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RESEARCH ARTICLE

Clean and sustainable transportation through electric vehicles — a user survey of three-wheeler vehicles in Pakistan

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Abstract

Transportation sector is one of the major contributors to GHG emissions, and it is essential to investigate the role of electric vehicles in economic and environmental performance of developing countries. In this research work, the authors seek to investigate the usage pattern of three-wheeler vehicle by taking a Pakistan-based survey approach and analyzing the responses from various three-wheeler drivers across the country. The survey results indicate that the adoption of hybrid and electric three-wheelers in Pakistan would be welcomed by the users due to increased economic benefits, despite having a high initial capital cost. On an average basis, the regular three-wheeler is run for more than 5 days a week, 101–150 km daily across more than 10 h, and enables the owner to make around PKR 20,000–25,000 (~ US $119–US $149) after approximately PKR 15,000 (~ USD $89) is spent every month on fuel and maintenance. The adoption of hybrid or electric three-wheelers can easily improve the monthly earnings by 50%. In addition to this, the GHG emissions from the transportation sector will be considerably lowered around 3–6 tonnes of CO_2 emissions per year per three-wheeler. At an investment return period of 13–16 months, the electric three-wheeler is a highly lucrative opportunity.

Keywords Three-wheeler vehicle · Electric vehicle (EV) · Clean transportation · Electric Vehicle Policy

Introduction

The industrial revolutions brought about a paradigm shift in the quality of lives of individuals; the world became a global village and the technological advancements resulted in extensive economic gains. However, the environmental impact of the economic gains was often overlooked and it eventually culminated in the pressing issue of climate change where the annual temperatures are forecasted to rise by 0.5–4.5 °C over the next century (GoP, 2016) if stringent measures are not taken. In this context, it is incumbent upon the stakeholders and policymakers to identify the areas where the carbon footprint can be reduced through conscious efforts. Transportation sector is one of the major contributors to environmental pollution[1] and the conventional internal combustion engines require stringent protocols for curbing the environmentally detrimental greenhouse gas emissions. Therefore, countries have promoted the use of electric vehicles (Kwon et al., 2020; Daina et al., 2017) to reduce the environmental impact of transportation, in addition to numerous clean energy initiatives. The commercially available electric vehicles are broadly classified into two categories: (i) plug-in hybrid electric vehicles or PHEVs and (ii) battery electric vehicles or BEVs and share the common aim of reducing the GHG emissions by reducing or eliminating the use of fossil fuels (Coffman et al., 2017). The worldwide adoption of hybrid technology vehicles has been an outcome of spreading awareness followed by relevant actions among governments, consumers, and producers. In the beginning, public and industries favored pure electric BEVs or fuel cell vehicles (FCEV) but plug-in hybrid technology offers an immediate solution to reduce emission and

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[1] Transport accounts for nearly quarter of the total energy related CO_2 emissions (https://www.unenvironment.org/explore-topics/resource-efficiency/what-we-do/cities/sustainable-transport-and-air-pollution).

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substantially improve fuel economy hence savings. In spite of massive development and cost reduction in components, BEVs still have a bottleneck. One of the major issues BEVs face is the limitation of range, to which even the inclusion of more batteries is a fix does not solve the issue at hand. The addition of more batteries is known as mass compounding, which changes the product performance. Mass compounding implies that for every kilograms of battery mass added to increase range, the size and weight of other BEV components must also be increased to maintain the performance and safety of the vehicle (Ma et al. 2016). However, future lies with electrification of the vehicles be it PHEV, BEV, or FCEV.

Being a developing country, Pakistan puts much more focus on fossil fuels to meet its energy demand. After electricity, the transport sector is the major contributor towards GHG emissions by accounting for 25% of the annual emissions (USAID 2016). With a social stratum that lives at a median wage of US $150[2]/month, the three-wheeled vehicle is the preferred mode of transport, colloquially known as rickshaw in the local vernacular which uses petrol, liquefied petroleum gas, or compressed natural gas as fuel. Due to steep rise in the number of vehicles on the road, the demand of fuels keeps rising that manifests itself in the inflated fuel prices. Therefore, a conscious effort is required to introduce electric vehicles which not only provide better environmental performance but also reduce running costs. In this scenario, it is of utmost importance to observe the usage pattern of commercially available vehicles, the feasibility of introducing electric vehicles in a developing economy and its overarching policy considerations. Therefore, the research objectives are given as follows:

1. What is the current state of technological development in three-wheeler electric vehicles?
2. What are the challenges faced by three-wheeler drivers?
3. How can the challenges be addressed through electric three-wheelers and integrated in the national policy?

Using a Pakistan-based study, the authors undertake a survey-based approach to observe the usage pattern of a three-wheeler vehicle in Pakistan by taking the responses of three-wheeler vehicle drivers from a metropolitan city to arrive at various policy implications regarding electric vehicles. Rasool et al. (2019) worked on the impact of economic growth and population density on the carbon dioxide emissions from the transport sector of Pakistan and utilized autoregressive distributed lag (ARDL) bounding approach to confirm the relationship between the aforementioned variables, but the research work did not take into account the electric vehicles facet. Wu and Zhang (2017) have discussed the impact of electric vehicles' utilization in developing countries and concluded that CO_2 emissions substantially decrease by doing so; however, the research work did not cater to the socio-economic facet of the electric vehicles (EVs). Previously, Asghar et al. (2020) have used a literature review approach to analyze the maturation of electric vehicles and the adoption challenges faced by Pakistan but the research work lacked a ground-level approach and the policy recommendations were based upon empirical evidence collected from the previous literature.

For a new technology, changing the perception of users and addressing their inhibitions are critical success factors towards their effective implementation. This narrative is even more pronounced in the case of electric vehicles, where the range of the vehicle is the major concern raised by the users, thus making consumer survey extremely important. Lebeau et al. (2013) collected over 1100 responses in Belgium to understand the user perception for battery electric vehicles; however, it did not account for the sustainability implications of the electric vehicles, except for eco-friendliness. For electric three-wheelers, Majumdar and Jash (2015) investigated their advantages over conventional three-wheelers by conducting a survey in West Bengal; however, the focus was on the collection of data regarding operating parameters, distance traveled, energy consumption, environmental impact, etc., and the holistic sustainability performance of the electric three wheelers was not discussed. Priye et al. (2021) worked towards understanding the socio-economic characteristics of paratransit drivers and assessed their perception towards electric three-wheelers. The research suggested that the despite the long hours and physically daunting job, the drivers earn very less and commonly use rented vehicles. However, the research did not discuss the policy relevance of adoption of electric three-wheelers. Other research works have covered the lack of regulatory mechanisms for electric three-wheelers regarding traffic and safety (Kumar and Roy 2019, Mondal and Saha 2020). However, a comprehensive effort to understand the social, economic, and environmental importance of electric three-wheelers that leads to policy suggestions is missing, and the authors of this research work aim to fill this gap. Therefore, to the best of the authors' knowledge, this is the first study that uses a survey-based approach to evaluate the current state of EV adoption and develops an implementation framework for national EV policy.

The paper is structured as follows: "Literature review" offers a brief literature review on three-wheeler vehicles and hybrid technologies, "Methods" discusses the methodology, "Results" discusses the results, "Discussion" expands on the key findings of the results, and "Conclusions" concludes the research.

[2] 1 USD = 167.38 PKR, as of September 2021.

