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ASSESSING THE IMPACT OF SOLAR-POWERED ELECTRIC MOTORCYCLES ON HOUSEHOLD PETROL EXPENDITURE IN KANO METROPOLIS, NIGERIA

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Abstract

The removal of Nigeria's petrol subsidy in May 2023 raised pump prices from about ₦200 to well over ₦1,000 per litre, straining household transport budgets in Kano Metropolis, where motorcycles are the dominant mode of private and commercial mobility. Solar-powered electric motorcycles (SPEMs) are a potential alternative, but their effect on household petrol expenditure has not been documented with household-level data. This study assessed the effect of SPEM adoption on household petrol expenditure in Kano Metropolis. A descriptive survey of 384 motorcycle-owning household heads, selected by stratified random sampling across the eight local government areas of the metropolis, was conducted with a structured questionnaire (Cronbach's $\alpha = 0.78$). Data were analysed with paired-samples t-tests, correlation, and simple and multiple regression at the 0.05 level. Of the respondents, 31.5% ($n = 121$) had adopted SPEMs. Among adopters, mean monthly petrol expenditure fell from ₦30,200 to ₦0, $t(120) = 31.42$, $p < 0.001$, $d = 2.86$. Adoption was a significant negative predictor of petrol expenditure ($\beta = -0.641$, $R^2 = 0.411$) and was associated with a lower transport cost burden ($r = -0.492$). High acquisition cost, limited charging infrastructure, unreliable grid supply and concerns about battery quality significantly constrained adoption, whereas awareness and maintenance skills did not. Access to solar charging was associated with a larger reduction in petrol expenditure ($\beta = 0.428$). Petrol expenditure is a gross measure that excludes charging and battery costs. The findings point to financing, solar charging hubs and battery quality assurance as policy priorities.

Keywords: Solar-powered electric motorcycles; household petrol expenditure; energy transition; Kano Metropolis; fuel subsidy removal; electric mobility

JEL classification: D12; L91; Q42; R41

1. Introduction

Household transport expenditure in Nigeria has risen sharply since the petrol subsidy was removed in May 2023. Pump prices have climbed from roughly ₦200 per litre before the removal to about ₦1,365 per litre in Gombe by August 2026 (M. A. Ibrahim, 2026) and ₦1,500 per litre in Kano by March 2026 (Daily News 24, 2026), forcing households to reallocate substantial portions of their budgets to mobility. For many Kano households the motorcycle is not a luxury but the main means of reaching work, markets, schools and health facilities. Kano is reputed to have the largest number of motorcycle taxis in West Africa, and an official estimate of two million motorcycles in the city has been reported, although the commentator who cited it considered the figure possibly exaggerated and noted that even half of it would be very large (J. Ibrahim, 2024). The price shock therefore falls directly on household consumption capacity. One Kano motorcycle owner, for example, reported cutting weekly petrol purchases from five litres to two or three as the price approached ₦1,500 (Daily News 24, 2026).

Solar-powered electric motorcycles (SPEMs) offer a potential remedy. Unlike petrol motorcycles, they can be charged from solar photovoltaic systems or solar charging hubs, bypassing both the fuel pump and the unreliable national grid. Sellers in Kano present solar charging as the answer to unstable grid supply, and early adopters report large reductions in running costs: one rider who once spent up to ₦3,000 on fuel said he no longer does, and another said a day's charge carries him about 70 kilometres when riding alone (A. Ibrahim, 2024). Recent national reporting likewise describes riders saving roughly ₦5,000 a week on fuel, while noting that the machines, at about ₦1 million, are out of reach for many households and that unreliable electricity remains a major obstacle (M. A. Ibrahim, 2026).

Despite this promise, empirical evidence on SPEMs in Kano is thin. Research in Nigeria has concentrated on cost modelling and adoption intention among commercial riders. Al-Hasan (2026), surveying 1,200 commercial riders in Lagos, Ibadan and Kano, estimated that electric motorcycles reach cost parity with petrol machines within 14.6 months under post-subsidy fuel prices, but that once unreliable charging is priced in, parity ranges from 10.5 months in Lagos to 20.7 months in Kano. Studies of this kind model costs rather than measure changes in household petrol spending, and they focus on commercial riders rather than households. Whether SPEM adoption reduces household petrol expenditure, and by how much, has not been established with primary household data from Kano Metropolis.

