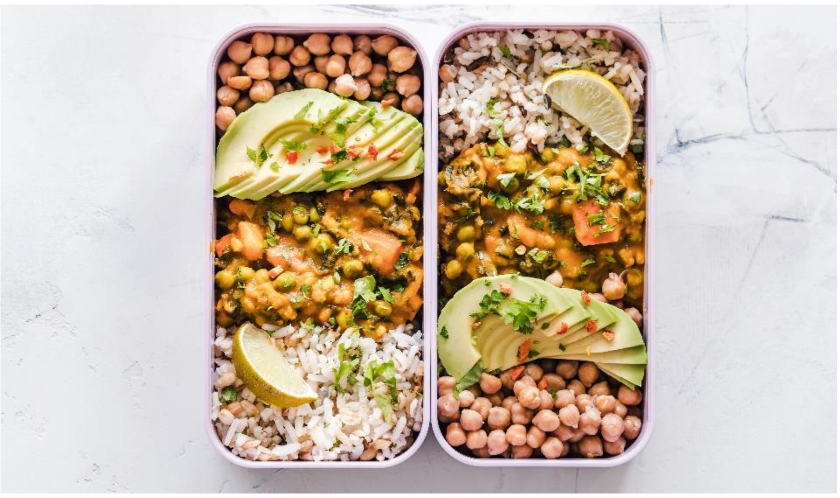

FIGURE 2: CONCEPT OF REUSABLE PACKAGING

- **Washing System**: To facilitate the reusability of these items, a washing system must be established. This system can operate at various levels, including vendor, street, and area levels. However, each level presents unique considerations:
    - **Vendor Level**: While washing at the vendor level may seem intuitive, it poses challenges related to health and safety measures. Handwashing dishes is not preferable, and the logistics of implementing dishwashing machines for each vendor are complex and economically impractical.
    - **Street Level**: Implementing washing facilities on the street level faces issues of space constraints and concerns related to the possibility of vandalism and theft of washing machines and equipment.
    - **Area Level**: The area-level washing system emerges as the most promising option. It involves large-scale washing facilities equipped with substantial dishwashers. The system is operated by an external entity that ensures compliance with health and safety standards. *For the purposes of this study, area-level dishwashing was deemed the most suitable.*

FIGURE 3: CONCEPT OF DISHWASHER CENTRE

- **Distribution of Packaging Items**: Efficient management of clean and dirty packaging items is essential. To optimise this process, a central organisation is crucial. Given the need to cover significant distances and manage large packaging volumes daily, *transportation vehicles* are required. Two alternatives will be explored: bicycles with carts capable of carrying multiple crates of plates or medium-sized trucks. It's essential to note that the truck option may produce CO_2 emissions, but for the purposes of this research, we focus solely on economics, <u>omitting environmental considerations</u>.
- **Collection and Return of Plates**: Customers will receive reusable plates from vendors, and they can return these plates either to the same vendor or to nearby deposit stations on the street. Food is commonly consumed at the vendor's kiosk or taken away to enjoy elsewhere. This flexibility in the return process is designed to enhance customer convenience.

FIGURE 4: BICYCLE CART

FIGURE 5: QR CODE APP

- **Logistics Management**: Effective logistics management is paramount to ensure the smooth functioning of the system. Two key aspects are:
    - **Return System**: Encouraging customers to return reusable plates in a timely manner is crucial. To incentivise returns, a *deposit system* is proposed. Customers provide a small deposit, which they can retrieve upon returning the plate. The deposit amount must strike a balance, discouraging plate disposal while remaining affordable. Two options are presented: one involving a mobile app and another that does not. The choice between them may depend on local realities and accessibility. Hybrid models may also be considered to accommodate users without mobile phones. The app-based system offers incentives, rewards, and discounts to foster customer and vendor participation, benefiting both economically. It should be noted that when eating directly at the kiosk, a deposit might not be necessary to simplify the process.
    - **Packaging Monitoring**: A monitoring system employing unique codes, such as barcodes or QR codes, will track individual packaging items. Vendors and customers can scan these codes, enabling the system to record who possesses the plate and when it was last scanned. This tracking system supports the deposit-based return system and helps manage inventory by monitoring stock depletion.
- **Ownership**: The proposed system necessitates the *establishment of a third-party entity* responsible for managing the logistics of reusable packaging. This entity would acquire reusable plates, distribute them to vendors, facilitate the return of dirty plates to the dishwashing facility, oversee the washing process, and ensure the clean plates are returned to vendors. Collaborative efforts with street food vendor associations could be explored, considering their close ties to the dishwashing centre's operations.

The introduction of this new system represents a transformative approach to packaging for street food vendors in India, aiming to enhance sustainability, economics, and overall operational efficiency while addressing environmental concerns.

