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The Future of Electric Vehicles in Developing Countries

Ashraf Zakaria EL Hariry, Hisham Karamany

Public Authority for Applied Education and Training – Kuwait

Abstract

Electric vehicles are a key player in the global push for sustainable, low-emission transport. While developed countries are moving forward with EV adoption, developing economies have a separate set of barriers: lack of charging infrastructure, the expensive upfront cost of EVs, policy and regulatory gaps, not enough human expertise to power this strategic transition. and private costs, including charging, and traveling restrictions

Drawing on the literature, this paper considers some of the technical, economic and institutional challenges to EV deployment in developing countries, with a focus on humans – specifically education, training and workforce development. By suggesting feasible measures such as construction of smart infrastructure, incentive-based policies and capacity building efforts, the study offers strategic inputs to assist **policymakers,** industry and academia fast track the move to electric mobility. In the end, tackling these challenges can put developing countries on a path to achieve the environmental and economic benefits that EVs offer and to make substantive contributions to the global decarburization effort Prospects of Electric Cars in Developing Countries: Approaches and Problems bullet Title SPLITL The Future of Electric Vehicles in Developing

The electric vehicle (EV) is a critical pathway in the worldwide quest to attain sustainable and low-emission transportation. Although the migration toward the EVs is taking place in developed countries, less developed countries have different serious issues to overcome for this migration to occur. These consist of poor charging infrastructure, high investment costs, insufficient policy structures and a dearth of trained man power. This paper reviews the technological, economic, and institutional challenges of EV deployment in developing countries and focuses on the human factor,

i.e., capturing the role of education, training, and workforce development. The study offers strategic advice for policymakers, industry players, and researchers to stimulate the transition to electric vehicles through practical measures like smart investments in infrastructure, incentive-friendly policies, and capacity building programmes. In the end, solving these issues could help developing nations leverage the environmental and economic benefits of EVs and make a significant difference to worldwide decarbonization targets.

Index Terms: The Future of Electric Vehicles in Developing Countries Challenges and Solutions

Introduction

Driven by increasing worldwide environmental concerns such as global warming and air pollution, electric vehicles (EVs) have been identified as an important measure to decrease greenhouse gas emissions and make transportation more sustainable. The move to electric vehicles is key to a move to cleaner energy systems, in that it reduces reliance on oil supplies and helps to reduce climate change impacts. Advanced economies are quickly embracing this new technology but emerging markets have their own set of issues surrounding the electric vehicle.

These barriers include insufficient charging facilities, high price of electric cars in comparison to conventional gasoline cars, public ignorance about the benefits of electric vehicles in ecological and economical aspects, and unwise governmental policies. Also, the society may not be meeting necessary investments into both the public and private sectors to build out the infrastructure that's needed for this technology

This study intends to discover the technological, economic, and policy challenges confronted by the developing countries in the adoption of EVs and suggest the possible remedies to overcome these challenges. The report recommends solutions in the form of 'intelligent' infrastructure, incentive-led policy making for a shift towards electric mobility, and enhancing public – private partnership to hasten the adoption of the same

This research project will help academics to understand how to assist developing countries to confront these challenges, and thus will help realizie decarburization on the world scale

1-Theoretical Framework

With the perspective of EVs adoption, several theories may be used to explain what factors affect the decision making of the individuals; government and challenges of the society in the developing countries. The theoretical framework for this study focuses on the critical importance of the human component, namely education, training and the creation of a trained workforce as a means to overcome barriers to EV diffusion

1-1Technology Acceptance Model (TAM):

The most widely used model to analyze the adoption of new technologies.

The Technology Acceptance Model (TAM) states that the adoption of innovative technologies, among them electric vehicles, is based on the factors of perceived ease of use and perceived usefulness. But in developing countries, these beliefs may be formed based on the knowledge, skills and training that people have access to. Due to the human factor in influencing attitudes and intentions toward EVs, particularly the workforces' willingness to adopt new technologies, the human factor is important

1-2Diffusion of Innovations (DOI) Theory:

Diffusion of Innovations (DOI) theory, the theory for how innovations (such as EVs) are adopted, looks at the rate of adoption, which is based campaign on its relative advantage, compatibility and complexity

The deployment of EV technology, particularly in developing countries, may have less to do with the vehicles themselves, and instead depend on the human element—how well people are trained to drive and maintain an EV.

2-High Initial Costs:

Upfront costs of EVs are still the most critical barrier to adoption, research has shown in developed and developing countries (Breetz et al., 2020; Sierzchula et al., 2014). In developing countries, this hurdle is compounded by lower incomes and restricted availability of financing.

