



Analysis of the Status of Auto Rickshaw-based Intermediate Public Transport System in Kerala

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Abstract: The auto rickshaws are India's most important intermediate public transport mode (IPT). Kerala, a southern state of India also depends on this mode as a vital part of public transportation. The COVID-19 situation affects the public transport system and a corresponding drop was observed during that period in this kind of para-transit system. This work analyzes the present status of the autorickshaw-based intermediate public transport system in Kerala on the basis of its number of registrations per year by the transport authority. The trend in registration is observed and suggestions were proposed. The existing nature of the E-Auto sector in Kerala is addressed based on its challenges.

Index Terms – Intermediate public transport, auto rickshaws, E-Auto rickshaws, growth rate.

1. INTRODUCTION

Transportation is the master root in the story of human development. The number of transportation activities increases with the increase in population. Thus, the total number of vehicles that are ready for operation is increasing day by day. Transportation is basically classified into public transportation and private transportation. For achieving a green policy in transportation, the first step is to promote the public transport system by tactically reducing the private trip generation. For planning such tactics in transport operations, we need an accurate analysis of the day-by-day increase in total vehicles based on its basic classification. This means that a proper transport analyzing wing must be there to check whether public transport facility or private transport facility is developing continuously. Definitely, the public transport sector and facilities must be developed to accomplish the green vision of every nation. Boosting public transportation requires adequate policies from the government for implementing more mass public transport systems like buses, metros, and other high-volume traffic modes after conducting proper studies on traffic data. To accomplish the operation of this kind of mass public transport system, we need some intermediate public transport modes (IPT). This mode is for feeding the mass public transport or collecting the outcome of mass public transport and providing a finish of trip up to the final destination requirement of the passenger. Taxis, minivans, tempo, and auto rickshaws (Autos) are the vehicles under the category of IPT. All states of India have their own IPT structure. The success of the mass public transport system will be based on the effectiveness of IPT. A mass transit system with inefficient IPT will create unwanted private trips. This will affect the economy of passengers and possibly deny the next public transport use. In short, a continuous look at the public transportation sector including IPT mode is essential to develop policies on public transportation that can cure social, economic, and environmental concerns of society.

This work is for analyzing the status of auto rickshaws in the Indian situation after the impact of COVID-19. Kerala state is selected for the study.

2. LITERATURE REVIEW

Public transport operation is classified as mass transit and Intermediate public transit (IPT). Auto rickshaws come under the category of IPT. Auto rickshaws are considered as basic common way to reach the actual final destination of a passenger after the usage of mass public transport like bus or rail. Without the facility of an effective intermediate public transport system, the total public transport system may fail (Behl, 2018). Strengthening Auto rickshaw-based IPT mode is essential to keep positive growth in the public transport sector. The Auto rickshaw operation in India is owner-based, which means all financial and management activities are handled personally. This nature is very much different from the fleet-based operation of mass public transport (Mani, 2012.). The reality of the economic background of auto rickshaw drivers and related challenges is crucial so that its negative impacts can make noticeable problems in the total public transportation system. This kind of challenges with public perception and realities in operations are studied by researchers and suggested various policies for drivers (Harding, 2016). Continuous monitoring of operations under this mode and updates in policy are crucial for the sustainability of auto IPT. The auto rickshaw operation is planned and implemented by a single person. The purchase, management, operation, maintenance, and all other related activities are managed by this single person. Hence the base of auto rickshaw IPT is an individual person who starts the purchase of an auto rickshaw and a subsequent group of auto owners. The auto rickshaws are best suitable para transit mode for Indian roads and are economical for the general public (Reynolds, 2011). This work observed the comments of drivers related to the owning and operating activities, vehicle activities, maintenance, and related activities, technical problems facing and handling, and socio-economic factors during the entire operational

activities. Even though the auto rickshaws are affordable and the best solution to last-mile connectivity, the pollution share is high. This is due to the increased number of oil-based auto rickshaws on the road. As per the 2018 reports, 10% of India's CO₂ emission is from the three-wheeler sector (Chandrashekar, 2022.). The driving pattern of an auto rickshaw operator is demand-dependent and creates flexible operation on fixed roads. Every operation has its own unique driving pattern in terms of frequent stop-and-go conditions, frequent acceleration, braking, and even excessive idling (Bagul, 2021.). In a two-month period study at Mumbai, operational challenges of auto rickshaw operators are collected which include: auto market issues, government regulations, comments from drivers and users, and personal data of drivers and users. Financial aspects etc. The solutions proposed by this work are training, infrastructure development, enforcement, fares, more fleet services, etc. (Shlaes, 2014). Implementing an organizational structure for auto rickshaw operations will increase efficiency. The unorganized inefficient nature of normal auto rickshaw operation is studied and an organization method using GPS was introduced after conducting various surveys (Vaidya, 2014). The completion of a decided trip or gap filling in a transport network is perfectly possible because of the flexible nature of auto rickshaw operation (Bagul T. P., 2018.). The characteristics of Auto rickshaws are: serving urban areas, middle and low-income earners, door-to-door trips, operation on narrow roads, operation in unplanned routes, flexible routes, and flexible schedules (Bisht, 2015). The growth rate of vehicles is the basis of economic development (Sharma, 2011.). India is now in its fastest-growing state. This growth rate shall be identified for various categories of vehicles to frame further policies. The literature related to the real status of auto rickshaws will give insights into the characteristics of that mode of transport operation and be able to create directions for solving the noted issues.

