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The Effect of Eco-innovation on Environmental Performance in Manufacturing Industries

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Abstract

This article assesses the effect of eco-innovative activities in manufacturing industries. Its study employed a mixed-methods approach by gathering, analysing, and mixing quantitative and qualitative methods. Thirty-nine (39) manufacturing industries participated in the study. These were identified using a non-probability sampling method, specifically a purposive sampling technique. The convergent parallel design was employed to collect, analyse, and integrate qualitative and quantitative data and results simultaneously. Minitab® version 21, Microsoft® Excel 2016, and SPSS® software collaboratively analysed all the gathered data. Both inferential and descriptive analyses were conducted to achieve the results for the main research question. The findings reveal that the technological factor that ranked the highest (62%) was the unavailability of technology for specific applications. This shows a need to invest in eco-innovation throughout the manufacturing industries. The findings also indicate crucial environmental performance indicators: developing products with the least waste, performing environmental improvement programmes, reducing solid and liquid waste, and tracking products that reduce waste. Furthermore, the findings show that approximately 53.8% of industries should replace materials with less polluting/harmful alternatives. The study is vital to government policy-makers in understanding the impact of environmental regulation on eco-innovation and environmental performance. It also provides information to the assessed manufacturing industries to adjust to the standards required for eco-innovation in facilitating positive environmental performance.

Keywords: *environment, eco-innovation, environmental performance, sustainable development, manufacturing industries, Tanzania.*

1. Introduction

Innovative economic growth paths and awareness of country-specific technology problems are critical for ecologically sustainable economic development (Lopes Santos et al., 2019; Pamba & Taifa, 2024). The innovation process, deeply embedded in the principles of sustainable development, has been widely recognised as a pivotal factor in this particular context (Sanni, 2018). The outcomes of such an innovation process are called eco-innovation

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(ibid.). Eco-innovation is defined as "… the production, assimilation or exploitation of a product, production process, service or management or business methods that are novel to the firm or organisation, and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resource use (including energy use) compared to relevant alternatives" (Kemp & Pearson, 2008). Eco-innovation is regarded as green or sustainable development innovation; encompassing production processes, research and development (R&D), new services, and new products (Pujari, 2006; de Jesus et al., 2021). It also involves creating new products, developments or services that provide value to customers and businesses while reducing environmental consequences considerably (Kaenzig & Wüstenhagen, 2010; Athuman et al., 2024). Under the auspices of the World Commission on Environment and Development, sustainable development is defined as "… the ability of present generations to satisfy their requirements without jeopardising future generations' ability to meet theirs" (Pujari, 2006).

Eco-innovation involves the development of products or processes that contribute to sustainability and provide value to customers and businesses alike (Costantini et al., 2017; Zhang et al., 2019; Taifa, Hayes, et al., 2021; Taifa, 2021). The concept of eco-innovation emerges when practices in the manufacturing industries are harmonised with the environment's expectations, including monitoring the amount of greenhouse gas emissions during production, and reducing solid and liquid waste (Fernando & Wah, 2017). Thus, eco-innovation implies new concepts, behaviours, products and processes that lessen environmental burden (Rennings, 2000; Buhl et al., 2016). Although factors such as global agreements, market conditions, advanced regulations, and technologies play key roles in advocating for eco-friendly investment (Sardianou et al., 2022), manufacturing industries are yet to be eco-innovative in most developing countries (Jayakrishna & Raj, 2022), Tanzania included.

Delmas and Blass (2010) categorised three types of environmental performance. The first category is the effects of emissions and energy use on the environment; while the second category includes achieving regulatory compliance, which includes operations such as installing a treatment system and a recycling facility. The third category of environmental performance is evident from a different perspective in the organisational processes and capital expenditures. It is logically deduced that factors that mediate or influence the choice of eco-innovative activities in manufacturing are still unclear. Subsequently, manufacturing industries must consider efficiency in resource utilisation, recycling pollution, and waste and emissions reduction to promote a positive environmental performance (Seman et al., 2019). In Zambia, Costantini et al. (2017) observed that eco-innovation directly decreases environmental effects of production, forming an indirect positive environmental effect via inter-market transactions. Hence, with eco-innovation implementation, manufacturing industries are expected to comply with government regulations in terms of waste disposal; avoid negative health and safety effects to neighbours, employees and consumers; reduce environmental-related follow-up cost of products; reduce environmental risks; increase the environmental reputation; and increase transparency and credibility.

Although extensive research on eco-innovation globally exists, the topic is yet to be well-captured in developing economies, especially in its dynamics (Buzohera, 2024). In Tanzania, especially, the dearth of robust eco-innovative activities and initiatives has escalated environmental degradation resulting from its industrial operations, and thus, it needs due attention to implement policies that foster eco-innovation to address the challenges as recommended by the World Bank (2019). Moreover, rapid industrialization has increased pollution levels, natural resource depletion, and ecosystem degradation: all of which significantly threaten Tanzania's public health and ecological balance (Buzohera, 2024). Generally, implementing eco-innovation activities in Tanzania is still hindered by numerous factors, including short-term costs, limited demand, technology issues, firm awareness, inadequate enforcement, and unknown rewards (Tumaini, 2021). Buzohera (2024) also conducted a study analysing the determinant factors for eco-innovation implementation in Tanzania, and concluded that external and internal factors must be considered to implement eco-innovation effectively. These factors include the availability of adequate financial resources, active engagement of internal and external stakeholders in environmental innovation, and investments in research and development activities related to environmental issues.

