Acta Universitatis Danubius
ŒCONOMICA

Environmental Relative Advantage and Business Image on Photovoltaic Technology Continuance Adoption Among Micro, Small and Medium Enterprises

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Abstract: This study aimed to examine the effect of environmental relative advantage and business image on the continuance adoption of photovoltaic technology among micro, small and medium-sized enterprises. The adoption rate of photovoltaic technology among micro, small and medium-sized enterprises in South Africa is comparatively low even though the grid-based energy costs are high. Existing research is yet to address the role of environmental relative advantage and considerations of the business image on the continuance adoption of photovoltaic technology among micro, small and medium-sized enterprises. Using a quantitative approach, this study employed the Partial-Least Squares Structural Equation Modeling to examine the effect of environmental relative advantage and business image on photovoltaic technology continuance adoption among a sample of 350 micro, small and medium-sized enterprises. The results revealed that environmental relative advantage and business image had a statistically positive effect (R^2 =0.454) on photovoltaic technology continuance adoption among micro, small and medium-sized enterprises. The significance of this finding is that these businesses notice environmental relative advantage of photovoltaic technology and consider their image hence they continue adopting this technology. This is significant for the entire country as this will contribute to the reduction of carbon emissions and help the country to meet its sustainability goals. The study contributes to literature on photovoltaic technology among micro, small and medium-sized enterprises.

Keywords: Environmental relative advantage; Business image; Photovoltaic technology; MSMEs

JEL Classification: Q42, M14, L26

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1. Introduction

The climate change has brought many challenges which compelled countries around the world to transition to renewable energy, and the most common one is rooftop photovoltaic (PV) technology (Poornima et al., 2025). This adoption of renewable energy is in line with the United Nations sustainable development goals which demand a transition towards cleaner energy (Qamar et al., 2022). PV technology is energy that households and businesses absorb from the sun through rooftop panels and converted into electricity (Agbo et al., 2021). However, micro, small and medium enterprises (MSMEs) in South Africa have not yet satisfactorily adopted sustainability strategies which include PV technology at the same rate as larger businesses (Tsikada et al., 2025). Furthermore, MSMEs in South Africa are heavily dependent on coal powered energy which account for 85% of the national energy grid which the power utility has sharply increased electricity prices since 2007 (Mathibedi et al., 2026). Coupled with this, the demand for energy outpaced the supply and resulted in households and businesses showing increasing interest in renewable energy of which PV technology is estimated to comprise 10% of the electricity generation mix by 2030 (Gatawa, et al., 2026).

This shortage of supply and high demand caused frequent disruptions in energy supply as the power utility implemented rotational power interruptions to protect the national grid from collapsing (Botha et al., 2025). These intentional energy interruptions by the power utility are referred to as '*loadshedding*', and have negatively impacted businesses, especially resource-constrained MSMEs who are unable to augment their energy needs (Mabunda et al., 2023). For example, in 2023 the number of job losses due to loadshedding in South Africa was estimated to approximately 800 000 with close to 224 billion South African rand (ZAR) of losses to the economy (Ledger, 2024). Because of these challenges, South Africa is gradually moving away from coal-powered energy and is expected to phase out 4900 Mega Watts (MW) of coal powered stations and replace them with about 6814 MW of solar power (Semelane et al., 2021). Furthermore, to increase energy capacity, the private sector through the Renewable Energy Independent Power Producer Program (REIPPP) is investing in PV technology to increase energy capacity in the country (Mutumbi et al., 2024). Currently, most of the PV technology installations are found in Gauteng, the Western Cape and Northern Cape provinces of South Africa (Moosa, 2025). This trend of moving towards PV technology is in line with the global PV

cumulative capacity which is projected to reach 15,000,000 MW by 2030 if it continues at this growth rate (Agbo et al., 2021).

Existing research on PV technology adoption, especially among MSMEs, uses the relative advantage of technology and not the environmental relative advantage as a contributing factor on PV technology adoption. Environmental relative advantage relates to the significant effect of renewable energy on the environment and benefits derived from using renewable energy as compared to fossil fuel energy (Qamar et al., 2022). On the other hand, relative advantage entails the benefits that the businesses derive from adopting new technology (Ejigu & Yeshitela, 2024). In other words, the focus is on the benefits of the technology to the business. In addition, there is limited research by MSMEs consideration of their perceived business image should they decide to adopt PV technology. Based on this literature gap, this study used environmental relative advantage and business image as possible contributing factors when MSMEs decide to adopt PV technology.