This study addresses that gap. It examines the effect of SPEM adoption on household petrol expenditure in Kano Metropolis, assesses the barriers that constrain adoption, and evaluates the role of solar charging access in the size of the expenditure reduction. It thereby provides evidence that households can use to judge whether SPEM investment is worthwhile, and that policymakers and energy-sector stakeholders can use to target the constraints that most strongly limit adoption.

1.1 Research Questions

1. To what extent does solar-powered electric motorcycle adoption reduce household petrol expenditure in Kano Metropolis?
2. What is the relationship between SPEM adoption and household transport cost burden?
3. What factors hinder the adoption of solar-powered electric motorcycles by households in Kano Metropolis?

4. How does access to solar charging infrastructure affect the level of petrol expenditure reduction?

1.2 Objectives of the Study

The study aimed to:

1. Assess the effect of SPEM adoption on household petrol expenditure;
2. Examine the relationship between SPEM adoption and household transport cost burden;
3. Identify the challenges affecting SPEM adoption; and
4. Determine the effect of access to solar charging infrastructure on petrol expenditure reduction.

1.3 Hypotheses

- **H_o1:** Solar-powered electric motorcycle adoption does not significantly reduce household petrol expenditure in Kano Metropolis.
- **H_o2:** There is no significant relationship between SPEM adoption and household transport cost burden in Kano Metropolis.
- **H_o3:** There is no significant relationship between the challenges faced by households and the adoption of SPEMs in Kano Metropolis.
- **H_o4:** Access to solar charging infrastructure does not significantly affect the level of petrol expenditure reduction among SPEM adopters.

2. Literature Review

2.1 Conceptual Review

Solar-powered electric motorcycles are two-wheeled electric vehicles whose batteries are charged, wholly or partly, from solar photovoltaic systems. They may be charged at household solar installations, at dedicated solar charging hubs, or at battery-swap stations powered by solar mini-grids. In practice, charging in Kano draws on the grid, solar hubs and generators; Al-Hasan (2026) distinguishes these three modalities and prices the downtime that unreliable supply causes. The source of charging matters. A solar-charged motorcycle displaces petrol spending without substituting one fossil fuel for another, whereas a generator-charged motorcycle merely moves the emissions from the exhaust pipe to the generator (M. A. Ibrahim, 2026). In this study, SPEM adoption refers to a household's ownership and use of an electric motorcycle, and solar charging access is treated as a separate condition distinguishing adopters who charge from household solar systems or solar hubs from those who rely on grid or generator charging (H_o4).

Household petrol expenditure is the recurring outlay a household makes on petrol for its motorcycle(s), whether the machine is used privately or for income-generating activity such as commercial transport or delivery. It is measured here as the self-reported monthly amount spent on petrol before and after SPEM adoption (for adopters), or currently (for non-adopters). Where petrol prices have risen as sharply as in Kano, this expenditure is a significant and volatile component of household budgets (Daily News 24, 2026).

Transport cost burden is the share of household income devoted to transport. Rising petrol prices force households to choose between mobility and other essential spending. The

concept connects the household-level energy transition to broader questions of affordability and economic welfare.

2.2 Solar-Powered Electric Motorcycles and Household Expenditure

The economic case for electric motorcycles in Nigeria rests on the gap between petrol and electricity costs. Al-Hasan (2026) estimated a true cost of ₦17.46 per kilometre for electric motorcycles against ₦26.71 for petrol, with parity reached in 14.6 months under post-subsidy prices. The advantage is not uniform across cities, however. Once unreliable charging and its downtime costs are priced in, the net per-kilometre advantage of ₦0.28 in Lagos becomes a net cost of ₦1.96 in Kano, and parity is delayed to 20.7 months in Kano compared with 10.5 months in Lagos (Al-Hasan, 2026). This suggests that Kano households may realise smaller net savings than households in cities with more reliable grid supply, because unreliable charging imposes downtime and fall-back costs. It also means that eliminating petrol spending, the outcome measured in this study, is not the same as reducing total transport cost.

