"Factors Influencing the Electric Vehicle Adaptation in Butwal Sub-Metropolitan City, Nepal"

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Abstract

The study aims to explore the relationship between Financial Incentive, Price, Charging Infrastructure, Social Reinforcement and Environmental Concern with Electric Vehicle Adaptation. It seeks to identify how different dimensions of financial incentive, price, charging infrastructure, social reinforcement, and Environmental Concern influences the Electric Vehicle Adaptation. The study applied a quantitative approach, gathering response from 384 respondents in Butwal Sub-metropolitan city, using a structured questionnaire. Following a snowball sampling method. Data were analyzed using PLS-SEM software with different tools like assessment of measurement items, Models fit, IPMA and implemented bootstrapping technique for hypothesis testing. The results revealed that financial incentives, Price, Charging Infrastructure, Social reinforcement and Environmental Concern are the key predictors of Electronic Vehicle Adaptation. It is evident that these factors are the major contributions to the dependent variables. Therefore, the Electronic Vehicle (EVs) Manufacturing Company. We should consider this aspect to enhance the Electronic Vehicle Adaptation. By Understanding and reformulating policies based on these factors, there is a higher possibility of improving the Electronic Vehicle Adaptation.

Keywords: *Financial Incentive, Price, Charging Infrastructure, Social Reinforcement and Environmental concern with Electric Vehicle Adaptation.*

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I. Introduction

A car using an electric motor instead of a combustion engine running on fuel or diesel can Precisely described as Electronic Vehicles. (EVs)are one of the major sources in transportation of man and material in Nepal. Although its usage has significantly risen in recent years, EVs have not yet penetrated the markets at desired levels. The development of EVs has become an important tool for the country in reducing its usage of oil along with enhancing the air-quality in the major urban cities. A huge amount petroleum and petroleum product are being imported from India resulting into increasing trade deficit for the country (Khanal et al., 2020). Petroleum products cover 23% of total import by Nepal in FY 2018/2019 (Singh, A.k., & Khanal, R.k.,2019). By 2030, the clean energy generation will be 15000 KW (NEA) Although, Nepal has imported 5,702 four-wheeled electric vehicles (EVs) worth Rs 14.19 billion in the first five months of the current fiscal year 2024/2025 The government has collected Rs 7.67 billion in customs duty from this import.

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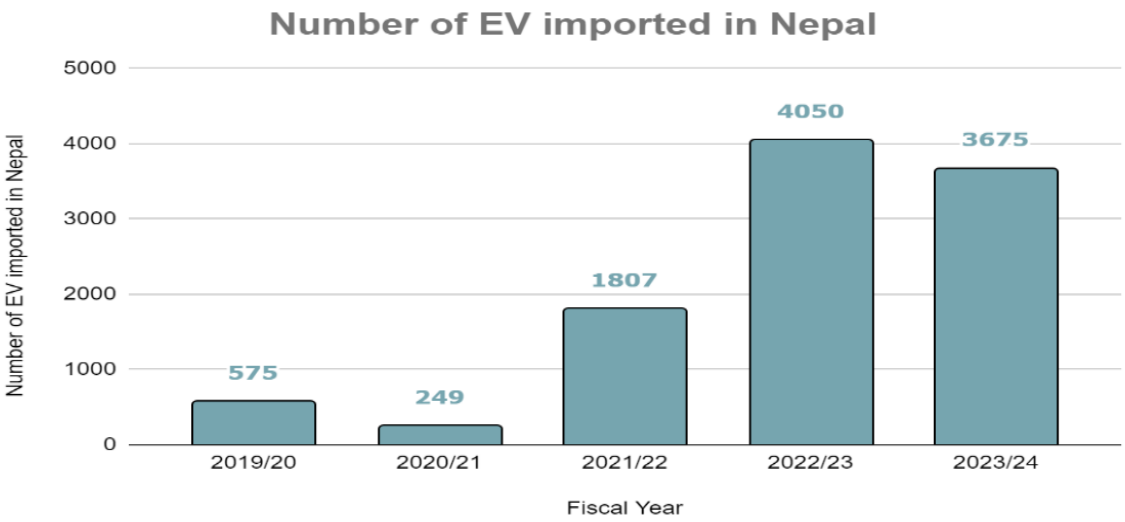
According to the data released by(*The Annapurna Express,* n.d.) the Department of customs, 1485 units of four-wheeled EV were imported in Mid-November to Mid- December (Mangsir) alone. Similarly, 3,285 units of fossils fuel four-Wheelers worth Rs 5 billion have been imported in five months. The numbers of fossils fuel vehicles in mangsir in 242 units.

According to the department, 93,351 units of petrol and two wheelers worth Rs 11.22 billion were imported. Those vehicles are worth Rs11.22 billion. Additionally, 11,694 units of bikes and scooters have been imported in mangsir. Meanwhile, 3810 units of two-wheeler EVs worth Rs 418.8 million were imported in five months. In Mid- July to Mid-December, the government has collected Rs 29.36 billion in revenue from import of vehicles.

The world is currently facing an environmental crisis due to pollution and climate change, and efforts are being made globally to reduce carbon emissions (Leiserowitz, 2007). Electric vehicles (EVs) offer a sustainable alternative to reduce carbon emissions and mitigate the impacts of air pollution by greenhouse gases (GHGs). Consumers are sceptical of their travel needs for EVs, but addressing the social issues regarding climate change, air pollution, and sustainable energy demands that many more consumers become EV users (Sierzchula et al., 2014; Wang, Tang& Pan , 2019; Zhou , Wang & Hang, 2020) The transport sector in Nepal is dominated by road transport, which accounts for about 90% of all trips (Shrestha & Nepal, 2016) Electric vehicles' main issues are their expensive batteries, poor driving range due to insufficient charging capacity, and lengthy recharge time (Cecelia & Garmendo, 2022). Therefore, it was crucial to investigate and understand the various perspectives held by Nepali consumers regarding the uptake of EVs in Nepal (Neupane & Sawagvudcharee, 2019). On the other hand, Nepal Electricity Authority (NEA) is planning to establish charging station infrastructure in different part of country to increase demand of electricity (Shrestha, P.M.,2023) The global interest in the rise of electric vehicles industry may be intriguing aspects, like the strict government laws and the growing desire of high-performance fuel-efficient and low-emission automobiles. Additionally, the main hurdle for electric vehicles are production costs, poor fuel efficiency, and limited serviceability. The global market of the EV is segmented on the basis of type, vehicle type, and region. Given the classification of petrol as a fossil fuel, it is inherently an unsustainable energy resource that is destined to deplete over time. To facilitate enduring development while preserving the intricate equilibrium of the ecosystem, it is imperative to utilize alternative energy sources. In this context, electric vehicles represent the most advantageous option, as they are more cost-effective than conventional automobiles and do not necessitate gasoline. An electric vehicle efficiently converts 50% of the electrical energy derived from its battery supply into

power at the wheels, whereas a gasoline-powered vehicle utilizes only 17% to 21% of the energy contained within the fuel. A multitude of prominent corporations, encompassing Tesla, BMW Group, General Motors, Nissan Motor Corporation, Toyota Motor Corporation, Volkswagen AG, BYD Company Motors, Daimler AG, Energica Motor Company S.p.A, and Ford Motor Company, are at the forefront of the swift advancement of electric vehicle (EV) technology. Each corporation and engineer are devoting considerable attention to the marketing strategies, development of EV technology, and the expansion of the market share of electric vehicles in contrast to conventional automobiles. EVs in Nepal:

Since the 1970s, Nepal has been at the forefront of sustainability through the implementation of zero-emission tram buses and Safa tempos for public transportation. Trolley buses exemplify equity and accessibility for the populace, providing a reliable source of power. Safa tempos have demonstrated that substantial technological investments are not a requisite for diminishing air pollution. Tax incentives and credit facilities were utilized to support these initiatives, which, at that period, resulted in the formation of the largest fleet of public electric vehicles (EVs) globally. However, the prospects for the future were compromised due to unresolved battery and technological challenges, in addition to governmental policies that predominantly favoured fossil fuel alternatives by reducing tariffs. Given the abundant availability of hydroelectric power, transitioning to electric options could represent the most prudent course of action. With the extensive potential for hydroelectric power, transitioning to electric vehicles and implementing more regulated public transportation systems may represent the most effective strategy for attaining global sustainability. The transportation sector, which is responsible for the second-highest emissions of CO2, must be reformed to ensure sustainability, particularly in light of the recent declaration by the European Union that this year has been recorded as the warmest to date. In alignment with a more comprehensive strategy, Nepal aspires to achieve a target of 90% electric vehicles by the year 2030. Escalating fuel prices, coupled with governmental incentives such as tax reimbursements, have stimulated an increase in the adoption of electric vehicles due to their reduced operational expenses. Financial institutions are now offering financing for the acquisition of electric vehicles amounting to as much as 90%. The sustained demand for battery-operated vehicles is supported by a reliable supply of electricity generated from successful hydroelectric projects. Deliberate decision-making and the adoption of charging-friendly lifestyles significantly contribute to the increasing demand for electric vehicles.



