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Circular Economy: Enhancing Futuristic Outcomes in the Transportation Sector of India - A Case Study

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Abstract

The circular economy contributing for the environmental sustainability, especially in the automotive sector is studied with a case study for the pros and cons based on its impact in the implementation in India. The government policy with scrappage of policy of 2021 and waste disposal of 2022 aims for the recovery, recycle and reuse of raw materials which are being imported heavily now by the industry. Contrary to this expectation, the recovery had not been as expected as authorized scrapping centers are not getting vehicles to the capacity created by both government and private entities. Old vehicles are handed over for condemnation even now to the unorganized sector. Hence, the intended purpose issue of a certificate of deposit at the RVSF is not a reality and the user of the vehicle is not going to repurchase in such cases or the incentive is adequate to enough to hand over the vehicle to an authorized center. This case study concentrates the lacuna in the system and suggest ways of improved scrapping procedures and incentives for the end-of-vehicles (ELV). A matrix of combining the ELV and the condition of the vehicle is not being done now for incentives. This needs a corrective action and the evaluation methods of balance life left should be more practical and the incentives given should be felt as a reward by the user for encouraging him to deposit the vehicle at the authorized RVSFs. The study has taken 5 articles for literature review and the contribution by them over the years is acknowledged. This case study differs with the findings of some the studies and the same have been explained in para 3.0. The proposed method which would encourage the user of the vehicle to deposit at authorized centers have been explained in paragraph 4.0. The conclusions arrived at have been explained in paragraph 5.0. It is concluded that the proposed method with emphasis on life and conditions of vehicle assessed for incentives will help for the total aims of circular economy.

Keywords: Circular economy, End-of-life vehicles, environmental sustainability, incentives, RVSF.

1.0 Introduction

A circular economy is an economic model that contributes to minimize waste and maximize resource efficiency (Shubhrajyotsna Aithal & Aithal P.S., 2023) [1]. It helps to extend the life cycle of products through reducing, reusing, repairing, refurbishing, remanufacturing and recycling materials. Thus, it reduces dependence on virgin resources and minimizes environmental impacts. In the automotive industry, a circular economy measure is meant to the sustainable management of vehicles, components and materials throughout their entire life cycle by promoting eco-design, preventive maintenance, repair, remanufacturing, reuse, recycling and responsible disposal of end-of-life vehicles (Molla A.H et al., 2022)

[2]. This approach conserves natural resources, reduces waste generation, lowers greenhouse gas emissions and improves the operational and economic sustainability of the industry in a closed loop system (Shubhrajyotsna Aithal & Aithal P.S., 2023) [1]. In the Indian automotive industry, which is poised for the green transition and aiming to have 30% of electric vehicle in the total population of vehicles in 2030, the circular economy supports green innovation by reducing waste, improving resource efficiency, recovering valuable materials from end-of-life vehicles, promoting battery recycling and remanufacturing, and contributing to environmental sustainability, operational efficiency and long-term industrial growth [2]. Thus, it provides a framework for integrating green innovation, vehicle scrappage, battery recycling, Extended Producer Responsibility (EPR), remanufacturing and resource-efficient manufacturing to achieve environmental sustainability, economic resilience and sustained industrial growth [2].

Table 1: Performance of RVSFs in India

Performance Indicator	Status
Operational RVSFs	134 across 22 States/UTs (March 2026)
Vehicles scrapped	4,65,393 vehicles processed by March 2026
Private vehicles	2,87,389 vehicles
Government vehicles	1,78,003 vehicles
Earlier status (Nov. 2025)	123 RVSFs operational; about 3.6 lakh vehicles scrapped

Source: Vijayanta Ahuja & Shakti N Khanna (2019) [3]

The arisings for ELVs after completion of 15 years life will be those sold from 2013 and are shown in table 2. The total automobile domestic sales figures for passenger vehicles, commercial vehicles, three wheelers, two wheelers including new entrant - quadricycles, are as follows:

Table 2: Vehicles sold, year-wise

year	Vehicles sold
2013-14:	1,84,23,223
2014-15:	1,97,24,371
2015-16:	2,04,68,971
2016-17:	2,18,63,281
2017-18:	2,49,81,312
2018-19:	2,62,67,783

Source: Vijayanta Ahuja & Shakti N Khanna (2019)

As of recent tracking under India's Voluntary Vehicle Modernization Program, official aggregated totals for all private and commercial vehicles handed over specifically to Registered Vehicle Scrapping Facilities (RVSFs) remain low and are only partially reported.