3. OBJECTIVES

Objectives of this work are:

1. To observe the entry of Three-wheeled vehicles in the transport operation sector per year
2. To observe the rate of growth or rate of decline of the Auto IPT mode.
3. To calculate the year-wise percentage of various categories of three-wheeler autorickshaws.
4. To forecast a trend in the Auto IPT mode.
5. To propose suggestions for managing the status of Auto IPT mode.

4. METHODOLOGY

The methodology used in this work contains data collection, data processing, growth rate calculation or decline rate calculation, and trend detection.

1. **Data Collection**
The data related to number of registrations per year is collected from the authority. The registered number of vehicles in different categories of three-wheeler type is collected. Various categories are passenger auto, goods auto, Non-transport auto, E-passenger auto, and E-goods auto.
2. **Data Processing**
Data is processed using Excel software. The graphs must be plotted for easy visualization. Graphs for each category are prepared.
3. **Growth Rate (GR) calculation**
The growth rate can be calculated using the equation.

$$GR = \frac{\text{Final Value} - \text{Previous Value}}{\text{Previous Value}}$$

Using the same procedure, we can calculate the decline rate of registration status.

4. **Trend detection**
To observe the trend, the number of registrations at present has to be noted. This value is entered in the value set of previous years and we can generate the visualization of trend. These trend observations must be done for separate categories. Category-wise trend observation is a necessary thing to identify whether a special category is appreciated or denied by the autorickshaw purchaser community. The trend calculation after the pandemic period can be considered as the right direction in forecasting. The entry of data observed during the COVID-19 period will deviate from the forecasting. The data from recent years is the most reliable as the whole world and businesses are on their return way from the pandemic scenario.
5. **Comparison**
All these categorical observations are verified and comparison to reveal the status must be done. The comparison in the sense of growth or denial is enough. A detailed comparison chart can be prepared for various categories of vehicles under the major heading three-wheeler.
6. **Year wise percentage**
Using the consolidated data of vehicle registration per year and the year-wise share in the total volume can be prepared for each category.

5. CASE STUDY FROM KERALA

Kerala state has 87 road transport offices located at different places in 14 districts. The registration and re-registration process of all kinds of vehicles including transport and non-transport vehicles are managed by these road transport offices. The registration details of all vehicles are available on the website vahan.parivahan.gov.in. The registration details of three-wheeled vehicles are taken from the dashboard of this Parivahan website. The data from the year 2014 to September 2023 is collected. The categories of data are passenger Autos, goods Autos, non-transport Autos, E- passenger Autos, and E- goods Autos. The data collected are shown in Table 1. The growth rate of registration, the decline rate of registration, the present status of registration, and current trends were observed from this data. The year-wise percentage of each category is calculated to understand their share on the total volume. This calculation will reveal the trend of autorickshaw purchasers in every year. This result is useful for both production companies and transport planners.

5.1. DISCUSSION

All kinds of vehicle registration data are available on the Parivahan website. The registration is a direct indication of entry of the vehicle into the operation on the road. Hence this value is considered for preparing the growth rate or decline rate of vehicles in the transport sector. Table 1 contains registration data of various categories of three-wheelers.

Table 1: Registration data of Three wheelers

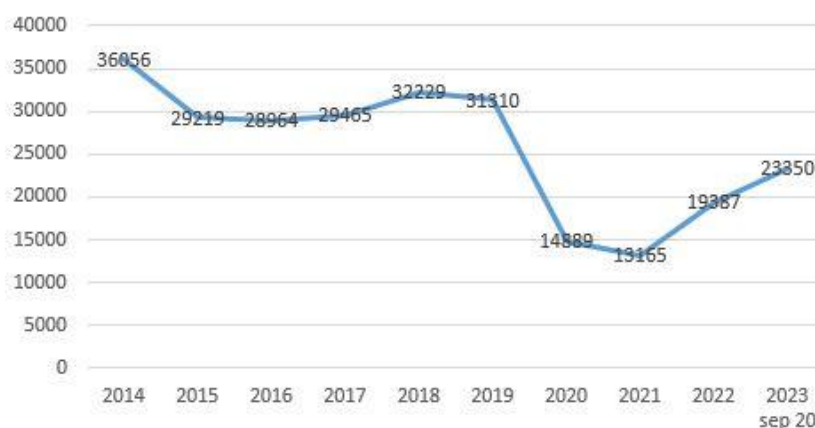
Year	Passenger Autos	Goods Autos	Non-Transport Autos	E- Passenger Autos	E-Goods Autos	Total
2014	27692	6350	2014	-	-	36056
2015	23006	5026	1187	-	-	29219
2016	22486	5553	925	-	-	28964
2017	22226	6417	814	4	4	29465
2018	24728	6770	700	26	5	32229
2019	24780	5976	492	52	10	31310
2020	9367	5052	261	207	1	14889
2021	8413	4069	207	369	107	13165
2022	15977	2698	206	278	227	19387
2023 September 20	20623	2338	241	8	140	23350
Total	199299	50249	7048	944	494	258034

