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EV Markets: A Comparative Analysis between India & Nigeria

Rudresh Pandey[1], Sushant Kumar Vishnoi[2], Swarn Tiwari[3], Amarachi Onukele[4], Himanshu Kumar Gupta[5]
IMS Ghaziabad, India[1,2,3,5]
Alex Ekwueme Federal University, Nigeria[4]
Correspondence Email: swarntiwari17@gmail.com
ORCID ID: 0009-0006-1892-5580

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ABSTRACT

This study conducts a thorough comparative analysis of the Electric Vehicle (EV) markets in India and Nigeria, two emerging economies with distinct socio-economic and infrastructural profiles. The primary objective is to comprehensively understand the factors influencing EV adoption for the consumers in these nations. We meticulously examine consumer preferences, purchasing barriers, and government role, highlighting the unique challenges in each context. We delve into the economic and policy-driven influences on the EV landscape, emphasizing Economic Factors and Economic reforms for EV in both nations. We evaluate policy frameworks in the context of national development goals and environmental objectives, encompassing Government plans and financial perks. This study also emphasizing domestic economic growth potentials. The study employs a structured questionnaire distributed to 100 respondents, resulting in 60 valid responses. This questionnaire includes 19 items for the study which are taken under to analyze or examine on the basis of Electric Vehicle (EV) Market of India and Nigeria.

Keywords: Consumer Preferences, Electric Vehicle (EV), Emerging Economies, Factors, Government Reforms, India and Nigeria, Policy Framework

INTRODUCTION

Environment and natural resources are inputs in economic mobility which influence the economic growth of a country (Santika & Lutfi, 2021). Environmental pollution is a pressing global concern primarily driven by toxic emissions from internal combustion engines. To combat this issue and mitigate fossil fuel-related environmental impacts, there is a worldwide push for electric vehicles (EVs). EVs, powered by electric motors and equipped with rechargeable batteries, offer eco-friendly alternatives. They are celebrated for their energy efficiency, reducing greenhouse gas emissions and noise pollution. EVs come in various forms, including hybrid electric vehicles, plug-in hybrids, and battery electric vehicles.

Significantly the transportation sector on its own contributes an approximately 25% that is the one-fourth or quarter of global greenhouse gas emissions. India's domestic EV industry, spearheaded by companies like Tata Motors, MG Motor, and Mahindra & Mahindra, is flourishing. However, challenges persist, such as inadequate charging infrastructure, high battery costs, low consumer awareness, and grid reliability issues. In contrast, Nigeria is in the early stages of EV development, hindered by high costs, inadequate infrastructure, and limited consumer awareness.

LITERATURE REVIEW

The literature review is to punctuate the problem, we're exploring from former studies and current script in both the countries Electric Vehicle request. Actually, the literature review is to points out the research gap which we will be bridging through our study.

An exploration study by Khurana, Kumar, and Sidhpuria (2020) addresses station which surfaced as a strong middleman, impacting the relinquishment of electric buses. (Khurana, Kumar, & Sidhpuria, 2020) is contemporary and examines the different factors that affect a consumer’s relinquishment of an EV. The repliers of the study are being auto possessors in India. The data were anatomized using Structured Equation Modelling (SEM). Station (ATT) surfaced as a strong middleman, impacting the relinquishment of electric buses.

A study by Mauger (2023), formulated recommendations, similar as interpreting in ade-growth favorable way the mentioned vittles and challenging the current as well as forthcoming frame, for case by amending the proposed energy effectiveness first principle to include energy adequacy.

Besides it, the scholarly work of the experimenters by Krishna (2021) in which he brings out worth noting from the interconnectedness of the intangible factors with the advancements in the areas to consider is the speed and its range. Technological research has yielded promising outcomes across various domains, and its influence is expected to grow in future. When we dive deep into the consequences, there are several factors which are hindrance in Nigeria’s aspiration to become the leader in the leader board in technology, husbandry, trade and so on.

This exploratory study has linked the enormous capabilities of EVs in Nigeria as a growth and development agent. Now inferring crucial challenges overlaying EV commercialization in Nigeria and Options and precedencies for the unborn EV deployment in Nigeria (Agunbiade & Siyan, 2020). They had anatomized that's grounded on secondary as it doesn't have any primary data and its analysis. Nigeria possesses the potential to facilitate the growth of renewable energy development by rolling in two-way charging strategy.

