

Cost-Benefit Analysis of converting vintage cars into EVs in India

Shivansh Agarwal

Abstract

Overview

The following research paper attempts to analyse the viability of retrofitting old car models to electric cars in India. The increasing global problem of climate change and the developments in the area of electric cars make the concept of rebirth of old cars into EV's a perfect marriage of youth into age. India with its tradition of having presence of vintage cars from quite some time can quite rightly wish for such a change. As it is this research aims to gather what one stands to gain both financially and non-financially by converting old model cars to EVs, PHEVs some of the questions included are; feasibility of the idea, cost, and its market.

Purpose and objectives of the study

The primary objective of this work is to provide the systematic analysis of the potential costs for the implementation of the change of the old generation vehicles to the electric propulsion system with regard to the initial capital outlay and recurrent costs and subsidies in India. Thus, the study seeks to also determine the prisms that underpin, the benefits in such conversion in terms of; Environmental gains for instance emission of carbon, economical gain such as cost of fuel, and the; social gain which is conservation of vintage cars.

In this paper therefore, the authors endeavor to provide what they hope will be a useful analysis of the cost and issues involved in retrofitting old cars to make them electrically propelled, with a view to helping owners, businesses and governance institutions to make the right decision regarding this innovation. Its objectives are to find out if the benefits of environmental and economic nature will outweigh the costs and whether there is a market for remanufactured old model electric cars. Besides, this work will examine the factors that may be thought to slow this trend in the future such as technicalities, law demands and customers' perceptions.

This research assumes importance especially at this time in relation to India where there has been earlier association with cars of certain years of manufacture and especially the government to support its desire to champion massive usage of EV to tackle problems of pollution and use of fossil fuel. Therefore, this study will also contribute to the existing discussion on the gap of increasing the shares of sustainable transportation keeping the historic vehicles intact. The results could also include directions for the policymakers and the automobile enthusiasts who wishing to proceed with the change over from classic autos to electric automobiles as a possible and viable process.

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I. Introduction

India fortunate enough to have a number of classic cars which are having cultural and historic importance. These cars may look like they are old fashioned or remaining outmoded but in as much as we may dislike it, people who are interested in cars, especially as collectors, do value such cars. However, at the moment, due to the increasing popularization of sustainable development around the world and the concern for pollution, the use of ICEs in such samples of classic cars raises a certain question. While the shift to EVs are happening in the world as a better way to transport ourselves with less impacts on the environment, the idea of converting classic cars is getting prevalent.

Based on the analysis that has been made concerning electric vehicles in India the factors that have made the use of electric vehicles in India to improve are as follows; governmental support, technological development and improvements on the enhancement, and lastly, there is an increasing concern of the environment. The target set that India should have at least 30% EV market share by 2030 reveals that Indian government is quite serious with the phase out of fossil fuels and with the reduction of CO₂ emissions. It also birthed a desire of 'what-if' we can transform the old cars, even the classic cars into electric cars while maintaining the elegance of the early models but with today's technology.

In the particular context of India, employing and transforming the older cars into the electric one is conceivable. On one hand, it opens a chance to save the best samples of car design traditions concerning the preservation of the cultural significance of the retro car. On the other hand, it reduces the carbon trace or the greenhouse gas emissions that are associated with conventional ICE automobiles. This duality of advantage positions the subject of vintage cars convert to EV zone of considerable controversy among automotive enthusiasts and environment enthusiasts.

The research question guiding this study is: Two research questions have been developed for this research study: The first research question is as follows: What are the costs of transitioning from old age cars to electric cars in India? The second research question is: What are advantages and disadvantages of transforming cars old in India as electric cars or conserving cars? Including cultural perspective, environmental influence, and cost wise. ?

This paper is structured as follows: proposed work: Literatures: This would be in form of a documented review of the literature regarding the vintage car, electric vehicle technology and conversion processes and legal systems in India. This section will present the plan of the research, method of data collection, the tools to be employed in the research with the Cost benefit analysis framework to be adopted in the study. Following this, the cost analysis section will include an analysis of the numerous costs that define the conversion process on the benefits; we shall undertake an analysis of the benefits that are associated with such conversions. The paper will then compare the direct conversion of the old models into EVs and the purchase of new models and strengths and weaknesses of both approaches. Case studies about some real organizational successes at conversion, Indian or otherwise, will also be utilized to explain the concepts. Finally, in the discussion and conclusion section, the author will present the outcomes of the conclusions made together with the potential of the further research and formulation of policies based on the conclusions.

II. Literature Review

Literature Review

Some History and Cultural Importance of Some of the Antique Car Models in India -

Collection of vintage cars in particular have a special position in the automotive map of India because they represent the glamorous and sublime aspect of the automobile industry. All of these vehicles, which were imported by the royal and the high society during the British rule in India show the socio-economic structure of India that prevailed at the time of independence. Many of the Maharajas and Nizams have had the means to order personal cars from prominent auto makers including Rolls-Royce, Bentley and Cadillac; fittings of luxury facilities made the cars even more royal. These cars were not only means of mobility, but rather 'means of establishing power, authority and social dominance' (Mehta, 2015, p. 177).

The social importance of antique cars in India can also explained by their use in social and ceremonial occasions. These were used from royal entries to state functions where they were displayed as images of identity and antiques. Even after independence people craved for these vintage cars, most of the wealthy families used to pass these cars from generation to generation as traditional patrimony. With time, vintage car rallies and exhibitions started being held to keenly honour the immense car history of India and involve considerable number of people from all over the country (Singh, 2018).