Source: vahan.parivahan.gov.in

Table 1 contains data from the year 2014. The auto rickshaws registered before 2014 are also operating on roads. The total number of registrations is, passenger auto: 730341, goods auto: 185104, Non- transport: 138802, E-passenger: 944, and E-goods: 494. The registration of E-auto rickshaws starts in 2017. So, the total number of registered vehicles in this category can be calculated from Table 1. The total number of registered E-rickshaws in Kerala is 1438. The total number of three-wheeler registrations was reduced during the COVID-19 period but came back in the way of growth in post pandemic period. According to Motor vehicle act 1988, Fifteen years is the validity period of registration in India. The vehicles registered in 2014 need reregistration in the year 2029.

Figure 1:

Three-Wheelers



The percentage-wise analysis will give a clear vision of the status of the entry of new autorickshaws in the public transport sector.

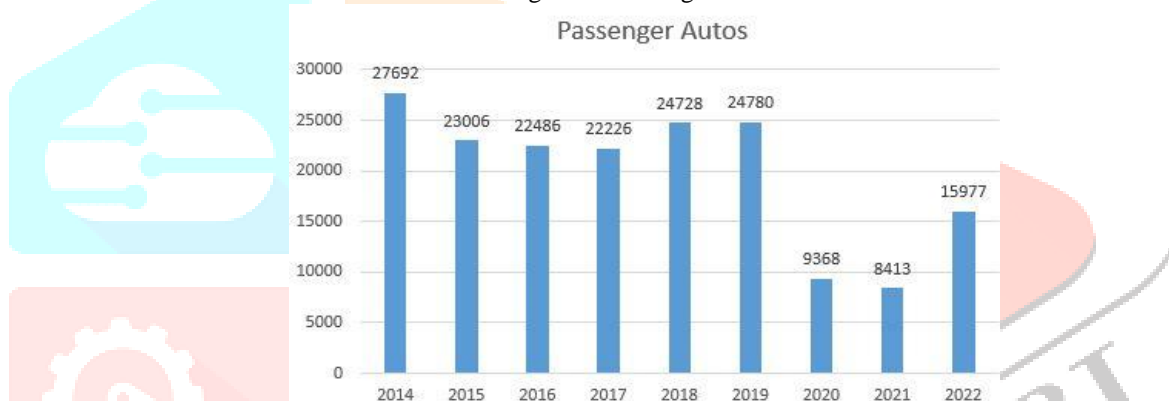
Table 2: Percentage-wise share of each sector

Year	Passenger Autos %	Goods Autos %	Non-Transport Autos %	E- Passenger Autos %	E-Goods Autos %	Total
2014	76.80	17.61	5.59	-	-	36056
2015	78.74	17.20	4.06	-	-	29219
2016	77.63	19.17	3.20	-	-	28964
2017	75.43	21.78	2.76	0.135	0.135	29465
2018	76.73	21.00	2.17	0.08	0.016	32229
2019	79.14	19.09	1.57	0.166	0.032	31310
2020	62.91	33.93	1.75	1.39	0.0067	14889
2021	63.90	30.90	1.57	2.8	0.81	13165
2022	82.41	13.92	1.06	1.43	1.17	19387
2023 September 20	88.32	10.01	1.03	0.034	0.599	23350

5.1.1. Passenger Autos

A noticeable drop in number of passenger auto registrations can be observed in the COVID-19 period. During 2022, the registration attained a high value of 15977. A growth rate of 89.91% compared to the previous year's rates: 2020 (decline rate of 62.2%) and 2021 (decline rate of 10.19%). This indicates that the auto rickshaw-based para transit system is in its growth stage after the pandemic 2019-2021 duration. Even though private trip generation by individual persons increased after COVID-19, the passenger auto-rickshaw sector is continuously growing.

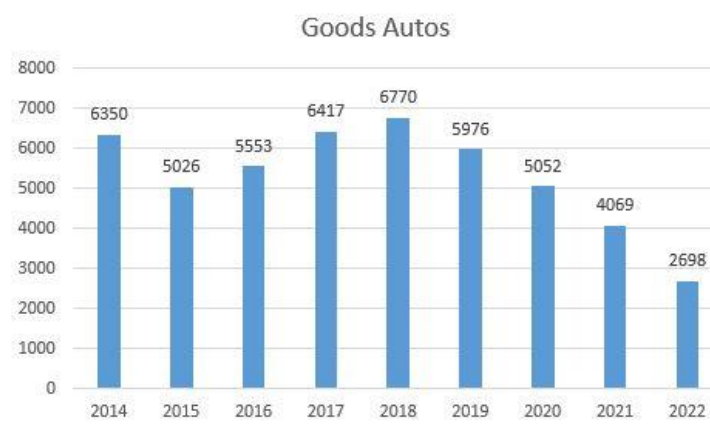
Figure 2: Passenger Autos



5.1.2. Goods Autos

The situation of goods auto rickshaws is different from the passenger autos. The registration is continuously declining after the year 2018. Continuous decline rates from the year 2019 were 11.73%, 15.46%, 19.46%, and 33.69%. The number of goods auto in the paratransit sector is continuously decreasing with a noticeable change in the decline rate. During the pandemic period, a sudden decline was observed in the passenger sector. But in the case of the goods sector, there is no such sudden heavy decline. The reason may be the use of goods vehicles for handling the pandemic situation and the corresponding hike in registration.