Source: Ideaprenuer, Nepal

Due to the favorable regulations for electric vehicles, the customs department has reported that EV imports have surged by more than threefold during FY 2022-2023. Furthermore, over 60% of all imports consist of electric vehicles, indicating a significant rise in the market for personal electric transportation. Additionally, two-wheelers accounted for 80% of all registered vehicles during the same period (FY 2022-2023). Promoting the use of e-scooters would be an effective approach to reducing pollution and alleviating traffic congestion.

Efforts from the government:

The Nepal Electricity Authority (NEA) and the Nepal Tourism Board are two government entities that are fervently promoting eco-friendly transportation solutions. They have committed to exclusively using electric vehicles (EVs) for their transportation needs. They have vowed to exclusively employ electric vehicles (EVs) for transportation in order to motivate the general populace. NEA's ambitious target of achieving 100% electrification by 2024 aligns with and supports sustainable development goals (SDGs), while also fostering the widespread adoption of EVs and creating a conducive ecosystem for them. The Fiscal Year 2023-2024 offers incentives, such as land leases and tax relief, to stimulate the establishment of EV manufacturing and assembly plants in Nepal. These commitments will facilitate a smoother transition to electric vehicles.

At present, with approximately 140 charging stations in operation, the government is diligently working to establish an additional 500 through public-private partnerships (PPPs), which collaborate with the private sector for the development of EV infrastructure. Alongside the NEA, automobile dealerships such as BYD and Sajha Yatayt are vigorously expanding the charging infrastructure. The government has notably mandated petrol stations install charging facilities

for both new and existing vehicle registrants. These actions reflect the government's heightened focus on promoting the adoption of electric vehicles (EVs).

The fiscal year 2023-2024 budget encompasses substantial impositions on electric vehicles. The Customs Department has identified that the most prevalent models of electric vehicles within the 50-100 kW category, including the BYD Atto3, Hyundai Kona, Honda Neta, Tata Nexon, among others, are the most frequently imported. Notably, this particular category is unexpectedly subjected to a 10% excise duty in addition to a 15% customs duty, thereby increasing their overall cost.

Another significant obstacle in Nepal's intricate topography and inadequate infrastructure is that the majority of charging stations are predominantly located in the capital city. Consequently, a considerable number of individuals question the viability of long-distance travel utilizing electric vehicles (EVs). Moreover, there have been four revisions to the tax legislation within the past two years, which may have adversely affected public enthusiasm. While the prevalence of EVs has increased as a result of governmental initiatives, further actions are necessary to secure their long-term sustainability.

The way forward Electric vehicles (EVs) hold significant potential for advancement in Nepal; however, several factors may influence their adoption and proliferation within the region. In order to facilitate an increase in EV sales, it is imperative that the government continues to support the industry through legislation, subsidies, and comprehensive regulatory frameworks. This encompasses policies such as tax incentives, financial assistance, and the establishment of pollution control standards. To promote widespread acceptance of EVs, it is essential to enhance the infrastructure for charging facilities. Strategic investments in charging stations along highways, urban areas, and rural areas will be crucial to mitigate range anxiety and encourage the transition to electric vehicles. Furthermore, enhancing consumer awareness regarding the benefits of EVs—such as diminished operating costs, potential long-term financial savings, and positive environmental impacts—will be essential in addressing skepticism and accelerating the adoption process.

Global perspective on EV Adaptation

The adaptation of electric vehicles (EV) in Butwal reflects the emerging trends toward sustainable transportation, determining factors governing the transition include government incentives such as tax exemptions and subsidies, which enhance the affordability of EVs for the local population. Generally. It encompasses the policy and Regulatory support, Charging Infrastructure Availability, Economic consideration and Total cost of ownership, Environmental

awareness and Attitudes, Technological trust and Vehicle Performance, Social Influence and Visibility, Urban Design and Mobility Patterns and Energy Mix and Emissions Impact. At first the adaptation is crucial for the environmentally, economically and socio-culturally aspects for the vital component of sustainable transportation system, addressing issues such as climate change, urban air quality and energy security. A systematic approach that integrates sustainability into the EV adaptation process can magnify the grasp market dynamics, and policy impacts, ultimately a more effective transition to the EVs (Lopez- Arboleda et al., 2021).

Policy and Regulatory support: - The adjustment of the Electric Vehicles (EVs) in Nepal is notably influenced by the policy and regulatory support, which is necessary for overcoming the existing blockade and encourage the sustainable transportation. The government is exploiting its hydroelectric power potential to facilitate EV charging, while consumer preference specifies that the price reduction and Targeted policies can enhance the adaptation rates. A multifarious policy approach is recommended to approach the endorse to address the need of potential EVs users. Government initiatives: Nepalese Government should promote the EVs adaptation through the Incentives and the Infrastructure development, acknowledging the absence of fossil fuels reserve as a driving factor for transformation of EVs (Ghimire et al., 2023). Also, Policy Mix effectiveness is research indicates the combination of supportive measures rather than isolated policies, is more effective than encouraging EVs (Ghimire et al., 2023).

Charging Infrastructure Availability: - The accessibility of Charging infrastructure is critical factor influencing the adaptation of electric vehicles (EVs) in Nepal. The present-day Landscape reveals the significant challenges that must be addressed to smooth all-round EV usage. This survey will explore the key aspects of charging infrastructure, including its current state, technological advancement and challenges faced in Nepal at first the current state of the charging infrastructure. The existing charging infrastructure is limited, leading to rang anxiety among the Nepal is limited, leading to anxiety potential among the EVs users (Prasadh et al., 2023). A robust nature of charging station is essential to alleviate the concerns regarding the availability of charging options (Omase et al., 2023). Technological Advancement Integration of smart charging alternatives can enhance the efficiency of charging stations, allowing for better management of power distribution and grid stability (Chung, 2014). The development of AC recharging infrastructure is important for aligning EV charging with renewable sources, which can deduct the overall demand variability (Kirby & Hassan, 2012). Although there may be challenges on that circumferences that the major Key challenges include the need of standardization of charging protocols and the integration of charging stations with the existing power grid (Omase et al., 2023) (Yousuf et al., 2023). The High cost associated with establishing

the comprehensive charging network can deter investment and slow down infrastructure development (Prasadh et al., 2023).

Economic Consideration and Total Cost of Ownership: - The conversion of the electric vehicles in Nepal is remarkably control by the economic consideration and Total Cost of Ownership (TCO). Latest studies had specified the public battery Electric Vehicles (BEV) exhibit the lower TCO compared to the diesel counterparts, making them financially attractive for the business (Pokharel,2023). Furthermore, the economic viability of EVs is increased through the factors such as the intensive usage, financial incentive, and the potential for battery second life application (Taborda-Ospina et al., 2024) (Lebeau et al., 2019). Total Cost of Ownership Analysis comparison with the Disel vehicle: TCO of the electric microbus is lower than the half of the Disel microbus indicating a favorable financial outlook (Pokharel, 2023). Factors affecting the TCO, the major elements include the purchase price, maintenance cost, and energy consumption with EV showing the lower operational cost over time (Taborda-Ospina et al., 2024) (Tiwari and Pokhrel. 2021). Charging Station impact: Beginning of the EV charging station is crucial for carrying the EV adaptation, with projections indicating the payback period for the 3 to 4 years for this investment (Tiwari and Pokhrel,2021).

Environmental awareness and attitudes: - The adaptation of electric vehicles (EVs) is notably influenced by the environmental awareness and attitudes among potential consumers. Research indicates the mixture of Socio-Demographic factors, Financial Incentive, and public perception plays a pivotal role in shaping these attitudes. Environmental concern that's contain the many respondents in the Kathmandu valley express strong environmental concerns, viewing EVs as a solution to reduce air pollution and climate change (Ale,2024) socio-demographic influences factors such as income, education and family size significantly affect attitude towards the EV adaptation. Higher educational level correlates with increasing the environmental awareness and willingness to adopt EVs (Ghimire et al., 2023). Behavioural nudges is also the attitudes informational nudges such as highlighted the environmental impact of vehicle choice have been shown to positively influence consumer preference for electric motorcycles (Filippini et al., 2020).