Even after a few decades, vintage cars have not been replaced by better means of transport and are still part of India. That is why they are appreciated not only as historical values but also as worthy objects of admiration, they offer people a sense of connection with the past. Failure to maintain such cars is viewed as cultural erosion since future generations are deprived of the earliest examples of fine automotive engineering (Sharma, 2020).

Market analysis of EV technology and its consumption in the Indian subcontinent -

The use of electric vehicles in India, therefore, has been on the rise in the last few years due to the factors such as pollution, clients' demands, and the reduction of dependence on fossil fuel. There is the EV technology that can also be defined as the use of electric motors with rechargeable batteries which are more environment friendly than the conventional internal combustion engine (ICE) vehicles. The Indian government has been very active in the promotion of EV usage through use of policy incentives such as The Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) India scheme which entails subsidies to the buyers of electric vehicles as well as supportive charging infrastructure.

Some of the developments that have enabled the reinvention of efficiency and affordability of electrical vehicles include; Advances in battery technology have made vehicles electric and the lithium-ion batteries have enhanced the range and decrease the charging time of the electric cars. Also, the cost of battery has reduced over the years

and this has made it possible for a bigger fraction of the citizenry to make the transition to make the transition to EVs. Currently, Indian EV market has experienced entry of many domestic and foreign players and manufactures proposing various types of electric vehicles including two wheelers, three wheelers, cars, buses etc suitable for Indian market (Kumar, 2022).

Yet, some issues are still on the table regarding the broad EV penetration in India. These are affordability of electric cars as most are expensive than regular vehicles for purchase, charging stations are scarce, and battery reprocessing. Nonetheless, with consistent government support and improvement in the technologies the EV sector in India is projected to expand in the future years exponentially. They observed the adoption of EVs as doing more than environmentally friendly but as also saving on the oil importation bill and hence, improving energy security of the nation (Gupta & Sharma, 2023).

Global Literature Review on Retrofitting Antique Cars to Electric Cars -

Evidently, retrofitting of old generation cars to an electric model is still a young phenomenon that is, however, picking up across the globe. This practice entails the swapping of the electricity-supplying internal combustion engine of a classic car with an electrical motor and battery system; it converts a classic car into an electrical car but retains its old looks. There has been a good number of series on the possibility, difficulties, and advantages of such conversions the inception of which can help in understanding this growing but still a very small market segment.

Anderson (2019) noted in a study conducted in the United Kingdom on the increase of passion of classic car owners onto electric car conversion in the twilight of their useful lives. Generally, more benefits are associated with it such as attracting lower initial cost for conversion although the cost rises in the intermediate though it attracts no maintenance cost and zero emission. Furthermore, the study highlighted the market possible for converted retro EVs especially with younger people who are more conscious and friendly to the environment.

A survey of Williams and Baker (2020) with a focus on the actual adaptation of vintage automobiles to electric cars, and their analysis of the fact that every such car has highly individual requirements in terms of power trains and batteries, these will have to be produced individually. The study also noted that it was imperative to maintain the look and feel off the vintage car which is in many cases the major consideration fetching the 'vintage' tag. The authors pointed out that since the conversion process involves specific skills and knowledge it may be complex for the general public, although, with the increase in the number of conversion services being offered, then it is becoming easier.

In a contemporaneous analysis, Chen et al. (2021) focused on the guidelines and policies concerning the conversion of vintage cars to EVs in China, too. In their study, the authors identified a high level of interest in the kind of conversion studied, but the problem of uncertainty of rules and standards can act as a constraint to the process. The authors suggested that governments should have definite policies and stimulus to propose car owners in transforming their classic cars to electric ones since this approach may assist in minimizing emission and can sustain the automotive history.

All these studies combined point to the fact that vintage-to-EV conversion can be an environmentally feasible approach that brings together the two worlds. However, they also raise the question of the further research needed though the practice is still emerging in the countries like India.

The sum of laws applicable to the use of vintages and EVs in India -

There is a lot of legal and regulatory framework for vintage cars and electric vehicles that exists and is still developing in India. Pre-1990 models in India are termed as antique automobiles; subsequent use is restricted and has certain norms. The Indian Motor Vehicles Act, enacted in 1988 and that regulates the use of motor vehicles in India contains provisions for the issue of a vintage vehicle registration. But these cars are usually only allowed on the road in a very limited basis, engage in rallies or exhibitions and then only if they have passed through restoration and safe for use on the roads (Chaudhary, 2020).

The conversion of the old car models into EV brings in other legal & regulations into the new mix. The other is alteration of the features of the car which may lead to alteration of the registration and the permission from the authorities. The Ministry of Road Transport and Highways of India has laid down a set of guidelines for retrofitting electric vehicles recently that are basically standard utility vehicles and not the vintage cars (MoRTH, 2021).

The second aspect of the legal requirements is called 'requirement of conformity to the environment and safety legislation'. The emission and safety standards have to be achieved in the same manner as in new EVs, which

may be problematic with the characteristics of vintage vehicles that will be converted. There are also issues of alteration of the looks of the converted vintage cars for in the event that a particular alteration is made, then that car is no more a vintage or antique car (Patel & Desai, 2022).