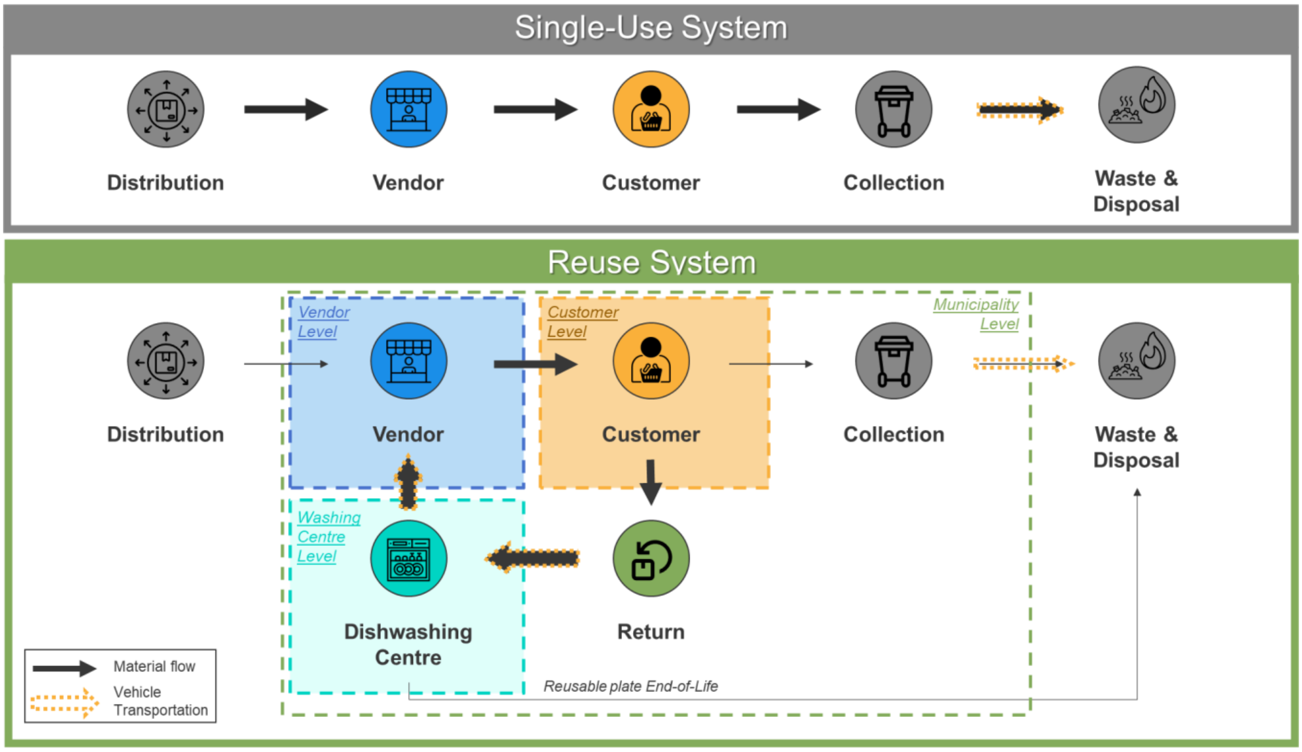

FIGURE 6: HIGH-LEVEL COMPARISON OF THE CURRENT AND THE PROPOSED SYSTEM

Deposit system explanation

At this point, it is important to explain how the deposit system works from the perspective of the key stakeholders. The customers need to place a small deposit to the app to be able to participate in the reuse system. As we discussed earlier, the system can also work with physical cash deposits, however, the app facilitates the process and allows enhanced capabilities. Once the deposit has been verified, the vendors can give a clean plate to the customer. If the customer returns the plate directly to the vendor or a smart return bin, the deposit is immediately released for reclaim. This means that the deposit is only "frozen" as long as the customer is in possession of the reusable packaging. On the other hand, if the customer does not return the packaging, then the deposit is kept as a no-return fee by the dishwashing centre (which owns the reusable packaging). See Figure 7:

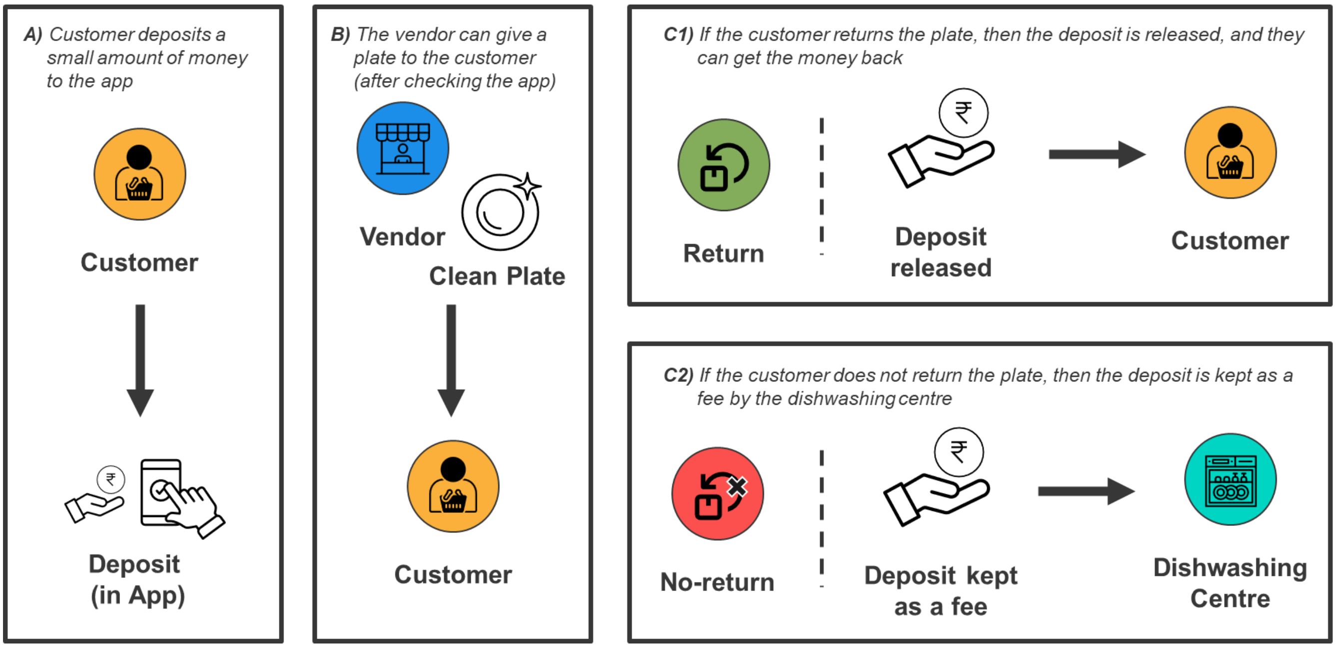

FIGURE 7: VISUAL EXPLANATION OF HOW THE DEPOSIT SYSTEM WORKS

Important clarifications:

- The **dishwashing centre** will derive a portion of its revenue from non-returned items. This means that if a deposit amount is too high, the centre may inadvertently benefit from a high non-return rate. i.e., the centre might become more profitable when fewer people return their plates, creating a conflict of interest between two key stakeholders. The deposit amount should be set at an appropriate level that consistently maintains the dishwashing centre's revenue, regardless of customer return rates. Ideally, the centre's financial viability should improve as the return rate increases, incentivising the promotion of plate return. By doing that, the environmental benefits are also optimised, as there is less need for restocking and less packaging ends in the waste management system.

