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Conceptual Role Of Artificial Intelligence In Vehicle Scrappage Policy In India: Perspectives And Sustainability Roadmap

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ABSTRACT

Being a purposeful initiative, India's Vehicle Scrappage Policy, 2021, aims to deal with economic distortions, safety risks, and implementation challenges arising from an ageing vehicle fleet. From a social perspective, an integrated regulatory framework is conducive to enhancing transparency, compliance, road safety, and trust in the operationalization of policies. With reference to this, Artificial Intelligence (AI) has developed as a transformative enabler with the scope to facilitate policy design, implementation, monitoring, and performance appraisal.

By adopting a conceptual and policy-led approach, qualitative approach, this paper studies the role of Artificial Intelligence in upgrading the economic sustainability and social impacts of India's Vehicle Scrappage Policy, 2021. In the social context, the regulatory framework, with the help of AI, enhances transparency, regulatory compliance, road safety outcomes, and trust in the execution of effective policy. At the economic level, AI enables industrial efficiency, employment generation, cost optimisation, and sustainable market restructuring, keeping environmental gains as a secondary yet positive outcome. This study additionally identifies the major constraints faced in the implementation of policies. It lays out a strategic roadmap for future research.

The study indicates that the incorporation of Al in the scrappage policy improves the effectiveness of the policy significantly, which can be achieved through the identification of end-of-life vehicles, enhanced compliance, and operational efficiency. Al-based diagnostic and trend assessment also ensures timely scrappage and promotes transparency in scrappage activities.

Keywords: Vehicle Scrappage Policy, Artificial Intelligence, Economic Sustainability, Social Effectiveness, Sustainable Mobility Policy.

1. INTRODUCTION

The rapid increase in the automobile sector has been acting as an accelerator of growth, mobility and industrial development of the Indian economy. It is being observed that the continuous use of old, outdated and inefficient vehicles is not just creating costs as higher fuel consumption, higher maintenance costs, but has also led to fall in road safety concerns with negligible efficiencies in transportation and logistics networks. By default, all these downsides have paved a pressure on public infrastructure, fiscal resources and overall economic output.

To tackle this limited effectiveness, a Vehicle Scrappage Policy has been introduced. Being a structural and systematized form, the policy tries to voluntarily phase out the outdated and aged vehicles. Despite the fact that this policy supports environmental concerns including reduced emission, low pollution and improvement in air quality, the major perks of this policy hold its capacity to boost economic activities, upgrade industrial efficiency and formalize the vehicle scrappage sector. Further, the policy sustains social implications covering improved road safety, consumer welfare and credibility in regulatory systems.

The policy is competent enough to improve decision-making, administrative capabilities and governance outcomes. With no alteration in the original form of this policy, Artificial Intelligence figures out opportunities strengthening economic planning, reduces implementation costs and modifies operational transparency. Henceforth, the conceptual role of AI acts as the main focus of this study, in support of the economic and social perspectives of India's Vehicle Scrap page Policy, keeping environmental gains as a complementary impact of economically effective governance.

2 LITERATURE REVIEW

2.1. Vehicle Scrappage and the Circular Economy

In the existing literature, Vehicle scrappage policies have been acknowledged as vital tools to achieve transition to a 'circular economy'. As per the studies of Nieuwenhuis and Wells (2015) and the OECD (2020), these policies are essential to address environmental inefficiencies of aged vehicle stock and, also, to stimulate industrial renewal. While in developed economies, scrappage initiatives are linked

to industrial output, life cycle cost and fuel efficiency (Bhattacharya et al., 2022). In developing economies these linkage are equally relevant for sustaining industrial activities and national fuel efficiency.

2.2. The Indian Policy Landscape

In India, the need for a scrappage policy has been further underscored by comments from the Ministry of Road Transport and Highways (MoRTH, 2022) and NITI Aayog (2023), who point out that any such policy will need a structured ecosystem for scrapping, to formalize the highly fragmented informal recycling systems. Such a formalised organised system of scrapping will help in increasing compliance and also create employment and ensure organised resource recovery and recycling.

2.3. AI as a Catalyst for Sustainable Governance

The integration of Artificial Intelligence (AI) into public policy is increasingly viewed as a driver for economic and social sustainability. Bughin et al. (2018) demonstrate that AI enhances economic outcomes by optimizing resource allocation and enabling predictive demand forecasting. Beyond economic metrics, AI strengthens social governance by fostering institutional trust, reducing discretionary human bias, and increasing procedural transparency (Zuiderwijk et al., 2021).