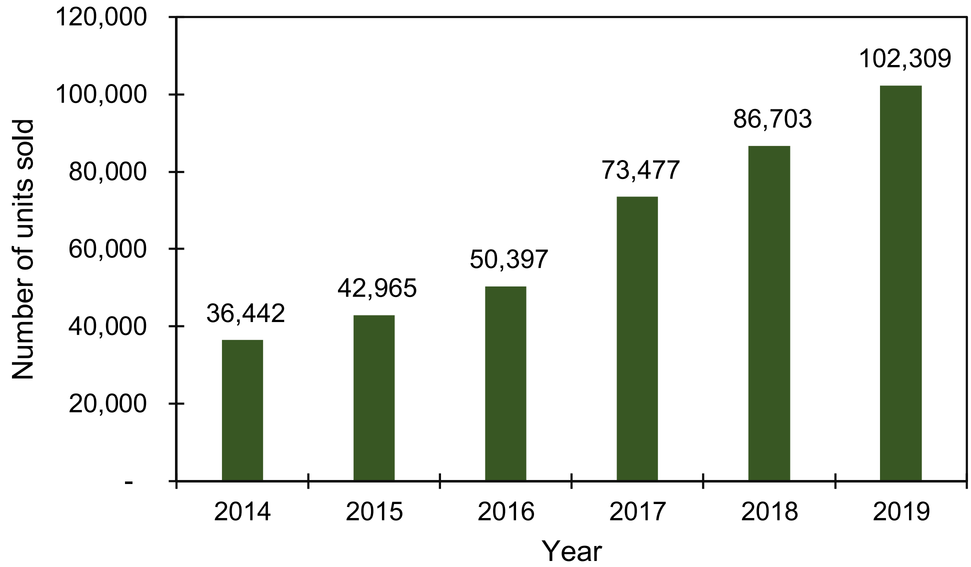

Fig. 1 Number of three-wheelers sold in Pakistan from 2014 to 2019

Literature review

Three-wheeler vehicles are a common mode of transportation in the MENA, South Asian, Southeast Asian, and some Central American countries, carrying their own titles in local vernaculars. In Pakistan, they are referred to as rickshaw; in India and Sri-Lanka, they are referred to as tuk-tuk. Sometimes referred to as autos, they are suited to intra-city transport over short distances but are less feasible for longer routes due to the limitation of speed, vehicle comfort, stability, and overall aerodynamics of the vehicle. Used predominantly by the lower and middle class of Pakistan for daily commute, a survey by PBIT (2017) concurred that it offers the most economical means of transportation for the social stratum in the user base. Statistics show that 73,477 units were produced in 2017 across Pakistan, and the market has shown a compound annual growth rate of 18%.

The data shown in Fig. 1 concurs with the 2010 survey conducted by the Pakistan government which suggested that the number of rickshaws on the road touched the hundred thousand mark, and it can be safely assumed that the number has increased by at least 2 times over the past decade. With 400,000 three-wheelers running, it is imperative to gauge their climate change potential and the fuel economics to identify the caveats.

Electric vehicles — key concepts

In recent times, various powertrain and energy source topologies have been proposed for electric vehicles and they have gradually made their mark in commercial vehicles and research prototypes. In terms of energy source configurations, the mechanical energy to drive the wheels of pure electric vehicles may be provided by batteries, fuel cells, super capacitors, or a combination of two or all three configurations. In the combination's configuration, the primary source of energy is usually the battery that is maintained along with the auxiliary energy source or storage units. In batteries, series or series parallel cell combination of lithium ion (Li-ion) is the most extensively commercialized (Deng 2015). The powertrain topology indicates various battery and engine combinations and energy flow with single motor or dual motor (one motor acting as a generator) design for the various types of electric vehicles. The electric vehicle powertrain types comprise of battery electric vehicles (BEV) – purely battery as sole and single energy source with no internal combustion engine (ICE), HEV (hybrid electric ehicle) – battery and ICE combination, PHEV (plug-in hybrid electric vehicle) – battery, and ICE combination along with on the spot plugin charging feature. Within the domain of HEV, PHEV, and BEV topologies, numerous models and implementation techniques have been proposed (Hanifah et al. 2015; Cipollone et al. 2014). A major step in these topologies is the mathematical modeling of the vehicle powertrain; here, the modeling of energy source as close as possible to the rated and practical behavior is the target of researchers so that the vehicle performance characteristics meet the designed values.

Li-ion cells are the most extensively used in batteries, but the anionic combinations with the alkali metal lithium's ion are many. These include lithium iron phosphate battery (LiFePO4) – LFP, lithium cobalt oxide($LiCoO_2$) – LCO, lithium manganese oxide ($LiMn_2O_4$) – LMO, lithium nickel manganese cobalt oxide ($LiNiMnCoO_2$) – NMC, lithium nickel manganese cobalt oxide ($LiNiMnCoO_2$) – NMC, lithium nickel cobalt aluminum oxide (LiNiCoAlO2) – NCA, lithium titanate (Li_2TiO_3) – LTO. Besides lithium ion, other metallic ion combinations include nickel-metal hydride (Ni-MH) and sodium-nickel chloride ($Na/NiCl_2$). Super capacitors are high-rated capacitors in large numbers, their key feature being they allow fast charging but provide low energy density. They are used mostly in combination with the Li-ion Bank. In recent times, batteries with higher energy and power densities are being developed, such as lithium-air (Li-air), lithium-metal, or lithium-sulfur (Li–S); however, these are still in research and technology development phase (Hacker et al. 2009). In the coming years, Li-air batteries may reach energy densities of to the mark of 11,680 Wh per kg, stated by the researchers Imanishi and Yamamoto (2014), equivalent to gasoline energy utilized.

A summary of commercially available electric vehicles would be quite insightful; regenerative braking technique is a method to save energy the otherwise wasted mechanical energy of braking or decelerating wheels. Commercially available RBS (regenerative braking system) in electric vehicle examples includes the Renault Zoe and the Nissan Leaf. Zoe has a 22-kWh Li-ion battery and an energy consumption of 14.6 kWh per 100 km, which yields a range of about 140 to 210 km per battery charge on the New European Driving Cycle (NEDC). Nissan Leaf version 2015 includes a 24-kWh battery (30 KWh for 2016 model) and an official consumption of 15 kWh per 100 km. Available models of PHEV include the Chevrolet Volt in US markets (which is the Opel Ampera in EU markets) and the Toyota Prius Plug-in Hybrid. The 2015 Opel Ampera uses a 16-kWh Li-ion battery and consumes 16.9 kWh per 100 km in electric mode on the NEDC. The 2015 Chevrolet Volt has a 16.5-kWh battery, and the 2016 model has an 18.4-kWh battery.

Overview of hybrid three-wheeler

The hybrid electric three-wheeler attaches to the existing engine by eliminating or keeping the gearbox. It comprises of a power split device (PSD) which is the key mechanical design unit and allows contribution of multiple power sources, electric motors/generators to provide electric power, and recuperate energy in regenerative braking, batteries, and additional ultra-capacitor unit to store electrical energy, various sensors, actuators, and control system. Additional features may include an appealing interface (HMI) to present information and enable user to select various modes. PSD and motor/generators would be assembled in HPA (hybrid powertrain assembly) directly attached to IC engine. With substantial power contributed by electric source and smaller engine size/inertia, major savings are warranted in fuel cost. Energy harvested during frequent braking of typical urban driving in the form of deceleration or stopping at traffic lights adds to further fuel saving. Batteries can be charged through normal household power socket and unlike an electric vehicle, user is more confident in using it with no maximum range issue and concern on unavailability of consistent electric power source. It envisions service to the environment while providing savings to the user and is a major step towards total electrification of vehicles, which inevitably will take time and major investment in infrastructure.

Current state of the art of electric three-wheeler

Three-wheeler vehicle development is an oft-discussed topic in the literature and many researchers have worked on improving its efficiency by proposing various energy management solutions. The development of electric three-wheeler has been discussed in the literature and a summarized account is given below in Table 1.

Policy gap

From Table 1, it can be seen that a lot of work has been done on the energy management system of the vehicle for improving the economic and environmental performance of the three-wheeler, but the idea of its relationship with the economic and environmental policy remains an unexplored avenue. Mao et al. (2017) worked on pricing policy for vehicle-to-grid power by keeping in view the system considerations, load profile, power limit, etc. This will help the EV user in balancing their energy bill and the operator's profit is ensured. However, the pricing strategy bodes well for developed nations but does not help the case of developing countries. Vidhi and Shrivastava (2018) discussed the policy implications in Indian context and suggested that offering the electric vehicles to price-sensitive consumers on a subsidized rate, increasing awareness among the four-wheeler drivers of shared mobility, subsidizing the cost of renewable energy projects, and providing funding for development of battery technology will help in implementing the EV policy smoothly in India. However, the authors have utilized literature review approach and did not cater to the idea of electric three-wheelers. Wu et al. (2019) have utilized lifecycle assessment methodology to calculate the environmental impact of battery electric vehicles and conventional internal combustion engine vehicles. They suggest that priority areas should be set with reference to the reduction potential and the climate change mitigation efforts vary from case to case and there cannot be one generic solution to cure the ills. However, the recommendations cater to the environmental aspect of sustainability and do not discuss the socioeconomic impact of the EV adoption.