Vehicles, when completing 20 years in the case of commercial vehicles from 2033 onwards and 15 years in the case passenger vehicles from 2028 onwards. necessary planning for disposal through authorized centers should be planned. The factors that contribute for vehicles to be handed over for disposal has to be corroborated for vehicle-wise and a monitoring system needs to be developed for positive handing over of the vehicles and timely disposal shall be ensured.

While India currently aims to have an 80% recyclability rate and 85% recoverability rate (by mass) other counties in the European Union have progressed forward towards an 85% recyclability rate and a 95% recoverability rate (Vijayanta Ahuja & Shakti N Khanna 2019) [3].

The current cycle of an automobile right now can be considered as incomplete as a vehicle currently retires only due to other reasons such as not roadworthy beyond economic repair or due to road accidents, rather than guided by a robust systemic process to end the life cycle and close the loop of these vehicles (Vijayanta Ahuja & Shakti N Khanna 2019) [3].

Linking of VAHAN, I&C regime, PUC and ELV together will finally close the loop - from the purchase of the vehicle, to its maintenance and pollution checks (PUC) and check for roadworthiness through I&C; when found unfit, the vehicle can finally be processed towards dismantling for reuse and recycling purposes in a standardized, controlled and environmentally friendly manner (Vijayanta Ahuja & Shakti N Khanna 2019) [3].

The digitization of Registered Vehicle Scrapping Facilities (RVSFs) in India centers around key platforms like the Vahan database, Digi-ELV trading platform, and the CPCB EPR portal. This digital shift tracks end-of-life vehicles (ELVs) from scrap to final recycling. RVSFs connect directly to the central Vahan database to check vehicle registration, verify clear dues, and confirm the vehicle is not blacklisted or stolen via police records before accepting it. Digi ELV Platform functions as an official digital marketplace where users trade the Certificate of Deposit (CD) issued by an RVSF after scrapping a vehicle. CPCB EPR Portal facilities must register on the Central Pollution Control Board EPR portal to file compliance reports, manage recycling targets, and track hazardous waste handling. Operational & Compliance Tracking Single-Window Clearance, Online National Informatics Centre (NIC) portals process applications, fees, and approvals for new RVSF units. Digital Certificates: Scrapping confirmation and electronic Certificates of Deposit are generated automatically through government-linked systems to pass on tax rebates for new vehicle purchases. Traceability has to be ensured with every component and scrap category recycled or sent downstream must be logged digitally to meet strict environmental targets.

Registered Vehicle Scrapping Facilities (RVSFs) in India recover distinct weight percentages of metals from end-of-life vehicles, dominated by ferrous metals (65–80%) and non-ferrous metals like aluminum and copper (8–12%). Cumulative formal processing reached over 430,000 vehicles across 129 operational facilities by early 2026, though specific aggregate national tonnage for metal recovery over the past three years is not centrally published in a single consolidated government dataset (PIB, Feb 2026) [4].

Under the National Vehicle Scrappage Policy, a vehicle owner receives a cash payout equivalent to 4% to 6% of the ex-showroom price of a new vehicle (or equivalent model). In practice, this converts to roughly ₹15,000–₹40,000 for a standard passenger car and ₹55,000–₹90,000 for a heavy commercial vehicle. The estimation and calculation of this payout are managed directly by the Government-authorized RVSF. Beyond the raw metal scrap value, the RVSF system provides an official Certificate of Deposit (CoD), which unlocks a larger stack of government-mandated financial perks. It is seen that the circular economy in the transportation sector is impacted by the scrappage and waste disposal policy and the way in which it gets implemented through RVSF centers.

Table 3: Incentives and benefits provided by various agencies

Incentive Type	Value / Benefit Given	Provided By
Scrap Value Payout	4% to 6% of new ex-showroom price	RVSF directly to owner's bank
Road Tax Rebate	Up to 25% (personal) / 15% (commercial)	State Government
New Vehicle Discount	Around 5% discount on the new vehicle	Vehicle Manufacturers (OEMs)
Registration Fee Waiver	100% waiver on new vehicle registration	Regional Transport Office (RTO)

Source: MMCM (March 2026) [5].