Few African countries demonstrate a good gross domestic product (GDP), or gross domestic expenditure on R&D (GERD) ratio. For example, through research on developing and developed countries globally, only one African country (i.e., Tunisia) scored at least one per cent. None of the twenty-five countries worldwide included any African country as per the Global Innovation Index (GII) of 2016. Similarly, South Africa seemed to have better eco-innovation policies for the manufacturing industries (Moses, 2017). Gault et al. (2016) reported that, although the African Union established the ten-year Science, Technology and Innovation Strategy for Africa (STISA-2024), nonetheless the STISA-2024 document does not consist of eco-innovation as it prioritises the environmental component that concentrates on protecting the environment, including climate change. Notably, there are huge opportunities for eco-innovation practices that are well-supported by initiatives that show implementable policies. Therefore, Tanzania's industrialisation program must include systems for tapping into industrial-economic contributions, while considering their ecological (environmental) footprint.

It is also important to consider innovation in industrial operations in developing environmentally friendly goods; thus, practitioners should consider eco-innovation practices (Fernando & Wah, 2017). In this regard, Ekins (2010) suggests that eco-innovation involves creating, adopting, or using a new product, service, process, or management and business strategy. This means that eco-innovation practices should strive to prevent or significantly minimise environmental pollution, risk and other negative effects of resource utilisation throughout its lifespan, including energy. Moreover, the components of innovation capacity include technology, cross-functional collaboration, and market focus. Likewise, the key drivers of eco-innovation are regulation, cross-functional coordination, technology, supplier engagement, and market emphasis (Fernando & Wah, 2017).

Developing and implementing integrated sustainable practices to enable environmental performance is paramount because manufacturing industries account for nearly 61% of the world's natural resources and waste generation (Maxwell et al., 2006). García-Granero et al. (2018) also emphasised the significance of sustainable practices. García-Granero et al. (2018) emphasised that eco-innovation has a direct relationship with eco-marketing innovation (EMI) because clients like to acquire eco-innovative items in which their purchasing decision is influenced by pricing, quality, delivery, and green industry's image. However, García-Granero et al. (2018) did not cover all aspects of eco-innovation that the processing and manufacturing industries should address, thus indicating a research gap to be addressed. In fact, implementing eco-innovation in the manufacturing industries can potentially reduce carbon emissions, increase financial performance, and promote a healthy ecosystem as pointed out by Lee and Min (2015). Buhl et al. (2016) also stated that eco-innovation enhances waste reduction and emissions, and promotes customer satisfaction. Dong et al. (2014) also found that eco-organisation in China -- including eco-process, product and end-of-pipe innovation -- directly impacts the reduction of environmental pressure.

Generally, the extent to which eco-innovation practices account for a healthy ecosystem and the challenges that such industries face have been demonstrated by several researchers, including Buzohera (2024), Maxwell et al. (2006) and García-Granero et al. (2018), to mention a few. Maxwell et al. (2006) demonstrated the manufacturing industries' resource consumption and waste generation. Likewise, García-Granero et al. (2018) studied industrial eco-marketing innovations in Nigeria, while Hoffman and Ehrenfeld (2017) reported the sustainability of processing companies.

It is evident from all the foregoing that literature on the effect of eco-innovation on environmental performance is still scarce, particularly on products that directly impact the environment, such as consumable goods. Moreover, manufacturing industries in developing countries, including those in Tanzania, have inadequately addressed the issue of developing clear frameworks and models to effectively implement eco-innovation activities, and assess their impact on environmental performance. Thus, this is the research gap that this study addresses: to assess the effect of eco-innovation on environmental performance from the perspective of manufacturing industries.

Hence, the following research questions were addressed to assess the effect of eco-innovative activities on the environmental performance of manufacturing industries:

a) What are the eco-innovative activities in manufacturing industries that enhance environmental performance?
b) To what extent are eco-innovative activities implemented in manufacturing industries?
c) What are the challenges hindering manufacturing industries from being eco-innovative?

With regard to the research questions and a thorough examination and analysis of prior research, a conceptual framework for assessing eco-innovation on environmental performance is constructed and depicted in Figure 1.

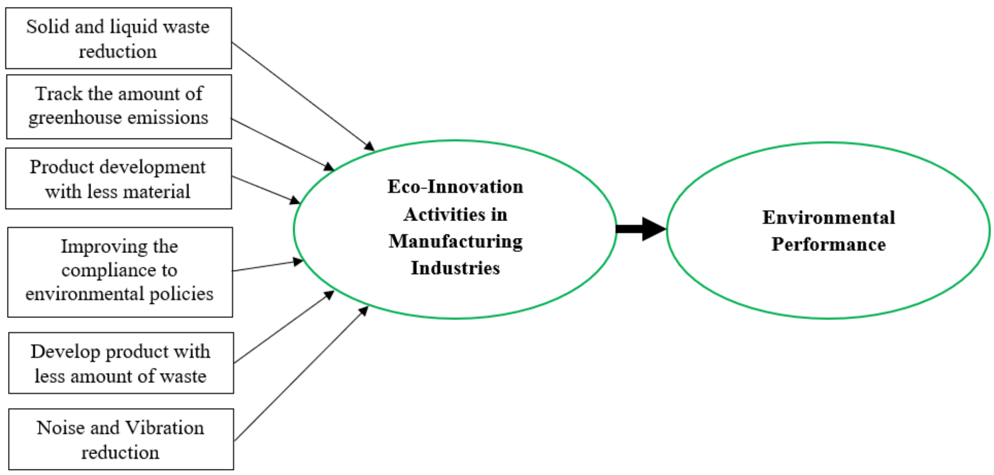


Figure 1: Conceptual Framework for Eco-innovation on Environmental Performance
Source: Author