- The **system only penalises the customers** if they do not return the packaging. The deposit they pay should be high enough to incentivise return but low enough to encourage participation.

- The **vendors** only pay for acquiring the clean plates from the dishwashing centre. The washing fee should be lower than the current price that they pay for single-use plastic packaging to incentivise participation. As such, the return rate does not affect them.

Assumptions

In this section the input data, along with the assumptions that were made, are presented.

Input Data[1]

TABLE 1: VARIOUS MODELLING ASSUMPTIONS

Name	Value	Unit
Salary (unskilled worker) [2]	₹ 10,000.00	rupees/month
Salary (skilled worker) [3]	₹ 12,000.00	rupees/month
Rent (dishwasher centre) [4]	₹ 6,000.00	rupees/month
Dishwasher cost (100 racks/hr)	₹ 945,000.00	rupees
Dishwasher elec. consumption	20	Kwh
Dishwasher water consumption	2.7	litres/rack
Dishwasher detergent consumption [5]	₹ 15.00	rupees/1000 plates
Rack cost	₹ 30.00	rupees
Rack weight	2.4	kg
Water cost	0.02	rupees/litre
Electricity cost[6]	9.66	rupees/kwh
Electricity (truck) [7]	₹ 4,590.00	rupees/vehicle/month
Vehicle (truck) cost	₹ 1,000,000.00	rupees
Vehicle (bicycle cart) cost	₹ 25,000.00	rupees
App development cost	₹ 3,000,000.00	rupees
App maintenance cost	₹ 50,000.00	rupees/month
Setup costs [8]	₹ 50,000.00	Rupees / per 300 vendors
Company setup costs (legal fees, registration)	₹ 50,000.00	rupees
Working hours of vendors	10	hours

[1] The values were estimated based on data given by our partners in India.
[2] Wages are based on minimum, fair wages in India, excluding child labor, and explicitly giving equal opportunity to both men and women. Unskilled workers are needed for the operation of the dishwashing machines or for transporting the packaging items on the bicycle carts.
[3] Skilled workers are needed for the operation of the trucks that are transporting the packaging items.
[4] It is assumed that the rented space is enough to fit four large dishwashing machines and the packaging stock. It is also assumed that in each location four people are employed, one of which is supervising the operations.
[5] An estimate based on similar applications.
[6] This estimate is higher than the electricity cost in most cities. However, since electricity prices are increasing, it is useful to make the calculations with a higher rate.
[7] Estimate consumption. It could vary based on the model used.
[8] Communication materials, educating vendors, drop-off station for reusables

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Average distance between street and dishwashing centre	2.5	km
Average vendor street length	1.5	km
Average bicycle speed	15	km/hour
Average truck speed [9]	20	km/hour
Time for racks refill & rest at dishwashing centre[10]	10	min

TABLE 2: PACKAGING ITEM DELIVERY AND SPEED BASED ON THE VENDOR DENSITY

	Low vendor density	**Medium** vendor density	**High** vendor density
Packaging item delivery and receive speed - **Bicycle**) [racks/min] [11]	0.8	1.0	1.2
Packaging item delivery & receive speed - **Truck** [racks/min]	1	2	3

TABLE 3: INPUT DATA RELATED TO THE FOUR PACKAGING ITEM TYPES

Type	Packaging item	Cost	Weight (kg)	Items/rack[12]
Single-Use	Plate	₹ 0.60	0.01	-
	Bowl	₹ 0.60	0.01	-
	Cup	₹ 0.60	0.01	-
	Takeaway container	₹ 2.00	0.02	-
Reusable (Plastic)	Plate	₹ 30.00	0.08	20
	Bowl	₹ 30.00	0.09	12
	Cup	₹ 20.00	0.06	16
	Takeaway container	₹ 40.00	0.10	8
Reusable (Metal)	Plate	₹ 60.00	0.08	20
	Bowl	₹ 40.00	0.09	12
	Cup	₹ 40.00	0.06	16
	Takeaway container	₹ 100.00	0.10	8

[9] Average speed is low as the streets near the markets might be busy.
[10] During this time, the racks are refilled with the washed plates (or the new from the storage)
[11] These values relate to speed of delivering and receiving the packaging items *after* the delivery vehicle reaches the street for delivery. The values vary depending on the vendor density, as denser streets will have vendors closer to each other and therefore the delivery therefore receiving can happen faster. Similarly, trucks are faster so they have increased speed.
[12] Based on the typical sizes of the 4 packaging items it is possible to estimate how many can fit in each rack.

TABLE 4: INFORMATION ABOUT ITEM TYPES IN THE MARKET

Packaging item	Percent in the market [13] [14]	Retention Time (days)[15]
Plate	20%	1
Bowl	20%	1
Cup	20%	1
Takeaway container	40%	5

[13] Based on the estimated percent of each packaging item on the market it is possible to model the logistics for the inventory items that are needed. To simplify the modelling a packaging item with the weighted average of the costs, weights and items per rack is assumed.

[14] It is also assumed that 50% of all the meals are currently served in single-use plastic items. The remaining 50% mainly refers to dine-in options that are being used. The proposed system therefore aims to replace the SUP items.

[15] Referring to the time that the customer retains the packaging item.