2. Literature Review

2.1. PV Technology Adoption Among MSMEs

Micro, small and medium enterprises play a significant role for economies of many countries because they create job opportunities. These businesses are known to experience many challenges which among others include high energy costs. It is for this reason that some researchers advise MSMEs to adopt PV technology as it is cheaper than the grid-based energy (Ofori et al., 2022). Despite this, the adoption of PV technology among MSMEs remains uneven in various parts of the world (Alsharari & Ali, 2025). For example, Akangbe and Sharifi (2025) report that the adoption of PV technology among MSMEs in Nigeria remains low despite the availability of solar resources. In Mexico, Hancevic and Sandoval (2023) report an adoption rate of 7.5% among MSMEs. According to Walsh et al. (2024), the PV technology adoption rate in South Africa stands at 10.4% for MSMEs and households combined. Based on this, it is important to investigate the effect of several factors contributing to the adoption of this technology among MSMEs.

There are many studies that investigated the factors influencing and hindering the adoption of PV technology among MSMEs around the world. For example, Hancevic and Sandoval (2023) found that among other factors the sector in which the MSMEs operate as well as the ownership status determine the adoption of PV

technology among MSMEs. According to Mkhwebane and Ntuli (2019), the decreasing prices of solar panels together with improved manufacturing technology led to the adoption of PV technology among MSMEs. Ajah (2023) found that among others, the perceived benefits derived from PV technology has a positive influence on the adoption of the technology among MSMEs. Similarly, MSMEs also consider factors such as perceived affordability and technical familiarity when deciding to adopt PV technology (Ogedengbe & Adelowotan, 2025). Akinwale and Adepoju (2019) highlight trust, peer effect and technology acceptance among many factors as contributing to MSMEs decision to adopt the technology. On the other hand, there are factors that hinder the adoption of PV technology among MSMEs. According to Smarte Anekwe et al. (2024), the high investment costs are associated with MSMEs reluctance to adopt PV technology. Alsharari and Ali (2025) mention limited financial capacity, technological complexity as well as high capital costs as some of the factors that hinder the PV technology adoption by MSMEs. Despite all these, the importance of PV technology cannot be overemphasised.

2.2. Importance of PV Technology for MSMEs

Beside PV technology reducing dependency on fossil fuel, it presents substantial benefits for the environment (Memtimin et al., 2025). According to Agbo et al. (2021), PV technology is important because it mitigates the environmental degradation and reduce health risks associated with fossil fuels. Solar PV technology has also played a meaningful role in mitigating shortages of electricity in certain countries (Ajah, 2023). In addition, PV technology contributes significantly to cost savings for MSMEs (Ogedengbe & Adelowotan, 2025). Owusu-Sekyere et al. (2024) found that when MSMEs are powered through solar energy, their expenditure significantly decreases. According to Apfel and Herbes (2021), by adopting PV technology MSMEs can experience stable energy supply as well as contribute to help the fight against climate change. Accordingly, due to technological advances, there has been a noticeable reduction in the cost of PV technology which is encouraging MSMEs to consider adopting this technology as it is a reliable alternative (Hancevic & Sandoval, 2023). In the case of South Africa MSMEs are also gradually adopting the PV technology given its perceived benefits (Mkhwebane & Ntuli, 2019). Since the factors involved in adoption of PV technology are not yet exhausted (Qamar et al., 2022), this study investigated the effect of environmental relative advantage and

business image on the PV technology continuance adoption among MSMEs in South Africa.

