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A STUDY ON THE FACTORS INFLUENCING THE ADOPTION OF E-RICKSHAWS AMONG TRADITIONAL RICKSHAW PULLERS/FUEL-POWERED RICKSHAWS OPERATORS IN PUNJAB

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Abstract

The transition from conventional fuel-powered rickshaws to electric rickshaws (e-rickshaws) in India carries substantial economic and environmental benefits, as indicated by a comprehensive literature review. Financial incentives play a pivotal role in incentivizing this shift, with studies affirming that tax benefits and reduced operating costs promote the adoption of electric vehicles (EVs). Moreover, the lower maintenance requirements of e-rickshaws not only ensure longevity and functionality but also prevent expensive repairs, enhance safety, and improve overall performance. Environmental considerations emerge as a significant driver for consumer intention to embrace EVs, particularly e-rickshaws, reflecting a growing consciousness towards sustainability. Social dynamics also exert considerable influence, with cultural factors, subjective norms, and social acceptance playing crucial roles in shaping consumer behavior. Furthermore, the alignment between consumer self-perception and product perception, along with the symbolic value attached to EVs, underscores the importance of attitude in fostering adoption. Overall, this synthesis underscores the multifaceted impact of transitioning to e-rickshaws in India, emphasizing the interplay of financial, environmental, social, and attitudinal factors in driving this transformative shift towards sustainable urban transportation systems.

1. INTRODUCTION

In recent years country like India has evolved as a country of growth and development. India has fast paced towards economic development and urbanization. The urbanization has taken place in all sectors and industry so far. If we particularly talk about automobile industry, we have seen massive evolution. The history of the automobile industry in India can be traced back to the early 20th century. Since automobile industry is one of the largest industries in India. It is one of the key drivers of the Indian economy but at the same time also the main cause of increasing air pollution in the country. Since, liberalization of the automobile sector in 1991 and allowing of 100% FDI through automatic route, Indian automobile sector has come a long way. This chapter highlights the importance of e-rikshaws in India.

1.1 History of Automobile Industry in India:

The total production of vehicles was 23040066 in 2021-2022, this now has increased to 25931867 in 2022-2023. This has recorded as an absolute growth 2891801 of vehicles as compared to 2021-2022. If we calculate it in percentage terms, the total growth recorded was 12.54% (approx.) during the period from 2021-2022 to 2022-2023.

Figure 1: Automobile Production Trends

Automobile Production Trends

(In Numbers)

Category	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Passenger Vehicles	4,020,267	4,028,471	3,424,564	30,62,280	36,50,698	45,78,639
Commercial Vehicles	895,448	1,112,405	756,725	6,24,939	8,05,527	10,35,626
Three Wheelers	1022,181	1,268,833	1,132,982	6,14,613	7,58,669	8,55,696
Two Wheelers	23,154,838	24,499,777	21,032,927	18,349,941	1,78,21,111	1,94,59,009
Quadricycles	1,713	5,388	6,095	3,836	4,061	2,897
Grand Total	**2,90,94,447**	**3,09,14,874**	**2,63,53,293**	**2,26,55,609**	**2,30,40,066**	**2,59,31,867**

Source: Society of Indian Automobile Manufacturers

The Three-Wheelers production also took a jump from 758669 in 2021-2022 to 855696 in 2022-2023, recording an absolute growth of 97027. In percentage terms the total growth recorded was 12.80% (approx.) during the period from 2021-2022 to 2022-2023. Several international automotive companies have tried to enter the Indian market and has been successful as well, leading to increased competition and technological advancements.

The automobile industry has experienced significant growth with the launch of various models, including compact cars, SUVs, and luxury vehicles. The 2018-2019 saw further expansion and innovation, with a focus on electric and hybrid vehicles, The Indian government also introduced at the same time the policies and incentives to promote electric and eco-friendly vehicles, encouraging manufacturers to invest in cleaner technologies.

But from the above chart provided by the Society of Indian Automobile Manufacturers we can have a clear overview of how there was drop in the production of three-vehicles in the year 2020-2021 when compared to year 2019-2020 this probably due to the impact of post covid-19. Also, the total production is just 22655609 for the year 2020-2021 when compared to the year 2019-2020 which is whooping figure of 26353293.

1.2 Concerns as per World Health Organisation

The industry has also faced challenges such as environmental concerns, congestion, and changing consumer preferences. According to World Health Organisation (WHO), many Indian cities are exceeding the air pollution levels that are set in the guidelines by the organisation for health safety purposes. As exposure to air pollution can lead to respiratory and cardiovascular diseases, which is estimated to be a cause for millions of early deaths and the health cost of air pollution has been assessed at a significant percentage of the GDP of the world and that of India. According to the data released by WHO, air pollution was responsible for 3.7 million deaths of people aged under 60 in 2012.

In recent years, air pollution in India as acquired critical dimensions. The levels of PM2.5 and PM 10 as well as concentration of dangerous carcinogenic substances such as Sulphur Dioxide (SO_2) and Nitrogen Dioxide (NO_2) have reached alarming proportions in most Indian cities, putting people at additional risk of respiratory diseases and other health problems. As per WHO, Delhi tops the list of most polluted cities. Among the world's 20 most polluted cities in the world, 13 are in India. India is in the group of countries that have the highest levels of

particulate matter (PM) levels. Most of the vehicles in India, run mainly run on fossil fuels such as petrol and diesel. These vehicles have internal combustion engines that emit pollutants such as carbon monoxide (CO), Nitrogen Oxides (NOx), Particulate Matter (PM), Hydrocarbons (HC), and Volatile Organic Compounds (VOCs) during the combustion process.

The growing demand for automobiles has led to increased emissions from the transportation sector. India has a substantial number of older vehicles that may not comply with modern emission standards, these vehicles tend to emit higher levels of pollutants compared to newer, more fuel-efficient models.

1.3 Reasons of air pollution in India

India faces a multifaceted challenge in its transportation landscape. The absence of an effective, efficient, and well-networked public transport system contributes to the proliferation of private vehicles, exacerbating the issue of immense population and a consequent surge in the number of vehicles. Moreover, the lack of a fast railway network, particularly one operating on cleaner technologies, hampers sustainable mobility across the country. Major cities grapple with the absence of fast and cost-efficient intra-city railway networks, further aggravating congestion and pollution.

The sheer volume of vehicles on the road is compounded by faulty traffic management systems and frequent traffic jams. Additionally, the deplorable state of road conditions poses a significant challenge to smooth and safe transportation. The use of adulterated fuels, coupled with automobiles equipped with faulty engines or suboptimal maintenance, compounds environmental concerns. The prevalence of older vehicles, often relying on inferior technology, further contributes to pollution. A critical issue is the lack of stringent enforcement of various standards and norms aimed at checking and curbing pollution from vehicles, emphasizing the need for comprehensive reforms in the transportation sector to address these pressing challenges.

1.4 Standard norms set by Government

The emission standards/norms for automobiles for the first time were introduced in India in 1991 for petrol and 1992 for diesel vehicles. In 2002, the Indian government accepted the report submitted by the Mashelkar committee. The committee formed a Euro based road map for the roll out of the emissions norms in India. It recommended a phased implementation of future norms with the regulations being implemented in major cities first and extended to the rest of the country after a few years. Based on the recommendations of the committee, the National Auto Fuel policy was announced officially in 2003. The policy also created guidelines for auto fuels, reduction of pollution from older vehicles and R&D for air quality data creation and health administration.

In order to address the issue of air pollution the government had to take serious action in terms of formulation of policy and implementation of the same. Adoption of Electric vehicles (EVs) for road transport contributes to a wide range of goals. These include- better air quality, reduced noise pollution, enhanced energy security and in combination with a low carbon power generation mix, reduced greenhouse gas emissions. The Government of India has plans to promote eco-friendly vehicles that is those based on CNG and electric vehicles. The government has formulated a scheme for Faster Adoption and Manufacturing of Electric and Hybrid Vehicles in India (FAME), under the National Electric Mobility Mission 2020.

Moreover, the Government of India plans for a scheme of scrapping old vehicles and help owners of older vehicles, which are more polluting, with a subsidy to upgrade to new vehicles which use cleaner fuel. To enable this paradigm shift in road transport, Government of India with the help of the said above policy framed in 2020 is able to vision for facilitating EV sales of 6-7 million units by 2020. As a part of the plan, FAME has also been able to rapidly fuel the objective of promoting the electric vehicles. In 2019 FEMA II phase was launched with much bigger budget to enable demand and infrastructure creation to support the mobility transformation.

Additionally, the phased Manufacturing Program has been launched to promote indigenous manufacturing of EVs and EV components and provide a thrust to EV manufacturing in India. It is estimated that the success of FAME II coupled with other policy initiatives. The state

policies were estimated to result in EV sales with a penetration of 30% of private cars, 70% of commercial cars, 40% of buses and 80% of two-wheelers and three-wheelers by 2030.

1.5 Air pollution in Punjab

Many popular cities and in India are affected by air pollution and a state like Punjab is not an exception. There are many factors that result to air pollution in the state of Punjab but the number of vehicles on roads of Punjab has been drastically increasing post covid due to relaxation in the state governments policy to avail loans for personal transport like cars and bikes resulting in more air pollution challenge. Also, the number of traditional rikshaw users in quite large in number compared to E-Rikshaw users even after the government has introduced the Punjab Electric Vehicle Policy (PEVP) in 2022 in order to promote the use of Electric Rikshaws. The traditional cycle rikshaws and auto-rikshaws in Punjab typically run on internal combustion engines, which burn fossil fuels like petrol or diesel. In Punjab rikshaws are commonly used for short distance travel as well, especially in congested markets and narrow lanes where larger vehicles may face difficulty. The high density of rikshaws in these areas can contribute to localized air pollution.

Even some of the rikshaws in use belong to an older vehicle fleet that may not comply with modern emission standards. Older vehicles tend to emit more higher levels of pollutants, leading to increased air pollution. The collective emissions from rikshaws, along with other vehicular sources, contribute to the overall air quality in Punjab.

The below charts show the monthly average air quality data for CAAQMS (Continuous Ambient Air Quality Monitoring System) for the year 2021 for city:

In the table number 1 below we can see the data pertaining to the Ludhiana city. The table shows the level of pollution in this particular city. It is monthly average data till year 2021. The table contains the detailed information on monthly basis with respect to various harmful gas emissions. Here, for the purposes of air quality regulations, particles are characterized by their diameter. When breathed into the lungs, particles having a diameter of 10 microns or smaller (known as PM10) can have a negative impact on health. Particles with a diameter of no more than 2.5 microns are referred to as fine particulate matter (PM2.5). On the other hand, the colourless, reactive air pollutant Sulphur Dioxide (SO_2) has a pungent smell. Plant life, animal health, and human health may all be at risk from this gas. Fossil fuel burning is the primary source of Sulphur Dioxide emissions.

Also, three oxygen atoms make up the gas molecule known as ozone (O_3). Good up high, terrible down low is ozone. We are mostly protected from the sun's UV rays by the ozone layer, which is located high in the upper atmosphere. On the other hand, breathing in ground-level ozone pollution poses a major health risk. The two gases that are commonly referred to as "nitrogen oxides" (NO_x) are nitrogen dioxide (NO_2), a reddish-brown gas with a strong odour, and nitric oxide (NO), a colourless, odourless gas. Nitrogen dioxide is created when nitric oxide combines with oxygen or ozone in the atmosphere. Pure gas inhalation is quickly lethal. Nitrogen trioxide (NO_3), nitrous oxide (N_2O), N_2O_4, and N_2O_5 are further forms of nitrogen oxides. A strong greenhouse gas that depletes the ozone layer is nitrous oxide.

The central nervous system is toxically affected by acute exposure to benzene; however, myelotoxic, potentially chromosome-damaging, and leukemogenic effects of benzene must be taken into account when assessing the chronic effects. The duration needed to manifest the toxicity of chlorine benzene suggests a significant variation in personal susceptibility. Also, Ammonia (NH_3) is a poisonous gas that can burn and irritate the eyes, mouth, throat, and skin. The route, dosage, and length of exposure all affect how severe the health impacts are. The gas carbon monoxide (CO) has no taste, smell, or colour. Because it binds to haemoglobin in the blood, it can be dangerous if inhaled because it lowers the blood's capacity to carry oxygen. The brain, heart, and other organs may be harmed as a result of the body's inability to use oxygen appropriately.

A) Ludhiana

Table 1: Level of pollution in Ludhiana

Monthly Average Data -Year 2021									
S.NO	MONTHS	PM_{10}	$PM_{2.5}$	SO_2	CO	Ozone	NO_x	NH_3	Benzene
		µg/m3	µg/m3	µg/m3	mg/m3	µg/m3	µg/m3	µg/m3	µg/m3
1	JANUARY	112.25	51.45	9.29	0.66	16.65	44.59	21.56	1.19
2	FEBRUARY	113.39	50.95	9.87	0.92	14.98	51.62	26.82	1.25
3	MARCH	114.74	55.15	9.78	0.50	21.03	64.24	20.65	1.03
4	APRIL	94.55	44.54	9.52	0.46	23.40	63.16	18.03	1.03
5	MAY	122.94	51.60	10.59	0.43	27.81	44.38	19.17	0.97
6	JUNE	100.18	46.56	9.06	0.42	27.96	35.22	17.18	0.85
7	JULY	88.64	41.22	5.83	0.63	18.00	29.52	10.83	0.83
8	AUGUST	75.18	34.73	7.04	0.72	18.40	30.60	14.59	0.91
9	SEPTEMBER	65.23	30.11	8.44	0.74	18.63	22.77	9.77	0.96
10	OCTOBER	117.90	55.40	7.17	0.88	24.57	39.50	15.76	1.02
11	NOVEMBER	209.66	102.96	13.92	1.54	20.69	62.16	23.69	1.36
12	DECEMBER	178.02	89.15	22.81	1.59	19.20	58.95	35.76	1.16

Source: *Punjab Pollution Control Board (Ludhiana)*

Almost half of the vehicular emissions in Punjab are contributed by 5 cities- Ludhiana, Jalandhar, Amritsar, Patiala and Bathinda. Additionally, there is a large inter-state vehicular movement in Mohali being a part of tri-city. These cities are collectively referred as "Target Cities" under the policy framed by the government. The most emitting vehicle segments in these cities are buses, taxis, LCVs, Three-wheelers and Two-wheelers. EV adoption in these segments would maximize reduction in vehicular emissions. Government of Punjab recognizes that catalyse adoption in these segments would require incentives towards making EVs cost-competitive and development of adequate charging infrastructure.