As indicated in Figure 1, implementing eco-innovation activities in manufacturing industries—including (but not limited to) solid and waste reduction, i.e., scrap, contaminated water, and acidic water from the process—

would drastically impact the surroundings. Manufacturing industries could also install a system that tracks the amount of greenhouse emissions and notify responsible technical teams in real-time using advanced technologies such as the Internet of Things (IoT) to take measures. Manufacturing industries could also develop products with less waste, especially by ensuring that the waste produced is recycled, thereby reducing the amount of waste dumped in the environment (Shen & Zhang, 2023). All these eco-innovative activities, if carefully implemented, eventually promote environmental performance.

3. Material and Methods

The study employed a mixed-method approach to collect data and analyse the results. To capitalise on the advantages of both qualitative and quantitative data, the approach was used to generate sufficient data to expand and elaborate the study's problem (Creswell & Plano Clark, 2011; Kivunja & Kuyini, 2017). The approach is useful in integrating the two data forms to obtain more information and evidence from the study's sample. In this study, the approach was also particularly helpful in understanding the effects of eco-innovation in manufacturing industries on environmental performance within the selected companies. The convergent parallel design was employed to collect, analyse, and integrate qualitative and quantitative data and results simultaneously. In this case, both strands were conducted concurrently, but independently. The study was conducted in Dar es Salaam because it is the economic hub of Tanzania, which has a large population. Also, as specified in the censor of industrial production, the region is highly industrialized; with the largest number of manufacturing establishments, accounting for nearly 15.1% of Tanzania's mainland (UNIDO, 2017). Also, there is limited literature regarding eco-innovation's effect on environmental performance, especially for products that directly impact the environment, i.e., consumable goods. Therefore, the targeted population for this study were the manufacturing industries dealing with consumer goods.

Moreover, equation (1) was employed to calculate the sample size for the study's unknown population (Taherdoost, 2017; Maganga & Taifa, 2022):

$$n = \frac{p(1-p) * Z^2}{e^2} \qquad (1)$$

Whereby n is the needed sample size, p is the proportion occurrence of a condition, e is the needed marginal error, and Z is the corresponding value of the significance level of confidence required.

The percentage of a sample having a characteristic (p) is 10%, with a confidence interval of 90% (Z = 1.645), and a marginal error (e) of 10%. Substituting these values into equation (1) yields 25 as the sample size. However, because Dar es Salaam is highly populated with manufacturing industries, and thus the need for reliable results, a total of 39 manufacturing industries were involved in this study. In the data collection phase, a closed-ended questionnaire was used to gain insights and a deeper understanding of the research problem. The questionnaire was divided into sections to obtain demographic information about the study respondents, eco-innovative activities in industries that improve environmental performance, the extent to which eco-innovation impacts environmental performance, and the challenges preventing industries from being eco-innovative. In addition, one questionnaire was provided to each manufacturing industry to be filled out by respondents working in the environmental department, research and development personnel, and top management personnel based on their experience, position, and eco-innovation knowledge.

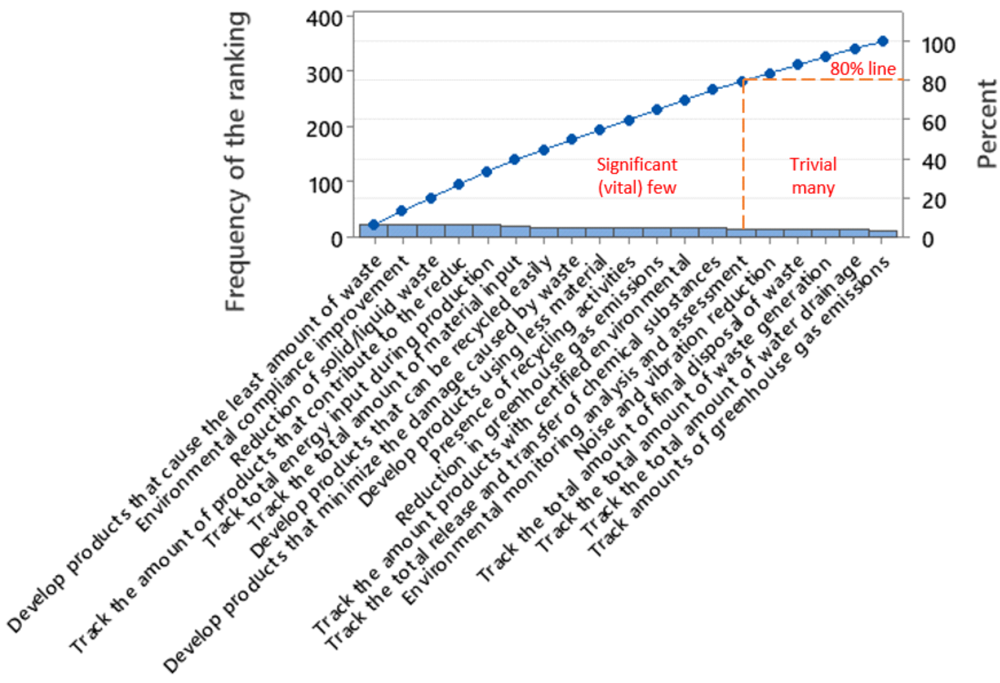
Furthermore, to effectively analyse data, the researchers systematically and logically organised the collected data to facilitate the analysis process using qualitative data analysis techniques. Minitab® (version 21), Microsoft® Excel 2016, and SPSS® software packages collaboratively analysed all the gathered data. The software packages were deliberately employed to analyse the respondents' demographic information, i.e., descriptive analysis, analysis of the eco-innovative activities in manufacturing industries, and the analysis of the implementation challenges. Moreover, the questionnaire's validity, reliability, and readability were tested. The research deployed a clean dataset, face validity, and content validity to establish the validity of the data to be collected and systematically analysed (Bolarinwa, 2015). To determine the reliability, this study computed Cronbach's Alpha (α) (homogeneity or internal consistency) (Nchalala et al., 2023). The SPSS software was used to compute the Cronbach's Alpha value.

