



FACTORS INFLUENCING THE ADOPTION OF ELECTRIC VEHICLES: A STUDY WITH SPECIAL REFERENCE TO KERALA

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Abstract: The adoption of electric vehicles (EVs) has gained significant traction worldwide as countries and individuals strive for sustainable and environmentally friendly transportation solutions. The purpose of this article is to investigate the factors influencing EV adoption and to assess consumer satisfaction with EV adoption. The researcher follows a descriptive research design and the data collected directly from 100 respondents via a well-structured questionnaire. The findings revealed that environmental concerns, social influence, performance, after-sales service, economic benefit, and physical appearance of electric vehicles are all factors that influence EV adoption.

Keyword: Adoption, Electronic Vehicles, Environmental Concern, Performance, Satisfaction

INTRODUCTION

In a country like India the movement for protecting our environment has begun in the early years, some of the movements were Swachh Bharath, clean Ganga, Narmada Bachavo Andolanss, etc.,

which was to clean surrounding, saving water, and protecting our environment. Present-day India is taking their next step towards reducing air pollution by promoting people in using the electric vehicle for this purpose the Central Government of India has implemented various incentives. (Capital subsidy, Road tax exemption, Concession in registration fee) These incentives vary for each type of vehicle according to their kilowatt hour. Similarly, each state has its own policies implemented to promote the usage of electric vehicles. In the budget presented by Ms. Nirmala Sitharaman, finance minister of India on 1st Feb 2023, many new incentives were introduced in terms of tax and excise duties for promoting EVs. Electric vehicles (EVs) are increasingly being recognized as a critical element in promoting a green economy. They run on renewable sources like solar, wind, and hydropower, and emit significantly less greenhouse gases and air pollutants than traditional combustion vehicles. This makes them an essential tool in the fight against climate change and air pollution. The entire world has joined hands together to promote the usage of EVs in our daily life, so as to improve the lifestyle and promote a green economy. This can help in reducing environmental degradation.

Kerala, a state in the southern part of India, has shown great potential for the adoption of EVs. The state has set an ambitious target of having one million EVs on roads by 2022, and the government has implemented various policies and incentives to promote EV adoption. The state government has launched a project to establish charging stations for EVs at strategic locations, including tourist destinations and residential areas. The adoption of EVs in Kerala has the potential to bring several economic and environmental benefits. It can reduce the state's dependence on fossil fuels, which can lead to energy security and a reduction in greenhouse gas emissions. Although EV technology is gaining popularity worldwide, India has yet to establish itself in this sector. The Indian government has laid forth an ambitious and desirable plan for all-electric cars. This ground-breaking shared-connected-electric mobility system may enable 100% of public transport vehicles and 40% of private vehicles to operate solely on electricity by 2030 (SIAM, 2017). This vision must be broadened in order to realize a future of entirely electric mobility by maximizing the use of electric vehicles. In order to assist the government in creating regulations and aid automakers in understanding consumer wants and aspirations, the study's objective is to identify probable factors that could have an impact on the adoption of EVs. To achieve this goal, sufficient market study needs to be conducted, and this is one drawback that the country currently faces at present.

Promoting EVs can improve the air quality in the state, which has been a major concern in recent years. The state has seen a surge in the number of vehicles, especially two-wheelers, which are major

contributors to air pollution. The adoption of EVs can help reduce air pollution and improve the health of citizens. This study aims to identify the variables influencing EV adoption, as well as to gauge public knowledge of EVs and customer satisfaction. The majority of the obstacles to the purchase and promotion of EVs may be recognized by understanding these aspects, and research can be conducted to address these obstacles, which can help to expand the adoption of electric vehicles in Kerala and later in India. This report also covers all recently established EV promotion policies, which will help potential adopters approach EVs with complete knowledge. It is done specifically with regard to the state of Kerala, so as to recognize the state government's initiatives to encourage the usage of EVs.

