CINEFORUM
ISSN: 0009-7039
Vol. 66. No. S5, 2026 (Special Issue 5)

Food–Mobility–Waste Nexus: An Integrated Conceptual Framework for Environmental Sustainability

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

[1] Research Scholar, USB, Chandigarh University, Gharuan, Distt. Mohali, Punjab, India.
Email: opkapoorz@rediffmail.com
[2] Professor, USB, Chandigarh University, Gharuan, Distt. Mohali, Punjab, India.
Email: anil.e4863@cumail.in
[3] Professor, Department of Automobile Engineering, Chandigarh University, Gharuan, Distt. Mohali, Punjab, India.
Email: hodautomobile@cumail.in
[4] Associate Professor, Department of Mechanical Engineering, Chandigarh University, Gharuan, Distt. Mohali, Punjab, India.
Email: akant.e13980@cumail.in
[5] PGDCSA (PU), MBE (KU), M.Tech. (ETH, Zurich, Switzerland), Business Development Manager, Staubli Industries, Basel, Switzerland.
Email: Rajk.chd@gmail.com
Corresponding Authors
Dr. Navdeep Sharma Dugala
Email: hodautomobile@cumail.in
Dr. Akant K Singh
Email: akant.e13980@cumail.in

Abstract
The rapid growth of global population, dietary demand and automobile use has exacerbated pressure on natural resource systems and environmental sustainability. Food loss and waste, and vehicular emissions are still contributing to growing environmental impact, and incoherent management and weak accountability in governance hinder effective problem-solving efforts. Food loss and waste and vehicular emissions, however, is often separately analysed, although they have received abundant investigation. This paper overcomes this fragmentation by conceptualizing the Food–Mobility–Waste Nexus: An Integrated Conceptual Framework for Environmental Sustainability.

The framework frames food waste and vehicle pollution as intertwined environmental stressors affecting a mobility-oriented food system. The work identifies numerous food system mobility interface categories, such as supply chain transport, food retail purchase mobility and food waste collection transport, and differentiates between resource loss and waste phase pollution and vehicle driven emissions. Behaviour, self control, accountability and governance & compliance act as cross cutting mechanisms and prevention, reduction, redistribution/reuse, recovery, circularity and resource efficiency as the sustainability response. Four conceptual propositions are produced as a way forward to future empirical research. The framework presents an overall approach which integrates aspects of the food systems, mobility, waste, pollution, human behaviour and institutions within a common system sustainability architecture.

By connecting what we eat, what we waste and how we move, the framework opens a new pathway for understanding and achieving environmental sustainability...

Keywords Food waste; Food-system mobility; Vehicular pollution; Environmental sustainability; Behaviour; Self-control; Accountability; Governance and compliance; Circularity; Resource efficiency....

INTRODUCTION

1.1 Global Food-Waste Challenge

The production of food utilizes various resources, including land, water, labour, agricultural inputs, infrastructure, transportation and energy. Food wastage has more meaning, however, than merely the rotten food itself. The

© CINEFORUM

environmental resources required to produce and transport food have already been spent, even if the purpose of feeding people has not been accomplished in the first place.

The level of food loss is significant. The United Nations Environment Programme (UNEP) estimated that around 1.05 billion metric tons of food was wasted in the world in 2022 at the household, food service and retail levels. Households wasted approximately 631 million metric tons, food service about 290 million metric tons and retail 131 million metric tons. UNEP also estimates that food loss and waste is responsible for 8 to 10% of total greenhouse gas emissions (UNEP, 2024).

Figure 1: Global Food Waste by Sectors, 2022, UNEP (2024),

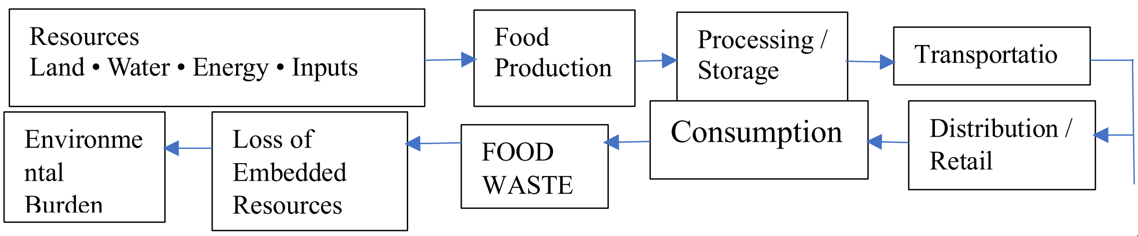
Table 1. Global food waste at consumer-level stages, 2022

Sector	Food Waste M Tons	Percentage
Household	631	60%
Food service	290	28
Retail	131	12
Total	1052	100

Source: **UNEP (2024**), Food Waste Index Report 2024.

The importance of these metrics goes beyond the last stage of disposal. Food waste can therefore be perceived as a cumulative environmental loss involving land, water, energy and various other resources used in food production as well as the environmental damage caused during processing, storing and transporting this food. That means that food loss and wastage can be treated as both a resource efficiency issue and a waste management problem (FAO, 2019; UNEP, 2024).

This distinction is important for sustainability analysis:



© CINEFORUM

Figure 2. Food waste as a cumulative environmental burden. Source: Authors' conceptualization based on FAO (2019) and UNEP (2024).

Furthermore, the mishandling or decaying food waste can lead to pollution through various gases, malodour, and other localized environmental damage, thus furthering its impacts beyond just the lost food and resources involved.

1.2 Food Waste in the Indian Context

The global issue is related to India. The UN Environment Programme's (UNEP) estimates suggest that households in India generate large amounts of food waste, approximately 68.76 million tons a year, with an estimated household food waste of around 55 kg per person per year. The UNEP considers this as a country estimate having medium accuracy.

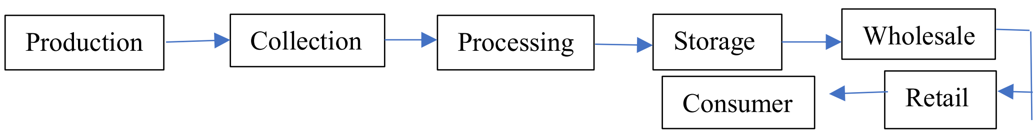
The importance of India arises not just from the size of its population. Food has to go through many stages such as farming, processing, market, selling and consuming before being delivered at home. Therefore, the wastage of food leads to the loss of precious resources and the negative effects of food on the environment.

In this case, India serves as an important example of a larger global issue rather than a specific country.

1.3 Food Systems and the Mobility Dimension

Food does not stay in the same place in which it is produced. Food produced in agricultural areas is transported to collection places, markets, factories, and storages. Processed food is transported through wholesale and retail channels to its customers. Thus, transportation is a core important part of the food system. According to the FAO, transport is one of the main elements of the food supply chain and transportation conditions can cause food losses, especially for perishable food (FAO, 2024).

The food-system pathway can consequently be represented as:



with transportation potentially occurring between and across these stages.

This point is significant because it stops the wrongful assumption that food vehicle movements are unneeded. Transport is needed to link various parts of the present food systems that are geographically dispersed. As a result, sustainability concerns the effectiveness, size, structure, and ecological impact of this necessary movement of food from point A to point B, including the impact of food being thrown away after it is carried through the food system.

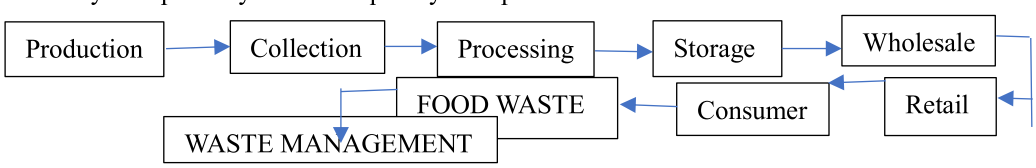
1.3 Food Systems and the Mobility Dimension

Food doesn't stay put in its place of origin. Agricultural products move from farms and production regions into collection points, processing plants, storage, wholesalers and sellers before they end up with consumers. Transportation is thereby an important part of today's food system. FAO sees transportation as being pivotal for food supply chains and points out that its role is essential with regard to food loss especially when it comes to perishables (FAO, 2024).

Nonetheless, the concept of food-system mobility goes beyond the commercial exchanges associated with food traveling along the supply chain. Food-system mobility also encompasses the actions of consumers in locating and acquiring food as well as the actions involved in managing food waste. As such, consumer mobility and waste management represent separate interfaces in the context of the food system as a whole.

Figure 5. Transportation interfaces within the food system

The food-system pathway can consequently be represented as:



© CINEFORUM

FOOD-SYSTEM MOBILITY

1. Supply-chain transportation
   Production → Processing → Retail
2. Consumer food-purchasing mobility
   Retail/Market → Consumer
3. Waste-collection transportation
   Consumer → Waste facility

Source: Authors' conceptualization based on FAO (2024).

The primary interface focuses on transportation within the supply chain; that is, the movement of food and food-related goods from the various phases of production, processing, storing and selling of the goods. The secondary interface concentrates on the mobility of food purchase by consumers. This includes traveling of consumers to the site of purchase of food from markets and vendors, which can include trips using private vehicles. The third interface is concerned with the transport of waste; that is, the movement of waste from the home premises and food outlets to the waste disposal sites.

These transportation interfaces are distinct in their purpose, scale and operational characteristics, but they are connected through the same food system. Consequently, the present study conceptualizes the relationship as:

FOOD WASTE ↔ FOOD-SYSTEM MOBILITY ↔ VEHICULAR POLLUTION

where **food-system mobility** encompasses supply-chain transportation, consumer food-purchasing mobility and waste-collection transportation as shown in Figure 5.

The concept does not suggest that food transport is naturally unnecessary. Rather, transportation makes important contributions to connecting different parts of the food system that are separated geographically. The sustainability issue relates to environmental impacts associated with the forms of transport used, especially in cases where the transport leads to food loss.

1.4 Growing Mobility and Vehicular Pollution

The advent of motorized transport has gone hand in hand with the rise in economic activities, urbanization, trade, and consumption trends. Transportation on the road provides us with essential mobility, while at the same time causing environmental damage. Operating vehicles contributes to greenhouse gas emissions and air pollution, meanwhile transit activities are also responsible for non-exhaust emissions. According to the World Health Organization, transport is a significant contributor to air pollution and should be cleaned up for a more sustainable transport system (WHO, 2021, 2025).

