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Determining Factors of Eco-Innovation Adoption: An Empirical Study of Micro and Small Enterprises in Johannesburg, South Africa

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Abstract **-** Eco-Innovation (EI) is a typical innovation that is beneficial to the environment. It is seen as a necessary step that positively contribute to the worldwide fight against carbon emissions. It is a crucial component for achieving sustainable development and improving environmental and economic performance. The research investigated what drives micro and small enterprises (MSEs) to adopt environmental innovation technologies in Johannesburg, South Africa. An econometric model was used to examine a total of 1,021 MSEs. The probit findings show that environmental tax, government subsidies, and research and development (R&D) activities, have a positive influence on EI adoption. Also, adoption of EI is dependent on the successful application of non-eco-innovations (e.g., innovation on new products, innovation on improved products, and innovation on improved services) by enterprises. The resarch concludes with policy implications.

Keywords: determining factors, eco-innovation adoption, MSE enterprises

I. INTRODUCTION

Some thirty years ago, many business firms were accustomed to strategies and practices that compelled their drive for competitiveness while ignoring critical environmental concerns. However, the establishment of the three sustainability pillars (economic, environmental and social) has compelled the global community to pressure businesses to once again consider novel ways and practices that preserve the environment (Aboelmaged, 2018).

Eco-innovation, often known as environmental innovation, is described as "business models which support the development of products and services (systems) with environmental benefits, reduce resource use/waste and which are economically viable" (Machiba, 2012). Therefore, by definition, an eco-innovation is a typical innovation that is beneficial to the environment as it reduces waste. Eco-innovation is acknowledged as a crucial component for achieving sustainable development, improving working conditions, and improving environmental and economic performance (Castellano et al., 2022).

The world is currently dealing with many major environmental problems including climate change and biodiversity loss. As a result, both manufacturers and consumers are becoming more concerned for the environment. Innovative solutions and more environmentally friendly technologies should be developed as a way to prevent or decrease the effects of such problems. Eco-innovation is the cutting-edge method for addressing environmental issues since it provides options to support industrial activity without damaging resources for future generations, and by reducing adverse environmental effects (Aboelmaged & Hashem, 2019).

The economic growth of South Africa has been sluggish for the past ten years, owing to the global financial crisis of 2008-2009 (Matekenya & Moyo, 2022). According to Furawo and Scheepers (2018), sustained innovation is essential for developing the competitive edge of a firm, which in turn affects its survival. The National Development Plan designates Small, Medium and Micro Enterprises (SMMEs) as tools for the attainment of the socio-economic goals and innovation (Lukhele & Soumonni, 2021; Van der Zee et al., 2018). The contributions of SMMEs to innovation and the Gross Domestic Product (GDP)

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still trail behind large enterprises. South Africa has developed legislative frameworks to encourage both the public and private sectors to prioritise innovation as a key driver of growth and development (Matekenya & Moyo, 2022).

In 1996, South Africa adopted the National System of Innovation (NSI), consisting of Doing, Using, and Interacting (DUI) and Science, Technology, and Innovation (STI), to address the innovation challenge faced by both small and large enterprises, and to boost the technological capabilities of the country (Lukhele & Soumonni, 2021). Later, in 2019, a revised White Paper on Science, Technology, and Innovation was adopted, in response to the shifting dynamics of the global economy. In spite of these initiatives, SMME innovation levels are still inadequate to support their growth and development (Furawo & Scheepers, 2018). Furthermore, despite its significance, innovation in South African businesses continues to be a challenge (Matekenya & Moyo, 2022).

While the debate over the adoption of eco-innovation is ongoing, the subject of eco-innovation in relation to micro and small enterprises (MSEs) is still in its infancy and merits greater attention, particularly given the significance of these businesses to the economic systems of various nations (Passaro et al., 2022). Studies have primarily concentrated on large manufacturing facilities with high pollution levels with less attention given to MSEs, which serve as the backbone of the industrial systems of many countries, creating 90% of jobs while contributing more than 60% of all pollutants Organisation for Economic Co-operation and Development (OECD, 2019). Due to these reasons, further research is necessary to fully understand the factors that influence MSEs' adoption of eco-innovation, to help quicken the advancement of eco-innovative techniques, and enforce the beneficial externalities produced by these firms for the entire socioeconomic environment.

There is a dearth of research on the adoption of eco-innovation in South African business enterprises. The research is a response to fill this critical knowledge gap. Gaining an understanding of the driving dynamics behind eco-innovation may assist policymakers in developing appropriate measures that would promote its development and acceptance in the economy's industrial sector. The purpose of the research is to find out what drives micro and small enterprises to adopt eco-innovation technologies. Given the situation described, the overall research question of this research is to determine the factors that influence the adoption of eco-innovation technologies by micro and small enterprises. The research seeks to provide answers to the question: What are the main drivers of micro and small enterprises to adopt eco-innovation in South Africa setting?

To achieve the aim, the research is structured as follows; Section 2 presents the literature review, theoretical background, and hypotheses development; Section 3 provides the method and research design; Section 4 presents the estimated results; and Section 5 concludes with policy implications.

Eco-innovation is viewed by Doran and Ryan (2016) as a type of innovation that has the potential to result in environmentally friendly and sustainable outcomes (Doran & Ryan, 2016; Ghisetti & Quatraro, 2017). Since eco-innovation is crucial to the development of sustainable industries (Adams et al., 2016; Dalvi-Esfahani, Shahbazi, & Nilashi, 2017), it remains pertinent to discover the factors that influence enterprise eco-innovation (Dalvi-Esfahani, Shahbazi, & Nilashi, 2017; Peng & Liu, 2016).

The factors that influence eco-innovation adoption at the firm level have been the subject of several empirical investigations (Melander, 2018; Tang et al., 2018). Many theoretical approaches have recently demonstrated the factors for eco-innovation drivers, arguing that enterprises are influenced by individual, organisational and contextual factors, internal resources, and external factors with a focus on the impact of policies and regulations (Costantini, Crespi, & Palma 2017; Da Silva et al., 2023; Dangelico, Pujari, & Pontrandolfo, 2017; Kiefer, González, & Carrillo-Hermosilla, 2019). Table 1 presents additional eco-innovation determining factors from previous

Table 1 Literature on Eco-Innovation Adoption

Author	Objective	Sample/Country	Methodology	Contribution
Calafat-Marzal et al. (2023)	To determine the factors that drive innovation and its ties to eco-innovation.	74 Spanish MSEs in the agri-food sector	Cross-Efficiency Matrix	Management support and competitive pressure, not external support from suppliers or government legislation, are the main drivers of eco-innovation.
Carchano, Carrasco, & González (2023	Analysing the linkage between eco-innovation and environmental performance.	239 Spanish MSEs	Structural Equation Model	Better environmental performance results from the adoption of eco-innovations, which is pushed by internal stakeholders.
Mendoza et al. (2023)	To comprehend how MSEs are implementing eco-innovation strategies.	40 MSEs from the Philippine municipalities of Cavite, General Trias, Imus, and Tanza.	Factor Analysis Design & Tucker-Lewis Index	Most eco-innovation adopters are sole proprietorships, with less than 10 employees and have been in operation for one to three years.