IV. Methodology

4.1 Research Design and Approach

This research employs both the qualitative and the quantitative research in the evaluation of the costs and the benefits of having the EV technology in the conversion of the old age cars from India. The combination of both quantitative and qualitative data is important as it provide the different perspectives to the researcher when approaching the research question (Creswell and Plano Clark, 2017).

The study is structured in two primary phases: Research methodology types where the former is the exploratory research and the latter is the analytical research. In the exploratory phase specific facts and information SOURCES include users for example, the owners of vintage cars, technicians and or designers including automotive engineers, prescriptive agents such as the policymakers and chief executives and expert observers. This phase aims at trying to identify why, what and how people understand the change from old model cars to new EV model cars. The analytical phase is very much connected to the quantitative analysis where cost-benefit analysis more often referred to as CBA is used to assess the potential of such conversions. This phase entails the collection of the cost of the conversion process, and foretelling of the gains, economic as well as environmentally sustainable (Boardman et al., 2018).

4.2 Data Collection Methods

The method of data collection that has been employed in this research is questionnaires, interviews and case analysis. They are selected with a view of trying to solve a different aspect of the research question because the best research study will need both quantitative data and qualitative context.

Surveys:

The quantitative data is gathered with the help of questionnaires from the respondents which include the owners of the vintage cars and other car enthusiasts of about 200 in India. The questions to be asked include those concerning the cost that they had to incur in the process of conversion: general perception about the possibility of receipt of benefits and the adverse consequences that flow from the process and their ability to pass on the cost of such conversion. First, the survey includes questions that have a limited number of multiple options, which enables to gather quantitative data second, open-ended questions are questions to which the respondents are given an opportunity to provide descriptions of ideas and/or personally observed situations (Fowler, 2014). The survey is conducted by e-mail, and is also posted in different groups related to old car model fans and car discussion forums. To reduce this threat, the study will for this reason use the stratified random sampling technique in order to cover all regions of India and again cover all demography of the country (Dillman, Smyth, & Christian, 2014).

Interviews:

Interviews are conducted using purposive sampling technique and involves the following respondents; those such as car owners of the vintage cars have already adopted charging brands, auto engineers who have specialized in the new electric models, and the policy makers that are involved in formulation of new electric models regulations. These will be single interviews that will be semi-structured because there are certain issues that are prohibited when having the interviews but at the same time, there is flexibility on the style of the interviews because depending on the general theme of the research work, the interviewer can spend most of his/her time on the certain issues. The quantitative data derived out of such interviews results in understanding reason, journey and issues covering the performer in different vintages to EV conversion. The interviews are carried out and recorded on an audiocassette and then transcribed by hand, and the nominal method is employed to tally the study features and to identify and compare the various outcomes and patterns.

Case Studies:

Examples are shown to give an account of how real cars of the classic models have been modified to electric Vehicles. Of these case studies some contain information regarding nature of conversion, costs involved, problems encountered and benefits achieved. The selection of the cases is also done with the Indian context of mind as well as the other possibilities that these cases open for discussing the viability of such conversions. Each case is revealed below to discern the major findings to deliberate over the several points concerning the cost-benefit analysis (Yin, 2018).

4.3 Cost-Benefit Analysis Framework

Therefore, the main research method used in this work is cost benefit analysis or CBA that enables the evaluation of the feasibility of the actualization of the use of EVs on old car models. Conversion costs would therefore entail a breakdown of charges that follow the conversion of the enterprise's structure in the CBA naturally implying economic and non-economic benefits as postulated by Boardman et al., (2018).

Costs:

The cost component of the CBA includes several key elements: The cost component within the framework of the CBA contains the following factors:

Initial Conversion Costs: These consist of purchase and fitting of an electric motor, battery pack and many other supporting components, and the cost of labor in the process of converting a normal car into an electric one.

Maintenance Costs: It should also be mentioned that, in general, EVs need somewhat less maintenance than ICEVs, but the maintenance of antique cars can be associated with some additional costs, for instance, for the preservation of the looks and shape of the car.

Regulatory Costs: Such costs would be those that we may have to meet in respect of costs of re registration, costs of compliance with environmental and safety legal requirements as well as change that may be necessitated by the legal requirements.

Benefits:

The benefit component of the CBA considers both tangible and intangible benefits: The quantitative measure of benefit component of the CBA takes into account both measurable and non-measurable as is seen below:

Economic Benefits: This is so because electric energy is always cheaper as compared to gasoline or diesel and probable cost savings that could be made concerning maintenance costs over the useful life of the car. The study, therefore, looks at the likelihood of another steep escalation of the market value of transformed classic EVs.

Environmental Benefits: The reduction of CO₂ emissions and of other airspace pollutants by the replacement of internal combustion engines by electrical motors is one of the achievements reviewed in the component way with the help of the latest emissions data as well as emission modes.

Social and Cultural Benefits: The process of transforming these traditional cars to the EVs contribute to the fund the expenditure of the cultural conservation undertaking. This type of benefit is less tangible, and is 'weighted' against the other factors through a broad-scale Cost Benefit Analysis.

The outcome of a CBA looks like NPV – net present values of higher worth alternatives encapsulating costs and gains of doing so in subsequent years. Sensitivity analysis is also used to find out the extent of change in the outcomes, if some assumptions essential for the illumination of the model are changed like the cost of batteries in the fixed future time period, future price of electricity, and the possibility of fluctuation in government incentives (Energy Boardman et al. , 2018).