The relationship relevant to this paper can therefore be represented as:

FOOD-SYSTEM MOBILITY → VEHICLE USE → EMISSIONS → AIR QUALITY / CLIMATE → ENVIRONM-ENTAL PRESSURE

The situation becomes even more serious when the transportation industry is seen not as a separate sector but as an important part of the whole food system which allows food and different products to flow through.

1.5 From Two Environmental Problems to a Food-Mobility-Waste Nexus

Food waste and vehicle emission pollution have historically been studied in different research and policy areas. Food waste is often related to food production, consumption, waste management and circular economics while vehicle emissions are usually studied under transportation, emissions, air quality and environmental policy.

While this division of disciplines makes sense, it may obscure the systemic linkages between them. Food travels from point of origin until it is eaten. By the time food becomes waste, all resources and related environmental impacts from previous steps, such as transportation, have already happened. Likewise, transport generates emissions from vehicles during all movements of food regardless of whether it has been consumed.

The proposed relationship is therefore:

© CINEFORUM

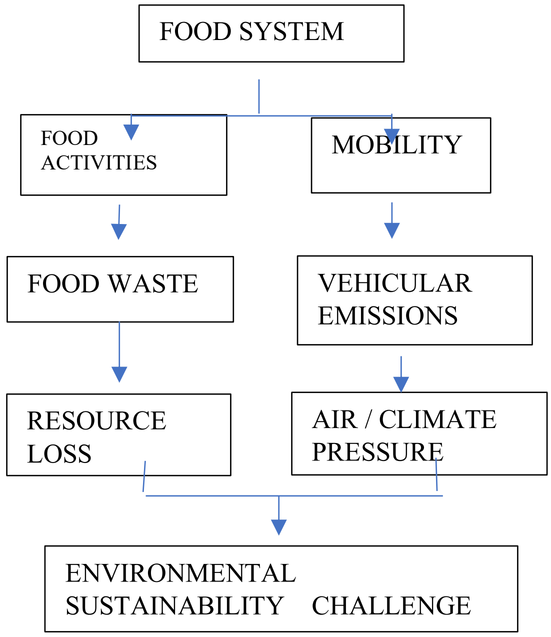


Figure 4. Basic logic of the Food–Mobility-Waste Nexus. Source: Authors' conceptualization.

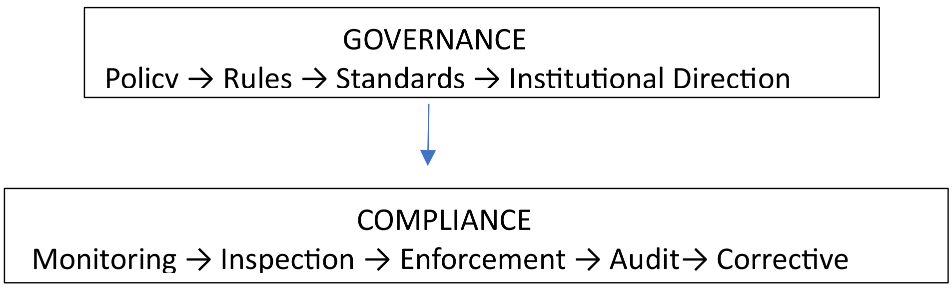
The framework posits that food waste does not lead to road pollution and vice versa. Rather, it posits that both of these environmental phenomena are interrelated via a transportation-dependent food system. This distinction serves as the conceptual basis of the current paper.

1.6 Behaviour, Accountability and Institutional Mechanisms

Environmental consequences do not occur only because of physical systems. Decisions made by households, consumers, businesses, transportation operators, and institutions can affect the way resources are used and waste is produced or avoided.

Behaviour and self-control play a role in making decisions about purchases, consumption, storage, and disposal. Accountability connects actions of individuals and organizations to their environmental effects. On the institutional level, governance and compliance have an impact on how policies, rules, and standards are developed, implemented, and enforced.

The distinction is important:



Consequently, governance identifies the direction of institutions and compliance is the means of transforming the direction into action.

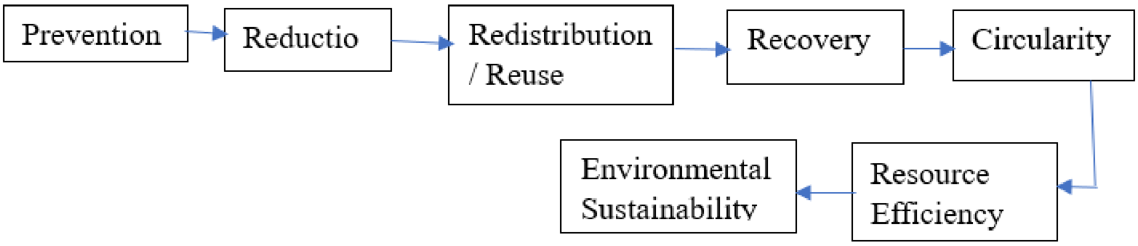
The frameworks concentrate on these aspects as cross-cutting factors instead of looking at them as supplementary environmental consequences.

1.7 Circularity and Resource Efficiency as Response Pathways

The importance of food waste from an environmental perspective has made it clear that managing waste at the end of the process is not enough. Rather, sustainability has to include prevention and reduction first, depending on the case redistribution, reuse, and recovery should follow.

The response pathway can be expressed as:

© CINEFORUM



This hierarchy prioritizes the prevention of waste ahead of the treatment of waste downstream, since avoiding excess production and disposal of waste will also avoid the associated environmental impacts of the food production processes.

1.8 Problem Statement

The increased volume of food waste produced and the environmental challenges posed by the use of cars represent major sustainability issues. Even though ample research has been done on food waste and pollution caused by vehicles, they are treated as two separate environmental issues.

The central problem addressed by this paper is therefore:

Current methods fail to achieve enough conceptual integration of food waste and transportation-associated vehicular pollution in the transportation-dependent food system, especially in terms of behavioural, accountability, governance and compliance mechanisms impacting environmental outcomes.

As a result, the paper examines the question if it is possible to comprehend these two supposedly different environmental concerns through an integrated **Food-Mobility-Waste Nexus**.

1.9 Research Gap

The literature indicates four principal gaps.

Table 2. Principal Research Gaps

Dimension	Existing emphasis	Identified gap
Food waste	Measurement, causes and environmental consequences	Limited integration with mobility-related environmental pressures
Food-system transportation	Logistics, distribution and food-loss considerations	Insufficient integration with vehicular pollution as a sustainability issue
Vehicular pollution	Emissions, air quality and transport regulation	Food-system mobility is insufficiently incorporated into the analysis
Integrated sustainability	Circularity, behaviour or governance examined separately	Limited conceptual integration of food waste, mobility, pollution, behaviour and governance/compliance

Hence, the existing gap is not about the limited research on either food wastage or vehicular pollution. The real gap is the lack of proper conceptual connection between the two concepts within a food system framework.

1.10 Objectives of the Study

The study has four objectives:

O1. To examine the conceptual relationship between food waste and transportation-related vehicular pollution within the food system.

O2. To synthesize literature concerning food waste, food-system transportation, vehicular pollution, behavioural mechanisms and institutional governance.

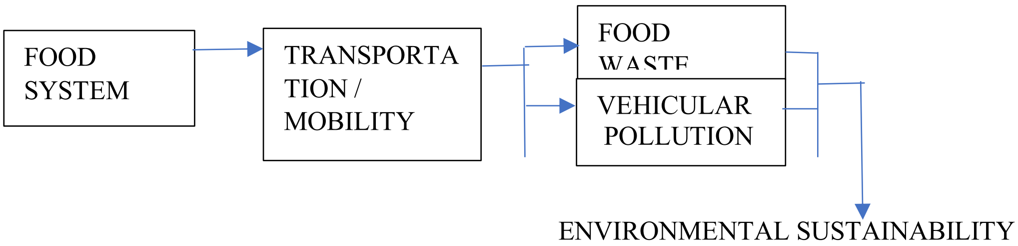
O3. To develop an integrated Food–Mobility–Waste Nexus framework incorporating Behaviour, Self-Control, Accountability and Governance & Compliance as cross-cutting influences.

O4. To formulate conceptual propositions and identify pathways for future empirical investigation toward environmental sustainability.

1.11 Contribution of the Study

The principal contribution is the development of an integrated conceptual framework that positions:

© CINEFORUM



within a broader system influenced by:

Behaviour + Self-Control + Accountability + Governance & Compliance

and supported by:

Prevention + Reduction + Reuse/Redistribution + Recovery + Circularity + Resource Efficiency

Thus, the contribution is integrative as opposed to being descriptive. The study merges environmental stresses that are usually examined in isolation and provides a theoretical framework for future research.

1.12 Scope and Boundary of the Study

The objective of the research is to deliberately emphasize the interplay between food, transport, and waste. The subject of concern includes: food wastage that occurs at various stages of the food system; transportation/mobility for food system-related activities; pollutants created by such transport; factors influencing behaviour, self-control, and accountability; factors affecting governance and compliance issues; and approaches to sustainability like prevention, minimization, reuse/recovery and circularity.The research does not imply the introduction of a complete model of the overall food production, transportation industry or pollution as a whole along with the treatment technologies.

The most important thing is that the model in question deals with interconnected systems rather than straightforward connections between wasted food and transport pollution. Such notions as transportation are treated as a connection between elements of the food sector with behavioural responsibility and controlled mechanisms functioning in the system.

1.13 Structure of the Paper

Following that, the rest of the paper takes a look at the literature related to food waste and environmental sustainability, food supply chain and transportation, vehicular emissions, behavioural and institutional drivers and circular economy. After the review of literature, the obtained knowledge is then synthesised and the research gap is determined and the scope of the proposed framework is identified. Lastly, the conceptual framework and propositions are explained and the theoretical contributions, practical implications, policy implications, future directions of research and limitations are discussed.

2. Literature Review

2.1 Food Waste and Environmental Sustainability

Food waste and loss are considered increasingly related issues when it comes to ecology, the economy and resource-saving. The Food and Agriculture Organization of the UN has made a distinction between food loss and food waste identifying that loss refers to the reduction in the volume or quality of food during the phases preceding the sale whereas waste deals primarily with retail and consumption (FAO: The State of Food and Agriculture).