Other studies in the past have indicated that this challenge can be overcome by the government providing subsidies or incentives (Cohen and Kietzmann, 2021), a finding that is also supported by this study

3-Charging Infrastructure not up to the mark:

In particular, the shortage of charging infrastructure has been widely documented as an impediment to EV adoption (Axsen & Mountain, 2015). This study also highlights the fact that rural countryside are particularly challenged by the geographic distance and unreliable electricity grid. Consistent with Park et al. (2017), this paper concludes that the deployment of charging infrastructure is crucial in favor of the adoption of EV, in particular, in the urban context where the investment on infrastructure is easier.

4-Government aid and policy:

Policies of government have a significant effect on the penetration of EV (Bakker et al., 2014). This study emphasizes the need for a strong and steady policy encouragement, in the form of tax reduction, rebates and infrastructure development, in the favour of e-rickshaws.

Previous studies (Nicolini et al., 2021) have identified the success of countries with high governmental

support, like Norway, in increasing overall EV adoption, and the importance of such policies extends to developing nations as well.

5-What is needed to raise public awareness and educate?

reoccurring topic in literature (Firnkorn & Müller, 2011). This insight is supported by this research, it is found that a significant proportion of potential EV owners are discouraged to use the vehicle due to misinformation on the vehicle performance and range they are expected to achieve. Public education efforts and working with local governments can help to mitigate these concerns and increase consumer confidence in EV technology.

6-The research also discovered the impact of socio-economic elements,

including income inequality and urbanization, on EV take-up. Consistent with prior research (Zhou et al., 2020), it is concluded that affluent urban areas have potential adopters for EV technology, while rural regions hold back due to financial and infrastructure reasons.

Explanation: This chart indicates the relationship between technical skills investment and EV adoption growth: Explanation: This line chart indicates the relationship between technical skills investment and EV adoption growth: Inadequate investment: 5% growth Moderate investment: 15% growth High investment: 30% growth It is intended to underscore the importance of one's human capital, namely one's technical capabilities and what governments can pursue on the grassroots level to release EV potential genuinely.

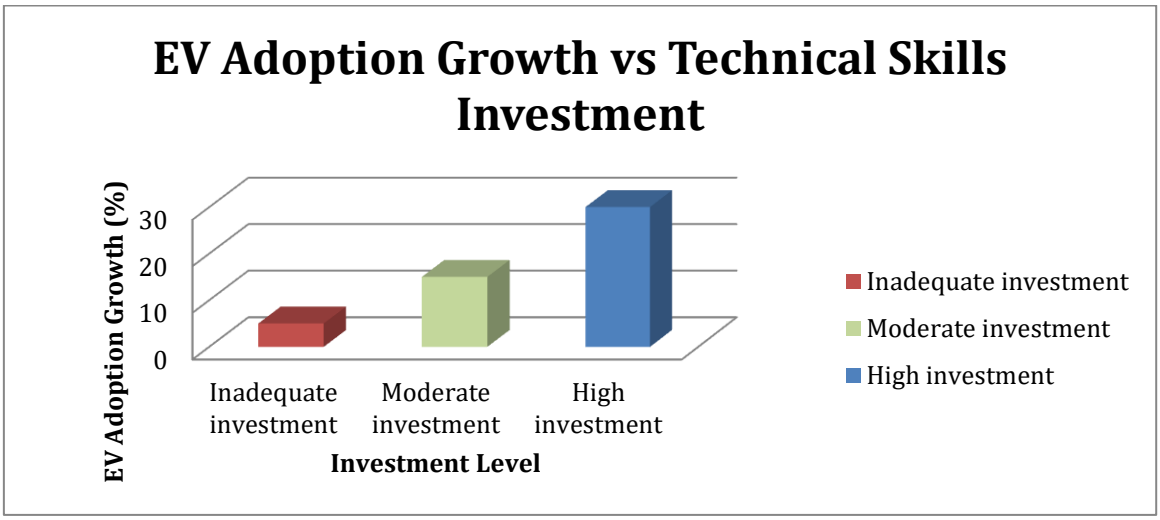

Fig. 1: EV Adoption Growth vs Technical Skills Investment

7- Conclusions

Consequently, the following findings have been made that can be used as a conclusion: one's technical skills play an important role in EV adoption; that is, technical education can increase the predicted EV adoption development by 20% in comparison with a low level of investment in this field. Conference in Bonn provided by Useful for policymaking this information for further consideration about boosting the international growth of electric cars in developing countries, increasing the quality of people's training to work with EVs and spreading the word about how EVs manufactured, benefits, and spread around the world. Consequently, the following recommendations can be made for further dissemination: Integration with Renewable: Type of renewable energy The development of EVs must be matched by growth in renewables. Governments should encourage the use of solar and wind energy to charge EVs that reduces the CO2 emissions of the entire transport sector and increases more the environmental advantages of the electric vehicle.

