

# A Strategic Assessment of Circularity in E-Commerce Packaging: Integrating Reverse Logistics and Consumer Behavior in India's Tier-2 Markets

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**Abstract**—The explosion of online business in India has brought about a structural change within the retail logistics which majorly was fueled by the increased online adoption rate of shopping in Tier- 2 and Tier- 3 cities. It is this geographical decentralization that offers deep-seated macroeconomic opportunities but at the same time is causing an acute vulnerability in ecological and logistic situation. The modern linear model of take-make-dispose that is largely dependent on low-density films made of polyethylene and corrugated fiberboard, is ecologically unsustainable, and economically unprofitable in regions which are price sensitive. There are unique characteristics of these markets which are as follows. Large Cash-on-Delivery transaction volumes, high Frequencies of Return-to-Origin instances that turn supply chain operations into a nightmare and increase environmental footprint by multiple times due to failed deliveries. The main focus of this extensive research report is the crucial intersection of packaging circularity, consumer behavior, and reverse logistics in the e-commerce within the context of reality of Infrastructure in the Tier-2 cities of India, with the city of Indore being used as the leading socio-technical example which is scaling in terms of sustainability.

The context of this change is astounding in its magnitude and pace. Macroeconomic projections forecast that India's e-commerce market will grow up to an extent bigger than it is valued today. estimated USD 345 billion in 2030, which will eventually increase to USD 550 billion in 2035. This growth is becoming more and more controlled by a digitally native generational Z target audience and the exceptionally fast growth of Direct-to-Consumer and Quick Commerce models that reach deep into regional pin codes. As a result, the amount of cargo flowing to Tier-2 cities has surpassed the demand of tier 1 cities, radically changing the distribution of logistics. However, the packaging architecture supporting this growth is still based on a linear consumption. The e-

commerce market produces millions of tonnes of plastic waste, each year, much of which does not go through formal recycling streams because of the multi-layered nature of cost effective but poor in quality polyethylene mailers used by logistics companies due to their low dimensional weight. By means of the strict implementation of a Design Science Research approach and a thorough exhaustive formation of secondary information- synthesis of market intelligence reports and solid waste in the city. operational audits and peer reviewed behavioral research- this report assesses the effectiveness of Switching to Reusable Transport Packaging as opposed to single-use packaging. The analysis is hypothetically based on various developed models, such as Installation Theory, the Theory of Planned behavior, The Theory of Consumption Value, the Resource-Based View and. Transaction Cost Economics.

All of these theoretical perspectives help to throw light on the long-standing attitude-behavior gap in the minds of Indian consumers and define the strategic necessity required for supply chain operators to shift to circularity without hampering financial stability The results of this research study deride arguments condemning environmental concern, revealing that consumer concern is increasing organically, yet sustainable behavior is often prevented by convenience, high cost concern, deeply ingrained habit and subconscious decision making. The Indore Municipal Corporation but has been a 'deviant' success story that presents an alternative counter-narrative and can offer inputs in the interventions needed. Through the combination of strong civic enforcement, IEC, and the incorporation of formal municipal management through the ICFs into informal waste-picker networks of processing and technology, Indore has attained 100% source segregation. What the Indore model has proven, is that, provided with secure physical environments and logical digital set-ups, Tier-2

populations have all the capacity to maintain circular behaviors at a high level of complexity.

Within this context, in order to begin to address the issue of plastic pollution as well as the lack of economic margins in logistics, this report designs and mathematically justifies a Return-on-Delivery framework. This circular, local system suggests the use of existing last mile delivery services to bring back empty or returnable polymer totes tagged with Radio Frequency Identification or Quick Response codes. The use of detailed cost-benefit analyses and mathematical modeling demonstrates that to be considered as a capitalizable and trackable asset, as opposed to the approach of disposability and something as an operational consumable, offers a more profitable long-term return on financial investment. Over the theoretical 30-year life cycle of each model of packaging, the unit cost of shipping materials would be cut in half, using the circular model, then it would using the problematic current linear packaging model. At the same time, it serves by canceling the heavy financial costs entailed in Return-to-Origin logistics is that the packaging of a failed delivery is easily re-inventoried as an asset, as opposed to written off as a lost cost. The following dialogue attempts to combine these quantitative and operational implications with more macro-level parallels to circularity, for instance with Algramo's localized packaging refills or reusable mailing systems in Europe, in order to show the fact that decentralized, technology-based reuse systems are found to be very amenable to the socio-economic structures of developing markets. It also points more broadly to the need for future EPR related regulations from the Government of India to heavily require compliance by e-commerce companies. The study ends by suggesting practical advice for industry actors, recommending the deployment of algorithmic right-sizing, gamified consumer micro-incentives, and informal sector incorporation as parts of broader circular transition programs. This eventually shifts the growing environmental liability Tier-2 has had to reckon with, to a fundamental operational, regulatory, and competitive advantage.

*Index Terms*—Circular Economy, Reverse Logistics, Tier-2 Markets, Reusable Transport Packaging, Return-to-Origin, Installation theory, Indore municipal corporation, Return-on-delivery (RoD) Framework, Attitude behavior gap.