REVIEW OF LITERATURE

Shanyong Wang et al.(2014) predicted the customers intentions to adopt EVs in China and identified Environmental protection as the major concern towards adopting EVs along with Consumers attitude, Subjective norms, and perceived behavioral control. The study recommended that in order to expand the number of service organizations, subsidies, and environmentalists, everyone should be made aware of their obligation to safeguard the environment. According to the study's findings, customers are more likely to adopt EVs if they have a high level of environmental awareness. **Lukiman Wahab and Haobin Jiang, (2019)** examined the factors influencing the adoption of EVs among the motorcyclists in Ghana and identified price, government subsidies, fuel efficiency and performance as the major factors influencing adoption of EVs. The study also identified that probability of adopting electric motorcycles decreases by 18.2% for a unit increase in the cost of electric motorcycles. It also suggested that the policy makers and EV manufacturers must develop strategies to be implemented in Ghana for consumer awareness. The researcher concluded that Riding pleasure, operating cost, charging infrastructure and life span of the battery have less statistical significance on adoption on EVs. **Jay P Trivedi and Kaushal Kishore, (2020)** investigated the factors influencing purchase intentions of EVs. The top three elements influencing consumers' purchasing intentions, according to the study, are vivacity, online reviews, and accessibility. Along with the aforementioned considerations, other automobile characteristics, outside influences, and pricing were also found to have an impact on people's intentions to buy EVs. The study determined that brand attributes and brand love play a mediating impact. The researchers found that brand love is a strong predictor of purchase intention, as opposed to brand attitude. **Virender Singh et al. (2020)** discussed a review and straightforward meta-analysis of the variables affecting EV adoption. According to the study,

environmental factors indirectly influence adoption intentions, whereas psychological and demographic factors have a beneficial impact on the adoption of electric vehicles. The high initial cost and short range of EVs are another key barrier to their widespread adoption. The study's findings support the idea that sociodemographic and psychological traits might be used to predict consumer adoption of electric automobiles. **Verma et al. (2020)** discussed financial incentives, physical appearances, environmental concern, and fuel efficiency as the factors influencing adoption of EV. The study suggested that the policies to increase the EV market share must simultaneously make efforts to decrease the use of EVs by increased taxes. It also suggested that formulating and regulating environmental policies will stimulate the adoption of EVs along with installation of battery charging infrastructure. According to the study's findings, there are no appreciable differences in EV awareness or readiness to buy EVs for environmental reasons across age, gender, and educational attainment. **Zhengwei Xia et al. (2022)** undertook an empirical investigation on the social, economic, and functional aspects affecting EV adoption in China. Finds that DOI theory has strong explanation power for the adoption of EVs. The study evidence that two significant economic factors that affect the adoption of EVs are the risk of financial subsidies and the risk of price reductions. The study also found that market penetration is positively impacted by intelligence functions and artificial intelligence. The comparison analysis led the researchers to the conclusion that perceptions of compatibility and relative advantage have the biggest impacts on EV adoption, while perceptions of complexity have the least. **V. Vijai Krishnan and Bino I. Koshy, (2022)** examined the factors influencing the consumers purchase intention of EVs in Kerala, and identified technological consciousness, social influence, price, usefulness, and ease of use are the factors that influence adoption of EVs. The survey also discovered that convenience of charging at home (5%), cheap fuel costs (19%), and environmental friendliness (60%) are the main variables affecting adoption. The report also outlined some of the disadvantages of EVs, including their short driving range, unavailability of on-road charging stations, high initial cost, prolonged recharging time, and lack of familiarity with cutting-edge technology. The study also recommended that the EVs' prices should be competitive with those of CVS, that EV test drives be made available, and that the promotional team should concentrate on appealing to consumers with high levels of education and those who commute short distances. The study concluded that the low public acceptance of EV is due to lack of faith in implemented public policies and uncertainties about its ease of use. **Pham Van Tuan et al. (2022)** examined the factors influencing purchasing intentions towards EV in Vietnam. According to the study, factors that positively influenced buying intentions included government assistance, environmental perception, attitude towards the infrastructure, and performance. With a standardized estimate of 0.343,