Evidence on enterprises points the same way for energy spending more generally. Owusu-Sekyere et al. (2024), using data from 700 micro, small and medium enterprises in Lagos, Kano and Ondo states, estimated that firms relying on the grid and standby generators could cut average monthly energy expenditure by 36.64% by adopting solar. Further evidence on solar adoption and enterprise performance in Kano also exists (Muhammad et al., 2026). Neither line of evidence, however, addresses household transport energy.

Field accounts from Kano support the expenditure-reduction mechanism. One rider who previously spent up to ₦3,000 on fuel reported that he no longer does, and another described being freed from worrying about fuel (A. Ibrahim, 2024). Recent national reporting describes a rider saving about ₦5,000 a week on fuel and avoiding major repairs (M. A. Ibrahim, 2026). These accounts are anecdotal, but they point consistently toward substantial reductions in petrol expenditure among adopters.

The literature also identifies constraints that may limit the savings households realise. The first is acquisition cost: electric motorcycles in Kano were reported at ₦750,000 to ₦900,000 (A. Ibrahim, 2024), and national reporting puts the price at about ₦1 million (M. A. Ibrahim, 2026), well beyond the immediate reach of many households. The second is charging. Al-Hasan (2026) reports that grid supply accounts for about 41% of intended charging events in Kano, solar hubs for 16.5% and generators for 42.5%, and unreliable electricity is described as a major obstacle to wider use (M. A. Ibrahim, 2026). The third is maintenance capacity: mechanics able to repair electric motorcycles are scarce, and parts such as tyres can be hard to find (A. Ibrahim, 2024). These constraints mean that the theoretical savings from SPEM adoption are not equally available to all households.

2.3 Solar Charging Infrastructure and Adoption

Because grid reliability is low, a household that buys an electric motorcycle without access to solar charging may find itself dependent on a generator, which erodes the cost advantage and defeats the environmental rationale (M. A. Ibrahim, 2026). A clean-energy company executive has argued that solar-powered battery-swap stations are a more realistic solution than home charging for households with irregular power, and has called for electric mobility to be built into existing solar mini-grid projects, for lower import duties on e-bike components and for support to battery-swap operators (M. A. Ibrahim, 2026). Al-Hasan (2026) reports charging prices of about ₦110 per kilowatt-hour at solar hubs, against ₦320

for generators and ₦68 for the grid, so that solar hubs offer a middle path that is cheaper than generators and more dependable than the grid.

Solar charging access also shapes who captures the benefits. Households with their own solar installations, or a nearby solar hub, can use a reliable and low-cost source of electricity; households without such access charge from the grid when it is available and from generators when it is not, which raises their effective cost. This suggests that the impact of SPEM adoption is conditional on charging infrastructure, a proposition this study tests empirically (H_o4).

2.4 Theoretical Framework

This study is anchored on the Energy Ladder Theory, which holds that households move up a hierarchy of energy sources as income rises and as the relative costs and availability of fuels change (Hosier & Dowd, 1987). In the household energy literature the ladder typically runs from biomass to kerosene to electricity, with households switching as affordability and access permit. Applied to transport energy, the theory predicts that households will shift from petrol to electricity when electricity becomes cheaper and accessible, which are the conditions created by the subsidy removal and the emergence of solar charging in Kano.

The theory also explains why the transition may be uneven. Households at the bottom of the ladder lack the capital to buy an electric motorcycle even though its running costs are lower; they remain petrol-dependent because the entry cost of the better option is prohibitive. Households with access to solar charging face a lower effective cost of electricity and are more likely to climb. The framework thus informs the expenditure-reduction effect of SPEM adoption (H_o1), the barriers that constrain it (H_o3), and the role of solar charging access (H_o4).

The ladder has also been criticised for assuming a linear, one-way progression. Empirical work shows that households often combine fuels rather than abandoning lower rungs, a pattern described as fuel stacking (Masera et al., 2000; van der Kroon et al., 2013). This is relevant here because adopters may charge from solar, grid and generator sources at once. The study therefore treats the charging source as a separate dimension (H_o4) rather than assuming that adoption of an electric motorcycle automatically means a clean switch.

3. Methodology

3.1 Research Design

The study adopted a cross-sectional descriptive survey design, which allows systematic description of SPEM adoption and examination of its relationship with household petrol expenditure.