## I. INTRODUCTION

1.1 Macro-economic context of Indian e-commerce  
In the last ten years, Indian retail has passed through the eye of the needle and emerged as the third largest

market in the world. At the heart of this ecosystem, as one key component of the larger infrastructure, is a growing digital commerce industry which has ballooned to a gross merchandise value of nearly \$60 billion and hosts the second largest online shopping population in the world. The long-term market fundamentals are very strong. As per capita GDP in India crosses the threshold of \$3,500, a population experiencing a greater discretionary surplus is expected to drive the e-retail market, growing over 18% annually and accumulating a gross merchandise value in the range of \$170-190bn by 2030. Even broader industry projections put the market on pace to hit USD 345 billion by 2030 and will eventually grow to USD 550 billion by 2035; this phenomenal growth is supported by massive smartphone penetration, robust digital payment infrastructure, and the proliferation of various digital commerce models. In 2025 for example, the Unified Payments Interface processed 20 billion transactions in one month, which gives a sense of the transactional density of the digital economy. There's also the even newer trend of Quick Commerce (Q-commerce), where delivery times have gone from days to just minutes, and Q-commerce is projected to reach a value of USD 50 billion by 2030. Simultaneously, the Direct-to-Consumer(D2C) market is expected to grow at a CAGR of 40% with sales projected to reach USD 60billion in 2027. The country's Micro, Small, and Medium Enterprises (MSMEs) collectively contributing almost close to 1 billion USD to the country's GDP, are leveraging these digital platforms to disconnect from traditional distribution networks and get directly to the consumers.

### 1.2 The shift to tier-2 geographies and gen-z demographics

The center of gravity of the Indian digital economy has significantly shifted. Cities and metropolitan centers have been leading the first rounds of e-commerce growth, but they are reaching at near saturation the main e-commerce markets. As a result, the new avenues for corporate expansion are now the smaller Tier-2 and Tier-3 cities like Indore, Jaipur, Surat, Bhopal and Patna. They have gone from being 'emerging zones and peripheral spaces, to becoming the leading centers of digital retail expansion. Information reveals a ratio of three out of five new digital consumers since 2020 are located in Tier-3

cities and smaller towns, thereby making previously brand-starved remote consumers, much more accessible. This geographical de-centralization is highly tied to a deep demographic dividend. The future of India's online e-commerce retail space will primarily drive by Generation Z shoppers. In the next three years alone, there will be an estimated 220 million digitally native Gen Z consumers that will begin to participate in online shopping, representing roughly \$44% of online retail spending. With Direct-to-Consumer shipments comprising 60% of total national orders in the space of a couple days in the greatest gift-giving seasons, the geography of logistics is turned on its head in the Tier-2 markets. As of today, while the bulk of the shipping volume at 40% is concentrated in major metropolitan postal codes, 40% is growing exponentially over these 5,000 to 6,000 pin codes which are tier-2 cities as well as the larger rural networks. But this is also a situation that is imposing an enormous structural pressure on the Indian logistics industry, which has to deal with unprecedented volumes as well as to manage regional distribution.

### 1.3 Scope and significance of the study

The focus of this research is situated within the geography of India's Tier-2 cities between which the city of Indore, as it has perpetually been ranked as India's cleanest city and boasts most cutting edge Municipal Solid Waste Management practices, has been chosen as an operative sandbox. The components of this are the formal, municipal processing pathways; the increasing incorporation of the informal sector; and the microeconomics of digital supply chains. This study is important because it has a double value in the sustainability of the environment and the financial strategy of corporations. This research moves from linear to circular supply chains in order to provide e-commerce platforms with strategies to proactively align with ever more stringent Extended Producer Responsibility policies, reduce their cost of capital and create sustainable sources of competitive advantage in a changing regulatory and demographic environment.

## II. LITERATURE REVIEW

### 2.1. Theoretical foundations of circular packaging and supply chains

The research and industrial focus on the circular economy (CE) in the context of supply chain

management is becoming less about isolated environmental concepts and more a core tenet of corporate operational strategy. According to academics this means, transition from linear to circular systems, demands a sensible approach in relation to supply chain management, speed of resources, protocols to deal with waste, and packaging as part of the same shift process. The Resource-Based View (RBV) of the firm is used as a critical theoretical perspective to analyze sustainable initiatives in packaging. According to RBV, a firm's competitive advantage is based on the "unique bundle of internal capabilities and resources that the firm controls". Herein, the shift to recycled, recyclable, or reusable packaging rather than being simply understood as a compliance cost or marketing trick is cast within this theoretical framework as a "strategic resource". Building on the work of Barney, who has argued that for a resource to be a source of a competitive advantage it must be a valuable, rare, inimitable and non-substitutable (VRIN), more recent studies have conceptualized closed-loop packaging structures as a way of creating a sustainable competitive advantage by embedding unique internal reverse logistics capabilities that are not easily replicable by competitors. Developing alongside, and in a parallel manner to the RBV, is Transaction Cost Economics (TCE), which offers a more structured method for evaluating the true economic considerations and costs of implementing sustainability. TCE specifically centers around the attempt to install optimal governance regimes that reduce the costs of such transactional processes to those found within the structure of an integrated firm. Despite the general deeming of the start-up capital costs (CAPEX) associated with circular packaging models as comparatively higher than simply purchasing single use materials, TCE frameworks show that the long-term transaction costs, primarily those related to fluctuations in raw material input markets, liability fines, and reverse logistics breakage are all orders of magnitude reduced through the retention of a closed-loop asset. According to this merging of the RBV and TCE, effective circularity should be both capable of creating value in the long run as well as work with as low as possible systemic operational friction.