the findings revealed that the infrastructure characteristic had the greatest influence on consumers' attitudes towards purchasing electric vehicles. The Price factor, which affected buyers' intentions to make purchases and had a standard estimate of 0.322, came in second behind infrastructure. Consumers' purchase intentions were significantly impacted by performance while they were very slightly impacted by environmental impact. The study indicated that in order to increase customer preferences for EV as a source of environmentally friendly goods, the government should offer battery leasing, cheaper registration fees, and road tax exemptions. **Sriram K V et al, (2022)** examined the variables affecting EV adoption in Bangalore. According to the survey, factors influencing adoption of EVs include finances, EV performance, a shortage of charging stations, environmental concerns, societal pressure, and EV awareness. According to the survey, the market adoption of EVs has slowed because of their expensive price, which is roughly two to five times that of CVs. According to the report, EV usage will increase as battery capacity increases, and the increasing cost may be offset by CVS's operational expenses. The study concluded that India would move towards a sustainable environment due to the increasing driving range and inexpensive cost of EVs. **Ehsan Javanmardi et al. (2023)** examined record of EV manufacturers in China. For the analysis of the secondary data and the inclusion of the pandemic situation, the researcher used a grey econometric method. The researcher discovered that cab drivers in China were the country's biggest EV consumers. The researchers proposed fast charging stations and charging stations, both of which had a big impact on EV sales. The researchers' recommendations to increase battery capacity and charging speed significantly affected EV sales. According to the researcher, the pandemic caused a fall in EV sales over the study period.

OBJECTIVES OF THE STUDY

- To identify the factors influencing the adoption of Electric Vehicles
- To measure the satisfaction of Consumers towards Electric vehicles

HYPOTHESIS

H₀₁: There is no significance between the gender of the respondent and the adoption of EV

H₀₂: There is no significant between the demographic variables of the respondent and their satisfaction towards the adoption of EVs

H₀₃: There is no impact of factors such as Physical Appearance, Economic Benefit, Social Influence, After-Sales Service, Performance and Environmental Concern on Adoption of Electric Vehicles.

RESEARCH METHODOLOGY

The study was descriptive research and data were collected directly from the respondents using a well-studied questionnaire. The researcher used a purposive sampling method for collecting the primary data. The sample size of the study is 100 and the data are collected from Ernakulum district, Kerala.

RESULT AND DISCUSSION

The purpose of the research project is to measure consumer satisfaction with EVs and to discover the factors driving the adoption of EVs. For this purpose, the researcher conducted regression and exploratory factor analysis. The following are the results of the analysis conducted and the discussions for the same are mentioned below:

TABLE 1
Demographic Profile of the Respondents

Variables	Attributes	Frequency	Percent
Age	18-25	12	12.2
	26-35	26	26.5
	36-45	32	32.7
	46-55	27	27.6
	56-65	1	1
Gender	Male	73	74.5
	Female	25	25.5
Occupation	Private	47	48
	Government	17	17.3
	Business	26	26.5
	Students	8	8.2
Educational Qualification	Plus two	15	15.3
	Undergraduate	39	39.8
	Postgraduate	43	43.9
	Others	1	1

Residence	Urban	55	56.1
	Semi-urban	41	41.8
	Rural	2	2
Income index (in Rs)	below 25000	10	10.2
	25000-50000	4	4.1
	50000-75000	23	23.5
	75000-100000	61	62.2

Source: Computed data

Table 1 shows the demographic profile of the respondents. It gives a better understanding of the behavior of the respondents toward the adoption of electric vehicles. Table 1 shows that majority (74.5%) of the respondents are male, with an age group of 36-45 (32.7 %), most of them are from urban areas (56.1 %) with an income index of Rs.75000- Rs.100000 (62.2 %).

TABLE 2
KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.765
Bartlett's Test of Sphericity	Approx. Chi-Square	1015.016
	df	171
	Sig.	.000

Source: Computed data

To assess the efficacy of the sampling and determine the acceptability of the data used in the questionnaire, the KMO-Bartlett's test is utilized. Using the data from adequate sampling, the researcher can classify or arrange the survey items. By grouping the objects being studied, the data set can then be divided into interpretable components to help the researcher better understand the constructions. The sampling appropriateness reveals how strongly an item correlates with other items in the EFA correlation matrix. It is clear from table 2 that the KMO value, which is 0.765, is higher than the acceptability value,

which is 0.5. As a result, the outcome demonstrates that the samples that were gathered were sufficient and acceptable. This indicates that there is correlation existing in the data collected. Here, the significance level is less than 0.05, indicating that the correlation matrix is not an identity matrix and allowing for the continuation of the exploratory factor analysis.