The manufacturers of the automotive industry have taken their maximum efforts by resorting to the use of renewable energy in production units. They have also been involved in the running of RVSF centers. A noteworthy effort of them is to have carbon credit by minimizing emissions. Their contribution to the circular economy is commendable and the user of the vehicles have to hand over the ELVs to the authorized centers of scrap disposal, for successful circular economy and that depends on the incentive the user gets from the government for handing over ELVs to the RVSFs. The impact of circular economy has been studied by some analysts and the papers by them have been taken for literature review.

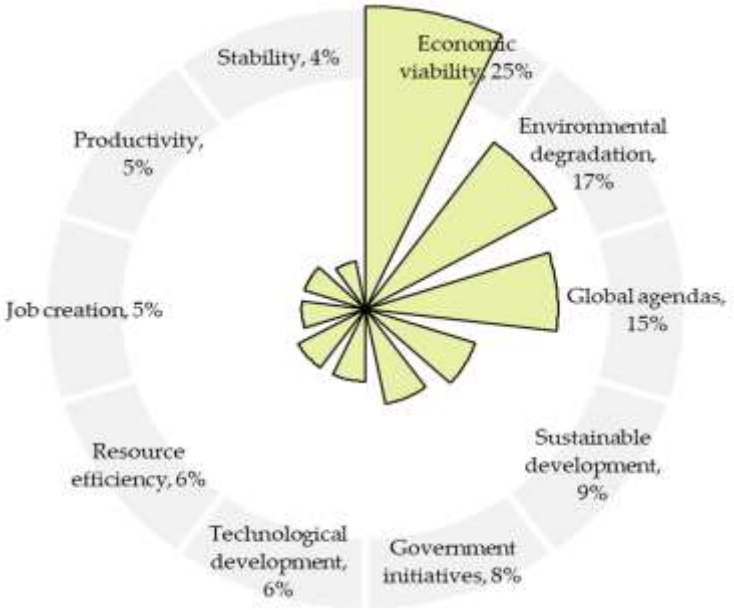
2.0 Literature review

Literature on the subject are available exclusively for transportation sector and also for all the other sectors covered under circular economy. The papers are on enablers and barriers, on resilience factors, on RVSFs and government policy guidelines through their websites. These form part of the literature review from paragraphs 2.1 to 2.9 and summary in 2.10.

2.1 Enablers and barriers for implementation of circular economy

India brought the vehicle scrappage policy in 2021 and waste disposal policy in 2022. The policy schemes enabled to have authorized scrappage centers, through which the owner of the vehicle disposed of the end-of-life (ELV) vehicle. These centers have been equipped with facilities for handling vehicles efficiently without spilling of oils and liquids and also have safe landfills. The recovery of precious raw materials also is ensured during the dismantling of the vehicles. Thus, reduce, recover and reuse become a reality and done with care to protect the environment as much waste is generated in the case of personal cars and private entities [2]. It is pertinent to note that the recovery of materials helps in minimizing the use of fresh resources [2]. Molla A.H. et al., (2022) [2] in an exploratory approach, studied the factors impacting a successful circular economy in automotive sector, at five places in India – Delhi, Mumbai, Kolkata, Chennai and Jamshedpur. They concluded that drivers that enable CE implementation in India's ELV recycling system are as shown in the figure:

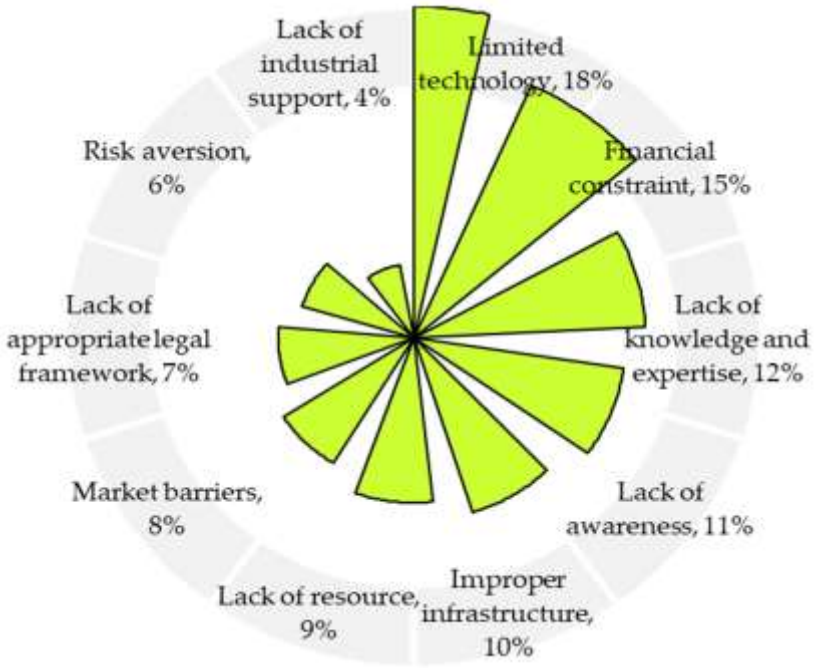
Figure 1: Enablers for implementation of circular economy in India