## 2.2. Institutional theory and coercive regulatory pressures

Institutional Theory has a large impact on how sustainable packaging gets woven into local fulfillment networks. This sociological model accounts for the isomorphic tendencies of corporate strategies- that is, the ways that all organizations in a certain sector come to look and act alike-because of external coercive, mimetic, and normative influences. At present, the most pervasive coercive force informing the space of Indian e-commerce is the coercive legislative pressure of Extended Producer Responsibility (EPR) being ratcheted up under the Plastic Waste Management (PWM) Rules of 2025. The ability of Producer, Importer, and Brand Owners (PIBOs) to count End-of- Life (EOL) disposal certificates toward their overall recycling goals have been unequivocally removed in recent drastic amendments made by the Central Pollution Control Board (CPCB). This model is in stark contrast to what was previously permitted in terms of how companies could achieve compliance and essentially mandates specific recycling certificates based on categories, which obliterates historic recognition and requires companies to physically invest in recovering material. In addition, the documentation of institutionally practiced literature contains copious amounts of references to the newly enforced mandates for 2025 which require category I rigid plastic packaging to consist of a minimum of 30% post-consumer recycled (PCR) material, quickly scaling to 60% by 2028-29, and for category III multi-layered flexible plastics a 5-10% threshold. Institutional theory would also predict that the inflexible and non-negotiable legislative dicta would create a path-dependent trajectory toward normalization within the e-commerce sector – pushing platforms to make vast transformations both in how they recruit and dispose in order to meet the criteria of legality and actual operation.

## 2.3. Linear vs. circular supply chains in e-commerce

Traditional e-commerce is built on the structure of the linear industrial model of “take-make-dispose”. Overall, online sales are growing exponentially and with them online packaging has also been growing, with environmental impacts. The concept behind Circular Economy is in fact exactly a break from this extractive paradigm, instead favoring supply chains that are closed loop, that keep value of products or

things as long in the economy as is feasible physically. The Circular Economy measures taken in the packaging industry are generally framed within the so-called R-strategies, i.e., Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Repurpose, and Recycle. Existing scholarship in this area demonstrates a highly significant bias towards later stage, downstream methods like waste reduction, and designs which are recyclable at their life’s end. Yet, recent scholars contend that “circularity on its own is not an effective solution since it implies a cycle, which still often refers to recycling, but in reality, cannot be an authentic closed loop unless packaging becomes a capitalized and monitored resource, such as it is through Reusable Transport Packaging (RTP) systems”. The move toward the introduction of reusable systems is intrinsically tied to the need to strengthen the incorporation of reverse logistics, or “all the logistics activities, planning and the control of the flow of goods from the point of consumption to the point of origin for the purpose of recapturing value of proper disposal”.

The existing literature describes how reverse logistics originally developed out of waste management, but instead is most relevant to digital retail as a profit-making and cost-saving distinct capability.

## 2.4. Advanced supply chain dynamics and reverse logistics

This implies that the leap from a traditional linear system to a Closed-Loop Supply Chain (CLSC) includes very strong material optimization frameworks. The focus of existing conceptual work on circular supply chain management has been on ‘closed-loop’ [‘closing the loop’] business models; or slowing, intensifying, narrowing and dematerializing resource loops. Their Reverse Logistics would be the essential operational motor of the CLSC, managing the important process of returning assets into the forward value chain of inspecting, sorting and dispositioning. As per Blackburn’s disposition models, products that enter a reverse logistics channel will be disposed of in one of the following ways: repaired and returned, reused/resold, or disassembled for raw materials and recycling. The importance of alliances across e-commerce platforms, third party logistics firms, and regional MRFs in forming successful closed-loop projects is a major focus of the secondary research. These studies also discuss case

studies of Alagramo's "Packaging-as-a- Wallet" (PaaW) model in South American developing markets where, for example, the use of Internet of Things (IoT) technologies including RFID chips within durable packaging turns a once inert vessel into a financial asset that can be tracked. Also, this IoT aggregation gamifies the return process and efficiently to reverse flow that is so strong that sales on Alagramo grow 356% during severe macroeconomic shocks such as the COVID-19 lockdowns, creating a shortcut for Amazon and Panamanian middleman alike. Even more, when matured systems of reverse logistics such as the processes of e-waste management in the European Union are compared, it is found that clarity and easy tracing and differentiation for all the network players is one of the first issues to solve for a reverse logistics network to be viable.

#### 2.5. Theory of Planned Behavior (TPB)

Consumer engagement is the essential piece of the puzzle in being able to complete this circular chain of supply – and the consumer is the one who determines how the material flows back. Ajzen's Theory of Planned Behavior has been the most popular applied psychological theory to explain pro-environmental behaviors. The theory posits that individual human action is determined by behavioral intentions which are influenced by three primary antecedents: "one's personal attitude toward the behavior, injunctive and descriptive social norms and control beliefs reflecting perceived behavioral control over the self-reported behavior". Recent empirical tests of Theory of Planned Behavior in e-commerce markets adds complexity to the picture. Findings suggest that personal norms and subjective norms both have a positive impact on intention to use circular products, but personal attitudes and perceived behavioral control have the highest relative influences on behavioral intention, although personal attitudes are the strongest overall predictor of behavioral intention, due to being primarily driven by environmental concern. This theory is commonly challenged by behavioral economists, who describe it as being based on "cross-sectional questionnaire data". This type of survey tool is extremely prone to social desirability bias and may capture inflated estimates of green intentions, that do not take into consideration the real-world limitations of disposal inconvenience or immediate economic pressure.

#### 2.6. The Attitude-Behavior gap in emerging markets

The gap between feeling and acting upon those feelings is a recognized and much-studied issue in existing environmental psychology work, referred to as the "attitude- behavior gap" – the separation between a person's pro-environmental attitudes, and their subsequent consumption or disposal behaviors. According to several macro-level studies, large numbers of consumers claim to know the environmental impact of plastic waste and express a general willingness to participate in environmentally sound systems. This heightened awareness does not equate with ongoing action in low involvement, high frequency activities like unpacking and discarding e-commerce shipments though. In price-sensitive and extremely pragmatic markets such as Tier-2 cities in India, behavioral economics shows that theoretical environmental consciousness often loses out to the immediate barrier to entry of a higher price associated with an item, as well as the psychological 'hassle factor' of complicated disposal methods. In debates around these issues, it has been argued that everyday consumer behavior depends much more on the "subconscious system" or System 1 thinking, which is responsible for deeply rooted habits and automatized responses, and far less on the rational, conscious thought or System 2 thinking needed to opt for a new, sustainable option. Therefore, in order to close this chasm, the interventions moving forward should not be based only on consumer education and moral appeals, but instead they need to focus on an active manipulation of the "choice architecture" in a way that the convenient path for the user will be the sustainable one.