Technological Trust and Vehicle Performance: - The adaptation of Electric Vehicles (EVs) in Butwal Nepal is affected by multiple factors, explicitly technological trust and vehicle performance. Grasp, these elements are pivotal for intensifying EVs uptake in the region. Particularly, technological trust, generally technological trust is the context of electric vehicles (EV) adaptation refers to the level of confidence that consumers business, and stakeholders have on the reliability, safety, performance, and long-term viability, of EV-related technologies. The

key aspect the technological trust are battery reliability and life, charging infrastructure, Driving range and performance, Software and connectivity, After sales service and support, and most importantly innovation risk also. Meanwhile for the technological trust are arguably affected by the Consumer knowledge. A remarkable gap exists between the technical maturity of EVs and consumer understanding, leading to hesitance in adaptation. Educational initiatives can bridge this gap, stimulate trust in EV technology (Bindhya et al., 2024). And Perception of Performance: - Consumer often Evaluate EV based on their performance compared to traditional vehicles positive performance regarding reliability and efficiency can enhance trust and encourage adaptation (Bindhya et al., 2024).

Social Influence and Visibility: - The customizing of electric vehicles in Butwal is governed by conjunction of social, economic, and environmental factors. Social influence plays an essential, as individuals influence play a essential, as individuals are frequently oscillating by peers, and community perceptions with respect to EVs. The social dynamic can help overcome perceived barriers to the adaptation, such as concerns about the performance and reliability. The following sections involved these key features of social influence. It generally refers to how people's decisions and behaviour are shaped by peers, family, community social norms and media. In the context of Butwal, social influence plays a critical role, mostly in developing urban center where community perception and word-of-mouth significantly impact the buying decisions. Alternatively, Social Influences is generally toward peer pressure: Individuals are more likely to adopt EV if they observe friends or family using them, as social norms significantly impact the consumer behaviour (Patel et al., 2024). And Community Expectation: - Positive community attitudes toward EVs can enhance their desirability, making them on the status symbol within social circles (Xian et al., 2024). Conversely, Economic factors as in the context of Butwal Sub-metropolitan city adhere the cost consideration: -The initial purchase price and operating cost of EV are crucial. Competitive pricing and Lower operational expenses can accelerate the adaption charges (Farajnezhad et al., 2024) Government incentive: - Financial Incentive from the government can alleviate the economic burden, encouraging more consumers to consider EV (Patel et al., 2024).

II. Literature Review

Factor influencing the Electronic Vehicle (EVs) Adaptation in Literature review is generally assumed by the various factors such as economic, infrastructural policy, technical, and social elements that either expedite or obstruct the willingness and ability of consumer to purchase EV. These factors are easily identified through empirical studies, expert survey and policy analysis. And are pivotal to understanding the pace and scope of EV Adaptation in the Nepalese context.

Studies such as (Neupane & Shakya.,2024) and other consistently highlight price, Financial Incentive, and Charging Infrastructures as the most significant factors, with Environmental concern and Social Reinforcement being less impactful in the Nepalese Context. Although, Additional research categorizes barriers into such as the technical, policy, economic, infrastructure and social ranking infrastructure and economic factors as the most critical.

Electronic Vehicle Adoption

Ev Adaptation is possible course of choice among a group of vehicle alternatives described by their hallmark and attributes (Liao,2017). EV adoption brings up electronic cars becoming progressively widespread in the automative industry (Connect,2002).

The transportation industry is the primary cause of the greenhouse gas emission and local pollution, with the vehicle emission being the main source of pollutants such as particulate matter (PM) in the Kathmandu Valley and contributing to approximately 63% of all PM10 emissions (Schwela, 2009). The most look-after following mode of private road transport in Nepal is two-wheelers (including motorcycles, combustion engine-based scooters, and electric scooters), which account for about 78% of the circulating vehicles in 2021 (MCD, 2022). In summation to build up transport systems, a possibility solution to the problem of pollution about emission is individuals switching to driving more fuel economy or electric vehicles (Filipini, Kumar & Srinivasan, 2021). However, customers have shown less return in buying fuel-efficient and environmentally clean two-wheelers in Nepal. In spite of their accessibility and market potential, even though they do not have remarkably higher acquisition costs, and in general have lower lifetime costs (Filipini et.al, 2021). Nepalese consumers Find 2WEVs insufficient as the existing ICE vehicles, motorcycles and scooters give higher ranges and speeds. Now, Although, several manners of large and small electric scooters from China and India have entered the Nepalese market and there is a chance that at non less than some of them will meet these merchandised desired attributes in the future (Wagle et al.,2021).

Electric Four wheelers are not achievable choice in developing countries due to their higher purchase price. Conversely, electric two-wheelers may be beneficial as they come with economical (Albrecht & Rajper, 2020). There is various impetus associated with EV adaptation such as the depletion in GHG (Green-House Gas); efficient energy use gasoline saving and low operational cost. The opposing forces influencing the acquiring of EVs incorporate high buying price, insufficient range, sluggish charging, and new production adjustment anxiety (Albrecht & Rajper, 2020). Essential elements behind the adaptation of electric vehicles are government financial incentives, industry development, and demand fluctuation in the market (Hertzke, Muller, Schenk & Wu, 2018). Persuading people to adopt and acquire electric vehicles by

contingent on the financial and non-financial incentives. High-performing and triumphant. The government wants to map out market and approachable policies such as the flexible regulatory framework, tax advantage, and other financial incentive to uplift rapid validation among potential customers (Jin, Searle, & Lutsey, 2014). All mass producers will float electric vehicles purchaser, and they will be more motivated to adopt electric vehicles manufacturers can achieve economies of scale. Which will improve company discounts for the customers (Ali & Naushad.,2022).

Financial Incentive

Financial Incentive incorporates 'direct subsidies for EV Acquired and road tax absolution. Government policy has notable collision on the acquisition of electric vehicles. By, create customer-Friendly strategy and presuming financial incentives on production and consumption. The government restoring the utilization of products (Ali & Naushad.,2022). Nepal's government has pushed the National Action Plan for the electric on potency in the country. The Budget of FY 2022/23 has enlarged the excise and customs duty on private EV extended from the 45-60%, depending on the road tax to 10% (Wagle et al., 2022). Moreover, the new customs duty for EV is still lower than the ICE vehicles, extreme increases in the tariff will almost double the price of EVs and require them less fierce in the market (Wagle et al., 2022).

Many nations have initiated quarry that grow the number of general shares of EVs or ban sales of ICE. Within, a targeted date. The country that has progressive target is Norway, where it will be illegal to sell petrol or diesel vehicles from the year 2020. The government has established incentives that inspired people to shift to EVs to meet this target (Fridstrome,2021).

China is considerably, the largest manufacturer and consumer of EVs. Its domination in the EV market is mainly for the strong support provided to the industry over the past decade. More or less, Financial Incentives Issue by the Chinese government includes subsidies and tax exemption on manufacturing consumption, and sales tax exemptions, 50% renunciation on vehicle registration fees (Shandlow,2019).

India's government has pushed the Fast adaptation and manufacturing of hybrid and electric vehicles (FAME) in the country. The Indian government has furnished demand incentives for the purchasing of EVs which decrease the purchase price and launch zero road tax (Wagle et al., 2021).

Financial Incentives are crucial element in regulating the alteration of electric vehicles. Customers are most influenced by purchasing electric vehicles due to accessibility of financial incentives. Come in wide variety of forms purchase inducement, coupon interest, subventions,

road tax exemption, registration tax benefits, scrapping incentive, interest -Free loans (NITI Aayog, n.d). Countless, research studies have established that electric vehicles adoption happens because of government financial incentives.

Government, financial incentives have been exceptionally beneficial and triumphant in countries such as Germany, France, Sweden and United States of America. (Wang, Tang, & Pan,2019). Moreover, electric vehicles are environmentally friendly and contribute to environmental protection. As a result, the government prepare the financial incentives to uplift the rapid acquisition of electric vehicles to preserve and protect the environment (Ali & Naushad, 2022). Consequently, it is supposed that financial incentives being an incidental force play a vital role in EV adaptation.

Hypothesis (H1): There is a significant association between financial incentive and Electric Vehicle adaptation.

The Planned Behaviour theory according to Ajzen (1991), three factors attitude toward the conduct, subjective norms, and perceived behavioural control influence behavioural intentions, which in turn drive individual behaviour. Financial incentives including tax breaks, subsidies, and lower registration costs have a favorable impact on consumer attitudes about the adoption of electric vehicles (EVs) by increasing their economic appeal. Because they lower the perceived difficulty or cost of buying an EV, these incentives also improve perceived behavioural control. This theory states that people are more likely to develop a strong intention to adopt and eventually carry out the activity if they believe that doing so is both economical and socially acceptable. Essentially, financial incentives match attitudes and control beliefs in Favor of EV adoption by removing a significant barrier: cost. Furthermore, if government regulations indicate a movement in society toward sustainable transportation, such incentives may also have an impact on subjective standards. Thus, the Theory of Planned Behaviour offers a strong basis for comprehending how monetary rewards can directly impact behavioural intentions and behaviours associated with the adoption of electric vehicles, thereby bolstering the impact of financial incentives on EV adoption.