Source: Molla A.H. (2022) [2]

Their findings showed that the most significant enabler for CE was economic viability and they also emphasized that these are due to internal and external drivers. The predominant internal drivers as per their study are economic viability, environmental degradation, sustainable development, technological development, resource efficiency, job creation, productivity and stability. They identified the external drivers contributing to the CE as global agendas and government policies. They also identified the barriers to CE implementation in India as in Figure 2.

Figure 2: Barriers to CE implementation



Source: Molla A.H (2022) [2]

They identified the limited technology as the major barrier and other internal barriers as financial constraint, lack of knowledge and expertise, lack of awareness, improper infrastructure, lack of resource, market barriers and risk aversion. The external barriers pointed out by them are the lack of appropriate legal framework and lack of industrial support.

They have analyzed in all possible ways of the transportation industry in India to arrive at above conclusions. The enablers pointed out by them of importance is economic viability and environmental concerns. The barriers highlighted by them as the most important ones are limited technology and financial constraint. The table 1 on introduction has clearly brought out that the RVSF centers are not getting adequate vehicles in several centers and this study will be concentrating on the improvements needed for that. However, it is to be pointed out that the study by Molla A. H [2] on the lack of technical expertise or limited technology needs a thorough study in future. The improvement needed in that area may help for cost effective and efficient disposal of waste and may also contribute for recovery of materials economically.

2.2 Linking of VAHAN to other data for effective disposal of vehicles

Vijayanta Ahuja & Shakti N Khanna (2019) [3] state that there is a growing demand for the vehicles in India. The manufacturers have responded with increase in installed capacity of 7% in the case of four wheelers and more than 5% in the case of two wheelers. They quote Akolkar et al. (2015) to emphasize that by 2025, the total ELV count will be more than 21 million vehicles. They caution a large number of vehicles with nearing ELV will result in excess emissions and the rejection of them from utility and handing them over to disposal will result in better environment. They recommend for the strict implementation of the scrapping policy for these ELVs, to get the benefit of 3Rs, reuse, recover and recycle for better use of resources and with recycling of salvaged parts, the user will be the beneficiary with cost reduction. They also suggest for linking of the VAHAN, I&C regime, PUC and ELV together will finally close circle of the buying the vehicle to end-of-life disposal. This will help to identify of vehicles with both ELV and condition-based disposal. A successful ELV program will not only cater to the environmental impact, but will also address on-road safety by encouraging outflow of unsafe and polluting vehicles to give way for new and safer vehicles.

2.3 SWOT analysis on circular economy in India

Dr. Anil Kumar (2025) [6] has done a SWOT analysis on the circular economy in India. He has studied on CE in all fields inclusive of transportation sector. He states that authentic data has been sourced from organizations such as the Ellen MacArthur Foundation, OECD, UNIDO, CPCB, and various academic journals. He states that India a saw a growth in demand of 218% for electrical vehicles in 2022 indicating users' preference towards lesser emissions and contributing to the circular economy. He further states that e-waste recycling is an opportunity for employment for more than a million people.