TABLE 3
Exploratory Factor Analysis (EFA)

SL NO	Factors	Item	
		Q NO	Question
1	Environmental Concern (EC) (15.004 %)	EC 01	Driving an electric vehicle reduces our dependence on fossils
		EC 02	Driving an electric vehicle reduces the carbon footprints
		EC 03	Electric vehicles are useful to reduce carbon emission and alleviate the energy shortage problems
		EC 04	The electric vehicle can contribute to the environment for the future generation
2	Social Influence (SI) (12.664 %)	SI 01	The people close to me think that it is important to consider the environment when purchasing an EV
		SI 02	Driving the EV would make me feel socially responsible
		SI 03	Among my peers, I am usually the first to try new products like EV
3	Performance (P) (11.794 %)	P 01	The instant acceleration played an important role in adopting the EV
		P 02	The increased braking efficiency played an important role in adopting the EV

		P 03	The Cranking power at low and high temperatures played an important role in adopting the EV
4	After Sales Service (AFS) (11.446 %)	AFS 01	The EV manufacturers hear to the complaints of the customers
		AFS 02	There are enough service centers nearby
		AFS 03	The spare parts are easily available
5	Economic Benefit (EB) (10.959 %)	EB 01	EVs are useful to reduce my household expenses
		EB 02	I will save on fuel expenses, as running cost should be lower in case of an electric vehicle
		EB 03	The maintenance cost of EV would be less
6	Physical Appearance (PA) (10.93 %)	PA 01	The design of the EV attracted me
		PA 02	The green number plate attracted the crowd
		PA 03	It is easier for me to park the vehicle (reserved parking)

Source: Computed data

Table 3 displays the EFA results, from which the researcher identified the major factors affecting the uptake of electric vehicles. The study examined a sample of 100 respondents from various regions in Kerala. The principal component and varimax rotation were applied to each of the 19 items. Based on eigenvalues greater than 1, the number of factors to extract was calculated. The EFA computed 6 factors and explained 72.797% of the variance using the rotational factor loadings. The parameters identified from the research are named as Environmental Concern (15.004%), Social Influence (12.664%), Performance (11.794%), After Sales Service (11.446%), Economic Benefit (10.959%), and Physical Appearance (10.93%).

TABLE 4
Rotated Component Matrix

Rotated Component Matrix	
	Component

	1	2	3	4	5	6
EC01	0.863					
EC02	0.852					
EC04	0.845					
EC05	0.756					
SI01		0.814				
SI02		0.762				
SI03		0.75				
P01			0.86			
P02			0.773			
P03			0.701			
AFS01				0.821		
AFS02				0.813		
AFS03				0.71		
EB01					0.856	
EB02					0.768	
EB03					0.74	
PA01						0.878
PA02						0.812
PA03						0.776
Extraction Method: Principal Component Analysis.						
Rotation Method: Varimax with Kaiser Normalization.						
Rotation converged in 6 iterations.						

Source: Computed data

Table 4 shows that all the 19 items are grouped according to their respective factors with each value greater than the accepted limit of 0.5. Hence, it is understood that the first 4 items are to be evaluated under the factor Environmental Concern, the next three items are grouped under Social Influence, then the next

three items under Performance, then the next 3 under After Sales Services, the next 3 under Economic Benefit and the balance under Physical Appearance.

TABLE 5
Reliability statistics

Cronbach's Alpha	N of Items
0.766	19

Source: Computed data

In order to determine how closely the variables were related to one another, the reliability test was carried out. The Cronbach's Alpha test can be used to evaluate the accuracy and consistency of the variable evaluation. Previous researchers have proposed that the elements of the affirmation of Cronbach's Alpha will be 0.70. In Table 5 Cronbach's Alpha value is more than 0.70. Hence, the scale is reliable.