B) Jalandhar

Table 2: Level of pollution in Jalandhar

Monthly Average Data -Year 2021									
S.NO	MONTHS	PM_{10}	$PM_{2.5}$	SO_2	CO	Ozone	NO_x	NH_3	Benzene
		µg/m3	µg/m3	µg/m3	mg/m3	µg/m3	µg/m3	µg/m3	µg/m3
1	JANUARY	110.93	54.25	23.82	0.56	19.48	28.66	19.90	1.71
2	FEBRUARY	125.05	55.78	7.00	0.66	15.08	18.80	12.24	1.73
3	MARCH	95.97	45.41	8.42	0.74	22.89	35.65	20.19	1.81
4	APRIL	93.97	40.78	7.36	0.60	17.76	29.52	18.86	1.73
5	MAY	107.64	50.38	7.06	0.59	20.54	33.26	10.15	1.65
6	JUNE	104.62	44.52	12.46	0.60	25.07	32.18	8.77	1.30
7	JULY	92.31	39.38	8.96	0.62	34.09	37.36	17.89	1.87
8	AUGUST	71.52	32.89	9.17	0.78	35.86	22.43	19.22	1.88
9	SEPTEMBER	61.08	31.21	9.26	0.78	39.38	20.12	18.83	1.51
10	OCTOBER	100.15	58.69	8.19	0.97	47.70	30.98	12.00	2.04
11	NOVEMBER	178.84	103.21	12.33	1.84	46.04	72.69	45.73	2.80
12	DECEMBER	146.41	83.73	17.72	2.00	45.30	46.42	35.80	2.80

Source: *Punjab Pollution Control Board (Jalandhar)*

To encourage the adoption of EVs in the state of Punjab, the government policy here focuses on a combination of fiscal and non-fiscal incentives for electric two-wheelers, three-wheelers segments and supporting the electrification of public/shared transport and goods carrier. The above table 2 pertains to the air pollution levels in the city of Jalandhar with the same contents as specified in explanation of table number 1.

C) Amritsar

Table 3: Level of pollution in Amritsar

Monthly Average Data -Year 2021									
S.NO	MONTHS	PM_{10}	$PM_{2.5}$	SO_2	CO	Ozone	NO_x	NH_3	Benzene
		µg/m3	µg/m3	µg/m3	mg/m3	µg/m3	µg/m3	µg/m3	µg/m3
1	JANUARY	104.41	52.07	8.67	0.62	14.46	36.27	32.36	1.84
2	FEBRUARY	109.09	63.06	11.55	0.74	14.78	44.05	28.91	1.39
3	MARCH	86.80	36.77	14.42	0.81	21.10	25.39	24.98	1.43
4	APRIL	87.22	45.02	16.93	0.71	40.44	37.06	24.99	1.12
5	MAY	113.46	44.22	11.57	0.67	39.96	20.13	23.23	1.41
6	JUNE	116.38	52.32	13.66	0.70	35.67	17.97	20.64	1.58
7	JULY	73.24	37.42	14.63	0.63	20.03	27.10	26.30	1.91
8	AUGUST	84.42	42.22	16.73	0.64	24.15	33.06	27.57	1.28
9	SEPTEMBER	63.40	31.68	17.65	0.57	21.26	26.00	13.98	1.26
10	OCTOBER	102.28	41.47	15.96	0.64	28.81	27.19	20.45	1.13
11	NOVEMBER	180.93	97.32	14.48	0.77	28.71	53.47	27.05	1.18
12	DECEMBER	162.82	75.79	12.05	0.51	10.67	28.18	14.88	1.19

Source: *Punjab Pollution Control Board (Amritsar)*

Here, also this table number 3 detects the level of air pollution in the city of Amritsar. More than 3/4th (76%) of new vehicle registrations in the state comprises of Two-wheelers (motorcycles, mopeds, and scooters) during the period 2013-2019. The policy aims to increase the share of electric two-wheelers significantly to reach 25% of the new sales over the policy period. In addition to incentives there is a purchase incentive of INR 3,000/- per kWh of batter capacity provided per vehicle, subject to maximum incentive of INR 10,000/- per vehicle to the first 50,000 registered owners of electric two-wheelers. The maximum total incentive will be INR 50 Crore (Approx.).

In case of E-Rikshaw and E-Carts the number of e-rikshaw sales during the period FY 2014-2021 was 2548. However, this number seems less when compared to the visibility of e-rikshaws in the state. This may be because manty of these vehicles may not be registered. E-Rikshaws provide an excellent value proposition for last mile connectivity and have also emerged as a livelihood opportunity. The policy aims to support the use of e-rikshaws that are safe and driven in compliance with regulations.

The FAME II phase of the scheme, has promised purchase incentive of INR 3,000/- per kWh of battery capacity shall be provided per vehicle, subject to maximum incentive of INR 15,000/- per vehicle to the first 10,000 registered owners of e-rikshaw. The total incentive will be INR 15 Crore (Approx.). The purchase incentive on e-rikshaw will be available for individual purchasers only, and for one e-rikshaw per individual.

1.6 Future prospects

Overall, we can understand how important this innovative shift from traditional to e-rikshaw is necessary for reducing the air pollution level in Punjab. Therefore, stringent and drastic measures are required immediately like ban on inferior technologies used in automobiles/engines like diesel etc, superior and environment friendly technology should be used in automobile production, clean and good quality fuels like CNG should be used, fast and cost-effective inter-city railway network example METRO (MRTS) should be established covering a large area of cities, phasing out of old vehicles and also there must be stringent enforcement of various standards/norms for checking/curbing pollution. By doing so we will surely be able to overcome the issue of air pollution in the upcoming future years not just in the state of Punjab but India as whole.

2. LITERATURE REVIEW

This chapter particularly emphasis on the e-rikshaw concept and the various studies carried out to bring out the importance of the use of electric rikshaws. Here in this particular chapter, we focus on the challenges and obstacles faced for implementing the use of electric rikshaws in India and also, how these challenges are delt. This chapter gives us the overview of the various reasons for air pollution and how can we bring it down to a substantial level with use of the new innovative electric mode of road transport.

2.1 Natural Resources

As we know that we are surrounded by nature and it is our prime responsibility to safe guard our mother earth in every way possible. But due to the rapid growth of automobile industry our biodiversity is affected adversely due to high level of air pollution. The impact of rikshaw generated air-pollution on resources, particularly air quality, can have several consequences was found in one of the papers studied (Kumar *et al*., 2019).

It showcased in detail how there were emissions of toxic substances like particulate matter (PM), nitrogen oxides (NOx), and volatile organic compounds (VOCs) from the use of traditional rikshaws which work on fossil fuels. These components highly contribute to poor air quality. This also has adverse effects on human health, leading various respiratory diseases and other health issues. The paper also talks about how not only humans but also plants and animals suffer from severe levels of poor air quality. This can harm our vegetation and disrupt ecosystems at large.

2.2 Climate concerns

Climate is one of the significant factors that is highly impacted by concerns such as air pollution and a country like India has been facing the issue of global warming and drastic climatic changes due to the same. As per the study in one of the research papers by (Khanna *et al.,* 2021), it was stated that the rikshaws, particularly those with internal combustion engines which are rely on fossil fuels, contribute to high levels of air pollution, and this, can have huge impact on the climatic changes. The carbon dioxide (CO2) is termed one of the major greenhouse gases (GHG). Increased component of CO2 concentrations in the atmosphere contribute to the enhanced greenhouse effect, trapping more heat and leading to global warming.

Table 4: CO2 emissions by various vehicles

Sl. No.	Vehicles	Specific CO_2 emission (gm/passenger-km)
1.	Auto-rickshaw (LPG)	23.556
2.	Auto-rickshaw (Diesel)	21.51
3.	Mechanized Van-rickshaw (Diesel)	4.46 – 11.38
4.	E-rickshaw	19.129

Source: Central Pollution Control Board

Some rickshaws may also tend to emit methane, which is another potent greenhouse gas. The production of methane in the air is one of the warning signs over a period of time. Also, the traditional rikshaws are capable to emit particulate matter (PM) which can have both direct and indirect effects on climate. Soot, which is a dark particle, can settle on snow and ice surfaces, which can ultimately reduce their reflectivity. This will in turn contribute to the localized warming and it will accelerate the melting of ice caps and glaciers (Bagul *et al*.,2021).

Aerosols released by rikshaws can also influence cloud formation and properties. The emissions from rikshaws also contribute to the ozone layer depletion. So, the author here has stressed on making a dynamic shift towards the use of e-rikshaw or those powered by renewable energy sources, which can in future help to mitigate the climate impact associated with the traditional rikshaws.

2.3 Innovation: A dynamic shift

In case of country like India we see that majority of people have to run their livelihood below poverty lines. This is because of huge population but less skilled labours that ultimately results in unemployment. When people tend to be unemployed, they go for seeking jobs that earn day to day income to run their homes. A majority of people tend to own rikshaws and start running the errands to earn income. Such people at large are unaware about the government schemes which are introduced to avail e-rikshaws. Such people only tend to be depended on the traditional rikshaws (Singh *et al.,* 2021).

In one of the types of research papers it is clearly mentioned about bringing a dynamic shift from fuel-based rickshaws to e-rikshaws. Here, the authors key focus is on the technological shift. The objective is to convert the traditional rikshaws into electric rikshaws (e-rikshaws). This process is never easy tough (Singh *et al*., 2021). As it involves integrating electric propulsion systems while considering factors like battery technology, charging infrastructure, and overall efficiency.

It is very important to replace the internal combustion engine with an electric motor. Brushless DC (BLDC) motors are one of the most common components of e-rikshaws because they are efficient and reliable. Necessary, power electronics, such as controllers and inverters should be made available to manage and control the flow of electricity from the battery to the electric motor (Singh *et al.,* 2021).

2.4 Factors influencing the decisions for switching to E-Rikshaws

In the recent studies that were conducted we have seen that the initial cost associated with the electric rikshaw is slightly higher when compared to traditional rikshaws. Although they are economical the traditional rikshaw pullers may not have sufficient funds to purchase the same. Also, in the study by (Ling *et al*., 2021) it was found that there is lack of awareness among the traditional rikshaw pullers about the e-rikshaws. This is usually result of being illiterate as it makes them difficult for them to understand about the latest technology and innovations associated with it. Many of the researches have also focused on the area of charging infrastructure.

This is mainly because e-rikshaws predominantly function of battery and in order to charge the battery we need proper charging stations. And, we are also aware that the infrastructure development in India is not at par when we compare it with other technologically developed countries. This adds up to be one of the significant barriers for the rickshaws pullers to switch to the e-rikshaws. Then in one of the studies by Mannchen (2023) it was found that e-rikshaw can only travel a certain distance with the single use of electric charging.

If the e-rikshaw runs out of power and if there is no nearby charging station it can create a serious problem. Hence, the traditional rikshaw pullers doesn't consider it as a good option for commute purposes. Also, there are government policies implemented to promote the use of electric rikshaws but there is no solid offering of financial assistance from the government's side for the traditional rikshaw pullers to switch to e-rikshaws. The e-rikshaws are the result of innovation and hence their maintenance is a must. After, a certain period of time the motor of e-rikshaws should be regularly checked and serviced so that they can run for a longer period of time. This can be sometimes cumbersome to the traditional rikshaw pullers. The e-rikshaw drivers need specialised knowledge about how to use it and also related to various spare parts. Whereas the traditional rikshaws are simple to use and hence do not require much knowledge and care.

Making the switch to e-rickshaws might necessitate some basic training on battery care and charging techniques. For drivers with little technical expertise or access to training programs, this can be a hurdle. Compared to traditional rickshaws, e-rickshaws need less physical effort, which lessens fatigue and enhances the health and wellbeing of drivers. Those who are physically limited or elderly drivers may find this especially helpful.

In the study conducted by **Singh (2020)** the rate at which e-rickshaws are adopted might be influenced by public view of them as dependable, practical, and eco-friendly. Additionally, drivers' businesses may be impacted by passenger preferences for affordability, safety, and comfort. The popularity of e-rickshaws can be influenced by the availability of other modes of transportation and the state of the roads. In economies with lesser incomes, buying costs and finance availability may have a greater influence. Compared to rural areas, urban areas with heavy traffic and pollution issues can benefit more from e-rickshaws.

The smooth operation of e-rickshaws depends on having access to a charging infrastructure that is both economical and dependable. Drivers' schedules can be thrown off and their earning potential diminished by limited charging alternatives. The operational efficiency of e-rickshaws

can be greatly impacted by the batteries' performance and range. Driver productivity is impacted by the need for more frequent charging of batteries with short lifespans or rapid degradation. Government initiatives that provide subsidies for the purchase of e-rickshaws, tax breaks, and designated lanes can greatly incentivize drivers to make the move. On the other hand, stringent laws or a lack of support may prevent adoption.

In the research study by Bhattacharya (2019) it was found that particularly in crowded urban areas, e-rickshaws contribute to cleaner air and a quieter environment because they emit no pollutants and make very little noise. This enhances public health and is consistent with sustainability goals. Compared to rural areas, urban areas with heavy traffic and pollution issues can benefit more from e-rickshaws. In economies with lesser incomes, buying costs and finance availability may have a greater influence.