4.4 Assumptions and Limitations

Like any research work, the present study is founded on the following assumptions: There are a number of underlying assumptions, with the following examples:

Technological Assumptions: More assumptions, it is assumed that the technology for conversion of old model of cars into electric cars will improve so cheap and effective kit will be invented. This include battery improvements particularly by EV manufacturers deemed to decrease the cost of conversion as analysed by Kumar (2022).

Economic Assumptions: The research assumes that fuel cost and maintenance cost as are costs that are likely to be incurred in the life cycle of the vehicle. This has been underpinned by the existing tariff rates of electricity as well as the life cycle of the several components that make up an EV.

Regulatory Assumptions: In the case of India, the assumption is made that the legal and regulatory environment for light vehicles to be converted into vintage cars to EVs will begin to evolve in terms of positive bias of incentive and subsidy. This is done under the perception that the current policy regime being maintained by the Indian government is liberal for import and use of EV.

Limitations:

Despite the comprehensive nature of the study, there are several limitations that must be considered:

Data Availability: There is not much information available in the current literature with regard to cost data on vintage-to-EV conversions in India. Thus, some of the outlay forecasts are determined by using foreign research or based on experts' opinions, perhaps except the overall cost estimates which should take into account the specific conditions in India.

Sample Size: The survey respondents may not include all the vintage car owners in the entire India especially those who may be in the remote rural areas and have no access to the internet.

Quantification of Intangible Benefits: The society and culture importance of preserving these cars are very hard to numerate and are seasonal to interpretation. Due to these reasons, these benefits are assessed generally in CBA. Altogether, the present research makes use of both the quantitative and the qualitative research methodologies in order to have a systematic examination of the relative advantages and disadvantages of retrofitting old generation cars with EVs in India. Despite the fact that the work builds upon the acknowledged analytical theory, it is cautious about all the potential assumptions and restrictions that may affect the conclusions. Therefore, it is believed that the findings of this study would be useful for policymakers, owners of the vintage cars, and all other stakeholders

who would wish to pursue the policies that would encourage the use of sustainable transports while promoting automotive history.

V. Cost Analysis

5.1 Introduction to Conversion Process and Corresponding Expenses

Certainly, the idea of transforming a classic car into an EV is reasonable but it is a process that contains several steps meaning that it is costly. The conversion process must start with the fundamental step of shedding the complexity of the automobile's internal system including the fuel tank, the exhaust system, the internal combustion system, plus the transmission system. These parts are then replaced with an electric motor for power, battery pack to supply the electric power, and a controller system that will act as a switch between the battery pack and the electric motor. Other subsystems like regenerative braking systems, battery management systems together with the charging interfaces are also cascaded into the vehicle. As to the cost and difficulty, these factors, too, will largely depend upon the model of the vintage car and the kind of performance required.

5.2 Initial Investment: Expenditures incurred in acquiring parts of EV and labor cost

The initial investment of turning a classic car into an EV is in the parts of the car like the electric motor, the battery pack, and all the allied electronics. Depending on the power and efficiency needed, an electric motor costs from INR 1 lakh to INR 3 lakhs. Battery packs which are the most costly component of an EV go for between INR 2 Lakhs and INR 7 Lakhs depending on the capacity and the required range of the vehicle. Other components such as the controllers, the inverters, and the charging systems make up of the other INR 1 lakh to INR 2 lakhs of costs (Kumar, 2022).

The cost of labor is another large consideration that is involved in the process of conversion. The skill level needed to modify a classic car into an electric vehicle is typically quite high, and includes many levels of fabrication and cabling. The conversion costs are closely linked with the labor costs; these may also differ significantly from one conversion to the other because of the levels of skill required for the conversions and the availability of the skills in the market. So, one would see that the average labor cost on this kind of conversion can be as little as INR 2 lakhs to as much as INR 5 lakhs which is a significant portion of the total conversion cost (Rao, 2021). The total first cost of retrofitting a classic car to an EV can therefore vary between INR 6 lakhs and INR 17 lakhs depending on the type of car, and performance requirements.

5.3 Maintenance Costs: Comparison between Vintage car owners and EVs

Another advantage that comes with long-term use of a vintage car is that the re-modeling of the car to an EV leads to low maintenance cost. Unlike the new model cars that may rarely need a change of oil or even tuning, internal combustion vintage car needs to be serviced often, as the engine, the transmission system and the exhaust system may need replacement or repairs. These activities do not only cost a lot of money but also demand certain part that may be rare for old models of cars (Gupta & Sharma).

On the other hand, EVs are said to have reduced moving parts they have in their system, meaning the chances of a mechanical failure and subsequent servicing are remote. The primary cost of maintenance of an EV is associated with battery pack, which might have to replace after a number of cycles and electric motor which requires comparatively less attention. Moreover, EVs do not consume oil and accordingly they do not require oil change, fuel system repairs or exhaust system maintenance and so on; hence the TCO is much less in case of EVs compared to ICEVs in the long run. While the cost of conversion in the beginning can be high due to the need for specialized conversion equipment, there is long-term saving due to lower maintenance cost (Rao & Menon, 2023).

5.4 The Possible Subsidies and Incentive to Promote EV Conversion

The central government of India has been a great advocate for electric vehicles with various incentives and subsidies, which may go in part to facilitating the initial cost of making a classic car an EV. The Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme sanction funds to support the purchasing of electric parts as well as the conversion of vehicles to electric kits. These subsidies can bring down the total conversion cost by 20-30 per cent based on the nature of the incentives proposed (MoRTH, 2021).