H₀₁: There is no significance difference between the gender of the respondent and their satisfaction towards EVs

TABLE 6
Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
				F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
		Lower	Upper							
satisfaction	Equal variances assumed	0.236	0.628	1.709	96	0.091	0.196	0.115	-0.032	0.424

	Equal variances not assumed			1.783	44.989	0.081	0.196	0.11	-0.025	0.418
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Source : Computed data

Table 6 points out that there is no significance between the gender and their satisfaction towards electric vehicles. It can be seen that the P value is above the 0.05 acceptable level. The null hypothesis is therefore accepted. The mean value of male is 4.12 and that of female is 3.92 which is approximately equal, this shows that both male and female has equally satisfied with the performance, price, performance, driving range, nearby charging stations, and government policies implemented with reference to EVs.

H₀₂ : There is no significant difference between the demographic variables of the respondent and their satisfaction towards the EVs

TABLE 7
ANOVA

Demographic Variable		Mean	Std. Deviation	F	Sig.
AGE	18-25	4.44	0.644	5.675	.000
	26-35	4.24	0.359		
	36-45	4.17	0.103		
	46-55	4.54	0.196		
	56-65	4.27	0.3		
PROFESSION	Private	4.17	0.274	11.098	.000
	Government	4.32	0.235		
	Business	4.58	0.118		
	Students	4.46	0.772		
	Plus two	4.44	0.155	11.343	.000

EDUCATIONAL QUALIFICATION	Undergraduate	4.46	0.307		
	Postgraduate	4.12	0.354		
	Others	4.39	0.31		

Source: Computed data

According to Table 7, there is a substantial correlation between respondents' happiness with electric vehicles and demographic factors including Age, Profession, and Educational background. The P value of demographic variables is less than 0.05. Hence, the null hypothesis is rejected. It concludes that there is a significant difference in their satisfaction towards the electric vehicles. In the table, the researcher found that the respondents with age group 46-55 are more satisfied (mean 4.54) with other groups. The Post Hoc concluded that the age group 46-55 are more satisfied. Whereas, in the case of profession the highest mean score was obtained by the business profession(4.58) which shows that they are highly satisfied with the electric vehicles, compared with others such as private employees, government employees, and students. In case of educational qualification, the highest mean score was seen in case of undergraduates (4.46) whereas the least was seen in postgraduates(4.12) which shows cases that the respondents with the educational qualification as undergraduates show the highest satisfaction towards electric vehicle in Kerala. The Post Hoc test confirms the result.

H₀₃ : There is no impact of factors such as Physical Appearance, Economic Benefit, Social Influence, After-Sales Service, Performance and Environmental Concern on Adoption of Electric Vehicles

TABLE 8
Mode Summary

Model	R	Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.899	0.808	0.795	0.226	1.788
a. Predictors: (Constant), Physical Appearance, Economic Benefit, Social Influence, After-Sales Service, Performance, Environmental Concern					
b. Dependent Variable: Adoption of EVs					

Source: Computed data

In order to find the impact of factors such as Physical Appearance, Economic Benefit, Social Influence, After-Sales Service, Performance, and Environmental Concern on adoption of electric vehicles, the researchers used multiple regression. Here, adoption of EVs is treated as the dependent variable, whereas physical appearance, economic benefit, after-sales service, performance, and environmental concern are considered independent variables. The R square value is 0.795, this means that the factors thus explains 80.8 % of the variation in adoption. The Durban-Watson test illustrates that there is no autocorrelation in the variables. Here, the test result shows 1.788 which is less than 2, this implies a positive autocorrelation.

TABLE 9
ANOVA of Regression

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19.589	6	3.265	63.836	.000
	Residual	4.654	91	0.051		
	Total	24.243	97			

Source: Computed data

Table 9 reveals the result of regression ANOVA. It shows P value is below the acceptance limit ($P < 0.05$). This demonstrates the rejection of the null hypothesis. Consequently, it can be concluded that there is an impact of physical appearance, economic benefit, social influence, after-sales service, performance, and environmental concern on adoption.