With little access to formal finance and stable income, rikshaw pullers make their living in informal marketplaces. Even with possible long-term benefits, the initial expense of an e-rickshaw can be seen as a substantial financial risk. Lack of experience with the technology and perhaps worries about battery life or maintenance can increase scepticism and hinder acceptance. Many people may have only known rickshaw pulling as their primary source of income for many years, which fosters a feeling of routine and familiarity. Even with the apparent benefits, switching to e-rickshaws may require picking up new skills, getting used to new work schedules, and figuring out new charging infrastructure. This may set off resistance to change and a dread of the unknown.

Within the rikshaw pulling community, peers' opinions and experiences can have an impact on the decision to adopt e-rickshaws. It may discourage others from switching if early adopters run into problems or have bad experiences. On the other hand, encouraging word-of-mouth and social support can promote adoption widely. Pulling a traditional rikshaw frequently requires physical effort and depends on various elements, such as the weather and traffic.

As per the research scholar Prakash (2018) with their electric motors and possibly longer range, e-rickshaws might provide a feeling of more independence and control over working hours and pay. This might encourage some people to make the decisions to embrace e-rickshaws may be influenced by the idea that they are cutting edge, eco-friendly, and may even elevate their social standing. Possessing an e-rickshaw can be viewed as a step toward advancement and upward mobility, which encourages people to get past their initial doubts. transition.

Policymakers and other stakeholders can foster a more positive atmosphere that encourages rikshaw pullers to welcome the switch to e-rickshaws by recognizing and addressing the psychological aspects at play. This will benefit the rikshaw pullers' livelihoods, the environment, and society at large. Additionally, the traditional rikshaw pullers are also very stubborn and are reluctant to change. Because they have been using the traditional rikshaws from a very long period of time and switching to e-rikshaws will be really hard task for them. It will also take them a lot of time to adjust to the latest technology. They would need certain training as well to be well equipped with the various functions of it. All in all, there are many factors that impact the decisions of traditional rikshaw pullers to switch to e-rikshaws.

E-rickshaws offer economic and environmental benefits in developing countries. They are energy-efficient, less polluting, and have the potential to reduce fuel consumption for passenger transportation, leading to economic gains. Despite challenges like conflicts with other vehicle types and decreasing driver incomes due to passenger load division, e-rickshaws are seen as a promising alternative in public transportation due to their efficiency and environmental advantages. The transition to electric vehicles, including e-rickshaws, is encouraged in developing countries as it can lead to improved public health, reduced traffic congestion, and decreased reliance on imported fossil fuels, offering substantial financial rewards in the long run.

Research conducted by (Khurana *et al*., 2019) indicates that financial incentives are a significant factor in encouraging the substitution of conventional vehicles with electric vehicles (EVs). The switch to electric mobility, especially e-rickshaws, is advantageous economically and environmentally in developing nations since it has fewer running expenses. Empirical evidence suggests that financial incentives such as reduced operating expenses and income tax benefits can promote the uptake of battery electric vehicles (BEVs) and hybrid electric vehicles (HEVs).

The lower energy consumption and power tariff of EVs result in reduced running costs, compensating for the higher initial investment in EVs. Moreover, the total cost of ownership for EVs is lower than that of traditional vehicles, making them financially attractive in the long run.

Consumers with longer driving ranges benefit more from EV adoption, emphasizing the importance of economic incentives in influencing consumer choices towards sustainable transportation options like EVs.

The longevity and optimum functioning of e-rickshaws depend on proper maintenance, which also has financial advantages by averting future expensive repairs and replacements. Since major repairs can be expensive and time-consuming, regular maintenance helps identify and solve possible concerns early on, saving time and money in the long term. By inspecting tires, brakes, and other components, maintenance also guarantees safety by averting collisions and safeguarding the wellbeing of passengers. Regular maintenance and tune-ups also boost the e-rickshaws' overall performance, making them faster, more powerful, and more dependable. E-rickshaws can last longer with proper maintenance, which lowers the need for pricey replacements and results in long-term cost savings. In order to properly combine repairs and maintenance, a proactive strategy is advised.

This include keeping an eye out for wear and damage on critical components, investing in high-quality spare parts to ensure optimal performance and prevent serious malfunctions, routine cleaning to prevent contamination and identify issues early, and inspecting spare parts on a regular basis to prevent breakdowns. Owners of e-rickshaws can guarantee the smooth, economical, and efficient operation of their vehicles for a considerable amount of time by meticulously adopting these procedures for maintenance.

In order to maximize the economic benefits of e-rickshaws and integrate them into the transportation system, government policies are essential. Governments may encourage the use of e-rickshaws by putting supportive policies in place, which will promote equitable and long-term economic growth. Important things to think about while incorporating government policy are as follows:

a) **Gender-inclusive policies:** Developing fair policies that empower women and offer safe connection alternatives through e-rickshaws requires acknowledging the gendered character of travel patterns and infrastructure requirements.

b) **Equitable transitions and social inclusion:** Social inclusion should be a priority for investments in e-mobility, especially in post-COVID recovery plans. This will help to guarantee that policies assist households and drivers alike while fostering inclusive growth.

c) **Opportunities:** The development of the electric vehicle ecosystem creates jobs, emphasizing the necessity of all-encompassing skill development initiatives to assist the labour force engaged in e-rickshaw ventures.

d) **Laws and safety:** To guarantee e-rickshaw safety standards, governments can alter current motor vehicle acts to provide more suitable laws. These amendments can include quality checks, driver testing, and fare regulations that safeguard both drivers and passengers.

e) **Infrastructure development:** In order to properly accommodate e-rickshaws, infrastructure must change. This entails setting up appropriate charging stations in various locations, educating auto mechanics on difficulties unique to e-rickshaws, and making sure that the road infrastructure supports their safe operation.

f) **Local production:** Encourage local production of batteries for e-rickshaws to strengthen local economies, cut expenses, and establish a long-lasting supply chain nationally.

There are many initiatives that are proposed by central as well as state government in order to promote e-rikshaws. There are many incentives also provided by the government or the traditional rikshaw pullers to convert to e-rikshaw. There are also training programs provided for rikshaw drivers on the operation and maintenance of e-rikshaws. This will indeed help the rikshaw drivers to make proper use of them and take care of the new technology (Jain, 2020).

One of the research papers has also suggested to make use of supportive services established by the governments for maintenance and repairs. There can be focus made on forming partnerships with local service centres familiar with vehicle technology (Dangi & Vohra, 2020).

Short-distance transportation can be made more sustainable and environmentally friendly by switching from traditional rickshaws to e-rickshaws, which have major environmental benefits. The introduction of e-rickshaws addresses a number of important environmental issues, such as:

a) **Minimizing carbon footprint:** Since e-rickshaws run entirely on electricity and employ cutting-edge batteries from Emiko, they have zero tailpipe emissions. By doing away with the usage of fossil fuels, this helps to reduce air pollution and enhances the quality of the air in crowded cities.

b) **Reduction of noise pollution:** Because of their electric propulsion system, e-rickshaws run silently, which lowers noise pollution levels in urban areas. In addition to improving passenger comfort, this noise reduction makes the city a more tranquil place for everyone to live.

c) **Enhanced energy efficiency:** When compared to traditional rickshaws, e-rickshaws use a substantially larger percentage of the battery's energy to power the vehicle. Longer driving range between charges and lower energy consumption are the results of this increased energy efficiency.

d) **Encouraging Sustainable Urban Mobility:** For short trips, e-rickshaws offer an affordable, eco-friendly substitute for polluting modes of transportation. They support India's attempts to develop smart cities with sustainable transportation options and are a crucial part of urban sustainable mobility.

In order to maximize the environmental benefits of e-rickshaws and encourage their adoption, government laws are essential. Governments may promote the switch from traditional rickshaws to e-rickshaws by putting supportive laws in place, which will result in a greener future for everybody.

As per the study conducted by (Bockarjova *et al*., 2014) states that when it comes to electric vehicles (EVs), especially e-rickshaws, consumer adoption intentions are heavily influenced by environmental concerns. Research has repeatedly demonstrated that those who care deeply about the environment are more likely to purchase electric vehicles (EVs), highlighting the significance of environmental advantages as an adoption incentive. The convergence between environmental preservation and EV adoption aspirations is highlighted by the identification of pro-environmental consumers as likely EV adopters. The adoption of electric vehicles (EVs) is driven by the benefits to the environment, according to research, with findings indicating that these benefits favourably affect consumer decisions towards sustainable transportation options such as e-rickshaws. One of the most important steps in lowering environmental risks and advancing sustainable urban mobility is the switch to electric vehicles (EVs), including e-rickshaws.

Also, in the study by (Schuitema *et al*., 2013) it was observed that governments have realized how important it is to help this transition by enacting legislation, offering incentives, and launching policy initiatives that hasten the move to electric transportation. E-rickshaws have benefited greatly from this official backing. E-rickshaws are an environmentally sustainable mode of short-distance transportation; this is demonstrated by their lower carbon emissions, less noise pollution, increased energy efficiency, and overall contribution to a greener future. With nations like India working to develop smart cities with environmentally friendly transportation, e-rickshaw adoption has the potential to revolutionize urban mobility and successfully address urgent environmental issues.

As battery-powered e-rickshaws become more widely used, the electric vehicle (EV) market is predicted to develop significantly. These vehicles provide consumers with an economical and practical alternative to traditional rickshaws, requiring less maintenance and costing less to buy. In conclusion, incorporating environmental considerations into the switch from conventional to electric rickshaws not only solves environmental issues but also opens the door for more environmentally friendly and sustainable urban transportation in the future.

The switch from conventional to electric rickshaws has major positive social effects and adds to a more equitable and sustainable urban transportation system. Key findings from the search results are as follows:

a) **Community-centric travel:** Because of their small size and agility, rickshaws—including e-rickshaws—perform well in community-centric travel situations because they can deliver door-to-door services that larger vehicles are unable to. This localized strategy facilitates a more effective transportation system and lessens the need for large-scale infrastructure improvements.

b) **Reducing traffic congestion:** By manoeuvring through congested streets with efficiency, rickshaws contribute significantly to the reduction of traffic congestion. This results in improved traffic flow and a reduction in emissions from idle automobiles. This makes the urban environment more sustainable.

c) **Empowering immigrant and homeless workers:** By incorporating them into the rickshaw workforce, legislators are putting up creative ideas to empower immigrant and homeless people. This program promotes social inclusion, female emancipation, and cultural variety in urban transportation in addition to creating work possibilities.

d) **Environmental and social impact:** By providing last-mile connectivity and zero-emission transportation options that support healthy lifestyles, rickshaw drivers are the unsung heroes of the battle against climate change. Their fuel efficiency, eco-friendliness, and advantages for economic empowerment make them indispensable for sustainable urban mobility.

e) **Government support:** Government initiatives that encourage environmentally friendly transportation options have a major impact on the expansion of e-rickshaws. Encouraging the use of e-rickshaws and developing a more ecologically friendly public transportation system require strong government assistance.

In addition to addressing environmental issues, the switch from traditional to electric rickshaws encourages social inclusion, economic empowerment, and cultural diversity in urban transportation networks, paving the way for a more sustainable and inclusive future for all.

As per (Chen *et al*., 2014) research paper social considerations are important in determining whether or not electric vehicles (EVs), such as e-rickshaws, are adopted. Research elucidates the ways in which social pressures, peer pressure, subjective norms, and cultural factors influence people's decisions to use electric vehicles. Studies show that people look to friends, family, and social networks for approval when deciding whether or not to adopt electric vehicles (EVs), highlighting the significance of social acceptability and approval in influencing consumer behaviour. People's actions within their social networks have a significant impact on the adoption of EVs, highlighting the significance of social dynamics in shaping decisions about sustainable mobility.

In addition, a number of factors have been found to have an impact on rickshaw operators' readiness to switch to battery-operated vehicles, such as social influences and public opinion of electric three-wheeled rickshaws in Indian cities like Delhi. The adoption of e-rickshaws and other electric vehicles is influenced by social factors, which emphasizes the importance of taking social impacts into account while advocating for sustainable transportation options.

The transformation from traditional rickshaws to e-rickshaws reflects a move towards sustainable and contemporary transportation solutions and raises issues of empowerment and self-image. Key findings from the given search results are as follows:

a) **E-rickshaws are a symbol of empowerment**: It is a challenge to gender stereotypes, especially with regard to the status of women in public transit. They signify a change in the direction of empowerment and inclusivity, providing chances for people to question conventional positions and beliefs.

b) **Environmental sustainability:** In order to improve the environmental friendliness of paratransit services, the Government of India approved e-rickshaws in 2015. This action highlighted the e-rickshaws' contribution to sustainable urban mobility and the reduction of carbon emissions.

c) **Convenience and sustainability:** The introduction of e-rickshaws has brought about a sustainable, eco-friendly, and convenient method of transportation that has had a tremendous impact on urban mobility. This change is a turning point in urban mobility and highlights how crucial it is to adopt cutting-edge, environmentally friendly transportation options in order to create a more sustainable future.

The use of e-rickshaws not only denotes a move toward more ecologically friendly modes of transportation but also a change in the way people view themselves, their level of empowerment, and the advancement of sustainable urban mobility.

The shift from traditional rickshaws to e-rickshaws involves a number of aspects pertaining to customer perception, social standing, and self-image, all of which are significant variables in determining the adoption of electric vehicles (EVs), such as e-rickshaws. Alignment between self-image and product perception has a major impact on consumer behaviour when it comes to EV adoption. When a consumer's self-perception and the product—such as e-rickshaws—are consistent, adoption attitudes can be positively impacted. Furthermore, people frequently give their cars a great symbolic value; EVs, such as e-rickshaws, are a mark of high social prestige. This EV symbolism can influence consumer choices, especially for people who prioritize social status and look to their mode of transportation for a way to express who they are as per the study conducted by Breakwell (1993).