Based on the research analysis by Dioha and Caldeira (2022), we found out that it provides us with the analysis that shows the specialized and profitable indicators based on the performance of optimum level of the charging stations, which are thoughtful to the changes in the perceptivity variables. Thus, the result and findings in this study can be applied by all applicable sects involved in to speed up the development of EVs not only in Nigeria but also in the other African mainland corridors and the rest of the world (Oladigbolu, Mujeeb, Imam, & Rushdi, 2023).

Electric Vehicles (EV)
As per the IMARC Group 2022 that highlights electric vehicle (EV) as an automobile powered by one or more electric motors, that opposed to an internal-combustion engine, which relies on burning gasoline or diesel or fuel. Electric Vehicle (EVs) are designed for transportation goods and passengers, enabling to travel from one location of origin to another place that is the destination.

Electric Vehicles (EVs) works using energy stored in batteries and can be changed through self- charging mechanisms like turbochargers and regenerative braking systems, which can transform kinetic energy into electrical energy. They propose cost-effective operation, produce less noise, and demand lower maintenance compared to traditional gasoline- powered vehicles. It generates zero tailpipe emissions that device to decrease the air pollution and greenhouse gas (GHG) emissions.

Types Of Electric Vehicles
(Agunbiade & Siyan, 2020) There are majorly three types of electric vehicles (EVs) as follows.

Hybrid Electric Vehicles (HEVs)
These vehicles operate using dual power source, namely gasoline and electricity. In this configuration, electric energy is generated through the vehicle's braking system, replenishing the vehicle's battery. This process is also named as 'regenerative braking'. Hybrid Electric Vehicles (HEVs) initiate their operation with electric motor and gradually introduce the petrol engine as power demands or speed increase. The coordination of both motor is managed by an internal computerized system, that is ensuring optimum level of fuel efficiency customized to the prevailing driving conditions.

Plug-in Hybrid Electric Vehicles (PHEVs)
PHEVs are also termed as Extended-Range Electric Vehicles (EREVs), these are also sourced by both the sources that is gasoline and electricity. The battery is recharged through regenerative braking and 'plugging-in' to an external electrical charging Stations. In EREVs, the petrol engine increases the range of travelling of the cars by recharging it to its secondary source that is the battery as it gets low.

Battery Electric Vehicles (BEVs)
These vehicles are fully electric based and commonly known as 'plug-in' EVs, they charge or recharges their vehicle's battery through charging stations. BEVs can also be recharged through regenerative braking.

Factors Affecting EV Market
In terms of factors affecting the EV market in India, some of them include surging fossil fuel prices, increasing demand for vehicles which are fuel-efficient and high-performance, growing or spreading awareness about the economic and environmental benefits of adopting EVs, and pollution indices which is keep on rising (Rangrajan, 2019). In our Indian study, it was observed that while financial and infrastructure considerations exert a favorable influence on the rate of electric vehicle (EV) adoption, vehicle

performance aspects tend to hinder the acceptance of EVs. This suggests that individuals who prioritize vehicle performance characteristics exhibit a more reserved attitude toward embracing EV technology (Fortune Business Insights [FBI], 2022). India, being an emerging economy, has experienced significant economic growth over the years. Key factors such as GDP, employment rates, and industrial development to understand the underlying dynamics affecting the EV market in India.

Nigerian automotive industry, which includes information on the electric vehicle market in Nigeria . The report states that the Nigerian government is committed to promoting the use of electric vehicles in Nigeria and has implemented policies and programs to support this initiative . The report also highlights some challenges faced by the electric vehicle market in Nigeria, such as high import duties on electric vehicles and inadequate charging infrastructure (IMARC, 2022). Nigeria the largest economy in Africa, faces unique challenges and opportunities. We will delve into factors like GDP, oil dependency, and economic diversification efforts to gain insights into the EV market landscape in Nigeria.

India's EV Market

As per the report by FBI, the Indian EV market is growing rapidly, with a projected market size of USD 113.99 billion by 2029. The Indian government's, Production Linked Incentive (PLI) scheme is expected to boost the India's Electric Vehicle (EV) industry. As per the study by CEEW Centre for Energy Finance, the Indian EV market will be a USD 206 billion opportunity by 2030 (Kukreja, 2022) if India maintains steady progress to meet its ambitious target by 2023. High-speed electric 2Ws accounted for 61% of unit sales, e-3Ws accounted for 33%, and e-4Ws accounted for 4% of all EVs sold in India.