In case of Pakistan, Naseem et al. (2019) have discussed the case of EVs in Pakistan and have recommended that charging stations and photovoltaic power plants should be established to leverage improved environmental performance; however, the research is based on secondary data and empirical evidence. Ullah (2019) developed a comprehensive report on EVs and proposed that the taxes/duties should

Table 1 Literature review on electric three-wheeler development

Author (year)	Methodology	Contribution
Mulhall et al. (2010)	Prototype development	The authors have proposed the installation of solar panels on the roof of a conventional three-wheeler to achieve fuel efficiency and increased driving range as compared to a conventional three-wheeler naming it Rickshaw 2.0. By developing a prototype model and running extensive simulations; the authors posit that the average daily range of vehicle can be easily achieved and implicates the improved environmental and economic performance
Chandran and Brahmachari (2015)	Empirical investigation	Using an Indian market case study, the authors have explored the solar powered rickshaw in case of manually pulled rickshaws and have utilized BLDC type hub motor to harness the solar energy. However, the semi-automation is quite limited in nature and needs to be expanded to the conventional engine driven rickshaw. Despite that, the economic benefit is quite appreciable and facilitates poverty alleviation
Trovão et al. (2016)	Energy management	The authors have explored the case of dual energy storage system of a three-wheeler vehicle in which the battery system is integrated with super capacitors in such a manner that the battery is responsible for meeting the average portion of the energy demand, whereas the super capacitors are used to handle the energy level in a smart manner by utilizing fuzzy logic approach. The results have been validated using simulation and applied to a real-time case study to achieve positive results with a reduction of 3% consumption for average driving cycle
Saleque et al. (2017)	Simulation-based drivetrain design	The authors have employed the novel idea of using a permanent magnet synchronous motor-based drivetrain of three-wheeler vehicle and have proposed a solar-wind hybrid power system that would be extremely beneficial for developing countries; and offers improved environmental performance in comparison to the commercially available options. However, the viability of the project needs to be further researched
Kumar Pathak et al. (2017)	Drive cycle development	Contrary to the widely used European diving cycles that help in gauging the vehicle performance, the authors have endeavored to develop a new driving cycle for electric three wheelers that has been implemented via a pilot study in India. The parameters include average speed 13.79 km/h, 1125 s duration and 4.31 km of distance. The validation of the driving cycle was carried out by comparing the electrical energy consumption by simulating the chassis dynamometer with on-road driving
Jijith and Indulal (2018)	Design and development of controller	The authors have developed a state-of-the-art controller for converting a conventional three-wheeler to a hybrid three-wheeler. The controller utilizes Artificial Neural Network which has been trained offline and subjected to simulations. The motor assistance was triggered using the trained algorithm for various RPM and speeds. However, an online training module needs to be developed for effective and efficient operation
Arefin et al. (2018)	Simulation for use of renewable energy resources	In this research work, the authors have utilized simulation approach to compare the use of solar power and wind turbines in the propulsion of a three-wheeler vehicle, concluding that by doing so, the load on national grid will be lowered considerably and the environmental impact will be obviously minimal

Table 1 (continued)

Author (year)	Methodology	Contribution
Dixit et al. (2019)	Prototype development	The authors Dixit et al. have proposed a DC-to-DC Buck-Boost Convertor Topology which is used to vary the voltage levels according to the power requirements of prototype electric rickshaw. Design of single stage active power factor correction was added to the convertor providing an on board battery charger rated at 3.3 kW in simulation version and 1.5 kW in hardware prototype version. Control strategy proposed is simplistic in approach comprising of just a single integrator
Priye and Manoj (2020)	Survey for safety features	The researchers have undertaken a user survey approach regarding the holistic picture and safety features of the rickshaw, and the responses from India suggest that the overall safety features of a rickshaw are a source of serious concern among the daily commuters, specifically the lightweight body, inadequate guard rails and rear-end protection. This carries social implications as well as females are less likely to use this mean of transport due to the safety concerns
Macías et al. (2020)	Coupling configurations	The researchers have focused on the development of active and passive couplings in a fuel-cell electric hybrid three-wheeler by formulating a sizing problem and using optimized fuzzy energy management strategy for splitting power between the components, concluding that the passive configuration is 17% economical in comparison to active configuration

be no more than 5%, and in the nascent stages, the adoption of EV vehicles should be free of any government duties. Since the EVs will require charging stations, the idea of smart metering is proposed. In addition to that, public–private partnerships are of paramount importance in this case. Despite the exhaustive effort, the report does not include the user requirements and does not gauge the socioeconomic potential of EV adoption. Ul-Haq et al. (2020) have developed a technical framework for electrical transportation in which technical, financial, and infrastructural requirements have been stipulated. The authors have used the case study of China-Pakistan Economic Corridor in which transportation has been simulated using photovoltaic charging and conclude that it provides socio-economic benefits and results in reduced environmental impact. The authors recommend public–private partnerships, tax levies, subsidized costs, stipulation of safety standards, and investment in research and development (R&D). However, the research work is based on secondary data and does not include the user perception of EVs. More importantly, it focuses on inter-city transport rather than intra-city transport that is carried out by three-wheelers, wagons, or local busses. Asghar et al. (2020) have reviewed the literature on the current state of EV adoption in Pakistan and suggest that subsidies are integral in the adoption of electric vehicles, and government guardianship is required to set up EV charging facilities along with lower excise duty rates. In addition to that, it is incumbent upon the government to invest heavily in research and development along with provision of a wide-scale charging infrastructure. Doing so will increase the economic activity, provide employment opportunities, and can help in braving climate change. Despite the comprehensive outlook, the research work lacks a ground-level approach and the policy recommendations are based upon empirical evidence collected from the previous literature.

In light of the aforementioned, it is quite clear that following gaps exist in the literature:

- The policies work well for developed countries but in case of developing nations, the socioeconomic conditions need to be considered and, in that case, a survey is necessary to gauge the public perception.
- The case of electric three-wheeler has been discussed in technological context, but there is a paucity of approaches that discuss the socioeconomic impact of electric three-wheeler adoption.

Methods

In order to deeply understand the usage pattern of three-wheelers (the "what" part of the proposed research) and the sustainability implications of the use of electric three-wheelers (the "how" part of the proposed research) — the authors have utilized quantitative research method. Quantitative techniques are useful in studying large sample groups and drawing generalizations based on the collected data (Swanson and Holton 2005). Therefore, in order to address the first research objective that is inclined towards the deductive research logic, the authors undertook a quantitative research approach and utilized survey to collect data regarding the general perception towards electric three-wheeler vehicle. In this context, the authors administered a survey from the local three-wheeler drivers in the metropolitan city of Lahore, Karachi and Peshawar, whereas the cities of Jehlum and Mirpur were also taken into the account. A questionnaire was designed (given in Supplementary material) which was subjected to a pilot study first by taking into account the responses from field experts. After a few minor corrections, the questionnaire was finalized, and the data was collected from rickshaw drivers across Pakistan.

While there is no doubt that open-ended questions help in getting spontaneous and unbiased answers from the survey participations, and help in exploring other narratives as well, however, the nature of research and the socio-economic conditions of the respondents merit that close-ended questions should be used — thus eliminating the need for extensive coding and larger item non-response (Reja et al. 2003). Therefore, close-ended questions were utilized that were extremely simple in nature and related to the daily routine of the rickshaw drivers, the fuel consumption, and the monthly fuel expenditures. The survey included both yes/no and polytomous-score-based questions which helped the authors in gathering relevant information and observing the general perception of the drivers. In this vein, the research demanded use of such a tool that can help in gathering large data with high person reliability, established validity, and ease of analysis (Nemoto and Beglar 2013); therefore, the five-point Likert scale was used to gauge the economic, environmental, and social sustainability implications of the adoption of electric three-wheelers. The questionnaire was developed in English and was later translated to Urdu for the ease of respondents. In a 5–7-min interview, the authors explained the questionnaire to the respondents and collected their responses, and the authors utilized statistical package software SPSS v22 for the data analysis and results.