According to the UNEP Food Waste Index Report (2024), in 2022, about 1.05 billion tons of food were lost in the world, which is equivalent to around 19% of the food products reaching consumers. Households accounted for the largest share of losses, while foodservice industry and retail followed the lead (the UNEP Food Waste Index Report 2024 published in October 2025).

The impact that food waste has effects on the environment does not end with its disposal. Food which is thrown away and wasted has already made use of land, water and energy during the production process. In this way, food waste means that considerable environmental resources have been wasted and that further waste-treatment takes place: FAO states that any food loss or waste has a carbon footprint, land footprint, and water footprint. In turn, UNEP highlights that food loss is among the forces which contribute to climate change, loss of nature and pollution of air and water bodies (FAO: The state of food and Agriculture 2019).

Apart from the implications concerning natural resources and climate, mismanagement and decomposition of food waste may result in localized environmental pollution. This is especially true in the locations where organic waste is concentrated, dumped or improperly disposed of. In a systematic review of research into food loss and waste,

© CINEFORUM

the authors found out that resource use and environmental consequences are important themes but pointed out the need to take the food loss and food waste perspective in the entire supply chain rather than at some specific point. (ScienceDirect Food Loss and Waste in Food Supply Chains 2021).

Table 3. Environmental dimensions of food loss and waste

Dimension	Principal environmental concern	Relevance to the present study
Resource use	Land, water, energy and agricultural inputs are used for food that may not be consumed	Establishes food waste as resource inefficiency
Climate	Greenhouse-gas emissions occur across food production and supply-chain stages	Connects wasted food with accumulated environmental burden
Waste-stage pollution	Poorly managed or decomposing food waste can generate gaseous emissions, odour and localized environmental pollution	Establishes food waste as a direct environmental pollution concern
Transportation	Food may be transported through several supply-chain stages before becoming waste	Provides a mobility connection
Waste management	Discarded food requires collection, treatment or disposal	Creates additional environmental and management requirements
Circularity	Recoverable food and organic resources may be diverted from disposal	Provides a sustainability-response pathway

The literature provides an important environmental argument for the consistent reduction of food waste. Nevertheless, when it comes to transportation aspect, it is mostly treated in the context of food supply chain analyses rather than as a key link with vehicle emissions. This is a crucial distinction in the framework of this study.

2.2 Food Systems, Supply Chains and Transportation

Food systems must be understood in terms of both their geographical distribution and their dependency on movement. Agricultural products move from their point of production through various stages such as collection, storage, processing, wholesale, and distribution until they reach the end users. The Food and Agriculture Organization acknowledges transportation as a vital segment of the food supply chain due to its linking function between various activities in the process.

Transportation can have an impact on food loss as well. Bad infrastructure and delays due to bad logistics make rotting much more likely, especially for highly perishable foods. Therefore, transportation and logistics are seen by the FAO as key intervention points in the field of food loss.

In recent studies of food loss and waste in supply chains, the concepts of logistics, procurement, distribution, storage, processing and transportation have been analysed in combination. In a systematic literature review involving 152 studies, it was found that food loss and waste generation, mitigation measures, sustainability effects and supply chain management have been highlighted as the core themes of the study (ScienceDirect Food Loss and Waste in Food Supply Chains 2021).

Nevertheless, there is a gap in relevant literature. One of the analyses of food loss and waste quantification revealed that more than half of the reviewed studies focused on only one of the supply chain components; besides, it was revealed that downstream processes have been considered much more than upstream processes (ScienceDirect Food Loss and Waste in Food Supply Chains 2021).

Table 4. Food-system stages and mobility interfaces

Food-system stage	Principal activity	Mobility interface
Production	Production and harvesting	Movement from production location
Collection/storage	Aggregation and preservation	Goods transportation
Processing	Conversion and packaging	Input/output transportation

© CINEFORUM

Wholesale	Bulk distribution	Commercial transportation
Retail	Consumer access	Commercial and consumer mobility
Consumption	Purchase and use	**Consumer food-purchasing mobility**
Waste management	Collection and treatment	**Waste-collection transportation**

This literature provides a key conceptual insight: **mobility around food is not a uniform entity**. It includes both transportation along the food supply chain for market purposes, transportation for consumers in buying food, and transportation related to food waste.

Building on these insights, this study therefore broadens the classic food supply chain model by analysing **mobility between food practices and the natural environment**.

2.3 Transportation, Vehicular Pollution and Environmental Externalities

Transportation supports much of our economic and social activity today however it generates environmental externalities. The World Health Organisation identifies transport as a major source of pollution of air as a greenhouse-gas sink. Pollution by road transport arises not only from exhaust emissions, but also from 'non-exhaust' emissions brake-tyre wear, road dust (WHO 2025) etc.

The environmental costs of transport thus are even broader than just fuel combustion; operating a vehicle produces numerous and substantial contributions to pollution and other environmental impacts making transport critical part of all environmental sustainability analysis.

Table 5. Transportation and environmental externalities

Transportation dimension	**Environmental pathway**
Fuel consumption	Greenhouse-gas and pollutant emissions
Exhaust emissions	Air-quality degradation
Brake and tyre wear	Particulate pollution
Road activity	Dust and associated emissions
Goods transportation	Environmental burden of supply-chain mobility
Consumer mobility	Additional vehicle-use emissions
Waste transportation	Emissions associated with waste collection and movement

Thus, the literature on transportation and the literature on food loss and waste investigate the bulk of two different and **distinct and sizeable environmental systems**, but in the academic record have been produced largely by different sets of authors.

This is an attractive conceptual angle. If food travels through transportation systems before it is purchased and consumed and people, who buy it, drive to obtain it, this creates the potential for food system impacts on the environment to link up with transport.

The proposed nexus is consequently**: Food Waste ↔ Food-System Mobility ↔ Vehicular Pollution** It must not be seen as indicating a direct causal link between food waste and vehicle emissions. Instead, the relevant literature shows that these two factors are interconnected at the system level via transportation-dependent food activities.

2.4 Behaviour, Self-Control, Accountability and Governance & Compliance

Food waste is affected not just by the physical conditions of the supply chain but also by human choices; according to the FAO (FAO 2019), poor purchase and meal planning, overbuying, improper storage and other household decisions are factors that contribute to food waste.

This introduces a **behavioural** aspect to the issue of food waste. The same kind of behavioural factors are involved in decisions about mobility, such as those relating to how often one travels, the mode of transport chosen, and purchasing habits.

Self-control offers a useful way of understanding whether or not people turn their awareness into responsible action. In the present framework, though, self-control is not regarded as a separate psychological construct; rather it is placed alongside **Accountability**, whereby both individuals and organisations are expected to take responsibility for their decisions and outcomes.

© CINEFORUM

At the organisational level, we have a further layer involving both G**overnance & Compliance**. Governance relates to policy, directions, standards and responsibilities and compliance to policy implementation through auditing, reporting, inspections, surveillance, corrections and corrective actions.

Table 6. Cross-cutting mechanisms within the proposed nexus

Mechanism	Principal function	Potential relevance
Behaviour	Shapes consumption and mobility decisions	Food purchasing, consumption and travel
Self-control	Converts awareness into controlled action	Avoidance of unnecessary consumption/waste
Accountability	Links actions with responsibility	Individual and organizational responsibility
Governance	Establishes policy, rules and institutional direction	Integrated food, transport and waste policy
Compliance	Converts requirements into operational practice	Monitoring, enforcement and performance
Coordination	Connects institutional actors	Cross-sector implementation

This evidence, then, provides considerable support to behavioural and institutional influences, although these influences are often addressed within specific arenas. Integration between domains (waste, mobility and vehicular pollution), though incipient, is limited.

2.5 Circularity, Resource Efficiency and Sustainability

A complementary answer to food waste is the concept of the **Circular economy**, shifting focus from disposed food as a problem of waste management to **prevention, conservation of resources, distribution, recycling and recuperation.**

This principle is particularly interesting, since the environmental impacts of food waste start well before the disposal phase. Prevention measures may help to avoid investing environmental resources in food that will never be consumed. FAO's analysis also states that for food loss and waste interventions, effectiveness of the intervention as far as environmental issues are concerned, varies according to the level of the food supply chains at which the interventions are performed (FAO 2019).

Life-cycle assessment studies provide strong arguments for prevention as well: one of the reviews of literature carried out by life-cycle analysis of food loss and waste shows that the higher levels of the waste pyramid, namely prevention, are poorly focused, suggesting there is a considerable room for improvements towards stronger sustainable action.

Table 7. Circularity response to food waste

Response	Conceptual purpose
Prevention	Avoid generation of food waste
Reduction	Minimize avoidable losses
Redistribution	Direct surplus food toward productive consumption
Reuse	Retain materials/products in productive use
Recovery	Recover energy, nutrients or other resources
Circularity	Keep resources within productive cycles
Resource efficiency	Achieve greater value with fewer resources

Hence circularity represents the response side of the new framework and food waste and traffic pollution represents the connected pressures on the environment.

The literature reviewed above can be condensed into five observations.

© CINEFORUM

Table 8. Synthesis of the Reviewed Literature

Literature domain	What the literature establishes	Remaining conceptual issue
Food waste	Food waste represents substantial resource and environmental loss	Its mobility dimension is less prominent
Food supply chains	Transportation is integral to food movement and food-loss prevention	Mobility is generally treated as logistics rather than as a nexus variable
Vehicular pollution	Transport generates significant environmental externalities	Food-system activities are insufficiently integrated
Behaviour and institutions	Decisions, accountability and institutional arrangements influence outcomes	Cross-domain integration remains limited
Circularity	Prevention and resource recovery support sustainability	Circular responses are rarely positioned within a food–mobility–pollution framework

Overall interpretation

Overall interpretation Food waste and vehicular pollution have not been established as independent phenomena; rather, they may be intertwined through the system-at-large stages of a transport-dependent food system, though much existing research and governance may continue to address them in silos.

This observation serves as a rationale for the next section-Section 3 - Synthesis of Literature and Identification of the Research Gap, where this disconnect will be discussed in a more structured manner and transforms into the particular conceptual gap that this paper seeks to fill.