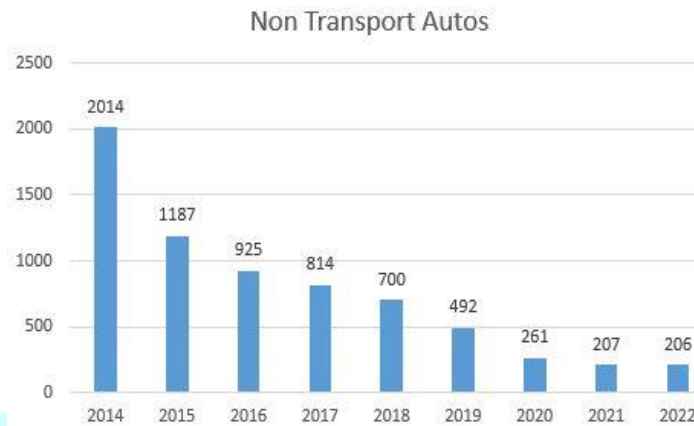
Figure 3: Goods Autos



5.1.3. Non-Transport Autos

The above two sections discussed the passenger autos and goods autos. Both these categories came under the general heading “Transport Autos”. The Non-Transport autos are registered for personal use. A declining nature of non-transport autorickshaws is observable from the year 2014. The declining nature shows a near future end in the non-transport auto sector. This may be due to the shift of common people and users of non-transport autos towards the use of economic small cars. The decline rates from the year 2015 are 41.06%, 22.07%, 12%, 14%, 29.7%, 46.95%, 20.69%, and 0.5%. decline rate from 2021 to 2022 is very small.

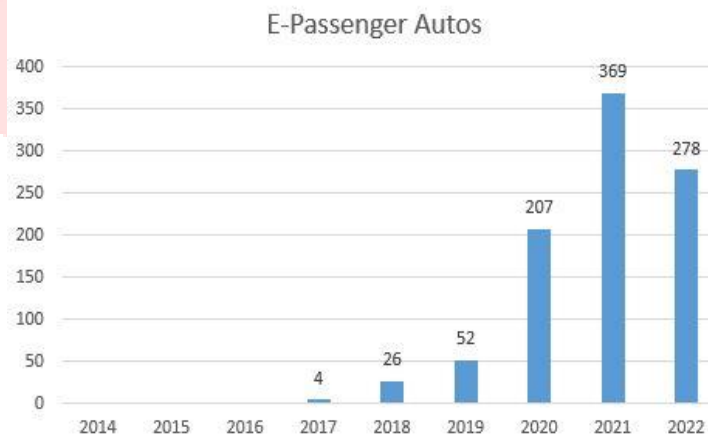
Figure 4: Non-Transport Autos



5.1.4. E- Passenger Autos

The registration of E- Passenger Auto rickshaw starts from the year 2017. Even in the COVID-19 situation, this category shows a growth rate in registration. After the pandemic period, the registration figure shows a growth of 78.26% during the year 2021. The total number is very low when compared to the number of conventional auto rickshaws. But the data shows a remarkable decline rate of 24.66% for the year 2022. Even though electric auto manufacturers strongly played for their market, the registration data reveals negative feedback from the customer group. At the same time, conventional auto rickshaws show 89.91% growth rate for the year 2022. This represents that the demand for this kind of paratransit still exists in the conventional type but not in the electric type. To increase the share of E-autos in the transport sector, adequate tactics must be planned for solving the present issues existing in this area. The government policy of E-vehicle must be entertained only after the proper involvement of manufactures in these concerns. The decline trend is an indication of dissatisfaction generated in the society. The news related to this dissatisfaction must be addressed by the authority, Identification of reasons behind this dissatisfaction, technical solutions, proper trainings and support are the major concerns in this area.

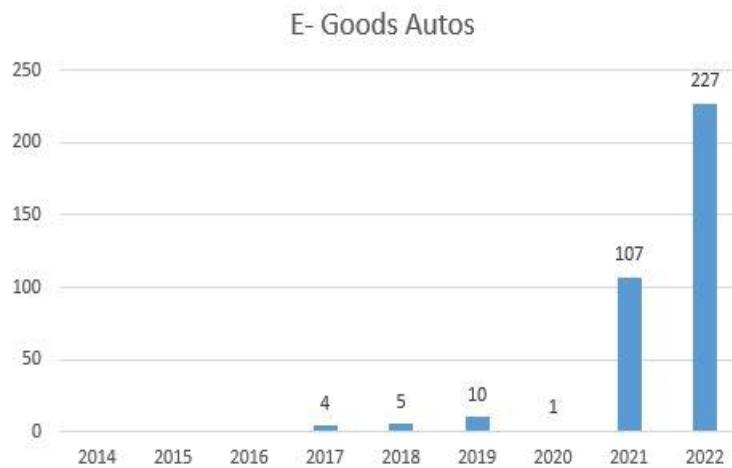
Figure 5: E- Passenger Autos



5.1.5. E-Goods Autos

The registration of E-Goods Auto rickshaw starts from the year 2017. A decline in nature is observed in the year 2020. Only one goods auto rickshaw was registered during the year 2020. The years 2021 and 2022 show a growth rate of 106% and 112.15% respectively. The total electrical autos registered during the year 2021 is 476 and during the year 2022, the value is 505. This shows a growth rate of 128.85% in the year 2021 and 6.1% in the year 2022. Even though a small growth rate is observed during the analysis, its number is too small and the deep split analysis reveals the growth rate is based on the E-goods autos.