The idea of assessing the sustainability performance of electric three-wheelers requires a series of questions, the answers of which could lead to a single numerical value that can help us in providing policy recommendations. When the items are scaled (1 to 5 in the case of this research work), there needs to be internal consistency, i.e., the items should have a correlation with one another and must measure the same thing. Thus, the Cronbach's alpha value (Cronbach 1951) is used to calculate the internal consistency of the items and is calculated as follows:(Eq. 1)

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum {s_i}^2}{{s_r}^2}\right) \tag{1}$$

where k is the number of items, ${s_i}^2$ is the variance of the ith item and ${s_\mathrm{r}}^2$ is the variance of the total score formed by summing all the items (Bland and Altman 1997).

In order to check for the experimental variability between the responses, the Friedman's chi-squared test is used which determines the difference between rank totals for each scenario and the values that could be expected by chance (Pereira et al. 2015). The null hypothesis suggests that the population medians are all equal, which needs to be rejected in order to ascertain the alternative hypothesis, i.e., differences in responses exist. In this case, the significance value, or p-value, needs to be less than 0.05, which means that there is less than 5% likelihood that null hypothesis could have been true. The strengths of this test lie in the independence from the sample size, resistance to over parameterization, and opportunity to conduct multiple comparisons (Rigdon 1999). In order to further ascertain the differences between responses, Hotelling's t-squared test is used (Hotelling 1951), the higher values of which suggest that significant difference exists between the responses.

The survey was conducted over a period of 2 months, i.e., September 2020 to November 2020 in which responses were collected from the metropolitan and non-metropolitan cities.

It was generally observed that the closed three-wheeler/rickshaw was mostly used in metropolitan cities, whereas the non-metropolitan cities of Jehlum and Mirpur saw open rickshaws (colloquially known as Chingchis) running on the roads due to various sociocultural factors. The respondents from the aforesaid cities maintained that the female populace preferred to commute in an open rickshaw or Chingchi as they felt safe, whereas the female populace in the metropolitan cities preferred a closed rickshaw for privacy reasons, thus the lower number of responses from the cities of Jehlum and Mirpur. Out of the 534 surveys conducted, 489 responses were received which show a response rate of 91.7%. Karachi, being the largest city of the country, had the greatest number of responses at 196, followed closely by Lahore with 194 responses as shown in Fig. 2.

As shown in Fig. 3, most of the rickshaw drivers belong to a lower socioeconomic stratum and this is evident from the figure below that a whopping 40% of the responses had no formal education whatsoever. Approximately 43% of the respondents had acquired basic formal education, out of which 28% had studied up to grade 5, and up to 23% cleared their 10th grade examination.

Out of the 489 filled results, 76% of the users owned a rickshaw whereas the remaining 24% was paying the monthly rent to some individual, AOP (association of persons) or an installment company. This suggests that there is a trend of owning the rickshaw (Fig. 4), rather than renting it,

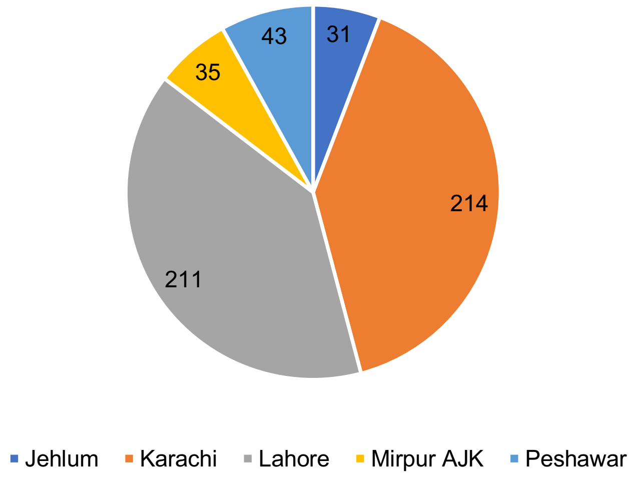

Fig. 2 City-wise distribution of the survey results

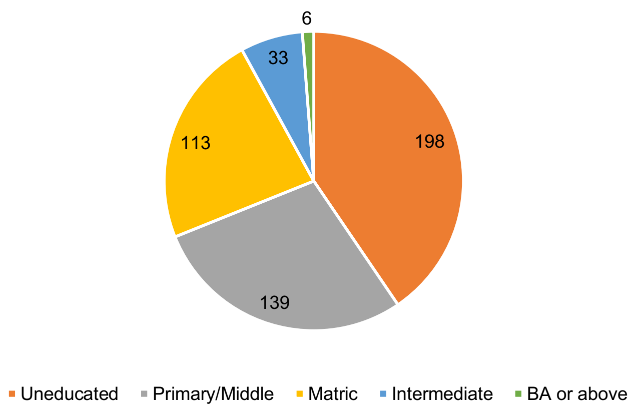

Fig. 3 Qualification of the rickshaw drivers

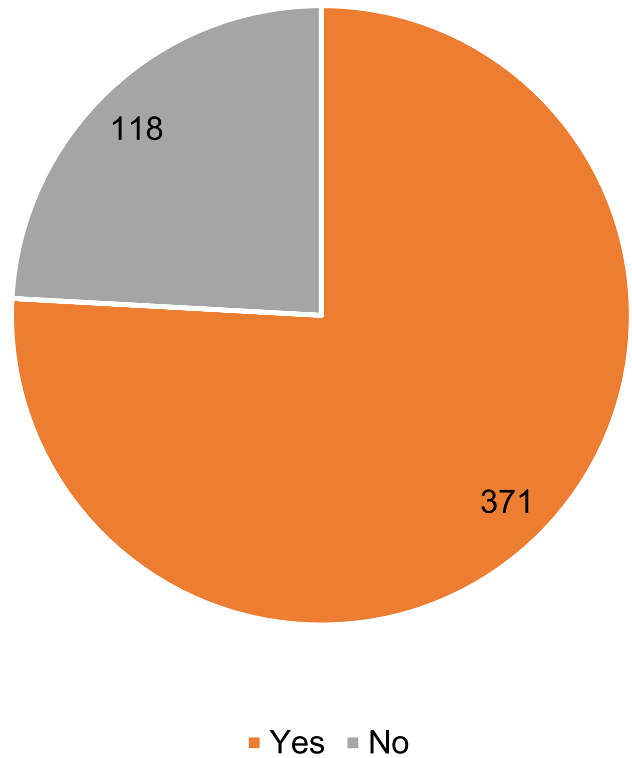

Fig. 4 Rickshaw ownership statistics

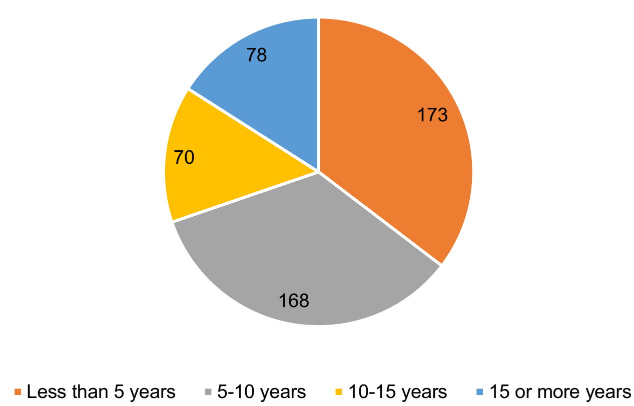

Fig. 5 Duration of driving the rickshaw

and this is a strong indicator that upon the arrival of electric rickshaws, the general consensus would be to own it.