TABLE 10
Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	0.656	0.264		2.489	0.015		

Environmental Concern	0.204	0.04	0.325	5.151	0	0.53	1.888
Social Influence	0.142	0.036	0.229	3.97	0	0.635	1.575
Performance	0.138	0.036	0.22	3.821	0	0.637	1.571
After Sales Service	0.121	0.03	0.214	4.094	0	0.772	1.295
Economic Benefit	0.126	0.024	0.292	5.354	0	0.709	1.41
Physical Appearance	0.095	0.045	0.099	2.115	0.037	0.954	1.049

Source: Computed data

Table 10 clearly shows that all the hypotheses are supported as the P-value is less than 0.05. This denotes that all the predictors such as environmental concern, social influence, performance, after-sale services, economic benefit, and physical appearance are impacted by the adoption of electric vehicle. The VIF value signifies multicollinearity in regression analysis. The VIF value is less than 5, which indicates that there is no multicollinearity amongst predictors, as is seen from the table. The table clearly shows that environmental concern is the most influencing factor for adoption of electric vehicle, followed by social influence, performance, economic benefit, after-sales service, and physical appearance.

The multiple regression equation based on the analysis is as follows:

$$Y(\text{adoption}) = 0.656 + 0.204X_1 + 0.142X_2 + 0.138X_3 + 0.121X_4 + 0.126X_5 + 0.095X_6$$

Where,

X1= environmental concern, X2= social influence, X3= performance, X4= after-sales services, X5= economic benefits, X6= physical appearance

FINDINGS AND SUGGESTIONS

In India, the market penetration of electric cars is currently extremely low, approximately 1.3 % for private automobiles, 3 % for two-wheeler, and almost zero for commercial vehicles. This might be due to a number of things, such as a widening affordability gap, a lack of consumer acceptance (i.e., a lack of

demand), the absence of public charging infrastructure, a lack of manufacturing activity for electric vehicles, etc. However, it is possible to anticipate that with a focused effort and enough time for it to be effective, all of these factors may be adequately taken into consideration. It was found that the respondents were least satisfied by the appearance factor of the electric vehicles. In the coming generation people are more beauty conscious in both their appearance as well as what they use. People are recognized by the brand they use, their appearance, the products they use etc., these shows their personality in front of their society. If the appearance of electric vehicles were much more modern like sports bikes, classic bullets etc., it could attain much more attention and attraction in the eyes of today's generation.

In India the latest generation of electric vehicles are having the maximum range of 170km/ charge for two wheelers and 631km/charge for four wheelers. As the vehicle consumes electric power it is mandatory to maintain its charge level so as to reach our destination, for this the EV manufacturing company's provide charging cables along with the vehicles which helps the users to charge from their home or wherever they are able to charge. In a situation where the user faces a shortage of charge on travelling there has to be an ample number of charging stations along the road. This is one of the major issues faced by EV users, if this issue is solved EV can attract more customers.

CONCLUSION, LIMITATION AND SCOPE OF FURTHER STUDY

Electric vehicles are one of the developing inventions in automobiles. In a state like Kerala such a study is really essential as it is promoting adoption of electric vehicles. This study's primary goals were to determine the elements influencing EV uptake and gauge consumer satisfaction with EVs. The study concluded that the respondents with the age group between 46-55 with an educational qualification of undergraduate and a profession of business showed the highest satisfaction towards adoption of electric vehicles in Kerala. It was found that as the study was restricted to the state of Kerala the result of the study cannot be applied for the entire country as Kerala is a small state in India and as the study didn't focus on the cost factor, which is one of the major factors that influences the adoption of EV, there is a huge scope in conducting future studies based on other factors such as cost, awareness etc.

EV is a growing business in India and the survey of sales of vehicles in India till April 2023 showed that 41% of the sales was electric vehicles. It was also studied in a survey that Uttar Pradesh are the highest consumers of electric vehicle in India. In a survey of sales of vehicles in Kerala, it was seen that 7.92% of the vehicles sold were electric vehicle, from these surveys the need for the study of awareness of EV among

the customers as well as the factors that can influence the adoption of EV among customers is seen essential and mandatory. The researcher discovered that this research can be helpful for electric vehicle producers and suppliers, for institutions both governmental and commercial that focus on green business solutions or sustainability, as well as for the government in improving its policies to draw in more and more customers, which can result in the development of a green economy.

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