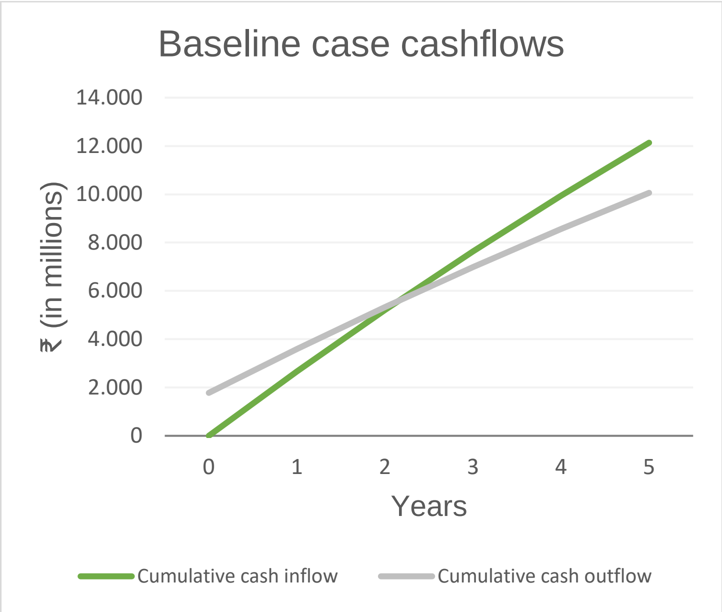
Baseline Case: Single-use vs Reusable Packaging

- For the baseline case, **Kolkata** was selected[16]
- For the reusable packaging material, **plastic** was selected
- A **return rate of 98%** was assumed, which is within the typical estimate range of reuse systems
- The **deposit**, and subsequently the no-return fee, was chosen to be **₹ 70**
- This can help keep the return rate high, and likely without impacting the vendor sales
- The **bicycle cart** was chosen as the vehicle for transporting the packaging items

		Baseline Case
Input - Parameters	Location	Kolkata
	Number of vendors	80,000
	Demand per day per vendor [17]	75
	Vendor density	Low
	Distance (d/w centre to street) [km]	2.5
	Tax rate[18]	18%
	Material	Reusable Plastic
	Number of cycles before EoL	500
	No-return rate per cycle	2%
	Return period	2.6
	Deposit (No-return fee)	₹ 70.00
	Item cleaning cost per item	₹ 0.70
	Vehicle	Bicycle

		Baseline Case
Output (Single-use)	Single-use items needed per year	**2,190,000,000**
	Yearly cost of single-use items	₹ 2,540,400,000
	Plastic produced per year [tonnes]	30,660
Output (Reuse)	Plate stock needed per year	**47,591,619**
	Number of vehicles needed	1783
	Number of dishwashers	469
	Number of dishwash facilities	118
	Personnel (Vehicle)	1783
	Personnel (Dishwasher)	469
	Delivery cycle time (min)	73
	Plastic produced per year [tonnes]	4430
	Reduction of plastic waste	**86%**

[16] This was done to showcase the implementation at a realistic scale. The other cities are compared on the "*Implementation in 5 cities in India*" section of the report.
[17] The total estimated demand for meals per vendor per day is 150. However, since we assumed that only 50% of those meals are served in SUP items, then the demand for SUP per vendor per day is 75.
[18] Based on the goods and services tax in India.



Investment Needed	**₹ 1,796,900,270**
Net Present Value (NPV)	₹ 1,278,516,429
Return on Investment (ROI)	**21%**
Payback Period [Years]	**2.3**

Key Takeaways – Baseline Case

A) Single-use system

- The 80,000 vendors in Kolkata collectively pay **~2,540 million rupees** for single-use plastic packaging each year.
- They require **2,19 billion items of packaging** per year.
- This packaging ends up in the waste management system or the environment and is approximately **30,660 tonnes of plastic per year.**

B) Proposed reuse system

- The 80,000 vendors in Kolkata will now need to pay **₹ 0.70** for each clean plate instead of the higher prices for single-use plastic (average **₹ 1.16** in our case).
- The vendors will need to pay collectively **~1,533 million rupees per year** for clean plates (**40% reduction compared to the current single-use system)**
- The **customers** also have a **collective benefit of ~504 million rupees per year** (half of the savings of the vendors), given out in the form of **return customer benefits** and **discounts** to **increase the demand.**
- The **yearly stock** of reusable plates is now only 47,591,619 packaging items (**98% reduction**).
- The packaging that ends up in the **waste management system (or leaked into the environment)** is therefore **reduced by 86%,** leading to significant savings for the municipality. These savings could **finance the investment** via an outcome-based funding mechanism.
- The total investment is also highly promising since, in **2.3 years,** the investment will be repaid, and the **return on investment is 21%.**
- The **1,796 million rupees** required for the investment might seem heavy. However, if we consider that **2,540 million rupees** are being used yearly for acquiring single-use plastics, then the investment is relatively low.

Overall, there is a strong business case for reusable packaging for street vendors in India, benefiting the vendors, the customers, the municipality and the dishwasher centre.

Sensitivity Analysis

In this section, the effect of various design parameters on the economics of the system is explored. Based on the scope of this project, the sensitivity analysis focused on the following parameters, which can help us answer the subsequent questions:

A. **Packaging Parameters**
   1. **Material:** Should we choose metal packaging?
   2. **Packaging types composition:** What happens if we introduce only takeaway containers?

B. **Packaging Parameters**
   1. **Rotation Cycles before End-of-Life (EOL):** How durable should the packaging be?
   2. **Return Rate:** Does a lower return rate negatively affect the economics?
   3. **Retention Time:** What if customers keep the packaging for longer?

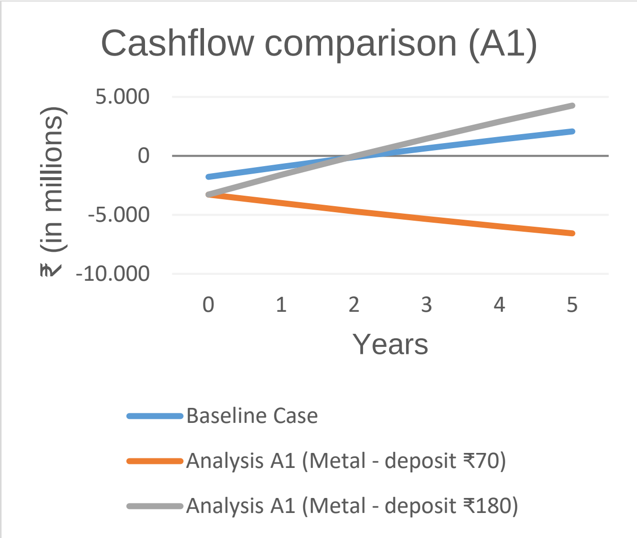
C. **Packaging Parameters**
   1. **Transportation Vehicle:** Should we use trucks or bicycle carts?
   2. **Tax rate:** Can the government assist in this venture?
   3. **Number of vendors:** How many vendors should be included?