Figure 6: E- Goods Autos



5.2. TREND AS ON 2023 SEPTEMBER

The trend can be identified by forecasting the collected data. Here the data after 2022 and up to 2023 September 20 were collected from the Parivahan dashboard and compared with the previous years. The monthly progress during 2023 is considered and a normal Excel-based forecasting technique is used for finding the trend and upcoming values. The back-year data is not considered as it contains the components of the pandemic period. This forecast reveals the existing trends of three-wheeler registration under various categories in the Kerala state.

Table 3: Forecast

Year & Month	Passenger Autos	Goods Autos	Non-Transport Autos	E- Passenger Autos	E-Goods Autos	Total
2023 Jan	2039	245	22	0	13	2319
2023 Feb	2126	277	25	0	20	2448
2023 Mar	2503	369	24	1	35	2932
2023 Apr	1763	286	16	6	24	2095
2023 May	2196	255	22	0	30	2503
2023 Jun	2198	226	31	0	6	2461
2023 Jul	2712	236	22	1	9	2980
2023 Aug	2942	280	53	0	3	3278
Forecast Sep	2869	245	24	0.4	1.4	3140
Forecast Oct	2973	240	25	0.4	0	3238
Forecast Nov	3077	235	25	0.3	0	3337
Forecast Dec	3180	230	25	0.3	0	3435
Total	30578	3124	314	9.4	141.4	34167

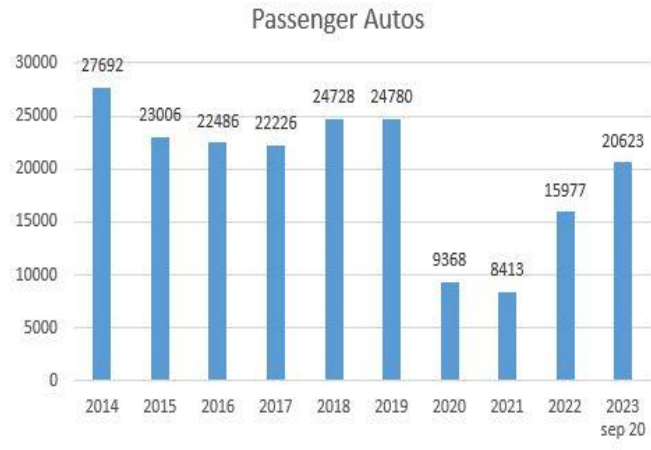
Data Source: vahan.parivahan.gov.in

5.2.1. Passenger autos

The number of registered passenger autos from 2023 January up to 2023 Sep 20 is 20623. Using the forecast technique in the first eight months, we can expect 12099 more registrations in the upcoming four months. Then total number of registrations in the year 2023 will be 30578. This means a remarkable growth rate of 91.38% is expected this year. This will be the maximum growth rate after the year 2014. Also, this will be the maximum number of registrations in one year after 2014. Conventional autos are the base of this calculation, which means that people even in this electric vehicle era, deviating from purchasing e-autos to conventional autos. The second maximum growth rate observed is in the year 2022, the value is 89.91%. Hence a continuous same level of growth rate exists in the passenger auto category of IPT mode in Kerala. Figure 7 shows the actual trend on 2023 September 20 without

considering the forecast result. The last bar in the graph, which represents the current year will rise above the value of 30,000 at the end of this calendar year.

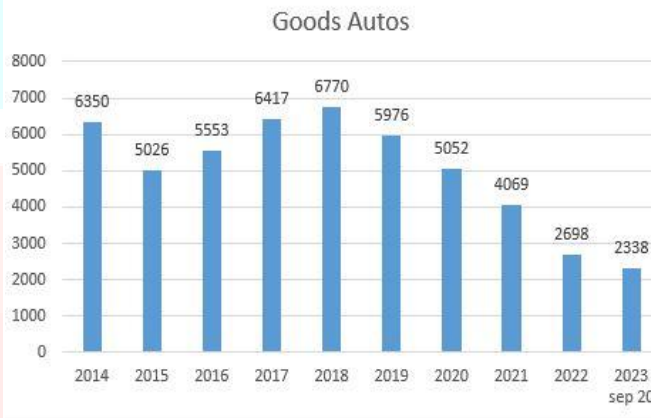
Figure 7: Trend of Passenger Autos



5.2.2. Goods Autos

The number of registered goods autos up to 2023 Sep 20 is 2338. Using the forecast technique based on the previous eight months of 2023, we can expect 950 more registrations in the upcoming four months. Then total number of registrations in the year 2023 will be 3124. If we are considering the continuous decline nature, this value will fall below 2338. Otherwise, a growth rate of 15.79% can be expected this year. A total number of 33702 transport autos can be expected in this year. Which shows a total growth rate of 80.47%.

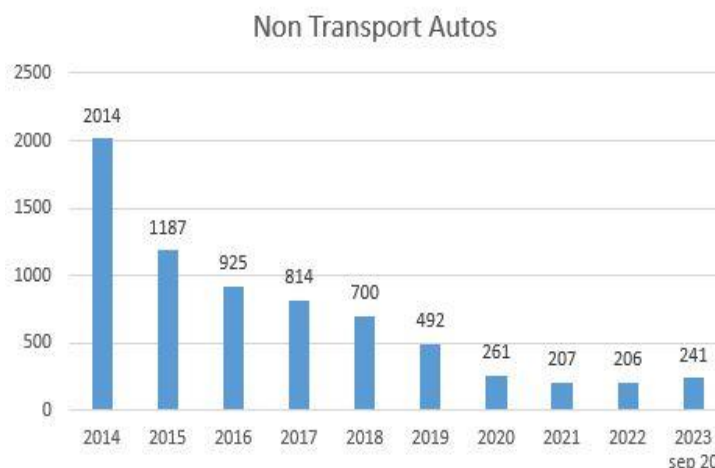
Figure 8: Trend of Goods Autos



5.2.3. Non-Transport Autos

The number of registered Non-Transport autos up to 2023 Sep 20 is 241. Using the forecast technique based on the previous eight months of 2023, we can expect 99 more registrations in the upcoming four months. Then total number of registrations in the year 2023 will be 314. A growth rate of 52.43% can be expected this year.

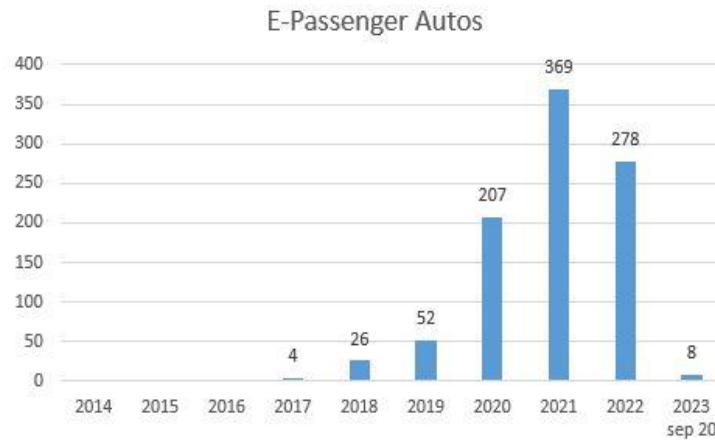
Figure 9: Trend of Non-Transport Autos



5.2.4. E-Passenger Autos

The number of registered E-passenger autos up to 2023 Sep 20 is 8 only. Using the forecast technique based on the previous four months of 2023, we can expect a maximum of 2 more e-auto registrations in the remaining four months. Then total number of registrations in the year 2023 will be 10. The decline rate is 96.4%.

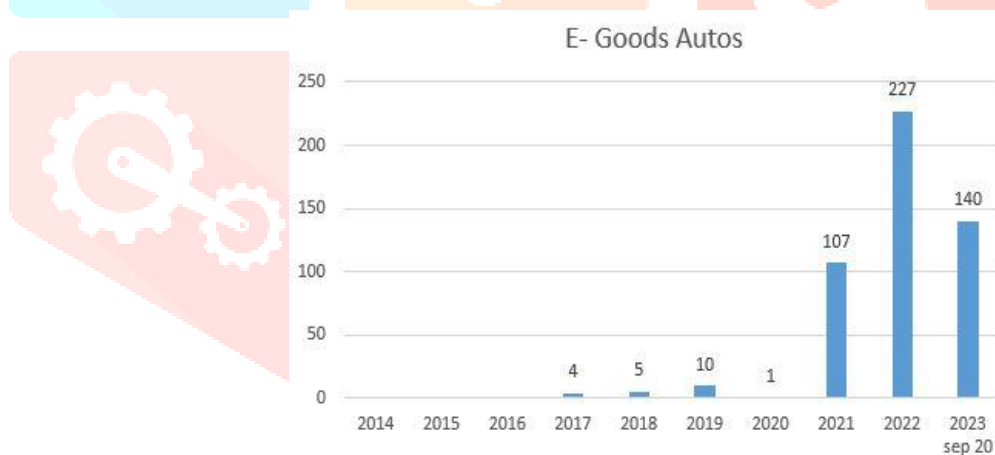
Figure 10: Trend of E- Passenger Autos



5.2.5. E-Goods Autos

The number of registered E-goods autos up to 2023 Sep 20 is 140. Using the forecast technique based on the previous four months of 2023, we can expect a maximum of 2 more e-goods auto registrations in the remaining months. Then total number of registrations in the year 2023 will be 142. The expected decline rate is 37.44%.