Price

Price is a key factor in a customer buying decision. Consumers are mannered by tight budget with which to acquire a product (Winbrake & Green,2014). Consumers want to collect the price they paid for a product with the benefit they collect. When the benefit received exceeded the cost sustain, customers are more likely to purchase a product. This is mostly true when electric vehicles are more expensive than conventional vehicles (Ali & Naushad,2022). End-users may

not favor purchasing on narrow and they cannot afford the high cost of such vehicles. Electric Vehicles are expensive due to batteries and lack of economies of scale (Turrentine & Kurani., 2007). Producers can easily attain economics of scale if their manufacturing functioning is extraordinarily large. The stipulation for traditional products is huge and sustainable. The result is in the manufacturer lowering the prices but demand for electric vehicles is low and unsustainable. When it comes to purchasing an electric vehicle, prices are critical factor (Theo, Henkel & Waller,2011).

Affordable: Procuring a car's decisions are constantly made by decisions that are constantly made using the rational model of purchase, which implies that people are always looking for cars that offer excellent value. However, absorbing phenomenon that has been researched in relation to electric vehicles is that the initial high cost of electric vehicles is what causes negative view of electric vehicles, and conversely, their long-term efficacy and fuel savings provide a slight boost to acceptance and perception (Bhalla, Nazneen, & Ali, 2018). The initial investment is a significant consideration when purchasing an electrical vehicle (Lane & Potter., 2007)

Hypothesis 2: There is a significant relationship between the price and Electric Vehicle Adaptation.

Value, Quality, and Price model Zeithaml (1988) suggested that the trade-off between what is given (price) and what is received (quality or advantages) determines how much a buyer thinks a thing is worth. This model emphasizes that the most important factor influencing customer decision-making is perceived value. According to this model, when it comes to the adoption of electric vehicles (EVs), the cost of an EV should be justified by the advantages it offers, such as reduced fuel consumption, low maintenance costs, and environmental benefits. Customers are more likely to view EVs as providing excellent value if the perceived advantages surpass the cost, which will increase adoption. Conversely, adoption may slow if EVs are perceived as costly without offering commensurate benefits. EVs are becoming more affordable as production scales up and technology advances, increasing their appeal to buyers. As a result, cost continues to be a major factor in EV adoption. According to this notion, consumers are more inclined to switch from conventional to electric vehicles when they perceive a favorable price-to-value ratio.

Charging Infrastructure

EV charging stations are stream of power electronics that securely convey managed electricity from the grid to the car batteries. They are typically walls or pedestal- mounted. Various charger models provide varying current and voltage levels to satisfy the needs of various car batteries. EV chargers range from as low as 500 watts (W) to as high as 500 kW. Future improvements in

battery chemistry are foretold to allow for even faster charging rates (Fitzgerald, 2020). Infrastructure for charging electric vehicles is needed. The availability of charging infrastructure gives consumers more confidence to buy an electric car. Each customer cannot install a charging infrastructure at their home. Thus, it is imperative to upgrade the infrastructure for public electric vehicle charging. (Naushad & Ali, 2022). For EV dispersion to occur, there must be a enough number of charging stations. Customers' ability to purchase EVs has been found to be restricted by the smaller quantity of charging networks. Because there are still not enough EV users, the public and private sectors are uncertain to invest in charging stations, and potential EV users are also caution from buying EVs because there are not enough charging stations (Adhikari, Ghimire, Aryal & Khadka, 2020).

At the moment, there are more EVs on the road. Nevertheless, most of the cars are ineffective, have large batteries, and can only travel 99–498 km between charges (Mali, Shrestha, Chapagain, Bishowkarma, & Kumar, 2022). Extensive research is conducted globally to develop batteries with enhanced overall capacity. This will enable the development of long-range capable vehicle services. Furthermore, as the mileage of electric vehicles improves annually, the demand for enhanced recharging facilities is also rising (Kumar, 2017). Charging stations must efficiently provide power to batteries in a manner that is rapid, safe, and cost-effective 30. Charging stations must be designed to accommodate batteries with varying capacities and terminal voltages (Kumar, 2017). The electric vehicle charging station can be classified into three categories (Mali et al., 2022): Home Charging Station, Public Charging Station, and Battery Swap Station. Due to the high costs associated with technology and installation, only a limited number of charging stations are located in major cities, owned by private entities. The NEA is currently undertaking the installation of fifty charging stations in major cities across the country. Currently, vehicle owners are required to charge their vehicles using conventional methods at home or in the office, which are limited to low ratings (i.e., single-phase power supply with 16 A or 32 A current limit). Long-distance EV driving is extremely unlikely due to the small number of charging outlets along the highway. According to (Mali et al., 2022), the infrastructure for charging electric vehicles has begun to develop a favorable association with the adoption of electric vehicles. It is for this reason that a reliable charging infrastructure plays a significant role in the adoption of electric vehicles by consumers. The hypothesis that is presented here can be stated now.

Hypothesis 3: There is a significant relationship between charging infrastructure and Electric Vehicle Adaptation.

Theory of Innovation Diffusion observability, trialability, complexity, compatibility, and relative advantage are some of the characteristics that affect the acceptance of new technologies,

according to Rogers (2003). Electric vehicles (EVs) are more advantageous and less complicated when charging infrastructure is available, which also makes it easier to integrate into daily life. A widely dispersed network of charging stations improves convenience and reduces range anxiety, which is a major deterrent to EV adoption. Similarly, the availability of public charging stations makes EV use more apparent and easier for customers to try, watch, and assess. Rogers asserts that technologies that are more observable and trailable are embraced more quickly. The existence of infrastructure encourages increased adoption by demonstrating that the technology is well-established and supported. Early majority and late majority adopters, who wait for obvious use cases and benefits before altering their behavior, are also impacted. Because infrastructure readiness serves as a stimulant in the diffusion process, Innovation Diffusion Theory demonstrates how the availability of charging infrastructure influences the uptake of electric vehicles.

Social Reinforcement

The term "social reinforcement" refers to the influences of friends, family, and neighbors on the purchasing decisions of customers. Before purchasing a product, every customer wishes to obtain consent from their friends and family members. Customers make purchases based on the opinions, preferences, and dislikes of family and friends (Ali & Naushad, 2021) Customers prefer to purchase products that are socially acceptable and are praised by their friends and relatives. Consequently, clients determine their purchasing decisions regarding a product (Ali & Naushad, 2022). The behaviour of others influences customers' purchase decisions. Social reinforcement is a crucial determinant in the decision to get an electric vehicle. It can be categorized into two exogenous variables: external influence and interpersonal influence (Yang & Tu, 2019). Generally, it is categorized into main aspects that are the internal and external influences.

i) Internal Influences: In this study, the influence of the groups with which consumers have frequent interactions, such as parents, family, acquaintances, and supervisors, on their purchase of electric vehicles is interpreted.

ii) External Influences: This study examines the influence of mass media, expert opinions, and other non-interpersonal information on customers' decisions to acquire electric automobiles.

An individual's choices are anticipated to be shaped by the conduct of individuals inside their social network and prevailing social norms, which can be viewed as the behaviour of the collective society (Lane & Potter, 2007). Numerous qualitative research have demonstrated that

social impact significantly contributes to the promotion of electric vehicles (Liao, 2017). Social reinforcement influences client purchase behaviour and intentions (Ali & Naushad, 2022).

Hypothesis 4: There is a significant relationship between social Reinforcement and electric vehicles.

Theory of Social Cognitive

Human behaviour is primarily melded by modelling, social reinforcement, and observational learning, according to Bandura (1986). Observed behaviours are typically imitated by others, particularly when those acts are perceived to provide favorable results or social acceptance. When it comes to EV adoption, people are more inclined to buy an EV if they observe their friends, neighbors, or other influential people doing the same. EVs are widely used in a social circle, which supports the idea that possessing one is advantageous, socially desired, and acceptable. Conversations, exposure to social media, and environmental efforts are further social cues that support this behaviour. Perceived uncertainty is also decreased by social influence since people consider the experiences of others before making their own judgments. Bandura's thesis thus contributes to the understanding of how social reinforcement can influence consumer choices and encourage environmentally friendly actions. By showing how social modelling and community behaviour have a big impact on people's decisions about sustainable choices like adopting electric vehicles, this theoretical framework supports the idea that social reinforcement has an impact on EV adoption.

Environmental Concern

Environmental concern is a term that refers to a person’s awareness of environmental issues and concerns. Environmental concern signifies an individual's aspiration to address ecological issues. Environmental concerns are a paramount priority for governments, consumers, and international organizations at present. Numerous studies have demonstrated that environmental considerations influence a customer's decision to acquire an electric vehicle. Environmental concerns are continuing to develop at an alarming rate, and customers are willing to adopt electric vehicles as a result (Ali & Naushad, 2022). Numerous researchers have examined the correlation between environmental concern and consumer purchasing behaviour, discovering that increased environmental awareness correlates with a higher likelihood of purchasing eco-friendly products, such as electric two-wheelers (Jayasingh et al., 2020). A research survey done in Germany indicates that the environmental advantages of electric vehicles are a primary driver for the intention to purchase them. A study conducted in China demonstrated that environmental concern indirectly influences the desire to adopt hybrid electric vehicles, with attitude serving as a mediating factor.