Results

Duration

It was observed that approximately 70% of the rickshaw drivers started this business within the past 10 years. The increase in population has merited an increase in the means of transport, which is agile and compact, thus addressing traffic congestion. This is manifested in the growing number of rickshaw drivers in the past 10 years, given in Fig. 5.

Rickshaw cost

Regarding the cost of rickshaw, a very interesting pattern was observed in the responses (Fig. 6). The survey results from Karachi indicated that the general consensus was to buy a used rickshaw that costed below PKR 100,000 (~US $597) and then the drivers spent PKR 15,000–20,000 (~US $89–~US $119) of their own funds in the repair and refurbishment of the rickshaw. However, this trend manifested itself in a different manner in other cities and the holistic results indicate that the median value of rickshaw lies between PKR 100,001–150,000 (~US $597–~US $896), as the users prefer a second-hand/used rickshaw, as a regular brand new rickshaw has a starting price of PKR 225,000

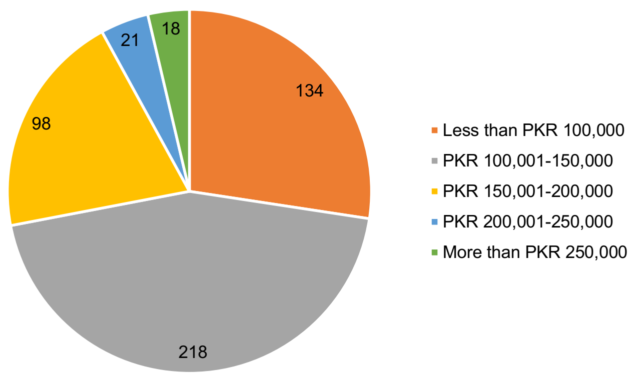

Fig. 6 Rikshaw cost statistics

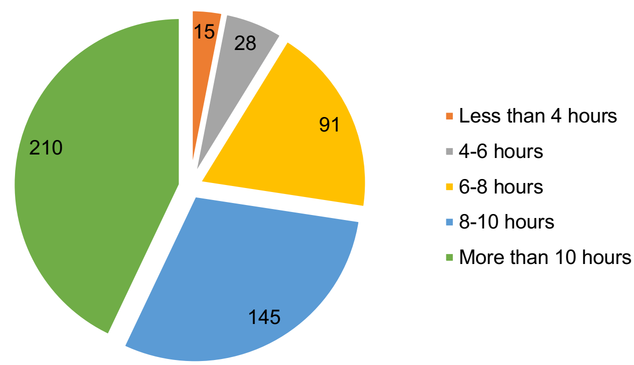

Fig. 8 Daily usage statistics

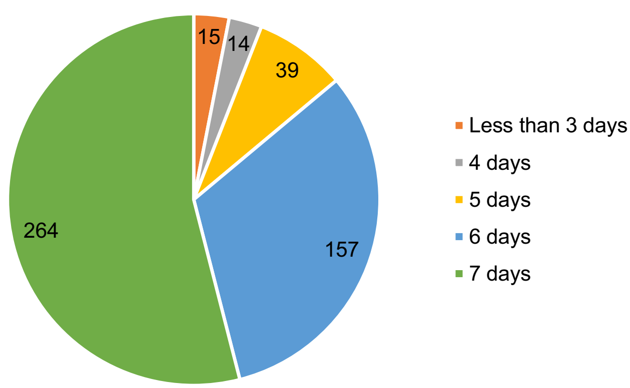

Fig. 7 Weekly usage statistics

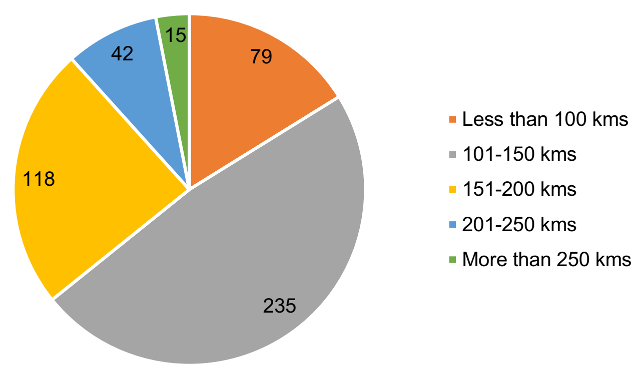

Fig. 9 Daily driving statistics

(~US $1344). This is evident from the fact that only 8% of the rickshaw drivers had a rickshaw costing more than PKR 200,000 (~US $1194).

Usage statistics

One of the most useful result of the study was the weekly use statistics of the rickshaw (Fig. 7) as a whopping 54% of the users drive the rickshaw the whole 7 days a week, whereas a meager 9% of the respondents drive the rickshaw less than 4 days a week. This suggests that the rickshaw use is strong among the residents and people are willing to spend their weekends driving the rickshaw, as 76% of the respondents drive the rickshaw for 6 or 7 days a week.

In line with the usage statistics, the driving statistics suggest that the median populace drives the rickshaw for more than 10 h a day, whereas 30% of the respondents suggested that the rickshaw was driven for 8–10 h. This suggests that the economic benefits of an electric rickshaw would be immense, if driven for more than 10 h as the fuel charges are minimal. The statistics given in Fig. 8 are extremely important in infrastructure development for charging stations.

The daily commute statistics are given in Fig. 9 where out of the 489 respondents, 48% drove 101–150 km a day, whereas 24% drove 151–200 km a day. Considering the fact that the running rickshaws cause a lot of air pollution, the long hours and the extensive travels indicate that there needs to be a conscious effort to regulate the emissions of these rickshaws, and the introduction of electric rickshaws can be a panacea to these ills.

Expenditures and earnings

The median expenditure on rickshaw's monthly maintenance came out be PKR 2000–3000 (~US $12–~US $18) (Fig. 10). In addition to this, 44% of the users suggested that the monthly expenditure on the maintenance activities exceeded PKR 3,000 (~US $18). The introduction of electric rickshaws can bring about a considerable reduction in these expenditures, as the skyrocketing prices of lubricants and amenities indicate that this figure will go upwards.

The most interesting finding of the survey suggests that more than half of the respondents spend more than PKR 12,000 (~US $72) on fuel every month (Fig. 11), which is almost 40% of their monthly earnings, whereas 29% of the

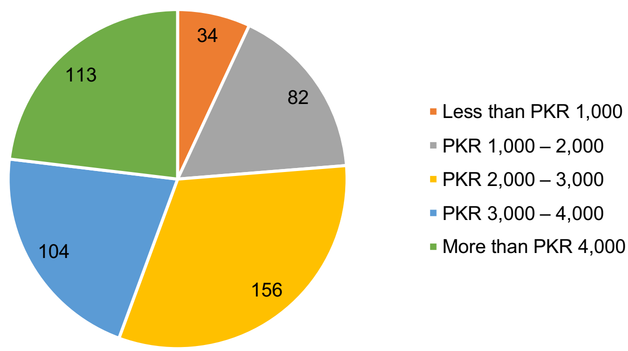

Fig. 10 Monthly maintenance expenditure

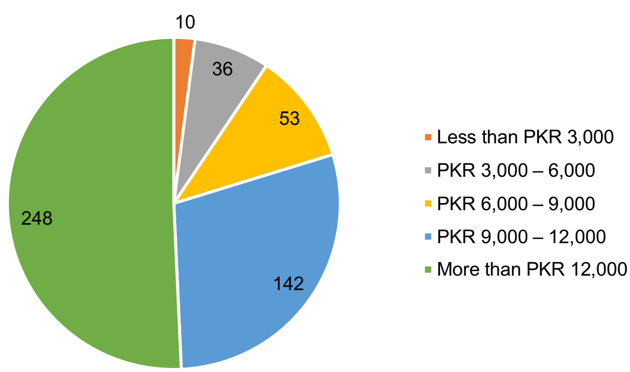

Fig. 11 Monthly fuel expenditure

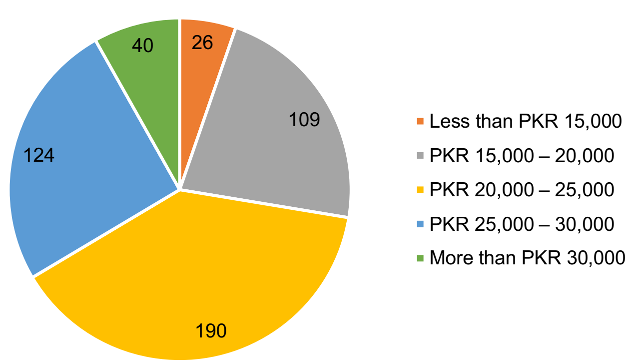

Fig. 12 Monthly earning of the rickshaw drivers

respondents indicated that their monthly fuel expenditure ranged between PKR 9000 to PKR 12,000 (~ US $53–US $72). This huge economic burden can easily be reduced by the introduction of electric rickshaws.