Table 1 Literature on Eco-Innovation Adoption (Continued)

Author	Objective	Sample/Country	Methodology	Contribution
Gąsior et al. (2022)	To determine whether it is possible to consider MSEs eco-innovation as a factor influencing the economy's energy efficiency.	400 Polish enterprises	Review of literature, Cronbach's alpha test, and Likert estimation scale	- There is a connection between MSEs' increased eco-innovation implementation activities and their competitive position. - The actions and attitudes of MSEs entrepreneurs have a significant influence on the choices made regarding the adoption of particular eco-innovations.
Jun et al. (2021)	To draw attention to the primary elements influencing green innovation adoption by SMEs in Pakistan.	288 SMEs in Pakistan, spread across five different sectors.	Partial Least Squares Structural Equation Modelling	Adoption of green innovations is positively and significantly impacted by human resource and organizational factors, customer and market factors, government assistance and technology factors.
Thomas, Scandurra, & Carfora (2022)	To research how stakeholders influence companies' decisions to use green innovations to attain sustainable development goals.	222 innovative Italian SMEs	Partial Least Squares Structural Equation Modelling	Green innovations are impacted by stakeholders with non-contractual links to SMEs.
Valdez-Juárez & Castillo-Vergara (2021)	To examine how eco-innovation, technological capability and open innovation, relate to corporate performance.	684 SMEs in Mexico	Smartpls-based Structural Equation Modelling	Although it may not directly affect corporate performance, technological capability significantly impacts eco-innovation and open innovation practices.
Almalki et al. (2020)	To identify and rank Saudi Arabia's barriers to environmental innovation, as well as to offer solutions.	SMEs in Saudi Arabia	Fuzzy Analytical Hierarchy Process (FAHP)	The strategic solution, "Developing research practices to carry out green innovation in SMEs," is more crucial in tackling barriers in SMEs, related to green innovation.
Ooi, Ooi, & Memon (2020)	To examine how stakeholder pressure affects eco-innovation strategies in Malaysian manufacturing SMEs	100 Malaysian manufacturing SMEs	Structural Equation Modelling	SMEs adopt eco-innovation strategies as a result of stakeholder demands.
Ceptureanu et al. (2020)	To investigate the impact of eco-innovation capacity on SMEs innovation practices.	397 Romanian manufacturing SMEs	Partial Least Squares–Structural Equation Modeling (PLS–SEM) Approach	The growth of eco-innovation capability has a favourable and direct impact on innovation strategies used in manufacturing SMEs, by motivating them to adopt cleaner production methods.
Seth, Rehman, & Shrivastava (2018)	To comprehend green manufacturing drivers and the dynamics that underlie their interactions	Indian SMEs and large industries	Interpretive Structural Modelling (ISM) Approach	GM drivers are more than a simple toolkit, that may be used without taking into account the economic, political and socio-cultural contexts of a country.
Jové-Llopis & Segarra-Blasco (2018)	To investigate how eco-efficiency measures affect SMEs' success in terms of sales growth.	11,336 SMEs based in 28 different European countries	Ordered Logit Model	Increased investment in eco-strategies enhances firm growth. Increased investment in eco-strategies enhances firm growth.
Hojnik, Ruzzier, & Manolova (2017)	To determine the nexus between eco-innovation and firm efficiency.	120 Slovenian enterprises	Linear Regression Analysis	More innovative MSEs are more likely to adopt eco-innovation.

Table 1 Literature on Eco-Innovation Adoption (Continued)

Author	Objective	Sample/Country	Methodology	Contribution
Maçaneiro & da Cunha (2017)	To examine how eco-innovation strategies are adopted.	81 Brazilian MSEs	Descriptive Statistics, Bartlett's Sphericity Test, Kaiser-Meyer-Olkin Test	Enterprises consider eco-innovation adoption to short-term, reactive strategies.
Martinez-Conesa, Soto-Acosta, & Palacios-Manzano (2017)	Effects of corporate social responsibility on innovation and the performance of a firm.	552 Spanish firms	Structural Equation Modelling	The findings suggest that innovation performance somewhat mediates the association between firm performance and corporate social responsibility.
Kuzman, Rajat, & Zbašnik-Senegačnik (2016)	To outline a general characterization of eco-innovation in Slovenia.	535 production and service oriented Slovenian MSE firms	Descriptive Statistics	Eco-innovation presents enterprises of Slovenia with the opportunity to create new markets.
Triguero, Moreno-Mondéjar, & Davia (2016)	To investigate what influences eco-innovation levels in European SMEs.	3852 European SMEs	Generalized Ordinal Logistic Model	The level of environmental innovation is positively impacted by the adoption of eco-organizational innovation, as well as the rising demand for green products.
Cainelli, De Marchi, & Grandinetti (2015)	To find out whether different resources need to be used to develop environmental innovations.	4829 Spanish manufacturing firms	Probit Model	For environmental innovations, internal resources are more significant.
Triguero, Moreno-Mondéjar, & Davia (2015)	To identify the pertinent eco-innovation drivers in SMEs	5.135 SMEs in Europe	Bivariate Probit Model	(1) Subsidies are only significant for small firms, particularly when adopting greener technologies. (2) For medium-sized firms, not however for smaller ones, the adoption of cleaner technologies can be attributed in large part to current environmental regulation.
Hoogendoorn, Guerra, & van der Zwan (2015)	To better understand the motivations behind SMEs' use of environmental practices and determine whether these motivations vary according on the type of practice.	8.000 SMEs across 36 countries, spread across 12 sectors.	Ordered Logit Regression	Environmental regulations that are strict encourage businesses to actively engage in environmental activities, but only when they are providing green products and services.
Cuerva, Triguero-Cano, & Córcoles (2014)	To determine the major forces driving eco-innovation in SMEs.	SME in a low-tech sector in the Spanish food and beverage Spanish firms	Bivariate Probit Models Using Simulated Maximum Likelihood	Differentiation and the use of Quality Management Systems are the only factors that explains why green innovative activities have been adopted.
Bossle (2013)	To determine the methods used by Brazilian food enterprises to integrate innovation and sustainability, and to confirm the factors that influence eco-innovation adoption.	351 Brazilian MSEs food enterprises	Descriptive Statistics	Environmental management concern has a significant direct influence on enhancing enterprises performance, as a result of the adoption of eco-innovations. Also, it acts as a mediator for other significant aspects.

Table 1 Literature on Eco-Innovation Adoption (Continued)

Author	Objective	Sample/Country	Methodology	Contribution
(Triguero, Moreno-Mondéjar, & Davia (2013)	To examine the elements influencing the various eco-innovations in European SMEs.	Database of 27 European countries	Trivariate Probit Model	For organizational innovations and environmental processes, as opposed to environmental product innovations, supply-side factors appear to be a more significant driving force.
(Zhu, Wittmann, & Peng, 2012)	To determine how innovation in SMEs, is affected by institution-based barriers.	41 SMEs in China	Cost-Risk-Opportunity Innovation Triangle	The top five institutional bottlenecks to innovation in China include (1) access to financing, (2) competition fairness, (3) laws and regulations, (4) support systems, and (5) tax burden.