4. Results and Discussion

A Cronbach's Alpha value was computed to measure the internal consistency of the closed-ended questionnaire (Leung, 2015). As per Lewis-Beck et al. (2011), a reliability of at least 0.7 is required for the used questionnaire and obtained results to be valid (Nchalala et al., 2023). During the computation, the questionnaire items were entered into the SPSS software, with each item being placed in a separate column, and the respondents' answers in separate rows. The analysis was done, and the Cronbach's Alpha for the study was 0.9725, which showed higher internal consistency (Lewis-Beck et al., 2011). With the higher internal consistency of the questionnaire, the respondents' demographic information in the visited manufacturing industries was as follows. Male participants who were representing their companies during the study were 33 (93%), and females were 6 (7%). In the case of years of experience, twelve (12) participants had less than one year, six (6) had between 1 to 3 years' experience, three (3) had experience of 4 to 5 years, and eighteen (18) had experience of more than five years.

The results further showed that respondents with high school/diploma/full technician certificate (FTC) were 3, 36 had bachelor's degrees, and none had a master's degree or PhD. The age range was as follows: 18–25 years (15), 26–35 years (18), 36–45 years (6), and no respondents had 46–55 and above years. This demographic information indicates that men were more readily available to respond than females, probably because they were more employed in the manufacturing industries than women, following the nature of the jobs within the industries. It is also evident that the young generation, aged around 18 to 35 years, are employed in the manufacturing industries.

Moreover, the respondents identified several eco-innovation activities in the manufacturing industries. These activities were further analysed by ranking them according to their impact on environmental performance, according to the Pareto principle (Taifa, 2016). As indicated in Figure 2, the significant indicators for environmental performance include developing products that cause the least waste, and improving environmental compliance to monitor and assess the environment. This implies that when manufacturing companies plan to reduce various environmental-related waste, they should consider all highlighted indicators in Figure 2. However, if a company has more resources, it can also consider the many trivial indicators shown in Figure 2.



Frequency	24	24	24	24	24	21	18	18	18	18	18	18	18	15	15	15	15	15	12
Percent	7	7	7	7	7	6	5	5	5	5	5	5	5	4	4	4	4	4	3
Cum %	7	14	20	27	34	40	45	50	55	60	65	70	75	80	84	88	92	97	100

Figure 2: Environmental Performance Indicators

To establish the extent to which eco-innovation activities are implemented in manufacturing industries—which eventually influences environmental performance—respondents were also asked to respond on the level or status of implementing the identified activities, ranging from 'not implemented' to 'fully implemented'. This was done using a 5-Likert scale: 'not implemented' (1); 'planning stage' (2); 'partially implemented' (3); 'close to completion' (4); and 'fully implemented' (5).

As indicated in Figure 3, as regards lowering material consumption per unit of produced products, 7.7% of the responses showed that their industries had not lowered the material consumption per unit of produced products; 7.7% said that they were at the planning stage, 46.2% indicated that the industry had partially implemented eco-innovation, 23.1% said that this was close to completion, and 15.4% indicated that this had fully been implemented. Regarding the use of cleaner process technology for the produced products, the results were as follows: 23.1% – fully implemented; 15.4% – close to completion; 53.8% – partially implemented and 7.7% – planning stage. None of the respondents indicated that eco-innovation implementation had not started.

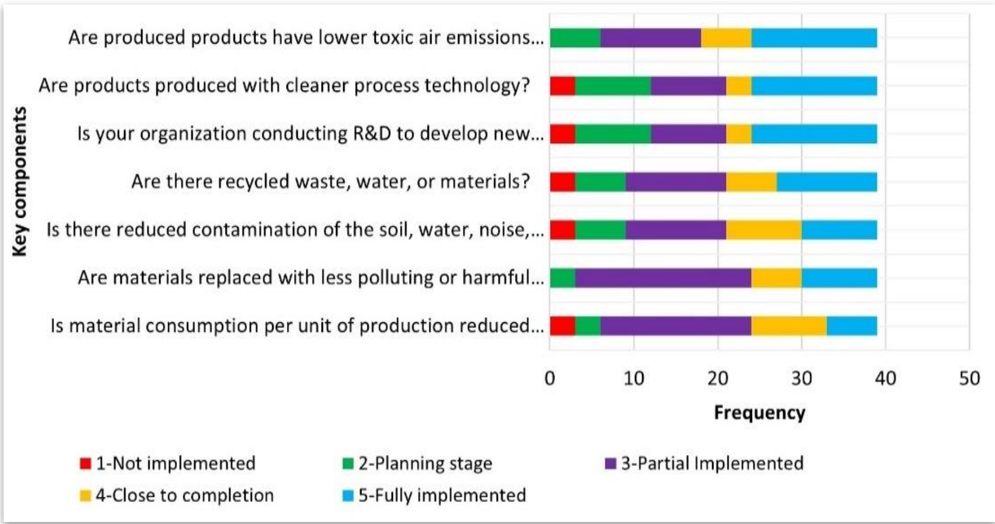


Figure 3: Extent of Implementing Eco-Innovation Activities in Manufacturing Industries