2.3. Environmental Relative Advantage and Renewable Energy

According to Kurniawan et al. (2025), while environmental consciousness plays an important role towards a positive disposition on PV technology adoption, the environmental benefits serve as a more decisive influence. Scheller et al. (2024) also affirm that the environmental relative advantage influences the adoption of low carbon technology like PV technology. This affirms the view that there is a correlation between environmental benefits and renewable energy (Shin et al., 2018). Kumar et al. (2023) found that environmental benefits are some of the contributing factors in the adoption of PV technology among non-residential customers. Similarly, Parsad et al. (2020) found that the environmental advantages are associated with PV adoption among Indian households. Schelly et al. (2020) confirm the significance of the environmental advantage when they reveal that among all the factors, households rate environmental benefits higher. Considering this, this study proposes that environmental relative advantage should contribute to the continuance adoption of PV technology among MSMEs in a comparable way it does to households. Based on this, the following hypothesis is formulated:

H1: *Environmental relative advantage has a statistically positive effect on PV technology continuance adoption among MSMEs in South Africa*

2.4. Business Image and Renewable Energy

Sitompul et al. (2024) and Owusu-Sekyere et al. (2024) agree that the adoption of solar energy enhances the image of the business. This supports the view that when MSMEs pursue strategies that are contributing to environmental legitimacy, this can potentially enhance the image of the business (Khalid et al., 2023). According to Baah et al. (2021), MSMEs that engage in green energy practices are likely to experience high organisational reputation which is good for the image of the business. Similarly, Awamleh et al. (2025) argue that by integrating renewable energy strategies MSMEs can create an enduring value and promote the business image. This means that MSMEs environmental and social responsibility could result in benefits such as stronger business image and improved public perception (Africa Centre for Policy, 2021). However, there is limited research on the effect of business

image on PV technology continuance adoption, especially among MSMEs. Therefore, this study proposes that when MSMEs consider their business image, they may manifest continuance adoption of PV technology. Based on this, the following hypothesis was formulated:

H2: Business image considerations would have a significant positive effect on PV technology continuance adoption among MSMEs in South Africa.

3. Theoretical Framework

Drawing from the Technology-organization-environment (TOE) framework developed by Torntzky and Feischer (1990), this study develops a conceptual model to examine the effect of environmental relative advantage and business image on PV technology continuance adoption among MSMEs in South Africa. From the three contexts of the TOE, this current study deemed environmental context as well as the organisational contexts appropriate. The environmental context relates to the external factors that are beyond the control of the business which impact the decision to adopt modern technology. On the other hand, the organizational context relates to the internal characteristics of the organisation such as the culture. In terms of the organisational context, businesses with a culture of enhancing their business image may adopt modern technology (Ramayah, 2013). Mohanty et al. (2025) found that when a business adopts technology relative to rivals, this helps to build a positive social image. In terms of the environmental context, previous studies such as Kurniawan et al. (2025 and Scheller et al. (2024) found a correlation between the environmental benefits and technology adoption. In line with this, this study propose that concern for the business image and environmental relative advantage are related to PV technology continuance adoption among MSMEs.

4. Research Methodology

4.1. Research Design

The study followed a quantitative deductive research design to examine the effect of environmental relative advantage and business image on the continuance adoption of PV technology by MSMEs in South Africa. The respondents who were managers and owners of MSMEs who adopted PV technology completed an online questionnaire which the researcher shared through a link administered by a reputable

survey research company. The researcher approached the survey company to recruit respondents from their database. Prior to commencing with the survey, the study obtained ethics approval from the research ethics committee of the researcher's institution (NWU-00635-26-A4). The questionnaire scale items were sourced from previously validated scales. Items measuring environmental relative advantage and business (MSMEs) image were adapted from Qamar et al. (2022) and items measuring PV continuance adoption were adapted from Kapoor and Dwivedi (2020). The Likert scale ranged from 1 (strongly disagree) to 5 (strongly agree). Table 2 lists the measuring items with cross loadings. In accordance with Hair et al. (2017) 10 times the largest number of items pointing to a particular construct, the sample size was set at 400. Before the analysis a thorough cleaning process was conducted. This included the removal of duplicate IP addresses, removal of short completion times as well as inconsistent responding. In the end, the analysis was performed on 350 valid questionnaires giving a responds rate of 87.5%. The SMARTPLS software and Statistical Package for Social Sciences version 32 (SPSS) were used to analyse the data. SPSS was used to establish Sampling Adequacy.