3. Synthesis of Literature, Research Gap and Scope

3.1 Synthesis of the Literature

Food waste, transport in the food supply and vehicular emissions in the food system are all highly established fields in environmental research, as shown by the literature outlined in section 2. Food waste has linked effects on resource scarcity, greenhouse gas emissions and inefficient utilisation of resources across the food system (FAO, 2019; UNEP, 2024). Transport activities have been identified as vital to Food Supply chains, with an effect on both food losses and environmental outcomes (FAO, 2019, 2024). Further more food system transport is linked to air pollution and others environmental effects (WHO, 2025).

These topics have, however, tended to develop through their own distinct analytical and scientific narratives.

Table 9. Synthesis of Existing Knowledge and Remaining Integration

Area	Established knowledge	What remains insufficiently integrated
Food waste	Scale, causes, resource loss and environmental consequences	Mobility-related environmental burden
Food supply chains	Production, processing, distribution and transportation are interconnected	Vehicular pollution as an explicit environmental outcome
Consumer food behaviour	Purchasing, storage and consumption influence food waste	Relationship between purchasing mobility and food-waste outcomes
Transportation	Vehicle activity generates emissions and environmental externalities	Food-system activities as a specific context of mobility
Governance & compliance	Policies, standards, monitoring and enforcement influence environmental performance	Cross-sector governance of food, mobility and waste
Circularity	Prevention, reduction, redistribution and recovery improve resource efficiency	Integration with food-system mobility and vehicular pollution

Thus, it is argued from the synthesis that it is not a lack of expertise in different domain but a lack of the conceptual integration between these domains.

3.2 Four Dimensions of the Research Gap

Four interconnected gaps can be found based on this literature synthesis:

© CINEFORUM

CINEFORUM
ISSN: 0009-7039
Vol. 66. No. S5, 2026 (Special Issue 5)

Gap 1 - Disciplinary Fragmentation
Investigated by separate disciplinary lenses: studies on food waste mainly cover food systems, consumptions and waste disposal; studies on vehicle pollution are dominated by transport research that focuses on mobility, emission and air quality.
This generates great amount of fragmented knowledge.
Gap 2 — Mobility Integration Gap
We acknowledge that mobility is connected to food supply chains, yet we mostly consider mobility as a purely logistical aspect of these food systems. Other facets of food-system mobility, such as food system supply chains mobility (transportation of goods), food purchase mobility (consumer food mobility for buying food products) or food waste transportation, are seldom integrated as a unified concept.
Gap 3 — Cross-Cutting Mechanism Gap
While behaviour, self control, accountability, and institutional mechanisms work on the food, waste, and environment actions, and while governance, and accountability and compliance work on transport and environmental actions, none of these are typically presented together as cross-cutting forces across the food-mobility-waste system.
Gap 4 — Integrated Sustainability Gap
The provision of circularity and efficient resource use can make a crucial response to the problem of food waste, and transport is cleaner to account for vehicular pollution impacts. These responses are considered distinctly by and large and consequently a space has opened up to establish a framework which integrates the following together: **Food Waste + Food-System Mobility + Vehicular Pollution + Behavioural/Institutional Mechanisms + Circularity.**

3.3 Specific Conceptual Gap

These four gaps converge upon one central theoretical/concept issue: literature on food waste, food-system transport and vehicle emissions exists in relative amounts individually.
The present study addresses this gap by proposing as given in Figure-5

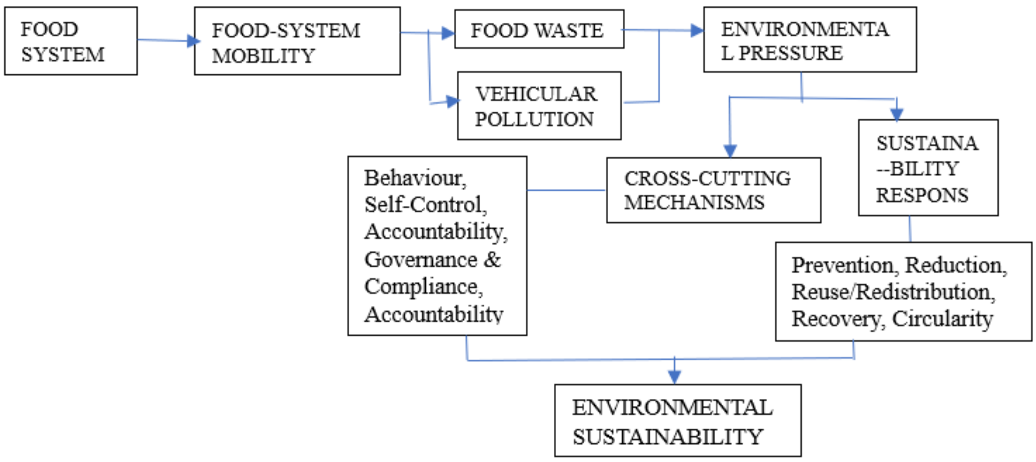


Figure 5. Conceptual gap addressed by the study.
Source: Authors' conceptualization.

However, information integrating the three fields using the central concept food-system mobility, and discussing these under one joint framework, a paradigm of food-system environmental-sustainability, has to date been rather meagre in evidence.
The framework is therefore intended to provide a system-level conceptual bridge rather than to replace existing food-waste, transport or environmental models.

3.4 Scope and Boundary of the Study

The proposed framework intentionally limits its scope to the **Food-Mobility-Waste nexus**.
Within the scope it covers:

© CINEFORUM

(a)**Food dimension**-(i) Food loss/waste (relevant to the food system); (ii) Household, retail, and food-service waste;(iii) Resource loss related to food waste.
(b)**Mobility dimension**-(i) Transport of food from production to consumption;(ii) Transport associated with food processing and distribution;(iii) Food purchasing mobility;(iv) Waste collection transport.
(c) **Pollution Dimension**-(i) Road transport exhausts(ii) Air-pollution consequences(iii) Environmental influences related to vehicle usage connected to climate pressures. (iv) Environmental pollution from rotting food waste; lack of proper waste management;
(d)**Cross-cutting mechanisms**-(i) Behaviour; (ii) Self control(iii) Accountability(iv) Governance (v) Compliance
(e)**Sustainability response**-(i) Prevention;(ii) Reduction(iii) Redistribution/Reuse;(iv) Recovery;(v) Circularity;(vi) Resource efficiency.

Outside the core field of study

The framework does not seek to provide: (i) The overall pattern of worldwide food production;(ii) A comprehensive transport-planning model;(iii) A detailed vehicle-emission inventory;(iv) A full account of every possible kind of pollution;(v) Detailed waste-treatment engineering;(vi) An economic estimation of the cost of waste food;(vii) An empirically verifiable identification of relationships.

This outer boundary is useful because the aim of the paper is conceptual: an overview; rather than an investigation; a life-cycle or an emissions study based on real data.

3.5 Nature of the Proposed Relationship

Here a specific important boundary concerns causality. The framework does not claim:

Food waste → Vehicular pollution or: **Vehicular pollution → Food waste**.

Instead, it proposes:

Food Waste ↔ Food-System Mobility ↔ Vehicular Pollution

The arrows provide for the interconnectedness between the components in the system, while the mechanisms operating across the system may influence the magnitude and sustainability consequences of the outcomes.

This distinction protects the framework from making a stronger causal claim than the existing literature can support.

3.6 From Research Gap to Conceptual Framework

The synthesis can now be condensed into a simple progression as depicted in the figure:

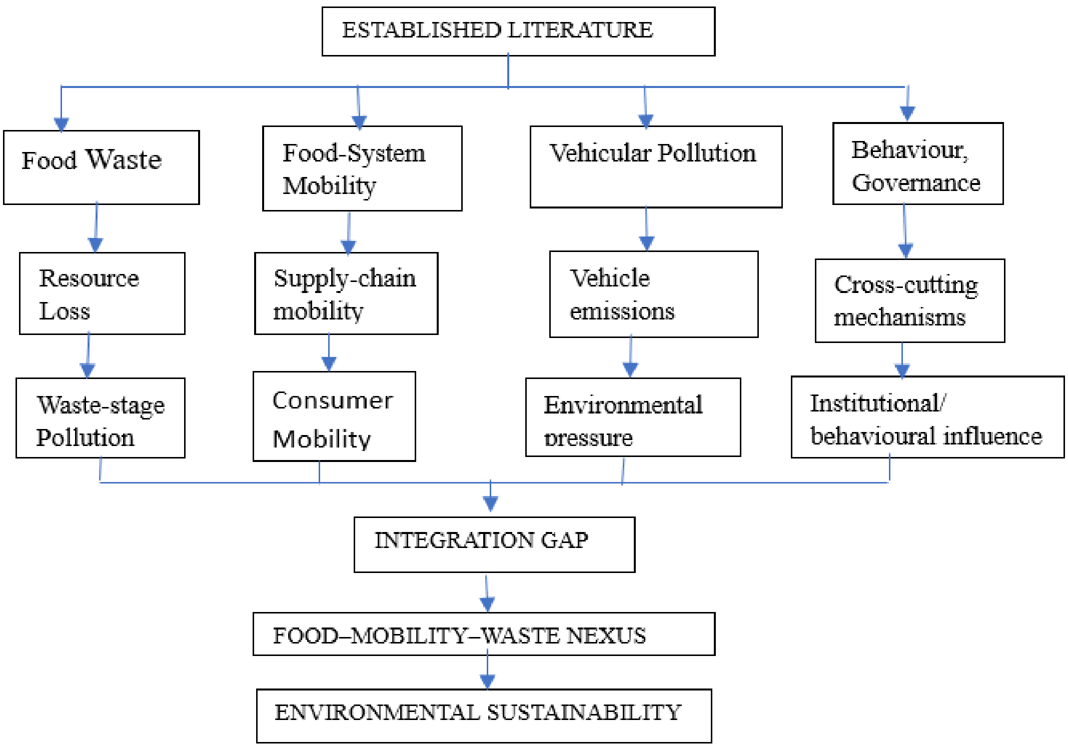


Figure 6. Transition from literature gap to proposed conceptual framework.

Source: Authors' conceptualization.

© CINEFORUM

The following section now thus continues, transitioning from what the literature can portray to the structuring of these into a conceptual framework.