2.4 Cost reduction due to recycling resulting in profit

Shubhrajyotsna Aithal & P. S. Aithal (2023) [3] have done an exploratory study with multiple industries concerning CE. They have addressed the problems in the automotive industry too and have stated that the circular economy helps to reduce emissions by minimizing energy consumption and promoting renewable energy sources in production units. He correlates recycling and efficient use of resources and states that this reduces the demand for virgin materials. Circular economy adoption allows waste streams to be viewed as valuable resources rather than disposables. The reduced purchase of new raw materials contributes to cost reduction. This shift promotes longer product lifetimes, facilitates maintenance and repair services, and enhances profitability and reducing costs associated with continuous production. The

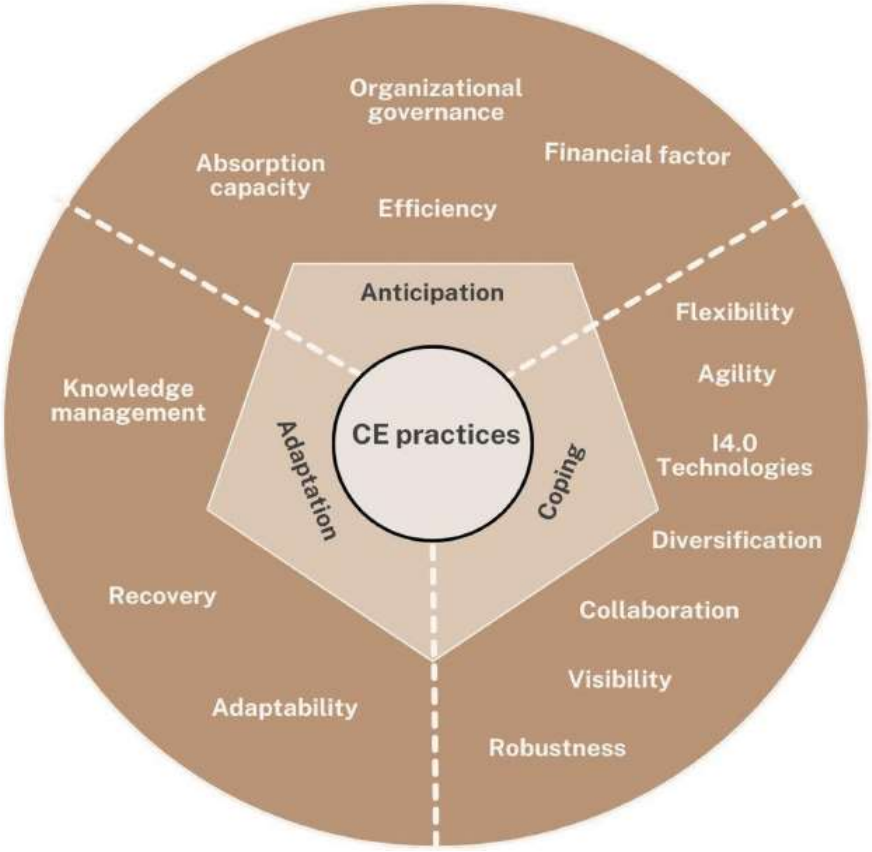
circular economy encourages innovation in product design and manufacturing processes. The major advantage CE offers is the enhancement of environmental protection by safe and efficient disposal of waste. He concludes that all stakeholders are benefitted by the implementation of CE with resource optimization.

2.5 Resilience factors in circular economy

dos Santos, J. E. A., & Gohr, C. F. (2026) [7] have analyzed the resilience factor in the practice of circular economy.

17 resilience factors were identified, and after analysis only 14 were retained. The Figure 3, shows the resilience factors.

Figure 3: Resilience factors in circular economy



The Organizational governance, absorption capacity, efficiency and financial factor account for the CE practices under anticipation. This phase is meant for anticipating potential hazards to implementation. This is a stage to act pro-actively and utilize the resources effectively.

Flexibility, agility, technological capability, diversification, collaboration, visibility and robustness form part of the CE practices under coping. The adaptation part of CE practices comprises of knowledge management and adaptability. In a coping phase, disruptive situation present demand performance to meet the challenges appropriately. Adaptation phase is after challenges have been met and after a crisis and the lessons learnt has taught adapting to the situation critical to circular economy. The author is also referring to the phase as 'recovery'. Thus, this study has attempted to give a framework for CE but have opined in conclusion that more studies have to be conducted before arriving at a framework for CE.