The use of e-rickshaws also represents a change in the direction of empowerment, dispelling stereotypes, and questioning conventional roles in the transportation industry. In addition to their positive effects on the environment, e-rickshaws promote inclusivity and a sense of empowerment in urban travel. This change is indicative of a larger social movement in favour of environmentally friendly, socially responsible, and self-image-enhancing sustainable transportation solutions. The transition to e-rickshaws is a big step toward adopting cutting-edge, environmentally responsible mobility options that meet the demands of a varied range of customers and social goals as per the study conducted by (Bearden *et al*., 1989).

The move from conventional rickshaws to e-rickshaws necessitates a profound change in perspective on contemporary and environmentally friendly modes of transportation. The following are the main takeaways from the given search results:

a) **Economics of transition:** Converting from conventional transportation options to e-rickshaws offers financial advantages that impact adoption attitudes. The opinions and attitudes regarding this shift are significantly shaped by the affordability and effectiveness of e-rickshaws in comparison to more conventional modes of transportation.

b) **Sustainable future:** By highlighting the long-term sustainability and environmental advantages of switching to electric vehicles like e-rickshaws, e-rickshaws are laying the groundwork for a sustainable future in public transportation. This change indicates a favourable mindset toward adopting environmentally friendly transportation options.

c) **Mobility preferences:** Determining people's attitudes on this shift requires knowing their preferences for e-rickshaws in terms of mobility. Convenience, accessibility, and environmental impact are some of the factors that affect how people view and use e-rickshaws as a regular mode of transportation.

d) **Elements affecting desire:** Research on rickshaw operators' desire to switch to battery-operated rickshaws (BORs) provides insight into the elements affecting their perspective on this change. Determining these elements is essential to comprehending and encouraging e-rickshaw uptake by both operators and users.

e) **Past, Present, and Future:** Studies on the development of e-rickshaws in India emphasize their significance as a mode of transportation that has a big influence on the nation's transportation system. This historical viewpoint sheds light on how perceptions of e-rickshaws have changed over time and how they might influence India's transportation landscape going forward.

All things considered, the shift from traditional rickshaws to e-rickshaws is the result of a complex interaction between social, economic, and environmental forces that shape attitudes and beliefs about adopting effective and sustainable urban transportation options.

The adoption of electric vehicles (EVs), such as electric automobiles and electric rickshaws, is significantly influenced by attitude (ATT), which is a reflection of people's opinions about particular brands, goods, or services. ATT is made up of three parts: behavioural, affective, and cognitive. The cognitive part concentrates on beliefs and ideas about the thing or problem that is being discussed. Beliefs regarding the environmental impact of EVs may be included in the cognitive component of ATT. Research has indicated that ATT's inclination towards EV adoption is greatly influenced by elements like as identification, emotional influences, and motivation to contribute to a cleaner environment. When it comes to forecasting consumer intentions, ATT outperforms situational and demographic characteristics as a significant predictor of behaviour and EV adoption intentions as per the study conducted by (Guagnano *et al*., 1995).

According to research study conducted by (Mitchell *et al*., 1981) ATT is a crucial adoption element that directly affects consumers' desire to adopt electric vehicles. When it comes to influencing consumers' views toward embracing new technology cars like electric vehicles (EVs), interpersonal effects and community expectations are equally crucial. All things considered, ATT shows up as a crucial middleman impacting the uptake of electric cars, representing people's assessments and conclusions about these environmentally friendly mobility choices.

A study of the literature on behavioural intention (BI) towards the adoption of cleaner vehicles (e-rickshaws in particular) indicates that human intentions are greatly influenced by psychological factors. Research by Peters, Gutscher, & Scholz (2011), Ozaki & Sevastyanova (2011), and Kahn (2007) emphasize the impact of social norms, personal norms, and environmental concerns on intentions to switch to cleaner automobiles. Adoption intentions are greatly impacted by how an electric vehicle (EV) is used and evaluated, as shown by attitude (ATT). People also establish their intentions based on subjective standards, or how other people view their purchases. With the help of all such indicators that are stated above and also on the basis of the literature review, the following research model has been proposed as given in Figure 2.

In order to comprehend the interaction between attitudes, intentions, and behaviours regarding the adoption of cleaner e-rickshaws, a research model that incorporates these psychological elements is developed. In addition to highlighting the role of social norms and psychological factors in influencing consumer intentions and behaviours towards embracing sustainable transportation options like e-rickshaws, the model highlights the importance of attitude as a mediator affecting the adoption of electric vehicles.

There are other factors as well which play a significant role in transition from traditional rikshaws to e-rikshaws but they are not as significant as the indicators specified above:

2.4.1 Battery operated rickshaws

In a paper by Majumdar & Jash (2015) the main emphasis has been on the emergence and popularity of battery-operated electric three-wheelers, commonly which is known as e-rikshaws, in the public road transport sector. These are popular because they provide a comfortable ride to the people. Also, they are economical mode of transport for commuters. The study done by them specifically examined the patterns of e-rikshaws. One of the key findings of their study was that they found remarkable efficiency of e-rikshaws, with an average specific consumption of 53.76 kJ per passenger-kilometre. This, efficiency definitely places e-rikshaws ahead of other forms of motorized three-heeled passenger vehicles and also highlights their potential as a sustainable and energy-efficient transportation option.

Also, the study highlighted the widespread implementation of e-rikshaws in public transport sector. The study also focused on the challenges and obstacles for the successful adoption of the e-rikshaws for public commuting. The e-rikshaws have a brushless DC motor for propulsion and rely on conventional lead-acid batteries for power. Notably, they are recognised for being eco-friendly, and having the potential to mitigate the carbon footprint associated with passenger transport activities. Despite of all the hinderances, e-rikshaws are gaining popularity as a preferred mode of transportation for short distances in major urban and suburban areas. Their operational presence signifies a positive shift towards sustainable and eco-friendly transportation solutions in various regions of India. The e-rikshaws not just address the issue of environmental pollution but also addresses the demand for efficient and accessible commuting options particularly over shorter routes.

2.4.2 Infrastructural needs

Although India is in the stage of technological advancement but still it lacks certain infrastructure for its rapid growth and development. There are many projects in India that have started with grate pace but ultimately took a toll due to poor infrastructure facility. Even In one of the research papers it was discussed that the e-rikshaws heavily rely on the use of electric motors which are dependent on the lithium-Ion batteries. These are used for energy storage. They offer high energy density and are commonly used in electric vehicles due to their lightweight and long lifespan (Kumar *et al.,* 2018).

Battery Management System (BMS) is also very much essential part of the e-rikshaw infrastructure. It is mainly implemented to monitor and manage the health of the battery, ensuring optimal performance and safety. Also, the main issue is of charging the battery Rajvanshi (2002). It is very necessary to develop this charging stations has to be set up in key locations to facilitate convenient and effective charging. Faster charging capabilities also should be developed rapidly in order to reduce the downtime for the e-rikshaws. The fast-changing technologies allow for quicker turnaround times between trips.

2.4.3 Initial cost

Also known as significant upfront investment. Traditional rickshaws usually cost between 30,000 and 50,000 rupees, whereas e-rickshaws can cost anywhere between 2 and 2.5 lakh rupees. For many drivers, who sometimes work with narrow profit margins, this can be a significant obstacle as it represents a four- to five-fold increase.

A large number of rickshaw drivers are not well-off and do not have official documentation or credit history. Because of this, it is challenging for them to get bank loans or loans from other lenders to buy an e-rickshaw. Moreover, the batteries in e-rickshaws have a finite lifespan and must be changed on a regular basis, raising the total cost of operation. Drivers may experience further financial burden as a result, particularly if they haven't recovered their initial investment in full.

Making the move to an e-rickshaw could need you to enter a new industry with distinct pricing and clientele. As drivers gain more customers and get used to driving electric vehicles, their income may initially decline. Different abilities and knowledge are needed to operate an e-rickshaw than a standard rickshaw. It can take time and resources to teach drivers about basic maintenance, charging infrastructure, and battery management.

It is inconvenient for drivers to keep their e-rickshaws running all day in many places because there is still a lack of infrastructure for charging them. Regulations pertaining to e-rickshaws can be intricate and differ depending on the location. Drivers may become uncertain as a result and be deterred from switching. The high initial cost of e-rickshaws continues to be a significant barrier, despite the fact that they provide long-term advantages in terms of environmental sustainability, lower operating costs, and better health for drivers.

2.4.4 Lack of awareness

For rickshaw drivers switching from traditional rickshaws to e-rickshaws (electric rickshaws), ignorance can be a significant obstacle. It's possible that a large percentage of rickshaw drivers, particularly those with years of experience, are unfamiliar with how e-rickshaws work. It's possible that they are ignorant of fundamental driving controls, battery maintenance, or even the charging procedure. Their ignorance of new technologies may cause them to be reluctant to adopt them out of concern for malfunctions or other technical issues.

It was found in the study conducted by (Goswami *et.al.,* 2018) The advantages of e-rickshaws, which include less physical strain, more earning potential because of their faster speeds and efficiency, and environmental advantages, might not be completely known to drivers. They risk missing out on the benefits of transitioning if they don't have access to services or appropriate awareness campaigns. Drivers may be discouraged from switching to e-rickshaws by rumors and unfavorable opinions about them. These could include worries about the short lifespan of the battery, its restricted range, the availability of charging, or possible laws from the government. Drivers might continue to be cautious if they cannot obtain accurate information and have these worries addressed immediately.

Drivers may not have access to adequate training in e-rickshaw operation, maintenance, and safe driving techniques, even if they are interested in operating them. This may result in mishaps and deter people even more from embracing the new technology. Furthermore, having few resources for maintenance, troubleshooting, and charging infrastructure can make them feel unprepared and exposed. Drivers may not have access to adequate training in e-rickshaw operation, maintenance, and safe driving techniques, even if they are interested in operating them. This may result in mishaps and deter people even more from embracing the new technology. Furthermore, having few resources for maintenance, troubleshooting, and charging infrastructure can make them feel unprepared and exposed.

There's a chance that traditional rickshaws are ingrained in the way people live there. When converting to e-rickshaws, some drivers can encounter social stigma or opposition from colleagues or communities. This could be an extra layer of difficulty that calls for community support and social awareness efforts in order for adoption to be effective. To persuade rickshaw drivers to switch to e-rickshaws, it is imperative to address the lack of awareness through targeted education, information campaigns, training programs, and financial support systems. Their livelihoods will be enhanced, and it will also help to improve urban transportation options and environmental sustainability.

2.4.5 Range anxiety

Range anxiety, or the worry of running out of battery power, presents a serious obstacle for rickshaw drivers who are thinking about switching from conventional (human-powered) to electric (e-rickshaw) rickshaws. In the study conducted by (Harikumar *et. al.,* 2022) found that E-rickshaws have a limited range on a single battery charge, in contrast to traditional rickshaws, which have an infinite range as long as the driver has stamina. Depending on variables including battery capacity, driving style, and topography, its range normally varies between 50 and 120 kilometers. It may be uncomfortable for drivers who are used to traveling long miles without stopping to refuel.

Particularly in smaller towns and rural areas, charging facilities for e-rickshaws are not yet widely available. Stations may be grouped together in specific areas even in larger cities, which makes drivers anxious that they may become lost if they deviate from their regular routes. Their earning potential may be restricted and range anxiety may result from this unpredictability. In contrast to the instantaneous "refueling" that a regular rickshaw provides after a brief break, the batteries in an e-rickshaw require a few hours to fully charge. If drivers have to wait a long time at charging stations, especially during busy business hours, this can affect their daily profits.

Some drivers may find the technology in e-rickshaws intimidating as they are used to the straightforward operation of traditional rickshaws. Adoption reluctance and worry might arise from not understanding battery life indicators, scheduling charging, and probable maintenance problems. For drivers, especially those with limited funds, the initial cost of an e-rickshaw is typically more than that of a traditional rickshaw. The cost of replacing batteries can also be high, which raises further concerns about possible range anxiety-related breakdowns in terms of finances.

In addition to the practical issues, some drivers may feel more in control and free when operating a conventional rickshaw due to their own physical stamina and power. Making the switch to a battery-operated e-rickshaw may increase range anxiety by making the rider feel vulnerable

and dependent. Notwithstanding these obstacles, it's critical to remember that improvements in battery science, the construction of infrastructure for charging, and financial support programs are gradually elevating e-rickshaws to the status of a more practical option. A more seamless transition and the full potential of e-rickshaws for drivers and the environment depend on addressing the issues around range anxiety.

2.4.6 Resistance to change

In the study conducted by (Nishant, 2019) for rickshaw drivers, the word "resistance" can refer to a variety of strategies they employ to combat the difficulties they encounter. Those who operate rickshaws may have competition from other transportation options, such as ride-hailing services or taxis. Opposition may take the form of advocating for improved rickshaw infrastructure, emphasizing their benefits, or adjusting to shifting market dynamics. Rickshaw drivers frequently deal with issues like harassment, heavy traffic, and long hours on the job. Finding detours, creating support networks, or promoting improved safety regulations and working conditions are some examples of resistance.

It's critical to keep in mind that resistance can be a complicated, multidimensional phenomenon, and that no one term fits all circumstances. The particular setting, the objectives of the drivers, and the resources at hand will all have an impact on the types of resistance they select. The complexity and expense of switching may increase in certain locations if e-rickshaws are subject to special laws or licensing requirements. Drivers may encounter administrative obstacles when registering and ensuring their e-rickshaws, or they may need to obtain new licenses or permits.

E-rickshaws could have a social stigma in some communities or be viewed as less respectable than traditional rickshaws. Drivers who convert to e-rickshaws could worry about losing passengers or encountering prejudice. Some drivers might be concerned that the arrival of e-rickshaws will cause traditional rickshaw drivers to lose their jobs. They might worry that e-rickshaws are more effective and need fewer drivers, or they might worry that e-rickshaw competition will lower prices and make it harder to make a living.