3.7 Section 3- Core Finding

The main finding of the synthesis of the existing literature can be concisely expressed as one proposition-like sentence:

The main conceptual deficit is not the discrete interpretation of food waste or vehicle pollution, but a lack of food-system mobility being the common space in which environmental pressures are analysed under a common understanding of sustainability.

4. Conceptual Framework

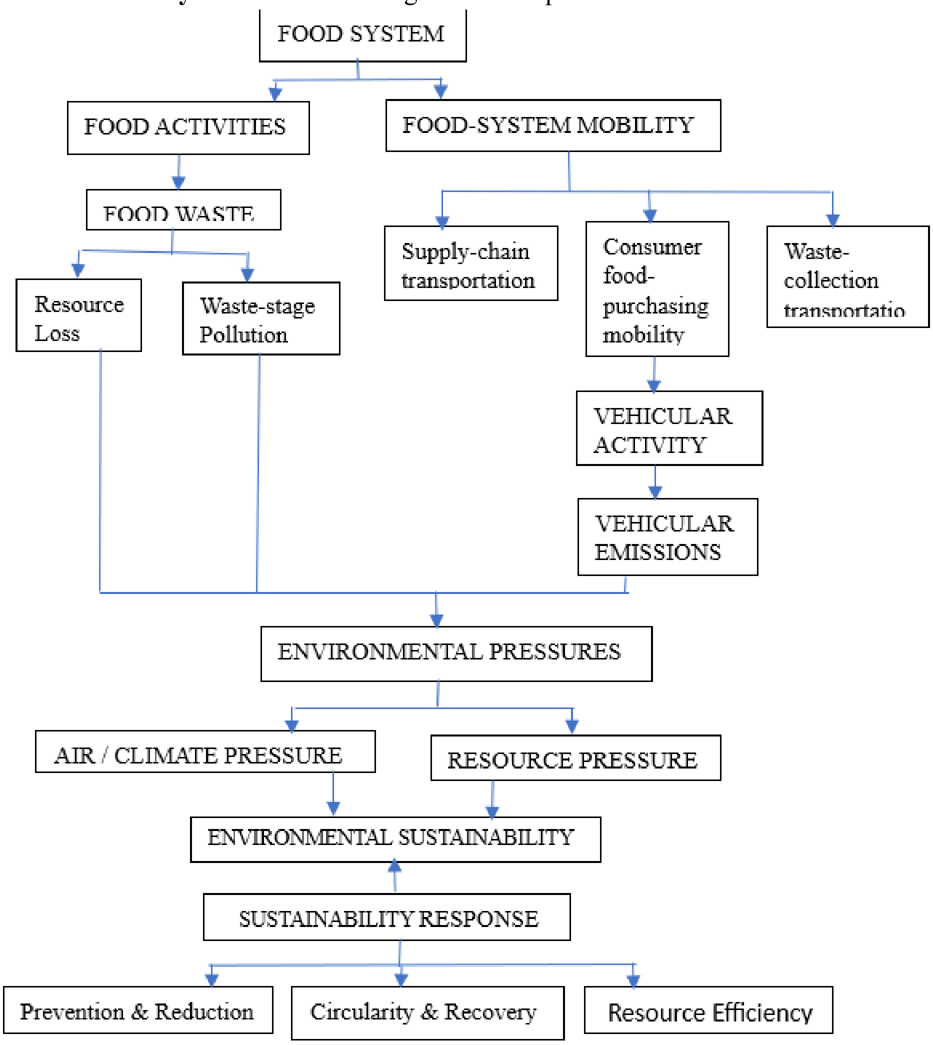
4.1 Rationale & Architecture of the Framework: shows that research streams associated with food waste and food-system mobility and vehicle pollution are well represented although each one falls into a different analytic domain. The approach outlined below, merges the different analytic domain by the construct **Food-System Mobility**, but at the same time accepts that the food waste generates pressure to the environment at the both consumption level-resources loss and pollution stage in disposal processes.

The framework consists of four core components. These are: (i) Food System & Food Waste (ii) Food-System Mobility (iii) Vehicular & Waste-Stage Pressure on the Environment (iv) Sustainability Response

These cross-cutting mechanisms include Behaviour, Self Control, Responsibility and governance & compliance.

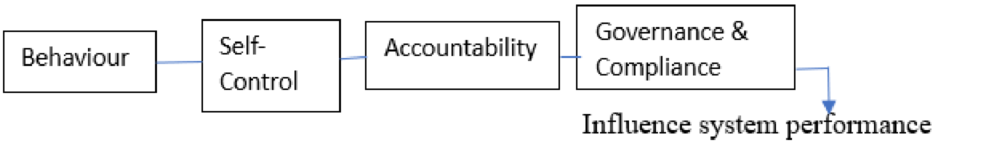
4.2 Central Conceptual Framework

Figure 1. Food-Mobility-Waste Nexus: Integrated Conceptual Framework for Environmental Sustainability



Cross-cutting mechanisms operating across the framework:

© CINEFORUM



Source: Authors' conceptualization.

4.3 Core System: Food, Mobility and Waste

Since food proceeds through linked production, processing, storage, transport, retail and consumption, the food system is a suitable starting point. Food waste may occur anywhere within the system and has the impact of loss of inputs and the generation of wastes for the waste stages.

'Food-system mobility' is the means which brings these together and is deliberately segmented into three interfaces:

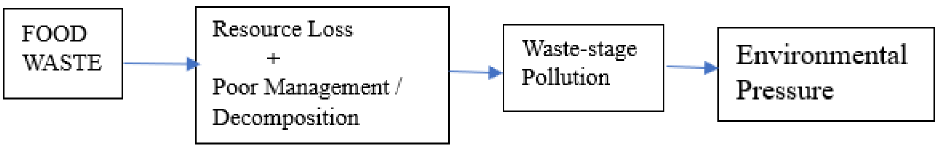
Mobility interface	Function
Supply-chain transportation	Moves food between production, processing, storage, wholesale and retail
Consumer food-purchasing mobility	Enables consumers to travel to obtain food
Waste-collection transportation	Moves discarded food to treatment, recovery or disposal facilities

This distinction prevents transportation from being treated as a single homogeneous activity.

4.4 Environmental Pressure Pathways

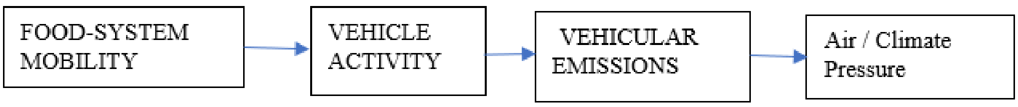
The framework identifies **two principal environmental pathways**.

Pathway 1 — Food-waste pathway



The first element represents resources in food which has not been consumed as desired. This covers the embodiment resources within. The second element represents the environmental pollution occurring from mismanagement and decay of the food waste (gas emission and odour, and effect of environment.)

Pathway 2 — Mobility pathway



Thus, the framework presents neither a cause-and-effect mechanism where food wastage causes vehicles' pollution. Food waste is associated to the transportation-dependent food systems.

4.5 Cross-Cutting Mechanisms

Four mechanisms function throughout the framework:

Behaviour

Consumption/Eating and mobility decisions (for the behaviours we studied) also affect food purchase, consumption, storage, use and disposal.

Self-Control

The ability to manage consumption/eating and mobility decisions with sustainability in mind.

Accountability

Creates a link between decisions, actions and the responsibility for their environmental effects.

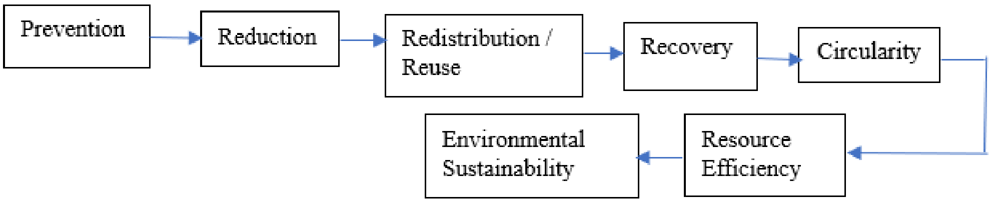
Governance & compliance

© CINEFORUM

The mechanisms within governance offer: policy, legislation, standards, institutional accountabilities and strategy while the mechanisms within compliance focus on monitoring, inspections, enforcement, audit, reporting and corrective action.

The above do not act in isolation as separate environmental outcomes-rather their effectiveness impact on the food, mobility and waste system's performance.

The framework identifies sustainability as a response to the environmental pressures generated within the system. The preferred hierarchy is:

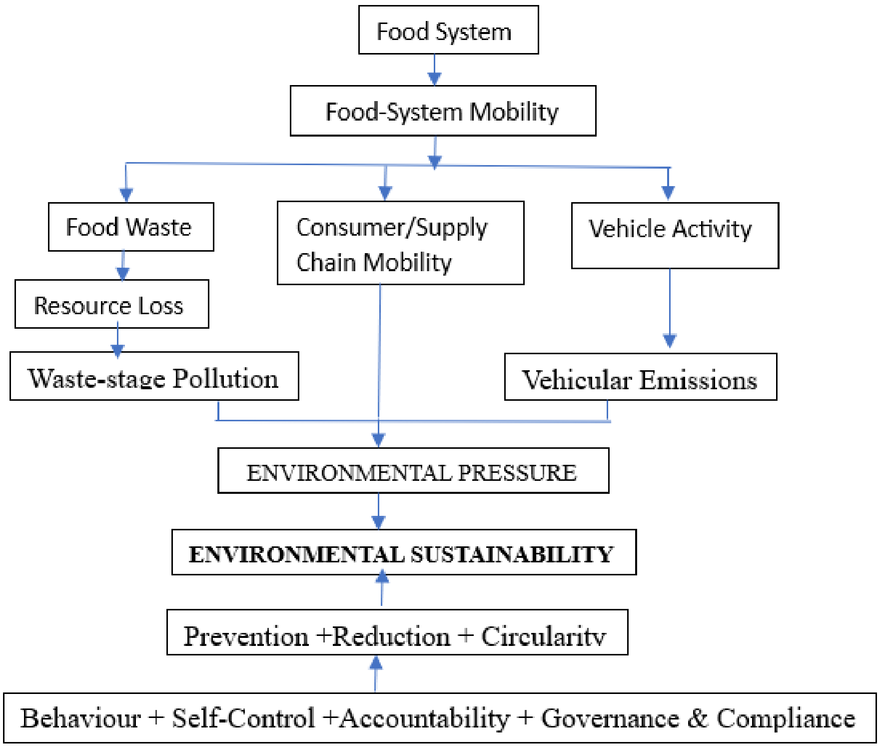


Environmental Sustainability

Prevention and reduction are in fact furthest upstream, in that the less waste is produced, transported, consumed or discarded resulting in lower burden on the environment.