Source: Prepared by the author

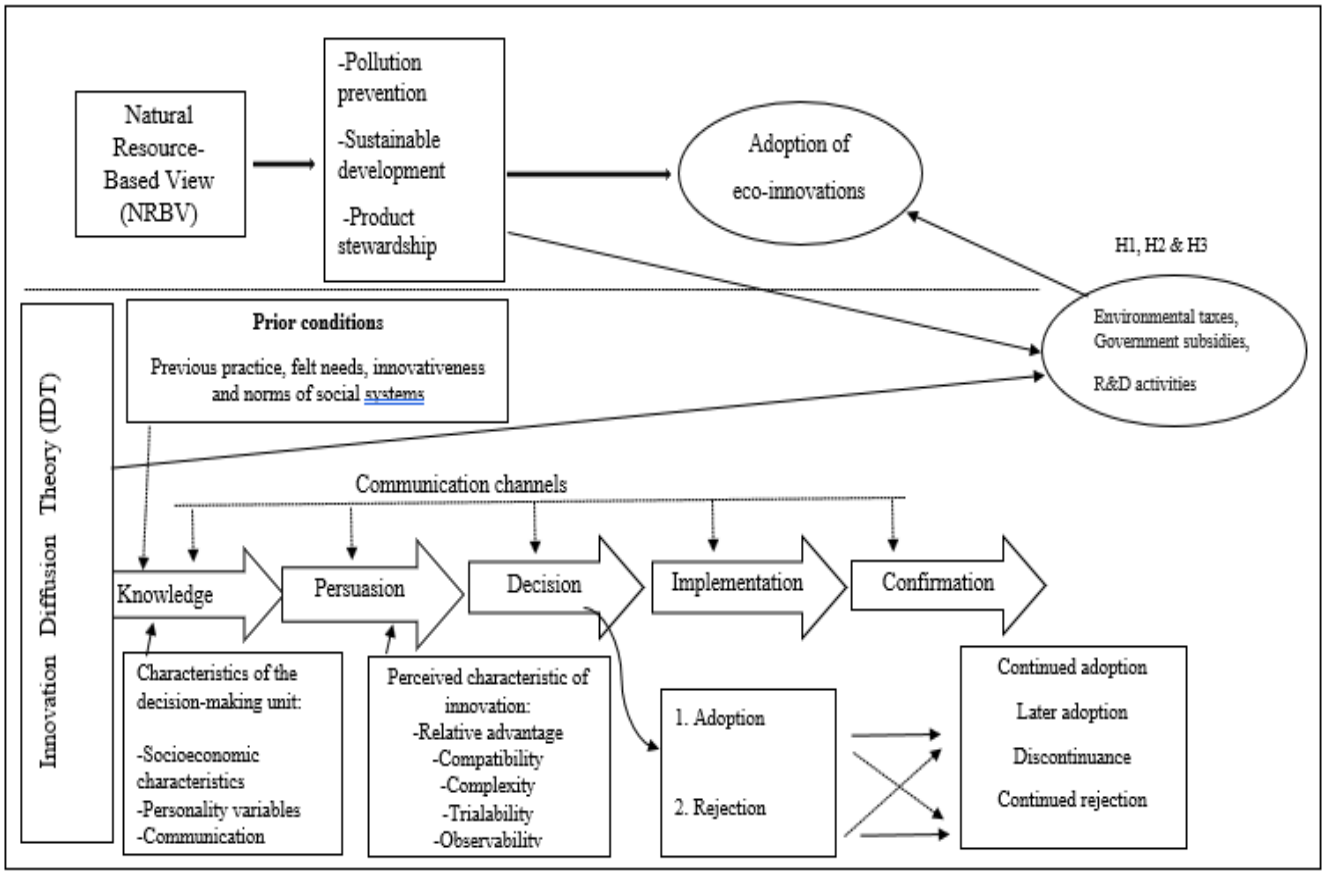

Figure 1 Theoretical Model of Eco-Innovation Adoption
Source: (Hart & Dowell, 2011; Rogers, 2003)

studies.

Despite the critical necessity of research in this area, there is a dearth of empirical information at the level of micro-economic firms (Mazzanti & Zoboli, 2005). Numerous studies on eco-innovation have been published, but few focus on how many of these innovations are in the small and medium-sized enterprise (SME) manufacturing sector (Dalvi-Esfahani, Shahbazi, & Nilashi, 2017). It is important to fully understand and assess the factors that lead manufacturing SMEs to implement eco-innovations; by doing so it will help to implement green practices and promote environmental sustainability. The existing gap in the current research on eco-innovation in MSEs and SMEs confirms the significance of the research.

The Natural Resource-Based View (NRBV) and the Innovation Diffusion Theory (IDT) are the best-known and most often used theories in eco-innovation research, thus, the research employs the NRBV framework and IDT. The NRBV asserts that pollution prevention, sustainable development, and product stewardship represent the three primary strategic capabilities that depend on numerous essential resources. Furthermore, they are impacted by several

environmental elements and benefit from a variety of sources to maintain their competitive advantage (Hart & Dowell, 2011).

Pollution prevention aims to stop waste and emissions and is linked to cheaper costs. Product stewardship provides a potential competitive edge by strategic pre-emption, for instance by obtaining exclusive use of resources (Walls, Phan, & Berrone 2008). Finally, yet importantly, a sustainable development strategy encompasses not only environmental concerns, but also those that are social and economic (Hart & Dowell, 2011).

According to Rogers (2003), diffusion is the process by which an innovation is disseminated over time and through specialised routes among members of a social system (Folorunso et al., 2009). The five fundamental stages of the decision-making process for innovation are knowledge, persuasion, decision, implementation, and confirmation (see Figure 1). The process of deciding on an innovation begins with familiarity with the innovation and continues until the stage of confirmation (Kocak, Kaya, & Erol, 2013). Each successive stage in Figure 1 is necessary for the next stage to occur. The decision stage is where firms decide whether to adopt or reject the innovation (Kitchen & Panopoulos, 2010). In conclusion, the NRBV and IDT are used as theoretical underpinnings to show the theme's importance and its unique characteristics for the development of eco-innovation literature. Thus, the availability of natural resources, advancements in technology and the demand of local consumption on global markets are criteria that eco-innovation adoption should be expanded, particularly in developing countries, like South Africa. Therefore, the research contributes to the NRBV and IDT to enhance how resources are used to improve the performance of enterprises on both the economic and environmental fronts.

Economic growth is significantly influenced by innovation. Environmental taxes are considered one of the most successful policy tools available, which OECD countries are implementing more frequently. Thus, it is crucial to look into the connection between environmentally related taxation and innovation, to fully comprehend the effects of this policy tool, as it is one of the potential aspects of "green growth" (OECD, 2010). Empirical studies show that environmental taxes have a positive influence on eco-innovation adoption (Nchofoung, Fotio, & Miamo, 2023; Sánchez & Deza, 2015; Tchorzewska, Garcia-Quevedo, & Martinez-Ros, 2022).

Hypothesis 1 (H1): Environmental taxes are positively related to the adoption of eco-innovation.

Government subsidy is one of the most important financial tools for supporting firms to transition to green development. Cao et al. (2023) point out that "government subsidies are a possible way to facilitate green transition". In addition, these subsidies encourage firms to engage in research and technology initiatives to achieve the policy objectives. Prior studies indicate that when there is a strong market demand and a government subsidy, firms are more likely to embrace proactive environmental strategies to boost eco-innovation (Sun, Tang, & Li, 2022; Tsai & Liao, 2017).

Hypothesis 2 (H2): Government subsidies are positively related to the adoption of eco-innovation.

Eco-innovation is essential to enhance the environmental performance of a firm but it requires technological capabilities, making R&D a crucial component. However, R&D activities need substantial investments, and even firms that engage heavily in internal R&D, sometimes work in collaboration with external partners to diversify the risks (Stumpf, Schöggl, & Baumgartner, 2023). Previous studies confirm that R&D spending has a beneficial effect on eco-innovation adoption (Galván-Vela et al., 2023; Guandalini, 2022).

Hypothesis 3 (H3): Research and development (R&D) activities have a positive impact on the adoption of eco-innovation.