The survey results in Fig. 12 suggest that the median income of the respondents ranges from PKR 20,000 (~ US $119) to PKR 25,000 (~ US $149) per month, whereas one quarter of the respondents make PKR 25,000–30,000 (~ US $149–US $179) per month. These figures can easily observe an increase of 50% with the introduction of electric rickshaws as the maintenance and fuel expenditure will be minimized.

The usage pattern results indicate that there is a general trend of owning the three-wheeler in Pakistan, and with a median driving of 101–150 km per day for 6–7 days a week and clocking more than 10 h daily, the drivers are making PKR 20,000–PKR 25,000 (~ US $119 – US $149) every month, which barely makes the ends meet. The introduction of electric rickshaws can increase this figure by 50% by considerably reducing the maintenance and fuel expenditures, while reducing the emissions at the same time. This will not only act as a strong lever for economic development but will help in attaining environmental sustainability.

Sustainability analysis

After the usage pattern analysis, the responses to the adoption to electric three wheelers were collected. Out of the 534 surveys conducted, 423 responses were received which shows a response rate of 79.2%. 170 responses were collected from Lahore whereas 163 responses were collected from Karachi.

Descriptive statistics

The scoring results of the whole sample sorted from the highest to lowest average score are given below in Table 2. Despite belonging to a lower socioeconomic stratum, the respondents were very much in favor of government imposing fines on the rickshaws with uncontrolled emissions, with climate change being the second most important aspect. It was seen that the respondents were more willing to buy an electric rickshaw from government-run easy loan scheme rather than spending a sum of 1.5–2 times the average price of a regular rickshaw. The variable of increased economic opportunities for women did not perform well, and this can be having two major explanations: (a) 100% of the respondents were men and belonged to a stratum where there is lack of awareness regarding gender equality, and (b) a lot of women from lower social strata work as housemaids in relatively affluent households, and their driving a rickshaw becomes more of a safety issue.

Reliability of the responses

The authors used the Cronbach's alpha to determine the reliability of the respondents, and the responses were segregated into the three pillars of sustainability. The overall reliability (Cronbach's alpha) of all the responses came out to be 0.801. The inter-item correlation matrix is given in Table 3, whereas the results of Friedman's chi-squared test are given in Table 4.

Table 2 Ranked statistics of the responses based on average score

Sustainability question	Mean	Std. Deviation	Rank
Support of government on imposing fines	4.26	1.205	1
Importance of climate change	4.06	1.04	2
Importance of regular maintenance for emissions check	3.89	0.976	3
Willingness to buy from government scheme	3.88	1.287	4
Chances of increased economic opportunities	3.64	0.946	5
Relationship of charging stations with electric rickshaws	3.62	0.995	6
Likelihood of success	3.53	1.034	7
Chances that Pakistani rickshaw is reliable	3.41	1.019	8
Chances to spend more on rickshaw	3.25	1.174	9
Willingness to spend bi-annually on batteries	3.22	1.19	10
Women jobs	2.8463	1.04973	11

Segregating along the sustainability dimensions, the ranked statistics are given in Table 5. It can be seen that the Cronbach's alpha value for economic sustainability is 0.796, which is considered to be quite good. In case of environmental sustainability, the Cronbach's alpha value comes out to be 0.584, which shows moderate reliability (Hinton et al. 2014).

The detailed item reliability statistics are given in Table 6 and it can be seen that a visible difference can be observed in the Cronbach's alpha value if the question pertaining to the social sustainability aspect of opportunities for women is deleted from the questionnaire.

The questions of social sustainability had surprisingly low values for Cronbach's alpha, which were close to 0. This can be explained through the difference of psychometric and edumetric tests that was proposed by Carver (1974). The Global Gender Gap Report 2020 suggests that economic opportunities for women are extremely limited in India (35.4%), Pakistan (32.7%), Yemen (27.3%), Syria (24.9%), and Iraq (22.7%). (Crotti et al. 2020). Therefore, unless the public is educated regarding the gender disparity the results would remain inconsistent.

Discussion

Considering that the tentative price of an electric or hybrid three-wheeler would be 1.5–2 times the cost of a commercially available rickshaw, more than 50% of the respondents were willing to spend that sum, provided it offered reduced fuel and maintenance costs. Therefore, it is incumbent upon the government to take active measures in the introduction and promotion of electric three-wheelers. Approximately 68% of the respondents were of the view that the success of electric three-wheelers is dependent upon the availability of charging stations throughout the city. A total of 56% of the respondents were satisfied with the indigenously developed three-wheeler in Pakistan and only 19% was of the view that a locally developed three-wheeler would not be durable and reliable. However, the bi-annual expenditure on batteries seemed a difficult proposition. This can be countered by the governmental loan schemes as 68% of the respondents were very much willing to acquire an electric three-wheeler through government schemes. Another welcoming narrative is the response of 64% respondents that an electric rickshaw is likely to succeed in Pakistan. A total of 81% of the respondents were aware of the problems that arise due to climate change and showed cognizance regarding this pressing issue, despite belonging to a lower socioeconomic stratum, and 65% strongly supported the government to impose fines on the vehicles that are major sources of GHG emissions. A total of 66% of the respondents suggested that the adoption of electric three-wheelers would result in increased economic opportunities and would help improving the standard of living. Despite these positive responses, only 21% of the respondents suggested that the adoption of electric rickshaws would help creating economic opportunities for women. In order to achieve holistic sustainability through the adoption of three-wheeler vehicle, the following policy considerations should be made by the governments of developing countries to achieve the sustainable development goals stipulated by the UN. The policy recommendations are given in Fig. 13.

Reduced GHG emissions for environmental sustainability

Besides the economic challenges faced by the country, the environmental issues are of a grave concern. It has been projected by Lin and Raza (2019) that by year 2035, the CO_2 emissions will reach 277.9 MT and conclude that the increase in transport-related emissions is directly related to increase in the population. In this scenario, it is incumbent upon the government to reduce the usage of fossil fuels and transport sector accounts for 29% of the CO_2 emissions (Rehman et al. 2020). A paradigm shift towards cleaner fuels is necessary and at the same time, conscious efforts

Table 3 Inter-item correlation matrix for all responses

	Chances of increased economic opportunities	Women jobs	Chances to spend more on rickshaw	Chances that Pakistani rickshaw is reliable	Relationship of charging stations with electric rickshaws	Willingness to spend bi-annually on batteries	Willingness to buy from government scheme	Likelihood of success	Importance of climate change	Importance of regular maintenance for emissions check	Support of government on imposing fines
Chances of increased economic opportunities	1.000	0.003	0.401	0.352	0.308	0.338	0.402	0.361	0.214	0.114	0.091
Women jobs	0.003	1.000	0.099	0.110	0.001	0.058	0.114	0.119	0.030	0.090	0.052
Chances to spend more on rickshaw	0.401	0.099	1.000	0.414	0.431	0.378	0.473	0.392	0.295	0.375	0.282
Chances that Pakistani rickshaw is reliable	0.352	0.110	0.414	1.000	0.276	0.475	0.396	0.286	0.217	0.175	0.197
Relationship of charging stations with electric rickshaws	0.308	0.001	0.431	0.276	1.000	0.393	0.401	0.440	0.277	0.266	0.325
Willingness to spend bi-annually on batteries	0.338	0.058	0.378	0.475	0.393	1.000	0.375	0.418	0.187	0.143	0.216
Willingness to buy from government scheme	0.402	0.114	0.473	0.396	0.401	0.375	1.000	0.403	0.395	0.297	0.329
Likelihood of success	0.361	0.119	0.392	0.286	0.440	0.418	0.403	1.000	0.082	0.230	0.146
Importance of climate change	0.214	0.030	0.295	0.217	0.277	0.187	0.395	0.082	1.000	0.260	0.482
Importance of regular maintenance for emissions check	0.114	0.090	0.375	0.175	0.266	0.143	0.297	0.230	0.260	1.000	0.207