TABLE 5: KEY DESIGN PARAMETERS. THE EFFECT OF THOSE COLOURED IN GREEN ON THE ECONOMICS OF THE SYSTEM WILL BE TESTED.

A. **Packaging** Parameters	B. **Reuse** Parameters	C. **Local** Parameters
1. Material: Plastic vs Metal	**1. Rotation Cycles before End-of-Life (EOL)**	**1.Transportation Vehicle**
2. Packaging Types Composition	**2. Return Rate**	**2. Tax rate**
3. Cleaning Cost	**3. Retention Time**	**3. Number of vendors**
4. Deposit (no-return fee)		4. Demand per vendor
		5. Vendor density
		6. Distance from dishwasher centres

A. Packaging parameters

1. Material: Plastic vs Metal



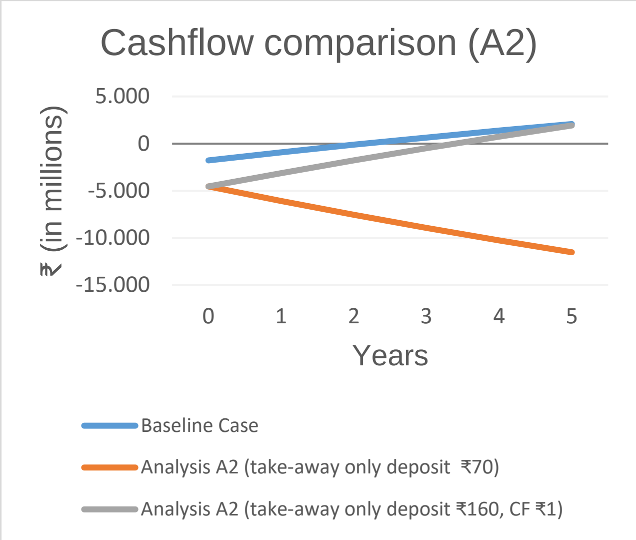
	Baseline Case	Analysis A1 (Metal - ₹70)	Analysis A1 (Metal - ₹180)
Investment Needed (₹ in mil.)	₹ 1,796	₹ 3,312	₹ 3,312
NPV (₹ in mil.)	₹ 1,278	-₹ 30,172	₹ 3,736
ROI	21%	-35%	23%
Payback Period (Years)	2.3	-5.0	2.2

Should we choose metal packaging?

- There are two differences between **reusable plastic and metal** packaging: purchase cost and number of cycles until the end-of-life.
- The number of cycles until the end-of-life for both cases (500 for reusable plastic, 1000 for metal) is **much higher** than the number of revolutions the packaging will realistically undergo before not being returned (46 on average). This means the packaging gets "lost" much sooner than it reaches its end of life due to wear and tear.
- As such, there is **no immediate economic benefit** to choosing metal, which is much more costly than plastic. This can also be seen in the cash flow diagram comparison (A1) where the metal option is not profitable.
- To make it profitable, we would need to **change another parameter**, for instance, the **deposit** amount (cost of no return). In the case of A1, for example, we raised the deposit amount to **₹180**, making the venture profitable. However, it should be noted that the increased deposit will have a **direct impact on the sales of the vendors**, thus reducing the street food vendor business.
- It should be noted that metal packaging **might be a promising option** if a proper waste management and recycling system is in place. In this case, the metal that ends up in the recycling could be **reintroduced into the system**, thus **reducing the environmental impact** and the usage of recycled content in the packaging. A full lifecycle assessment would need to be made to investigate if this is a good option.

Overall, metal packaging is generally not a promising option as it significantly increases the capital and operational expenses without providing any economic benefit.

2. Packaging Types Composition (Takeaway container only)



	Base Case	A2 (₹70)	A2 (₹160,₹1)
Investment Needed (₹ in mil.)	₹ 1,796	₹ 4,586	₹ 4,586
NPV (₹ in mil.)	₹ 1,278	-₹ 49,370	-₹ 7,286
ROI	21%	-45%	8%
Payback Period (Years)	2.3	-3.3	3.5

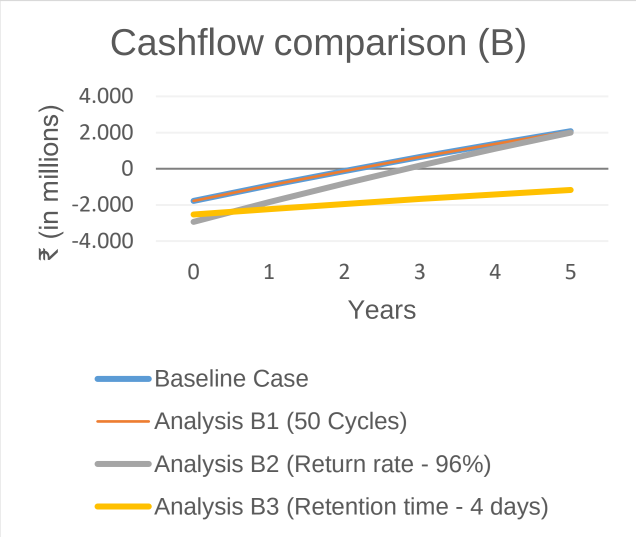
What happens if we introduce only takeaway containers?