A study in Macau corroborates the finding that environmental concern affects the uptake of fully electric automobiles. Previous research indicates that environmentally conscious consumers are likely to purchase eco-friendly products, such as electric vehicles (Jayasingh et al., 2020). Environmentally concerned consumers seeking to reduce gasoline expenses are more inclined to get an electric vehicle. Environmentally conscious customers demonstrate a preference for electric automobiles. According to (Ali and Naushad, 2022), the widespread use of electric vehicles would not only help to solve a number of environmental problems, but it will also lead to large reductions in energy consumption. As stated by (Mashor & Difrazno.,2021), electric vehicles are not only favorable to the environment but also contribute to the reduction of environmental degradation. Not only should manufacturers of electric vehicles target energy conservation, but they should also address environmental problems because of their importance. According to (Liu & San.,2015), consumers who are environmentally conscious and who believe that they are ecologically responsive are more inclined to purchase electric vehicles. Therefore, earlier research suggested that electric vehicle (EV) owners could experience a "warm glow" and "intrinsic emotional reward in pro-environmental behaviour" (Datta & Hwang, 2021).

This conclusion was reached in a manner that was analogous to the act of performing self-sacrificing actions, such as donating to a charitable organization. as they perceived that they played their role in curtailing carbon emissions and preserving the environment. This pleasing sense of honor encourages consumers to adopt EVs. Environmental concern has been growing dramatically in recent years due to severe environmental issues and the government's appeal to protect the environment. According to the Global Burden of Diseases project report, air pollution was responsible for 4.2 million deaths worldwide in 2015 (Datta & Hwang, 2021). It appears that governments of various countries are attempting to find solutions to the problem of pollution in a variety of different ways. In this regard, electric vehicles present Taiwan with potential to enhance air quality by lowering emissions (Datta & Hwang, 2021). Hence, individual environmental protection concerns can improve Taiwanese individuals' motivation to adopt EVs. The following hypothesis can be stated.

Hypothesis 5: There is a significant relationship between Environmental Concern and Electronic Vehicle Adaptation.

Norm Activation Model

The Norm Activation Model (NAM), first presented by Schwartz in 1977, aims to explain prosocial and ecologically conscious behaviour. The main predictor of altruistic behaviour, according to NAM, is personal norms, which are triggered when people feel a moral duty to act (ascription of responsibility) and become conscious of the repercussions of their acts (knowledge

of consequences). Environmental concerns serve as a catalyst that activates personal norms in the context of the deployment of electric vehicles (EVs). Customers are more likely to switch to electric cars (EVs) when they understand that conventional gasoline-powered vehicles contribute to pollution and climate change, and they feel accountable for lowering their carbon footprint. This internalized sense of moral duty becomes a powerful incentive that frequently triumphs over strict financial factors. The strategy is also in line with the expanding trend of green consumerism, in which consumers base their purchases on environmental and ethical considerations. Schwartz's approach thus supports the idea that pro-environmental norms that Favor sustainable transportation choices are activated as a result of increased environmental awareness.

Empirical Review

The integration of electric vehicles (EVs) in emerging urban regions like Butwal Sub-Metropolitan City, Nepal, is compounded cooperation of Financial, infrastructural, Personal and social factors. Recognize the tendency at paly experimental studies across factors have progressively relied on conventional behavioural and innovation-diffusion theories. This review combining foregoing empirical research on the independent variables—financial incentives, price, charging infrastructure, social reinforcement, and environmental concern—in relation to the dependent variable—EV adoption, using the structure of Ajzen's Theory of Planned Behaviour (1991), Zeithaml's consumer value theory (1988), Rogers' Diffusion of Innovations (2003), Bandura's Social Cognitive Theory (1986), and Schwartz's Norm Activation Model (1977).

Financial Incentive

Financial incentives, such as tax rebates, subsidies and reduced registration fees, are pivotal in reducing the financial hurdle to EV adoption. Drawing from Ajzen's (1991) Theory of Planned Behaviour (TPB), incentives to shape behavioural intention by determine ascertain behavioural control. Several empirical studies (Sierzchula et al., 2014; Jenn et al., 2018) have found that government subsidies remarkably increase EV uptake, especially in regions where the upfront costs are a primary obstacle,

In the context of Nepal, local policies present tax exemptions have been partially successful in promoting EVs, but limited awareness and inconsistent execution restrict broader impact (Paudel et al., 2022). Empirical data from urban Nepal suggest that financial factors are among the top three motivators for EV adoption (Karki & Adhikari, 2020). although their effect varies depending on socio-economic status.

Price

Price remains an unfavourable roadblock to EV scattering, especially in lower-income regions. Zeithaml's (1988) consumer behaviour theory underlines that perceived value, which weighs, governs purchase intention, perceived benefits against price. EVs often carry a higher initial price tag than internal combustion engine (ICE) vehicles, which can offset long-term savings from lower operational costs.

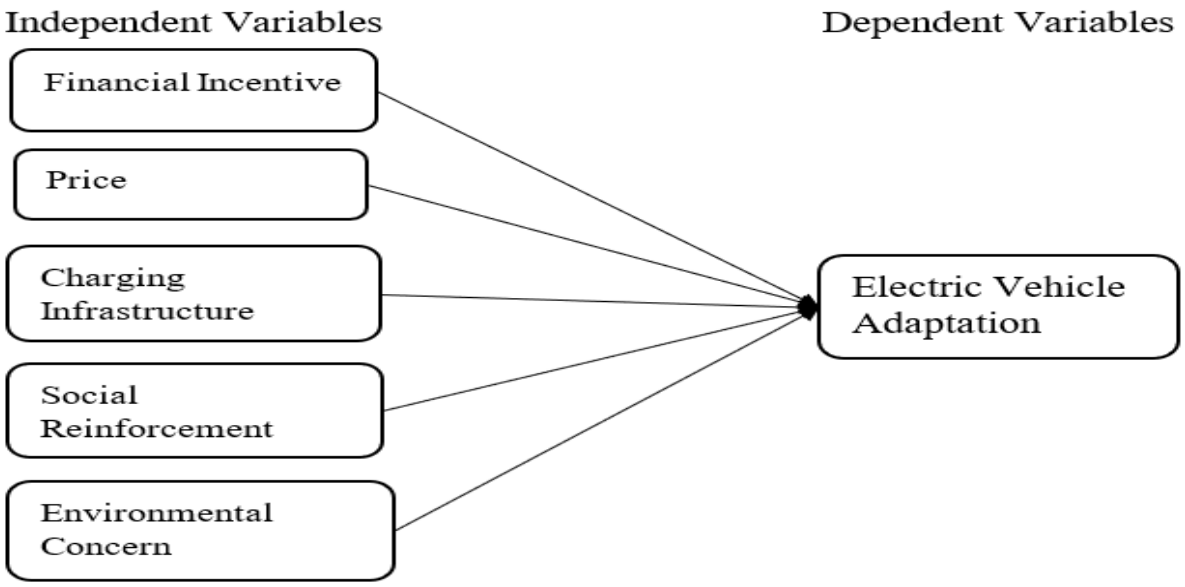
Empirical research by (Hardman et al. 2017) confirms that high upfront costs scare off consumers despite long-term benefits. In Butwal, where middle-income groups dominate, price sensitivity is high, and the lack of competitive pricing for EVs in comparison to fuel-based alternatives limits adoption. The perceived lack of financial equality is a significant psychological fence (Ghimire, 2021).

Charging infrastructure by (Zhou et al. 2021) found a positive correlation between the density of charging stations and EVs registrations in urban area across China. Their regression analysis showed that 10% increase in public chargers leads to 4% increase in EV purchase. Using panel data from 100 US cities, it revealed that charging station availability has stronger impact on EVs in adaptation than government subsidies (Li et al.,2017).

Social Reinforcement by (Axsen & Kurani. 2011) new the concept of "social influence networks" in Ev adoption, showing that individuals are more likely to purchase EVs if someone in their peer group already owns one. Also demonstrated that word-of- mouth recommendations and social comparisons significantly increase EV interest in China, especially in tight-knit communities (Zhou, Wang & Hao., 2020).

Conceptual Framework

A conceptual framework is a research design that visually or logically explains how the main concepts in a study are related to each other, it may include the variables like the Technological Trust, Social Influence, Economic Factors and Government policies.



III. Research Methodology

This section describes the approach and techniques used in the study to investigate the research questions and solve the identified problems. It explains the key elements of the research design, such as how the target group and sample were chosen, how participants were contacted, where data was obtained, the tools used to gather information, and the methods for analyzing the data. The methodology is divided into the following parts: research structure, target population, sample size, sampling technique, data sources, data collection methods, and data analysis tools.