5. Results

5.1. Respondents' Profile and Business Characteristics

Of all valid responses, the owners comprise 36.6% and managers comprise 63.4%. In terms of age, 41.7% were 26 to 35 years old. Then, those who were 18 to 25 years made up 26% and followed by those who were between 36 and 45 years who made up 20.9% of total respondents. The age group 46 to 55 years made up 6.3%. The smallest groups were those aged between 56 and 65 who made up 3.7% and those above 65 making up 1.4%, respectively. In terms of the size of the business, medium-sized enterprises made up 42% and followed by small enterprises with 31.7%. Lastly, the micro enterprises made up 26.3%. In terms of the industry of the MSMEs, 21.1% selected other, followed by Finance (13.4%; then IT/Technology making up 12.3% followed by Retail and Wholesale (11.7%) and Education (11.7%). The next industries were manufacturing (6.9%) and Healthcare (6.9%). The service industry made up 6.6%, Hospitality 5.7% and Logistics 3.7%, respectively.

5.2. Common Method Bias

The current study implemented procedural remedies suggested by Podsakoff et al. (2003) which include assurance of anonymity and confidentiality of respondents. Also, the researcher embarked on a careful construction of scale items to avoid ambiguity. Then followed with a full statistical collinearity assessment which yielded the highest VIF value of 2.037 and therefore below the 3.3 threshold (Kock, 2015). Item 2 of PV continuance adoption yielded a value above the 3.3 threshold and was subsequently removed as recommended by Kock and Lunn (2012). Therefore, the common method bias was not a problem.

5.3. Data Analysis

The analysis applied the PLS-SEM to estimate the measurement and structural models. It began with establishing the measurement model validity then followed with the assessment of the structural model.

5.4. Reliability and Convergent Validity

The reliability showed a strong internal consistency of the constructs. The Cronbach Alpha values were above the recommended 0,7 threshold with environmental relative advantage (0.865), image of business (0.855) and PV adoption (0.878). The composite reliability values were above the recommended 0.7 threshold with environmental relative advantage at (0.867), image of business (0.855) and PV adoption at (0.879). For convergent validity, the AVE values were 0.623 (environmental relative advantage), 0.664 (image of business) and 0.708 (PV continuance adoption) and therefore above 0.5 threshold (Hair et al., 2017). Table 1 presents the reliability and convergent validity values.

Table 1. Reliability and convergent validity

	Cronbach's alpha	**Composite reliability (rho_a)**	**Composite reliability (rho_c)**	**Average variance extracted (AVE)**
Environmental relative advantage	0.865	0.878	0.867	0.623
Image of business	0.855	0.856	0.855	0.664
PV continuance adoption	0.878	0.882	0.879	0.708

5.5. Discriminant Validity

The heterotrait-monotrait ratio (HTMT), the Fornell- Larcker criterion and the cross loadings were applied to assess whether the constructs were distinct from each other. Cross loadings ensure that each item on a variable is greater than the cross loading on another construct. The Fornell-Larcker criterion used the square root of the AVE for each construct and should be greater than the inter-correlation between different constructs (Fornell & Larcker, 1981). The HTMT compares the average correlation of items across constructs with a strict threshold of less than 0.85 and liberal threshold of 0.9 (Hair et al., 2017). Discriminant validity was confirmed and the results are presented in Table 2. Using SPSS, Sampling adequacy was confirmed through the Kaiser-Meyer-Olkin with a value of 0.918. The standardized root mean square residual (SRMR) assessed the quality of the model and yielded a value of 0.025 and therefore below the recommended 0.08 threshold indicating excellent fit (Wong, 2019).