#### 2.7. Installation theory and sociotechnical settings

To overcome the constraints of cognitive-based psychological theories in research on sustainability the research community has begun to include the Installation Theory. It is this sociological interpretation, that sees human behavior as locally and is structurally constrained by surrounding "installations" in local society. They take place within a dense network of physical, psychological and institutional conditions which are both directly supportive of, and coercive to particular behaviors. In the case of e-commerce circularity, asking consumers to perform unexpected, effortful new forms of participation – e.g., holding on to and returning

packaging for optimal recovery – will almost universally not work unless physical affordances (like hyper- local collection nodes or optimized delivery routes), psychological cues (like gamified digital rewards, or social norms), and institutional support systems (like municipal regulation) all coincide to enable that behavior. Installation Theory is relevant to a discussion of contemporary waste management because it accurately locates the onus of the circular on something outside of the individual consumer’s moral fortitude and instead onto the structure, the connectivity of the larger system, and the installed environment of flows and channels within and outside the urban environment around waste handling.

## 2.8. Theory of consumption value

The Theory of Consumption Value, which looks at the way that people consider multiple aspects, values, and benefits of products, products in competition such as functional, social, emotional, epistemic, and conditional values, can also be a perspective for understanding how consumers perceive new circular models, such as reusable packaging. According to the literature on sustainable packaging systems, “consumers continuously assess the benefits in terms of utility (e.g., product protection/durability/hygiene) relative to the inconvenience (cost premiums, effort in returning items, time)”. Reusable packaging is subject to high psychological barriers. Reusable containers for food or products may, for example, be seen as a priorinely sanitary, unsafe, or prohibitively expensive rather than clean substitutes to brand new single-use ones. On top of that this theory describes the “halo effect” in packaging design, whereby visual signals of sustainability – for example, overt recycled content claims or earthy- looking material textures – spill over into positive general product perceptions causing the product enclosed within to be perceived as higher value, healthier, or more natural. In order for a circular business model to grow effectively, actors need to understand the “value” they derive from participating in them, which means getting the consumer out of the end of the linearity and transforming them from a passive recipient, to a value co-creator within the reverse supply chain.

## 2.9. Resource-Based View (RBV) and Transaction Cost Economics (TCE)

At the firm and macroeconomic level, the corporate shift toward circular packaging is best understood through the Resource-Based View (RBV) and Transaction Cost Economics. According to the Resource-Based View a company attains competitive advantage through the development of VRIN resources and capabilities. Finding environmentally responsible packaging alternatives and having strong capabilities in reverse logistics development are now seen as a competitive asset in world markets. Such capabilities reduce cost of capital to the firm, manage regulatory risk before it becomes an issue, and create significant brand equity and appeal for investors. The conundrum involved in the transaction cost is taken care of by Transaction Cost Economics; in some cases, external, upstream conduct is heavily organized, so that the transaction costs associated with it can be addressed by the backward-flowing operations. The need for reverse logistics- the ‘detection of the package,’ the receiving of the package, the cleaning of the package, and the reusing of the package- presents a highly asset specific, very complex operation, and a lot of margin pressure. Efficient models in the circular economy must reduce these transaction costs to the point where they are financially viable at scale. Literature proposes that the most relevant way to do this, is to “build capacity for support of reverse flows internally within the currently well-functioning forward network, making the return movement a part of already-adopted cost structures”.

### 2.9.1. Identified gaps in the literature

Even though the circular economy – and sustainable packaging design – have become subjects of academic research, there are still considerable gaps in the literature. There is certainly an empirical bias towards the first, because the majority of the existing empirical studies, quantitative studies on ROI, and notable success cases (like the Repack model in Europe) that one knows of deal heavily with these types of economies and/or highly formalized, wealthy urban contexts. A dearth of literature that is particularly rigorous in its attention to the peculiar socio-economic dynamics, pricing mechanisms, and infrastructural conditions that are prevalent in such markets- in the context of developing countries- like India is evident. Second, the “attitude-behavior gap,” that captures the

inconsistency between what is actually done and what we think we should do, is often detached from the actual mechanics of reverse logistics, as present studies often do not conceptualize a framework that portrays the connection of the psychology of consumers with the mechanics of the operations and how these dialogues with supply chain optimization and unit economics. Lastly, despite the established effective environmental arguments for reusable packaging, sound financial analysis across these variables within developing world contexts is conspicuously absent in the present literature. This report specifically fills this void by attempting to combine behavioral theories with economic analyses to propose a very locally integrated circular model.

### III. RESEARCH PROBLEM AND OBJECTIVES

#### 3.1. Problem statement

But, behind this macroeconomic growth lie other expansions—the ecological and logistical vulnerability of packaging waste. The logistics of e-commerce, aiming for speed and product safety over large and uneven terrains, produce a massive amount of cardboard boxes, styrofoam, plastic bubble wraps, polyethylene sleeves, and multi-layered plastics. India produces nearly 9.46 million tonnes of plastic waste annually, 43% of which is packaging waste, most of it single-use plastic that stays in use for a few minutes and then enters the waste streams.

Local delivery services are disproportionately impacted by the infrastructural frictions arising from the sprawling urban geography of Tier-2 markets. Due to unruly address systems and unreliable last-mile connectivity, delivery vans must cover much longer distances on surface roads. To prevent product damage, goods are over-packaged; typical boxes have up to 55% empty space, creating a packaging waste footprint of 2,705.94 kg of CO<sub>2e</sub> per metric tonne. Crucially, in Tier-2 markets, consumers are highly sensitive to the product price and overwhelmingly opt for Cash-on-Delivery payments. Almost 26% of COD orders are rejected upon delivery, triggering a Return-to-Origin that doubles the carbon footprint of transit and guarantees that the packaging will have a short life as waste. Shipping boxes are often substituted with lighter weight and multi-layered polyethylene envelopes to maximize dimensional weight and minimize freight charges, subverting principles of

circularity as these envelopes are among the most problematic materials to recycle and are prone to leakage into nature.

#### 3.2. Research objectives

In this report, I aim to address the fragmented relationship between logistics-related costs and downstream recyclability of materials in emerging markets. The goal of this research is to:

- 1) Contextualize the anatomy and economics of e-commerce packaging waste in emerging Tier-2 Indian cities such as Indore,
- 2) Understand the social and technical challenges related to sustainable disposal and circular use from the perspective of consumers in emerging markets,
- 3) Design and model a Return-on-Delivery system that envisions e-commerce packaging shift from being a single-use cost center to a durable and profit-saving collateral,
- 4) Show the potential of the existing reverse logistics infrastructure to minimize the crippling costs of Return-to-Origin and eliminate single-use flexible plastics from the digital supply chains.

### IV. RESEARCH METHODOLOGY

#### 4.1. Design science research (DSR) approach

This research adopts a Design Science Research (DSR) methodology to address the e-commerce packaging problem and develop a practical, high-level solution. The benefits of this approach are that it is solution oriented, rather than purely descriptive, and is concerned with the design, engineering, and critical assessment of new kinds of artifacts that tackle complex, messy, real-world operational problems. The DSR approach used in this paper is framed by three ongoing and iterative processes:

##### 1. Artefact Development:

Creation of the “Return-on-Delivery” (RoD) framework that leverages the assets reusable transport packaging within the non-refrigerated surface delivery networks prevalent in Indian e-commerce.

##### 2. Contextual Testing:

Verifying the soundness of the theory and the practical possibilities for the idea in actual practical constraints of a lead-specified operational sandbox, so as to

guarantee our model is not an ideal model but one based on real infrastructure.

### 3. Implications Deduction:

Inferring important insights obtained from the context analysis to produce general theoretical, managerial, and policy implications about the development of supply chain circularity in a context of emerging markets.

### 4.2. Secondary data synthesis

Because of the staggering macroeconomic size of the question, the study thus depends on the extensive aggregation of good secondary data. This data was collected primarily through a synthesis of scholarship, leading industry logistics studies, local governance materials, and case studies in pragmatic sustainability. Meaningful data streams informing the analysis were:

#### 1. Logistics and E-commerce Metrics:

Aggregated statistics for Tier-2 penetration, the volume and return rates of Cash-on-Delivery transactions, the frequency of returns to the origin, the exact cost of shipping freight when using staple materials (corrugated fiberboard, flexible polyethylene) relative to alternative materials, such as can be provided by companies like McKinsey and Bain & Company, and from the India Brand Equity Foundation.

#### 2. Municipal solid waste statistics:

actual operating data from the Indore Municipal Corporation on daily waste generation at 1,115 MT/day, source segregation compliance rate, and capacity to process material recovery.

#### 3. Regulatory Frameworks:

Government of India policy documents for Extended Producer Responsibility (EPR), in particular the Plastic Waste Management Amendment Rules that require incremental and legally enforceable recycled content levels.

### 4.3. Data analysis and mathematical modeling

The data analysis was conducted with a “strong” mixed methods design. Informants’ descriptions of consumer behavior, administrative practices of municipal institutions, and psychological barriers were analyzed qualitatively in order to see if there

were structural barriers or enablers, with a framework directly based on Installation Theory. The quantitative information was analyzed via cost benefit comparisons and an economic lifecycle model. In the financial viability analysis, a break-even model was developed where the linear packaging system was compared to the circular asset model using a standardized lifecycle of the system consisting of 30 cycles as a base line conservative scenario. The fundamental variables of this modeling were the initial capital costs ( $C_{\{rp\}}$ ), the yearly cost of reverse logistics and sanitization amortized ( $C_{\{ops\}}$ ), and the cost avoidance for single use consumables ( $C_{\{su\}}$ ).

### 4.4. Justification of the methodological approach and Indore archetype

This is a justifiable limitation since eco-innovation in the packaging field is a “complex and multidimensional process” and therefore depending on a connection between a systematic second review and a conceptual model have to be acceptable. These were found to be a far larger and surer base to evaluate pilot data done on the field than primary survey restricted in space. In addition, the use of existing sustainability and ESG frameworks such as the Scope 1-2-3 Emissions Framework and Green Logistics Frameworks have been incorporated to allow for easy adoption of the proposed models into corporate strategy and reporting to comply with regulatory standards.

The choice of Indore, Madhya Pradesh, as the ideal “site” or Living Lab for this study is highly strategic and key to the research methodology. Consistently listed as India’s cleanest city on the national Swachh Bharat Mission, Indore is a significant sociotechnical anomaly within the context of the larger Indian city. It has a huge population, well trained to do the strenuous six bin waste segregation at source and with 100% door to door collection into GPS enabled fleets. Secondly, the city boasts of the most advanced decentralized processing infrastructure with state-of-the-art Material Recovery Facilities and Asia’s largest bio-CNG plant located at Devguradia. Such high level of civic obedience and infrastructural development make the familiar variables of “consumer ignorance” coupled with “collection failure” largely irrelevant. This research allows for clear isolative variables related to the actual mechanisms of supply chain,

pricing and reverse logistics of e-commerce packaging within the context of an advanced nature, eliminating the noise of the unkempt or desolate state of many unorganized municipalities.

## V. FINDINGS AND SOLUTIONS

### 5.1. Macro data on e-commerce and packaging growth.

The rapidity of growth in the Indian digital retail market means that a large physical space footprint is required. By 2030 the e-commerce market will

increase from \$125 billion in 2024 to \$345 billion, based on projections of unprecedented consumer demand. As a result, the India E-Commerce Packaging Market is growing rapidly. It is projected to grow to a value of USD 7.59 billion in 2031, with a CAGR of 12.48% from 2025, where it was estimated to be USD 3.75 billion. Specific types of packaging are compliant and are also more associated to the environmental criteria that consumers are expecting, as in the case of paper and paperboard with over half of the market with 50.83% and corrugated boxes with 45.73% of the share belonging to this type of packaging.

Table 1: Macroeconomic data on e-commerce packaging market growth.

E-Commerce Packaging Market Metrics	2025 Valuation	2031 Projected Valuation	CAGR (2026–2031)
Total Market Size	USD 3.75 Billion	USD 7.59 Billion	12.48%
Paper & Paperboard Share	50.83%	N/A	N/A
Corrugated Boxes Share	45.73%	N/A	N/A
Biodegradable/Compostable	N/A	N/A	14.08%

### 5.2. The anatomy of e-commerce packaging waste

The linear model that is up and running in minute detail illustrates a supply chain inherently addicted to cheap, synthetic polymers, even while it tries to replace papers for paperboard. E-commerce logistics firms looking to enter Tier-2 cities are, by necessity, predominantly seeking to reduce dimensional weight (DIM weight) to mitigate exorbitant land-freight expenditures. This makes the 5–15-gram polyethylene mailer costing between ₹3 and ₹6 a preferable choice over the 60–120-gram corrugated box which can cost between ₹12 and ₹18. But these poly mailers are multi-layered and also not mechanically recyclable because even the sufficiently flexible poly mailer is typically pre-fused with heavy adhesives, waybills, or bubble wrap.

The end result is a lower grade of recycled material that is not available for re-injecting into the loop for quality packaging. Plus, the generalized fear of damaged goods following prolonged, bumpy over-land travel also causes gross over-packing. Typically included in the standard shipments is about 55% by volume of plastic dunnage. This inefficient logistical operation translates into a significant carbon footprint, releasing 2,705.94 kg (CO<sub>2</sub>e) per metric ton of mixed packaging waste. While the industry acknowledges this crisis through measures like the Flipkart Group's success in 100% elimination of single-use plastic in its

own supply chain, spanning 70 factories, the prevalence of single use products continues to be an industry-wide standard.

### 5.3. The Indore municipal solid waste paradigm

The distance package waste must travel in order to be processed in Indore represents the most extreme of what is possible within the municipality's formal capacity to process. In Indore an abiding consumer throws all dry packaging in a dry or plastic bin and has to follow a compulsory protocol to segregate waste at source into six bins. This waste is collected in partitioned tipper tipper vehicles across 85 wards and taken to mechanized Garbage Transfer Stations. The city produces roughly 1,115 MT of municipality solid waste daily, which is all collected at source and highly advanced Material recovery Facilities with Ballistic separators, Density Sensor, and Optical Sorting m/cs at the Devguradia central processing site that effectively segregate different higher grades of Polymer with almost 100% accuracy. As the multi-layered LDPE films (poly mailers) cannot be efficiently sent for high-value recycling, the Indore unit instead cleans out the used multi-layered LDPE packaging pouches and shred it to extrude them into solid plastic briquettes. They are then used as Refuse Derived Fuel (RDF) or are also mixed with coal tar to give highly strong and durable plastic cement pools

and roads, recycling about 45,000 kilos plastic daily. Plus, Indore runs Asia's largest bio-CNG plant, processing 550 tonnes wet of wet waste per day in order to sustain city buses, meaning that the municipality earns high revenues. Running parallel to this hyper-formal pathway is an informally augmented by technology branch, digital Producer Responsibility Organizations like "The Kabadiwala". This start-up uses a mobile application to digitize

scrap collection and sends executives with IoT-based weighing machines to guarantee transparent, market-driven pricing. The existence of this dual infrastructure supports Installation Theory, which posits that when a stable and structured infrastructure can be counted on, people will continue to exhibit complex forms of waste recovery.

Table 2: Overview of Indore's Municipal Waste Management Metrics, Processing Capacity, and Operational Impact

Indore Municipal Waste Metrics	Processing Capacity / Details	Operational Impact
Total Daily Waste Generation	1,115 MT/day	100% door-to-door source collection across 85 wards
Bio-CNG Plant Processing	550 MT/day (wet waste)	Powers 150 city buses; generates ₹8-₹14 crore annually
Plastic Road Recycling	45,000 kg/day (LDPE plastic)	Downcycles flexible packaging into durable public infrastructure
Green Waste PPP Model	30-70 MT/day	Generates ₹3,000 per tonne royalty for the municipality

#### 5.4. The Return-to-Origin (RTO) crisis in tier-2 markets

At the level of consumer psychographics in Tier-2 cities, there is a basic level of e-commerce supply chain vulnerability. These consumers, who experience high value sensitivity and a need for localized trust as their primary motivators, also have high preference for COD payment options. But whereas COD reduces the transaction costs involved and the discomfort faced by the consumer from online fraud or shoddy products, it creates a process nightmare for the retailer. A rejection at the door is almost 20 times more likely to occur in a COD order than in a prepaid one, with an average of about 26% of COD orders being rejected, while prepaid orders see a less than 2% rejection rate. This behavior is the direct cause of the Return-to-Origin crisis. The loss due to missed deliveries and RTO shipment has been around 25-30% of revenues for online-first brands during the peak festive season. Every disallowed bid turns the use of its forward-transit protection into the use of reverse-transit protection. The singular package bears twice the literal weight and, ironically, returns to the place of origin, the fulfillment center, only to be rejected and killed, "before its time". On top of that, in low-margin categories the profit margins from several future successful sales are wiped out altogether because the forward shipping charge bore by the retailer, the return

shipping cost, the cost of the destroyed box, and possibly damaged product.