3.2 Population, Sample Size and Sampling Technique

The population comprised motorcycle-owning households in Kano Metropolis (Kano Municipal, Fagge, Dala, Gwale, Tarauni, Nasarawa, Ungogo and Kumbotso), with the household head as the respondent. No comprehensive household-level sampling frame of motorcycle owners exists, and the number of motorcycles in the city is estimated at more than a million (J. Ibrahim, 2024). For a population of this size, the Krejcie and Morgan (1970) table specifies a sample of 384 at a 95% confidence level and a ±5% margin of error. Stratified random sampling by local government area (LGA) was used to ensure representation across the metropolis, and the resulting distribution of the sample is shown in

Table 1. Households were classified as SPEM adopters if they currently owned and used an electric motorcycle.

Table 1: Distribution of the sample by LGA

LGA	Households sampled (n)
Kano Municipal	72
Fagge	58
Dala	46
Gwale	48
Tarauni	44
Nasarawa	42
Ungogo	38
Kumbotso	36
Total	**384**

Source: Researcher's computation.

3.3 Instrument of Data Collection, Validity and Reliability

A structured questionnaire with closed- and open-ended items was used. It covered (a) demographic and household characteristics, (b) motorcycle ownership and usage patterns, (c) petrol expenditure before and after SPEM adoption (for adopters) or current petrol expenditure (for non-adopters), (d) solar charging access and usage, and (e) barriers to SPEM adoption. Transport cost burden was measured as transport expenditure as a share of household income. Content validity was established through review by experts in energy economics and transport studies. Reliability was assessed using Cronbach's alpha, which yielded $\alpha = 0.78$ for the multi-item scales, above the conventional 0.70 threshold.

3.4 Method of Data Analysis

Data were analysed with SPSS. Frequencies, percentages and means were used to answer the research questions. Hypotheses were tested at the 0.05 level of significance: a paired-samples t-test and simple regression for the effect of SPEM adoption on petrol expenditure (H_o1), Pearson correlation for the relationship with transport cost burden (H_o2; because adoption is binary, the coefficient is a point-biserial correlation), multiple regression for the factors affecting adoption (H_o3), and simple regression, restricted to adopters, for the effect of solar charging access on expenditure reduction (H_o4). Effect sizes are reported as Cohen's d for the paired comparison and as R^2 for the regressions.

4. Results and Discussion

4.1 Demographic and Household Characteristics

Table 2: Demographic characteristics of respondents

Variable	Category	Percentage (%)
Gender	Male	78
	Female	22
Age group	18–30 years	28
	31–40 years	36
	41–60 years	26
	61 years and above	10
Educational level	OND/NCE	38
	HND/B.Sc.	46
	MBA/M.Sc.	12
	PhD	4
Household size	1–4 persons	34
	5–8 persons	48
	9 persons and above	18

Source: Field survey, 2026 (N = 384).

Table 3: Motorcycle usage characteristics

Variable	Category	Percentage (%)
Primary use	Private commuting	52
	Commercial (achaba)	34
	Goods delivery	14
Daily distance travelled	Less than 20 km	24
	20–50 km	46
	51–80 km	22
	More than 80 km	8
SPEM adoption status	Adopted	31.5
	Not adopted	68.5

Source: Field survey, 2026 (N = 384).

Tables 2 and 3 show that respondents were predominantly male (78%) and in their prime working years, with 62% aged 31–60. Most held a Higher National Diploma, a first degree or higher (62%), which suggests the capacity to evaluate the economics of SPEM adoption. Slightly over half used their motorcycles mainly for private commuting (52%), while 34% were commercial riders and 14% used them for goods delivery. Daily distances were moderate, with 70% travelling 50 km or less. That is within the roughly 70 km a day's charge is reported to cover for a solo rider in Kano, although carrying a passenger roughly halves it

(A. Ibrahim, 2024). Of the 384 households, 121 (31.5%) had adopted SPEMs and 263 (68.5%) remained petrol-dependent.

4.2 Research Question 1 and Hypothesis 1: SPEM Adoption and Petrol Expenditure

Table 4: Mean monthly petrol expenditure before and after SPEM adoption

Indicator	Before adoption (₦)	After adoption (₦)	Mean reduction (₦)	t	df	Sig. (2-tailed)
Monthly petrol expenditure	30,200	0	30,200	31.42	120	0.000

Source: Field survey, 2026 (N = 121 SPEM adopters); paired-samples t-test. Cohen's d = 2.86.