Table 2. Discriminant validity results

HTMT

	Environmental relative advantage	**Image of business**	**PV continuance adoption**
Environmental relative advantage			
Image of business	0.714		
PV continuance adoption	0.621	0.745	

Fornell Larcker criterion

	environmental relative advantage	**Image of business**	**PV continuance adoption**
Environmental relative advantage	0.844		
Business image	0.619	0.881	
PV continuance adoption	0.547	0.648	0.897

Cross loadings

Code	Measurement item	environmental relative advantage	Business image	PV continuance adoption
ERA1	Solar PV Technology does not produce environmental pollution**.**	**0.750**	0.413	0.363
ERA2	Solar PV Technology leads towards a clean environment.	**0.869**	0.578	0.486
ERA3	Solar PV Technology contributes to less global warming.	**0.871**	0.515	0.494
ERA4	Solar PV Technology does not deplete the natural resources, but the non-renewable energy sources do.	**0.878**	0.565	0.486
Image 1	Solar PV Technology is good for the image of the business.	0.569	**0.888**	0.589
Image 2	The use of Solar PV Technology attracts customers because of loyalty to the environment.	0.552	**0.870**	0.556
Image 3	Image of utilising Solar PV Technology promotes the business revenues.	0.513	**0.884**	0.566
Adopt 1	I will continue using the solar equipment in my business.	0.533	0.604	**0.896**
Adopt 3	I want to carry on using solar equipment in my business.	0.476	0.605	**0.912**
Adopt 4	The possibility of continuing usage of solar equipment is high.	0.458	0.528	**0.882**

Prior to the testing of the structural model hypotheses, a multicollinearity assessment was done with the aim of checking the relationship among constructs. The VIF values were less than the threshold of 5 as recommended by Hair et al. (2017) and therefore affirming that multicollinearity is not a problem.

The result of the structural model using 5,000 bootstrapping subsamples indicates that environmental relative advantage had a statistically positive effect on PV

technology continuance adoption with (β=0.237, t=2.023, p<0.001, f^2 =0.038*)*. In other words, environmental relative advantage is significantly associated with continuance adoption of PV technology when other factors are constant. This result affirms Parsad et al. (2020) findings among Indian households that the environmental advantage influences the PV technology adoption. Similarly, consideration of business image had a statistically positive effect on PV technology continuance adoption (β=0.501, t=6.605, p<0.001, f^2=0.434*).* Put differently, consideration for business image is significantly associated with PV technology continuance adoption among MSMEs. This result is significant because according to Sitompul et al. (2024), when businesses adopt renewable energy, this may enhance their image. The R^2 value of 0.454 indicates that 45.4% of the variance in PV technology continuance adoption is accounted for by environmental relative advantage and consideration for the business image. The Q^2 value of 0,445 indicates that the model showed medium to high predictive relevance. Figure 1 presents the actual model.

Table 3. Results of hypotheses testing

Path	β	t-value	p-value	f^2
Environmental relative advantage → PV continuance adoption	0.237	2.023	p<0.001	0.038
Image → PV continuance adoption	0.501	6.605	p<0.001	0.434

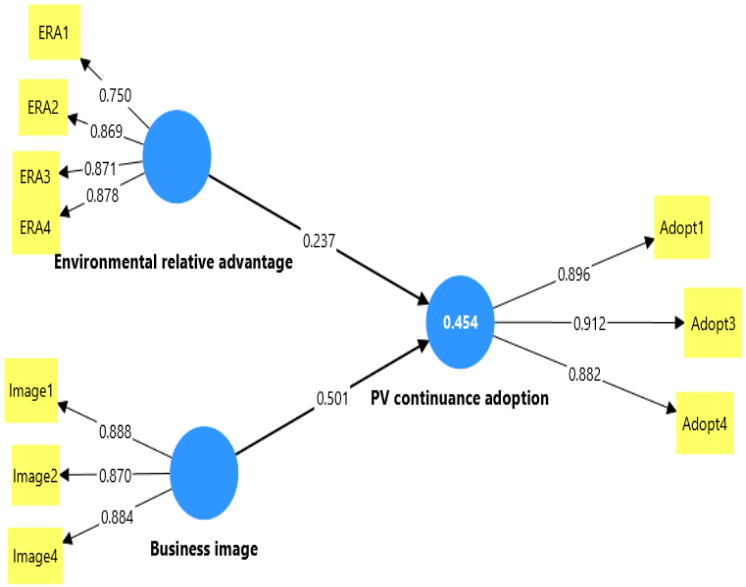


Figure 1. The effects of environmental relative advantage and business image on PV technology continuance adoption among MSMEs