2.6 India's approach to circular economy

India has a designated regulatory framework and enforcement agency for circular economy-related compliance (NITI Ayog, 2026) [8], primarily driven through Extended Producer Responsibility (EPR) regimes managed by the Central Pollution Control Board (CPCB), under the overarching policy direction of the Ministry of Environment, Forest and Climate Change (MoEFCC).

Core Functions of the CPCB Enforcement Regime

- Centralized Portals: Operates single-window digital platforms (such as the centralized EPR portals for plastic, e-waste, and batteries) to register Producers, Importers, and Brand Owners (PIBOs)
- Target Allocation & Tracking**:** Mandates annual recycling and collection quotas and tracks the trade of digital EPR/recycling certificates.
- Environmental Compensation**:** Conducts data-driven audits and levies financial penalties on non-compliant industrial units.

2.7 Circular economy and resource dynamics

Current studies on India's scrappage policy have predominantly concentrated on emissions reduction, fleet modernization, and recycling efficiency, rather than on systemic resource dynamics (Mishra et al.2024) [9]. They state that numerous studies highlight reductions in tailpipe emissions, safety improvements, and advancements in collection and dismantling procedures (Singh et al. 2021a; Hu 2022; Shui et al. 2024). Although these contributions offer significant operational insights, they mostly evaluate outcomes using limited metrics such as emission intensity or material recovery rates.

2.8 Performance of RVSFs

The facilities have strengthened supply-chain resilience by facilitating the recovery and reuse of valuable metals and components while reducing dependence on imported raw materials. A campaign for use of the authorized centers for scrap disposal is required to be done now, especially with the arisings of ELVs is on the increase. Vehicle Scrapping Policy is contributing to the development of a circular economy through systematic material recovery, environmentally sound disposal of hazardous waste and improved resource efficiency. Nevertheless, the overall scrappage volume remains considerably below the estimated stock of end-of-life vehicles in India, reflecting challenges such as low consumer participation, regional disparities and under-utilization of existing facilities. Continued policy support, enhanced consumer incentives and expansion of RVSF infrastructure will be essential to realize the full operational, environmental and economic benefits of the scrappage program (Vijayanta Ahuja & Shakti N Khanna 2019) [3].

2.9 Government policies towards circular economy

By early 2025, the policy ecosystem expanded further. The Ministry of Environment, Forest, and Climate Change finalized the Environment Protection (End-of-Life Vehicles) Rules, 2025, effective 1st April 2025 (Ministry of Environment, Forest and Climate Change 2025a) [10]. These rules formally establish Extended Producer Responsibility (EPR) for vehicles, meaning manufacturers (including importers) must ensure their vehicles are scrapped in an "environmentally sound manner" and can obtain EPR certificates by participating in the RVSF system. (Ministry of Environment, Forest and Climate Change 2025a) [10]. India now has a flagship circular-economy initiative for vehicles, through a combination of age-based retirement laws, automated testing, formal scrap facilities, and producer obligations, the policy explicitly aims to capture value in scrapped vehicles and promote recycling. As one government press note puts it, the scrappage policy will "reduce pollution from old and unfit vehicles in an environment-friendly manner through a scientific scrapping process." (Press Information Bureau, Government of India 2024a) [11]. It

even seeks to integrate informal dismantlers into the formal sector, treating them as partners in this new system. This framing – of phasing out the old to supply feedstock for reuse – reflects a broader policy-shift toward resource circularity in India's environmental governance. (Tasaki and Jaeger 2025) [12].

Despite its recycling-oriented rhetoric, the vehicle scrappage policy poses a paradox. Conventional-wisdom holds that recycling end-of-life vehicles conserves resources and reduces emissions. However, accelerating fleet turnover (i.e., retiring vehicles early) may undermine these goals (Singh et al.2021a) [13]. New vehicle production drives demand for metals, plastics, batteries, and the energy to make them. In effect, every scrapped car or bus is a double-edged sword, it supplies scrap material (e.g., steel) but also prompts the manufacture of a replacement vehicle with substantial embodied resource use (Sharma and Pandey 2020a) [14]. This can be called as a mirage that trade-off challenges the dominant assumption that increased recycling inherently equates to sustainability. There is also a view that even well-intentioned scrappage programs can yield only modest net carbon savings when manufacturing emissions are accounted for (James et al.2023a) [15]. However, this cannot be taken truly as many Indian manufacturers have surpassed the expectation in the use of renewable energy for production with huge capital investment since 2023.

In practice, the current policy may accelerate vehicle obsolescence. An owner deciding between costly repairs and a scrapping incentive may scrap a vehicle that could have otherwise lasted for years more. Over a period of time, this creates a self-reinforcing cycle of early disposal, the policy makes new purchases more attractive and lowers the bar for scrapping. (Malhotra 2023) [16]. This also can be countered with using a better product and the efficiency of the same pays for what is lost in early condemnation of the vehicle.

2.10 Summary of literature review

Molla A. H et al., (2022) [2] have discussed the circular economy factors under the themes of enablers and barriers for successful implementation of the circular economy. They have also classified the enablers and barriers as internal and external. Prominent enablers identified are economic viability, environmental degradation and sustainable development, technological development, resource efficiency, job creation, productivity and stability. The external enablers and drivers are global agenda and government policies. The internal barriers they have identified are limited technology, financial constraint, lack of resource, market barriers and risk aversion. The external barriers are lack of industrial support and lack of appropriate legal framework. Vijayanta Ahuja & Shakti N Khanna (2019) [3] have suggested to link portals for conditions of vehicles and ELV data to the VAHAN to enable disposal of vehicles both of ELV and on condition basis. Dr. Anil Kumar (2025) [6] has studied all sectors connected with circular economy and has come out with suggestions. The demand for electrical vehicles is on the increase which indicates the preference of the user to go for BEV and the awareness of him on the benefits to environment with green vehicles. He has mentioned of the employment opportunities due to implementation of circular economy. Shubhrajyotsna Aithal & P. S. Aithal (2023) [3] have studied multiple industries in the circular economy regime and of the opinion that recycling has helped the resources efficient use and thereby reduced cost for the user of the vehicle. They have also stated that there is lesser demand for the virgin materials due to circular economy. Dos Santos, J. E. A., & Gohr, C. F. (2026) [7] have studied on the resilience factors in the implementation of circular economy and have out with 14 factors which affect in the anticipation, coping and adaptation stages. He calls the adaptation stage as 'recovery'. The factors identified by him are quite useful for the implementation of circular economy in any sector. NITI Ayog (2026) [8] has come out with the procedure followed by the circular economy system and the role of CPCB

in the process of testing of vehicles to ensure upkeep of vehicles are maintained until the ELV. This can also be used for condition-based disposal of vehicle. Hence, the suggestion of Vijayanta Ahuja & Shakti N Khanna (2019) [3] to link VAHAN portal to other portals is essential to dispose vehicle on ELV and condition based when the vehicle deterioration has taken place. Mishra et al.2024) [9] has suggested for shifting to resource base dynamics instead of the present emissions reduction, fleet modernization, and recycling efficiency structure. The study aims to explore the enablers and barriers to the adoption of circular economy (CE) practices in micro, small and medium enterprises (MSMEs) and examine how these factors differ between developed and developing countries. They have identified the main constraint as availability of finance for implementation for the MSMEs while comparing developed countries and developing countries. Resource constraint has to be overcome by MSMEs for successful implementation of circular economy. The performance of the RVSF in India is under-utilization of resources. The main reason is the informal sector taking the business of disposal of vehicles. They have the advantage of stripping out sub-assemblies and directly selling to various manufactures and supply chain management. The valuation of the vehicle is much higher than the RVSF centers and payments made immediately by the smaller companies involved in the disposal of the vehicles. These informal sector companies have no wherewithal for efficient and environmentally friendly disposal. The government has to rethink and review the incentives to the owners of the ELVs for disposal of vehicle at authorized centers. Government policies on scrap and waste disposal have helped in setting up of the RVSF centers and these policies have helped disposal of vehicle efficiently and with the environment friendly action in handling oils, land fills and recovery of materials for recycling. The incentives to the owners of ELVs may require a relook as well as condition-based disposal also will be of use to maintain the goals of circular economy.

3.0 Methodology

The method is of descriptive analysis and a case study on the circular economy implemented in transportation sector of India. The stakeholders in the successful implementation are the government, the environmentalist, the manufacturers, units contributing for waste disposal, owners of vehicle and the society, which will ultimately contribute for the economic growth of the country. Hence, the secondary data available on the subject have been reviewed under the paragraph literature review. The circular economy practices that lead to improvement in various sectors have given factors that contribute for the successful implementation of the ELV disposal mechanism. In the summary salient points brought out in the literature review have been grouped for further discussion in paragraph 4 and conclusion arrived at in paragraph 5.

4.0 Discussion and findings.

The circular economy practiced in the Indian automotive sector, has helped to overcome partially the injurious effect to the environment, as still, informal sector is being used by the owner of vehicles for the ELV disposal. Full capacity utilization could not be achieved by RVSFs as seem from the vehicles that yet to be handed over for disposal to them. There are continuous arisings for ELV disposal, as seen from the vehicles manufactured and sold in the years of 2013 -2018 reaching the ELV. Condition based vehicle disposal also will be required for the benefits of circular economy to reach all the stakeholders and this will call for a review of the incentive system practiced now. One paper has stated there is need for adequate technical knowhow but has not spelt out, what exactly is the lacuna in the present technology. However, to overcome this problem, global practices have to be compared for the activities followed here. The

overall finding is that the Indian automotive industry is doing its best to implement circular economy and that they would improve with the learning curve, as only three years have passed since the introduction of RVSF units.

Finding can be summarized like this:

1. The arisings for disposal with ELVs do not fully comply with the law to engage authorized centers for disposal.
2. The incentives presently being enjoyed by owners of ELVs appears to use of informal sector for disposal, at the cost of environmental degradation.
3. Mandatory stipulations are not adequate for informal sector to be penalized for inefficient handling of hazardous waste.
4. Awareness has not spread among the users of ELVs on the benefits of handing over vehicles to RVSFs.
5. Manufacturers determined investment on renewal energy being used for production has not been publicized enough, to bring in discipline among vehicle users to go environmentally friendly to hand over ELVs to RVSFs.
6. Time for conducting a full-scale study on the present status of circular economy, as already 3 years have elapsed, and experience in these 3 years will enable to share the challenges by all the stakeholders and improve the system with corrective and preventive actions.

4.1 Conclusion

India is progressively adopting a sector-specific approach to the circular economy, with major initiatives spanning the automotive, construction, electronics, battery, plastics, textiles, agriculture, metals, packaging and municipal waste sectors. Among these, the automotive and transportation sector has emerged as a strategic priority due to its significant potential for resource recovery, emissions reduction and industrial sustainability. Through initiatives such as vehicle scrappage, battery recycling, remanufacturing, Extended Producer Responsibility and circular supply chains, the sector contributes to improved resource efficiency, reduced dependence on virgin raw materials and the achievement of national sustainability objectives. These developments demonstrate that the circular economy is becoming an integral component of India's transition towards sustainable industrial growth and a low-carbon economy. The arisings for ELV disposal will be on the increase as the production has increased over the years. The authorized centers have to be fully prepared and has to create an awareness on disposal through them and not through informal sectors. Government has to relook on its incentive policy which attracts more users to go in for authorized centers for disposal as well as for offering their vehicles on condition of the vehicles too. Campaign has to be organized for the user to hand over the ELV to only authorized center.

4.1 Recommendations:

1. Encourage the RVSF centers to improve their performance by comparing to global standards in the recovery of materials and with the learning curve obtained in the last two years.
2. Condition based condemnation of vehicle should be an added feature along with ELV and owner will have to be suitably rewarded for early condemnation of the vehicle.
3. Campaign for awareness to user of ELVs by agencies to dispose through authorized RVSF is an immediate requirement, to prevent hazardous leaks of waste oil, coolant, and battery acid into soil and water sources.

4. Study with primary data is necessary since the process of circular economy has come into effect with RVSF centers since 2022. The benefits of circular economy must be realized faster and should not turn out to be a myth.
5. Method for bringing the informal sector too in the fold of disposal of vehicles with instructions to dispose only in authorized centers. Alternatively, procedure to handle oil, battery made mandatory for informal sector too with penal actions for not following the norms.

4.2 Limitations:

The study has arrived at decisions based on secondary data. Primary data is not available in the government websites.

4.3 Summary of figures and tables used in the study:

Figure 1: Enablers for implementation of circular economy in India
Figure 2: Barriers to CE implementation
Figure 3: Resilience factors in circular economy
Table 1: Performance of RVSFs in India
Table 2: Vehicle sold, year-wise
Table 3: Incentives and benefits provided by agencies

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