Figure 11: Trend of E-Goods Autos



6. OBSERVATIONS

1. The registration status during COVID-19, shows a decline nature except E-Passenger autos.
2. The decline rates of passenger auto registration observed during the years 2015, 2016, and 2017 shifted to steady behavior during 2018 and 2019.
3. The Passenger Auto sector in Kerala is now at a growth rate.
4. Year 2018 is the peak year for goods autos, and after that, it shows a continuous decline irrespective of pandemic years.
5. The Goods Auto sector in Kerala is now at a declining rate.
6. Irrespective of the pandemic period, the Non-Transport registration in Kerala is at a continuous decline rate. However, a huge decline rate of 41.06% was observed during the year 2015.
7. Now the Non-Transport sector shows a growth rate.
8. E-passenger auto registration showed remarkable growth during 2021, but now following a worse decline rate.
9. E-goods auto registration also follows a decline rate.

The percentage-wise status of each category is shown below in which the conventional passenger auto sector has a growth rate.

Figures 12: Percentage of Passenger Autos in the Three-Wheeler Sector of Kerala

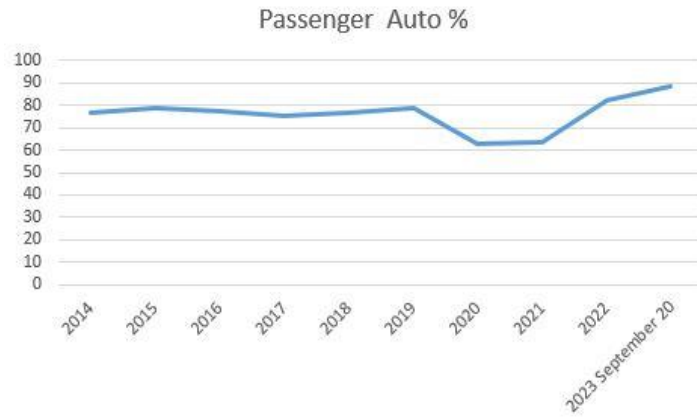


Figure 13: Percentage of Goods Autos in the Three-Wheeler sector of Kerala

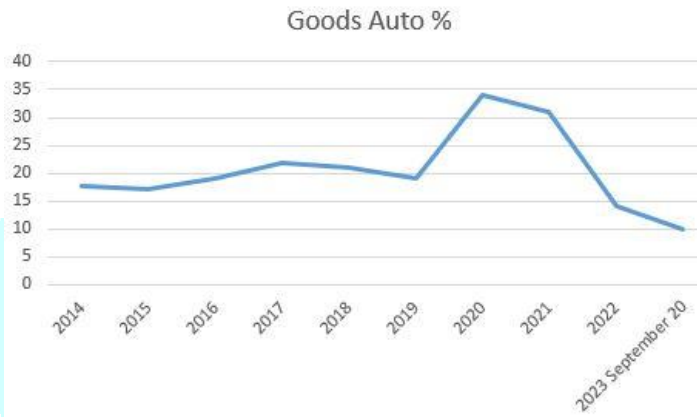


Figure 14: Percentage of Non-Transport Autos in the Three-Wheeler Sector of Kerala

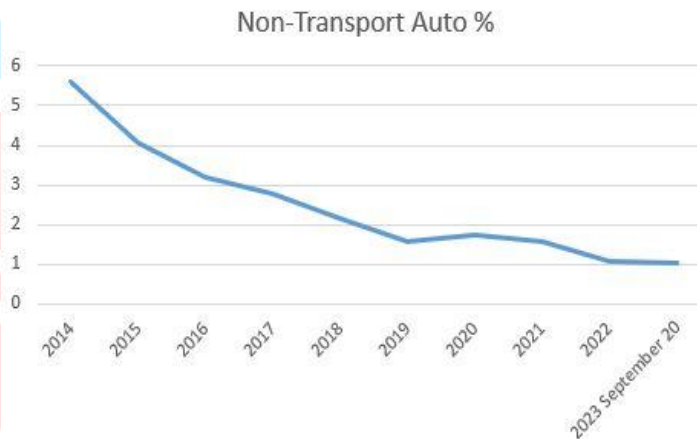


Figure 15: Percentage of E- E-Passenger Autos in the Three-Wheeler Sector of Kerala

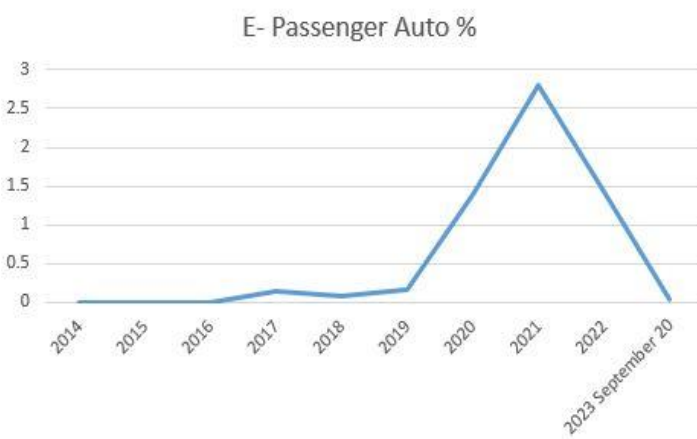
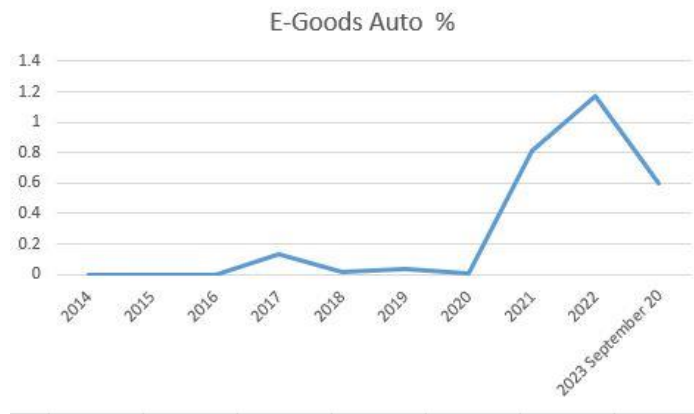