II. METHODS

Cross-sectional research design is used to address the research question to establish what drives micro and small enterprises to adopt eco-innovation technologies. The research uses secondary data from the survey "Innovation in micro and small enterprises in Johannesburg", South Africa. The data were collected in 2022 by Sigma Kairos, a reputable independent market research firm. It included 1,021 MSEs and is the first survey of its kind in South Africa. The purpose of this survey "Innovation in micro and small enterprises in Johannesburg" was to learn more about the challenges that businesses encounter and about the environment in which they operate.

Furthermore, to analyse the data, the research uses descriptive statistics making it possible to compare, explain and describe the features of a firm in relation to the desired characteristics. Also, a probit model, which is an econometric probability model, is employed to determine the drivers of eco-innovation adoption. The probit analysis process provides estimates of effective values for different response rates.

In the research, the aim is to determine the drivers of eco-innovation adoption by MSEs. Given that the response variable is binary in nature (eco innovation adoption), it is appropriate to use a qualitative response model to address the research problem. With the use of qualitative response models, one can relate multiple independent variables to the likelihood of an event. When examining MSEs' characteristics linked to adoption choices, such models are frequently helpful (Gujarati et al., 2015).

As a way to determine the drivers of eco-innovation adoption, a probit model is used, an econometric probability model. The probit model uses two categories for the dependent variable. The values of the binary dependent variable are zero and one. The probit analysis yields statistically significant findings of the independent variables that increase or lower the likelihood of adoption (Gujarati, 2015). Following Greene (2018), the researcher specifies the econometric model as empirical strategy: probit model.

The binary probit model assumes that a latent variable y is linearly related to the observed Xs, as follows:

$$y_i^* = X_i\beta + \varepsilon_i \quad (1)$$

Where X_i is the vector of independent variables, β is a vector of parameters to be estimated, and ε_i is the error term. The relation between y^* and the observed binary dependent variable y_i can be expressed as:

$$y_i = \begin{cases} 1 & if \quad y_i^* > 0 \\ 0 & if \quad y_i^* \leq 0 \end{cases} \quad (2)$$

Where $y_i = 1$ when an enterprise i adopts an eco-innovation, $y_i = 0$ when an enterprise i does not adopt an eco-innovation. The errors of y_i^* are assumed to be normally distributed. The binary probit model is expressed as:

$$\Pr(y_i = 1) = \Phi(X_i\beta) \quad (3)$$

$$\Pr(y_i = 0) = 1 - \Phi(X_i\beta) \quad (4)$$

Where Pr determines the decision of a firm to adopt an eco-innovation, Φ is the cumulative distribution function of the standard normal variable which ensures $0 \leq p_i \leq 1$. In the probit model, the error term is assumed to be homoskedastic with a mean of 0 and a variance of 1.

When it comes to the interpretation of the link between a specific variable and the probability outcome, the marginal effect is used. Marginal effects describe how an outcome variable varies when a particular independent variable changes, holding other factors constant. The following can be used to derive the marginal effect of continuous independent variables X_k on the probability Pr(Z = 1/X).

$$\frac{\partial p_i}{\partial x_{ik}} = \emptyset(x_i\beta)\beta_k \quad (5)$$

where $\emptyset$ denotes the probability density function. In contrast to continuous variables, the marginal effect on dummy variables is calculated differently. The effect is derived from the following:

$$\Delta = \Phi(\bar{x}\beta, d = 1) - \Phi(\bar{x}\beta, d = 0) \quad (6)$$

Marginal effects aid in the interpretation of model outputs or, more specifically, model parameters. With marginal effects, estimates are obtained in the probability scale. The analysis employed statistical software STATA to calculate the marginal effects.

III. RESULTS AND DISCUSSIONS

A summary of the statistics from the survey describes the data (Table 2). From our sample, the results indicate the adoption rates are still low; approximately 93% of the enterprise owners are male, the managers' average age is 41 years, and they had an average of 14 years' experience in the sector. In addition, small and medium-sized businesses account for 31% and 6%, respectively, as the top suppliers to the enterprises.

Table 2 Descriptive Statistics

Variable	*Measurement*	*Mean*	*Std. Dev.*	*Min*	*Max*
Dependent variable					
Adoption	Dummy = 1 if the business enterprise adopted eco-innovation, 0 otherwise.	0.059	0.235	0	1
Independent variables					
Business/firm profile					
Gender	Dummy = 1 if the owner of the business is male, 0 otherwise.	0.925	0.644	0	1
Age_manager	Continuous variable indicating the age in years of the manager for the firm.	41.117	11.798	18	81
Experience	Continuous variable indicating the number of years of experience the manager has been working in the sector.	14.146	10.024	0	60
Firm_affliation	Dummy =1 if the business enterprise belongs to any business association (e.g., South African Chamber of Commerce, National Small Business Chamber, or Business Unity South Africa), 0 otherwise.	1.951	0.272	0	1
Age of the enterprise	Continuous variable showing the duration in years an enterprise has been in business.	12.856	10.470	1	91

Table 2 Descriptive Statistics (Continued)

Variable	*Measurement*	*Mean*	*Std. Dev.*	*Min*	*Max*
No. of employees	Continuous variable indicating the total number of people who worked in the business at the end of the fiscal year 2022.	4.312	3.082	1	50
Suppliers and innovation activities					
Main supplier 1	Dummy = 1 if the enterprise main suppliers are small businesses, 0 otherwise.	0.308	0.462	0	1
Main supplier 2	Dummy = 1 if the enterprise main suppliers are medium businesses, 0 otherwise.	0.064	0.244	0	1
Innovation type 1	Dummy = 1 if the business enterprise innovated by introducing entirely new products during the previous financial year (FY2022, March 2021 - February 2022).	0.358	0.480	0	0
Innovation type 2	Dummy = 1 if the business enterprise innovated by introducing significantly improved products during the previous financial year (FY2022, March 2021 - February 2022).	0.169	0.375	0	0
Innovation type 3	Dummy = 1 if the business enterprise innovated by introducing significantly entirely new services during the previous financial year (FY2022, March 2021 - February 2022).	0.021	0.142	0	0
Innovation type 4	Dummy = 1 if the business enterprise innovated by introducing significantly improved services during the previous financial year (FY2022, March 2021 - February 2022).	0.029	0.169	0	1
R&D activities	Dummy = 1 if business enterprise engaged in Research and Development (R&D) activities for innovation during the most recent fiscal year (FY2022).	0.025	0.158	0	1
Regulations and reputation					
Environmental taxes	Dummy = 1 if existing environmental taxes played a significant role in the business enterprise's decision to introduce eco-innovations between March 2019 and February 2022.	0.093	0.291	0	1
Govt. subsidies	Dummy = 1 if government subsidies for environmental innovations played a significant role in the business enterprise's decision to introduce eco-innovations between March 2019 and February 2022.	0.038	0.192	0	1
Env. Regulations	Dummy = 1 if existing environmental regulations played a significant role in the business enterprise's decision to introduce environmental innovations between March 2019 and February 2022.	0.265	0.442	0	1
Market demand	Dummy = 1 if current or expected market demand for environmental innovations played a significant role in the business enterprise's decision to introduce eco-innovations between March 2019 and February 2022.	0.012	0.108	0	1
Enterprise reputation	Dummy = 1 if improving the enterprise's reputation played a significant role in the business enterprise's decision to introduce eco-innovations between March 2019 and February 2022.	0.007	0.083	0	1

Source: Prepared by the Author

Further analysis shows that the MSEs innovated by introducing entirely new products (36%), greatly enhanced products (17%), entirely new services (2.1%) and improved services significantly (3%). Besides, we note that 2.5% of the business enterprises are involved in research and development (R&D) activities.