The study further determined whether soil contamination, water, noise, or air pollution were reduced. The responses were: 7.7% – did not manage to reduce the contamination and were at the planning stage by 15.4%; 30.8% – partially implemented; 23.1% – close to completion; and 23.1% – fully implemented. Also, the study found that manufacturing companies were recycling waste, water, or materials by 30.8%; those close to completion of the process were

15.4%%; those that had partially implemented this were 30.8%; while those at the planning stage were 7.7%. Only 15.4% of manufacturing industries had not started recycling their waste materials.

Manufacturing industries (MIs) were also fully performing R&D to create new products, reducing toxic air emissions by 38.5%. Of the respondents, 7.7% indicated that performing R&D to create new products to lessen toxic air emissions was not implemented in their industries, 23.1% indicated that MIs were at the planning stage, and 7.7% indicated that their companies partially performed R&D programmes. For products produced with cleaner process technologies, 7.7% of the respondents suggested that this was not implemented in their firms, while 23.1% suggested that producing products with cleaner process technology was at the planning stage. Fifty-six percent indicated that industries were partially implemented; 23.1% said they were close to completion, and 38.5% reported that their industries had fully implemented cleaner process technology. These findings align with those of Khan et al. (2021), who examined the influence of green innovation in processing industries for environmental sustainability. Khan et al. (ibid.) highlighted that green design, eco-labelling, green marketing, and green consumerism must address sustainability through eco-designing.

However, the factors influencing most manufacturing industries were partially implemented, as shown in Figure 3. Kumar et al. (2021) suggested that packages have been a disaster in the environment, so using recyclable and reusable packages in industries is a great environment saver. It has been advanced that eco-innovation's influence on the environment affects industries and fosters the quality of eco-friendly products. Since the quality of products can be explained as the degree of excellence or meeting and/or exceeding customer satisfaction (Nzumile & Taifa, 2019), there is a high chance that eco-innovation practices can also contribute to improving the quality of products (Nzumile & Taifa, 2021a), increasing customer satisfaction (Nzumile & Taifa, 2021b), reducing the waste of materials during production (Taifa et al., 2021): hence ultimately increasing the productivity of industries (Mwasubila et al., 2022).

In addition to the eco-innovation activities and the extent of implementing them in the manufacturing industries, respondents were also asked to rank barriers towards eco-innovation. Figures 4 and 5 present the factors hindering eco-innovative practices, and factors hindering manufacturing industries from being eco-innovative, respectively.

Among all the technological challenges (Figure 5), the most ranked high was the unavailability of technology for specific applications (62%). For the financial barriers, it was found that economies of scale prevent investment in waste reduction options (e.g., in-plant recovery technologies) by 70%. Finally, regarding consumer-related barriers, there was the challenge regarding the higher price of eco-innovative products, which was 62%.

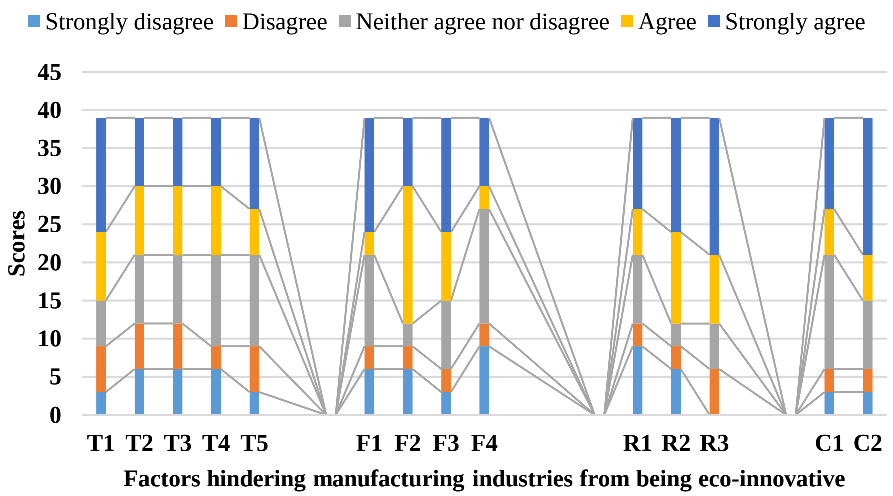


Figure 4: Histogram of the Factors Hindering Eco-Innovative Practices

Note(s): T1-T5 = Technological barriers, F1-F4 = Financial barriers, RI-R3= Regulatory barriers, and C1-C2 = Consumer-related barriers. All abbreviations are in Figure 5.