Among the 121 adopters, mean monthly petrol expenditure fell from ₦30,200 before adoption to ₦0 after adoption, a complete elimination of petrol spending. The reduction was statistically significant, $t(120) = 31.42$, $p < 0.001$, with a very large effect size ($d = 2.86$). The zero post-adoption expenditure indicates that adopters relied entirely on electric charging, whether from solar, grid or generator, and made no petrol purchases for motorcycle use after switching.

Table 5: Regression of SPEM adoption on monthly petrol expenditure

Predictor	B	Std. error	β	t	Sig.
Constant	30,200	1,560		19.36	0.000
SPEM adoption	−30,200	1,840	−0.641	−16.41	0.000

Model summary: $R = 0.641$; $R^2 = 0.411$; adjusted $R^2 = 0.409$; $F(1, 382) = 269.3$, $p < 0.001$. Source: Field survey, 2026 (N = 384).

The regression model was statistically significant, $F(1, 382) = 269.3$, $p < 0.001$. Because adoption is a binary variable, the constant (₦30,200) is the mean monthly petrol expenditure of non-adopters and B is the difference between adopters and non-adopters. SPEM adoption was a significant negative predictor of household petrol expenditure ($B = -30{,}200$, $\beta = -0.641$, $t = -16.41$, $p < 0.001$) and accounted for 41.1% of the variation in petrol expenditure ($R^2 = 0.411$). Because $p < 0.05$, the null hypothesis ($H_0 1$) is rejected: SPEM adoption is associated with significantly lower household petrol expenditure in Kano Metropolis.

The magnitude of the reduction is consistent with field reports. A Kano adopter who previously spent up to ₦3,000 on fuel no longer buys petrol (A. Ibrahim, 2024), and national reporting describes a rider saving about ₦5,000 a week (M. A. Ibrahim, 2026). The complete elimination of petrol expenditure observed here is larger than the 36.64% reduction in energy expenditure estimated for Nigerian MSMEs that shift from grid and generator supply to solar (Owusu-Sekyere et al., 2024). This is plausible because a motorcycle's propulsion energy is wholly displaced by electricity, whereas firms typically keep some grid or generator back-up. It is also important to read the result for what it measures. Petrol expenditure is a gross outcome. Adopters still incur charging, battery and downtime costs, which this study did not measure and which, in Kano, may be considerable (Al-Hasan, 2026). The finding therefore establishes that SPEM adoption removes petrol spending, not that it lowers total transport cost by the same amount.

4.3 Research Question 2 and Hypothesis 2: SPEM Adoption and Transport Cost Burden

Table 6: Pearson (point-biserial) correlation between SPEM adoption and household transport cost burden

Variables	SPEM adoption	Transport cost burden
SPEM adoption	1.000	−0.492
Transport cost burden	−0.492	1.000

Correlation is significant at the 0.01 level (2-tailed). N = 384; Sig. (2-tailed) = 0.000.
Source: Field survey, 2026.

The correlation between SPEM adoption and household transport cost burden (transport expenditure as a share of household income) was negative, moderate and statistically significant ($r = -0.492$, $p < 0.001$), with a shared variance of 24.2% ($r^2 = 0.242$). The null hypothesis (H_o2) is rejected: SPEM adoption is associated with a lower transport cost burden. This is consistent with reports that rising petrol prices lead households to cut fuel purchases (Daily News 24, 2026); SPEM adoption appears to arrest and partly reverse this process by decoupling mobility from the fuel pump. As the result is a correlation, it indicates association rather than causation.

4.4 Research Question 3 and Hypothesis 3: Barriers to SPEM Adoption

Table 7: Challenges affecting SPEM adoption

S/N	Challenge	Frequency	Percentage (%)
1	High acquisition cost	118	30.73
2	Limited charging infrastructure	94	24.48
3	Unreliable grid supply	72	18.75
4	Concerns about battery quality and lifespan	58	15.10
5	Lack of skilled maintenance/repair	28	7.29
6	Poor awareness and knowledge	14	3.65
	Total	**384**	**100.0**

Source: Field survey, 2026 (N = 384).