Table 1. Growth of the Indian EV Industry: How EV Sales Have Accelerated Over 10 Years

Growth of the Indian EV Industry: How EV Sales Have Accelerated Over 10 Years							
Year	**2-Wheelers**	**3-Wheelers**	**4-Wheelers**	**Buses**	**Good Carriers**	**Total**	**YoY Growth (%)**
2013	1,898	36	374	1	43	2,443	
2014	1,678	12	481	3	20	2,194	-10.19%
2015	1,454	5,399	678	3	19	7,553	244.25%
2016	1,459	46,561	621	4	54	48,699	544.25%
2017	1,523	82,238	820	17	533	85,131	74.81%
2018	16,572	1,08,289	98	49	657	1,26,555	48.65%
2019	29,756	1,31,375	847	468	53	1,62,499	28.40%
2020	28,632	88,227	3,179	88	13	1,20,139	-26.06%
2021	1,53,523	1,53,679	12,112	1,117	1,084	3,21,575	167.66%
2022	6,22,337	3,37,335	37,792	1,932	453	9,99,849	211.00%
Total	8,58,923	9,53,151	52,898	3742	2,929	18,76,637	

The current state of the Indian EV market is multidimensional, involving a wide array of stakeholders, in which the Hero Electric being a market leader in 2-wheeler segment having the market share of 36% (IESA, 2019) followed by Okinawa with 21%and then the Ather Energy with an 11.1% market share. Ather Energy is slowly gaining or increasing its market volume, as the company is currently doing expansions in its distribution sect across India.

Nigerian EV Market

Nigeria's electric vehicle (6Wresearch, n.d.) market is in its early stages, with limited adoption due to some reasons that are high price, improper infrastructural framework, and limited knowledge or awareness among consumers. However, the Nigeria's government has introduced various backup methods in the form of the financial incentives and subsidies for promoting EVs in their country.

Furthermore, renewable of electric vehicles (EVs) in Nigeria holds the promise of advancing renewable energy development through a bidirectional charging approach. The deployment of EVs has the potential to not only decrease harmful greenhouse gas emission but also reduce the necessary investments in the energy sector, possibly eliminating the need for certain resources (Dioha & Caldeira, 2022). This is considerably above the mean annual ₦2m salary produced by average Nigerians residing in Lagos.

Emerging Economies

Emerging economies refer to countries that are in the process of speedy industrialization and economic growth, often driven by relatively high economic growth and a rapid expansion of trade and investment flows (tutor2u, 2022). Based on FBI, the India's market of Electric Vehicles (EVs) have a speedy growth, with a market size which was forecasted as USD 113.99 billion by 2029 (Olurounbi, 2023). The Production Linked Incentive (PLI) scheme by Indian government is expected to boost the EV sector in India. As per the research by CEEW Centre for Energy Finance, if India continues its progress towards achieving its ambitious 2030 target, the electric vehicle (EV) market in India is projected to become a USD 206 billion opportunity by 2030. There is a limited adoption of EV by Nigerian Government due to certain reasons like high cost, improper infrastructure and limited awareness among consumers.

Government Role

A crucial role is played by the government for promoting, adoption and development of electric vehicle in both India and Nigeria. Various policies including incentives for promotion of EV, FAME scheme, subsidies for EV buyers and manufacturers have been introduced by Indian Government. (Bhardwaj, 2022). With the launch of the National Electric Mobility Mission Plan (NEMMP) 2020, by the Indian government (FBI, 2022), aims to achieve 100% electric mobility by 2030. Also the Indian government has built National Institution for Transforming India (NITI Aayog) with the objective to oversee the transition to electric mobility (World Economic Forum, 2019).

In order to promote EV in the country various support measures in the form of incentives and subsidies has been introduced by the Nigerian government. With the aim to promote local production of vehicles, including EV, the Nigerian government has also launched the National Automotive Industry Development Plan (NAIDP) (ET Auto, 2021).

Consumer Preferences

Consumer preferences play a crucial role in the adoption and development of electric vehicle (EV) markets in India and Nigeria. The highest impact on electric car purchase intention in India, followed by personal innovativeness (Pandey, & Mohan, 2021). In the present context, electric vehicles (EVs) have surfaced as a disruptive innovation within the automotive sector due to the imposition of strict emission regulations driven by climate change, the imperative for smart cities on a global and Indian scale, and advancements in battery technology. In effect, EVs have become a promising alternative to IC Technology (JC Review, 2020).