Finally, but not least, environmental regulations (27%) and taxes (9.3%), government subsidies (4%), market demand (1.2%), and company reputation (0.7%) all had a significant impact on the MSEs decisions to introduce eco-innovation between March 2019 and February 2022.

The findings in Table 3 show that environmental taxes, government subsidies, R&D activities, innovation of new products, innovation of improved products, and innovation of improved services are

important components in determining whether an enterprise will adopt eco-innovation. Hypothesis H1 (environmental taxes are positively related to the adoption of eco-innovation) is confirmed ($p < 0.01$) with a large effect. Environmental tax has a positive influence on eco-innovation adoption and is statistically significant at the 1% level. Based on the marginal effects, a percentage point increase in environmental tax would increase the likelihood of the business enterprise adopting eco-innovation by 18%. This is because pollution-related taxes offer polluters very clear incentives to cut back on emissions and look for cleaner alternatives. Also, the direct cost on pollution, offers enormous incentives for profit-maximising enterprises to innovate and develop greener alternatives. This is consistent with earlier studies that environmental taxes can promote eco-innovation adoption by business enterprises (Krass, Nedorezov, & Ovchinnikov, 2013; Zheng, Li, & Duan, 2023).

Hypothesis H2 (government subsidies are positively related to the adoption of eco-innovation) is supported ($p < 0.01$). Government subsidies have a positive and significant relationship with eco-innovation adoption at 1% level. According to the marginal effect, if government subsidies increase by a percentage point, there is a 12% likelihood of an enterprise adopting eco-innovation. Subsidies provide financial support to enterprises and encourage them to alter their behaviour or aid them in reducing the costs of environmental tax. The findings are consistent with those of (Ren, Sun, & Zhang, 2021; Wang et al., 2021) in which a positive result was reported between subsidies and the adoption of eco-innovation by enterprises.

Hypothesis H3 (research and development (R&D) activities have a positive impact on the adoption of eco-innovation) is supported ($p < 0.05$). There is a positive relationship between R&D activities of innovation and the adoption of eco-innovation by enterprises. According to this positive correlation, enterprises that engage in R & D activities are more likely to adopt eco-innovation by a factor of 6.2%. The probable explanation is that R&D is frequently the initial phase that an enterprise engages in the development process, and enterprise innovation may result from R&D. The innovation may lead enterprises to maximise profits and minimise costs. These results conform to those of other previous studies by Ebrahim, Ahmed, and Taha (2008). Dimakopoulou et al. (2022) and Ha, Thang, and Thanh (2022) which indicate that R&D spending activities are positively associated with eco innovation adoption.

The parameter estimates of innovation of new products, innovation of improved products, and innovation of improved services, have a positive effect on eco-innovation adoption and are statistically significant at levels of 5%, 1% and 5%, respectively. The marginal effects show that enterprises that have introduced innovation of new products, improved products, and improved services are more likely than their counterparts to adopt eco-innovation by 4.4%, 8.1%, and 9.5%, respectively. It follows that the adoption of eco-innovation is largely dependent on the successful application of non-eco-innovations by enterprises. According to Baumol (2014), "innovation breeds innovation". In other words, enterprises that invest in R&D activities and embrace non-eco-innovative activities, encourage more of eco-innovation adoption. The findings are consistent with those of Bossle et al. (2020), Pichlak and Szromek (2021), and Pujari (2006) in which a positive result was reported between non-eco-innovative activities and adoption of eco-innovations.

Table 3 Probit Regression Estimates for the Determinants of Eco-Innovation

	(1)
Variables	Marginal effects *(dy/dx)*
Gender	0.006
	(0.005)
Age of the enterprise	0.000
	(0.000)
Main supplier 1 (small businesses)	-0.006
	(0.007)
Main supplier 2 (medium businesses)	0.010
	(0.021)
Inno.1 (introduced entirely new products)	0.044**
	(0.019)
Inno.2 (significantly improved products)	0.081***
	(0.039)
Inno.3 (entirely new services)	0.059
	(0.073)
Inno.4 (significantly improved services)	0.095**
	(0.076)
R&D activities	0.062**
	(0.051)
Environmental taxes	0.181***
	(0.059)
Govt. subsidies	0.124***
	(0.065)
Env. regulations	-0.003
	(0.007)
Number of obs	*1,021*
LR chi2	*206.87*
Prob > chi2	*0.0000*
Pseudo R2	*0.4532*

Note: Standard errors appear in parentheses. The other co-efficients are marginal effects (dy/dx).

Asterisks represents level of statistical significance: *** (p ≤ 1%); **(p ≤ 5%); *(p ≤ 10%).

Source: Prepared by the author

IV. CONCLUSIONS

The purpose of the research is to find out what drives micro and small enterprises to adopt eco-innovation technologies. The empirical results show that environmental tax has a positive influence on eco-innovation adoption. The results imply that pollution-related taxes offer polluters very clear incentives to cut back on emissions and look for cleaner alternatives. Also, government subsidies have a positive and significant relationship with eco-innovation adoption. This implies that subsidies provide financial support to enterprises and aid them in reducing the costs of environmental tax. Besides, there is a positive relationship between R&D activities of innovation and the adoption of eco-innovation by enterprises. According to this positive correlation, enterprises that engage in R & D activities are more likely to adopt eco-innovation. The adoption of eco-innovation is also dependent on the successful application of non-eco-innovations (e.g., innovation of new products, innovation of improved products, and innovation of improved services) by enterprises.

The research has several implications (theoretical, managerial, and policy). On the theoretical side, using the natural resource-based view framework, the research demonstrated the importance of resources and capabilities of a firm in determining eco-innovation adoption. The results of the research further highlights the driving dynamics behind eco-innovation adoption by firms. This may assist policymakers in developing appropriate measures that would promote eco-innovation development and adoption in the economy's industrial sector.

On the managerial side, managers must realise that environmental innovations are required for businesses to become sustainable enterprises. Managers must support innovative environmental ideas to achieve this. Additionally, managers can influence the outcomes of innovation by efficient resource utilisation and providing R&D staff with the optimum framework, thereby maximising their capacity for creativity.

And last, on the policy front, policy measures should design a tax for the environment in such a way that it should ideally have the same scope as the environmental damage it is intended to repair. Also, given that environmental tax is an important toolkit in helping to lower carbon emissions and promoting green development, the pricing must provide firms with the flexibility to determine the most effective environmental "footprint" reduction strategies.

The existing body of literature has benefited theoretically by this work. For instance, the results of the research highlights the driving dynamics behind eco-innovation adoption by firms. This may assist policymakers in developing appropriate measures that would promote eco-innovation development and adoption in the economy's industrial sector.

Additionally, using the natural resource-based view framework, the research demonstrated the importance of resources and capabilities of a firm in determining eco-innovation adoption. Also, using innovation diffusion theory, the adoption of eco-innovations begins with a succession of decisions made by individual firms, many of which are the outcome of a comparison between the uncertain costs of adoption and the uncertain benefits of an innovation. Consequently, it follows that there is a need to encourage the adoption and diffusion of eco-innovations because; first, the biggest problem humanity has is how to successfully manage the environment. Second, the eco-industry is one of the fastest-growing industries globally.

Last but not least, the research substantially contributes to literature by focusing on micro and small enterprises, as opposed to large enterprises, which have typically been the subject of research. As a result, the research has provided several courses of action for policymakers as far as eco-innovation adoption is concerned.