2.4. Challenges in Implementation

Despite of the potential AI holds, it’s being warned by various experts not to use a "one-size-fits-all" approach in developing countries. Dwivedi et al. (2021) identified three main barriers in the effective implementation of the policy including:

- Algorithmic bias – It involves punishing the poor vehicle owners unfairly.
- Infrastructure gaps – It is concerned with the digital software which is more advanced than the original physical testing centers.
- Data privacy- It involves the risk of misuse of information related to the owners and their vehicles.

2.5. Research Gap

Though the individual domains of AI governance and scrappage policies are well-proved, there is a notable drawback of research examining their convergence within the Indian socio-economic framework. This research paper tackles this gap by suggesting a conceptual framework considering AI as a strategic enabler, supports socio-economic efficacy of Vehicle Scrappage Policy in India.

3. VEHICLE SCRAPPAGE POLICY IN INDIA: ECONOMIC AND SOCIAL RATIONALE

3.1 Economic Rationale

The Vehicle Scrappage Policy has a host of economic benefits, reaching well beyond the vehicle owner. These benefits encourage the registered vehicle owner to buy a new vehicle to avail costs saving on maintenance. Thus the benefits for the economy are much greater than that. As productivity goes up, so does industrial growth and fiscal revenue for the government. Phasing out old vehicles step-by-step would also improve fuel efficiency, lowering operating and logistics costs, which would especially have a huge impact on high growth transport sectors and improve economic efficiency overall.

Vehicle scrapping would pave way for induction of newer and more advanced technology vehicles and ensure optimal use of large inventory of reusable material including steel and aluminum in the country. The policy would aim to formalize the large unorganised Vehicle Scrapping Market in the country, and would help in bringing in tax compliance and plug the tax leakages. There would be creation of large-scale employment opportunities in authorised scrapping facilities, re Rolling units, logistics providers, etc. and also would generate demand for the raw material required for the growing Automobile manufacturing sector. With favorable macroeconomic outcomes like an increase in GDP, rise in employment level, and more, the Vehicle Scrappage Policy has become a landmark economic reform.

The scrapping of around 9.7 million unfit vehicles on the road will generate around Rs 40,000 crores of GST for the government and can generate up to 7 million man-years of employment. The private sector is also investing around Rs 2,700 crores in setting up authorised scrapping centres across the country, which will boost industrial capability, formalise recycling and create huge fiscal gains. This policy has the potential of being a harbinger of sustainable economic growth in the country.

Component	Pre-Scrappage Scenario	Post-Scrappage Impact
Fuel Efficiency	Low due to old vehicles	Improved with modern technology
Maintenance Cost	High	Reduced
Industrial Growth	Limited demand	Boost in the automobile sector
Employment	Informal	Formal job creation
Tax Revenue	Lower compliance	Increased GST collection

Table 1: Economic Impact of Vehicle Scrappage Policy in India
Source: Compiled from Ministry of Road Transport and Highways (2021) and NITI Aayog (2022)

3.2 Social Rationale

In the context of social efficacy, the policy Vehicle Scrappage upgrades safety concerns on road by providing incentives to influence the removal of unfit, outdated and ageing vehicles systematically. As per the current trends, 3-4 lakh vehicles have been scrapped approximately nationwide. This reflects a gradual and quantifiable shift in modernized automobile sector. Moreover, the vehicles which are more than 15 years old, and obsolete, considered more susceptible for mechanical drawbacks and formal weaknesses. When these are scrapped, the extracted material contributes in reduction of not just accident risks but also improves welfare of the public by diminishing the social costs. This cost is inclusive of road fatalities, risks of injury and expenditure on health.

In place of implementing coercive enforcement, the policy aims to encourage voluntary compliance of the vehicle owners by adopting an interactive and benefit-oriented approach by giving monetary and tax-related incentives. Few research imply that approx thousands of automobile owners have accessed incentive- based policy. This demonstrates the increasing level of acceptance of the policy throughout. It also strengthens the trust between residents and the state by promoting behavioral change and upgradation of sustained legal compliance.

However, the forward- looking design of the Scrappage ecosystem has started to offer formal employment and stimulate skill development by expansion of Registered Vehicle Scrapping Facilities (RVSFs) and Automated Testing Stations (ATSs). Inspired by this, the workers involved in informal and unmonitored dismantling operational activities

are now shifting towards risks-free, regulated and skill-driven roles, hence increasing the policy's focus on strong social governance and inclusion aims.