- Takeaway containers account for the **majority of SUP** that are used in the street food vendor market. Therefore, it makes sense to investigate what would happen if we only introduced these containers (and not plates, cups or bowls). A **pilot** of such a reuse system might also include only packaging for takeaway, making this analysis particularly relevant.
- The takeaway containers have a **higher cost of purchase**, **bigger size** (meaning that less of them can fit in each washing crate), **higher weight** and **higher retention time** (since they are not returned on the spot but first taken to another location for consumption). All of those factors **affect the economics of the system**.
- If we do not change any other parameters (A2), then it is evident that there is **no business** case for takeaway containers.
- However, since the takeaway is more costly than on-the-go consumables and will be kept longer, increasing the deposit amount and cleaning cost makes sense. In this case (A2, deposit ₹160, cleaning cost ₹1), the payback period is increased from 2.3 years to 3.5 years, which is still viable.
- Even though a higher investment will need to be paid (as the takeaway containers are more costly than plates, bowls and cups), in the long term, the **economics are favourable**.

Overall, introducing only takeaway containers can be profitable. However, it should also be accompanied by a relatively higher deposit and cleaning cost.

B. Reuse parameters

(B1. Number of cycles before EoL, B2. return rate, B3. retention time)



	Baseline Case	B1 (50 c.)	B2 (RR - 96%)	B3 (4 days)
Investment Needed (₹ in mil.)	₹ 1,797	₹ 1,797	₹ 2,969	₹ 2,558
NPV (₹ in mil.)	₹ 1,279	₹ 1,279	-₹ 2,367	-₹ 11,100
ROI	21%	21%	12%	-8%
Payback Period (Years)	2.3	2.3	3.0	9.3

How durable should the packaging be?

- For the baseline case, it was assumed that a typical reusable plastic item could last approximately 500 use cycles. However, based on the system's design, the average packaging item in the system realistically undergoes only 46 cycles before not being returned. As such, the bare minimum durability of the items should be enough to withstand this number of cycles.
- In the diagram, the **durability of the packaging items was reduced to 50 cycles (B1) from 500 cycles**. As it can be seen, the baseline case and case B1 overlap as there is **no impact on the system requirements**.
- By reducing the durability of each item, the **amount of plastic per item** and the **cost of purchasing them are reduced** without losing their effectiveness. In reality, however, it is **not easy** to **assess the durability** of each item with such precision.

Ideally, the packaging should be durable enough to withstand enough wear and tear before not being returned. It should not be too durable so that material and thus cost is wasted.

Does a lower return rate negatively affect the economics?

- By reducing the return rate, it is necessary to increase the holding stock of the packaging items so that there can be enough to last until the end of the year before needing to restock. This increases the **investment that needs to be made**.
- On the other hand, the items that are not returned are also a **source of income for the dishwashing stand**. A detailed graph of the deposit-return system can be found on page 12 (Figure 7:Visual explanation). If the deposit price is high enough, the dishwashing stand could benefit from the no-returns. This should be avoided as it goes against the reuse system and can incentivise theft.
- In the case of B2, where the return rate is **decreased from 98% to 96%**, it can be seen that the investment required is increased, and the return rate is decreased. As such, the dishwashing centre is incentivised to keep the return rate high, meaning less replacement stock needs to be purchased, reducing the environmental impact.
- It is worth noting, at this point, that this study is considering a (economically) **worse scenario** compared to the actual realities in India. As mentioned, the return rate was considered the same for all packaging types (plates, bowls, cups, takeaway containers). However, the plates, bowls and cups are used when the customers eat at the kiosk and as such, have a very high return rate. Therefore, the stock needed for these items would be much lower, thus requiring less capital and yearly operational significantly improving the system's economics.
- ***A lower return rate leads to the replacement of stock, which would reduce the profitability of the dishwashing centre.***
- ***A proper deposit amount should be selected so that the dishwashing centre does not benefit from an increase in no-returns.***

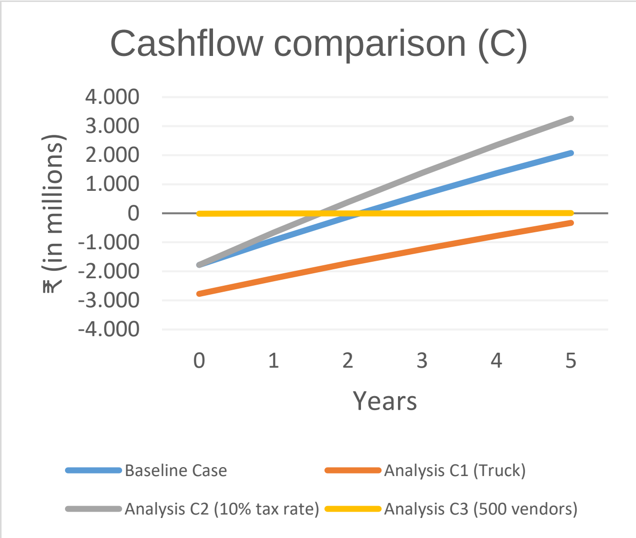
What if customers keep the packaging for longer?

- In the case of B3, the retention time was increased from **2.6 to 4 days,** meaning the customers could **keep the packaging items for longer**.
- As such, there is a **need for increased stock levels**, thus **decreasing the profitability** of the venture significantly.
- A **longer retention** time should be **accompanied by a higher deposit**. Using an app, as proposed in this system, it could be possible to adjust the retention time the customer is allowed to keep the packaging by increasing the deposit.

To allow a flexible system for the customers and, at the same time, a profitable business case for the dishwashing stand, it is proposed that a longer retention time should be accompanied by a higher deposit.

C. Local parameters

(C1. Type of transportation vehicle, tax rate, number of vendors)



	Baseline Case	C1 (Truck)	C2 (Tax 10%)	C3 (500 v.)
Investment Needed (₹ in mil.)	₹ 1,797	₹ 2,802	₹ 1,797	₹ 14
NPV (₹ in mil.)	₹ 1,279	-₹ 9,166	₹ 4,984	-₹ 18
ROI	21%	-3%	32%	10%
Payback Period (Years)	2.3	5.7	1.8	3.3

Should we use trucks or bicycle carts?

