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SURVEY

Green Growth, Waste Management, and Environmental Impact Reduction Success Cases From Small and Medium Enterprises Context: A Systematic Mapping Study

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ABSTRACT Small and medium enterprises (SMEs) are essential to global green growth and are a driving force of eco-innovation. With their capability of fast pivoting, they have become critical players in emerging green industry markets. New firms can especially distinguish themselves in developing sustainable markets with novel, creative, and innovative approaches. Simultaneously, radical innovations in sustainability continue to attract increasing attention. These include the development of green energy generation and storage technologies, bioenergy solutions, the application of eco-innovations, novel municipal waste reduction models, and the wide-scale revision of existing business models. Given SMEs' role in growing markets, this study aims to map academically studied explanations for current models that are deemed successful. We use a systematic mapping study focusing on English language publications devoted to SMEs. The studies selected were publications on environmentally sustainable waste management conducted successfully by SMEs. The studies for the mapping study analysis were selected using several relevant keywords and PRISMA methodology. The authors studied all 127 contributing publications on SMEs engaged in environmental activities, published from 2015 to 2022. This study investigated current trends and identified the most promising areas of environmental activities and sustainable business practices in the SME context. The distribution of recent research across industry sectors and locations has revealed research gaps and provided directions for future research. We have identified the eight most popular sustainability practices and environmental activities in the SME context. The practical implications of the study could help enterprise owners learn about various opportunities for the implementation and pursuit of sustainable economic, social, and environmental development.

INDEX TERMS Small and medium enterprises (SMEs), waste, sustainability, business, success, climate change, emissions, systematic mapping study (SMS), collaboration, environmental activity, recycle, reuse, sustainable operations, sustainable business, business model, performance indicator, green growth.

I. INTRODUCTION

The challenges of global climate change, harmful emissions, land and sea waste problems, and global warming are press-

ing issues that are constantly present in current news, as are dire warnings from academics and environmental specialists about the race against time to remedy them [1], [2], [3]. On the one hand, the importance of sustainable business practices has arisen from the need for positive environmental solutions. On the other hand, for many companies,

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being environmentally considerate is essential for good public relations and brand-related matters. Regarding practical solutions, many services, products, and business activities could contribute to improving the positive effect on our environment. Their contribution generates new jobs, societal improvements, and innovations. At the national level, environmental issues and the rational use of resources to reduce harmful ecological impacts are now a significant part of strategic plans, political dialogue, and the activities of governments and businesses worldwide [4], [5]. However, the human impact has caused the continuance of adverse environmental events, the threat of crucial resource exhaustion, and increasing climatic shifts in recent years, showing that certain ecological management practices may have been reduced to mere bureaucratic routines [6]. Such events signal to stakeholders and managers that it may be reasonable to rethink the role of environmental management by companies, as such methods do not always tangibly reward stakeholders. Managers can attempt to integrate principles for the rational use of resources with crucial business processes and outline ways to build green production chains.

Recent global crises, such as climate change, degraded air quality, deforestation, biodiversity loss, and stratospheric ozone depletion, demonstrate that the traditional economic model aimed at the unrelenting consumption of natural resources and services needs to be reviewed [7]. In recent years, [8] concepts of circular economy (conceptualized 30 years ago) (CE) [9] and green practices are actively being re-developed for the sustainable crowd [10] activities by NGOs, research organizations, corporations, and several national governments [11]. These activities involve the systematic introduction of environmental rules that transform strategies (product transporting supply chains, for example [12]) and even push for fundamental changes in companies' business models. Therefore, society and businesses must shift to a new, more sustainable economic model [13], [14], [15]. The boundless growth of technological and industrial potential, and the continuous introduction of new products to the market, which are then marketed as must-haves for people, have led to environmental degradation and huge e-wastage [16]; this now poses a present and future threat to society [17]. This cycle creates difficulties for future generations because they will face the repercussions later. That is why economic activities that do not destroy and stress the natural environment but increase the Earth's natural wealth have come to the fore in many countries. Products and manufacturing processes are being developed to be less environmentally harmful. Some examples of climate change mitigation methods are renewable energy, waste recycling, intensification of forestry, organic agricultural products, ecological tourism, wastewater, air treatment, and energy-efficient transportation [18], [19].

Currently, discussions in scientific and political circles are increasingly focused on green economy issues. In 2016, at the eleventh meeting of the G20 summit in Hangzhou,

the leaders of 19 countries recognized the importance of a green economy and the need to increase green financing to maintain environmentally sustainable global growth [20]. In recent years, there has been a growing consensus among scientists [21] and policymakers that the current model of economic development, based on the consumption of finite resources and the generation of waste, is unsustainable in the long term. Hence, there is increasing interest in exploring alternative economic models that are sustainable and can prioritize environmental protection and reduce barriers to green innovations [22], [23]. In general, compliance with the principles of sustainable development and employing socially responsible business practices are critical directions for many companies. The concept of sustainable development has grown from an exclusively ecological vision and is now integrating companies and individual entrepreneurs into a local or global socio-economic community. Here successful businesses are directly linked with sustainable development and social responsibility. Countries and companies are still in the middle of transitioning to new, sustainable processes and models. Therefore, environmentally oriented economies remain in need of more creative innovation. Without innovative resource-saving technologies, it is impossible to enhance the efficient distribution and consumption of natural resources.

A company's resources depend on its consumers and investors. To a large extent, the market dictates the price consumers are willing to pay for a product. This is a basic economic principle that companies naturally abide by. Sometimes, the capabilities and habits of a company become obstacles to the introduction of breakthrough innovations. The Resources-Processes-Values model from Christensen's Innovator's dilemma reveals that resources, people, or organizational structures determine the processes employed. They are tied to the company's values, not the publicly professed ones. A company that wants to incorporate breakthrough innovations into its processes and outcomes should be prepared to transform its present values, processes, and resources by utilizing modern technologies and being ready to move from traditional business models to new novel models [24]. We believe that small and medium enterprises (SMEs) can perform the unique role of forming such an economy. Due to their ability to respond to ongoing economic changes [25], [26] faster, they contribute to accelerating innovation processes in the circular and traditional economy.

Therefore, the sustainable economic development model is becoming a priority for successful SMEs [27], [28]. The structure of the concept of sustainable development recognizes the continuity of three aspects – social, economic, and environmental. Modern businesses that rely on short-term, fast economic profits fail to be able to build genuine trust between SME network partners to achieve long-term shared win-win results [29] and limits them to see the interconnections between the three sustainability aspects and the efficacy of environmental practices and their long-term effects [30].

The scientific novelty is restructuring existing environmental practices in the SME context and highlighting existing gaps for further studies.

The rising combined effect of global problems, such as climate change, global warming, and the trend of green consumption, entails changes in current practices. Companies are forced to consider reductions in their negative environmental impacts. Due to the trend of conscious consumption, buyers are also becoming more aware of the goods and services they consume. Generally, entrepreneurs are trying to reduce the material intensity of production, apply new technologies and make economic activity more environmentally friendly. The most effective approach to mitigating the impact of economic activity on the environment is the concept of sustainable development. This is, therefore, the significance and motivation of this study – we attempt to demonstrate the opportunities and successful solutions provided by environmental practices in the SME context.

SMEs significantly impact the environment, often through their use of resources, emissions, and waste. SMEs are the backbone of Europe's economy. They represent 99% of all businesses in the EU [31]. By studying their environmental practices, we can identify ways to reduce this impact and promote sustainability. SMEs are subject to environmental regulations like larger organizations, including those related to waste management, emissions, and energy efficiency [32], [33]. Understanding their environmental practices can help ensure they comply with these regulations and avoid penalties. Innovation is another driver for the sustainability of SMEs [34], [35], [36]. Developing and implementing environmentally sustainable practices often requires innovation and creativity [37], [38]. Studying the environmental practices of SMEs can help us identify innovative solutions to environmental challenges and promote sustainable development. Exploration of the current studies has positive practical implications. It brings awareness towards existing solutions and innovation; therefore, SMEs will not need to spend time inventing similar ideas and studying already tested implementations and approaches again and again.

The research goal of this mapping study is to identify the current trends and most promising areas of development in the environmental activities and sustainable business practices of SMEs. The goal is to obtain practical implications and real-world examples for SMEs by analyzing answers to the research question, “What are the current examples of successful environmental practices by SMEs, particularly in waste and recycling management?” We explore the patterns, challenges, and trends in the environmental activities of small and medium businesses by analyzing the results and content of recent studies on the subject. We conducted search queries in the Scopus database by Title, keywords, and abstract using waste AND sustainability. The search results did produce 29629 papers from 1981 to 2023. It is an enormous amount of work to process.

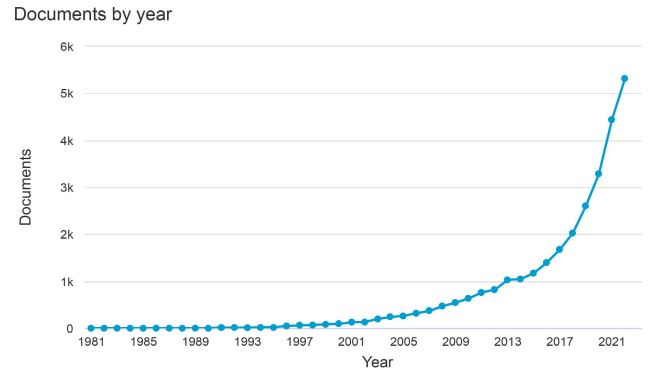


FIGURE 1. Results of scopus search using waste and sustainability keywords. Documents by year from Scopus.

Moreover, Figure 1 shows that the number of research papers is growing exponentially. Thus, exploring, analyzing, and synthesizing current literature is becoming crucial. Therefore, the primary goal of this study is reasonable.

This study follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology. A literature search and analysis were conducted to achieve this goal by utilizing the following academic databases: Scopus, ACM, Science Direct, Web of Science, and IEEE. The databases were searched with the keywords: small and medium enterprises, sustainability, waste management, recycling, success, and benefit. One hundred twenty-seven relevant papers were chosen based on the eligibility criteria and search filters.

A. BACKGROUND

Although the individual environmental impact of one enterprise in the small and medium size category may be insignificant, SMEs together are a significant entity, and their combined influence on the environment is notable. Fortunately, an increasing number of enterprises are realizing the benefits of environmentally friendly production, which include reduced raw materials costs, compliance with environmental standards, improved customer relations, and an overall competitive advantage.

Small- and medium-sized businesses make valuable contributions to society:

- 1) Creation of a progressively developing market. Experimental research is being conducted in small- and medium-sized businesses, new ideas are emerging, and significant changes are occurring. