CINEFORUM
ISSN: 0009-7039
Vol. 66. No. S6, 2026 (Special Issue 6)

Food–Mobility–Waste Interconnections within India's Food System: Integrating Evidence and Governance Mechanisms for Environmental Sustainability

Om Parkash Kapoor[1] , Dr. Anil Chandhok[2], Dr. Navdeep Sharma Dugala[3] , Dr. Akant K Singh[4],Rajeev Kapoor[5]. Sumedh Puri[6]

[1]Research Scholar, USB, Chandigarh University, Gharuan, Distt. Mohali, Punjab, India
E-mail: opkapoorz@rediffmail.com "Main Author"
[2]Professor, USB, Chandigarh University, Gharuan, Distt. Mohali, Punjab, India. E-mail: anil.e4863@cumail.in
[3] Professor, Department of Automobile Engineering, Chandigarh University, Gharuan, Distt. Mohali, Punjab, India. E-mail: hodautomobile@cumail.in
[4]Associate Professor Department of Mechanical Engineering, Chandigarh University, Gharuan, Distt. Mohali, Punjab, India. E-mail: akant.e13980@cumail.in
[5]Rajeev Kapoor, PGDCSA (PU), MBE(KU), M Tech (ETH, Zurich Switzerland), Business Dev. Manager, Staubli Industries, Basel, Switzerland. E-mail: Rajk.chd@gmail.com
[6]Sumedh Puri, B.Tech. CSE (CU), Sr. Consulting Data Scientist/Engineer, Deloitte.
E-mail: sumedh.puri@gmail.com

ABSTRACT
India's expanding food system, rising mobility, and thereupon growing environmental pressures need greater attention towards interrelationships among food movement, consumption, food waste and transportation-related pollution. Food waste of 55kgs/person/year and associated transportation air pollution are major concerns as these relate to resource use, efficiency and environmental sustainability. However, food waste and vehicular emissions are usually explored through distinct institutional and academic settings though they intertwine and are inextricably bound in everyday food system operations and environmental-health outcomes.
This study presents an adapted Indian contextualized analytical framework incorporating food system processes, mobility of food, mobility of consumer in food purchasing, pathways and destinations of surplus and waste of food, mobility of waste, and end-environmental impact. Relying on Indian evidences and related governance processes, the study separates governance from compliance and elaborates their cross-cutting importance to facilitate the translation of standards and policies to environmental performance. The framework also categorizes the food waste as decision points where safe surplus food may be facilitated to be retained and redistributed or where inevitable waste is managed in separate way, Collection, Recovery, Treatment and Final disposal.
In its broad intent, the paper does achieve its core claim; reframe food, mobility and waste as mutually integrated domains of environmental responsibility, rather than individually examined systems as hitherto. The framework described serves as a launching pad for evidence-based governance, compliance behaviour, responsible actions and closed-loop resources and outlines propositions for the future empirical investigation of diverse rural and urban India.
Ultimately, a sustainable future may depend not only on producing and moving more resources efficiently, but on ensuring that the food humanity produces, the mobility it creates, and the waste it generates are governed as one interconnected responsibility...
Keywords: Food systems in India; food waste; mobility; vehicular pollution; governance; compliance; environmental sustainability

INTRODUCTION:

1.1 India's Food System and Changing Environmental Pressures

An Indian food system consists of linked urban-rural processes from production and post-harvest activities through to distribution, sales, eating and waste disposal (e.g., Lanjouw, 1997; Saptaparasih, 2008; 22). It involves persistent flows of food, people, resources and waste and therefore a number of environmental interfaces within the system. "Food system" is therefore an extremely broad concept that encompasses beyond food production and considers interactions between production, consumption, mobility, resource use and environmental implications (Bn et al., 2019; Fanzo et al., 2021).

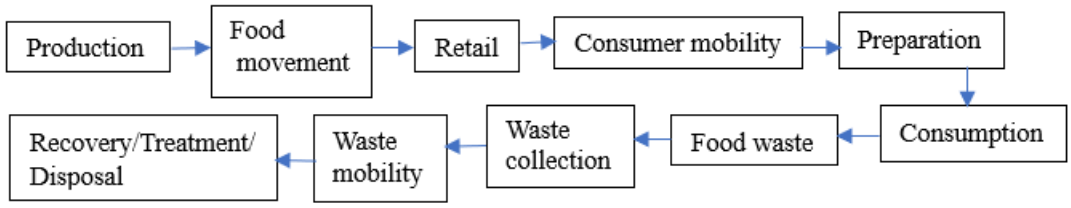
Another prime example to illustrate these linkages is food loss and waste. A discarded food item represents the use of land, water, energy, labour, and etc. Involved in its production and distribution chain. Food wastage was estimated to be as high as 55kg per person per annum in the household sector in India, which translates into nearly 78.2 m tonnes per annum (UNEP, 2024; WRI India, 2024). It can be seen that food loss and waste not merely relate to the problem of disposal of food, but also to resource-use efficiency and environmental sustainability.

Transportation, as one of integrated dimensions, includes transferring the food from its production sources via supply chains of collection, wholesale, processing and retail, traveling by individuals to get food, traveling for disposal, collecting and transporting the waste. Transportation of materials as well as cooking have been identified to impact the environmental cost of Indian food consumption (Agarwal et al., 2010). The newest food-environment studies regard transport, delivery, waste along other environmental characteristics as interacting aspects for sustainable food systems (O'Keefe et al., 2024)

These inter-relationships mean that neither food, mobility nor waste should be seen as a completely separate environmental sector; instead, the links between sectors are far greater, spanning across both rural and urban areas and impacting directly on resource use, emissions and generation of waste and subsequent effects on the environmental sustainability

1.2 Food, Mobility and Waste as Interconnected Processes

Food-system activities produce various interdependent flows:



It logically follows that mobility activities occur at different stages in food system, covering the movement of foods throughout supply chains and the movement of food as carried out by the consumer including both the purchase of food items and transportation of foods post purchase, i.e., transportation of waste etc.

Food waste may also have a variety of impacts and implications. In the consumption stage, food waste is seen to entail loss of the input value in the food, and once disposed, food waste is included in the waste management system, needing, collection, transport, processing or recovering, and disposal. The measurement of food waste, in all three stages, household, food service and retail stages, is a key element to follow the goal 12.3 of the SDGs [5].

The Indian context brings an additional governance dimension to the food system. Activities in the food system are covered through a diversity of governance arrangements spanning various domains; farming, food safety, food transport, sanitation, waste handling and environment quality. In addition, studies focusing on the governance of food policy in India also emphasized the significance of coordination and policy coherence for food systems (Ghosh et al., 2021).

Therefore, the analytical concerns of this paper are not the amount of food wasted or transport delivered but the relationships between food-system activities, mobility, the generation of waste and the structures that are involved in this process.

1.3 Indian Context

India's capacity for institution building mechanisms addressing sanitation, cleanliness, food-management, solid-waste, transport and environmental services constitutes an essential ground to analyse these three interconnections: Food-Mobility-Waste.

Initially focusing on sanitation and eradication of open-defecation, the Swachh Bharat Mission that began in 2014 eventually came to embrace the overall need for continued cleanliness and solid- and liquid-waste disposal management. A part of SBM includes SBM(G)-Swachh Bharat Mission (Gramin), which contains solid and liquid waste disposal systems and group structures, designed for continued sanitation and cleanness (Ministry of Jal Shakti, n.d.).

Additionally, India's solid-waste regulatory framework has been reinforced more recently with the introduction of the Solid Waste Management Rules, 2026. Effective from April 1, 2026 and notified on January 27, 2026, the

Solid Waste Management Rules mandate a four-stream segregation at source and identify wet waste more precisely in terms of kitchen waste; food waste, waste from processing of foods; vegetable, fruit, food, meat, flower waste etc. Local bodies, both rural and urban are mandated to adhere to the rule, as are, various monitoring and reporting processes, and, principles related to a circular economy (MoEFCC, 2026; CPCB, 2026).

Food governance is yet another important tool. The Food Safety and Standards Authority of India has framed regulations on the recovery and allocation of surplus food which has provided a channel of food governance in this direction, where appropriate surplus food is not allowed to be wasted.

A third part of the system comprises transportation. India has significantly improved its vehicle fleet and mobility-official VAHAN statistics register millions of vehicles annually while national transport policy has increasingly addressed alternative fuels and reducing emissions (Ministry of Road Transport & Highways, 2023).

This makes India an important test case as to how the embedded food-system processes in both rural and urban context are combined with the current food, mobility, sanitation and waste mechanisms and environments.

1.4 Research Problem

Food, mobility and waste are usually managed through fragmented sector-based arrangements and institutional structures. In one arrangement food supply, production, and distribution are dealt with by organizations in the agriculture and food sector; in another the transport system and its environmental impacts are considered, and the subsequent, but still relevant part, i.e. the disposal of food, fall under management systems for rural or urban waste.

Although these kinds of institutional expertise in relation to food administration are needed, the links among food movement, consumer mobility, food waste, waste transportation and environmental effects may then become harder to trace. Furthermore, the data are often held within various different countries' datasets and institutional sources.

Against this backdrop, the research problem of the study is:

What are the interlinkages between food, mobility and waste within India's food system, what does a national-level investigation into these links uncover, and how can current mechanisms for governance be mainstreamed to enhance environmental sustainability?

The overall study is written from a diagnostic and integrative perspective, as opposed to a critical or accusatory one. The study looks at the current mechanisms, their points of intervention and their potential for greater coordination across the Food–Mobility–Waste continuum.

1.5 Research Gap

Three connected gaps form the basis of the research:

First; a system gap: The processes in the food system of food production, food movements, consumption and food waste and mobility are studied and considered separately.

Secondly; an evidence -integration gap: Data on national levels of food waste and of food-system mobility and transportation and climate impacts exist in a number of different databases and measurement frameworks. UNEP (2024) itself highlighted the need for consistent national measurement of food waste throughout supply chain stages.

Third, a gap between governance and integration: There exist numerous policy mechanisms for tackling food management, waste, sanitation and transport in India. A further study based on a greater degree of analytical effort is necessary in order to examine the interaction of these policy mechanisms in conjunction with the full food-mobility-waste-flow pathway. The importance of coordination, coherence and integration for food sustainability in India has been discussed in previous analyses of the Indian food policy in general (Ghosh et al. 2021).

In the given study the gaps between evidence in the national level, available policy mechanisms, is being attempted to be analysed together by bringing policy mechanisms into the food-mobility-waste framework.

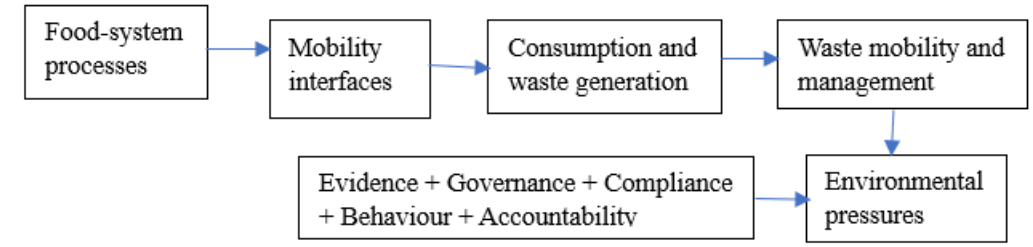
1.6 Objectives

1. Analyse how food, mobility and waste are linked together within India's food system.
2. Synthesize national quantitative evidence on food waste, food systems mobility, transport and environmental consequences.
3. Analyse how contemporary governance mechanisms and enforcement actions regulate these related activities.
4. Create an India-contextualised analytical framework integrating the evidence with governance mechanisms for environmental sustainability.

1.7 Original Contribution of the study.

1. This study adds an evidence and governance approach on the Food-Mobility-Waste nexus tailored to India. Instead of looking at Food waste, mobility, and the environmental stress as distinct elements; it explores the crosscutting areas that inter-connect these issues within food-system processes on both urban and rural dimensions

The contribution can be represented succinctly as:



The resultant framework lays a foundation for understanding how the established systems can be integrated rather than perceived in silos across the continuum of the food system.

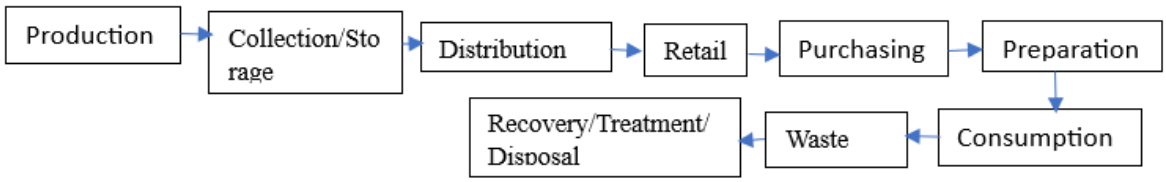
The analysis consequently moves from the question of managing elements to an understanding of links in relations between food, movement and waste in the context of India's food system.

2. CONCEPTUAL AND ANALYTICAL FOUNDATION

2.1 Food-System Perspective

A food system is considered as the activities and actors working together in order to produce, process, distribute, consume and manage foods together with natural resources and waste (FAO, 2018; Bn et al., 2019). Systems approach needs to be used as environmental impacts of the food chain can occur at a range of points not simply in a few,

For the present study, the food system is considered as a **rural–urban continuum**:



From this perspective, there is the opportunity to investigate food waste and mobility as process rather than an activity.

2.2 Mobility as a Food-System Function

Mobility is conceived within the scope of this analysis as an inherent functional dimension of the food system, not simply as a "transportation industry" topic, food needs to move from farms/producer locations to markets, processing sites, retailers and finally consumers. Mobility is undertaken by consumers to move to obtain their food. It is also undertaken to move away food waste

. Accordingly, three mobility interfaces are considered:

Mobility interface	Principal movement	Potential environmental interface
Food mobility	Farm/production → markets → retail	Fuel use and transport emissions
Consumer mobility	Household → food-purchasing locations → household	Vehicle activity and emissions
Waste mobility	Waste point → collection → treatment/disposal	Collection transport, emissions and resource use

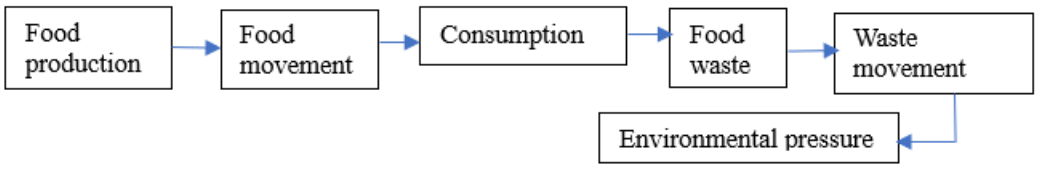
In expanding standard models of food system analyses, it's now recognised that transportation is a linking process of food production, consumption, and waste management. An emphasis is placed on multi-sector environmental assessments across food supply chains, instead of in production alone, to evaluate food system sustainability (Poore & Nemecek, 2018; Clark et al., 2020).

2.3 Food Waste as a System Interface:

Food waste is conceptualized as a system interface between consumption, resource loss, wastes and pressure on the environment. Wasted food can be understood as a set of investments (resources put in production and delivery of food) which do not result in appropriate consumption outcomes. After the discarding the food is subject to another chain (collection, transport, disposal and treatment).

The scale of the problem is enormous. Globally, it has been estimated to be roughly 1.05 billion tonnes of food waste in 2022, with households consuming the largest portion of it (UNEP, 2024). In India, household food waste has been estimated at about 55 kg per capita per year (UNEP, 2024; WRI India, 2024)

Therefore, the analytical chain adopted here is:



This prevents food waste from being treated merely as an endpoint of the food system.

2.4 Environmental Interfaces

The Food–Mobility–Waste system has multiple interfaces and there are four interfaces particularly applicable and relevant to this study.

1. Food-system mobility transport emissions

Transport associated with food, consumers and waste requires the use of energy and this consequently leads to emissions from transport.

2. Food preparation cooking-related emissions

Cooking requires the use of energy, and can potentially produce particulate and gaseous pollutants depending on fuel, technique and conditions (Bonjour et al., 2013; IEA, 2020).

3. Food waste loss of embedded resources and pollution at stages where waste is handled. Discarded food results in both a loss of the resources that had to be put into it, and may be a potential source of environmental burdens (given there is often some sort of waste handling that may involve decomposition in an inefficient manner (UNEP 2024).

4. Food waste public-space and animal/bird interface. Some exposed or poorly managed food waste provides conditions for scavenging (food opportunities that attract wildlife and birds) and environmental exposure. It should be noted this interface has been handled carefully as a complex research interface with no pre-supposition.

These interfaces are used to expand the area of study from Food waste management towards wider environmental connections within the food system.

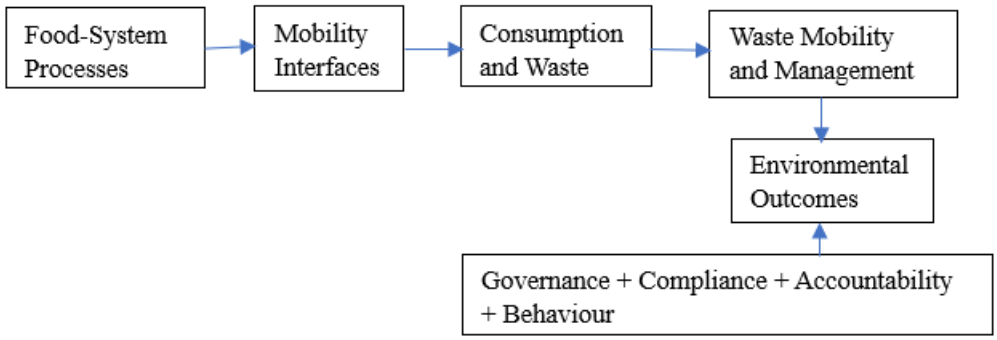
2.5 Governance, Compliance and Accountability

The study distinguishes governance from compliance.

Governance: The term governance refers to the measures, regulations, rules, organizational responsibilities, co-ordination processes and strategic arrangements which are used to respond to food, mobility, waste and environmental challenges. "Compliance" involves meeting and verifying against requirements; which relies on monitoring, inspection, reporting, enforcement, remediation and performance appraisal processes.

Accountability connects institutional responsibility with implementation and outcomes. The linkage between institution and accountability rests on institution's responsibility and on its functioning and results. This division becomes pertinent to India due to multi-institutions that deal with Food, Transportation, Sanitation, Solid Waste and Environment protection. The analytical challenge is not about existence of particular mechanisms but linking and integration of those mechanisms across the Food-Mobility-Waste chain. (FAO (2019); IPCC (2019); UNEP (2024)

The resulting analytical structure is:



3. NATIONAL EVIDENCE ON THE INDIAN FOOD–MOBILITY–WASTE SYSTEM

3.1 Food Waste: Magnitude and Distribution

The strongest national food-waste evidence for India's estimated household food is as:

55 kg/person/year

estimated food waste national quantity: approximately 78.2 million tonnes/year

Table 5 — Selected Indian Food-Waste Indicators

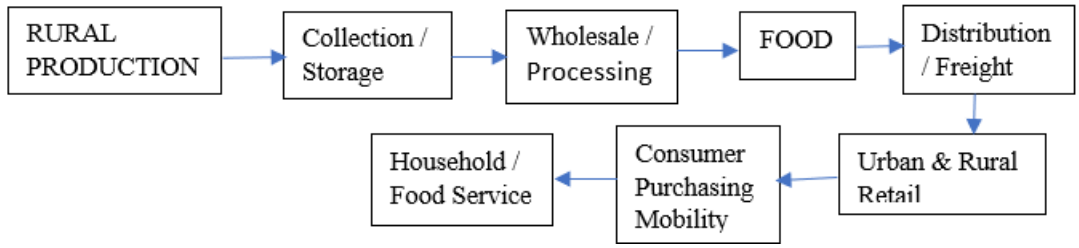
Indicator	India	Year	Source
Household food waste	55 kg/person/year	2022	UNEP/WRI India
Estimated household food waste	~78.2 Mt/year	2022	WRI India
Global household share of food waste	60%	2022	UNEP

According to the UNEP (2024) and WRI India (2024), waste household food in India amounted to about 55 kg/person/annum (or 78.2 million tonnes/annum). This volume signifies that the food waste is really a resource management problem instead of a waste problem. Since food waste occur after goods having passed the processes of production and distribution, environmental impact occurs in every part of the pathway of food system.

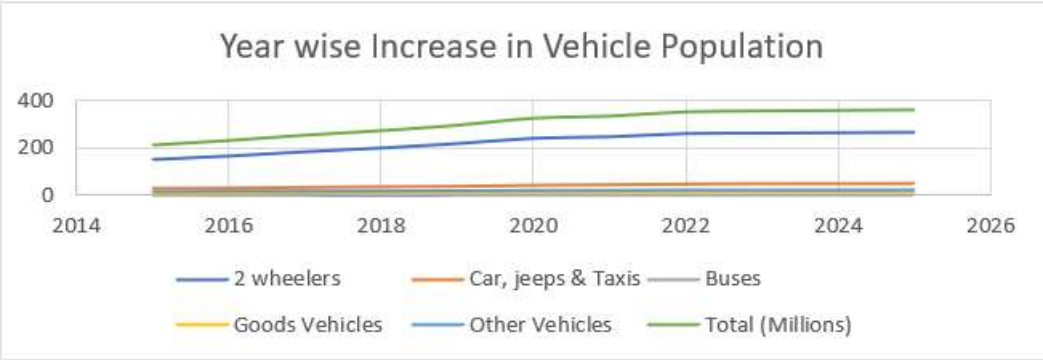
3.2 India's Food-System Mobility

This subsection shows food mobility is not an assumption—it is an observable component of India's food system mobility pathway as depicted in Figure 3.

Figure 3 — Rural–Urban Food Mobility Pathway



The growth in Registered Vehicles in India is laid out in the following graph: Year wise Increase in Vehicle Population

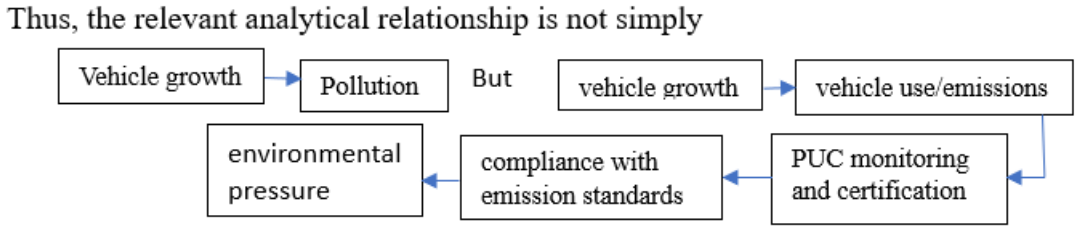


Source: Vehicle Population data from RTYB-2015 to RTYB -2025: MoRTH

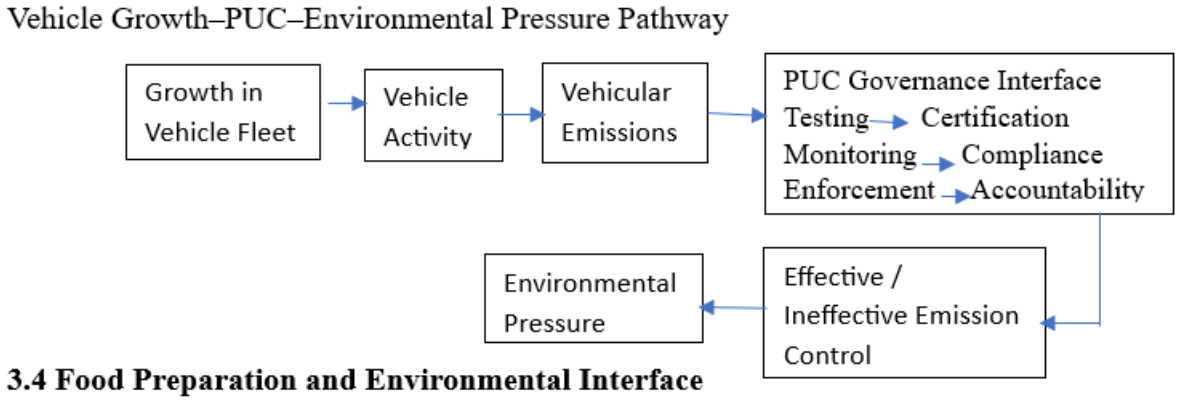
The purpose of this graph is not simply to say that vehicle numbers increased.
The analytical point is:
The spread of food consumption and distribution has to be sustained within an increasingly mobile economy, therefore mobilities constitute an significant interface for evaluation in environmental terms of the food system.

3.3 Vehicle Growth and Transportation Pressure

Although more vehicles on Indian roads imply a higher magnitude of mobility-induced environmental pressure, the actual burden of emission load cannot be attributed to more vehicle only. The ability of various methods to control emission levels is critical, with PUC being one of the mediating mechanisms. PUC in turn, is responsible for the control of on road vehicular emissions (CPCB, 2010; TERI, 2018;)



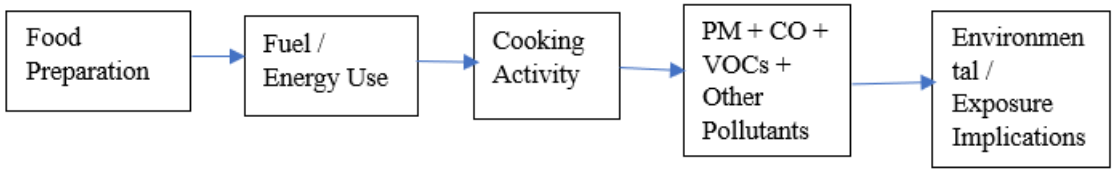
The available evidence suggests that the environmental performance benefit of PUC certification is a function of how well testing, monitoring, compliance and enforcement mechanisms work



3.4 Food Preparation and Environmental Interface

The cooking is an interface within our model rather than the central subject of the paper.

Figure 4 — Food Preparation–Emission Interface



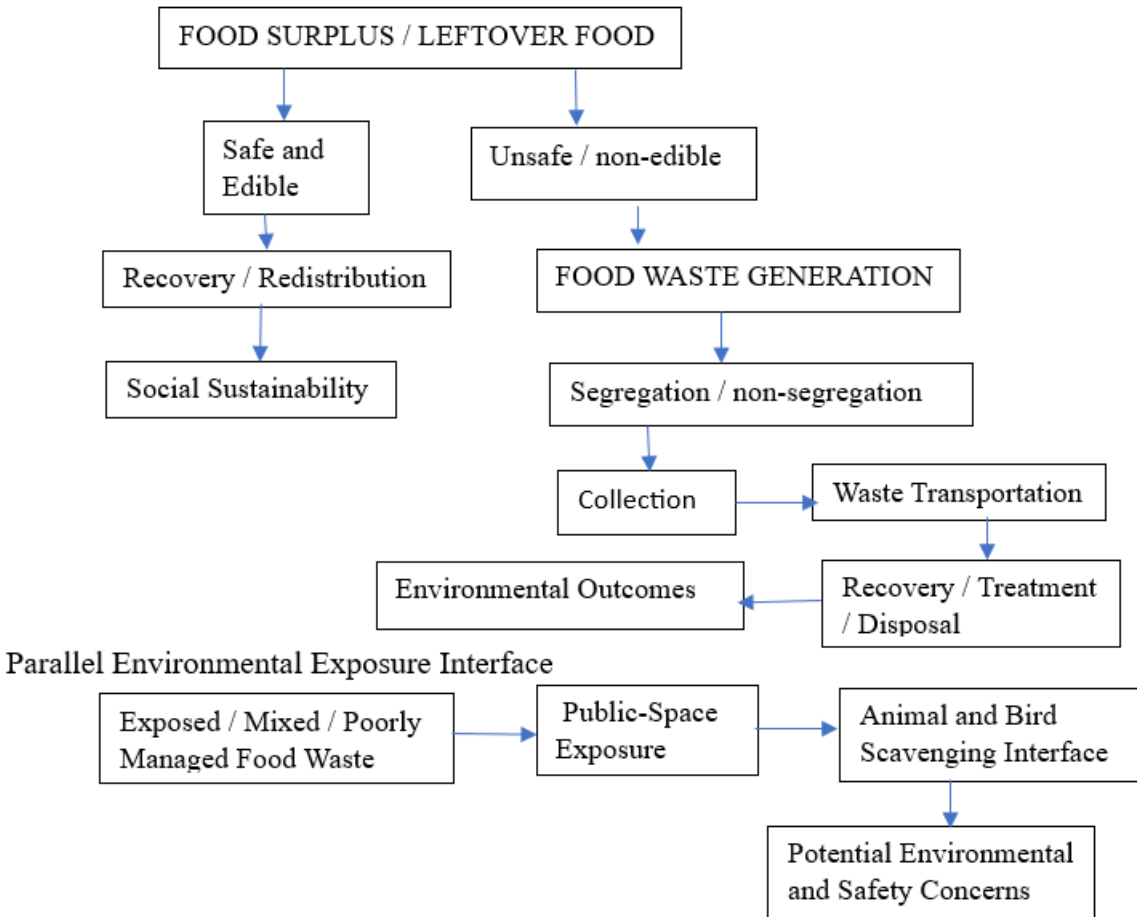
Another environmental interface within the food system is the use of food preparation technologies. Emissions are a function of the energy fuel source used for preparation, as well as the appliance, ventilation method and cooking practices employed (Bonjour et al, 2013; IEA, 2020). Here we incorporate preparation into the scope as an environmental interface and acknowledge emissions that arise in cooking processes.

3.5 Food Waste, Waste Mobility and Environmental Exposure

The issue of food waste has emerged as a key intersection within the food system, waste management, and environment sustainability, as food that is thrown away may also have to be segregated, collected, transported, treated and disposed off. It imposes both resource burden on, and environmental pressure as well (UNEP, 2024). Localized environmental problems may arise from the mismanagement and exposure of food waste. Local environmental problems resulting from the mixed collection or exposed storage of food waste where anaerobic decomposition occurs are the smell and localized pollution through gaseous products. Animal and bird involvement to the food waste may become interfaces where waste is not properly managed or where food waste and refuse is mixed together and thus may interact with plastic or other potential harmful elements. These relationships require context-specific investigation and should not be interpreted as implying that all exposed food waste automatically causes harm.

The concluding point stands in the need for drawing attention to the paradox of social sustainability concerning food degradation. Trends in food recovery and redistribution schemes operating within the boundaries of safety regulations can act as an important preventive link in order to resolve the challenges related to food waste. (FAO, 2019; FSSAI, 2019)

Figure 5. Food Waste, Recovery and Environmental Exposure Pathways



Its analytical value of the pathway is that food does not need necessarily to be discarded as waste once it has been left to expire or uneaten. In cases where food can be saved and remains edible and safe for consumption then prevention, recovery and redistribution offer a higher value sustainable solution. When the food can not be saved or is unfit to be consumed then effective segregation, recovery and waste management are needed.

Therefore, sustainability requires not so much what system makes efficient management of disposed food waste, but what enables or prevents valuable food to never be a waste.

3.6 Integrated Evidence Synthesis

The discussion above illustrates that how the food production and consumption, mobility, food waste and food waste management work in linked process rather than discrete environmental activity. Table 6 consolidate these links, each of the main food-system stage is connected to its related mobility, waste interface, environmental pressure, and indicator of evidence

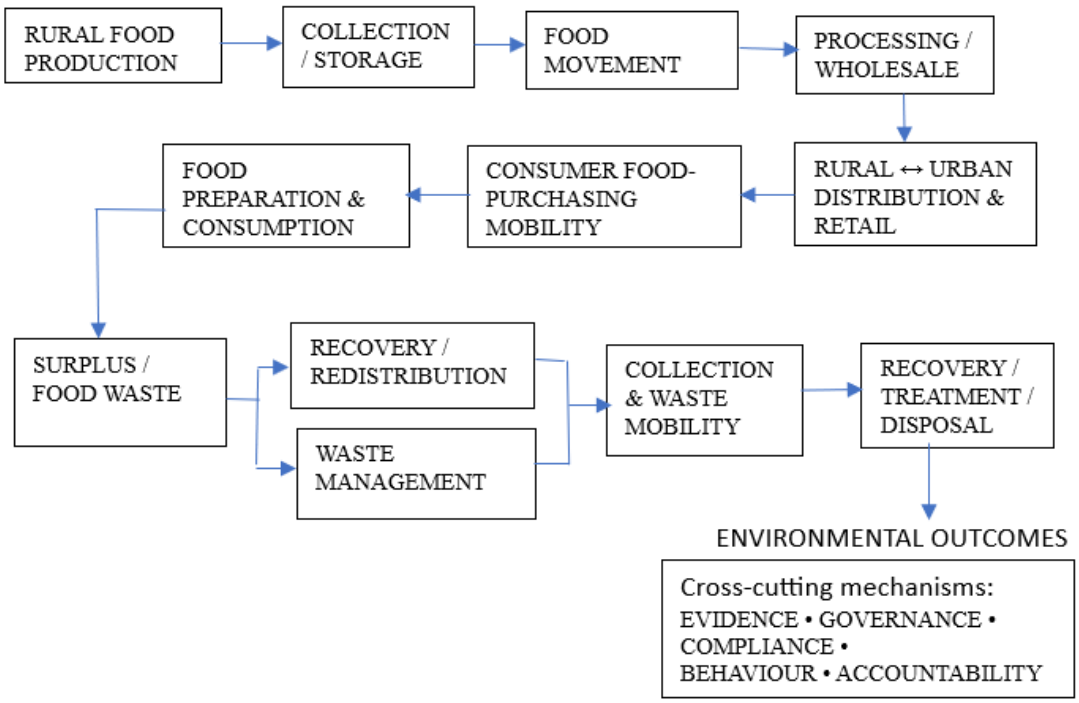
Table 6. Integrated Food–Mobility–Waste Evidence Matrix

Food-system stage	Food activity	Mobility interface	Waste interface	Environmental pressure	Evidence indicator
Production	Food production	Movement of inputs/produce	Production and post-harvest losses	Resource use	Agricultural indicators
Distribution	Food movement	Freight transportation	Handling and distribution losses	Fuel use and vehicular emissions	Transport and logistics indicators
Retail	Food availability and sale	Local distribution/access	Unsold and discarded food	Resource loss and waste generation	Food-waste indicators
Consumption	Food purchasing and preparation	Consumer mobility	Household food waste	Mobility-related emissions and resource loss	Household and mobility indicators
Collection	Waste collection	Collection vehicles	Organic and mixed waste	Transport and localized environmental pressure	Waste-management indicators
Recovery	Segregation and processing	Movement to recovery facilities	Organic waste recovery	Resource efficiency and emission reduction potential	Recovery/processing indicators
Disposal	Residual waste management	Transportation to treatment/disposal	Residual food waste	Environmental pollution and disposal pressure	Disposal indicators

Table 6 highlights that environmental pressures occur along the whole, as opposed to at discrete, phases of the Food-Mobility-Waste continuum and illustrates that food waste is not necessarily a linear destination, but rather a linking component, between consumption on one hand and collection, transport, recovery and disposal systems on the other.

These interconnections are then schematically illustrated in the rural-urban Food-Mobility-Waste continuum shown below, which collates together the main phases and interfaces highlighted in the national research and evidence:

Figure 6. Evidence-Based Rural–Urban Food–Mobility–Waste Continuum



It concludes the synthesis that there is no standalone rural-urban Food–Mobility–Waste in India but a tightly linked rural-urban nexus of consumption, movement of goods and consumption patterns where an environmentally sound approach can emerge through interactions in food flows, consumer mobility, food consumption and waste management. It stresses the inclusion of integrated sectoral approaches to examine food waste, transportation and environmental management rather than independently.

. The key analytic conclusion from this line of thought is then the development of environmental sustainability not merely through the improvement of various components of the system, but through improving the links between them. (UNEP (2024); Government of India sources; FSSAI (2019).

4. GOVERNANCE AND INSTITUTIONAL MECHANISMS

4.1 Governance Architecture of the Food–Mobility–Waste Nexus

Food-Mobility-Waste nexus exist across many of institutional spheres. Many regulations of food production and safety issues; transports; food safety and hygiene and food wastes and environmental protection are made within different institutional spheres. As such, a systems approach requires looking beyond each policy to identify intersections among the spheres within the food system. (FAO, 2018; Bn et al., 2019).

It is necessary to establish at this juncture how the term governance is differentiated from compliance. Governance is the development of policies, rules, standards, institutional responsibilities and coordination structures; compliance is concerned with implementation through monitoring, inspection, reporting, enforcement, correction, and performance evaluation.

Table 7. Governance and Compliance Interfaces across the Food–Mobility–Waste Continuum

System interface	Governance focus	Compliance focus	Sustainability relevance
Food production	Standards, agricultural systems and resource management	Adoption and implementation	Resource efficiency
Food distribution	Food safety, logistics and infrastructure	Operational adherence	Reduced losses and efficient movement

Retail and consumption	Food safety and responsible consumption	Standards and behavioural adherence	Waste prevention
Surplus food	Recovery and redistribution arrangements	Food-safety compliance	Social and resource sustainability
Consumer mobility	Transport and emission standards	Vehicle inspection and emission compliance	Pollution reduction
Food waste	Segregation and waste-management rules	Collection and handling compliance	Pollution prevention
Waste mobility	Collection and transportation systems	Operational monitoring	Efficient waste management
Recovery and treatment	Circularity and resource-recovery mechanisms	Processing and performance standards	Resource recovery

Source: Developed by the authors based on FAO (2018), FSSAI (2019), UNEP (2024), Government of India waste-management and transport governance frameworks.

As shown in Table 7 governance takes places at different points within the system. It is the interaction and integration of the individual governance processes that constitute the difficulty and complexity of analysing this system.

4.2 Key Indian Governance Mechanisms

India's governance landscape presents various appropriate governance mechanisms for tackling the different components of the nexus. The Swachh Bharat Mission establishes a necessary governance framework for hygiene and sanitation at the rural and urban level and; waste segregation, collection and the environmentally-sound treatment and disposal of solid-waste is managed by the Solid Waste rules, Food governance mechanisms deal with food safety, food waste and; as appropriate, the redispatch and onward consumption of surplus food (Ministry of Jal Shakti, undated; FSSAI, 2019).

Likewise, the transport and environment mechanisms cover standards for vehicles and vehicles-regulation and emission control, as well as compliance and its operation.

PUC system can be seen as a key point in ensuring compliance, as the positive effects of an emission standard require both tests and certificates, surveillance and control. Instead of dealing with the mechanisms individually as sets of arrangements, this work analyses possibilities for linkages and connections.

4.3 Integrated Governance–Compliance Framework

The relationship among the principal mechanisms can be summarized as seen in the Figure 7.

Figure 7. Governance and Compliance Integration across the Food–Mobility–Waste Nexus

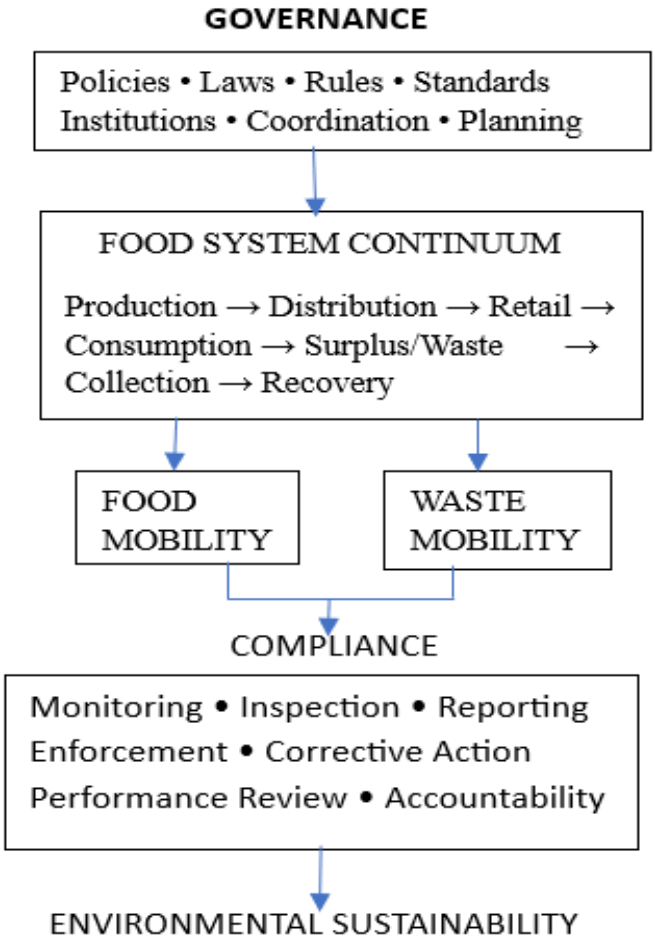


Figure 7 depict that the governance and compliance operate as inter-connected mechanisms across the Food-Mobility-Waste continuum. Governance addresses the institutional and policy guidance and whereas, compliance translates it to the actual operation and measurable outcome.

4.4 Analytical Implication

The main implication is that environmental sustainability can no longer be a sole concern of specific sectors; although waste-prevention, food surplus utilization, conscious mobility, emission reduction, resource separation and waste- recovery belong to several distinct institutional spheres, their impact upon the environment is integrated.

As such, a question of governance might not be whether additional institutions are needed, but that perhaps coordination, integration of information, as well as responsibility and accountability within the existing institutions need to be built-up, especially in a coordinated effort (Bn et al., 2019; FAO, 2018).

Ultimately, Food-Mobility-Waste governance not only relies on effective governance within their separate parts but on good governance linking parts that produce the same external effects for environmental outcomes (FAO (2024); MoEFCC (2016); FSSAI (2019).

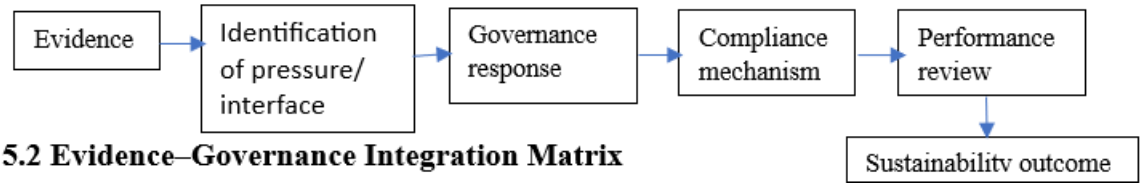
5. EVIDENCE–GOVERNANCE INTEGRATION ANALYSIS

5.1 Integrating Evidence with Governance Action

Section 3 of this national evidence reports identified environmental interfaces along the food chain, mobility, consumption and waste flow, and the analysis of the section 4 shows that governance and compliance mechanisms operate along several points along this continuum. Thus, it appears there is a need to join up what has been seen in the evidence and where the governance and compliance may operate.

An evidence-based approach is especially pertinent in sustainable food system transformation since governance needs Coordination, role/responsibility and informed policy-making using proper evidence (FAO, 2024; UNEP, 2023)

Accordingly, the Food–Mobility–Waste nexus can be examined through the relationship:



5.2 Evidence–Governance Integration Matrix

Table 8. Integrating National Evidence with Governance and Compliance Responses

Evidence/interface	Analytical concern	Governance response	Compliance/implementation mechanism	Expected sustainability direction
Food loss and food waste	Resource loss and unnecessary waste generation	Prevention and reduction strategies	Measurement, segregation and reporting	Reduced food waste
Safe surplus food	Food becoming waste despite potential human use	Recovery and redistribution arrangements	Food-safety and handling requirements	Social and resource benefit
Food-system freight mobility	Fuel use and transport-related emissions	Transport and logistics planning	Operational standards and monitoring	More efficient mobility
Consumer food-purchasing mobility	Additional vehicle activity	Sustainable mobility and access planning	Behavioural and operational measures	Reduced avoidable mobility pressure
Vehicle emissions	Air-pollution pressure	Emission standards and regulatory controls	PUC testing, monitoring and enforcement	Improved emission compliance
Food preparation	Energy use and cooking-related emissions	Clean-energy and efficiency measures	Adoption and performance practices	Reduced environmental pressure
Poorly managed food waste	Localized pollution and public-space exposure	Waste-management and sanitation arrangements	Segregation, collection and inspection	Improved environmental conditions
Organic food waste	Loss of recoverable resources	Circular-economy and recovery mechanisms	Processing and performance monitoring	Resource recovery
Animal/bird exposure interface	Exposure to mixed or	Public-space and waste-	Collection and waste-handling compliance	Reduced unsafe exposure

	poorly managed waste	management measures		

Source: Developed by the authors based on the evidence synthesized in Section 3 and the governance mechanisms examined in Section 4.

It is in Table 8 that the core analysis of this section resides, as it suggests each interface highlighted may not remain simply as a description; but that each identified interface may have a specific, identified governance and compliance response associated with it.

It can also be seen that certain environmental impacts may be mitigated at numerous levels-in example above, to reduce food wastage there was prevention at consumption, capture of safe surplus, separation after waste generation and subsequent capture of organic materials. And to reduce the environmental impacts from mobility, attention must be directed to vehicle emissions, legal compliance and an organisation of mobility.

5.3 The Evidence–Governance Feedback Framework

The relationships specified in Table 8 can be represented as a continuous feedback system rather than a linear policy process.

Figure 8. Evidence–Governance Integration Framework for the Food–Mobility–Waste Nexus

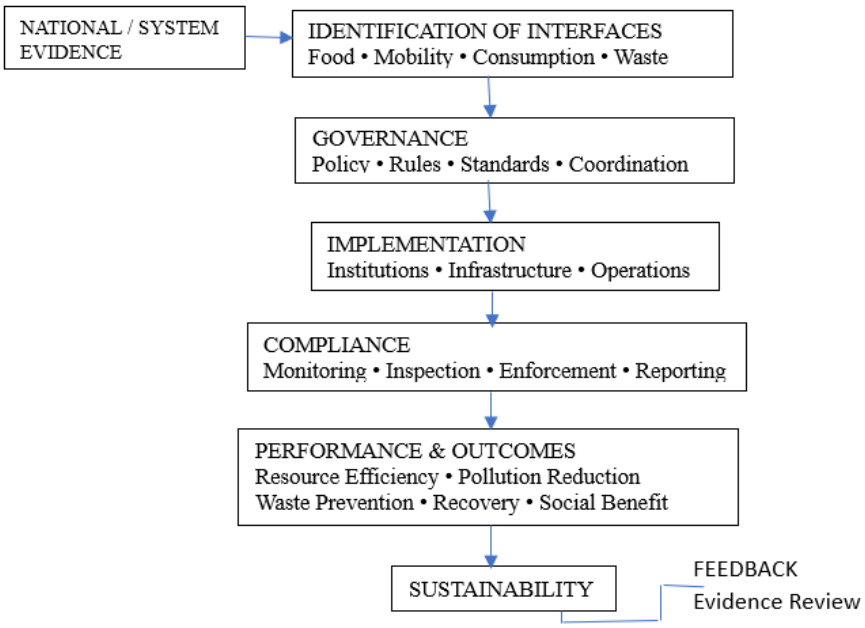


Figure 8 highlights that governance cannot be merely seen as a single, one-off policy intervention; evidence identified system pressures; governance will determine the response; compliance will formalize the requirements in the practice, and performance will yield more evidence to support review.

Such feedback approach complements widely cited across the broader system and nexus scholarship, emphasizing coordination, monitoring and adaptive governance across interlinked sectors (FAO, 2024; UNEP, 2023).

5.4 Analytical Significance

The primary analytical benefit of this integration is that instead of isolated sectoral issues the emphasis shifted towards integrated environmental interfaces.

Example:

Food waste evidence should inform and guide responses for prevention, recovery and waste management.

Vehicle emission evidence should inform and guide emission governance, PUC compliance and performance monitoring.

Waste management evidence should inform and guide waste collection, segregation and recovery and public space management.

Thus, the relevant question is not simply: "Which institution is responsible?"
but also: "What evidence identifies the problem, where does it occur within the system, and which governance and compliance mechanism can respond?"
This approach is consistent with contemporary food-system governance thinking, which emphasizes coordinated action and evidence-informed institutional responses to interconnected sustainability challenges.
Thus, the core claim of the Evidence-Governance Integration Analysis is the transformation of scattered evidence into identifiable points of institutional action along the Food-Mobility-Waste continuum.

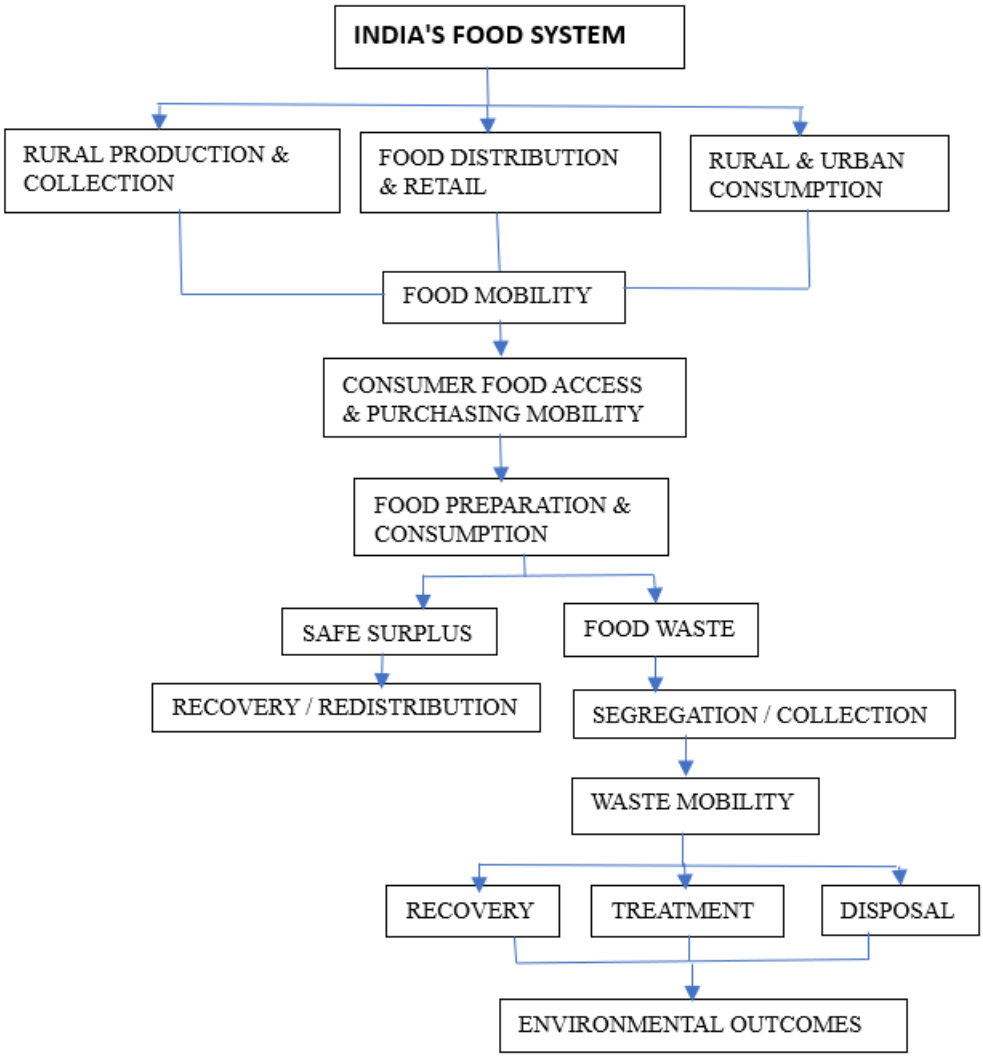
6. INDIA-CONTEXTUALIZED FOOD–MOBILITY–WASTE FRAMEWORK

6.1 Framework Rationale

The above analysis clearly demonstrates that the food–mobility–waste nexus in India permeates related rural and urban processes of food production, provision, access, consumption, leftovers and waste generation and handling. Emerging research on food-system strongly emphasizes the importance of a holistic examination of associated processes and governance spaces and avoid isolated treatment of sustainability issue within disciplinary boundaries (Donner et al., 2024; FAO, 2024).
Consequently, a framework developed into one analytical structure in the present work includes system processes, mobility interfaces, pathways of waste streams and institutional response.

6.2 India-Contextualized Framework

Figure 9. Food–Mobility–Waste Interconnections within India's Food System



Cross-cutting mechanisms operating across the entire system

EVIDENCE • GOVERNANCE • COMPLIANCE • ACCOUNTABILITY • BEHAVIOUR

6.3 Interpretation of the Framework

The framework makes four analytical contributions.

First, Food mobility as an embedded system function. Not only does it consider movement across production and distribution systems, but it also covers consumer mobility required for access to food. Recent literature on food-environments in South Asia likewise highlights consumer travel and food waste as appropriate interfaces for environmental sustainability.

Second, it treats food waste as decision stage instead of the end. Safe surplus may enter recovery, redistribution channels if suitable and in according with food safety requirements where as unavoidable and unsafe food waste enters segregation, collection, recovery, treatment and disposal. Sustainable circular practices, firstly avoid waste and waste generation in resource use, and then reduce waste (Circular approaches emphasize prevention and efficient resource use before disposal).

Third, framework integrates the rural and the urban. Food production, circulation, consumption and disposal occur across geographical boundaries, making it necessary to use an analytic lens that traces flow rather than to think of the rural and urban systems as discrete/separate realms.

Fourth, governance and compliance are processes which cut across the spectrum instead of representing a terminal mechanism. Policy, institutional setup provides direction and monitoring, inspection, enforcement, reporting and accountability contribute to the implementation process across several points along the continuum. Joint governance becomes particularly relevant for integrated systems which might otherwise be handled through compartmentalised institutions.

6.4 Central Analytical Proposition of the Framework

The framework can be summarized as:

It is possible to improve environmental sustainability of the food system by regarding the following pathways as intertwined and based on empirically sound governance, appropriate compliance, accountability, and responsibility: food movement, mobility consumers, food surplus and waste.

The framework does not state that every environmental pressure comes simply from food waste and/or mobility. Instead, it gives us a comprehensive framework to understand where environmental pressure comes from, what evidence is needed, and what mechanisms of government and enforcement.

The true worth of it is the linking of individual activities- food, mobility and waste-into an overall system of environment responsibility.

7. ANALYTICAL PROPOSITIONS

The framework that is constructed in Chapters 3-6 represents the linkage that occurs between food-system process, mobility, food-surplus and food waste, environment-pressures, governance mechanism and so on. In accordance to this argument, rather than established empirically proved facts, following propositions are forwarded as analysis-proposition for future empirical investigation. The research, conducted recently based on systems-perspective toward food-waste, also shows the need to link food-waste processes and structure rather than individually research it or examine in isolation (Rolker et al., 2025).

P1: Food-System Interconnection Proposition

P1: Greater integration in the analysis of food-system processes, food mobility, consumer mobility and waste mobility is associated with a more comprehensive identification of environmental pressures and sustainability intervention points.

From the proposition that Food, Mobility and Waste work through interconnected cycles over production, distribution, shopping, use and waste removal. In studies of research of sustainable food environments, consumer mobility, waste management and food waste practices have all been identified as "environmental interfaces" and ignored due to "narrow analysis of food systems".

P2: Food-Waste Prevention and Recovery Proposition

P2: The prioritization of food-waste prevention and the recovery or redistribution of safe surplus food, where appropriate and consistent with food-safety requirements, can strengthen both resource efficiency and social sustainability compared with approaches focused primarily on post-disposal management.

This Proposition relates to the basic premise of the framework which recognizes the safe surplus food and that the food wastes are either avoidable or unavoidable/unsafe. Research based on a systems perspective into the causes and mechanisms of food loss and waste facilitate prevention, reduction and value-recovery processes at various levels of the food system.

P3: Mobility–Emission Governance Proposition

P3: The environmental pressure associated with increasing mobility depends not only on the scale of vehicle activity but also on the effectiveness of emission-control, monitoring, compliance and enforcement mechanisms.

This proposition is pertinent in the context of India, since vehicular numbers alone do not reflect the environmental consequences that accompany mobility. For effective control mechanisms like emission standards, vehicle testing, certification, monitoring and enforcement form significant intervening interface.

P4: Evidence–Governance Integration Proposition

P4: Stronger integration of system-level evidence with governance, compliance and accountability mechanisms is expected to improve the identification, coordination and management of environmental pressures across the Food–Mobility–Waste continuum.

This proposition is the main analytical contribution of this paper. Evidence explains the location of the pressures, and institutional direction comes through governance, whilst institutional compliance determines implementation and success. Integrated approaches are especially needed in areas where food, mobility and waste are dealt with through separate institutional or sectoral systems.

Concluding Statement

In aggregate, the propositions imply that an environmentally sustainable food system in India cannot be solely achieved through individual or isolated efforts on one issue area such as food production, transportation or waste. Instead, the system framework suggests that connectivity, no-waste, intelligent mobility, coordinated evidence-based institutions as alternative paths towards better sustainability.

These propositions consequently constitute the framework for subsequent empirical studies, examining both individual relationships within the Food-Mobility-Waste interconnection and their synergistic efficiency.

8. PRACTICAL AND POLICY IMPLICATIONS

According to Food-Mobility-Waste framework, environmental sustainability could be enhanced through a collaborative and an integrated food, mobility and waste management system. There are four, interlocking, implications, the governance implications, implications for compliance, implications on behaviours and implications for circularity/resource use. The structure fits with the concept of an integrated food-systems model rather than dealing with fragmented sections as individual issue areas (FAO, 2018; Bn et al., 2019; UNEP, 2024).FAO (2019); FSSAI (2019); MoEFCC (2016); UNEP (2024).

8.1 Governance Implications

Firstly, the core governance implication is that we have to seek to enhance coordination among the existing institutional frameworks and institutions involved, not consider food, mobility, and waste as just separate policy areas. Appropriate governance arrangements include governance of food safety and of waste. Others could be rural and urban waste management. Or governance arrangements relating to transport and emission regulation, sanitation and environment.

Particular attention may be given to:

policy integration across food, mobility and waste sectors;

institutional coordination and clearly defined responsibilities;

integration of relevant national and local evidence into planning;

strategic identification of environmental pressure points across the continuum; and

coordination between rural and urban food and waste systems.

This approach thus helps promote integration, and it is on that basis (that governance is necessary in the first place) rather than a hypothesis about required institutional change that it seeks to build further.

8.2 Compliance Implications

To yield environment effects, institutional requirements are bound to materialize into operational practice. Compliance mechanisms accordingly remain indispensable for each segment of Food-Mobility-Waste continuum. Key areas of attention and action cover:

monitoring and inspection;
adherence to food-safety and waste-handling requirements;
source segregation and appropriate collection practices;
reliable emission testing and certification;
enforcement and corrective action;
reporting and performance review; and
institutional and operational accountability.

The aspect of PUC interfaces, while important, is of crucial relevance to mobility-related environmental pressure: emission standards are relevant not only by existence, but by being tested and certified properly. Compliance tests, certifications, monitoring and enforcement of standards and legislation are critical. Waste management regulations rely on adequate implementation and effective management systems for sorting, collection, transportation and disposal or recycling.

Therefore, governance establishes what should be achieved, whereas compliance determines whether established requirements are translated into actual environmental performance.

8.3 Behavioural Implications

The framework acknowledges that only through institutional arrangements can the problem of food waste and unsustainable pressure on the environment be tackled. The behaviour of individuals and organizations drives the issues of why and where food is bought and consumed, the extent of mobility to purchase it, the cooking method to prepare the food and finally how it is segregated for disposal or reused.

Behavioural priorities in this regard are:
responsible food purchasing and consumption;
prevention of avoidable food waste;
responsible food-purchasing mobility;
segregation and appropriate disposal of food waste;
individual accountability for environmentally consequential behaviour; and
greater awareness of the relationship between everyday activities and environmental outcomes.

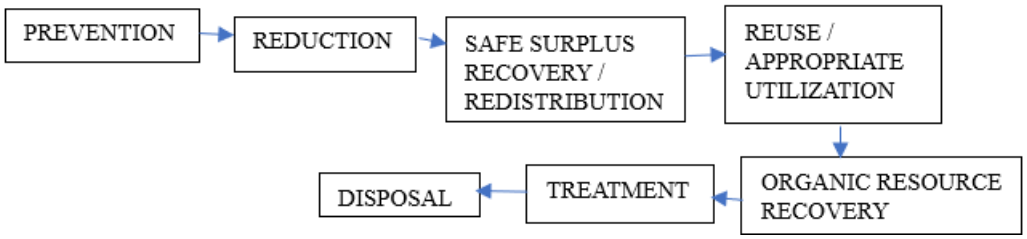
Behavioural accountability is an added value as the ultimate outcome of the Food-Mobility-Waste nexus reflects the choices made by a multiplicity of producers, retailers, households, consumers and service providers. Individual accountability thus reinforces the effect of institutional governance on sustainable outcomes.

8.4 Circularity and Resource-Efficiency Implications

The framework advocates a shift away from disposal towards greater emphasis on prevention and resource recoverability and efficiency. It means that uneaten food cannot be treated as waste by default.

The preferred sequence is:

Figure 10. Circularity and Resource-Efficiency Hierarchy for Food



This shows that overall greatest benefit of sustainability occurs when waste is prevented upstream (so nothing is wasted to start with) before resources are lost. If prevention no longer an option, safe recovery, reuse and relevant resource recovery routes can minimise impact of disposal, depending on the food safety and environmental conditions required (FAO, 2019; UNEP, 2024).

8.5 Concluding Implication

The four dimensions should not be considered as isolated to each other:

Governance provides direction; compliance ensures implementation; behaviour influences everyday decisions; and circularity converts prevention and recovery into resource-efficient outcomes.

The mechanisms will together offer an alternative, practical route towards the Food-Mobility-Waste interconnection without any suggestions for un-needed new institutions nor critical arguments regarding actual national initiatives or programs. (FAO (2019); FSSAI (2019); MoEFCC (2016); UNEP (2024)
The bigger point being is, the environmental sustainability is achieved when institutions govern responsibly, the systems comply effectively, individuals act accountably and valuable resources are prevented from becoming waste or not turned into waste.

9. FUTURE RESEARCH, EMPIRICAL VALIDATION AND LIMITATIONS

The paper conceptualizes a framework for investigating the links between food systems, mobility, food wastes, and governance in India at the same time the environmental sustainability of the food systems is considered. It is the intention of this conceptual and evidence-integrating work that it serves as an attempt to create a foundation to explore with further empirical works rather than assertion that casual connections are empirically evidenced.

9.1 Future Research and Empirical Validation

The research to be carried out in future; could test empirically, the assumptions presented in Section 7 in different places and institutions. Different studies could explore the variation of Food-Mobility-Waste interconnections from rural vs urban regions and also from institution to institution, and across different types of food systems.
Emphasis may be placed on:
Measurement of Food mobility along the supply chain and consumer phases;
links between the food waste generation, waste movement, and location-specific environmental conditions for food waste,
consumer behaviour regarding purchase decisions, and associated mobility of foods;
the effectiveness of measures for the recovering and re-distributing surplus food;
the relationship of vehicular traffic, emission control measures and environmental pressures;
the effectiveness of mechanisms between governance and compliance regimes at the food, mobility and waste system interfaces, and
behavioural and accountability factors influencing food waste and responsible disposal.
Future empirical research might adopt mixed methods-using national data sets, household surveys, institutional evidence, case studies, and geographically or nationally differentiated comparisons. This would determine which connections in the proposed framework remain most robust under varying Indian conditions.

9.2 Limitations of the Framework

There are various limitations within the framework that are worth recognising.
Firstly, it is an analytical and conceptual framework The analytical and theoretical nature is limiting; it does not in itself posit causalities between all variables in the framework.
Secondly there are substantial regional, rural–urban, economic and infrastructural diversity factors across India. The country experiences a vast heterogeneity. the relationships represented in the framework may not operate uniformly across all locations.
Thirdly, national statistics might not provide or exist in such granular format as is needed to quantify what amount of vehicle movement is directly attributable to food purchase/transport or food waste movement.
Fourthly, the framework provides governance and compliance interfaces but an integrated institutional-performance evaluation across all key programmes, policies or regulatory mechanisms is not envisaged within it.
Finally, inter linkages between food, mobility, waste and environmental sustainability lie at the core of the framework but other areas, for example how agricultural production technology, water use, energy system and overall socio-economic inequity relates with others, does not fall in its immediate analytical scope.
Despite its restrictions, these limitations in no way negate the value of the framework. They simply set the parameters within which its proposition(s) may be considered, tested and empirically examined.
The main purpose of the framework is not an ultimate explanation of the complex food and environmental system of India. It aims to provide an integrated structure through which previously separated relations may be revealed, studied, investigated and improved.

10. CONCLUSION

The existing food system in India is represented by complex inter-sectoral flow and network operations which include generation of food, delivery to the consumer, transportation, accessibility for the consumer, consumption, food waste and waste management. These processes are often dealt with in isolation of each other through the context of Agriculture, Food Security, Transportation, Environmental Pollution and Waste management. Such separate approaches possibly overlook significant connections among food mobility, consumer mobility, food waste, waste mobility and environmental impacts. This need for an integrated analytical perspective provided the central rationale for the present study.

This research consequently built an India-contextualised Food-Mobility-Waste framework using evidence from within the country and its institutional structures including mechanisms of governance and compliance. The major novelty of the research is neither proposing a new problem around food waste, vehicular transport, and environmental management nor providing isolated solutions to them individually; rather showing how all these apparently separate activities are interrelated with functioning parts of an overall sustainability framework. The framework widens the analysis of food to include not only its production and consumption but also food system mobility, unseen or overlooked mobility by the consumer to access food, pathways of surplus food and subsequent movement and management of food waste.

The work carried out in this study makes significant distinction governance and compliance. Governance includes the creation of institutional direction through policies, rules, standards, responsibilities and coordination structures and compliance puts these arrangements into practice through monitoring, inspection, enforcement, reporting, corrective action and through defining the levels of accountabilities. This distinction is imperative and relevant to environmental outcomes as the existence of policies and standards alone does not ensure effective implementation. The framework, therefore, places or positions governance and compliance as cross-cutting mechanisms operating throughout the Food–Mobility–Waste continuum.

The next contribution is to recognise that food waste should not always be taken and considered simply as a final disposal problem. The methods of prevention, recovery, and redistribution may provide socially and environmentally better and preferable pathways for the food which remains safe and suitable for consumption. The appropriate methods such as segregation, collection, transportation, recovery, treatment and disposal become essential, when food becomes unavoidable or unsuitable waste. This distinction emphatically connects resource efficiency, environmental protection and social sustainability within a common analytical structure.

What makes the study particularly relevant to India is the fact that it brings together both rural and urban food and waste management systems in one framework. As food travels through the different geographical areas starting from the point of production, going through distribution and retailing, and reaching the end consumer, wastes would be processed from either rural or urban waste management systems. In this way, environmental pressures can be produced at different sites and stages, rather than being limited to a single sector or space. The framework offers an opportunity to account for this connection while keeping in mind the vast geographic, institutional and socioeconomic diversity in India.

The current research provides a practical perspective in developing evidence into action. The use of national and local evidence can be beneficial for determining pressure points in the environment, governance can facilitate institutional and policy responses, relevant compliance tools can contribute to implementation and performance monitoring, behavioural responsibility can play a role in daily decision-making, and circularity can help avoid turning valuable resources into waste. Therefore, it is important to stress that the proposed framework does not require the establishment of a brand new institutional system. Instead, it is aimed at better coordination and integration of evidence while keeping the existing structure and mechanisms.

The system, moreover, establishes a basis for further empirical research. The claims made in this research can be tested through household surveys, regional comparisons, institutional evaluations, studies of mobility of movement, analysis of waste flows, and a combination of research methods. Future studies should find out the degree of importance of consumer cadre mobility, food-system transportation, compliance with vehicle emissions norms, generation of food waste, waste management, and governance.

Ultimately, the central contribution of this paper is to demonstrate that environmental sustainability cannot be fully understood when food, mobility and waste are examined as disconnected sectors. A more sustainable future may begin when the journey of food—from its movement to its consumption and, where unavoidable, its recovery or disposal—is understood as a continuous system of shared environmental responsibility

References

1. Agarwal, V., Kumar, A., & others. (2010). Carbon footprints of Indian food items. Agriculture, Ecosystems & Environment, 139(1–2), 66–73. https://doi.org/10.1016/j.agee.2010.07.002
2. Ardra, S., & Barua, M. K. (2022). Inclusion of circular economy practices in the food supply chain: Challenges and possibilities for reducing food wastage in emerging economies like India. Environment, Development and Sustainability. https://doi.org/10.1007/s10668-022-02630-x
3. Béné, C., Oosterveer, P., Lamotte, L., Brouwer, I. D., de Haan, S., Prager, S. D., Talsma, E. F., & Khoury, C. K. (2019). When food systems meet sustainability—Current narratives and implications for actions. World Development, 113, 116–130.
4. Bene et al. 2015 Feeding 9 billion fish on the menu Food Security DOI 10.1007/s12571-015-0427-z
5. Fanzo, J., Haddad, L., McLaren, R., Marshall, Q., Davis, C., Herforth, A., Jones, A., et al. (2021). The Food Systems Dashboard is a new tool to inform better food policy. Nature Food, 2, 243–246.
6. Food and Agriculture Organization of the United Nations. (2019). The state of food and agriculture 2019: Moving forward on food loss and waste reduction. FAO. https://doi.org/10.4060/ca6030en
7. Food and Agriculture Organization of the United Nations. (2024). Food loss and waste. FAO Policy Support and Governance Gateway.
8. Food and Agriculture Organization of the United Nations. (2024). Food safety in a circular economy. FAO.
9. Ghosh, S., et al. (2021). Moving towards sustainable food systems: A review of Indian food policy budgets. Global Food Security, 28, 100462.
10. Government of India, Ministry of Environment, Forest and Climate Change. (2016). Solid Waste Management Rules, 2016. Government of India.
11. India waste management rules 2025 pdf; 2026 solid waste management rules; solid waste management guidelines 2026 and swm rule 2026 pdf; hazardous waste management rules 2026
12. Intergovernmental Panel on Climate Change. (2019). Climate change and land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. IPCC.
13. Kharola, S., Ram, M., Mangla, S. K., Goyal, N., Nautiyal, O. P., Pant, D., & Kazancoglu, Y. (2022). Exploring the green waste management problem in food supply chains: A circular economy context. Journal of Cleaner Production, 351, 131355. https://doi.org/10.1016/j.jclepro.2022.131355
14. Ministry of Environment, Forest and Climate Change (MoEFCC). (2026). Solid Waste Management Rules, 2026. Government of India.
15. Ministry of Environment, Forest and Climate Change. (2026). Solid Waste Management Rules and related amendments. Government of India.
16. Ministry of Jal Shakti. (n.d.). Swachh Bharat Mission–Grameen. Government of India.
17. Ministry of Road Transport & Highways. (2023). Decarbonisation of road transport sector. Government of India.
18. O'Keefe, L., et al. (2024). Environmental sustainability of food environments: Development and application of a framework in four cities in South Asia. Current Developments in Nutrition.
19. Pandey, A. K., Thakur, S., Mehra, R., Kaler, R. S. S., et al. (2025). Transforming agri-food waste: Innovative pathways toward a zero-waste circular economy. Food Chemistry: X, 28, 102604. https://doi.org/10.1016/j.fochx.2025.102604
20. Pandey, A., Brauer, M., & colleagues. (The exact author details should be verified before final APA formatting.) Estimating emissions from the Indian transport sector with on-road fleet composition and traffic volume. (2014). Atmospheric Environment, 98, 123–133. https://doi.org/10.1016/j.atmosenv.2014.08.039
21. Reddy, A. S., Kasa, V. P., Samal, B., Dubey, B. K., Yadav, V., & Pandey, D. S. (2025). Sustainable agricultural waste management in India: Innovations, challenges, and future perspectives. Biomass and Bioenergy, 202, 108261. https://doi.org/10.1016/j.biombioe.2025.108261
22. Samal, R. R., Samal, K., Pattanayak, D., Rout, N., Jena, A., Samal, S. R., & Mohanty, M. (2026). Assessing the impact of modal shift and electric vehicles adoption on air pollution: A case study. Next Sustainability, 100479. https://doi.org/10.1016/j.nxsust.2026.100479

23. Sharma, M., Bhupal, B., & Jain, S. (2026). Bridging policies and practice: Integrated pathways for cleaner urban air and climate co-benefits from road transport. Journal of Cleaner Production, 147747. https://doi.org/10.1016/j.jclepro.2026.147747
24. Trends and challenges in valorisation of food waste in developing economies: A case study of India. (2021). Case Studies in Chemical and Environmental Engineering, 4, 100162. https://doi.org/10.1016/j.cscee.2021.100162
25. UNEP. (2024). Food Waste Index Report 2024. United Nations Environment Programme.
26. United Nations Environment Programme. (2024). Food waste index report 2024. UNEP.
27. WRI India. (2024). Defining food waste for sustainable food systems. World Resources Institute India.
28. (2025). Integrating life cycle assessment and avoid-shift-improve frameworks for sustainable mobility transition in India. Sustainable Energy Technologies and Assessments, 104327. https://doi.org/10.1016/j.seta.2025.104327