Consumers of Electric Vehicles usually have a react positively toward the EV's and expected that the India's market of Electric Vehicle would touch the benchmark of $2 billion by 2025. The study identified cost of the vehicle, duration of charging batteries, and range of vehicle as one of the primary challenges in EV adoption in India (Dixit & Singh, 2022).

Policy Framework of India and Nigeria

The Indian and Nigerian governments have introduced various aids in form of policies and incentives to uphold the acceptance and progress of electric vehicle (EV) markets in their respective countries. The Indian government has also launched the National Electric Mobility Mission Plan (NEMMP) 2020, which aims to achieve 100% electric mobility by 2030 . The National Institution for Transforming India that administers the switch to electric mobility (NITI Aayog, 2022).

About 50% of the Indian states have policies of states for promoting the use of Electric Vehicles. Concessions to users of EVs include a financial incentives or subsidy on its purchase, exemptions from road tax, registration charges, and lower-interest rates on loans or other way (Battery Bits, 2021). In Nigeria, the government wants to form a robust Electric Vehicle (EV) framework of a policy which guidelines the goal backed by an appropriate act or bill of parliament to start any significant debates or discussion on deployment of EVs in Nigeria (Dioha & Caldeira, 2022). The Nigerian government has also launched the National Automotive Industry Development Plan (NAIDP), which aims to promote the local production of vehicles, including EVs.

Research Questions

Here are some questions that we have found a gap from a previous research study that will bridged or answered through our research, that are as follow:

RQ1: How does the cost impact the affordability and demand for Electric Vehicles (EVs) in India and Nigeria?

RQ2: Which are the economic or non-economic factors which influence the EV market of India and Nigeria?

Research Objectives

This study intended to provide the solution of following research objectives:

RO1: To assess or examine the perception of Indian/Nigerian consumers towards adoption of EV.

RO2: To assess or analysis to what extent EV market of India and Nigeria different from each other, and point out the key challenges faced by both the countries, i.e., India and Nigeria and provide solutions for those challenges/problems.

Hypothesis Testing

Null Hypothesis (H0): There is no significant difference in the percentage of EV owners between India and Nigeria.

Alternative Hypothesis (H1): There is a significant difference in the percentage of EV owners between India and Nigeria.

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RESEARCH METHOD

Data Collection

Primary data collection involves distributing structured questionnaires to potential customers, yielding 60 valid responses. The questionnaire comprises 19 items grouped into three parts, aligning the variables: demographic information, of Electric Vehicle (EV) Market of India and Nigeria, Factors influencing the EV market, India and Nigeria, Economic situation, Government Reforms.

Data Analysis

Gender

Of the 60 respondents, 42 were male and 18 were female.

Age

Most of respondents fell in the age group of 23-34 (%), with minimal representation in other age categories.

Country

India had the highest representation (66.67%) than Nigeria (33.33%).

Occupation

Most respondents were students (72.55%), while 18.63% were employed, 4.90% were unemployed, and 3.92% fell into the “other” category.

Monthly Income

Most respondents earned less than $500 or Rs. 10,000 (75.6%), with only 11% earning above $2,000 or Rs. 50,000 and 4% above $3,000 or Rs.1,00,000.

EV Owners

Most respondents do not have electric vehicle but the percentage of EV owners in India is more than Nigeria. Out of 60 respondents, 84.1 % are non-EV owners and 15.9 % are EV owners but in Nigeria share in 15.9% is only 20% whereas India’s share is 80%.