It's crucial to remember that not all drivers of traditional rickshaws are against e-rickshaws. Many drivers are aware of the potential advantages of e-rickshaws and are prepared to convert if they can get beyond the aforementioned difficulties. By offering financial support, increasing awareness, streamlining laws, and enhancing charging infrastructure, governments and other organizations can aid with the shift.

In the end, drivers must make a hard decision about whether or not to convert to an e-rickshaw depending on their unique situation and risk tolerance. We can create better plans to assist traditional rickshaw drivers in smoothly switching to e-rickshaws, should they so desire, by comprehending the causes of their reluctance.

2.5 Research gap

As urban transport undergoes a revolution, one mode of transportation that has gained considerable attention is the e-rikshaw. These eco-friendly vehicles offer an innovative solution to urban congestion and pollution problems. However, despite their advantages, there is a noticeable reluctance among traditional rikshaw drivers to switch to e-rikshaws.

The research surrounding e-rikshaws is currently limited, leaving a sizable research gap that needs to be addressed. Understanding this gap is crucial for uncovering insights and formulating effective strategies to promote the adoption of e-rikshaws.

a) Lack of comprehensive studies

One major aspect of the research gap is the absence of comprehensive studies that explore the multifaceted dimensions of e-rikshaw adoption. While some studies have touched upon various aspects such as environmental impact and consumer preferences, there is a lack of in-depth analysis that considers the perspectives of traditional rikshaw drivers.

b) Limited understanding of driver motivations

Another significant gap in the research pertains to an inadequate understanding of the motivations that drive traditional rikshaw drivers' decision to stick with conventional rikshaws. By identifying these motivations, policymakers and stakeholders can tailor their approaches to encourage a smooth transition to e-rikshaws.

c) Long term economic viability

Evaluating the long-term economic viability of e-rikshaws is yet another area where further research is needed. While e-rikshaws offer potential cost savings in terms of fuel efficiency, their initial purchase cost and maintenance requirements remain factors of concern for traditional rikshaw drivers. Understanding the cost-benefit analysis can aid in dispelling apprehensions and providing insights for drivers looking to transition.

While the literature review extensively covers the environmental, technological, infrastructural, and policy aspects of transitioning from traditional rickshaws to e-rikshaws in India, there remains a notable research gap regarding the financial implications for e-rickshaw drivers compared to traditional rickshaw pullers. Despite government schemes and policies aimed at incentivizing the adoption of e-rikshaws, our study seeks to explore why e-rickshaw drivers may not experience higher earnings compared to their counterparts using traditional rickshaws in Jalandhar, Ludhiana, and Amritsar.

A key focus of our study is to investigate the Punjab government scheme's effectiveness in providing benefits to e-rickshaw drivers and understand the underlying reasons for their resistance to change. Despite the availability of supportive policies and financial assistance, our research aims to identify the barriers that prevent e-rickshaw drivers from capitalizing on these opportunities to improve their livelihoods. By conducting in-depth interviews and surveys with e-rickshaw drivers in the sampled areas, we aim to uncover the specific challenges they face in maximizing their earnings and adapting to the transition.

Furthermore, while other studies have examined similar topics, there is a research gap in comprehensively understanding the nuanced factors contributing to the resistance of e-rickshaw drivers to change. Our study seeks to fill this gap by conducting a thorough analysis of the socio-economic, cultural, and psychological factors influencing their decision-making process. By identifying these barriers and exploring potential solutions, our research aims to provide actionable insights for policymakers, government agencies, and other stakeholders to address the challenges faced by e-rickshaw drivers in Punjab.

Overall, our study aims to bridge the research gap by providing a comprehensive understanding of the financial implications, government policies, and drivers of resistance to change among e-rickshaw drivers in Punjab. Through empirical data collection and rigorous analysis, we seek to contribute to the existing literature by offering practical recommendations for fostering the successful transition to e-rikshaws while ensuring the economic well-being of drivers in the region.

2.6 Research Questions

The hesitation displayed by traditional rikshaw drivers to embrace e-rikshaws can be attributed to several factors. Unveiling these reasons is pivotal to designing effective strategies that address their concerns, foster trust, and facilitate a smooth transition.

a) Is there lack of financing options?

One significant hurdle faced by traditional rikshaw drivers is the lack of access to financing options for purchasing e-rikshaws. Many drivers operate on limited financial resources, making it challenging to afford the upfront cost of e-rikshaws. Policymakers and financial institutions can play a pivotal role in developing tailored financing programs to make e-rikshaws more accessible and affordable for drivers.

b) Why is there fear of technological complexity?

For traditional rikshaw drivers accustomed to the simplicity of conventional rikshaws, the technological complexity of e-rikshaws can be a perceived barrier. The fear of not being able to operate or maintain these advanced vehicles hinders their willingness to switch. Providing comprehensive training programs and educating drivers about the user-friendly features of e-rikshaws can help alleviate these concerns.

c) How to deal with charging infrastructure?

The availability and accessibility of charging infrastructure is a pressing concern for traditional rikshaw drivers considering the switch. In many urban areas, the lack of charging stations can deter drivers from adopting e-rikshaws. Policymakers and local authorities should focus on developing a robust charging infrastructure network to address this apprehension effectively.

d) How to cope with cultural and social stigma?

A factor that is often overlooked is the cultural and social stigma associated with the transition from traditional rikshaws to e-rikshaws. Traditional rikshaw drivers may perceive this transition as a loss of identity or a step backward in society. Engaging with the community and addressing these cultural aspects can help shift societal perceptions, fostering a more positive environment for the adoption of e-rikshaws.

In conclusion, the research gap surrounding e-rikshaws provides a fertile ground for further exploration. By understanding the motivations and concerns of traditional rikshaw drivers, we can bridge this gap and implement targeted initiatives to encourage the adoption of e-rikshaws. Access to financing options, comprehensive training programs, robust charging infrastructure, and addressing cultural stigma are essential components in facilitating this transition. With collective efforts, we can propel the adoption of e-rikshaws, creating a sustainable and efficient urban transport system for the future.

2.7 Research objective

To assess the factors that which shape the behavioural intention of traditional/fuel operated rickshaw pullers to transit from traditional/fuel-powered rickshaws to E-rickshaws.

The goal of the study is to evaluate the financial advantages and difficulties faced by rickshaw pullers when switching from manually operated or fuel-powered rickshaws to electric rickshaws. With 83% of the nation's EV market share, e-rickshaws are leading the way in India's shift to electric transportation. By 2027, the electric rickshaw market in India is expected to develop at a compound annual growth rate (CAGR) of more than 11%, reaching a value of USD 2.8 billion. Although the general adoption of electric vehicles (EVs) has been hindered by high initial costs, uncertainty surrounding investments, and regulatory ambiguities, e-rickshaws have emerged as a noteworthy market sector that bridges transportation gaps and offers environmentally acceptable alternatives.

To ensure a smooth transition, a number of obstacles must be overcome, including low quality e-rickshaws offered by unorganized sectors, problems with widespread deployment, and a lack of funding and confidence to test new technologies. The difficulties that e-rickshaw drivers encounter is related to paperwork, poor roadways, and the expense of charging. Although e-rickshaws have the potential to be a catalyst for equitable and sustainable economic growth in India, integrating them successfully would require overcoming obstacles related to infrastructure, safety concerns, and laws.

3. PROPOSED METHODOLOGY

3.1 Descriptive research

An effective and perceptive approach for fully comprehending and solving the complex issues of E-rickshaw growth in Punjab is descriptive study. This study's complexity calls for an approach that carefully describes the several aspects impacting adoption, obstacles encountered, and possible paths for advancement in addition to thoroughly examining the existing situation. Because of its methodical and thorough methodology, descriptive research may successfully offer a thorough picture of the major factors related to the growth of e-rickshaws in Punjab.

An in-depth examination of Punjab's current E-rickshaw situation is necessary before commencing this project. This involves keeping track of the present distribution, usage trends, and operational dynamics of e-rickshaws in the state's various cities. The varied topography of E-rickshaw deployment, including concentrations in metropolitan areas, extensively travelled routes, and any regional variances, may be captured by descriptive study.

Furthermore, the technique ought to explore the policy efforts and regulatory framework that are influencing Punjab's e-rickshaw market. This involves a thorough examination of the Punjab Electric Vehicle Policy (PEVP), which was implemented in 2022, to determine how it affects the uptake of e-rickshaws, spot any weaknesses, and provide possible areas for improvement.

Comprehending the viewpoint of the consumer is equally essential. Surveys and interviews are two methods that descriptive research may utilize to acquire information from E-rickshaw drivers, manufacturers, and end consumers. This will help determine user preferences, the difficulties drivers encounter, and the elements that lead people to select E-rickshaws over conventional ones. Additionally, the study should evaluate the E-rickshaws' economic feasibility by examining elements including operational expenses, driver revenue, and return on investment. This quantitative information can offer a strong basis for comprehending the financial effects of adopting e-rickshaws.

It's also important to investigate how E-rickshaws and traditional rickshaws affect the environment. To fully assess the environmental advantages, descriptive research can help gather information on emissions, energy use, and total ecological footprint. The technique needs to take into account technological elements as well, closely examining the status of E-rickshaw technology at the moment, battery efficiency, and any improvements that could lead to enhanced sustainability and performance.

Finally, it can be said that descriptive research is a suitable and comprehensive approach for the growth of e-rickshaws in Punjab. This method, which combines quantitative and qualitative data, can yield insightful information that is crucial for influencing legislation, improving technology, and promoting the long-term expansion of e-rickshaws in the state.

3.2 Data collection

For a thorough investigation into the growth of E-rickshaws in Punjab, a systematic approach to gathering data is essential. In order to obtain a comprehensive grasp of the topic, this technique integrates ideas from empirical studies and literature reviews into a multidimensional analysis.

3.2.1 Climate concerns and environmental impact

The research broadens its scope to include issues related to conventional rickshaws and climate change, particularly with regard to internal combustion engines. The study seeks to demonstrate a link between rickshaw-induced air pollution and climate change by citing academic publications that emphasize the rickshaws' contribution to greenhouse gas emissions, including carbon dioxide (CO2) and methane. Furthermore, the study explores how particulate matter emissions affect the surfaces of snow and ice, highlighting the necessity of a rapid transition to E-rickshaws that are powered by renewable energy sources.

3.2.2 Innovation and technological shift

A crucial component of the study is investigating the viability of switching from fuel-powered rickshaws to electric rickshaws. Based on research paper insights, the study highlights the technology change needed to make this shift. This includes the incorporation of electric propulsion systems, the substitution of brushless DC (BLDC) motors for internal combustion engines, and the necessary parts of power electronics, like inverters and controllers. The purpose of this part is to give a thorough overview of the technology infrastructure required for the effective deployment of e-rickshaws.

3.2.3 Infrastructural needs

The research makes reference to literature that addresses the infrastructure needs for E-rickshaws, including the necessity of charging infrastructure, the importance of Battery Management Systems (BMS) in monitoring battery health, and the reliance on lithium-ion batteries. The study highlights the need for quicker charging technology and charging stations in strategic places to minimize E-rickshaw downtime.

3.2.4 Government incentives and policies

The paper investigates several government initiatives and incentives targeted at boosting E-rickshaws, drawing on extant literature and policy documents. This entails collaborations with nearby service centres, maintenance and repair support services, and training programmes for rickshaw drivers. The research attempts to present a thorough overview of the supportive measures in place to ease the transition to E-rickshaws by reviewing literature assessments on government regulations.

To put it briefly, the data collection approach combines the knowledge gained from literature studies with practical research to thoroughly cover the various aspects of the development of e-rickshaws in Punjab. A comprehensive grasp of the topic is ensured by the holistic approach, which takes into account government actions, technology needs, infrastructure requirements, and environmental impact.

3.3 Sampling size and frame

3.3.1 Sample size

The sample size for this research on E-rickshaw development in Punjab has been judiciously set at 94 participants, with 30 traditional rickshaw operators selected from each city—Jalandhar, Ludhiana, and Amritsar. This sample size is determined to strike a balance between statistical significance and practical feasibility. It allows for a comprehensive exploration of the experiences, challenges, and perceptions of traditional rickshaw operators in the transition to E-rickshaws, ensuring diverse insights from various geographical locations and demographic backgrounds.

The selected sample size aligns with the pragmatic constraints of the research scope, permitting in-depth interviews and nuanced data collection. The outcomes derived from this sample will contribute substantively to the overarching goal of understanding the multifaceted aspects associated with E-rickshaw adoption in Punjab, enabling informed policy recommendations and industry advancements. The strategic choice of this sample size ensures that the findings are both statistically meaningful and contextually relevant to the specific challenges faced by traditional rickshaw operators in the region.

Traditional rickshaw operators from Jalandhar, Ludhiana, and Amritsar are carefully included in the sampling frame in an effort to obtain a targeted and pertinent sample for the study on the development of e-rickshaws in Punjab. To obtain a thorough understanding of the experiences, obstacles, and opinions of thirty traditional rickshaw operators in each city regarding the switch to e-rickshaws, the main goal is to interview them.

3.3.2 Sampling frame components

1. Identification of traditional rickshaw operators

The first crucial component of the sampling frame involves the meticulous identification of traditional rickshaw operators in Jalandhar, Ludhiana, and Amritsar. To achieve this, collaboration with local rickshaw associations, municipal records, and transportation authorities is imperative. These sources provide valuable insights into the individuals actively engaged in traditional rickshaw operations within each city. By tapping into such associations and official records, a comprehensive list is compiled, ensuring that the sampling frame is rooted in accurate and up-to-date information. This step not only establishes the foundation for participant selection but also lays the groundwork for building trust and cooperation with local stakeholders, fostering a collaborative approach to the research endeavour.