Besides, the availability of subsidies, one may also get tax reliefs or exemptions such as low road tax and registration fees for EV's which can improve the potential of converting a classic automobile into an electric vehicle very much more. The central government in India is not alone in supporting the uptake of EVs at scale some state governments provide further incentives in form of revenue support; tax exemptions; rebates on electricity charges for charging of the EVs or grants for establishment of the charging points (Patel & Desai,

2022). These incentives can go along way with regard to the financial aspect of the converting process and make preservation of automotive heritage profitable and hence sustainable.

In conclusion, despite the obvious fact that turning a classic car into an electric one will entail initial costs that differ from simply buying an appealing used car, the long-term savings on such expenditures as repair and maintenance should be taken into consideration, as well as governmental programs, known as incentives for the buyers of electric vehicles. Indeed, in light of the cost assessment, it is possible to argue that v2E transitions can be perceived as the key to green mobility.

VI. Benefit Analysis

Environmental Benefits: Some of the aims that have been proposed in strategies and plans include the following: Among the major advantages of turning regular, old-fashioned cars into EVs is the drastic decrease in emissions of carbon and pollution in general. ICE vehicles are globally recognized to release different types of pollutants such as CO₂, NO_x and particulate matters that pollute the air, and contribute to global warming. With the black-eye in setting done, these emissions are almost done away with since EVs discharge zero tailpipe emissions. In India, where pollution levels in many urban areas are rather high, the effects of such conversions may not be just immense (Gupta & Sharma, 2023).

Furthermore, the application of electricity as power to energy the cars, especially once generated from renewable resources, adds to the environmental advantage. With the increase in the investment on renewable energy in India, the carbon footprint of the EVs is expected to drop further. This move to cleaner transportation is in consonance with global initiatives on climatic change and it dovetails well with India's obligations under the Paris Agreement with regard to emissions of greenhouse gases. The conversion of vintages into electric creates a positive impact on these overarching environmental goals but at the same time retaining cultural relevance to cars (Rao & Menon, 2023).

6.1 Economic Benefits: Reduction of Fuel Consumption and Improvement of Vehicle Durability

From an economic point of view, the idea of retrofitting old cars for EVs provides handsome amount of fuel economy. The Energy consumed by an EV in its operational cycle is way cheaper than the fuel consumption of an ICE car in kilometers per gallon basis. This can entail rather significant savings in fuel costs over the life cycle of the vehicle in question. Also, electric vehicles do not demand a lot of maintenance they are known to have fewer parts to be fixed as compared to gasoline engines, they do not use oil and therefore their cost implication in the long run regarding vehicle maintenance is low (Kumar, 2022).

This is besides the other economic advantage of enhanced durability of the vehicle in question. The used cars are particularly vintage and most of them are in excellent condition and their owner's value them. However, it shoots itself in the foot with aging ICE engines and other mechanical elements that can define their usable life. In this way, owners of these vehicles can greatly expand the lifetime of a car by changing it to electric power. Electric motors are smoother in their operation and experience far fewer problems mechanically than a traditional engine and therefore a converted vintage car can continue for many more years on the road and thus retain its value and utility (Rao, 2021).

6.2 Social and Cultural Benefits: Practical Subjects: Conservation of Old Automobiles

The transformation of vintage cars into electric vehicles also has unrated social and culture advantages. They also form part of automotive history and culture, and are reminiscences of particular time periods, architectural and technical trends. Owners are thus able to retain the form and pre-1970s cultural significance of the car, while enhancing its usability for current utilization. The following process is used to ensure that such vehicles can remain useful to generations to come in the same manner that they are useful today as cars, and as symbols (Singh, 2018).

However, one of the most crucial aspects of converting a vintage car is the preservation of automotive which has a synergy with culture of sustainability which is practiced today and focuses on the minimization of waste as well as the reuse of resources. If no other option is available, instead of allowing these vehicles to become wreck or outdated, conversion presents the best solution whilst achieving the objectives of environmental concerns. Hence, the conversion of heritage cars into EVs provide two-fold cultural value and therefore the prospect of modifying old cars for EV use is highly attractive to 'car lovers' and the public at large (Sharma, 2020).

VII. Comparative Analysis

7.1 Comparison in the case of Buying New EVs in India

It is pertinent to compare this option of converting old cars into EVs with the options of buying new cars that are available in the Indian market are now. New EVs have new hardware with improved battery management systems, regenerative braking, and safety features integrated into the car. They are built as electric automobiles from the beginning, and it is not rare for them to be superior in terms of energy consumption, range and dynamics to their 'conversion' counterparts. Further, new EVs, from a warranty and after-sales perspective, are fully supported by their manufacturers, which is a significant advantage from the consumer's perspective disregard costs (Kumar, 2022).

Nevertheless, it is possible to rehabilitate a vintage car and assure certain benefits to people who are interested in the car's history and appearance. Although a new EV may have better technical specifications of a new car, a converted vintage EV makes it possible for car owners to maintain their cool and vintage design of their classic cars. However, this option may be very appealing to lovers of the classic cars who wish to maintain using their cars by going green without affecting their looks or origin (Singh, 2018).