Test Statistic Calculation

To test the hypothesis, we will perform a two-sample t-test to compare the means of the percentage of EV owners in India and Nigeria using the provided data:

Sample mean of EV owners in India ($\bar{x}1$) = 80%
Sample mean of EV owners in Nigeria ($\bar{x}2$) = 20%
Total Sample Size (n total) = 60 respondents
Sample Standard Deviation of EV owners in India (s1) = 0.1291
Sample Standard Deviation of EV owners in Nigeria (s2) = 0.3651

The researchers calculate the statistic using these formulas:

$$n = N \times \frac{\frac{Z^2 \times p \times (1-p)}{e^2}}{\left[N - 1 + \frac{Z^2 \times p \times (1-p)}{e^2}\right]}$$

$$\mathrm{SD}_{\mathrm{sample}} = \sqrt{\frac{\sum |x - \bar{x}|^2}{n - 1}}$$

Sample T-Test Calculation
Given the data, let's calculate the sample standard deviations (s1 and s2), sample sizes (n1 and n2), and the test statistic (t). Assuming a significance level (α) of 0.05 and degrees of freedom (d.f.) of 58 (60-2), we can find the critical value from a t-distribution table or calculator to be approximately 2.002.

This suggests that the Indian EV market is growing at a faster pace compared to the Nigerian EV market, as indicated by the higher proportion of EV owners among the respondents in India. Based on the information provided, we can perform a two-sample t-test to compare the means of two independent groups, India, and Nigeria, with respect to the percentage of EV owners. The test statistic can be calculated as:

$$t = \frac{x_1 - x_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

Where x¯1 and x¯2 are the sample means of India and Nigeria, s1 and s2 are the sample standard deviations of India and Nigeria, and n1 and n2 are the sample sizes of India and Nigeria. Using the information provided in the data analysis section, the researchers can calculate:

$$t = \frac{0.8 - 0.2}{\sqrt{\frac{(0.8 \times 0.2)}{48} + \frac{(0.2 \times 0.8)}{12}}} = 5.656$$

Assuming a significance level of 0.05 and degrees of freedom of 58 (60-2), we can find the critical value from a t-distribution table or calculator to be approximately 2.002. Since our calculated test statistic (5.656) is greater than our critical value (2.002), we can reject the null hypothesis and conclude that there is a significant difference between the percentage of EV owners in India and Nigeria. Therefore, based on this sample data, we can infer that Indian EV market is growing at a faster pace than Nigerian EV market.

RESULTS

Based on the information from the methodology in this research paper, here are some key findings.

Gender Representation
From the total respondents, 42 were male (70%) and the rest 18 were female (30%), which is indicating an imbalance gender representation from the survey.

Age Distribution
Young people are more aware or can be said that they are more inclined towards EV's, as the survey showed that majority of respondents fall in the age group of 23-24.

Representation by Country
If we talk about country, then India is showing a significantly higher representation (66.67%), whereas Nigeria represents lower (33.33%), which indicates that Indian EV market is growing at a higher pace as compared to Nigeria.

Occupation
Upon occupation, major respondents were students (72.55%), employed (18.63%), unemployed (90%) and from other categories (3.92%).

Monthly Income
(75.6%) respondents earned less than $500 or Rs. 10,000. (11%) of respondents earn above $2,000 or Rs. 50,000. While (4%) respondents earn above $3,000 or Rs. 1,00,000.

EV Ownership
Though many respondents were not owning electric vehicles, still the respondents who own electric vehicles (India-80%, Nigeria-20%) were higher in India as compared to Nigeria.

Independent Sample T-Test
A test named “Two-sample t-test” was conducted in order to show or compare percentage of electric vehicle owners between India and Nigeria. The test showed or rather indicated a significant difference between the two countries, where India having higher percentage of EV owners.

Market Share and Sales Data
The research even included the market share and sales data of different types of EVs such as E2Ws, E3Ws and E-Rickshaws in order to provide market insights.

Charging Infrastructure
This research even discusses the availability of charging infrastructure from various providers, including BOLT, tata power and also made a category for charging points slow and fast.

Battery Manufacturers
This study also mentions battery manufacturers data. Though there are some of the manufacturers who have not shared their capacity numbers. We rejected the null hypothesis as our calculated test statistics (t) is greater than critical value (2.002).

DISCUSSION

The largest economy in Africa, Nigeria, is dealing with opportunities and unique challenges. Factors like oil dependency, GDP, and economic diversification efforts to grab insights of the EV market landscape in Nigeria. Whereas, by being an emerging economy, India is experiencing significant economic growth over the years. Certain factors like employment rates, GDP, and industrial development are affecting the EV market in India.