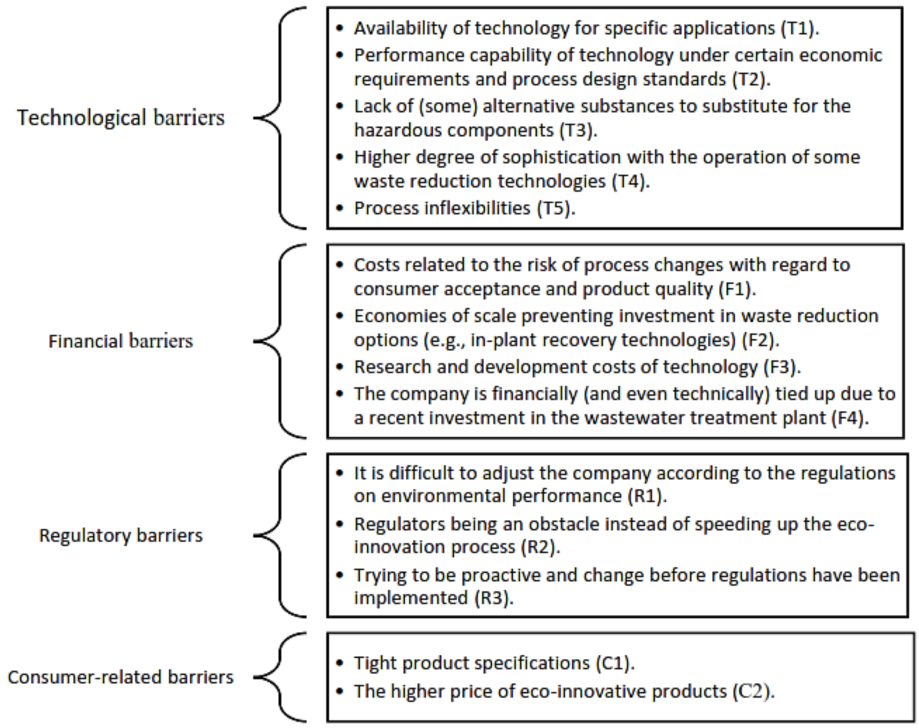


Figure 5: Factors Hindering Manufacturing Industries from Being Eco-innovative

The findings from Figure 5 are in line with other studies. For example, Pinget et al. (2015) studied various barriers to environmental innovation in manufacturing for small and medium enterprises (SMEs) across France. Their study found several factors—including legislation and technological barriers—hampered eco-innovation in SMEs. Likewise, in their project report measuring eco-innovation, Kemp and Pearson (2008) argued that financial barriers and technological capabilities were among the challenges hindering eco-innovation. Other studies that had similar findings include Fernando and Wah (2017) whose study explored the impact of eco-innovation drivers on environmental performance in Malaysia. Similarly, Fernando and Wah's (2017) study on the green technology sector found that green technologies were expensive and could not be afforded by many manufacturing industries. Meanwhile, in their investigation of the regulations, firm perceptions, eco-innovation, and firm performance, Doran and Ryan (2012) found that deploying eco-strategies in industries activates higher prices, increases competition and losses; thus, leading to more industries abstaining from being eco-innovative.

5. Conclusion, Recommendations and Implications

The study findings reveal that the technological factor that ranked the highest was the unavailability of technology for specific applications (62%). This shows a need to invest in eco-innovation throughout the manufacturing industries. The findings also indicate crucial environmental performance indicators. Such indicators include developing products with the least waste, performing environmental improvement programmes, reducing solid and liquid waste, and tracking products contributing to waste reduction. Among the intriguing finding is that approximately 53.8% of the industries have not replaced materials with less polluting or harmful alternatives. Some of the reasons given for this include inadequate commercial incentives, such as interest-free loans or subsidies. Therefore, this study recommends that manufacturing industries take vibrant measures to become more ecologically friendly. Where necessary, the government should enact regulations that proactively foster eco-competitive tactics by providing green infrastructure and coaching knowledge. More importantly, manufacturing industries should embrace the emerging technologies of the fourth industrial revolution, such as smart manufacturing (Shen & Zhang, 2023), which can cut production costs enormously, reduce the amount of material used per unit, and provide numerous environmental benefits.

Moreover, it is anticipated that this study will be of great significance to policymakers in understanding the impact of environmental regulation on eco-innovation and environmental performance. Additionally, it also provides information to the assessed manufacturing industries on how to adjust to the standards required for eco-innovation in facilitating positive environmental performance. Also, the study has added to the body of knowledge on eco-innovation for future empirical research.

References

Athuman, A.H., Mahabi, V. & Taifa, I.W.R. (2024). Conceptualising Management Practices for Mapping Mobile Phone Waste Through Scientometric, Bibliometric and Visual Analytic Tools. In Machado, C. & Davim, J.P. (Eds.), *Management for Digital Transformation*, Springer International Publishing, Springer, Cham, Springer, Cham): 183–211.

Bolarinwa, O.A. (2015). Principles and Methods of Validity and Reliability Testing of Questionnaires Used in Social and Health Science Researches. *Nigerian Postgraduate Medical Journal*, Medknow Publications, 22(4): 195.

Buhl, A., Blazejewski, S. & Dittmer, F. (2016). The More, the Merrier: Why and How Employee-Driven Eco-Innovation Enhances Environmental and Competitive Advantage. *Sustainability*, 8(9): 1–17.