Research Design

This study utilizes both descriptive and causal-comparative research designs to examine the relationships between factors influencing electric vehicle adoption. These designs help provide a clear picture of existing patterns and explore cause-effect relationships between the variables. In this context, Kerlinger (1986) highlights *ex post facto* research, where past independent variables are analyzed to assess their effects on dependent variables (Kerlinger, 1986; Pant, 2012, p. 117). Common statistical methods used in such studies include the Spearman Rank Order Coefficient, Phi Correlation Coefficient, Regression, t-test, Chi-square, and Analysis of Variance (Isaac, 1978; Pant, 2012, p. 118).

Population and Sample size

The research area for this study is Butwal Sub-Metropolitan City**.** The population consists of young generations studying and working in Butwal. However, the total number of customers using these services cannot be precisely determined, making the population unknown**.** To address this, the sample size for an unknown population is calculated using Cochran's formula (Cochran, 1977).

$n = Z^2 p (1 - p)/ e^2$ Where, Z = Given Z value based on confidence level (z = 2.576 for 99% level of confidence, 1.96 for 95% level of confidence, 1.645 for 90% level of confidence.

p = Proportion of event of interest for the study (0.5) and e= margin of error (it depends upon confidence level). Thus, the calculated sample size of the study n = 384

Sampling Method

The sampling method is chosen to select sample respondents from the overall population for data collection. In this context, the snowball sampling method is specifically employed to approach the sample respondents. Given that the study focuses on factors influencing electric vehicle adoption in Butwal Sub-metropolitan city, the snowball sampling technique is deemed appropriate.

Tools for Data Collection

A self-structured questionnaire was used as the survey instrument for data collection. It was developed based on operational definitions from previous literature. The questionnaire employs a five-point Likert scale (5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, and 1 = Strongly Disagree) to gather responses from participants. A set of questions was designed to measure each independent, dependent, and dependent variable, totaling 30 items. Out of 384 distributed questionnaires, 291 were fully completed, yielding a response rate of 75%.

Statistical Tool

The study utilized various statistical tools based on the nature of the data. Descriptive statistics, including mean and standard deviation (SD), were computed to analyze and interpret customer responses. Additionally, a reliability test was conducted to assess the consistency of the research instrument. A normality test, specifically the Kolmogorov-Smirnov (K-S) test, was performed to evaluate the data's distribution. After assessing normality, parametric and non-parametric tests were applied inferential statistics. Furthermore, correlation analysis was used to measure the relationship between variables, while regression analysis examined the effect of independent variables on the dependent variable.

IV. Result and Analysis

Measurement Items Assessment

Table 1 - *Assessment of measurement scale items*

Variables	Items	Outer loadings	VIF	Mean	Standard deviation
CI1 <- Charging Infrastructure	CI1	0.903	038	2.837	1.534
	CI2	0.837	187	5.96	1.412
	CI3	0.887	603	5.801	1.506

	CI4	0.718	486	5.688	1.645
	EC1	0.806	727	5.656	1.427
	EC2	0.814	868	5.58	1.449
EC1 <- Environmental Concern	EC3	0.913	992	5.504	1.714
	EC4	0.886	398	5.163	1.534
	EC5	0.826	888	5.156	1.846
	FI1	0.898	.12	4.866	1.869
	FI2	0.882	087	4.833	1.768
FI1 <- Financial Incentive	FI3	0.848	.45	4.757	1.776
	FI4	0.805	.27	4.743	1.898
	FI5	0.92	141	4.431	1.95
	P1	0.726	486	4.373	2.079
	P2	0.884	157	4.359	1.981
P1 <- Price	P3	0.798	187	4.236	1.972
	P4	0.865	643	4.232	1.893
	P5	0.715	558	4.192	1.968
	SR1	0.873	992	3.899	1.955
	SR2	0.912	945	3.257	1.898
SR1 <- Social Reinforcement	SR3	0.913	194	3.243	1.776
	SR4	0.722	818	3.167	1.768
	SR5	0.776	741	2.87	1.5
	EVA1	0.898	.23	5.152	1.702
	EVA2	0.903	675	5.145	1.715
EVA1 <- Electric Vehicle Adaptation	EVA3	0.778	.37	5.13	1.5
	EVA4	0.855	595	5.025	1.768
	EVA5	0.829	234	5.018	1.791

Table 1 presents the standardized outer loading and Variance Inflation Factor (VIF) of the scale items employed to measure the variables pertinent to this investigation. In accordance with Sarstedt et al. (2017), the outer loading of an item must exceed 0.708 to signify a substant ial contribution of that item in assessing the associated variable. Therefore, all 29 scale items ar e preserved for subsequent analysis. Furthermore, the VIF values for each item are less than the reby indicating no multicollinearity within the scale items (Sarstedt et al., 2014). Most of the m ean values are on higher side on the scale representing agreeableness towards each statement. F or S.D. values are small indicating less deviation in the responses. Therefore, the data is suitabl e for further analysis.

Quality Criteria Assessment

Table 2 - *Construct Reliability and validity*

Variables	Alpha	CR (rho_a)	CR (rho_c)	AVE
Charging Infrastructure	0.857	0.868	0.904	0.704
Environmental Concern	0.908	0.962	0.929	0.723
Financial Incentive	0.921	0.933	0.94	0.76
Price	0.858	0.863	0.899	0.641

Social Reinforcement	0.896	0.905	0.924	0.71
Electric Vehicle Adaptation	0.907	0.92	0.931	0.729

Table 2 contains the values of Cronbach's Alpha, Composite Reliability (CR), and Average Variance Extracted (AVE) to evaluate the convergent validity of the variables employed in this study. The Cronbach's Alpha coefficients for all items exceed the threshold of 0.705, signifying the adequate contribution of each scale item in the assessment of related constructs (Bland & Altman, 1997). Furthermore, the CR values for rho_A and rho_C surpass the minimum criterion of 0.70, denoting a robust measure of internal consistency (Saari et al., 2021; Hair et al., 2022). The AVE values also exceed the pivotal threshold of 0.50, suggesting that each variable accounts for more than 50 percent of the explained variance. This finding confirms the establishment of convergent validity (Hair et al., 2022). Subsequently, the outcomes.

Discriminant Validity

Table 3 - *Hetrotrait-Monotrait Ratio of correlations*

Variables	Charging Infrastructure	Electric Vehicle Adaptation	Environmental Concern	Financial Incentive	Price	Social Reinforcement
Charging Infrastructure						
Electric Vehicle Adaptation	0.695					
Environmental Concern	0.384	0.377				
Financial Incentive	0.398	0.475	0.889			
Price	0.763	0.737	0.421	0.41		
Social Reinforcement	0.72	0.808	0.469	0.54	0.762	

Table 3 contains the HTMT ratio of the correlation matrix, which evaluates the discriminant validity of the latent variables. The values of the HTMT ratio vary from 0.377 to 0.889. The HTMT ratio values need to remain below the critical threshold of 0.85; nevertheless, a range extending up to 0.90 is deemed acceptable, as posited by Henseler et al. (2015). Consequently, the presence of discriminant validity is confirmed among the reflective constructs (Hair & Alamer, 2022).

Table 4 - *Fornell-Larcker Criterion*:

Variables	Charging Infrastructure	Electric Vehicle Adaptation	Environmental Concern	Financial Incentive	Price	Social Reinforcement

Charging Infrastructure	0.839					
Electric Vehicle Adaptation	-0.621	0.854				
Environmental Concern	0.358	-0.39	0.85			
Financial Incentive	-0.359	0.457	-0.851	0.872		
Price	-0.975	0.662	-0.39	0.37	0.801	
Social Reinforcement	-0.63	0.748	-0.46	0.504	0.669	0.843

Table 4 displays the Fornell-Larcker Criterion, an important discriminant validity assessment in a structural equation model (SEM) (Fornell & Larcker, 1981). This criterion is satisfied when the average variance extracted (AVE) for every construct is higher than the squared correlation between that construct and any other construct in the model. The diagonal entries, the square root of AVE of every construct, are to be higher than the off-diagonal values for their corresponding columns and rows. As evident in Table 4, diagonal values (in bold) of Charging Infrastructure (0.839), Environmental Concern (0.85), Financial Incentive (0.872), Price (0.801), Social Reinforcement (0.843) and Electric Vehicle Adaptation (0.854) are all higher than their inter-construct correlations. This means the measurement model's discriminant validity is assured, implying that each construct is unique and taps into a distinct segment of variance (Hair et al., 2010). This ensures that the constructs do not overlap and that the measures are measuring what they should measure.