Figure 16: Percentage of E-Goods Autos in the Three-Wheeler Sector of Kerala



7. SUGGESTIONS

Observations reveal that the autorickshaw IPT mode in Kerala is in the path of growth after the pandemic period. But the electric auto sector is not that much entered in the IPT mode. Both the passenger and goods autos in the electric sector feel a repulsion from the auto purchasers. E-policy and its positivity must be spread in society to attract more people towards the E-auto. The negatives faced by E-auto owners and corresponding news in the media may be the reason for the declining nature of e-auto registration. This problem must be scientifically addressed and solved. The managerial and technical persons of e-auto makers must address the same. The charging and swapping-related problems are critical problems in Kerala. These problems must be solved by proper planning and installation of charging centers and swapping centers. Proper training for auto rickshaw drivers including financial management is crucial for the sustainability of Auto IPT mode in Kerala. Organized E-auto rickshaw operation based on a cluster system is a suggestion for solving the recharge-related issues that are often reported by owners.

8. CONCLUSION

This study observed the registration status and corresponding trends in the auto IPT sector of Kerala. Trends were identified for various categories of auto rickshaws. The consolidated trend in Kerala cannot be considered as the trend in various sub-centers of Kerala. The trend may vary for various districts. The reason for the trend must be identified separately using the data of individual road transport offices. The negative trend in the E-passenger sector needs more concentrated study for achieving the green policy of the nation.

REFERENCES

- [1] <https://timesofindia.indiatimes.com/city/kochi/kerala-ernakulam-witnesses-drop-in-registration-of-autorickshaws/articleshow/93719467.cms>
- [2] <https://timesofindia.indiatimes.com/city/kochi/vehicle-registrations-up-auto-taxi-decline-sharply/articleshow/88961896.cms>
- [3] <https://vahan.parivahan.gov.in/vahan4dashboard/vahan/vahan/view/reportview.xhtml>
- [4] Behl, A., Rathi, P. and Kumar, V.A., 2018. Sustainability of the Indian auto rickshaw sector: identification of enablers and their interrelationship using TISM. *International Journal of Services and Operations Management*, 31(2), pp.137-168.
- [5] Mani, A., Pai, M. and Aggarwal, R., 2012. Sustainable urban transport in India: role of the auto-rickshaw sector.
- [6] Harding, S.E., Badami, M.G., Reynolds, C.C. and Kandlikar, M., 2016. Auto-rickshaws in Indian cities: Public perceptions and operational realities. *Transport policy*, 52, pp.143-152.
- [7] Reynolds, C.C., Kandlikar, M. and Badami, M.G., 2011. Determinants of PM and GHG emissions from natural gas-fueled auto-rickshaws in Delhi. *Transportation Research Part D: Transport and Environment*, 16(2), pp.160-165.
- [8] Chandrashekar, C., Chatterjee, P. and Pawar, D.S., 2022. Estimation of CO₂ and CO emissions from auto-rickshaws in Indian heterogeneous traffic. *Transportation Research Part D: Transport and Environment*, 104, p.103202.
- [9] Bagul, T.R., Kumar, R. and Kumar, R., 2021. Real-world emission and impact of three wheeler electric auto-rickshaw in India. *Environmental Science and Pollution Research*, 28, pp.68188-68211.
- [10] Shlaes, E. and Mani, A., 2014. Case study of autorickshaw industry in Mumbai, India. *Transportation research record*, 2416(1), pp.56-63.
- [11] Vaidya, S., Gupta, S. and Singhal, G., 2014. GPS Devices to Increase Efficiency of Indian Auto-Rickshaw Segment. *International Journal of Economics and Management Engineering*, 8(3), pp.666-670.
- [12] Bagul, T.R., Patil, K., Kote, A., Balpgold, B.S., Kumare, R., Kumar, R. and Akurdi, P., 2018. Analysis of autorickshaw as an intermediate paratransit system. *Int J Pure Appl Math*, 118, p.24.
- [13] Bisht, L.S. and Ahmed, M.A., Socio Economic Characteristics of Autorickshaw Operators in Silchar.
- [14] Sharma, R.D., Jain, S. and Singh, K., 2011. Growth rate of Motor Vehicles in India-Impact of Demographic and Economic Development. *Journal of Economic & Social Studies (JECOSS)*, 1(2).