2. Geographical stratification

The second vital component of the sampling frame focuses on the geographical stratification of each city to ensure representation from diverse locations. Jalandhar, Ludhiana, and Amritsar are segmented into distinct areas, considering factors such as urban and suburban settings. This geographical stratification is paramount for capturing the nuanced experiences of traditional rickshaw operators in different environments.

By incorporating diversity in the sampling frame, the research aims to reflect the varied challenges and perceptions associated with E-rickshaw development across the landscape of each city. This strategic approach prevents potential biases that may arise from concentrating solely on specific regions, contributing to the overall robustness and representativeness of the sample. Geographical stratification enhances the research's ability to draw meaningful and context-specific insights, ensuring that the findings resonate with the varied operational contexts of traditional rickshaw operators in Punjab.

3. Demographic considerations

The third pivotal component of the sampling frame involves a nuanced consideration of demographic factors among traditional rickshaw operators. This step aims to ensure a well-rounded representation within the sample by taking into account variables such as age, years of experience, and types of routes covered by rickshaw operators. By including diverse demographic characteristics, the research can capture a comprehensive spectrum of perspectives, acknowledging the unique challenges and experiences that may vary across different demographic groups. This detailed demographic consideration is essential for crafting a sample that reflects the heterogeneity present within the traditional rickshaw operator community. It also serves as a foundation for understanding how age, experience, and specific operational contexts may influence perceptions and responses related to the transition to E-rickshaws.

4. Contacting rickshaw associations

The fourth component involves establishing communication with local rickshaw associations in each city, playing a pivotal role in the identification and engagement of potential participants. Rickshaw associations serve as key intermediaries, facilitating the outreach process and enhancing the credibility of the research within the rickshaw operator community.

Through collaboration with these associations, the research gains access to a network of operators who are likely to have a vested interest in the subject matter. The involvement of rickshaw associations not only streamlines the participant recruitment process but also fosters a sense of community engagement and cooperation, establishing a solid foundation for building rapport with the traditionally operated rickshaw community in Jalandhar, Ludhiana, and Amritsar.

5. Informed consent and voluntary participation

The final component of the sampling frame underscores the ethical considerations involved in participant recruitment. Emphasizing the principles of informed consent and voluntary participation, this step ensures that potential participants are fully aware of the research objectives, the voluntary nature of their involvement, and the confidentiality of their responses. Obtaining informed consent before inclusion in the study is essential for upholding ethical standards and ensuring that participants engage willingly in sharing their experiences and perspectives.

This component not only safeguards the rights and privacy of the participants but also contributes to the overall integrity and reliability of the research findings. The emphasis on ethical considerations enhances the credibility of the study and establishes a foundation of trust between the researchers and the traditional rickshaw operators selected for participation.

3.3.3 Sampling procedure

1. Selection criteria

Traditional rickshaw operators who have been actively operating for a significant duration and are willing to share their experiences and perspectives on the transition to E-rickshaws.

2. Random selection within strata

Employing random sampling techniques within each geographical stratum to ensure a representative selection of participants from various parts of each city.

3. Contact and invitation

Contacting the selected rickshaw operators through in-person visits to extend an invitation to participate in the research study. Clearly communicating the purpose, expected contributions, and voluntary nature of their involvement.

4. In-depth interviews

Conducting in-depth interviews with the selected 30 traditional rickshaw operators from Jalandhar, Ludhiana, and Amritsar, focusing on their experiences, challenges, and perceptions related to E-rickshaw development.

The careful design of the sampling frame guarantees that the study includes a range of viewpoints from conventional rickshaw drivers in Jalandhar, Ludhiana, and Amritsar, adding important context to the general comprehension of Punjab's shift to E-rickshaws.

3.4 Sampling method

The practical strategy and convenient accessibility of convenience sampling, a type of non-probability sampling, make it appropriate for this study. Obtaining a representative sample using conventional probability sampling techniques may be difficult due to the dynamic and diversified character of the E-rickshaw ecosystem in Punjab. By including participants according to their availability and willingness to participate, convenience sampling makes the process of gathering data more efficient and quicker.

3.4.1 Importance of convenience sampling

Convenience sampling is the process of choosing study participants based on their willingness to participate and ease of access. Convenience sampling is a practical strategy that is used in this research on the growth of E-rickshaws in Punjab to obtain information from rickshaw drivers, manufacturers, policymakers, and environmental specialists, among other stakeholders.

This sample strategy is aware of the difficulties in reaching a scattered and diversified population that is part of the ecology surrounding e-rickshaws. As a result, the selection of participants will be based on their availability, closeness to the research sites, and voluntary willingness to participate in the study. This methodology enables a more direct and efficient acquisition of data, consistent with the dynamic and rapid nature of the topic.

3.4.2 Rationale for convenience sampling

1. Accessibility

Convenience sampling means that participants from various places may be easily contacted, removing logistical constraints associated with a more structured sample technique. This is important because E-rickshaw operations in Punjab are dispersed.

2. Timeliness

By speeding up the data collecting procedure, convenience sampling allows the research to obtain timely insights from parties involved in the E-rickshaw sector. This is especially important in a setting that is changing quickly, as with new technology and changing laws.

3. Variety

Although convenience sampling might not provide an entirely representative sample, an attempt will be made to incorporate a range of viewpoints by choosing participants from various cities, rural and urban environments, and positions within the E-rickshaw ecosystem.

In order to provide a timely and useful investigation of the many facets related to the problem, this research uses convenience sampling to collect insightful opinions from a variety of stakeholders involved in the development of e-rickshaws in Punjab.

4. Data Analysis

4.1 Descriptive Statistics

Table 5: Descriptive Statistics

Factors	Mean	Std. Deviation	N
I will save on fuel expenses, as running cost should be lower in case of an electric vehicle.	3.7872	1.32691	94
The maintenance cost for an electric vehicle will be less.	3.5213	1.31761	94
Overall cost of owning an electric vehicle will be low due to government incentives (incentives = lower road tax/less insurance premium/cheaper loan).	3.5106	1.41986	94
I am fully familiar with the economic benefits offered by the electric vehicle.	3.7660	1.33139	94
I want to adopt an electric vehicle because of increased air pollution.	3.5319	1.27593	94
The Electric vehicle can contribute to the environment for saving the future generation.	3.5745	1.34795	94
I am familiar with environmental benefits offered by the electric vehicle.	3.5106	1.42742	94
I want to conserve the environment using the electric vehicle over the conventional vehicle.	3.4787	1.28455	94

People will react positively when they see an electric vehicle on the road.	3.6915	1.32816	94
I think I am more likely to adopt an electric vehicle if my friends and relatives adopt it.	3.8085	1.20283	94
People whose opinions are important to me find electric vehicles good.	3.5106	1.40464	94
Possessing an electric vehicle would be a status symbol for me.	3.8404	1.22959	94
Driving an electric vehicle fits my style.	3.6277	1.34392	94
Driving an electric vehicle will reflect my personality.	3.4255	1.49903	94
Eco-friendly people will opt the electric vehicle.	3.5319	1.40431	94
My knowledge about the electric vehicle will improve my image.	3.5000	1.45728	94
I am favourably inclined to switch to an electric vehicle.	3.6489	1.36553	94
Driving an electric vehicle will be a wise decision.	3.5000	1.38928	94
It makes sense to use an electric vehicle instead of a conventional vehicle.	3.5213	1.34986	94

I would recommend the adoption of an electric vehicle to others.	3.4574	1.41926	94
I would speak favourably about the electric vehicle to others.	3.5745	1.35591	94
I would definitely adopt an electric vehicle.	3.6489	1.49341	94

Descriptive Statistics shows that there is no missing data.

4.2 Reliability analysis of each factor

Table 6: Case Processing Summary

		N	%
Cases	Valid	94	100.0
	Excluded	0.00	0.00
	Total	94	100.0

Table 7: Reliability analysis of all factors

Cronbach's Alpha	N of Items
.910	22

Table 8: Reliability analysis of each factor

8.1 Reliability Statistics- Perception of Economic Benefits

Cronbach's Alpha	N of Items
.575	4

8.2 Reliability Statistics- Environmental Concern

Cronbach's Alpha	N of Items
.693	4

8.3 Reliability Statistics- Social Influence

Cronbach's Alpha	N of Items
.612	4

8.4 Reliability Statistics- Self Image

Cronbach's Alpha	N of Items
.656	4

8.5 Reliability Statistics- Attitude

Cronbach's Alpha	N of Items
.587	3

8.6 Reliability Statistics- Behavioral Intention

Cronbach's Alpha	N of Items
.649	3

Findings-: The value of Cronbach's alpha for Overall Satisfaction is more than 0.70 which means that the research is reliable.

4.3 Validity Analysis

Table 9: Validity analysis

KMO and Bartlett's Test		
Bartlett's Test of Sphericity	Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.806
	Approx. Chi-Square	872.922
	df	231
	Sig.	.000

The value of KMO and Bartlett's test is 0.806 which is more than 0.50 it means that research is 65.70% valid and is adequate to carry on a Factor Analysis.

4.4 Communalities

Table 10: Communalities

Factors	Initial	Extraction
I will save on fuel expenses, as running cost should be lower in case of an electric vehicle.	1.000	.662
The maintenance cost for an electric vehicle will be less.	1.000	.715
Overall cost of owning an electric vehicle will be low due to government incentives (incentives = lower road tax/less insurance premium/cheaper loan).	1.000	.833
I am fully familiar with the economic benefits offered by the electric vehicle.	1.000	.612
I want to adopt an electric vehicle because of increased air pollution.	1.000	.541

The Electric vehicle can contribute to the environment for saving the future generation.	1.000	.601
I am familiar with environmental benefits offered by the electric vehicle.	1.000	.514
I want to conserve the environment using the electric vehicle over the conventional vehicle.	1.000	.637
People will react positively when they see an electric vehicle on the road.	1.000	.545
I think I am more likely to adopt an electric vehicle if my friends and relatives adopt it.	1.000	.754
People whose opinions are important to me find electric vehicles good.	1.000	.802
Possessing an electric vehicle would be a status symbol for me.	1.000	.676
Driving an electric vehicle fits my style.	1.000	.548
Driving an electric vehicle will reflect my personality.	1.000	.678
Eco-friendly people will opt the electric vehicle.	1.000	.528
My knowledge about the electric vehicle will improve my image.	1.000	.799
I am favourably inclined to switch to an electric vehicle.	1.000	.587
Driving an electric vehicle will be a wise decision.	1.000	.527
It makes sense to use an electric vehicle instead of a conventional vehicle.	1.000	.635
I would recommend the adoption of an electric vehicle to others.	1.000	.698
I would speak favourably about the electric vehicle to others.	1.000	.624

I would definitely adopt an electric vehicle.	1.000	.529

Communalities represents that no value is below 0.50 hence no factor is going to distort result. Therefore, no variable should be deleted during Factor Analysis.

4.5 Scree Plot

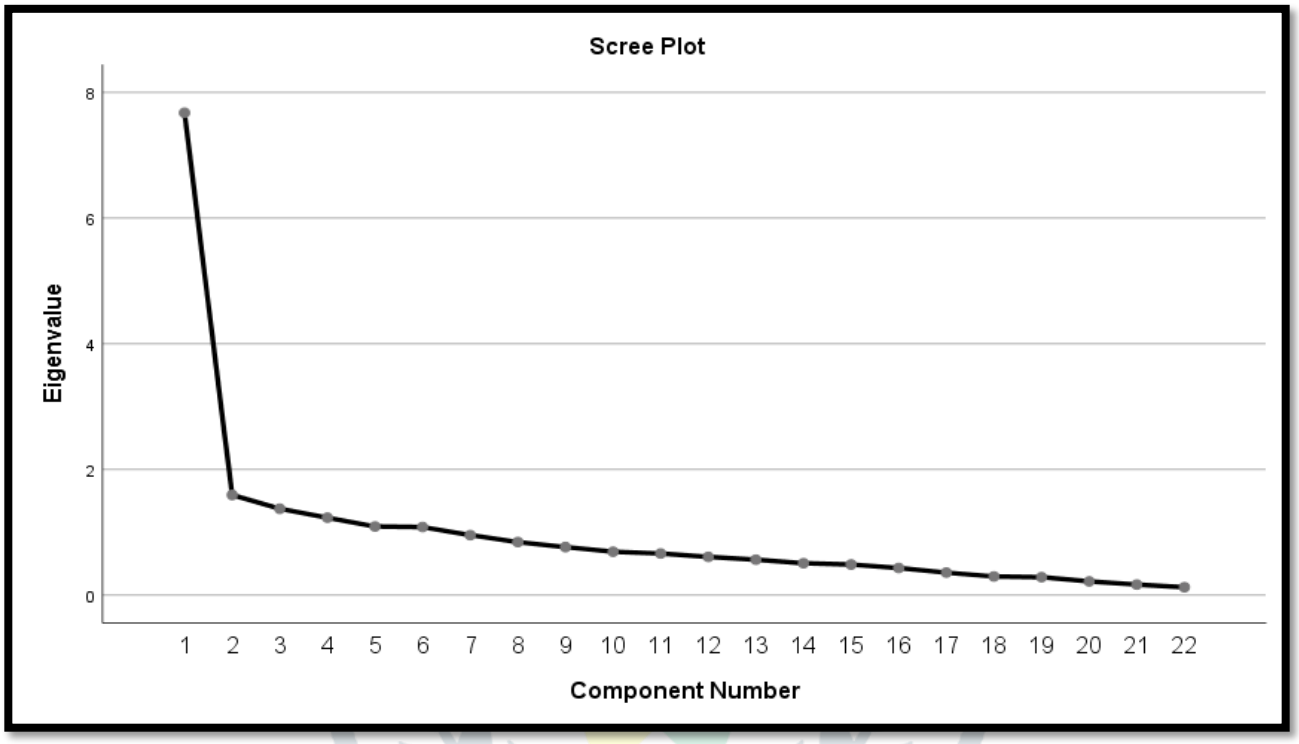

Figure 2 Scree Plot

It is evident from the Scree plot that there are possible 6 factors out of the total 22 factors to help in transitioning from fuel-powered rikshaw to E-rikshaw.