Aspects	Issue in old system	Improvement after policy
Road safety	High accident risk	Safer vehicles on roads
Public health	Pollution-related issues	Better air quality
Employment Quality	Informal sector dominance	Skilled & formal jobs
Public Trust	Low compliance	Increased participation

Table 2: Social benefits of Vehicle Scrappage Policy in India
Source: Compiled by the author based on government reports and secondary data.

3.3 Environmental Context

Although environmental benefits are not the primary focus of this paper, it is important to acknowledge that economically driven vehicle scrappage reforms generate measurable positive environmental externalities that reinforce broader sustainability objectives. Recent estimates indicate that the scrappage process has already recovered approximately 3.76 lakh tonnes of metal scrap from end-of-life vehicles, which could substitute a significant portion of imported ferrous material and support resource conservation. Scrapping older vehicles also supports broader emission reduction goals: official projections suggest that the policy could reduce carbon emissions by around 1 crore tonnes and lead to fuel savings of approximately 3.2 billion litres, reflecting substantial improvements in efficiency and lower aggregate tailpipe emissions as the fleet modernises. Moreover, scrapping older, high-emitting vehicles contributes to improved ambient air quality in urban areas, especially where traffic density is high, thereby complementing public health and climate mitigation aims. These outcomes emerge as positive externalities of the policy's economically oriented reforms and align with national commitments to cleaner air, circular material use, and sustainable transport systems.

Resource	Traditional disposal	AI-Enabled scrappage
Steel	Wastage	Recycled efficiently
Aluminium	Underutilized	Reused in production

Energy Use	High	Optimized
Imports	High dependency	Reduced imports
Waste management	Unorganized	Structured

Table 3: Environmental benefits of Vehicle Scrappage Policy in India
Source: Compiled from sustainability reports and government policy documents.

4. ARTIFICIAL INTELLIGENCE IN ECONOMIC AND SOCIAL GOVERNANCE: A CONCEPTUAL OVERVIEW

Implementing Artificial Intelligence (AI) in public sector governance has enabled the smooth operation of executive efficiency. Furthermore, it has enabled data-based policy formulation.

In the realm of economic governance, the analytical processing of data through the implementation of AI tools lends support to policymakers in examining market trends, predicting demand patterns, etc. Hence, the Vehicle Scrappage Policy, which involves various stakeholders with complex economic interactions, is an important policy amendment

.4.1 AI and Economic Sustainability

Economically, as a catalyst AI serves for cost optimization by automating financial incentives and eliminating executive- level inefficiencies. Further, facilitating the government with the mechanisms to evaluate if the set economic goals are being achieved is one of the important roles played by the AI-supported policy evaluation.

4.2 AI and Social Sustainability

As per the social governance, it is clear that the potential to increase the level of transparency and reduce discretionary action is possible with the support of AI. It is noteworthy to mention that the part played by the AI in the social governance field is conceptual and supportive, as it is deterministic to align with democratic values.

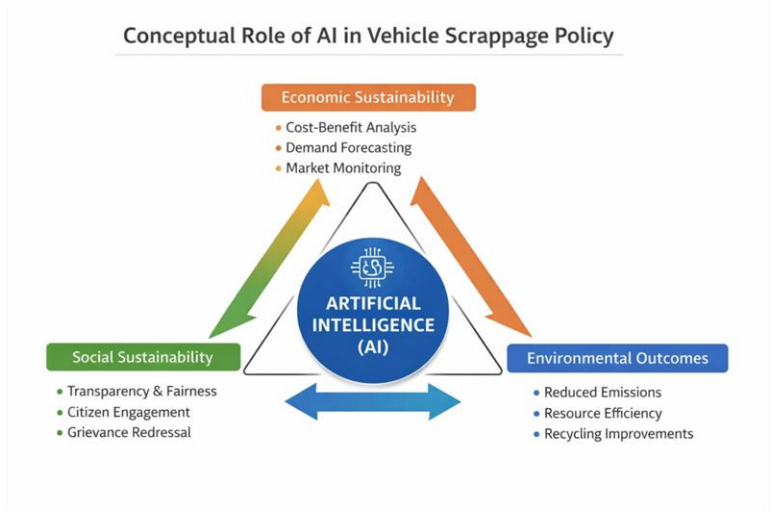

Figure 1: AI integration in Vehicle Scrappage Policy
Source: Author Compiled

The triangular model shows that AI is an integrative governance enabler, in which economic efficiency complements social trust, producing beneficial environmental externalities. This model is consistent with the principles of sustainable development, maintaining human oversight and democratic accountability.