Despite certain challenges, Nigerian government has also introduced subsidies to encourage EV adoption, along with import duties reduction, tax breaks and exemptions with the aim of driving the adoption of EVs in Nigeria. India, on other side offers various financial incentives to promote EV adoption along with other policies such as government subsidies, tax exemptions and incentives for EV manufacturing. In Nigeria for assessing the market potential certain factors are important such as income levels and consumer

purchasing power. In order to identify the affordability and demand for EV's, purchasing power and income level of the consumers plays a crucial role. To determine consumer segment to embrace electric vehicles, we analyzed disposable income, middle class growth and also income distribution. We explored and provided insights regarding the affordability of Electric Vehicles. Here some key challenges which both countries are facing in the electric vehicle (EV) market.

EV in Nigeria

High Upfront Cost

Despite being cheaper on a lifecycle basis, the initial capital outlay of EVs is substantially higher than for internal combustion engine vehicles. According to the estimate of Cox Automotive, the average cost of a new Electric vehicles (EV) is about $55,600. This is substantially above the mean annual ₦2m salary earned by ordinary Nigerians residing in Lagos. Without financial incentives, it will be challenging for Nigerians to consider the cost of electric vehicles (EVs) attractive, as upfront costs must drop below that of used internal combustion engine vehicles (ICEVs).

Lack of Infrastructure & Technical Know-how

Public EV charging infrastructure is essentially non-existent in Nigeria, and there is currently no defined roadmap for its future development. Nigerian mechanics are usually trained informally in fixing ICEVs, with little or no knowledge of EV maintenance.

Electricity Access & Reliability Gap

Nigeria has the world's most significant energy access gap, with over 85 million people lacking grid electricity access, and those with access usually lacking the reliable supply that EVs require. The dilemma for Nigerian decision-makers is whether to prioritize limited electricity supply for EV services when they already struggle to ensure reliable essential services, such as lighting.

Political Entrenchment of Oil & Gas

Nigeria gets over 90% of its foreign revenues from the export of crude oil, making the future of fossil fuels a major concern. EV market continues to mature, Nigerian policymakers could worry about negative impacts on Nigeria's crude oil exports to Europe and Asia, as well as reduced local demand. This is not a trivial concern. In April, 2019, a bill was rejected by the Nigerian Government that stated that by 2035 all the non-electric cars would be converted to electric cars due to the reason that their economy might collapse if they would shift to electric cars.

EV in India

Government Policy Challenges

There remains uncertainty among manufacturers and investors due to lack of clear policies.

Technical Challenges

Certain technical challenges that need to be address are- limited range of EV, its high cost, as well as inadequate charging infrastructure.

Safety Concerns

Safety reasons such as battery safety, its fire hazard, is the major concern among consumers during the purchase of EV.

Limited Consumer Awareness

Another reason for the low demand is that there remains limited awareness among consumers regarding EV's.

Charging Infrastructure Gaps
A major barrier to the adoption of EV's in India is the lack of adequate charging infrastructure.

CONCLUSION

Our research paper highlights distinctive challenges and opportunities in India and Nigeria EV market. India's matured market with strong policy support that contrasts Nigeria's early-stage development and infrastructure hurdles. The role of the economic factors and governmental financial incentives considerably impact adoption of EV in both countries. India's ambitious policies regarding fuel growth, while Nigeria's goal is to appeal to investments and local manufacturers. Shared challenges include high marginal or add-on costs, less charging stations, and limited consumer education regarding EVs. Prioritizing renewable energy integration and demographic-tailored policies are essential for sustainable EV markets. Based on the deep analysis of the provided data and the results of the independent sample t-test, we can determine that there is a significant variation in the percentage of EV owners between India and Nigeria. Basically, the percentage of EV owners in India (80%) is significantly more than in Nigeria (20%). These insights can robust green transportation and sustainability efforts in these two nations that is India and Nigeria.

LIMITATION

This study has limitations that includes a small sample size of 60 respondents (30 from each country), possibly limiting its generalizability to the broader population. There's a sampling bias towards younger individuals, students, and a specific income range, excluding older demographics and diverse income groups. Data collection relies solely on structured questionnaires, potentially limiting insights compared to qualitative methods. The absence of a specified data collection timeframe may affect findings' relevance. Finally, the study's applicability to other emerging economies with distinct socio-economic contexts may be limited.

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DECLARATION OF CONFLICTING INTEREST

There is no conflict of interest declared by the author in this research. The study was conducted with the sole purpose of academic research and does not involve any commercial or financial interests that could influence the findings or conclusions presented in this paper. There is no conflict of interest declared by the author in this research.

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