6. Discussion

On the backdrop of previous studies not focusing on the environmental relative advantage effect on PV technology adoption among MSMEs, the current study affirmed that environmental relative advantage has a significant effect on MSMEs continuance adoption. Put differently, MSMEs in South Africa are cognisant of the environmental benefits of adopting PV technology hence their continuance adoption of this technology. Albeit how small they may be, their actions are important in mitigating the impact of global warming (Ali, 2025). According to Hussain et al. (2025), the cumulative environmental footprint of MSMEs could exceed that of many large businesses and therefore make MSMEs important actors towards environmental sustainability. Therefore, the continuance adoption of PV technology by MSMEs has the potential to offer short-term as well as long-term solutions to manage their energy requirements and contribute positively to the environment (Alshahrani et al., 2024). In addition, the continuance adoption would allow MSMEs to reap huge benefits such as improving their competitiveness due to the decreasing operational costs. As stated before, South Africa has experienced inflation beating increment in energy prices since 2007 (Mathibedi et al., 2026) and continuance

adoption by MSMEs has the potential to cushion them against these increasing costs.

This study also investigated the concern for business image as a factor contributing to continuance adoption of PV technology among MSMEs. The results indicate that business image has a positive effect on PV technology continuance adoption among MSMEs in South Africa. In the past, Chen (2010) has advised businesses to invest in renewable energy to enhance their image. Liczmańska-Kopcewicz (2020) later confirmed the effect of investment in renewable energy as indeed enhancing business image. Issa and Hanaysha (2023) have also confirmed that beside lowering greenhouse emissions and decreasing costs, renewable energy enhance the image of the business which can lead to customer loyalty, employee morale and community support. Therefore, the findings of this study afford MSMEs in South Africa a chance to build good relationships and image with various stakeholders.

7. Theoretical and Practical Contributions

The aim of this study was to examine the effect of environmental relative advantage and business image on the photovoltaic technology continuance adoption among MSMEs in South Africa. From a theoretical perspective, this study contributes in the following way: Given the dearth of research in environmental relative advantage and business image on PV technology adoption among MSMEs, this study contributes to this deficiency in the literature. Existing studies mostly use relative advantage of the PV technology as a factor contributing to adoption. These two concepts are different as the environmental relative advantage focuses on the benefits for the environment when MSMEs adopt PV technology whereas relative advantage focuses on the benefits of the technology itself which may enhance the performance of the business. On the other hand, previous research on consideration of the business image when adopting PV technology focused on large businesses. For this reason, this study shifted the focus towards MSMEs because of their operations, they also contribute to the environmental pollution. Therefore, it is important that like big businesses, MSMEs should be concerned about their image if they do not continue to adopt renewable energy. Based on the above, this study fills an important gap in the literature of photovoltaic technology adoption among MSMEs.

The study has shown practical contributions in several ways. First, MSMEs who have adopted PV technology contribute to the fight against global warming and climate change. This is important because the effect of global warming and climate

change have impacted South Africa in recent years like the rest of the world. For example, the recent floods in the country have significantly affected MSMEs in many ways and some are yet to recover (Zulu, 2026). It is worth noting that the fight against climate change is the responsibility of everyone, including MSMEs. Therefore, MSMEs who have not yet adopted this technology should consider doing so. Second, when MSMEs continue to adopt PV technology, this would contribute to their reputation and business image in society. The results of this study show that MSMEs' continuance adoption is also affected by the consideration of the decision on the business image. For the South African government, this is encouraging as the country may be on the right path towards meeting its sustainability goals.

8. Limitations, Future Research and Conclusion

Like any other study, this study has some limitations. First, the study followed a cross-sectional design where data were collected at a specific period. Future studies could make a longitudinal approach to ascertain whether the continuance adoption of PV technology would happen over an extended period. Second, the study selected two factors which may not necessarily be the main ones driving continuance adoption of PV among MSMEs. Therefore, in future, studies could include other factors like a noticeable decline in the costs of PV technology. Furthermore, future studies could also compare MSMEs in terms of the industry in which they operate as previous studies have indicated that the demand for energy differs per industry. In conclusion, based on the results of this study it is evident that the effect of environmental relative advantage and business image are important in PV technology continuance adoption among MSMEs.

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