The results of the research have implications for firm owners and/or managers. Over time, managers have come to value eco-innovation more and more. It links resource and energy conservation to economic efficiency, boosting innovation-based competition. Eco-innovation also places a strong emphasis on environmental performance, which yields cutting-edge green techniques.

Managers must realise that environmental innovations are required for businesses to become sustainable enterprises. Therefore, managers must support innovative environmental ideas to achieve this. Additionally, managers can influence the outcomes of innovation by efficient resource utilisation and providing R&D staff with the optimum framework, thereby maximising their capacity for creativity.

Furthermore, in order for enterprises to develop innovative environmental practices, managers should ensure that environmental management is integrated into their overall corporate strategy. As a result, the proactive approach of an enterprise has a significant impact on the development of eco-innovation. In fact, enterprises that employ a proactive environmental approach might acquire the skills necessary to implement eco-innovation.

Lastly, managers ought to factor environmental protection into their decision-making. In light of this, eco-innovation may serve as one of the primary catalysts for enterprises to experience sustained growth. To better understand how environmental challenges may affect and be affected by innovative enterprises strategies, it is vital for managers to expand their understanding in this area. Not taking into consideration the fact that innovations occasionally need to take into account environmental and social factors, which could cause them to shift from being a competitive advantage source to being a competitive disruption source.

The aforementioned research findings have various policy implications. First, policy measures should design a tax for the environment in such a

way that it should ideally have the same scope as the environmental damage it is intended to repair. Also, given that environmental tax is an important toolkit in helping to lower carbon emissions and promoting green development, the pricing must provide firms with the flexibility to determine the most effective environmental "footprint" reduction strategies.

Second, the findings show that factors influencing eco-innovation include government subsidies for those innovations. Therefore, policy intervention should ensure the reduction and sharing of the risk associated with investing in cutting-edge, environmentally friendly technology that may not have sufficient access to venture finance from conventional sources. Besides, subsidies ought to be created in a way that promotes the use of environmentally friendly alternatives, while discouraging the use of products with a comparatively significant risk to the environment.

Third, since R&D is a major force behind innovative business models, policymakers should directly support R&D that underpins sustainable innovation. Also, investment on environmental R&D activities is essential to reduce emissions. In addition, policies should be designed to offer financial support (both directly and indirectly) to enterprises, to prevent innovative MSEs from failing due to funding issues. Lastly, the need to prioritise investments that will help enterprises foster innovation.

Despite the current research providing some insights, it has several shortcomings. First, it is challenging to generalise the findings of the study to the greater population because they are based on a small sample of 1,021 South African enterprises. In order to safely generalise the findings, future research needs to investigate the data from more respondents. Second, the instrument applied to collect the data only considered MSEs in the city of Johannesburg. To confirm the findings, further research need to uses the same instrument in other South African cities. Third, cross-sectional data dependence of the results causes problems with the causality of the interactions between the variables. Longitudinal studies may be used in future studies to correct these problems and aid in comprehending the evolution of the factors influencing eco-innovation. Last, even though our contribution is only a first step, it also serves as a strong appeal to rigorously explore the determining factors of eco innovation adoption among MSEs.

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REFERENCES

Aboelmaged, M. (2018). Direct and indirect effects of eco-innovation, environmental orientation and supplier collaboration on hotel performance: An empirical study. *Journal of Cleaner Production, 184*, 537-549. https://doi.org/10.1016/j.jclepro.2018.02.192.

Aboelmaged, M., & Hashem, G. (2019). Absorptive capacity and green innovation adoption in SMEs: The mediating effects of sustainable organisational capabilities. *Journal of Cleaner Production, 220*, 853-863. https://doi.org/10.1016/j.jclepro.2019.02.150.

Adams, R., Jeanrenaud, S., Bessant, J., Denyer, D., & Overy, P. (2016). Sustainability-oriented innovation: A systematic review. *International Journal of Management Reviews, 18*(2), 180-205. https://doi.org/10.1111/ijmr.12068.

Almalki S. M. O., Zhuo, Z., Almalki O. M. O., Siyal, Z. A., Hashmi, H., & Shah, S. A. A. (2020). A fuzzy multi-criteria analysis of barriers and policy strategies for small and medium enterprises to adopt green innovation. *Symmetry, 12*(1), 116. https://doi.org/10.3390/SYM12010116.

Baumol, W. J. (2014). *The free-market innovation machine: Analyzing the growth miracle of capitalism.* Retrieved from https://doi.org/10.5860/choice.40-0406.

Bhorat, H., Asmal, Z., Lilenstein, K., & Van der Zee, K. (2018). *Smmes in South Africa : Understanding the constraints on growth and performance.* DPRU Working Paper 201802 July 2018. Retrieved from https://commerce.uct.ac.za/sites/default/files/content_migration/commerce_uct_ac_za/1093/files/DPRU%2520WP201802.pdf.

Bossle, M. B. (2013). *Drivers for adoption of eco-innovation and enhancement of food companies' environmental performance.* Dissertation. Retrieved from http://hdl.handle.net/10183/134085.

Bossle, M. B., Bitencourt, C. C., Froehlich, C., & Zanandrea, G. (2020). What innovation means for the adoption of eco-innovation in a chemicah company? *Revista Gestão e Desenvolvimento, 17*(2), 32-56. https://doi.org/10.25112/rgd.v17i2.2004.

Cainelli, G., De Marchi, V., & Grandinetti, R. (2015). Does the development of environmental innovation require different resources? Evidence from Spanish manufacturing firms. *Journal of Cleaner*

Production, 94, 211-220. https://doi.org/10.1016/j.jclepro.2015.02.008.

Calafat-Marzal, C., Sánchez-García, M., Marti, L., & Puertas, R. (2023). Agri-food 4.0: Drivers and links to innovation and eco-innovation. *Computers and Electronics in Agriculture, 207*, 107700. https://doi.org/10.1016/j.compag.2023.107700.

Cao, G., Fang, X., Chen, Y., & She, J. (2023). Regional big data application capability and firm green technology innovation. *Sustainability, 15*(17), 12830. https://doi.org/10.3390/su151712830.

Carchano, M., Carrasco, I., & González, Á. (2023). Eco-innovation and environmental performance: Insights from Spanish wine companies. *Annals of Public and Cooperative Economics,* 1-29. https://doi.org/10.1111/apce.12421.

Castellano, R., Punzo, G., Scandurra, G., & Thomas, A. (2022). Exploring antecedents of innovations for small- and medium-sized enterprises' environmental sustainability: An interpretative framework. *Business Strategy and the Environment, 31*(4), 1730-1748. https://doi.org/10.1002/bse.2980.

Ceptureanu, S. I., Ceptureanu, E. G., Popescu, D., & Orzan, A. (2020). Eco-innovation capability and sustainability driven innovation practices in Romanian SMEs. *Sustainability 12*(17), 7106. http://dx.doi.org/10.3390/su12177106.

Costantini, V., Crespi, F., & Palma, A. (2017). Characterizing the policy mix and its impact on eco-innovation: A patent analysis of energy-efficient technologies. *Research Policy, 46*(4), 799-819. https://doi.org/10.1016/j.respol.2017.02.004.