4.7 Integrated Logic of the Framework

The complete conceptual logic can be expressed in one compact sequence:



Accordingly, the framework then conceptualizes sustainable environments not as a product of a single intervention, but as a result of interrelated food processes, mobility processes, waste processes, behaviour processes and institutional processes.

4.8 Conceptual Boundary

This framework is conceptual intentionally rather than causal or predictive. The arrows represent proposed connections and system relationships-they do not imply that each relationship has yet been observed empirically. In particular:

© CINEFORUM

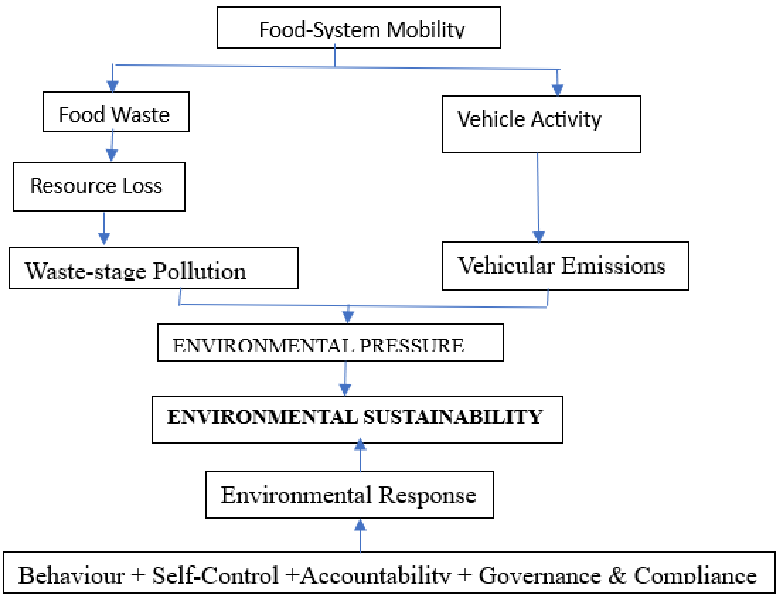
Food waste ≠ direct cause of vehicular pollution.

Rather:

A transportation-driven food system faces food waste and vehicular pollution pressures together, and this difference is foundational to the proposed nexus.

4.9 Summary of the Framework

The framework can therefore be reduced to the following architecture:



The central conceptual proposition emerging from Section 4 is:

Food waste and vehicular pollution can be conceptualized as interconnected environmental pressures arising within a transportation-dependent food system, with behavioural, accountability, self-control, governance and compliance mechanisms influencing system performance and circularity-oriented responses contributing to environmental sustainability.

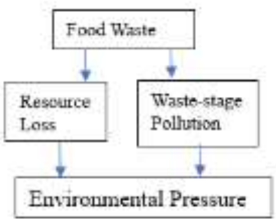
5. Conceptual Propositions

As shown through Section 4, the framework developed conceptualizes both food waste and vehicular emission sources as dependent environmental pressures within an immobile, transportation-reliant food system. The framework accounts for food system mobility, behavioural processes, accountability and compliance, governance and control, and circularity as core elements of environmental sustainability. From this framework the following four conceptual propositions are proposed.

5.1 Proposition 1 — Food Waste and Environmental Pressure

P1: Greater food waste is associated with greater environmental pressure through both the loss of embedded resources and pollution arising from the poor management or decomposition of discarded food.

Within the proposal there are two impacts identified due to waste: Resources utilized in food production, processing, storage, distribution, transport etc are 'used up' for a consumption purpose that failed and then, inappropriate handling or the decaying food waste contributes to emissions, odour and local contamination.
generate gaseous emissions, odour and localized environmental pollution.



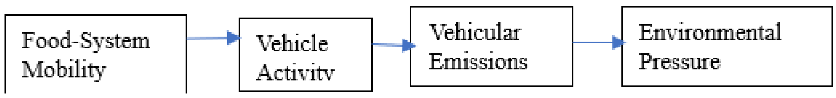
© CINEFORUM

5.2 Proposition 2 — Food-System Mobility and Vehicular Environmental Pressure

P2: Greater food-system mobility is associated with greater transportation-related environmental pressure through vehicle activity and associated emissions.

Food system mobility presents three main interfaces: Supply Chain mobility, Transport mobility of purchasing the foods in consumer level, Food waste mobility, Collecting the food waste.

It brings some necessary functions within the scope of food system but it causes some external factors when using vehicle as the transport means:

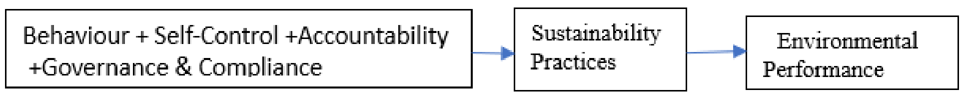


It does not mean that transportation of food can be avoided or is not of consequence though. The P2 statement simply claims that the environmental footprint of food movement should be reflected in the sustainability performance of the food system.

5.3 Proposition 3 — Behaviour, Accountability and Governance & Compliance

P3: Behaviour, self-control, accountability and governance & compliance influence the effectiveness of food-waste and mobility-related sustainability practices.

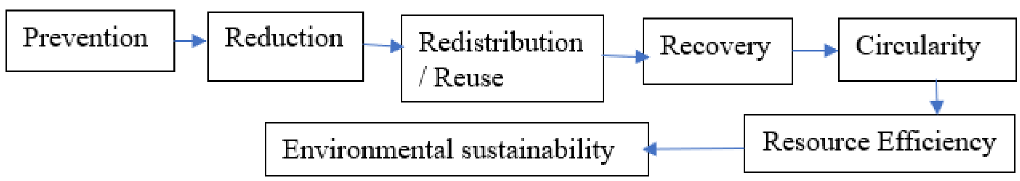
The rationale is based on a premise of both material flow and agency. Individual consumption, purchasing and disposal behaviour and mobility decisions depend on human behaviour and self-control. Accountability is the linkage between decisions and responsibility, while governance and compliance provide the necessary institutional and regulatory frameworks for effective oversight.



5.4 Proposition 4 — Circularity and Resource Efficiency

P4: Prevention, reduction, redistribution/reuse and recovery of food resources can improve resource efficiency and contribute to environmental sustainability within the Food–Mobility–Waste Nexus.

The proposal gives preference to avoided food waste, i.e., before treatment. If food waste cannot be avoided, food redistribution, reuse and recovery provide options to maintain resources in the circular economy.



5.5 Integrated Interpretation of the Propositions

© CINEFORUM

The four propositions should **not be interpreted as four isolated relationships**. Together they describe the logic of the proposed nexus:

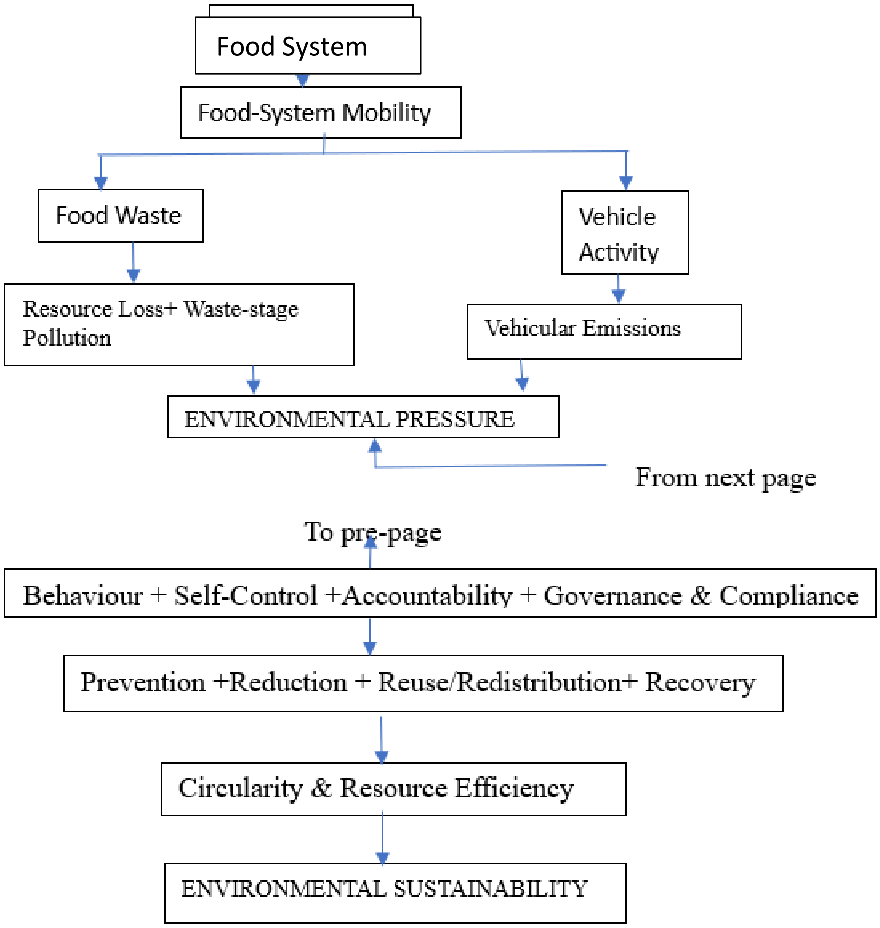


Table 10. Summary of Conceptual Propositions

Proposition	Core relationship	Expected direction
P1	Food waste → Environmental pressure	Positive
P2	Food-system mobility → Transportation-related environmental pressure	Positive
P3	Behaviour, self-control, accountability & governance/compliance → Sustainability practices/environmental performance	Positive
P4	Circularity/resource-efficiency responses → Environmental sustainability	Positive

P1 and P2 represent two main nexus propositions and P3 and P4 represent the mechanism and response dimensions respectively.