5. AI-ENABLED VEHICLE SCRAPPAGE POLICY AS AN ECONOMIC SUSTAINABILITY ROADMAP

Embedding Artificial Intelligence (AI) in the Vehicle Scrappage Policy will be a path to economic sustainability for India. Vehicles older than 15-20 years are plying on the roads in India numbering in millions, putting a larger burden on the vehicles in terms of increased fuel prices, enhanced risk to safety of citizens and lower efficiency of the exchequer. AI will enable forecasting of demand, better targeting of incentives and dynamic monitoring of the situation to ensure fiscal efficiency and plug leakages.

6. CONCEPTUAL ROLE OF AI IN ENHANCING ECONOMIC SUSTAINABILITY UNDER THE VEHICLE SCRAPPAGE POLICY

AI Function	Policy application area	Economic sustainability outcome
Data analytics on vehicle age and usage	Identification of end-of-life vehicles	Efficient targeting of scrappage incentives
Predictive modeling	Forecasting automobile demand and replacement trends	Industrial stability and production planning
Cost-benefit analysis tools	Evaluation of fiscal incentives	Optimal allocation of public resources
Market response monitoring	Tracking price, demand and supply changes	Timely policy adjustments and economic stability
Automation of administrative processes	Scrappage approvals and documentation	Reduction in administrative costs and policy leakage

Table 4: Conceptual role of AI in enhancing Economic Sustainability under the Vehicle Scrappage Policy
Source: Compiled by the author based on policy documents, sustainability reports and secondary data

6. LIMITATIONS AND IMPLEMENTATION CHALLENGES

Though Artificial Intelligence (AI) offers a transformative edge to the Vehicle Scrappage Policy, yet its practical application faces a "bottleneck" of multi-dimensional challenges.

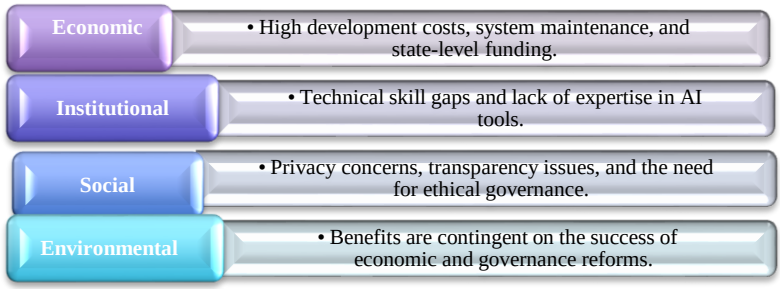

Figure 2: Limitations and Implementation Challenges of AI in Vehicle Scrappage Policy

Source: Compiled by the author based on the TERI policy brief (2023) and secondary data

As mentioned in figure 2, the barriers faced while using AI in policy implementation are categorized into economic, institutional, social and environmental challenges. The primary obstacle is financial involving high costs for the development of digital infrastructure and maintaining AI systems at the state and local levels where budgets may be constrained. Without technically-fit skilled personnel, it becomes difficult to leverage advanced AI-enabled tools to their full potential for inspections or data processing.

As per the social aspect, building public trust that the system is fair rather than a mechanical "black box". This trust can only be achieved by keeping privacy concerns of vehicle and owner data as well as explaining the role of AI in scrappage and retention decision-making. Acting indirect in nature, environmental benefits act as dependent drivers that rely on economic efficiency (Optimization of the recycling supply chain using AI) and governance reforms (Enforcement of the policy through new AI-based tools).

7. FUTURE RESEARCH SCOPE

As per future outlook is considered, there can be research focusing on the development and assessment of AI-driven tools, enhancing the financial effectiveness, accountability and transparency of the Vehicle Scrap page Policy. In addition, empirical research could examine the persistent fiscal and industrial impacts of AI-supported policy structure, inclusion of institutional capacity and regulatory oversight. A more comprehensive insights about the AI-support in the effective implementation of sustainable policies through such research.

8. CONCLUSION

The Vehicle Scrappage Policy has notably facilitated both economic reforms and social outcomes. Apart from relevant environmental gains, the principal strength of the policy relies on its potential to improve economic efficiency, stimulate industrial growth and substantiate governance effectiveness. With a conceptual application, Artificial Intelligence assists in fulfillment of the mentioned objectives using data-driven planning, fiscal optimization and better transparency in implementation of the policy. By framing the use of AI as a support system to inform policy-making and not as an autonomous decision-maker, accountability and democratic checks and balances are

maintained. Looking forward, using AI for design, monitoring and evaluation of policies and programmes can facilitate their implementation through adaptive governance structures with potential for scalability and economic benefits that could be sustainable over the long-term for sustainable development in India.

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