- As can be seen from case C1, using electric trucks instead of bicycle carts is detrimental to the system's economics. A benefit could be that fewer trucks and drivers are required. However, a **higher investment** (in buying the trucks) and **higher operational expenses** (electricity) will be incurred. It was also assumed that the trucks have a higher speed than the bicycle carts. However, this might not be the case in bustling streets where a **bicycle cart can be more agile**.
- Furthermore, the use of trucks is often associated with **carbon dioxide emissions**. In our study, we considered the use of electric trucks. However, it's important to note that if the electricity used to charge these trucks is generated from fossil fuels (as is frequently the case), it results in CO_2 emissions at the energy production source. Similarly, if internal combustion engines power the trucks, CO_2 emissions occur on-site. In both cases, there is a **significant adverse environmental impact without improving the economics of the system**.

Overall, the usage of trucks is not recommended as it does not offer any economic value, and it introduces CO_2 emissions, thus reducing the positive environmental impact of the system.

Can the government assist in this venture?

- The **economics of the system could vastly improve** if the government provided some **assistance** in the form of either tax reduction for the dishwashing stands or taxation to SUP usage.
- For instance, in case C2, the tax was reduced from 18% to 10%, which led to a sharp increase in the **ROI** (**32%** from 21%) and a significant decrease in the **payback period** (**1.8 years** from 2.3 years).

Even though the venture is profitable, it would be even better if the government provided incentives to accelerate the implementation of such a system.

How many vendors should be included?

- As expected, the economics of the business case **improve when the system is scaled**. This can be seen in the case of C3. Only the number of included vendors was adjusted to a lower number. However, even for **500 vendors**, the venture has an **ROI of 10%** and a payback period of **3.3 years**, making it a promising investment.

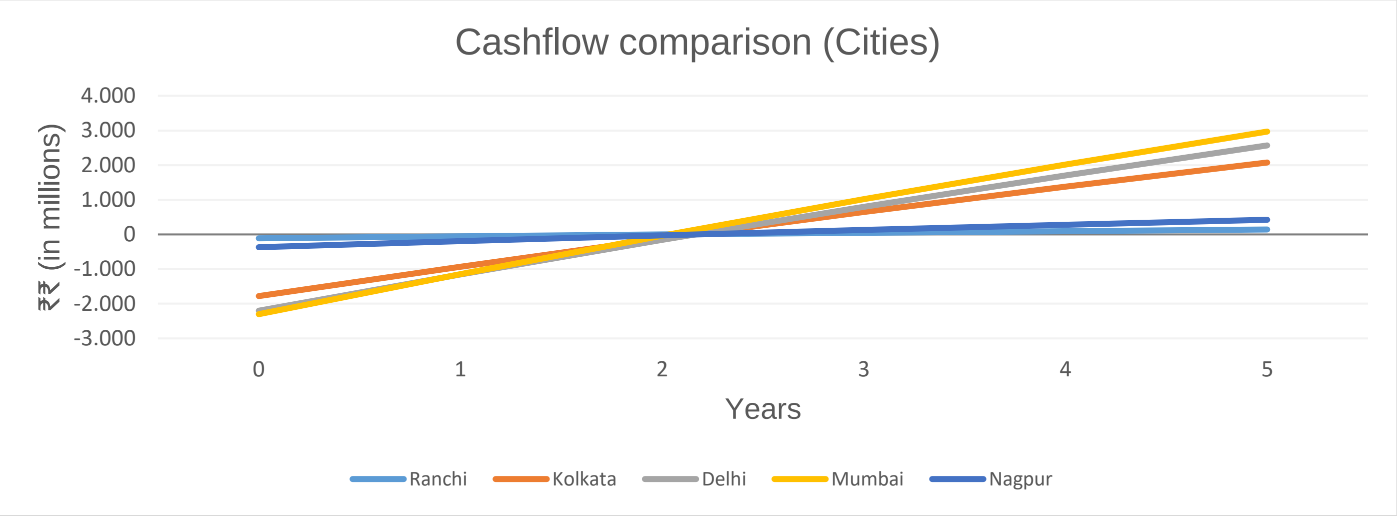
For an initial pilot case, it is recommended to include vendors from multiple streets (500-5000 vendors) so that a representative example can be tested. It is worth noting, however, that the system could also grow stepwise by including more streets.

Implementation in 5 cities in India

Input Data

	Number of street food vendors	Demand per day per vendor[19]	Vendors per street	Vendor Density	Phone availability
Kolkata	80,000	75	75	Low	50%
Delhi	99,000	75	75	Low	65%
Mumbai	105,000	75	150	Medium	40%
Nagpur	16,500	75	75	Low	50%
Ranchi	5,000	75	200	High	50%

Analysis Results



What city should be selected for a case study?

- The two key parameters that change from city to city are the **total number of vendors** and the **vendor density**. As can be seen from the diagram, the higher the number of vendors, the higher the investment needed, but also a higher cash flow by the end of year 5.
- More interestingly, however, **vendor density** is an essential parameter as it can improve economics by **shortening the travel time of deliveries**, thus leading to the need for **less infrastructure** and **employers** related to transportation.
- It is crucial to consider customers' and vendors' access to mobile devices to optimise an app system.

Overall, it is recommended to aim for a city with a high number of potential vendors so that the system can reap the economies of scale in an even shorter term. At the same time, streets with a high density of vendors should be prioritised.