4.6 Component Plot in Rotated Space

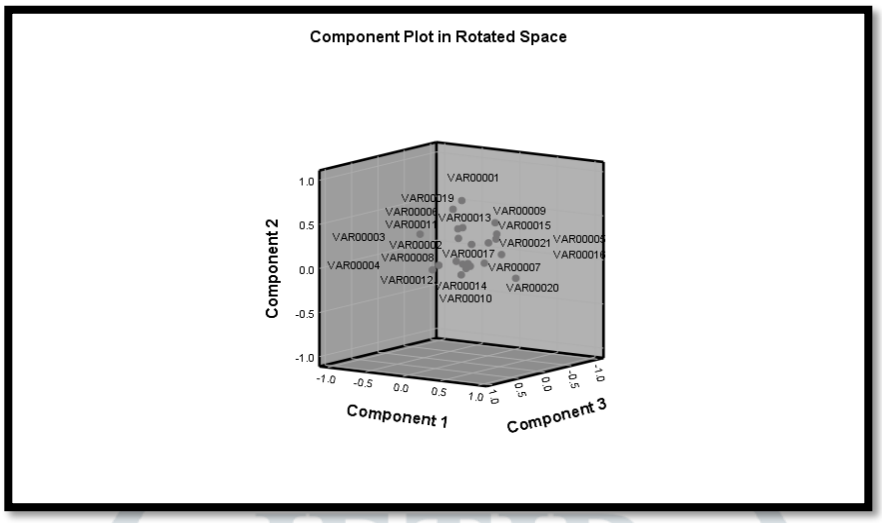

Figure 3 Component Plot in Rotated Space

The component plots show that all 22 variables are within the component space matrix and are aligned with the matrix of component 1, component 2 and component 3. The capacity of a component plot in rotated space to give light on the connections between the original variables and the primary components makes it significant.

Analysts can determine which variables are most strongly related with each component and how these linkages affect the overall structure of the data by looking at the positions of the variables on the rotating axes. Which hence has been proved in the above model.

4.7 Factor Analysis

Table 11: Factor Analysis

Rotated Component Matrix						
	Component					
	1	**2**	**3**	**4**	**5**	**6**
My knowledge about the electric vehicle will improve my image.	**.778**					
I would recommend the adoption of an electric vehicle to others.	**.755**					
I will save on fuel expenses, as running cost should be lower in case of an electric vehicle.		**.759**				
It makes sense to use an electric vehicle instead of a conventional vehicle.		**.650**				
People will react positively when they see an electric vehicle on the road.		**.522**				
Possessing an electric vehicle would be a status symbol for me.			**.764**			
Overall cost of owning an electric vehicle will be low due to government incentives (incentives = lower road tax/less insurance premium/cheaper loan).			**.687**			

Driving an electric vehicle will be a wise decision.			**.506**			
The maintenance cost for an electric vehicle will be less.				**.764**		
Driving an electric vehicle will reflect my personality.				**.690**		
I am favourably inclined to switch to an electric vehicle.				**.522**		
I want to conserve the environment using the electric vehicle over the conventional vehicle.					**.716**	
The Electric vehicle can contribute to the environment for saving the future generation.					**.570**	
I am fully familiar with the economic benefits offered by the electric vehicle.			**.505**		**.550**	
I think I am more likely to adopt an electric vehicle if my friends and relatives adopt it.						**.833**
People whose opinions are important to me find electric vehicles good.						**.593**
I would definitely adopt an electric vehicle.						**.570**
Driving an electric vehicle fits my style.						

Factor Analysis shows that out of the possible 18 components 22 were found to be taken into consideration headed under 6 different factors that are essential to elevate the transition from Fuel powered rikshaw to E-rikshaw in India.

Factor 1 (Perception of Economic Benefits)	Factor 2 (Environmental Concern)	Factor 3 (Social Influence)	Factor 4 (Self Image)	Factor 5 (Attitude)	Factor 4 (Behavioural Intention)
I will save on fuel expenses, as running cost should be lower in case of an electric vehicle.	I want to adopt an electric vehicle because of increased air pollution.	People will react positively when they see an electric vehicle on the road.	Driving an electric vehicle fits my style.	I am favourably inclined to switch to an electric vehicle.	I would recommend the adoption of an electric vehicle to others.
The maintenance cost for an electric vehicle will be less.	The Electric vehicle can contribute to the environment for saving the future generation.	I think I am more likely to adopt an electric vehicle if my friends and relatives adopt	Driving an electric vehicle will reflect my personality.	Driving an electric vehicle will be a wise decision.	I would speak favourably about the electric vehicle to others.
Overall cost of owning an electric vehicle will be low due to government incentives (incentives = lower road tax/less insurance premium/cheaper	I am familiar with environmental benefits offered by the electric vehicle.	People whose opinions are important to me find electric vehicles good.	Eco-friendly people will opt the electric vehicle.	It makes sense to use an electric vehicle instead of a conventional vehicle.	I would definitely adopt an electric vehicle.

I am fully familiar with the economic benefits offered by the electric vehicle.	I want to conserve the environment using the electric vehicle over the conventional vehicle.	Possessing an electric vehicle would be a status symbol for me.	My knowledge about the electric vehicle will improve my image.		

Table 12: Factor Description

These are the possible 6 factors to improve transitioning from Fuel powered rikshaw to E-rikshaw in India -:

These Factors are as follows-:

1. Perception of Economic Benefits
2. Environmental Concern
3. Social Influence
4. Self-Image
5. Attitude
6. Behavioral Intention

Hence it is concluded that out of the 18 components taken for study 22 components are included under 6 factors i.e. accounting for (22/18) *100=122.22% acceptability of research. Hence study is valid.

4.8 Reliability of Factor Analysis

In order to check the reliability data collected from the respondent author performed partial EFA (Exploratory Factor Analysis). EFA (Exploratory Factor Analysis) was applied assuming that samples produce more or less similar factors then the data is valid.

Table 13: Reliability of Factor Analysis

Rotated Component Matrix						
	Component					
	1	2	3	4	5	6
VAR00016	.778					
VAR00020	.755					
VAR00001		.759				
VAR00019		.650				
VAR00009		.522				
VAR00012			.764			
VAR00003			.687			
VAR00018			.506			
VAR00002				.764		
VAR00014				.690		
VAR00017				.522		

VAR00008					.716	
VAR00006					.570	
VAR00004			.505		.550	
VAR00010						.833
VAR00011						.593
VAR00022						.570
VAR00013						

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

4.9 Confirmation of Factors of Factor Analysis

The author has used AMOS 20.0 statistical software to detect the confirmation of the Factors derived from EFA (Exploratory Factor Analysis) applying CFA (confirmatory factor analysis).

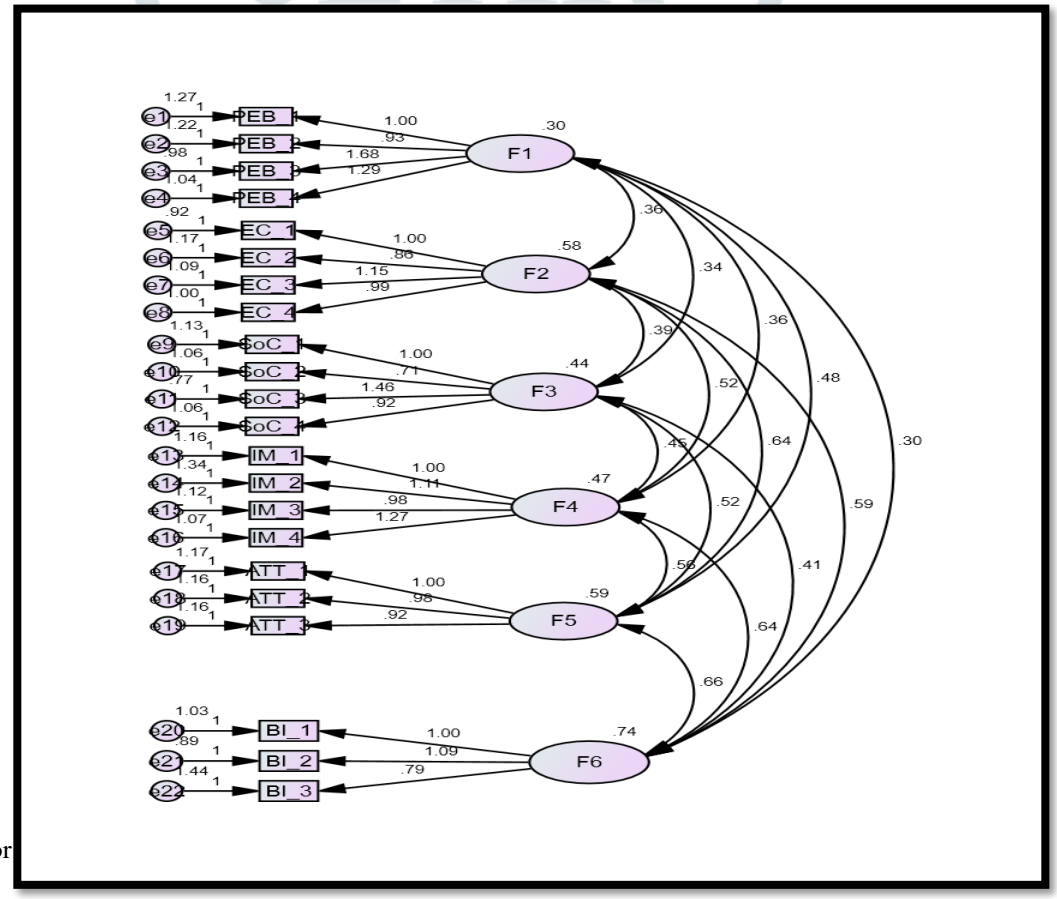

Figure 4 Confirmatory Factor

In Figure 5 it is seen that all the six constructs are having a loading of 0.50 or more so we can say that all the constructs are confirmed.

Construct 1 named PEB (Perception of Economic Benefits) has 4 items that loaded successfully item 1, 2, 3 and 4.

Construct 2 named EC (Environmental Concern) has 4 items that loaded successfully item 6, 5, 7 and 8.

Construct 3 named Soc In (Social Influence) has 4 items that loaded successfully item 9, 10, 11 and 12.

Construct 4 named IM (Self Image) has 4 items that loaded successfully item 13, 14, 15 and 16.

Construct 5 named ATT (Attitude) has 3 items that loaded successfully item 1 7 , 18 and 19.

Construct 6 named BI (Behavioral Intention) has 3 items that loaded successfully item 20, 21 and 22.

4.10 Validity of Factors of Analysis

Table 14: Validity of Factor Analysis

Description of Variables	Cronbach's Alpha
Perception of Economic Benefits	
I will save on fuel expenses, as running cost should be lower in case of an electric vehicle.	.575
The maintenance cost for an electric vehicle will be less.	
Overall cost of owning an electric vehicle will be low due to government incentives (incentives = lower road tax/less insurance premium/cheaper loan).	
I am fully familiar with the economic benefits offered by the electric vehicle.	
Environmental Concern	
I want to adopt an electric vehicle because of increased air pollution.	.693
The Electric vehicle can contribute to the environment for saving the future generation.	
I am familiar with environmental benefits offered by the electric vehicle.	
I want to conserve the environment using the electric vehicle over the conventional vehicle.	
Social Influence	
People will react positively when they see an electric vehicle on the road.	.612
I think I am more likely to adopt an electric vehicle if my friends and relatives adopt it.	
People whose opinions are important to me find electric vehicles good.	
Possessing an electric vehicle would be a status symbol for me.	
Self-Image	
Driving an electric vehicle fits my style.	.656
Driving an electric vehicle will reflect my personality.	
Eco-friendly people will opt the electric vehicle.	
My knowledge about the electric vehicle will improve my image.	
Attitude	
I am favourably inclined to switch to an electric vehicle.	.587
Driving an electric vehicle will be a wise decision.	
It makes sense to use an electric vehicle instead of a conventional vehicle.	
Behavioural Intention	
I would recommend the adoption of an electric vehicle to others.	.649
I would speak favourably about the electric vehicle to others.	
I would definitely adopt an electric vehicle.	

Table 14 shows that the value of Cronbach's alpha is above 0.5 hence all variables and factor loadings are acceptable. In order to check the reliability of SEM model the ratio of goodness of fit to degrees of freedom should not be more than 3 (Carmines and Maclver, 1981) and the values of RMR and RMSEA should be less than 0.05, with the GFI, AGFI, NFI, CFI more than 0.9 (Bagozzi and Yi, 1988).

Analysis returned the following values:

GFI (Goodness of fit index) should be >0.85 and FI (Fit Index) if less than 0.7 then the model is poor, if between 0.7-0.85 then the model is moderate and if it is greater than 0.85 then the model is the best fit. As per our findings our Fit Index is >0.85 hence our model is a best fit.

RMSEA (root mean square error of approximation) >0.05 Error Detection which will help us to know whether the loadings are Error full or not. The fit achieved is the best fit and was within the acceptable level. Therefore, construct validity and measurement efficiency were assured.