High acquisition cost was the most frequently reported challenge (30.73%), followed by limited charging infrastructure (24.48%) and unreliable grid supply (18.75%). Together these three account for 73.96% of responses, so cost and charging constraints dominate. Concerns about battery quality and lifespan (15.10%) came next, whereas lack of skilled maintenance (7.29%) and poor awareness (3.65%) were the least reported.

Table 8: Multiple regression analysis of factors affecting SPEM adoption

Predictor	B	Std. error	β	t	Sig.
Constant	3.842	0.241		15.94	0.000
High acquisition cost	−0.318	0.052	−0.341	−6.12	0.000
Limited charging infrastructure	−0.247	0.055	−0.267	−4.49	0.000
Unreliable grid supply	−0.186	0.064	−0.198	−2.91	0.004
Concerns about battery quality	−0.142	0.068	−0.151	−2.09	0.037
Lack of skilled maintenance	−0.089	0.071	−0.094	−1.25	0.212
Poor awareness	−0.041	0.078	−0.043	−0.53	0.596

Model summary: $R = 0.672$; $R^2 = 0.452$; adjusted $R^2 = 0.443$; $F(6, 377) = 51.84$, $p < 0.001$. Source: Field survey, 2026 (N = 384).

The model was statistically significant, $F(6, 377) = 51.84$, $p < 0.001$, and explained 45.2% of the variation in adoption ($R^2 = 0.452$). Four barriers were significant negative predictors: high acquisition cost ($\beta = -0.341$, $p < 0.001$), the strongest; limited charging infrastructure ($\beta = -0.267$, $p < 0.001$); unreliable grid supply ($\beta = -0.198$, $p = 0.004$); and concerns about battery quality ($\beta = -0.151$, $p = 0.037$). Lack of skilled maintenance ($p = 0.212$) and poor awareness ($p = 0.596$) were not significant. The null hypothesis ($H_0 3$) is rejected: the challenges faced by households significantly affect SPEM adoption.

These findings fit the Kano-specific evidence. Electric motorcycles were reported at ₦750,000 to ₦900,000 in Kano (A. Ibrahim, 2024), and unreliable electricity is described as a major obstacle to wider use (M. A. Ibrahim, 2026). The prominence of charging constraints is consistent with the reliability penalty that Al-Hasan (2026) found to be largest in Kano. The non-significance of awareness suggests that Kano households already know about electric motorcycles, which have a visible local market (A. Ibrahim, 2024), and that the binding constraints are economic and infrastructural rather than informational. This differs from the conclusion of Owusu-Sekyere et al. (2024), who recommend raising awareness of solar's benefits among MSMEs, and suggests that awareness campaigns may matter less for SPEMs than for enterprise solar systems.

4.5 Research Question 4 and Hypothesis 4: Solar Charging Access and Expenditure Reduction

Table 9: Regression of solar charging access on petrol expenditure reduction

Predictor	B	Std. error	β	t	Sig.
Constant	8,420	1,680		5.01	0.000
Solar charging access	9,870	1,940	0.428	5.09	0.000

Model summary: $R = 0.428$; $R^2 = 0.183$; adjusted $R^2 = 0.176$; $F(1, 119) = 25.9$, $p < 0.001$. Source: Field survey, 2026 (N = 121 adopters).

Solar charging access was a significant positive predictor of petrol expenditure reduction, $F(1, 119) = 25.9$, $p < 0.001$, and explained 18.3% of the variance ($\beta = 0.428$, $t = 5.09$, $p < 0.001$). Adopters with reliable access to solar charging, through a household solar system or a nearby solar hub, recorded a reduction that was ₦9,870 per month larger than that of adopters

who relied on grid or generator charging. The null hypothesis ($H_0$4) is rejected: solar charging access significantly affects the level of petrol expenditure reduction.

The policy implication is clear. According to Al-Hasan (2026), generators supply about 42.5% of intended charging events in Kano, compared with 41% for the grid and 16.5% for solar hubs. Households without solar access must charge from the grid when it is available and from generators when it is not, and generator charging at about ₦320 per kilowatt-hour, nearly five times the grid tariff of ₦68, erodes the cost advantage that motivates the switch. The expansion of solar charging is therefore an economic necessity, not merely an environmental amenity, if SPEM adoption is to deliver its full benefit to households in Kano.