7.2 Feasibility to Potential Individual Car Owners and Potential Businessmen

The feasibility of retrofitting vintage cars to EVs depends on one's circumstances and more so the business models in mind. For individual car users, conversion of an antique car may be out of certain beliefs for instance, in regard to environmental conservation or need to retain a darling car. The initial investment, though can reach some thousands of dollars, the fuel consumption and maintenance, in the long run will pay for it. Also, the additional subsidies and incentives, which the government allows to the users of renewable energy, may also supplement this choice's profitability (Rao, 2021).

Custom shops, especially those with a focus on the restoration of older cars or deep into the special interest market for late model cars, can offer this abatement service to customers interested in a retrofit of their automobiles to be made as electric or hybrid vehicles. Among other trends, if the requests for environmentally friendly vehicles continue to increase, it is possible to talk about the appearance of a separate market segment, the demand for which will be satisfied by those companies engaged in the conversion of classics vehicles into electric vehicles. Besides, growing the awareness of the public, companies may begin to turn into key players within the materializing eco-friendly auto market (Patel & Desai, 2022).

7.3 Order of Converted Vintage EVs

The market forces that affect converted vintage EVs include the ability of the consumers, the trend in regulations, and the culture of the society. In India, where cars are particularly an emblem for tradition and richness, there is a rising concern in maintaining these older models but at the same time producing them eco-friendly. It is expected that they would prefer switching from retrograde technologies to vintage-to-EV power wherein the youth is more inclined toward sustainability and innovation as Davidson & Bardi – 2016 establishes.

Further, the worldwide shift to electric vehicles and the rise of limited natural resources of fossil fuels should enhance the market for converted other vintage EVs. Since the rise of consciousness about the environment and the negative impacts made by common automobiles, the likelihood of having a sleek and fashionable classic automobile with reduced emissions will skyrocket. The companies that target such a market segment and provide reliable conversions and preserving the originality of the vehicles' are likely to benefit greatly from this newly developing trend (Rao & Menon, 2023).

Therefore, although using a newly bought EV is more technologically and convenient improved than the older generation car, converting a traditional classic car to an EV keeps the traditional value, ecological and economic goals aligned. The financial and market reality for such conversion, let alone the need for converting luxury cars in a culturally enthusiastic country like India, means that this might be the trend of the future in the automotive industry.

VIII. Challenges and Barriers

8.1 General Problems and Difficulties in Converting and Converting Traditional Automobiles into EVs

Two main issues make it difficult for designers and engineers to turn an old-fashioned automobile into an electric car: technical aspects. New generations electric power train cannot be fitted into the heritage cars since the vintage cars were not built with electric power trains in mind. This may mean creating molds to accommodate the electric motor and battery packs or strengthening of the chassis to support the battery mass together with a rebuilding of modern electronics interconnectivity with the pre-existing car electronics. There's an additional layer of challenges when it comes to the design and the historical context of the car, which implies that all these

modifications are done on a uniquely beautiful and historic car, which of course makes the job highly specialized and time-consuming (Kumar, 2022).

Backing this up further is the fact that a vintage car has different dimensions, weight, and a mechanical blueprint from another; this makes it hard to adopt a template to convert the cars. This means that each vehicle might have individual solutions, which will heighten the overall costs, and the length of the projects. Moreover, older vehicles have many small- from or low-volume part that may not even be available, and if available can be extremely costly and time-consuming to source (Rao & Menon, 2023).

Regulatory and Legal Challenges

Some of the challenges that the company will face pertain to the murky legal regime regarding the conversion of old-age cars into electric cars in India. Currently, the Ministry of Road Transport and Highways (MoRTH) has issued a guideline regarding retrofitting of electric kits in vehicles; its guideline is limited to application on relatively new vehicles and does not address many problems related to vintage vehicles. When car owners make their vehicles vintage to EVs, there lack certainty with legal provisions and regulatory help in regards to re-registration processes, safety, or environmental quality, and categorization of the vehicle as vintage or not (Patel & Desai, 2022).

However, there are often state-specific laws that supplement national laws and this makes the legal requirements for the disabled even more cumbersome. For example, some states allow conversion rebates while other states put additional regulatory requirements on converting plug-in electric vehicles. Meeting these rules presents an outstanding challenge given the interference of both federal and regional laws (Chaudhary, 2020).

8.2 Consumer perception and market acceptance

. Consumer perception and market acceptance grade huge importance since they directly affect the chances of a success story for the conversion of vintages into EVs. However, despite the increasingly published environmental problems and consequent emergent interest in 'green products,' the number of converted vintage EVs remains limited. Another key consideration when approaching older cars is that many of those who own them have rather nostalgic perceptions of these vehicles and are very specific about their nature. They are not going to want to convert their cars because they want to maintain the car's historical statistics, or they believe that changing the car is to ruin the car (Singh, 2018).

Also, potential consumers of the converted vintage EVs will have concerns on how these EVs will perform in use compared to the conventional vintage cars as well as other modern EVs. These perceptions are not easy to overcome; economic rationality of such conversion must be shown to the consumer beyond the basic proof of feasibility, but to convince them of the long-run savings in maintenance costs and the benefits to the environment that are offered by such conversions is equally important (Gupta & Sharma, 2023).