Cuerva, M. C., Triguero-Cano, Á., & Córcoles, D. (2014). Drivers of green and non-green innovation: Empirical evidence in Low-Tech SMEs. *Journal of Cleaner Production, 68*, 104-113. https://doi.org/10.1016/j.jclepro.2013.10.049.

da Silva, A. R., Cirani, C. B. S., Serra, F. A. R., Pigola, A., da Costa, P. R., Scafuto, I. C., Ruas, R. L., & Mazieri, M. R. (2023). Determining factors on green innovation adoption: An empirical study in Brazilian agribusiness firms. *Sustainability (Switzerland), 15*(7), 6266. https://doi.org/10.3390/su15076266.

Dalvi-Esfahani, M., Shahbazi, H., & Nilashi, M. (2017). Modeling the drivers of eco-innovation adoption within Iranian manufacturing small and medium-sized enterprises. *International Journal of Applied Operational Research, 7*(2), 13-41.

Dangelico, R. M., Pujari, D., & Pontrandolfo, P. (2017). Green product innovation in manufacturing firms: A sustainability-oriented dynamic capability perspective. *Business Strategy and the Environment, 26*(4), 490-506. https://doi.org/10.1002/bse.1932.

Dimakopoulou, A. G., Chatzistamoulou, N., Kounetas, K., & Tsekouras, K. (2022). Environmental innovation and R&D collaborations: Firm decisions in the innovation efficiency context. *Journal of Technology Transfer, 48*, 1176-1205. https://doi.org/10.1007/s10961-022-09963-9.

Doran, J., & Ryan, G. (2016). The importance of the diverse drivers and types of environmental innovation for firm performance. *Business Strategy and The Environment, 25*(2), 102-119. https://doi.org/10.1002/bse.1860.

Ebrahim, N. A., Ahmed, S., & Taha, Z. (2008). Virtual environments innovation and R&D activities: Management challenges. *Proceedings of the International Graduate on Engineering and Science (IGCES'08)*.

Folorunso, O., Vincent, R. O., Adekoya, F. A., & Ogunde, A. O. (2009). Diffusion of innovation in social networking sites among university students. *International Journal of Computer Science and Security, 4*(3), 361-372.

Furawo, T., & Scheepers, C. A. (2018). Factors impacting innovative capacity of small- and medium-sized enterprises in Cape Town. *Journal of Management and Administration, 2018*(2), 31-59.

Galván-Vela, E., Ruíz-Corrales, M., Ahumada-Tello, E., & Ravina-Ripoll, R. (2023). Eco-innovation as a positive and happy industry externality: Evidence from Mexico. *Sustainability (Switzerland), 15*(8), 6417. https://doi.org/10.3390/su15086417.

Gąsior, A., Grabowski, J., Ropęga, J., & Walecka, A. (2022). Creating a competitive advantage for micro and small enterprises based on eco-innovation as a determinant of the energy efficiency of the economy. *Energies, 15*(19), 9695. https://doi.org/10.3390/en15196965.

Ghisetti, C., & Quatraro, F. (2017). Green technologies and environmental productivity: A cross-sectoral analysis of direct and indirect effects in Italian regions. *Ecological Economics, 132*, 1-13. https://doi.org/10.1016/j.ecolecon.2016.10.003.

Greene, W. H. (2018). *Econometric analysis* (8th Ed.). New York, USA: Pearson, The Stern School of Business, New York University.

Guandalini, I. (2022). Sustainability through digital transformation: A systematic literature review for research guidance. *Journal of Business Research, 148*, 456-471. https://doi.org/10.1016/j.jbusres.2022.05.003.

Gujarati, D. (2015). Panel data regression models. In *Econometrics* (pp. 326-343). https://doi.org/10.1007/978-1-137-37502-5_17.

Gujarati, D. N., & Porter, D. C. (2015). *Dasar-dasar ekonometrika (basic econometrics).* Translated by Mardanugraha, E., Warhani, S., & Mangusong, C. Jakarta: Salemba Empat.

Ha, L. T., Thang, D. N., & Thanh, T. T. (2022). Effects of R&D, networking and leadership roles on environmental innovation adoption in Vietnam's SMEs. *Economic Research-Ekonomska Istrazivanja, 35*(1), 1211-1242. https://doi.org/10.1080/1331677X.2021.1962381.

Hart, S. L., & Dowell, G. (2011). A natural-resource-based view of the firm: Fifteen years after. *Journal of Management, 37*(5), 1464-1479. https://doi.org/10.1177/0149206310390219.

Hojnik, J., Ruzzier, M., & Manolova, T. (2017). Eco-

innovation and firm efficiency: Empirical evidence from Slovenia. *Foresight and STI Governance, 11*(3), 103-111. https://doi.org/10.17323/2500-2597.2017.3.103.111.

Hoogendoorn, B., Guerra, D., & van der Zwan, P. (2015). What drives environmental practices of SMEs? *Small Business Economics, 44*(4), 759-781. https://doi.org/10.1007/s11187-014-9618-9.

Jové-Llopis, E., & Segarra-Blasco, A. (2018). Eco-efficiency actions and firm growth in European SMEs. *Sustainability (Switzerland), 10*(1), 1-26. https://doi.org/10.3390/su10010281.

Jun, W., Ali, W., Bhutto, M. Y., Hussain, H., & Khan, N. A. (2021). Examining the determinants of green innovation adoption in SMEs: A PLS-SEM approach. *European Journal of Innovation Management, 24*(1), 67-87. https://doi.org/10.1108/EJIM-05-2019-0113.

Kiefer, C. P., González, P. D. R., & Carrillo-Hermosilla, J. (2019). Drivers and barriers of eco-innovation types for sustainable transitions: A quantitative perspective. *Business Strategy and the Environment, 28*(1), 155-172. https://doi.org/10.1002/bse.2246.

Kitchen, P. J., & Panopoulos, A. (2010). Online public relations: The adoption process and innovation challenge, a Greek example. *Public Relations Review, 36*(3), 222-229. https://doi.org/10.1016/j.pubrev.2010.05.002.

Kocak, N. G. N., Kaya, S., & Erol, E. (2013). Social media from the perspective of diffusion of innovation approach. *The Macrotheme Review, 2*(3), 22-29.

Krass, D., Nedorezov, T., & Ovchinnikov, A. (2013). Environmental taxes and the choice of green technology. *Production and Operations Management, 22*(5), 1035-1055. https://doi.org/10.1111/poms.12023.

Kuzman, M. K., Rajat, P., & Zbašnik-Senegačnik, M. (2016). A preliminary characterization of eco-innovators and eco-designers in Slovenia. *Drvna Industrija, 67*(3), 166918. https://doi.org/10.5552/drind.2016.1546.

Lukhele, N., & Soumonni, O. (2021). Modes of innovation used by SMMEs to tackle social challenges in South Africa. *African Journal of Science, Technology, Innovation and Development, 13*(7), 829-837. https://doi.org/10.1080/20421338.2020.1834960

Maçaneiro, M. B., & da Cunha, S. K. (2017). Adoption of eco-innovation strategies in Brazilian chemical industry. *Revista de Administração Faces Journal, 16*(2), 46-59. https://doi.org/10.21714/1984-6975FACES2017V16N2ART3885.

Machiba, T. (2012). The future of eco-innovation: The role of business models in green transformation. OECD Background Paper, in *Proceedings of the OECD/European Commission/Nordic Innovation Joint Workshop*, 1-27. Retrieved from http://www.oecd.org/innovation/inno/49537036.pdf.

Martinez-Conesa, I., Soto-Acosta, P., & Palacios-Manzano, M. (2017). Corporate social responsibility and its effect on innovation and firm performance: An empirical research in SMEs. *Journal of Cleaner Production, 142*(4), 2374-2383. https://doi.org/10.1016/j.jclepro.2016.11.038.