#### 5.5. AI integration and reverse logistics costs

Advanced technology has been increasingly utilized by the industry in order to get around the logistical friction present in Tier-2 deliveries. Forecasts for the world reverse logistics market speak of a value of USD 59.5 billion by 2034, at an average annual growth rate of 5.81%. Digital-first brands in India, meanwhile, are employing AI-based efforts to enhance last-mile certainty. Voice calls, automated order verification and COD-to-prepaid conversion mechanisms have increased delivery completion rates by 11% substantially. All order is screened before shipping based on number of returns, COD and address quality. The use of these technologies optimizes the route and lessens the failure, but do not address the material waste left behind by the moment of failure that becomes inevitable.

#### 5.6. The Return-on-Delivery (RoD) framework

In order to address the plastic waste crisis and establish sustainability in waste management businesses, as well as to stop the financial loss generated by the RTO, this dissertation introduces the Return-on-Delivery model based on principles of Design Science Research. The proposed solution changes the model from a disposable consumable to a reusable durable

asset which is managed (Reusable Transport Packaging), utilizing existing forward logistics networks to attract reverse flows. The first sits at the intersection of three operational levels:

1. The Asset Layer (Smart Packaging)

Single-use poly mailers and corrugated boxes are eliminated in favor of robust, consistent collapsible polymer totes or heavy-duty fabric mailers (such as woven recycled PET canvas). Each unit has a unique RFID tag or QR code, and is rated for 50 transit cycles. This layer of integration between the physical asset, the IoT, and the e-commerce platform connects the physical asset to the central inventory management of the e-commerce platform and to the specific user’s digital profile.

2. Behavioral Layer (Gamified Incentives):

In direct alignment with Installation Theory, the system provides low resistance participation opportunities that reduce the attitude-behavior gap. The other, called 'Instant Return', allows customers to open the box delivered by the courier in front of the agent and return it on the spot, like the established cultural practice of Mumbai’s Dabbawala system. In the case of “Deferred Return”, a micro-deposit is captured digitally. The flattened tote can then be deposited at hyperlocal aggregation points (i.e.,

neighborhood Kirana stores), or a pick- up can be arranged via The Kabadiwala, scanning of which instantly deposits the refund digitally into the wallet.

3. The Logistical Layer (Reverse Flow & Sanitization):

The logistical masterstroke of this model is to harness the logistical capabilities that already exist. Collapsed packaging is sent back to micro-fulfillment hubs via the “deadhead capacity” space in the return trip of delivery couriers. The bags fold flat and have no dimensional space requirements so transport along the return leg of a journey is very low cost in terms of fuel and freight. The industrial cleaning, digital record-keeping, and the reintroduction of these “waste” products back into the supply chain are handled by specialized circular economy partners such as Saahas Zero Waste.

5.7. Financial cost-benefit analysis and ROI modeling

It also provides a clear economic argument to support the RoD concept through the life cycle cost analysis of the model over a given base of 30 cycles for full deployment which has been developed. This re-usable system has a critically important financial advantage to the linear system in that it is able to turn a cost of operation into a depreciated asset.

Table 3: Cost Comparison: Linear vs Circular Asset Model (30-Use Lifecycle)

Cost Component	Linear Incumbent Model (per 30 uses)	Circular Asset Model (per 30 uses)	Strategic Financial Impact
Initial Asset CAPEX	₹0	₹150 (Durable Tote)	Shift from continuous operational expense to capitalized asset
Material/Consumable Cost	₹450 (30 cycles × ₹15 avg unit cost)	₹0	Absolute elimination of recurring packaging material procurement
Reverse OPEX (Sanitization)	₹0	₹90 (30 cycles × ₹3)	Utilizes existing deadhead capacity to minimize reverse freight costs
Total Cost over 30 Cycles	₹450	₹240	Net savings of ₹210 per packaging asset
Amortized Cost per Order	₹15.00	₹8.00	46.6% reduction in per-unit packaging cost over the asset lifecycle

More important than the reduction in per unit materials costs at 46.6% directly is the lack of product damage during rough Tier-2 surface transit thanks to the fact that totes have rigid frames, preserving margins on high value inventory. The packaging-loss aspect of a

failed delivery is the key item to concern, and in an RTO event, the packaging is scanned back into inventory as usable material and not as a loss or destroyed mess, and so the unit economics of the retailer are essentially protected. This also assures

strict compliance with Extended Producer Responsibility requirements set by the Ministry of Environment, Forest and Climate Change Brands that guarantee following packaging down the chain can take advantage of the created EPR certificates and no longer have to pay fines for non-compliance, instead demonstrating that they are a responsible brand and encouraging green investment in their compliance obligations.