Model Fit Assessment

The SRMR and NFI fit indices evaluate the model's explanatory efficacy. The model's SRMR value is 0.086, below the acceptable threshold of 0.80 (Bollen & Stine, 1992). Consequently, this finding suggests that the model exhibits adequate explanatory capability. The effect sizes (f^2) for the independent variables Charging Infrastructure (0.023), Environmental Concern (0.029), Financial Incentive (0.036), Price (0.050), and Social Reinforcement (0.293) reflect their respective impacts on Electric Vehicle Adaptation. According to Cohen's (1988) guidelines, these values suggest that Charging Infrastructure, Environmental Concern, and Financial Incentive exhibit small effects, Price demonstrates a small to moderate effect, while Social Reinforcement exerts a substantial, near large effect on the adoption behaviour. Collectively, these variables explain 62.4% of the variance in Electric Vehicle Adaptation, as indicated by the R^2 value of 0.624. This demonstrates Electric Vehicle Adaptation demonstrates moderate predictive ability (Hair et al., 2013).

Structural Equation model

Figure 1 - *Path Relationship Diagram*

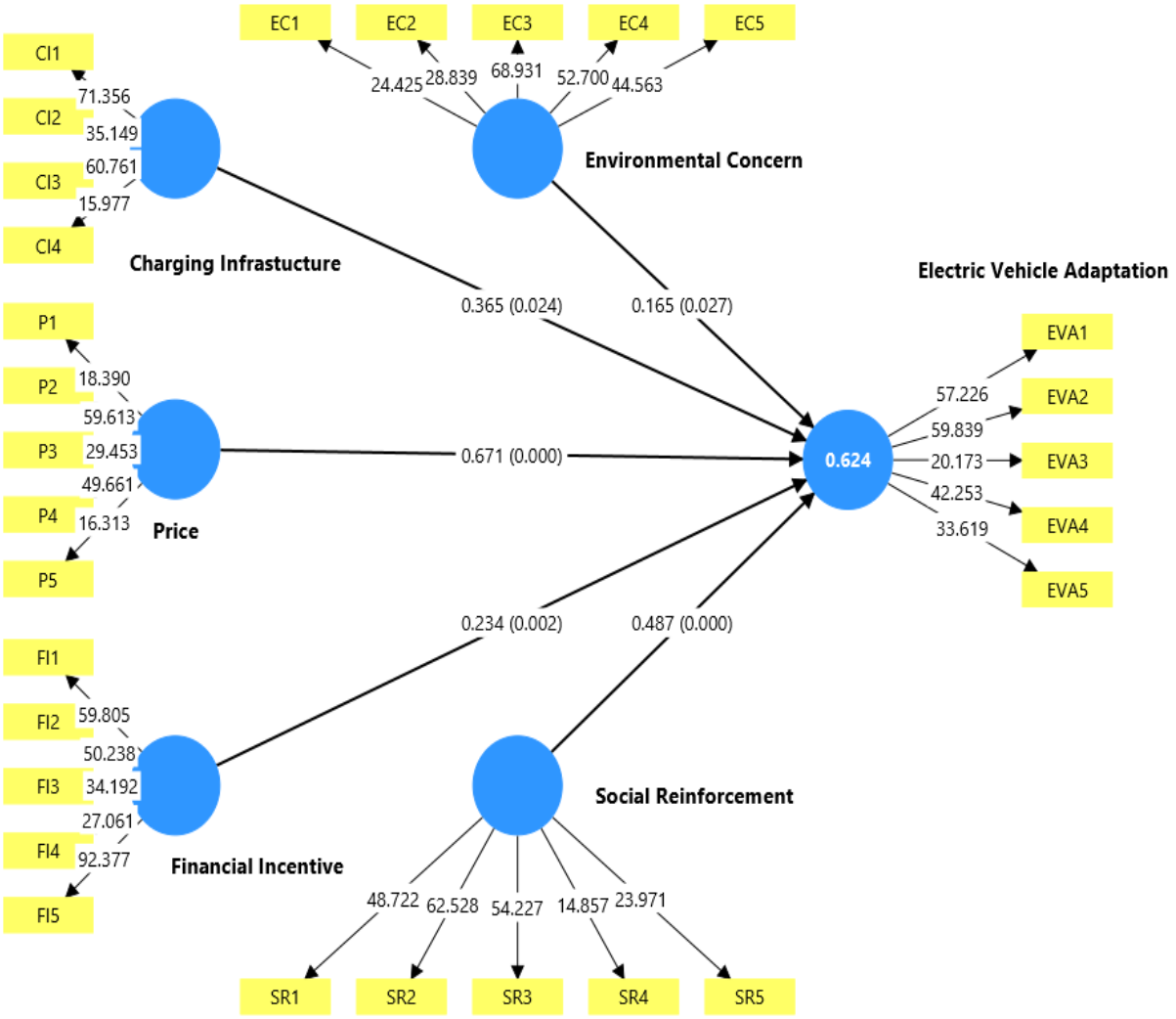


Table 5 - *Hypotheses Testing using Bootstrapping*

Hypotheses	B	Sample means (M)	Standard deviation (STDEV)	Confidence Interval 2.50%	Confidence Interval 97.50%	T statistics (|O/STDEV|)	P values	Decision
H1: Financial Incentive -> Electric Vehicle Adaptation	0.365	0.348	0.162	0.009	0.641	2.254	0.024	Accepted
H2: Price -> Electric Vehicle Adaptation	0.165	0.163	0.074	0.018	0.311	2.212	0.027	Accepted
H3: Charging Infrastructure-> Electric Vehicle Adaptation	0.234	0.232	0.075	0.083	0.379	3.118	0.002	Accepted

H4: Social Reinforcement -> Electric Vehicle Adaptation	0.671	0.651	0.185	0.265	0.99	3.635	0	Accepted
H5: Environmental Concern -> Electric Vehicle Adaptation	0.487	0.492	0.079	0.342	0.648	6.197	0	Accepted

Figure 1 and Table 5 report the results of a bootstrapping analysis performed with 10,000 subsamples, which examines decisions regarding the proposed hypotheses. Hypotheses H1, H2, H3, H4, and H5 have achieved acceptance at a significance threshold 0.05. Multiple independent. Thus, there is a positive and significant impact of financial incentive, Price, Charging Infrastructure, Social Reinforcement and Environmental Concern on Electric vehicle Adaptation.

Table 6 - ***Importance Performance MAP Analysis***

Variables	LV performance	Importance
Charging Infrastructure	33.399	0.365
Environmental Concern	51.043	0.165
Financial Incentive	55.92	0.234
Price	67.135	0.671
Social Reinforcement	77.42	0.487
Mean	56.9834	0.3844

Table 6 shows the total effects of Charging Infrastructure, Environmental Concern, Financial Incentive, Price and Social Reinforcement on Electric Vehicle Adaptation for the unstandardized effects. These effects are the same as the unstandardized weights of ordinary least square regression modelling (Hair et al. 2010). Furthermore, the Electric Vehicle was calculated as 72.888.

Notably, we derived the four quadrants successfully based on the mean values of the constructs' importance and performance value. As per Fig. 2, if we increase 1 unit in Charging Infrastructure performance from 33.399 to 34.399, the impact of EV adaptation from 72.888 to 73.253. Similarly, if we increased 1 unit in performance of Price from 67.135 to 68.135, then Electric Vehicle Adaptation grew from 72.888 to 73.559. Therefore, out of the five determinants of Electric Vehicle Adaptation, the most critical factor was noted to be Price and Social reinforcement.