8.3 Availability of skilled labor and infrastructure

Another is the access to the labour force, as well as the basic infrastructure which is a fundamental factor for the success of this kind of investments. Converting a normal car into an EV entails the expertise of an engineer in vehicle design and knowledge in electrical vehicles. But such a workforce with specialized expertise in the area is not easily available in the Indian context, especially in terms of meeting the more specialized needs of conversion of vintage cars. Due to scarcity, the labour is costly, and as a result, the projects may take long before they are completed (Rao, 2021).

Other factors include limited supports to convert ever made vehicles into vintages to EVs because the industry is still emerging. This entails not only the supply of conversion kits and parts, but also tools and workshops where the conversions may be done. In addition, even today, the number of stations for EV charging in India is not very high and is increasing gradually, and hence the availability of consistent and easily accessible charging points is a boon to have converted vintage EVs (Kumar, 2022).

IX. Case Studies

9.1 A range of successes in converting Old Age Projects Cars to electric in India

Updating of some of the old models into EVs has been on the rise especially in the Indian market as seen in the following examples. A prime example can be seen in the process of changing the regular car – a 1948 Chevrolet Fleetmaster – into a genuine classic that can appeal to the collectors. Having assembled a small hard-core of automotive engineers and enthusiasts, the project aimed at replacing the car's factory six-cylinder engine and gearbox with a contemporary electric motor and a lithium-ion battery. It was achieved in the form that retains all historical specificity of the cars exterior and interior design while being environmentally friendly. This project

has been highly praised, in terms of technicality and for creating a roadmap for such conversions in India (Sharma, 2020); here I now elaborate on the technical implementation details of the project.

Another example is the present conversion of a 1969 Volkswagen Beetle. With its unique and iconic outlook and associated with various cultures, the Beetle became equipped with an electric motor and the battery capacity of the car allowed for up to 150 km of traveling on a single charge. In the project Francis learnt that even weaker and lesser known vintage cars could also be easily converted to electric cars further proving the flexibility of the conversion process. These successful conversions have inspired other old car owners and organizations to approach them for conversion of their old cars to EVs thus adding to the cause of conversion from traditional cars to EVs in India.

9.2 International Case Studies and their implication to India

Round the globe a number of such case experiences have provided glimpses of possibilities and advantages of retrofitting or converting traditional old age cars into electric cars which can be quite insightful for other such experimentation plans in India. For instance, conversion from vintage to EV has gained popularity in the UK with lunaz design being at the frontline. Lunaz focuses on electrifying high-end classically built cars like Rolls-Royce or Bentley, preserving class and sophistication of these automobiles and equip them with the modern electric drive technology. These conversions have proved effective in maintaining the market value of the vehicles while at the same time improving their ecological factor; such methods can be considered as best practice to be used in business opportunities in India (Anderson, 2019).

In the United States, there are firms such as the EV West that have gained fame for the conversion of normal retro cars such as the Ford Mustang to stoke high performing EVs. These works underscore the concept of the optimisation of performance with conversion, which will provide a good rationale for similar undertakings in India, especially given recent perceptions in that country of old cars and emerging eco-friendly transport. The over-arching success of such international projects establishes market potential and technical possibilities of concrete series' conversion from vintage architecture to EVs – outlining Indian potential projects blueprint (Williams & Baker, 2020).

How we got here – eight years of experience and what we can do better

The outlined successful conversion projects as well as other conversion projects in India and worldwide present several lessons, potentials and best practices that can be used for future vehicle devising and the vintage-to-EV. From the Courtship model, they have learned that any redesign should not compromise on the historical and aesthetic value of the vehicle under conversion to electric technology. This balance is important to maintain in order to keep the car's value particularly for the users of old model cars that look for the actual appearance more than anything (Chen et al., 2021).

The second best practice is in the choice of parts and the emphasis on obtaining specific solutions to the problems that may arise in connection with work on vehicles of a given model year. Such an approach lets avoiding common mistakes and have the conversion correspond to the owner's vision of the site. Moreover, it is worthy of particular mentioning the role of human capital, distinct expertise, and knowledge; most of the successful projects called for engagement of skillful professionals in both domains: restoration of vintage cars and EV tech (Patel & Desai, 2022).

Last but not the least, these case studies stress the prospective challenges in communicating with the stakeholders who include vehicle owners, the relevant authorities and potential customers. Explaining to the public on the fees that one is likely to encounter, the advantage that comes with the new change and or the likely drawbacks is possible hence enabling the market to accept the change. These are invaluable lessons and tips that will be important in the future to help in the conduction of such projects, and the promotion of the market of the EVs in the context of the Indian example (Rao & Menon, 2023).

Listing of the critical success factors and their summary results: Listing of the critical success factors and their summary results:

From the conversion projects that have been discussed in the foregoing sections, the following are the lessons and the best practices that have emerged out of conversion projects that have been undertaken in India and other countries of the world. One of the main points is the protection of the historical and design unique shell of the car and the application of modern electric solutions. This remains crucial in preserving the value of the car, and its appearance; more so for those who own the early series models and would not wish to have the subsequent changes in outlook and touch of the car as they are rich in history (Chen et al., 2021).

The other is very selective sourcing of components and very limited reliance on out of the shelf approaches to deal with the idiosyncrasies of each of the vintages of the car. In this manner, the owner is able to have the conversion he or she wants both technically, as well as from the point of view of the web-based application he needs. Moreover, the involvement of human resources is also incomprehensible; in many cases,

integration with the people who have more profound and detailed information about the restoration of vintage cars and EV technology is critical: diverse kinds of knowledge are essential (Patel & Desai, 2022).