P1 — What happens with food waste?
P2 — What happens through mobility?
P3 — What influences system performance?
P4 — What can provide the sustainability response**?**

6. Theoretical Contribution

Originality and Contribution The conceptualization of the **Food-Mobility-Waste Nexus** helps to enrich the sustainability scholarship as it integrates system, behavioural, accountability, governance, and circularity

© CINEFORUM

perspectives into a unique conceptual framework. Its contribution mainly comes from integration rather than in a proposed newly isolated theory.

6.1 Systems Thinking

In an enhancement to systems thinking, the framework interconnects food waste, food-system mobility, and transport-related environmental impacts within a single systems boundary. Unlike solutions aimed solely at mitigating either food waste or transport consequences in isolation, the proposed systems concept explores these relationships within production, distribution, consumption and waste management spheres, highlighting the systems conception that environmental performance emerges from the interactions of the interconnected elements of a system (Meadows, 2008).

6.2 Behaviour and Self-Regulation

Behavioural and self control factors are included as overarching themes impacting on decisions across food purchase, consumption and disposal and travel. This is an advancement of analyses of food-waste or transport impacts because sustainability outcomes are seen to be dependent, to a degree, on peoples' ability to control their behaviour according to their knowledge about long term environmental goals (Baumeister & Vohs, 2007; Duckworth et al., 2019).

6.3 Accountability

Accountability links the behaviour of individuals and organizations to their impacts on the environment. Accountability serves to close the gap between responsibility for sustainability and realized behaviour, and offers a behavioural and organizational tool for holding environmental performance to account. The proposed framework uses this functionality to close this gap (Bovens, 2007).

6.4 Governance and Compliance

The framework positions Governance and Compliance as an overarching policy type-or mechanism-within the institution. Governance represents an institution, a policy and legislation process, standards and institutional tasks, while compliance involves verification processes, monitoring, enforcement, inspection, and controls including, auditing, and reporting, reporting back and taking corrective actions. A distinct treatment of these issues (i.e. Food-waste objectives, transport objectives and environmental objectives) enables them to be placed in a combined governance process and policy architecture.

6.5 Circularity and Resource Efficiency

Lastly the framework uses circularity as the main sustainability-response pathway for the food system. Prevention, reduction, redistribution/reuse and recovery are considered instruments for the recovery and preservation of resources within economic circles and to lessen the environmental burden of waste: in line with circular-economy approaches this provides an additional point where resource-efficiency gains are associated with the issues of mobility and of pollution within food systems (Geissdoerfer et al., 2017).

Table 11. Theoretical Contribution of the Framework

Perspective	Contribution to the proposed framework
Systems thinking	Integrates food waste, mobility and environmental pressures
Behaviour & self-control	Explains individual sustainability-related decisions
Accountability	Links actions with environmental responsibility
Governance & compliance	Connects policy direction with implementation and enforcement
Circularity	Provides the resource-efficiency and sustainability-response pathway

6.6 Overall Theoretical Contribution

The main theoretical implication is thus the consolidation of previously scattered thoughts in the form of an integrated “Food-Mobility-Waste Nexus” framework, suggesting environmental outcomes depend not on either pollution and food-waste avoidance in a segregated manner but through dynamics between food-system practices, the travel induced by needs and the social practices of food, human accountability and institutional action and circular strategies.

The integrated outlook may serve as an intellectual justification for future empirical investigations on the interrelations proposed in Section 5.

7. Practical and Policy Implications

© CINEFORUM

The presented framework will influence how food waste, mobility and pollution in the environmental field will be tackled in practice. Instead of dealing with these topics as separate policy areas, the framework promotes integrated policies within **governance, compliance, behaviour and resource cycles**. Likewise, FAO addresses these points within coordinated governance, policy integration, stake holder engagement and accountable institutions to facilitate transformation of food systems.

7.1 Governance Implications

Governance should provide the overarching policy direction for the Food-Mobility-Waste Nexus. Food waste prevention, transport impacts and environmental sustainability should therefore be taken into account simultaneously when creating the food-waste prevention policy.

Important implications are:

Policy-making with cross cutting issues of food waste and transport and environment policy goals;

Thematic regulations and standards relevant for preventing and recovered food waste;

Responsibility from food, waste and transport sector organisations;

Intergovernmental level action among previously disparate policy domains;

Policy integration between food, waste, transport and environment policies programmes; and

Goal oriented policy planning regarding specific sustainability target measures.

Such combination fits with FAO's work with integrated governance structures and cross cutting co-ordination toward sustainable agrifood systems (FAO Home).

7.2 Compliance Implications

Governance sets the way, but performance in action on environment is about compliance and implementation of it. Thus, the framework point to the requirement of operational tools to execute policies and standards in a tangible manner. Important outcome will be:

Monitoring of food waste, transportation and environmental performance;

Inspection and enforcement of applicable standards;

Auditing and reporting of performance;

Corrective actions where standards are not achieved;

Performance review using measurable indicators; and

Accountability for institutional and operational outcomes.

The following are especially important because measurement, monitoring, and implementation are factors that FAO has listed as essential to a successful intervention regarding food loss and food waste (FAO Home-Food loss and Food Waste).

7.3 Behavioural Implications

The framework highlights that sustainability cannot simply rely on regulation or infrastructure. The behaviour of individuals and institutions are also critical:

The primary behavioural implications are:

Self-control in purchasing and consumption;

Responsible food-use and disposal;

Responsible mobility associated with food acquisition;

Individual accountability for avoidable waste; and

Greater awareness of the environmental consequences of consumption and mobility choices.

Awareness alone also must come with the necessary institutional structures and incentives that encourage such behaviour.

7.4 Circularity and Resource-Efficiency Implications

This framework positions avoidance and reduction higher up in a hierarchy that then includes recovery and reuse, followed by recycling, and ending with disposal. In its own definition, FAO uses prevention and avoidance first and then goes on to talk of recovery and redistributive initiatives to valorise surplus food.

The practical implications are:

Prevention of avoidable food waste;

Reduction of losses throughout the food system;

Redistribution/reuse of suitable surplus food;

Recovery of unavoidable organic resources;

© CINEFORUM

Resource mobilization through circular systems; and
Reduction of environmental pressures associated with both wasted food and its subsequent management.

Table 12. Summary of Practical and Policy Implications

Dimension	Principal action	Intended outcome
Governance	Policy integration and institutional coordination	Coherent system management
Compliance	Monitoring, inspection, auditing and enforcement	Effective implementation
Behaviour	Self-control and responsible consumption/mobility	Reduced avoidable waste
Circularity	Prevention, reduction, redistribution and recovery	Resource efficiency
Overall	Integrated Food–Mobility–Waste management	Environmental sustainability

7.5 Overall Implication

The major practical implication to be drawn is that food-waste and transport (vehicle) pollution ought not automatically to be run as two separate sustainability agendas. For at those interfaces-food-system transport, consumer shopping and the travel involved with disposing waste-there are opportunities to combine action.

Thus, the framework facilitates a move from an approach which is managed segment by segment to an approach in which systems are managed and yet in which decision-making responsibility is clear regarding system management, compliance, behaviour, and circular resource management.

8. Future Research and Empirical Validation

The presented framework is conceptual in nature and will ultimately need to be tested empirically. Empirical testing is necessary to support the constructs and hypothesized relationships present in a conceptual framework in the appropriate contexts or level of analysis (American Academy of Paediatrics, Oct 2024).

8.1 Empirical Testing of the Propositions

Research questions stemming from these four propositions could be conducted using the described quantitative, qualitative, or mixed-method techniques. In particular:

P1 can be examined by relating food-waste quantities and management practices to environmental indicators.

P2 can be examined through food-system mobility, vehicle-use patterns and associated emission indicators.

P3 can assess the influence of behaviour, self-control, accountability and governance & compliance on sustainability practices.

P4 can examine whether prevention, reduction, redistribution/reuse and recovery improve resource efficiency and environmental outcomes.

With research, a great deal of benefit can be gained from the proposition stage if it transpires that this is a conceptually viable premise that could potentially result in conceptually observable indicators and testable hypotheses (Willey online Library Jun 2024).

Table 13. Potential Directions for Empirical Validation

Framework component	Possible empirical indicators
Food waste	Quantity, frequency, avoid ability, disposal practices
Food-system mobility	Trips, distance, transport mode, vehicle use
Vehicular pressure	Fuel use, emissions, air-quality indicators
Waste-stage pollution	Decomposition conditions, emissions, odour, disposal practices
Behaviour & self-control	Purchasing, consumption and disposal behaviour
Accountability	Responsibility and reporting practices
Governance & compliance	Standards, monitoring, inspection and enforcement
Circularity	Prevention, redistribution, reuse, recovery and resource efficiency

8.2 Methodological Opportunities

© CINEFORUM

Depending on the proposition under investigation, data will come from **surveys, interviews, ethnographic/observational studies, life-cycle assessment (LCA), mobility and emission data, case studies, and structural modelling**. LCA should be a central methodology where an analysis is attempting to capture and attribute the full set of environment burdens for one or more tightly coupled stages of the food system. Life cycle analyses are now often also able to be used to assess together the impacts of food production transport and waste, together with food policy (Navigating and sustainability challenges of Food Systems, Sep 2025, ScienceDirect).

8.3 Multi-Level and Comparative Research

The framework is applicable at the level of households, businesses, communities, regions and country-level, so, for instance a comparative study of city Food waste-behaviour. The framework allows for comparisons across cities, region, and countries on food waste behaviour, mobility, transport systems, governance and circularity-practices.

This multi-level option is therefore one of the important strengths of the framework. Indeed conceptual frameworks is useful if it can articulate empirical research between different contexts and levels of analysis (PMC, Jan 2008).

8.4 Framework Refinement

Empirical findings are valuable not only for their corroborating and falsifying contribution, but also for refining the conceptual framework. Geographic factors, available infrastructure, household income levels, the nature of food-system organization, dominant modes of transport and regulatory circumstances can influence the relationships studied. Validity confirmation of conceptual frameworks therefore represents an iterative process, as evidence and literature-based research inform refinement of the framework (Building a Conceptual Framework, Sage Journals, Dec 2009).