Buzohera, M.I. (2024). Analyzing the Determinants Factors for the Implementation of Eco-innovation in the Developing Economies, A Case of Tanzania Agri-food Sector. *Cogent Business. & Management*, Cogent, 11(1): 1–21.

Costantini, V., Crespi, F., Marin, G. & Paglialunga, E. (2017). Eco-innovation, Sustainable Supply Chains and Environmental Performance in European Industries. *Journal of Cleaner Production*, 155(2): 141–154.

Creswell, J.W. & Plano Clark, V.L. (2011). Choosing a Mixed Methods Design. *Designing and Conducting Mixed Methods Research*, 2): 53–106.

Delmas, M. & Blass, V.D. (2010). Measuring Corporate Environmental Performance: The Trade-offs of Sustainability Ratings. *Business Strategy and the Environment*, Wiley Online Library, 19(4): 245–260.

Dong, Y., Wang, X., Jin, J., Qiao, Y. & Shi, L. (2014). Effects of Eco-innovation Typology on its Performance: Empirical Evidence from Chinese Enterprises. *Journal of Engineering and Technology Management*, 34: 78–98.

Doran, J. & Ryan, G. (2012). Regulation and Firm Perception, Eco-innovation and Firm Performance. *European Journal of Innovation Management*, 15(4): 421–441.

Ekins, P. (2010). Eco-innovation for Environmental Sustainability: Concepts, Progress and Policies. *International Economics and Economic Policy*, 7(2): 267–290.

Fernando, Y. & Wah, W.X. (2017). The Impact of Eco-innovation Drivers on Environmental Performance: Empirical Results from the Green Technology Sector in Malaysia. *Sustainable Production and Consumption*, 12): 27–43.

García-Granero, E.M., Piedra-Muñoz, L. & Galdeano-Gómez, E. (2018). Eco-innovation Measurement: A Review of Firm Performance Indicators. *Journal of Cleaner Production*, Elsevier, 191: 304–317.

Gault, F., Ambali, A. & Mangwende, T. (2016). Innovation in Africa: Measurement, Policy and Global Issues. UNU Merit.

Hoffman, A.J. & Ehrenfeld, J.R. (2017). The Fourth Wave: Management Science and Practice in the Age of the Anthropocene. *Corporate Stewardship*, Routledge): 228–246.

Jayakrishna, K. & Raj, S.A. (2022). Influence and Relation of Sustainability Drivers in Footwear Manufacturing Firms Using Structural Equation Modelling. *Progress in Industrial Ecology*, 15(1): 32–52.

de Jesus, A., Lammi, M., Domenech, T., Vanhuyse, F. & Mendonça, S. (2021). Eco-innovation Diversity in a Circular Economy: Towards Circular Innovation Studies. *Sustainability*, 13: 1–22.

Kaenzig, J. & Wüstenhagen, R. (2010). The Effect of Life Cycle Cost Information on Consumer Investment Decisions Regarding Eco-innovation. *Journal of Industrial Ecology*, Wiley Online Library, 14(1): 121–136.

Kemp, R. & Pearson, P. (2008). Final Report of the Project Measuring Eco-Innovation. *Maastricht (The Netherlands).*

Khan, N., Jhariya, M.K., Raj, A., Banerjee, A. & Meena, R.S. (2021). Eco-designing for Sustainability. *Ecological Intensification of Natural Resources for Sustainable Agriculture*, Springer): 565–595.

Kivunja, C. & Kuyini, A.B. (2017). Person Re-identification with Fusion of Hand-crafted and Deep Pose-based Body Region Features. *International Journal of Higher Education*, 6(5): 26–41.

Kumar, R., Verma, A., Shome, A., Sinha, R., Sinha, S., Jha, P.K., Kumar, R., *et al.* (2021). Impacts of Plastic Pollution on Ecosystem Services, Sustainable Development Goals, and Need to Focus on Circular Economy and Policy Interventions. *Sustainability*, Multidisciplinary Digital Publishing Institute, 13(17): 9963.

Lee, K.-H. & Min, B. (2015). Green R&D for Eco-innovation and Its impact on Carbon Emissions and Firm Performance. *Journal of Cleaner Production*, 108: 534–542.

Leung, L. (2015). Validity, Reliability, and Generalizability in Qualitative Research. *Journal of Family Medicine and Primary Care*, 4(3): 324–327.

Lewis-Beck, M.S., Bryman, A. & Liao, T.F. (Eds.). (2011). Likert Scale. *The SAGE Encyclopedia of Social Science Research Methods*, SAGE Publications, Inc., Thousand Oaks, 1–573.

Lopes Santos, D.F., Valente Rezende, M.D. & Cruz Basso, L.F. (2019). Eco-innovation and Business Performance in Emerging and Developed Economies. *Journal of Cleaner Production*, 237, available at:https://doi.org/10.1016/j.jclepro.2019.117674.

Maganga, D.P. & Taifa, I.W.R. (2023). Quality 4.0 Transition Framework for Tanzanian Manufacturing Industries. *The TQM Journal*, 35(6): 1417–1448.

Maxwell, D., Sheate, W. & Van Der Vorst, R. (2006). Functional and Systems Aspects of the Sustainable Product and Service Development Approach for Industry. *Journal of Cleaner Production*, 14(17): 1466–1479.