[19] Demand for SUP items to serve their meals

Stakeholder Perspectives

Stakeholder	Benefits	Costs
Customer	➢ No increase in food cost ➢ Returning customer rewards ➢ Extra benefits for customer who continuely return items	➢ Need for deposit ➢ Need QR code app ➢ Need to return plate
Vendor	➢ 50% decrease in costs ➢ Increase in customer uptake and retention rate ➢ Significant reduction in time and resources for purchasing SUP	➢ Need QR code app ➢ Need space for crates
Dishwashing Centre	➢ Profitable business model in the long run ➢ Strengthening of street food vendor association ➢ First-mover advantages for expansion	➢ Need investment for infrastructure ➢ Warehouse and personnel needed
Municipality	➢ Decrease in waste management costs due to less waste generated ➢ Less virgin plastic reliance overall, thus increased resilience ➢ Creation of green jobs	➢ Need stakeholder coordination ➢ Need marketing and communication ➢ Need to set up a QR code system

Recommendations

System Implementation

The modelling of the proposed reuse system demonstrated its economic viability, showing profitability based on the provided assumptions and input data. Therefore, it is **strongly recommended** to proceed with implementing the reusable system.

Investment Strategy

The investment required for the proposed system was found to be on a comparable scale, and in many cases even lower, than the annual costs incurred by street vendors for purchasing single-use plastics (SUP). Given the high Return on Investment (ROI), Net Present Value (NPV), and relatively short payback period (2.3 years for the baseline case), it is advisable for the **street food vendor association** to consider becoming one of the **founders and key stakeholders of this venture**. This would allow them to reap economic benefits and exert control over the process, aligning with their status as key stakeholders in the street food sector.

Participation Scale

The analysis indicated that the number of participants does not significantly impact the ROI. Therefore, there is **no compelling reason to prioritise a large-scale implementation** with a high initial investment.

Instead, initiating a smaller-scale implementation involving 500-5000 vendors is recommended. Based on local conditions, this pilot case would help accurately estimate crucial parameters, such as the return rate, the deposit amount, and the return period.

Choice of Material

The primary driver for the choice of material is the return rate. Reusable plates are often lost (not returned) well before their end of life. Therefore, **paying a premium for materials like metal may not be economically justified**.

However, it's essential to consider **environmental factors** alongside economic ones. If a city has an efficient waste management system capable of retrieving and recycling materials like metal (tin) at high rates, then exploring tin as a material could make economic sense. Recycled tin could be repurposed into necessary packaging materials and resold to the dishwashing company, bolstering the local economy. Conversely, if recycling methods are lacking, these plates may end up in landfills or incineration. Assessing the potential environmental impact through a full lifecycle analysis is crucial to guide system design and decision-making.

Taxation Incentives

Taxation policies have the potential to significantly enhance the economics of the reuse system. While the new dishwashing entity may be subject to standard taxation, considering the system's contribution to a more sustainable and resilient future for cities, a case could be made for **lower tax rates**.

Since several single-use plastics are currently banned in India, producers may offer alternative materials for the single-use items. These may be cheap but, at the same time, environmentally harmful. In this case, **taxing such single-use products** could further bolster the business case for the reuse system. This could be done to reflect the True Price of such items better. A True Price includes externalised costs, typically not included in the market price. Even a modest tax could provide a strong incentive for systemic change and drive the adoption of a more sustainable alternative.

Finally, polypropylene (PP) and polyethene (PE) etc, commonly used in packaging, could also be taxed at a higher rate, so reuse systems are promoted, packaging products could be used multiple times, thus decreasing the need for virgin materials.

Conclusions

This study aimed to: explore the economic feasibility of implementing a reusable packaging system as an alternative to the existing single-use plastic (SUP) system for street food vendors in India. The goal was to assess the potential benefits, costs, and key parameters affecting the economics of this proposed system.

To achieve that: a comprehensive analysis was conducted, comparing the baseline case of the current single-use system with a proposed reuse system. Additionally, sensitivity analysis cases were examined to understand the impact of various parameters on the system's economics.

The study found: that the current single-use plastic system costs for Kolkata's street food vendors is approximately ₹2,540 million annually, generating 30,660 tonnes of plastic waste. In contrast, the proposed reuse system could reduce vendor costs to ₹1,533 million (a 40% reduction) and save customers around ₹504 million per year. This transition would dramatically decrease the yearly packaging stock needed by 98%, down to 47,591,619 items. With a 21% ROI and a 2.3-year payback period, the reusable system proves economically attractive while addressing plastic waste issues.

Some key takeaways from the **sensitivity analysis** include:

- **Material Choice**: Opting for metal packaging over plastic did not yield immediate economic benefits due to higher costs, making plastic a more cost-effective choice. However, the environmental impact of recycling metal should be calculated.
- **Packaging Types**: Introducing different packaging types alongside a gradual transition approach could offer flexibility, simplifying logistics and testing the system effectively.
- **Reuse Success Parameters**: Parameters such as rotation cycles, return rate, retention time, deposit, and cleaning costs were sensitive to the system's economics. Adjusting these parameters can impact the system's profitability and efficiency.
- **Local Parameters**: Factors like the number of vendors, demand per vendor, vendor density, distance from dishwashing centres, and taxation influenced the system's performance in different cities. High vendor density and favourable tax rates improved profitability.
- **Transportation Vehicle**: Choosing bicycle carts over trucks proved more economically viable, with reduced operational expenses and environmental impact.
- **Government Incentives**: Government support, such as tax reduction for dishwashing stands or taxation on single-use plastics, positively affected the system's ROI and payback period.
- **Scale of Implementation**: Scaling the system improved economics, but even smaller ventures (e.g., 500 vendors) showed promise.

In conclusion, the study reveals a **strong business case for implementing a reusable packaging system for street food vendors in India**. This system benefits vendors, customers, municipalities, and dishwashing centres. However, careful consideration of material choice, deposit amounts, return rates, and retention times is essential to optimise economic outcomes. Government or municipal support, in the form of tax incentives or outcome-based funding mechanisms, can significantly boost the system's feasibility and success. By implementing this sustainable approach, India's street food sector can contribute to a more resilient and environmentally conscious future, creating a win-win scenario for all stakeholders involved.

"The numbers in India are so astronomical it's hard to visualise. So many vendors, so many people, so much packaging. If there is a compelling business case for reusable packaging in such a complex scenario, it can work anywhere. It's simple, reuse adds up."

Willemijn Peeters, CEO of Searious Business

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