Figure 2 - ***Importance -Performance Map***

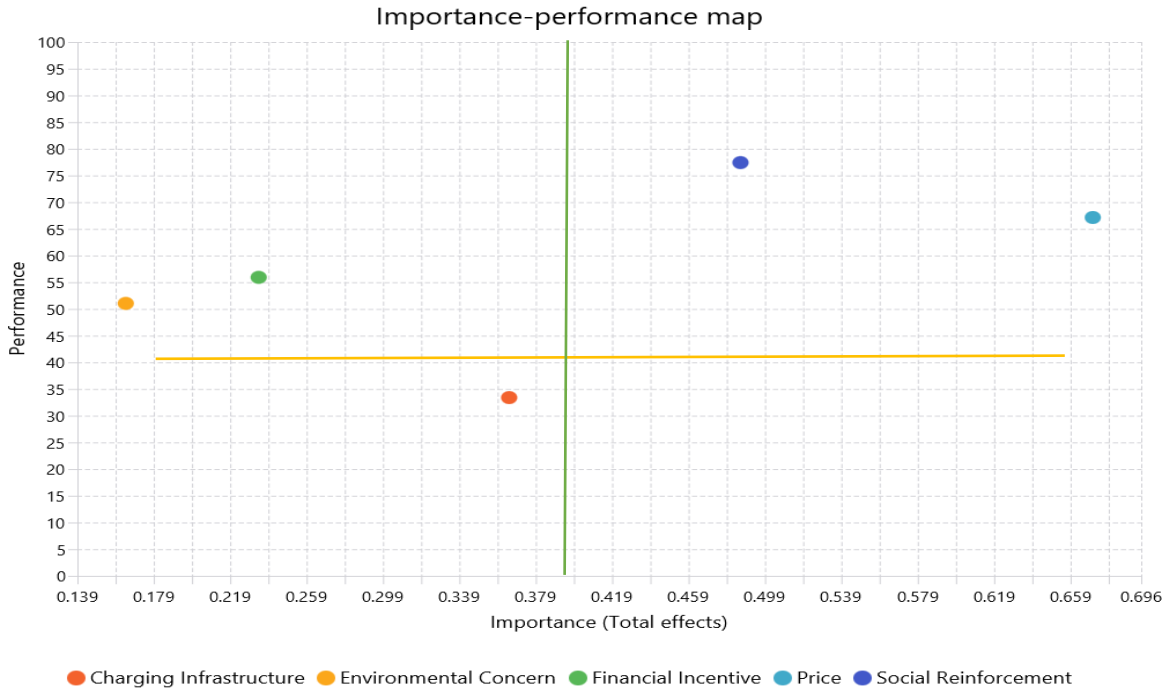


Table 7 - *Necessary Condition Analysis (NCA) – Bottleneck Values*

	LV scores - Electric Vehicle Adaptation	LV scores - Charging Infrastructure	LV scores - Environmental Concern	LV scores - Financial Incentive	LV scores - Price	LV scores - Social Reinforcement
0.00%	18%	0%	NN	NN	NN	NN
10.00%	26%	0%	NN	NN	NN	NN
20.00%	34%	0%	NN	NN	NN	NN
30.00%	43%	0%	NN	NN	26%	20%
40.00%	51%	0%	NN	NN	27%	21%
50.00%	59%	0%	NN	NN	29%	23%
60.00%	67%	0%	NN	NN	30%	25%
70.00%	75%	0%	NN	NN	32%	26%
80.00%	84%	0%	NN	NN	33%	28%
90.00%	92%	0%	NN	16%	35%	30%
100.00%	100%	0%	21%	23%	37%	32%

Table number 7 represents Bottleneck values of latent variable using Necessary Condition Analysis. To achieve 34%, of Electric Vehicle Adaptation, no factors are necessary. To achieve 43% of Electric Vehicle Adaptation, 26% of LV Score of Price and 20% of LV score of social reinforcement. Similarly, to gain 92% of Electric vehicle adaptation, it required 16% of LV score of financial incentive, LV Score of Price and 30% of LV score of Social Reinforcement. Further. to achieve 100% of Electric Vehicle Adaptation, 21% of LV score of Environmental Concern, 23% of LV scores of Financial Incentive, 37% of LV scores of Prices and 32% of LV scores of Social Reinforcement.

V. Findings of the Study

The key findings of this particular research study show that Financial Incentive has positive and significant relationship with Electric Vehicle Adaptation. Similarly, Price also has positive and significant association with Electric Vehicle Adaptation. Likewise, Charging Infrastructure also has positive and significant association with Electric Vehicle Adaptation. Correspondingly, Social Reinforcement also has positive and significant relationship with Electric Vehicle Adaptation. Also, Environmental Concern also has positive and significant association with Electric Vehicle Adaptation.

The research in Butwal Sub-Metropolitan City, Nepal, examines factors driving electric vehicle (EV) adaptation, finding that Financial Incentives, Price, Charging Infrastructure, Social Reinforcement, and Environmental Concern significantly influence adoption, supporting Nepal's target of 90% EV sales for private vehicles by 2030. The structural equation model (SEM) explains 62.4% of the variance in EV adaptation ($R^2 = 0.624$), with an SRMR value of 0.086 indicating good model fit. Financial Incentives significantly promote adoption ($\beta = 0.365$, $p = 0.024$) through subsidies and reduced import duties, which have narrowed the price gap between EVs and fossil fuel vehicles, though inconsistent tax policies, with customs and excise duties fluctuating four times in two years, create uncertainty for buyers.

Globally, such incentives have proven effective, with tax exemptions boosting EV uptake in multiple markets (Hardman et al., 2017). Price is a major barrier ($\beta = 0.165$, $p = 0.027$), with a performance score of 67.135, as high battery costs require 26% of Price's latent variable score for 43% adaptation. In 2023, EVs comprised 83% of car sales in Nepal due to low EV taxes (10-30%) compared to 200-300% for internal combustion engine (ICE) vehicles, highlighting price's critical role. Charging Infrastructure impacts adoption ($\beta = 0.234$, $p = 0.002$), but with limited public charging points, mostly in urban areas, and a low performance score of 33.399, rural access in Butwal remains a challenge. Nepal's hydroelectric grid supports sustainable charging, yet infrastructure lags due to high investment costs. Social Reinforcement strongly drives adoption ($\beta = 0.671$, $p < 0.001$), with a performance score of 77.42, leveraging Nepal's collectivist culture where peer influence, evident in electric bus operations like Sundar Yatayat's in Butwal, encourages uptake, requiring 20% of its score for 43% adaptation.

Environmental Concern also promotes adoption ($\beta = 0.487$, $p < 0.001$), with high reliability (AVE = 0.723, Cronbach's Alpha = 0.908), as urban air pollution drives awareness, though its moderate performance score (51.043) suggests education campaigns could amplify impact. In Kathmandu Valley, EV adoption is projected to reduce greenhouse gas emissions significantly, supporting Nepal's net-zero emissions goal by 2045 (Rajbhandari et al., 2024). Policymakers

should sustain tax incentives, expand rural charging networks, and promote community campaigns to leverage social and environmental factors. While focused on Butwal, these insights are vital for Nepal's sustainability goals, though rural barriers and financing innovations need further exploration.

VI. Conclusion and Implication

Conclusion

The study on EV adaptation in Butwal Sub-Metropolitan City, Nepal, critically advances the understanding of sustainable transportation by identifying key drivers of adoption. Crucial findings reveal that Financial Incentives, Price, Charging Infrastructure, Social Reinforcement, and Environmental Concern all exhibit positive and significant relationships with EV adaptation, with Social Reinforcement exerting the strongest influence ($\beta = 0.671$, $p < 0.001$), followed by Environmental Concern ($\beta = 0.487$, $p < 0.001$), collectively explaining 62.4% of adoption variance ($R^2 = 0.624$). These results underscore the pivotal role of cultural and environmental motivations in Nepal's collectivist, resource-constrained context. By integrating TAM, ECT, and SDT, the study offers a robust theoretical framework for future research, while practically guiding policymakers to sustain tax incentives, expand rural charging networks, and promote community-driven campaigns. Focused on Butwal, these findings provide a scalable model for Nepal's 2030 EV adoption target and offer valuable lessons for other developing nations striving for sustainable mobility futures.

However, as a cross-sectional study employing convenience sampling, its findings are limited by potential sampling bias and an inability to capture temporal dynamics, restricting generalizability beyond Butwal's urban context. Future research should adopt longitudinal designs to track evolving adoption patterns, utilize probability sampling to enhance representativeness, and explore rural and other regional contexts within Nepal to uncover diverse barriers and facilitators. Comparative studies with other developing nations could further validate the framework's applicability. Practically, the study urges policymakers to sustain tax incentives, expand rural charging infrastructure, and promote community-driven campaigns to achieve Nepal's ambitious 2030 target of 90% EV sales. These findings offer a scalable model not only for Nepal but also for other developing countries striving to transition to sustainable mobility, providing actionable insights to overcome economic, infrastructural, and socio-cultural challenges in the pursuit of a Green.

Implications

The empirical study on factors influencing electric vehicle (EV) adaptation in Butwal Sub-

Metropolitan City, Nepal, grounded in the Technology Acceptance Model (TAM), Expectation-Confirmation Theory (ECT), and Self-Determination Theory (SDT), yields significant theoretical and practical implications. Theoretically, it enriches TAM by confirming that perceived usefulness and ease of use, reflected in Financial Incentives ($\beta = 0.365$, $p = 0.024$) and Charging Infrastructure ($\beta = 0.234$, $p = 0.002$), drive EV adoption, while extending ECT through Environmental Concern ($\beta = 0.487$, $p < 0.001$), which sustains post-adoption satisfaction, though its moderate performance score (51.043) suggests gaps in expectation fulfilment. SDT is advanced by Social Reinforcement's dominant role ($\beta = 0.671$, $p < 0.001$), highlighting intrinsic motivations in Nepal's collectivist culture, challenging economic-centric models given Price's lower impact ($\beta = 0.165$, $p = 0.027$). Practically, policymakers should stabilize low EV taxes (10-30% vs. 200-300% for ICE vehicles) and expand financing to address Price barriers, extend the 140 urban charging stations to rural Butwal to improve infrastructure performance (33.399), and leverage community campaigns, like those for electric buses, to amplify Social Reinforcement, supporting Nepal's 2030 goal of 90% EV sales. These insights benefit researchers studying technology adoption in developing contexts and stakeholders aiming to scale sustainable mobility.

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