Moses, C. (2017). Eco-innovation in South African Manufacturing Enterprises: Trends and benefits, Human Sciences Research Council (HSRC) Policy Brief, March, available at: http://hdl.handle.net/20.500.11910/10799

Mwasubila, I.J., Taifa, I.W.R. & Kundi, B.A.T. (2022). An Analytical Study on Establishing Strategies for Improving the Productivity of the Spinning Industries. *International Journal of Industrial and Systems Engineering*, 40(1): 1–28.

Nchalala, A., Alexander, T. & Taifa, I.W.R. (2023). Establishing Standard Allowed Minutes and Sewing Efficiency for the Garment Industry in Tanzania. *Research Journal of Textile and Apparel*, 27(2): 246–263.

Nzumile, J.M. & Taifa, I.W.R. (2019). Assessing the Awareness of Local Consumer's Product Producers Towards Packaging Standards in Tanzania. *International Journal of Research in Industrial Engineering*, 8(1): 40–52.

Nzumile, J.M. & Taifa, I.W.R. (2021a). Emperical Analysis of the Quality Infrastructure in Trade Facilitation Within the African Continental Free Trade. *Business Education Journal*, I(II): 1–13.

Nzumile, J.M. & Taifa, I.W.R. (2021b). Stratification of Students' Satisfaction Requirements Using the Kano Model. *Business Education Journal*, I(II): pp. 1–16.

Pamba, A.G. & Taifa, I.W.R. (2024). Mapping and Conceptualising on Environmental Performance. in Machado, C. & Davim, J.P. (Eds.), *Smart Engineering Management. Management and Industrial Engineering*, Springer, Cham, Cham, available at:https://doi.org/10.1007/978-3-031-52990-0_5.

Pinget, A., Bocquet, R. & Mothe, C. (2015). Barriers to Environmental Innovation in SMEs: Empirical Evidence from French Firms. *M@ N@ Gement*, AIMS, 18(2): 132–155.

Pujari, D. (2006). Eco-innovation and New product Development: Understanding the Influences on Market Performance. *Technovation*, 26(1): 76–85.

Rennings, K. (2000). Redefining Innovation—Eco-innovation Research and the Contribution from Ecological Economics. *Ecological Economics*, Elsevier, 32(2): 319–332.

Sanni, M. (2018). Drivers of Eco-innovation in the Manufacturing Sector of Nigeria. *Technological Forecasting and Social Change*, 131(November): 303–314.

Sardianou, E., Gkaragkani, V. & Kostakis, I. (2022). Environmental Management Decision-making in Greek Hotels: Barriers and Drivers to Sustainability. *Progress in Industrial Ecology*, 15(1): 53–69.

Seman, N.A.A., Govindan, K., Mardani, A., Zakuan, N., Saman, M.Z.M., Hooker, R.E. & Ozkul, S. (2019). The Mediating Effect of Green Innovation on the Relationship Between Green Supply Chain Management and Environmental Performance. *Journal of Cleaner Production*, Elsevier, 229): 115–127.

Shen, Y. & Zhang, X. (2023). Intelligent Manufacturing, Green Technological Innovation and Environmental Pollution. *Journal of Innovation and Knowledge*, Elsevier Espana, S.L., available at:https://doi.org/10.1016/j.jik.2023.100384.

Taherdoost, H. (2017). Determining Sample Size; How to Calculate Survey Sample Size. *International Journal of Economics and Management Systems*, 2(2): 237–239.

Taifa, I.W. (2016). *Integration of Quality Function Deployment (QFD) and Ergonomics Principles in Product Design Improvement. Case Study: Student Desk at Engineering College*, Master's dissertation, Gujarat Technological University, Ahmedabad.

Taifa, I.W.R. (2021). Sustainable Industrialisation for Luxury Products: Manufacturers and Retailers must Commit to Tackling Modern Slavery in Africa. In Coste-Maniere,

I. & Gardetti, M.Á. (Eds.), *Sustainable Luxury and Jewelry. Environmental Footprints and Eco-Design of Products and Processes*, Springer, Singapore, Springer, Singapore): 199–228.

Taifa, I.W.R., Hayes, S.G. & Stalker, I.D. (2021). Enabling Manufacturer Selection and an Equitable Order Allocation Amongst Textiles and Apparel Manufacturers. *International Journal of Management and Decision Making*, 20(1): 58–87.

Taifa, I.W.R., Twaha, I. & Mwakibambo, M.A. (2021). Critical Analysis of Material Consumption and Cost Reduction Techniques for the Apparel Cutting Processes. *Tanzania Journal of Science*, 47(5): 1689–1700.

Tumaini, J.W. (2021). Towards Industrialisation in Tanzania: Drivers and Barriers to Green Manufacturing. *European Journal of Economics*, 1(1): 41–50.

UNIDO. (2017). *Mapping Industrial Production in Tanzania A Disaggregated Analysis Based on the 2013 Mainland Census*, United Nations Industrial Development Organization, Vienna, Austria. Available at: https://eprints.soas.ac.uk/ 25112/ 1/ 2017-Andreoni-UNIDO-WP.pdf.

World Bank. (2019). *Tanzania 2019 Country Environmental Analysis: Environmental Trends and Threats, and Pathways to Improved Sustainability*, World Bank, available at: https://www.worldbank.org/en/olc/course/58191.

Zhang, Z., Gong, B., Tang, J., Liu, Z. & Zheng, X. (2019). The joint Dynamic Green Innovation and Pricing Strategies for a Hybrid System of Manufacturing and Remanufacturing with Carbon Emission Constraints. *Kybernetes*, 48(8): 1699–1730.