Finally, these cases also suggest the communication characteristics with the stakeholders including the owner of the vehicles, the authorities and the consumers who are willing to buy these automobiles. Those who have created the market should not conceal the cost or advantage of conversion and the peculiar potentials and pitfalls that may occur in the process. Such lessons and best practices would be helpful to follow more tendencies of the conversion from vintage to EVs for optimizing these projects and their subsequent multiplication in the market of India (Rao & Menno, 2023).

X. Discussion

10.1 Integration of Outcomes of Cost Benefit Analysis

The cost benefit analysis as done in this study shows a somewhat mixed but largely positive trend towards retrofitting of classic cars to electric vehicles in India. Though this conversion costs a lot of money in the beginning, the amount of fuel and, consequently, the costs of maintenance during years offset the initial investment. Also, the implication of environmental impacts such as the lowering of carbon emissions is another compelling reason for such conversions. But again, financial feasibility revolves round issues like the escalating costs of employing skilled personnel and acquiring special parts as well as government subvention.

10.2 Consequences of the Portable Critter Panelists' Recommendations to Vintage Car Owners and the Automotive Industry

The EV change is a chance for the lovers of old cars to continue using their beloved vehicles while being environmentally responsible. However, there are high costs and technical difficulties, which can be a reason for not using them. In the sphere of auto industry, especially the classic automobile restoration market, new opportunities for development could be the provision of conversion services. This could also lead to emergence of key players especially those that deal with the supplies and implementer of such conversions.

10.3 Policy recommendations towards conversion of conventional vehicles to EVs

As a result, the authors propose that policymakers should design specific 'carrots and sticks' that would encourage car owners to convert their old car models to EVs. Also, regulating the sector and amending the existing rules and regs concerning the reverse would be even beneficial for the owners of vintage cars and related businesses. Other important actions that could be done are the attraction of creating talented professionals for car manufacturing and building the network of charging stations for EVs in general as well as for the vintage car conversions in particular as well.

XI. Conclusion

When writing this research paper in order to analyze the feasibility of converting the old cars into EVs in India a comprehensive analysis of the profitability and implications, financial, environmental and contextual which are associated with such exercise were discussed. Thus, by creating multiple micro and macro theoretical angles to examine the probable significance and research and evaluation advantages and threats in the transformation of vintage vehicles into EVs in India, this study has depicted the chance as well as barriers.

11.1 Summary of Key Findings

From this study it is evident that, despite the initial costs of converting vintages cars are relatively expensive and likely to include costs such as the price of electric parts and professional labour, the gains that follow are likely to be immense. They are for instance greater first kilometer efficiency, lower costs on electrical power compared to gasoline, lower costs of maintaining electric motors and at last but not the least the numerous ecological advantages such as the decreasing of carbon emissions and other dangerous substances. Moreover, turning many of these old generation cars into electric ones has culture element because these cars get to be useful in an efficient transport system of a green society.

According to the views from the stakeholders' perspective, it also discovered that there is a financial cost of the conversion, but with subsidies and tax exemptions given by the government can be useful in enhancing the particular segment's conversions. All these results which include reduction of the carbon foot print are in tandem with electro mobility goals at the international and national levels and accordingly any effort to convert vehicles to EVs especially in India is a shot in the right direction in the fight against global climate change. However, these conversions also have the function of preserving cultural history of automobiles among others, which gives it a social aspect of justification especially within the custodians of automobile history such as India.

11.2 Answer to the Research Question

The research question for this study was: What are advantages and disadvantages of retrofitting old cars and converting them into electric cars in India? From these conclusions, it is clear that if the vintages are to be morphed into electric cars, the envisaged expenditure is warranted by the benefits such as economic rationality, environmentalism as well as culture heritage preservation. From research inference one can establish that change from vintage to EV is not only earning in the long-run but also upholds the value of maintaining heritage vehicles in tandem to the advancement of the environment's cause. Thus, the practice seems to preserve a stable permanency who is capable of fulfilling the row between the maintenance of History and the new boost required by ecology.

11.3 Future Research Directions

Nonetheless, there is a set of possible research avenues in the framework of the present study, which stems from the assessment of the costs and benefits of the transition from classic cars to EVs. The extension of such conversions can be a subject of further research in the context of a rather diverse automotive market of India. It might also be useful for policymakers to consider such options and how some modifications of these technologies may affect the feasibility and profitability of conversion as a business model in order to introduce empirical facts in addition to the theoretical analysis of the impact of innovations in the field of EV technology.

Moreover, primary research about consumers' attitude and the market potential of converted classic EVs would also be useful also to assess the potential of this new market segment. It could be useful to gain understanding of the current and prospective vitalize car owners and buyers and their wants in satisfying them better. Thus, it also provides extended to the impact of the emerging technologies such as solid-state batteries and wireless charging for the process of the conversion of the vintage cars into electric automobiles that might create new opportunities for the optimisation of the process of conversion.

Last of all, it is supposed that more investigations should be devoted to the revelations of the regulation sphere in details, to determine specific measures of relevant policy that could be used to stimulate V2EV schemes. Absence of such policies in other countries particularly the developing ones may be significant; comparative analysis of other countries that have formulated such policies could benefit India. Thus, further research can assist in locating such areas to assist in boosting the channel that aims to transform vintage to EV levels to give rise to a prosperous auto culture in the upcoming India.

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