## VI. DISCUSSION

6.1. Interpretation of economic and behavioral results  
Academically this concept's achievement in conceptualizing the Return-on-Delivery framework marks a significant theoretical as well as practical shift in the retail supply chain management. These findings also provide strong support for the Resource-Based View and for Transaction Cost Economics from an economic point of view. The transaction costs that are usually linked with the collection are, are in part approached to marginal zero by ingeniously absorbing the backhauling into the already existing forward logistics infrastructure; in other the word the deadhead capacity of a courier. This effectively nullifies the traditional industry obstacle to a circular process, which has been that reverse logistics networks are too expensive to develop and operate. Finally, behaviorally, the model proposed is able to bridge the "attitude-behavior gap" that the literature has failed to explain thus far. Plus, the system removes the psychological "hassle factor" by putting the burden of complex, multi-bin waste disposal on someone other than the consumer. Attaching the harvest directly to the moment of delivery, or providing seamless hyper-local drop-off points accompanied by immediate financial micro-rewards, are consistent with the suggestions of Installation Theory. It orients individuals toward a behavior that is no longer a challenging moral choice, but rather a natural act, toward which consumers are unconsciously directed from the physical and institutional environment.

6.2. Integration with theoretical frameworks  
These perceptions stressing the insufficiency of exclusively utilizing TPB in new developing markets. Though the need for consumer environmental consciousness is recognized, empirical evidence shows that even when this is present, most Tier-2

consumers are unwilling to pay a premium or sacrifice convenience. The Theory of Consumption Value can be easily applied to the case of reusable tote system; in this case, functional value (having undamaged goods) and conditional value (micro-incentive refund) must be persuasive enough to clearly be greater than the perceived costs (minimal cost of waiting in line to return bag, etc.) of utilizing the system for the consumer to do so. The Return-on-Delivery model works on paper because it changes the low value act of garbage disposal into valuable act of value-recovery to the consumer.

### 6.3. Study limitations and analytical biases

Though the potential economic and environmental benefits from these theoretical models are strong, there are serious caveats to be recognized. The first limitation of the study is its heavy reliance on the city of Indore as a working model. Indore should be noted but as the best-case scenario in India where other gaps are still glaring- as seen in a city that has more public will, more government will, more enforcement and more funding than just about any other in the country; the fact that this best case can only achieve 100% source segregated over decades of intense civic training and massive municipal funding. Scaling the behavioral compliance demonstrated in the project to any other city in China not only in Tier-1, but in any other- Tier 2 or even Tier 3 city is biased, as these only exist in 4 different regions and not being 'sufficiently mature' municipal infrastructure for pursuing such a high-tech state of behavioral compliance in these other categories of cities begs the question. The financial analysis, second, assumes the precariously short 30-cycle life of the reusable tote; nevertheless, variables like asset shrink (loss/theft/hoarding) or damage in-transit could reduce the real average life of the bag, therefore pushing considerably the breakeven point. Lastly would be the capital-intensive nature of the model given that there is the need for an upfront investment in smart packaging infrastructure as well as in the regional sterilization centers. This cost of adoption is likely to be an unforeseeable barrier for many smaller medium sized or MSME retailers even with the evident savings in operational expenditures thereafter.

## VII. CONCLUSION

### 7.1. Synthesis of key findings

The same geographical pivot of the Indian digital economy movement into Tier-2 and Tier-3 cities that is fueling astounding retail growth is simultaneously and interrelatedly causing an ecological crisis through, an e-commerce packaging waste crisis. The existing models that use linear supply chains and single-use flexible plastics do not align well with the need to build infrastructure in high RTO regions, nor can they compete with cash-on-delivery in markets that are just developing. Yet all the more integrated study of the Indore archetype demonstrates that regional city populations are quite capable of engaging in circular behavior over time, if provided consistent, well-designed socio-technical infrastructure to do so. This conceptualized Return-on-Delivery framework supports this argument that replacing cardboard with Reusable Transport Packaging is not only an act of environmental responsibility, but a smart economic investment. E-commerce businesses can effectively cut amortized packaging costs in half by making packaging a recoverable, reusable asset, eliminate the cost of RTO logistics which can be significant, and achieve EPR at a national level proactively and with the most stringent audit points possible, by turning packaging from a disposable expense into a trackable long term use product.

### 7.2. Strategic recommendations

These recommendations should be useful for stakeholders in the industry, based on the comprehensive review of behavioral theory, logistical data, and economic models.

- For E-commerce Platforms and 3PL Providers: Start phase-wise pilot projects of reusable totes as 'Living Labs' for E-commerce, in high-density tier-2 pin codes, starting with non-fragile, high-volume product categories such as apparel and shoes. At the same time these platforms will themselves need to make investments in RFID/QR tracking infrastructure to be able to capture granular supply chain telemetry that can be used to perfect dynamic routing and further cut transportation costs.

- Digital PRO's and the informal sector

E-commerce players should institutionalize solid partnerships with businesses similar to The Kabadiwala to manage the aggregation of postponed plastic packaging returns. The process of helping digitized fleets of informal workers recoup lost capital will infuse urgently needed cash into the local economy and create a more flexible, localized web of collections that straddles the formal and informal line.

- For Consumer Engagement:

Brands must move from education campaigns to choose-architecture games. They need to enable instant micro-credits through digital wallets on the return of the packaging, using insights from behavioral economics to basically leapfrog the attitude-behavior gap and to avoid unconscious disposal behavior.

## VIII. SCOPE FOR FUTURE WORK

Scholarly and industry research going forward, should seek to conduct empirical, large-scale tests in several Tier-2 and Tier-3 cities to test the viability of reusable packaging, rather than the Indore anomaly, that may be more or less compliant from other cities with varying rates of civic compliance. Also, we need to investigate the possibility of incorporating Artificial Intelligence to enable an 'algorithmic right-sizing', a second operational approach that uses the power of machine learning to forecast the most appropriate packaging configurations in real-time and to begin the elimination of unit load devices altogether for resilient products. Lastly, coupled with ascendancy to life-cycle end-of-life, an investment into the research of "superior" bio-polymers, resultant in uniquely strong bioplastics would alleviate the negative effect on environment by those compostable reuse items – guaranteeing end-life compostability that maintains durability through transit.

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