. **Overall Future Research Direction**

The immediate research priority is therefore to move from:

Conceptual integration → Operationalization → Empirical testing → Framework refinement

Such analysis can confirm whether the **Food-Mobility-Waste Nexus** can be provided a useful framework for environmental sustainability, to explain and practise sustainability.

9. Limitations of the Conceptual Framework

Although a potential conceptual framework offers an integral explanation for the Food-Mobility-Waste Nexus, it needs to be acknowledged some limitations.

9.1 Conceptual Rather Than Empirical

The structure of the framework is based on existing literature and through a synthesis of the concepts but this framework has not yet been empirically tested. Thus, the linkages proposed in the framework and the four propositions put forward below, are as conceptual instead of established casual linkages. (Building a conceptual framework, sage journals, Dec 2009).

9.2 Measurement and Operationalization

Many constructs - especially food systems mobility, accountability governance and compliance, and waste stage pollution - are multi-dimensional, requiring further empirical elaboration of the constructs' operational definitions, indicators, and scales.

9.3 Causal Relationships

The framework recognizes links between relationships but does not address individual relationships by means of their strength, intensity, direction. No assumption about a direct causal relationship between food waste and vehicular emission is explicitly made in the framework, for example.

9.4 Contextual Variation

The proposed relationships might be contingent on location, infrastructure systems, patterns of how food systems are organized, consumer habits, modes of transportation, and regulations. The proposed framework should therefore not be taken to work in the same way in all countries or contexts.

9.5 Literature and Boundary Limitations

The construct is inherently an abstraction/selected conceptual synthesis of the multidisciplinary corpus of literature; alternative variables/Relationships may become salient in empirical testing. Conceptual frameworks synthesized from multidisciplinary literature will probably represent differences in how authors conceptualized and represented the same construct (Building a Conceptual Framework, Sage Journals, Dec 2009).

OPEN ACCESS © CINEFORUM

Table 14. Principal Limitations and Future Requirements

Limitation	Requirement for future research
Conceptual, not empirical	Empirical validation
Multidimensional constructs	Operationalization and measurement
Relationships not causally established	Statistical/empirical testing
Contextual variation	Cross-regional and comparative studies
Selective conceptual integration	Further literature and empirical refinement

9.6 Overall Limitation

Thus, the overriding limitation of this framework, as it stands, is that it represents a conceptual map but not an empirically proven model. What the framework may offer, however, is the consolidation of hitherto disparate concepts into a more integrated framework on which further research may be built. As such, the framework ought to be considered tentative and 'refinable' rather than a final causal model. Such a perspective is appropriate given the function of conceptual frameworks as sets of interrelated concepts which can organize understanding and provide for systematic future study.

10. Conclusion

Food waste and motor pollution are some of the significant environmental issues relating to our present patterns of production, consumption, mobility and disposal. However, they are most frequently treated in separate sectors. The very magnitude of food waste highlights why this separation may no longer make sense: while producing a volume of 1.05 billion tonnes of wasted food worldwide, UNEP found it “also causes and exacerbates climate change, nature loss and pollution.

Addressing this fragmentation this paper argues for The Food-Mobility-Waste Nexus: An Integrated Conceptual Framework for Environmental Sustainability. I am not suggesting that food waste leads to increased road emissions but that there is an inherent link between them as types of environmental pressures in our transportation-based food-system. Food involves movement of the production system via collecting, processing and storing centres, as well as from wholesale and retail distribution centres to retailers.

Individuals may use vehicles to collect food; and then food waste needs to be collected for disposal by transportation networks.

Food-system mobility offers this bridge between food-related activity and transportation-associated environmental pressures.

The overarching contribution of the framework is the inclusion of all three issues food **waste, food-system mobility and vehicular environmental pressure** in the same system boundary. Moreover, it delineates two separate categories of food-waste effects, namely, resources lost and waste related pollution (from improper decomposition or management of food waste); and two types of vehicles related environmental impacts (from transportation and emissions on the road) that arise separately of food-waste within the system boundaries. Separating these pathways into separate flows while placing them within a shared boundary, however, prevents direct claim-casualization and lends a more appropriate representation to the nexus.

Additional elements to this provision are mechanisms such as **Behaviour, Self-Control, Accountability and Governance & Compliance** as overarching themes. It is argued that physical food and traffic flows are not enough to create a sustainability impact; decisions in relation to purchasing behaviour, disposal habits, mobility and consumption, by and on part of individuals, are equally important to determining how system performances will respond. Moreover, institutional **governance and accountability** will determine if sustainability goals turn into actual actions. The governance sets up frameworks of policies, laws, standards and guidance of institution; the compliance system aims at controlling and verifying system behaviours, inspection, application, control mechanism and remedial process.

The framework puts circularity and resource efficiency in the heart of the response towards sustainability. As with the others, the framework's hierarchy of responses in relation to food waste is prevention and reduction first, then redistribution, reuse and recovery if applicable. This changes the focus of food waste from disposal towards the maintenance of resources within productive cycles, and resonates with the nexus thinking paradigm and the theory of the circular economy whereby taking into account the interdependence of resources and sectors is assumed vital for sustainability.

© CINEFORUM

This proposed conceptual framework is therefore important not so much for the addition of another standalone environmental construct, but for the integration of areas which have commonly been addressed as distinct bodies of work. It provides a conceptual bridge between food-waste research, transportation and vehicular-pollution research, behavioural sustainability, governance and compliance, and circular resource management.

Equally important is its pragmatic application: The framework helps policymakers and organizations to detect points for intervention ranging from food production and distribution to consumption decisions, and then from waste collection to resource recovery. It supports food, transport, waste-management and environmental sectors policy-makers to address interface points instead of applying interventions in an isolated sectorial approach.

The conceptual and schematic framework is intended to be generic and working. It is subject to operationalization for concrete studies through data derived from surveys (households and firms), travel mobility and use of motor vehicles, measured quantity of food wastes generated and related emissions and life-cycle, by comparison to regions and countries.

Finally, the paper advocates a fundamental change in our perspective: "Food waste should not just be seen as a food waste issue, and pollution caused by transport should not just be seen as a transport issue. The interfaces between them, within the context of the food system, demand integrated thinking. The Food-Mobility-Waste Nexus offers an entry into such thinking. It is a first step to generating a conceptual space within which food waste, mobility, pollution, behaviour, responsibility, governance, compliance, and circularity can be understood cohesively."

It would seem that tackling food waste and reducing vehicular pollution are a separate sustainability goal**. The proposed nexus suggests that examining the systems connecting them may reveal opportunities for achieving both more effectively.**..

References

1. 9Jabareen, Y. (2009). Building a conceptual framework: Philosophy, definitions, and procedure. International Journal of Qualitative Methods, 8(4), 49–62. https://doi.org/10.1177/160940690900800406.
2. Pannucci, C. J., & Wilkins, E. G. (2017). Identifying and avoiding bias in research. Plastic and Reconstructive Surgery, 140(4), 619–625.
3. Sackett, D. L. (2006). Limitations are not properly acknowledged in the scientific literature. Journal of Clinical Epidemiology, 60(4), 324–329. https://doi.org/10.1016/j.jclinepi.2006.09.011.
4. 8Cane, J., O'Connor, D., & Michie, S. (2012). Validation of the theoretical domains framework for use in behaviour change and implementation research. Implementation Science, 7, 37.
5. Hollebeek, L. D. (2024). Crafting conceptual proposition-based contributions: The 7C framework. Psychology & Marketing. https://doi.org/10.1002/mar.22055.
6. Jabareen, Y. (2009). Building a conceptual framework: Philosophy, definitions, and procedure. International Journal of Qualitative Methods, 8(4), 49–62. https://doi.org/10.1177/160940690900800406.
7. 6Baumeister, R. F., & Vohs, K. D. (2007). Self-regulation, ego depletion, and motivation. Social and Personality Psychology Compass, 1(1), 115–128. https://doi.org/10.1111/j.1751-9004.2007.00001.x
8. Bovens, M. (2007). Analysing and assessing accountability: A conceptual framework. European Law Journal, 13(4), 447–468. https://doi.org/10.1111/j.1468-0386.2007.00378.x
9. Duckworth, A. L., Milkman, K. L., & Laibson, D. (2019). Beyond willpower: Strategies for reducing failures of self-control. Psychological Science in the Public Interest, 19(3), 102–129. https://doi.org/10.1177/1529100618821893
10. Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The circular economy—A new sustainability paradigm? Journal of Cleaner Production, 143, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048
11. Meadows, D. H. (2008). Thinking in systems: A primer. Chelsea Green Publishing.
12. 2 Chauhan, C., Dhir, A., Akram, M. U., & Salo, J. (2021). Food loss and waste in food supply chains. A systematic literature review and framework development approach. Journal of Cleaner Production, 295, 126438.
13. 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.

© CINEFORUM

14. Food and Agriculture Organization of the United Nations. (2024). Technical Platform on the Measurement and Reduction of Food Loss and Waste. FAO.
15. United Nations Environment Programme. (2024). Food Waste Index Report 2024. UNEP.
16. World Health Organization. (2025). Transport: Sectoral solutions for air pollution and health. WHO.
17. References for Section 1
18. 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.
19. Food and Agriculture Organization of the United Nations. (2024). The losses along the way: Why we need to think about transportation systems to reduce food loss. FAO.
20. United Nations Environment Programme. (2024). Food Waste Index Report 2024. UNEP.
21. World Health Organization. (2021). Sustainable transport for health. WHO.
22. World Health Organization. (2025). Transport: Sectoral solutions for air pollution and health. WHO.
23. 10Dora, M., Biswas, S., Choudhary, S., Nayak, R., & Irani, Z. (2021). A system-wide interdisciplinary conceptual framework for food loss and waste mitigation strategies in the supply chain. Industrial Marketing Management, 93, 492–508. https://doi.org/10.1016/j.indmarman.2020.10.013.
24. Parsa, A., Van De Wiel, M. J., & Schmutz, U. (2021). Intersection, interrelation or interdependence? The relationship between circular economy and nexus approach. Journal of Cleaner Production, 313, 127794. https://doi.org/10.1016/j.jclepro.2021.127794.
25. United Nations Environment Programme. (2024). Food Waste Index Report 2024. UNEP....

..

© CINEFORUM