Matekenya, W., & Moyo, C. (2022). Innovation as a driver of SMME performance in South Africa: A quantile regression approach. *African Journal of Economic and Management Studies, 13*(3), 452-467. https://doi.org/10.1108/AJEMS-06-2021-0306.

Mazzanti, M., & Zoboli, R. (2005). The drivers of environmental innovation in local manufacturing systems. *Environmental Sociology, 22*(3), 1-33.

Melander, L. (2018). Customer and supplier collaboration in green product innovation: External and internal capabilities. *Business Strategy and the Environment, 27*(6), 677-693. https://doi.org/10.1002/bse.2024.

Mendoza, X. L. D., Tadeo, J. B., Basanes, J. A., Jimenez, J. M., & Serrano, L. V. T. (2023). The implementatıon of green actıvıtıes among mıcro and small enterprıses: A factor analysıs approach. *Asian Journal of Management Entrepreneurship and Social Science, 3*(2), 15-35. http://dx.doi.org/10.13140/RG.2.2.10017.07523.

Nchofoung, T. N., Fotio, H. K., & Miamo, C. W. (2023). Green taxation and renewable energy technologies adoption: A global evidence. *Renewable Energy Focus, 44*, 334-243. https://doi.org/10.1016/j.ref.2023.01.010.

OECD. (2019). *SMEs: Key drivers of green and inclusive growth*. Retrieved from https://www.oecd.org/greengrowth/GGSD_2018_SME%20Issue%20Paper_WEB.pdf.

OECD. (2010). *Taxation, innovation and the environment.* Retrieved from https://doi.org/10.1787/9789264087637-en.

Ooi, S. K., Ooi, C. A., & Memon, K. R. (2020). The role of CSR oriented organisational culture in eco-innovation practices. *World Review of Entrepreneurship Management and Sustainable Development, 16*(5), 538-556. http://dx.doi.org/10.1504/WREMSD.2020.10032785.

Passaro, R., Quinto, I., Scandurra, G., & Thomas, A. (2022). The drivers of eco-innovations in small and medium-sized enterprises: A systematic literature review and research directions. *Business Strategy and the Environment, 32*(4), 1432-1450. https://doi.org/10.1002/bse.3197.

Peng, X., & Liu, Y. (2016). Behind eco-innovation: Managerial environmental awareness and external resource acquisition. *Journal of Cleaner Production, 139*, 347-360. https://doi.org/10.1016/j.jclepro.2016.08.051.

Pichlak, M., & Szromek, A. R. (2021). Eco-innovation, sustainability and business model innovation by open innovation dynamics. *Journal of Open Innovation: Technology, Market, and Complexity, 7*(2), 1-15. https://doi.org/10.3390/joitmc7020149.

Pujari, D. (2006). Eco-innovation and new product development: understanding the influences on market performance. *Technovation,*

26(1), 76-85. https://doi.org/10.1016/J.TECHNOVATION.2004.07.006.

Ren, S., Sun, H., & Zhang, T. (2021). Do environmental subsidies spur environmental innovation? Empirical evidence from Chinese listed firms. *Technological Forecasting and Social Change, 173*, 121123. https://doi.org/10.1016/j.techfore.2021.121123.

Rogers, E. M. (2003). *Diffusion of innovations* (5th Edition). New York: Free Press.

Sánchez, Á. P., & Deza, X. V. (2015). Environmental policy instruments and eco-innovation: An overview of recent studies. *Innovar, 25*(58), 65-80. https://doi.org/10.15446/innovar.v25n58.52426.

Seth, D., Rehman, M. A. A., & Shrivastava, R. L. (2018). Green manufacturing drivers and their relationships for small and medium (SME) and large industries. *Journal of Cleaner Production, 198*, 1381-1405. https://doi.org/10.1016/j.jclepro.2018.07.106.

Stumpf, L., Schöggl, J. P., & Baumgartner, R. J. (2023). Circular plastics packaging – Prioritizing resources and capabilities along the supply chain. *Technological Forecasting and Social Change, 188*, 122261. https://doi.org/10.1016/j.techfore.2022.122261.

Sun, X., Tang, J., & Li, S. (2022). Promote green innovation in manufacturing enterprises in the aspect of government subsidies in China. *International Journal of Environmental Research and Public Health, 19*(13), 7864. https://doi.org/10.3390/ijerph19137864.

Tang, M., Walsh, G., Lerner, D., Fitza, M. A., & Li, Q. (2018). Green innovation, managerial concern and firm performance: An empirical study. *Business Strategy and the Environment, 27*(1), 39-51. https://doi.org/10.1002/bse.1981.

Tchorzewska, K. B., Garcia-Quevedo, J., & Martinez-Ros, E. (2022). The heterogeneous effects of environmental taxation on green technologies. *Research Policy, 51*(7), 104541. https://doi.org/10.1016/j.respol.2022.104541.

Thomas, A., Scandurra, G., & Carfora, A. (2022). Adoption of green innovations by SMEs: an investigation about the influence of stakeholders. *European Journal of Innovation Management, 25*(6), 44-63. https://doi.org/10.1108/EJIM-07-2020-0292.

Triguero, A., Moreno-Mondéjar, L., & Davia, M. A. (2013). Drivers of different types of eco-innovation in European SMEs. *Ecological Economics, 92*, 25-33. https://doi.org/10.1016/j.ecolecon.2013.04.009.

Triguero, A., Moreno-Mondéjar, L., & Davia, M. A. (2015). Eco-innovation by small and medium-sized firms in Europe: From end-of-pipe to cleaner technologies. *Innovation: Management, Policy and Practice, 17*(1), 24-40. https://doi.org/10.1080/14479338.2015.1011059.

Triguero, A., Moreno-Mondéjar, L., & Davia, M. A. (2016). Leaders and laggards in environmental innovation: An empirical analysis of SMEs in Europe. *Business Strategy and the Environment, 25*(1), 28-39. https://doi.org/10.1002/bse.1854.

Tsai, K. H., & Liao, Y. C. (2017). Sustainability strategy and eco-innovation: A moderation model. *Business Strategy and the Environment, 26*(4), 426-437. https://doi.org/10.1002/bse.1926.

Valdez-Juárez, L. E., & Castillo-Vergara, M. (2021). Technological capabilities, open innovation, and eco-innovation: Dynamic capabilities to increase corporate performance of SMEs. *Journal of Open Innovation: Technology, Market, and Coplexity, 7*(1), 1-19. https://doi.org/10.3390/joitmc7010008.

Walls, J. L., Phan, P. H., & Berrone, P. (2008). *Assessment of the construct validity of environmental strategy measures*. Ross School of Business Working Paper Series No. 1105. Retrieved from http://ssrn.com/abstract=1133585.

Wang, P., Dong, C., Chen, N., Qi, M., Yang, S., Nnenna, A. B., & Li, W. (2021). Environmental regulation, government subsidies, and green technology innovation—a provincial panel data analysis from china. *International Journal of Environmental Research and Public Health, 18*(22), 11991. https://doi.org/10.3390/ijerph182211991.

Zheng, Q., Li, J., & Duan, X. (2023). The impact of environmental tax and R&D tax incentives on green innovation. *Sustainability (Switzerland), 15*(9), 7303. https://doi.org/10.3390/su15097303.

Zhu, Y., Wittmann, X., & Peng, M. W. (2012). Institution-based barriers to innovation in SMEs in China. *Asia Pacific Journal of Management, 29*(4), 1131-1142. https://doi.org/10.1007/s10490-011-9263-7.