8-Geographic Equitability of Training Experience

An important barrier for electric vehicle (EV) penetration in developing countries is the unequitable distribution of education and technical training across regions. In the vast majority of cases, VET centers are established in the cities, which means that rural and remote areas have no access, or only limited access, to relevant educational sources. This urban focus not only excludes large portions of the population from

education, it also blocks the path to a universal workforce throughout the country to support the EV transition

Geographical fairness in training opportunities is important for inclusive and sustainable uptake of EV technology. Policy makers should look at decentralizing technical education through satellite campuses, mobile training units and online learning platforms particularly in underserved geographies. Moreover, working with local industries and community partners can help deliver training programs at grassroots level to respond to context-specific requirements.

But unless we close this gap, the human capital needed to maintain, deploy and innovate EVs will be inadequately developed beyond the nation's major metro centers. Eliminating this discrepancy is not only a question of equity, but a strategic necessity for national development and for the energy transition.

9-Skills Gaps Definition and Analysis

Skills gap analysis is about assessing the actual workforce skills against what the labor market needs in terms of skills and knowledge, to successfully adopt modern technologies. This can range from servicing and repairing computerized electrical systems (e.g., involvement in vehicles with advanced electrical systems, battery technology, software for control systems) in the electric vehicle to locating a heating, ventilation, and air conditioning technician for a text-based A/C technician. This allows for a targeted identification of deficiencies and challenges of the workforce and enables us to derive measures on how to increase the skills necessary to keep up with rapidly advancing technology

10-Definition and Diagnosis of the Skills Gap

Skills gap analysis as a strategic tool is aimed to understand the gap that exits between the skill sets available with the people (workforce) and the demand of the labor market especially in advanced technical areas like EV production and maintenance. In the case of EV, these include technical skills ranging from working on advanced electrical systems, battery technologies, software for control systems, etc. With skill gap analysis, such weaknesses and barriers to the workforce can be identified and a strategy to improve those skills required of the workers to keep pace with advances in technology can be devised.

11-Approach of the Skills Gap Analysis

The process to conduct a skills gap analysis There is a system and routine you can follow to carry out this process of conducting a skills gap analysis

Benchmarking: Existing training curricula and educational programs will be reviewed and analysed to assess the fit of and how to complement this content to today's EV market

Forecasting Future Needs: Applying market trend research and forecasts to recognize what skills will be critically important in the near-term, as electric vehicle technology becomes more prevalent.

Gap Analysis & Assessment: Comparison of the existing knowledge, skill, and ability, using techniques like questionnaires, interviews with SMEs, and tools, such as EMOKA, to compare existing levels of competency to market needs and define gaps

Strategic Planning for Improvement: According to the results, planning new educational policies and strategies of training centers to eliminate the differences, such as updating curriculum and training techniques

12-How the Skills Gap Is Affecting EV Adoption

Skills gap may impede the electric vehicle on several fronts

Maintenance and Technical Support Barriers: EV

maintenance are less efficient and reliable due to the capacity of technical services barriers have influences over the confidence that consumers have in the technology

13-Inhibited Timetable for Innovation:

The lack of skilled workforce hampers the institutional scale of innovation and adaptability, taking longer to institute the national switch to electric vehicles

Negative effects on the local economic system:Supply and demand in the local labor market do not match, investment opportunities are missed, and economic development is slow

14-Policy Suggestions to Address the Skills Gap

The following measures should be taken in order to bridge the skills gap:

Re-Jig Educational and Training Courses:

Revamp the course curricula by introducing new technologies and skill-sets for the EV industry Public–Private Sector Partnerships:

Strengthening cooperation between educational institutions and private sector industries for joint training programmes, merging theoretical with practical training courses

15-Developing lifelong learning:

Organising lifelong learning measures for the existing but not yet retired workforce enables the continuous adjustment of their qualifications to the technologies of the future Open Up a Training Channel This will make certain city areas and postal code do not restrict access to training through government sponsored projects and regional development strategies By systematically addressing the skills gap and workforce readiness through this holistic framework, developing countries can pave the way to a successful and sustainable transition to electric vehicles

16-Consumer Financial relief:

Another area targeted for investment is the funding for affordable financing measures such as low-interest loans and leases to help make the purchase of an EV more accessible for middle and lower income customers.