Table 3 (continued)

	Chances of increased economic opportunities	Women jobs	Chances to spend more on rickshaw	Chances that Pakistani rickshaw is reliable	Relationship of charging stations with electric rick-shaws	Willingness to spend bi-annually on batteries	Willingness to buy from government scheme	Likelihood of success	Importance of climate change	Importance of regular maintenance for emissions check	Support of government on imposing fines
Support of government on imposing fines	0.091	0.052	0.282	0.197	0.325	0.216	0.329	0.146	0.482	0.207	1.000

are required to reduce the dependence on fossil fuels for transportation. Despite being a country that is highly susceptible to climate change, Pakistan is still ranked 33 among the petroleum product consumers with 151,200 barrels of fuel imported on daily basis (Saleh et al. 2017). Twenty-one percent of the imported fuel is used in the transportation sector, which accounts for 22.69% of the GHG emissions produced annually, amounting to 37.7 Tg of CO_2 (Mir et al. 2017). Out of all the transport-related emissions, the road transport produced 34.4 Tg CO2eq, which is a whopping 92% share.

The commercially available three-wheeler rickshaws in Pakistan mostly use either compressed natural gas (CNG) or liquified petroleum gas (LPG) as main sources of fuel. As per the general statistics observed from the survey, the authors used the protocols stipulated by Eggleston et al. (2006) to calculate the minimum and maximum emissions from the three-wheelers for the median distance traveled. The emissions produced by the CNG and LPG consumption are calculated using the given formula:(Eq. 2)

$$Emission = \sum_{a} Fuel_a \times EF_a \tag{2}$$

where a is the type of fuel, Fuel_a is the fuel sold in terajoules, i.e., LPG or CNG and EF_a is the emission factor in kilograms per terajoules. In case of LPG and CNG, the default rate is 56,100 kg/TJ for CO_2 emissions. In case of road transportation emissions, the default emission factor for CH_4 is 92 kg/TJ for CNG and 62 kg/TJ for LPG. Similarly, the default emission factor for N_2O is 3 kg/TJ for CNG and 0.2 kg/TJ for LPG. These statistics require extensive knowledge of the three-wheeler engine and performance parameters; therefore, the emission factors in milligram per kilometer for light duty vehicles are convenient from a generalizability perspective. The N_2O and CH_4 emission factors for CNG are 27–70 mg/km and 215–725 mg/km, respectively, whereas for LPG the stats are at 5 mg/km and 24 mg/km (Eggleston et al. 2006). Using the figure of 98 g emission of CO_2 per kilometer for a 4-stroke rickshaw that has been utilized by Reynolds et al. (2011) for Delhi, the annual emission statistics for the rickshaw clocking a median distance 101–150 km a day for 6 days a week are given in Table 7.

These emissions can easily be curtailed by the adoption of electric or hybrid three-wheeler vehicles and can have a significant impact in improving the air-quality index of the metropolitan cities. Moreover, the noise pollution levels would be considerably reduced as well.

Development of indigenous technology

The government should focus on promoting indigenous technology in Pakistan regarding the manufacturing and development of hybrid or electric three-wheelers. Tax incentives

Table 4 Friedman's chi-squared test for all responses

		Sum of squares	Df	Mean square	Friedman's chi-squared	Sig	Hotelling's T-squared
Between people		1839.856	422	4.360	686.427	< 0.001	614.341
Within people	Between items	709.116[a]	10	70.912			
	Residual	3660.702	4220	0.867			
	Total	4369.818	4230	1.033			
Total		6209.674	4652	1.335			

Where [a] is the Kendall's coefficient of concordance $W = 0.114$

Table 5 Ranked statistics of the responses based on average score

Sustainability aspect	Questions	Cronbach's alpha	Friedman's chi-squared	Hotelling's T-squared
Economic sustainability	1–6	0.796	156.305	153.767
Environmental sustainability	7–9	0.584	34.165	29.798
Social sustainability	10–11	0.006	101.047	132.448

Table 6 Detailed item reliability statistics

	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Squared multiple correlation	Cronbach's alpha if item deleted
Chances of increased economic opportunities	35.9764	41.620	0.446	0.296	0.787
Women jobs	36.7660	45.274	0.112	0.041	0.818
Chances to spend more on rickshaw	36.3593	37.629	0.621	0.415	0.767
Chances that Pakistani rickshaw is reliable	36.2009	40.369	0.506	0.326	0.781
Relationship of charging stations with electric rickshaws	35.9929	40.088	0.546	0.355	0.777
Willingness to spend bi-annually on batteries	36.3877	38.906	0.514	0.357	0.779
Willingness to buy from government scheme	35.7329	36.476	0.632	0.416	0.765
Likelihood of success	36.0780	40.356	0.497	0.355	0.782
Importance of climate change	35.5556	41.205	0.425	0.333	0.789
Importance of regular maintenance for emissions check	35.7187	42.326	0.368	0.196	0.794
Support of government on imposing fines	35.3546	40.409	0.398	0.298	0.793

should be given to the organizations that are ready to develop such technologies and assemblies in Pakistan, and it is suggested that the general sales tax be reduced to 5% from the existing 17% for these industries. In addition to this, these manufacturers should be exempted from the withholding tax as well. In addition to manufacturing and assembly of three wheelers, conscious efforts should be made to develop chargeable batteries within the country, so that the import bill is considerably reduced. Therefore, it is incumbent upon the government to provide subsidy on the purchase of electric vehicles and they should be at the same level as that of commercially available three-wheeler vehicle. The prime focus should be made on PHEVs as they offer flexibility to the user, and then gradual progression can be made towards BEVs. Efforts should be made to locally develop motors, batteries, and powertrains to achieve economic and social sustainability goals.

Government easy loan scheme

The results suggest that one of the decisive factors in the success of electric three-wheelers would be the availability of easy loans that are offered by the government. The price point of electric three-wheelers is almost 1.5–2 times as that of a commercially available petrol/gas run three-wheeler; however, the economic benefits offered by the electric or hybrid rickshaw make it a very lucrative option for the users. At present, the users are forced to buy rickshaws on installments via various private investors who charge high markup rates. Once government loan scheme is introduced, these

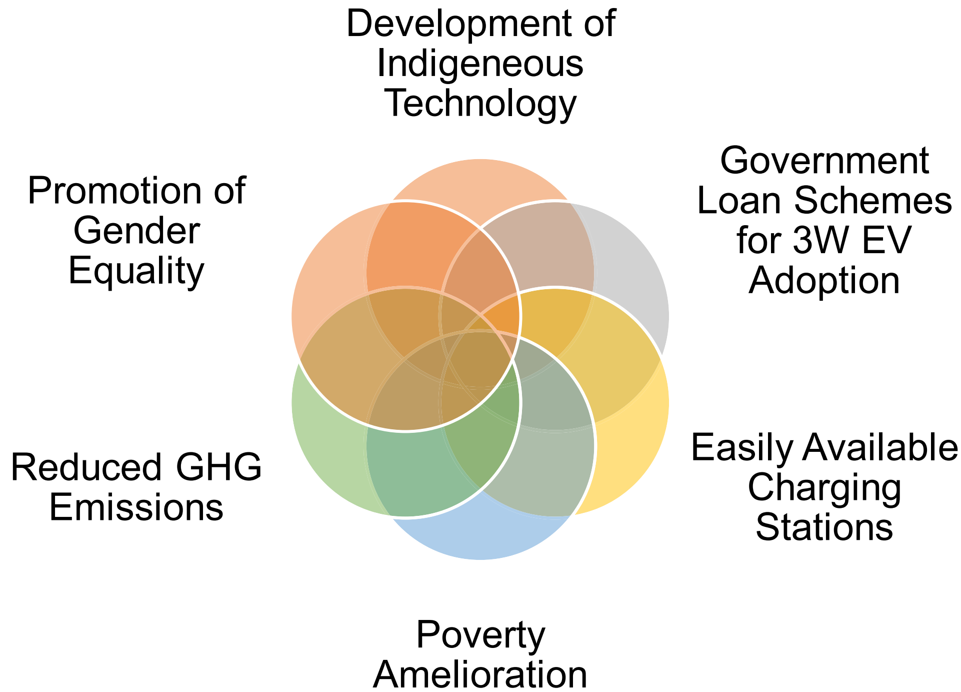

Fig. 13 Electric three-wheeler policy recommendations

Table 7 Minimum and maximum GHG emissions in tonnes from CNG and LPG run three-wheelers, driven 101–150 km a day for 6 days a week throughout the year