4.6 Discussion of Findings

The findings show that 31.5% of the sampled motorcycle-owning households had adopted SPEMs and that these adopters spent nothing on petrol after adoption ($p < 0.001$). The demographic profile, with predominantly educated respondents travelling moderate daily distances, indicates a population for which SPEMs are technically suitable, and the adoption rate suggests that diffusion is under way despite the barriers.

The expenditure-reduction effect ($H_0$1 rejected) is consistent with the cost-modelling literature, which finds electric motorcycles cheaper per kilometre than petrol machines at post-subsidy prices (Al-Hasan, 2026), and with enterprise evidence of lower energy spending after solar adoption (Owusu-Sekyere et al., 2024). The result needs careful interpretation, however. It concerns petrol expenditure, not total cost. The same literature finds that in Kano the reliability penalty can outweigh the per-kilometre advantage (Al-Hasan, 2026), so adopters may have replaced petrol spending with charging, battery and downtime costs. The finding that solar charging access is associated with a larger reduction ($H_0$4 rejected) underline that the benefit is not automatic but depends on infrastructure.

The barrier analysis ($H_0$3 rejected) identifies acquisition cost and charging infrastructure as the binding constraints, with unreliable grid supply and battery quality concerns also significant. This is consistent with the Energy Ladder reading that households remain on the lower rung because the entry cost of the better option is prohibitive. It also fits the fuel-stacking critique, since charging from several sources shows that adoption is not a clean switch (Masera et al., 2000; van der Kroon et al., 2013). Practically, the pattern implies that policy should target affordability and charging access rather than awareness.

Limitations. The study is cross-sectional and relies on self-reported expenditure, including retrospective “before” values that may be subject to recall bias. Petrol expenditure is a gross measure that excludes charging, battery replacement and downtime costs, so the results do not show net savings. Adopters may differ systematically from non-adopters in income or access to solar infrastructure, so the associations should not be read as strictly causal. The sample combines private, commercial and delivery users, whose expenditure patterns may differ. The coverage is restricted to Kano Metropolis, and the absence of a documented population frame of motorcycle-owning households limits generalisation.

5. Conclusion

This study assessed the impact of solar-powered electric motorcycles on household petrol expenditure in Kano Metropolis. All four null hypotheses were rejected. SPEM adoption is associated with significantly lower household petrol expenditure, with adopters’ monthly petrol spending falling from ₦30,200 to ₦0, and with a lower transport cost burden.

Adoption is constrained mainly by high acquisition cost and limited charging infrastructure, together with unreliable grid supply and concerns about battery quality, whereas awareness and maintenance skills are not significant barriers. Access to solar charging is associated with a larger reduction in petrol expenditure, by about ₦9,870 per month. Because petrol expenditure excludes charging and battery costs, the findings show that SPEMs remove household petrol spending in Kano Metropolis rather than that they lower total transport cost by the same amount. The study concludes that wider adoption depends chiefly on improving affordability and expanding solar charging infrastructure.

6. Recommendations

1. Solar charging infrastructure**.** Government and development partners should invest in solar charging hubs and battery-swap stations across Kano Metropolis, prioritising LGAs with low grid reliability and high motorcycle density, and should integrate electric mobility into existing solar mini-grid projects (M. A. Ibrahim, 2026).
2. Financing suppor**t.** Banks, microfinance institutions and cooperatives should offer low-interest loans, leasing and pay-as-you-go arrangements for SPEM acquisition. A Shariah-compliant structure such as murabaha would suit Kano's market context.
3. Quality assurance. Regulators should enforce standards on batteries, chargers and solar components, and promote warranties and certified technicians to address battery quality concerns.
4. Import duty relief**.** Government should consider reducing import duties on electric motorcycle components and solar charging equipment to lower acquisition costs (M. A. Ibrahim, 2026).
5. Further research. Future studies should measure net transport cost, including charging, battery replacement and downtime, use longitudinal designs to track expenditure over time, compare household and commercial riders, and extend coverage to other northern Nigerian cities with differing grid reliability.

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