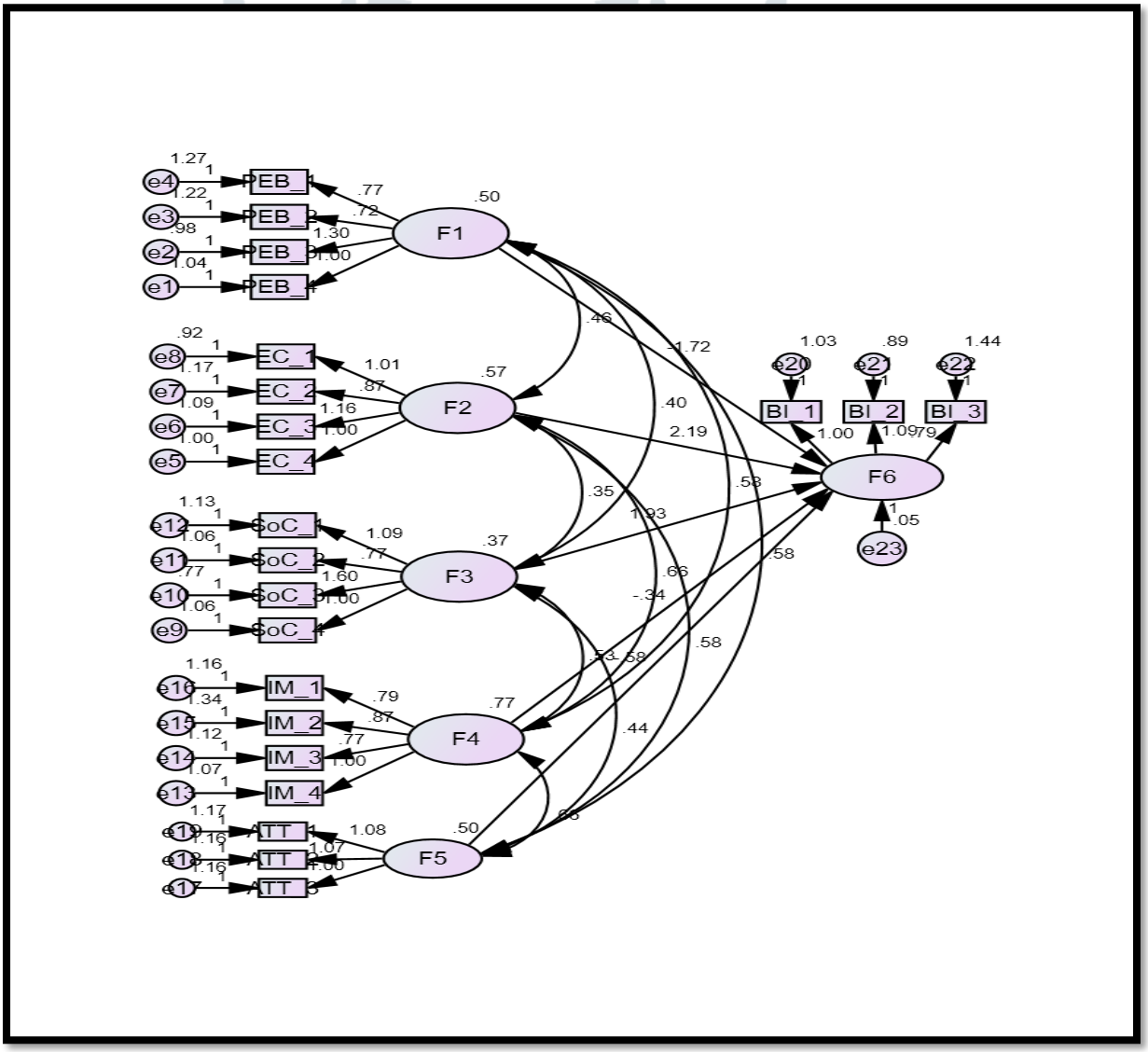

Figure 5 Structure equation Modelling

Standardized model

Here,

PEB stands for Perception of Economic Benefits.

EC stands for Environmental Concern.

Soc In stands for Social Influence.

IM stands for Self-Image.

ATT stands for Attitude.

BI stands for Behavioral Intention.

This is a working standardized model of SEM (sequential equation modeling) with reliable values which shows that factors obtained from Factor Analysis were reliable with few modifications. Complete analysis of the study was done by CFA (Confirmatory factor analysis) and SEM (Structural Equation Modeling) using AMOS 20.0.

5. Result and Conclusion

5.1 Findings

From the study the findings are as follows-:

1) Descriptive statistics proves that data collected for the study was valid and reliable as the statistical values were within the acceptable range.

2) Scree plot shows that there are possible 18 factors out of the total 22 factors to improve the smooth transition from fuel powered rikshaw to E-rikshaw.

3) Factor Analysis shows that out of the possible 33 components 32 were found to be taken into consideration headed under 6 different factors that are essential to elevate the quality of higher educational institute in India. They are-:

1. Perception of Economic Benefits
2. Environmental Concern
3. Social Influence
4. Self-Image
5. Attitude
6. Behavioural Intention

4) From factor analysis it is evident that-:

a) Perception of Economic Benefits contains sub factors such as I will save on fuel expenses, as running cost should be lower in case of an electric vehicle, The maintenance cost for an electric vehicle will be less, Overall cost of owning an electric vehicle will be low due to government incentives (incentives = lower road tax/less insurance premium/cheaper loan) and I am fully familiar with the economic benefits offered by the electric vehicle.

b) Environmental Concern contains sub factors such as I want to adopt an electric vehicle because of increased air pollution, The Electric vehicle can contribute to the environment for saving the future generation, I am familiar with environmental benefits offered by the electric vehicle and I want to conserve the environment using the electric vehicle over the conventional vehicle.

c) Social Influence contains sub factors such as People will react positively when they see an electric vehicle on the road, I think I am more likely to adopt an electric vehicle if my friends and relatives adopt it, People whose opinions are important to me find electric vehicles good and possessing an electric vehicle would be a status symbol for me.

d) Self-Image contains sub factors such as Driving an electric vehicle fits my style, driving an electric vehicle will reflect my personality, Eco-friendly people will opt the electric vehicle and My knowledge about the electric vehicle will improve my image.

e) Attitude contains sub factors such as I am favourably inclined to switch to an electric vehicle, driving an electric vehicle will be a wise decision and it makes sense to use an electric vehicle instead of a conventional vehicle.

f) Behavioural Intention contains sub factors such as I would recommend the adoption of an electric vehicle to others, I would speak favourably about the electric vehicle to others and I would definitely adopt an electric vehicle.

5.2 Results

The rigorous and extensive literature review done by the author citing the studies done by (Khurana *et al*., 2019) assert that financial incentives are a major factor in encouraging people to switch from conventional to electric cars (EVs). Because electric mobility has lower operating costs than other modes of transportation, emerging economies stand to gain economically and environmentally from the adoption of e-rickshaws. Research indicates that tax benefits and lower operating costs can encourage the use of hybrid electric cars (HEVs) and battery electric vehicles (BEVs).

Sufficient maintenance keeps e-rickshaws long-lasting and functional, and also saves money by averting expensive future repairs and replacements. Frequent maintenance is essential for seeing possible problems early on, preventing costly repairs, and saving time down the road. In addition to guaranteeing passenger safety by lowering the chance of accidents, maintenance improves the general performance of e-rickshaws, making them more dependable and effective. Important components like tires and brakes are inspected. It is advised to use a proactive approach that incorporates both maintenance and repairs to extend the life of e-rickshaws and lower overall costs.

According to study by (Bockarjova et al., 2014), consumer intentions to embrace electric vehicles (EVs), especially e-rickshaws, are highly influenced by environmental factors. Several studies have demonstrated that people who care deeply about the environment are more likely to purchase electric vehicles (EVs), highlighting the significance of environmental advantages as an adoption motivator. Significant progress in the electric vehicle (EV) sector is anticipated as battery-powered e-rickshaws become more popular.

These e-rickshaws, which require less maintenance and are less expensive to purchase than traditional rickshaws, provide customers with an affordable and practical alternative. In the end, incorporating environmental considerations into the switch from traditional to electric rickshaws not only addresses environmental issues but also opens up possibilities for improved environmentally friendly and sustainable urban transportation systems down the road.

As per (Chen *et al*., 2014) research paper When it comes to the adoption of electric vehicles (EVs), such as e-rickshaws, social issues are quite important. Studies reveal the impact of cultural factors, subjective norms, peer pressure, and societal pressure on people's decisions to

utilize electric cars. Findings highlight the significance of social acceptance in influencing consumer behavior by showing that people look to friends, family, and social circles for validation when thinking about adopting EVs. The adoption of EVs is significantly influenced by the behaviors of individuals within their social networks, highlighting the importance of social dynamics in influencing mobility decisions that are relevant to sustainability.

The adoption of electric vehicles (EVs) like e-rickshaws is heavily influenced by a number of elements, including consumer perception, social standing, and self-image, all of which are involved in the shift from traditional rickshaws to e-rickshaws. One important factor influencing customer behavior with regard to EV adoption is the degree of congruence between one's self-perception and product perception. When a customer believes that a product—like e-rickshaws—they are using, it might have a good effect on their adoption attitudes. Furthermore, people frequently give their cars a lot of symbolic meaning, seeing EVs—including e-rickshaws—as a mark of high social standing.

The adoption of electric vehicles (EVs), such as electric automobiles and electric rickshaws, is significantly influenced by attitude (ATT), which is a measure of people's opinions about particular companies, goods, or services. The three parts of ATT are cognitive, affective, and behavioral. The cognitive component focuses on ideas and opinions about the topic or problem at hand, which may include opinions about how EVs affect the environment. Studies have demonstrated that identity, emotional impacts, and the desire to help create a cleaner environment all have a significant impact on people's attitudes on adopting EVs. ATT is a better indicator of consumer intents than situational and demographic characteristics when it comes to behavior and intentions to embrace EVs as per the study conducted by the researches (Guagnano *et al*., 1995).

Hence from above points we can derive that there is a significant and positive on impact on transitioning from traditional fuel powered rikshaws to E-rickshaws in India if we pay indeed importance to the 6 factors considered in this particular study.

5.3 Scope for future study

Future studies should concentrate on longitudinal analyses to monitor the changing e-rickshaw adoption patterns, looking into regional differences, the efficacy of policies, technology developments, and sustainability implications. Comprehensive research on consumer behaviour, intervention strategies, and socioeconomic evaluations are also required, in addition to interdisciplinary cooperation and integration with urban transportation planning. Through examining these domains, scholars may enhance comprehension and formulate efficacious approaches to foster sustainable and equitable transportation infrastructure in India.

6. APPENDICES

A.1 QUESTIONNAIRE FOR RESPONDENTS

To assess the factors that which shape the behavioural intention of traditional/fuel operated rickshaw pullers to transit from traditional/fuel-powered rickshaws to E-rickshaws.

This questionnaire seeks your perceptions on what helps the most in transitioning from fuel powered rikshaw to E-rikshaw. Thank you for your assistance as this survey will allow us to understand your needs and improving in the future to increase your satisfaction. Your participation in this study is entirely voluntary. You should read the project information sheet first and ask questions about anything you do not understand, before deciding whether or not to participate in this study. The questionnaire is voluntary; all replies are confidential and anonymous.

On a scale of 1 to 5, please indicate your response by circling the appropriate level of satisfaction for the factors mentioned below.

1=Strongly Disagree, 2=Disagree, 3=neutral, 4=Agree, 5=Strongly Agree

Table 14 A: questionnaire

S.No.	PARTICULARS
	A. PERCEPTION OF ECONOMIC BENEFITS
1	I will save on fuel expenses, as running cost should be lower in case of an electric vehicle.
2	The maintenance cost for an electric vehicle will be less.
3	Overall cost of owning an electric vehicle will be low due to government incentives (incentives = lower road tax/less insurance premium/cheaper loan).
4	I am fully familiar with the economic benefits offered by the electric vehicle.
	B. ENVIRONMENTAL CONCERN
5	I want to adopt an electric vehicle because of increased air pollution.
6	The Electric vehicle can contribute to the environment for saving the future generation.
7	I am familiar with environmental benefits offered by the electric vehicle.
8	I want to conserve the environment using the electric vehicle over the conventional vehicle.
	C. SOCIAL INFLUENCE
9	People will react positively when they see an electric vehicle on the road.
10	I think I am more likely to adopt an electric vehicle if my friends and relatives adopt it.
11	People whose opinions are important to me find electric vehicles good.
12	Possessing an electric vehicle would be a status symbol for me.
	D. SELF IMAGE
13	Driving an electric vehicle fits my style.
14	Driving an electric vehicle will reflect my personality.
15	Eco-friendly people will opt the electric vehicle.
16	My knowledge about the electric vehicle will improve my image.

	E. ATTITUDE
17	I am favourably inclined to switch to an electric vehicle.
18	Driving an electric vehicle will be a wise decision.
19	It makes sense to use an electric vehicle instead of a conventional vehicle.
	F. BEHAVIOURAL INTENTION
20	I would recommend the adoption of an electric vehicle to others.
21	I would speak favourably about the electric vehicle to others.
22	I would definitely adopt an electric vehicle.

Personal Information

a) Name
b) Phone number
c) Age group

20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 – 50

d) City

Jalandhar
Amritsar
Ludhiana

e) Working Experience

1 - 2
3 - 4
>=5

A.2 RESULTS OF PILOT STUDY

Table 15: Reliability analysis of questionnaire

Case Processing Summary			
		N	%
Cases	Valid	94	100.0
	Excluded	0.00	0.00
	Total	94	100.0

Table 16: Reliability Statistics of Perception of Economic Benefits

Cronbach's Alpha	N of Items
.575	4

Table 17: Reliability Statistics of Environmental Concern

Cronbach's Alpha	N of Items
.693	4

Cronbach's Alpha	N of Items
.612	4

Table 18: Reliability Statistics of Social Influence

Table 19: Reliability Statistics of Self Image

Cronbach's Alpha	N of Items
.656	4

Table 20: Reliability Statistics of Attitude

Cronbach's Alpha	N of Items
.587	3

Table 21: Reliability Statistics of Behavioural Intention

Cronbach's Alpha	N of Items
.649	3

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