	CNG three-wheeler — minimum	CNG three-wheeler— maximum	LPG three-wheeler — minimum	LPG three-wheeler — maximum
kg-CO_2 emission	945.36	7,768.8	3,088.176	4,586.4
kg-CH_4 emission	6.77508	33.93	0.756288	1.1232
kg-N_2O emission	0.850824	3.276	0.15756	0.234

Table 8 Economic feasibility of electric three-wheeler

Description	Upfront payment	Government loan scheme at 8% for 3 years
Electric three-wheeler price	PKR 450,000 (~US $2,688)	PKR 558, 000 (~US $3,334)
Annual charging cost for 2-kW battery	PKR 840 (~US $5)	PKR 840 (~US $5)
Annual maintenance cost	PKR 1,500 (~US $9)	PKR 1.500 (~US $9)
Total expenditure	PKR 452,340 (~US $2,702)	PKR 560,340 (~US $3,348)
Annual median income	PKR 420,000 (~US $2,509)	
Return on investment	13 months	16 months

markup rates would be considerably lower. It is suggested that the markup rates should be at maximum around 7–8% for the buyers.

Poverty amelioration for economic sustainability

It is evident from the survey results that median income is between PKR 20,000 and PKR 25,000 (~US $119–US $149) and the users spend more than PKR 12,000 (~US $72) per month on fuel and maintenance of their three-wheelers. This extra economic burden can easily be reduced by a considerable margin and the median income can see a substantial increase of 40–50%, thus increasing the spending power and the standard of living. Against an initial investment of PKR 450,000 (~US $2688), the user can get a full return on their investment by the 13th month, as given in Table 8. In case the user opts for a 3-year loan scheme offered at 8% per annum, the return would be possible by the 16th month. Therefore, the business model is highly lucrative and sustainable for the socioeconomic strata, as they will also experience an increase in the monthly earnings due to minimal fuel and maintenance related expenses.

Easily available charging stations

Keeping in view that the three-wheeler drivers belong to a social stratum that resides in the underprivileged neighborhoods, the charging stations should be integrated with the readily available gas stations. This would have dual functionality: (a) ensuring the user that their household electricity bill will not increase and (b) providing peace of mind that the vehicle will not face range issues. In this scenario, the government should focus on PHEVs and once the vehicles are fully adopted by the market, BEVs can be introduced as it is posited that the existing infrastructure will be upgraded by the time BEVs come into the equation. As per a 2016 report, there were 7560 petrol pumps operating throughout Pakistan (Ali 2016). Since most of these petrol pumps are already being used by the three-wheeler drivers to park their vehicles at night, these petrol pumps can be equipped with charging stations as the consensus among the respondents suggested that the ease of availability of charging stations is essential for the success of electric three-wheelers. The government should work with the electricity companies and regulatory authorities to check the extra grid load that is offered by the charging stations and how it can be distributed. In case the establishment of charging stations becomes an uphill task, the government can introduce small solar panels and battery bank in the three-wheeler package so that the three-wheelers can be charged at home, and the rest of the time, the solar panels are used to run other domestic electrical appliances which would considerably reduce the electricity bill.

Promoting gender equality

Even though the results do not indicate that the adoption of electric three-wheelers would help in lowering gender disparity, the literature suggests that that a specific portion of the questionnaire can be treated as edumetric measure as it investigates the level of awareness regarding the narrative of gender equality. A whopping 40% of the responses had no formal education whatsoever. Approximately 43% of the respondents had acquired basic formal education; out of which, 28% had studied up to grade 5; thus, it is understandable as to why the correlation of three-wheeler adoption and creation of economic opportunities for women was considered weak. Therefore, it is incumbent upon the government to introduce national campaigns on gender equality and promote inclusion of women in the macroeconomics to achieve economic sustainability. In addition to women, the marginalized handicapped individuals can earn a decent wage as well.

Conclusions

In this research work, the authors have sought to understand the usage pattern of three-wheeler vehicles and the general consensus on the adoption of electric three-wheelers. Using a survey-based approach, data from 534 three-wheeler drivers were collected from the major metropolitan cities of Pakistan and it was observed that there exists an opportunity to introduce electric three-wheelers to achieve holistic sustainability. Many researchers have discussed the importance of adoption of electric vehicles and their economic benefits; however, the case of three-wheelers from driver/owner viewpoint has remained an unexplored avenue. To the best of authors' knowledge, this is the first study that describes the usage pattern of three-wheelers and performs the sustainability analysis of adoption of three-wheeler vehicles in Pakistan, and it can be said with confidence that the results can be extended to other countries with similarity in socioeconomic demography. The higher price point of the electric or hybrid three-wheeler will not affect the buyer as the investment can easily be recouped within 13 months if the three-wheeler is bought on lump sum basis, whereas the return period is 16 months if the electric or hybrid three-wheeler is bought through a government loan scheme. The adoption of electric three-wheelers will result in improved environmental performance as on average 3–6 tons of CO_2 emissions is produced from a single three-wheeler throughout the year at a driving cycle of 101–150 km a day for 6 days a week. With more than 100,000 three-wheelers running across the country, the environmental benefits will be substantial. Therefore, policy measures need to be taken to reduce the environmental impact of conventional three-wheeler through the introduction of electric three-wheelers, and the technology should be developed in-house by incentivizing the national manufacturers through tax exemptions. In addition to this, the consumers should be provided subsidies on the purchase of electric three-wheelers, and the government can introduce easy loan schemes for the individuals that would be instrumental in improving their socioeconomic performance. However, it is pertinent to mention that the government must provide charging infrastructure by using already existing gas stations as charging points to the electric three-wheelers, to address the inhibitions regarding range issues. Lastly, the introduction of electric three-wheelers would be quite helpful in creating earning opportunities for females, thus leading to economic empowerment.

However, this study does not reflect the existing performance parameters of conventional three-wheelers and the benefits offered by an electric or hybrid three-wheeler. Moreover, the emission stats were taken from the IPCC guidelines and there needs to be a conscious effort to investigate the real-time CO_X, NO_X, SO_X, and noise emissions. In addition to this, the power load on the grid introduced as a result of adoption of electric three-wheelers needs to be investigated as well. Further research needs to be carried out on the standards, codes, and manufacturing policies for the electric three-wheeler vehicles so that there are stringent protocols in place for accreditation, minimum design requirements, and large-scale production. Moreover, a country-specific urban driving cycle can be developed as a benchmark to monitor and test the vehicular performance. The authors aim to cater to the aforementioned issues in their upcoming research work.

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Author contribution MAK, SFB, and AK supervised the whole project; MAK and MSA designed the questionnaire; MAK and AK provided resources for data collection; MSA performed data analysis and wrote the initial draft; MZR and MAK validated the data; AMB, MAK, AK, and MZR reviewed and edited the final draft.

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Data availability The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Consent to participate Informed consent was obtained from all individual participants included in the study.

Consent for publication Consent to publish was obtained from all the survey participants.

Competing interests The authors declare no competing interests.

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