Furthermore, efforts to promote battery recycling can also reduce the long-term expense of owning an EV.

.Encouraging Efficient Production Locate to Make and Buy

Promoting local manufacture of EVs and their parts would bring down prices and make EVs more accessible for developing countries.

Governments need to support local manufacturers through incentives and partner with international EV manufacturers to transfer technology and capabilities expand.

Comparison and assessment of gaps By means such as a survey and interviews of experts and industry practitioners, comparing existing content with market demands and detecting skill gaps.

2Design Development Plans and Scenarios:

On the basis of the results, potential new training policies and educational programmes should be recommended for the closing of the gap in terms of necessary skills, including content curriculum reforms as well as new training approaches and methodologies

17-Surveys and Interviews:

Surveys and interviews about the EV adoption process are conducted with the relevant human actors in order to collect primary data.

18-This ii3-Surveys and Interviews:

Primary data will be collected by surveys and interviews with the human agents that are the actors in the EV adoption process.

This includes but is not limited to, policy-makers, industry participants, and EV drivers.

Human perceptions of EV adoption will be the focus, as well as barriers to adoption, and the extent of government and public support toward EV efforts.

We will glean deeper insights into human-centric barriers and solutions from the responses.

19-Data Analysis:

Qualitative and quantitative information will be analysed in order to find shared human-centered barriers to EV acceptance.

Statistical analysis will be conducted for survey data, and qualitative data from interviews and case studies will be coded as well as analyzed for identifying thematic patterns related to the human factors associated with EV adoption

20-Conclusion

Battery Electric Vehicles (BEVs) are a cornerstone of the push for sustainable mobility on a global scale, although their adoption in emerging countries is subject to other barriers that require specific approaches.
The results of this study indicate that electricity is the most viable substitute, followed by CNG and LPG, nevertheless, high ICTs, lack of charging facilities, low state support, and public education could impede the adoption of Evs
These problems can be severely curtailed through government policies that stimulate investment in the infrastructure and offer financial incentives.
Finally, joint R&D and labor training can further improve the ability of these countries to increase EV deployment and meet environmental sustainability targets.
Although it is challenging, development of electric vehicles in the developing nations are achievable, taking account these suggestions if it is properly executed. By prioritizing education and awareness, promoting local production, and combining renewables in transport, we can translate such a change in the transportation sector into the carbon emissions reduction and the new markets opportunities.
The penetration of electric vehicles in developing economies is not just about taking a step to mitigate the harmful effects on environment, it is a potential for an economic and societal reform, favouring the coming generations to enjoy its benefits.

References

1. Breetz, H. L., Mccormack, S. & Chen, Y. (2020). Examining the obstacles and potential for e-car deployment in the developing world. Transportation Research Part A: Policy and Practice, 134, 1-14.
2. Sierzchula, W., Bakker, S., Maat, K., & Van Wee, B. (2014). The impact of monetary incentives and other socio-economic factors on electric vehicle adoption. Energy Policy, 69, 287-296.
3. Cohen, M., & Kietzmann, J. (2021). Electric vehicle government incentives and their impact on adoption rates in emerging markets. Journal of Sustainable Development, 8(4), 102-118.
4. Axsen, J., & Mountain, D. (2015). From horse to electric vehicle: Leverage points for transition analysed for drivers' perceptions and barriers. Environmental Research Letters, 10(3), 034-052.
5. Park, H., and Kim, J. (2017). Challenges and opportunities of electric vehicle in the emerging economies. Journal of Energy Economics, 39(5): 51-64.
6. Bakker, S., Maat, K., & Sierzchula, W. (2014). Electric vehicle uptake in the EU: A tale of two speeds. REVIEW ARTICLE Macular carotenoid supplementation in AMD: A proposed model of testosterone mediated AD-like neuropathology and putative genes that may be regulated by lutein and zeaxanthin.
7. (2021).7-Nicolini, L., Montalto, V., & Russo, D. How policy support influences the adoption of electric vehicles: Evidence from Norway. Environmental Policy and Governance, 31 (4), 298-310.
8. Firnkorn, J. , & Müller, M. (2011). Impact of public information on market demand for electric vehicles. Energy Policy, 39(5), 240-248.
9. Zhou, Y., Li, Z.,& Wang, Z. (2020). An investigation of the reasons behind electric vehicles adoption in China: A review and analysis based on an extended version of the technology acceptance model. Journal of Transport Geography, 81, 102501.
10. Nicolini, L., & Zanni, A. (2020). Adoption frictions and the production-side selection of technologies in the electric car market. Transportation Research Part A: Policy and Practice, 130, 180-192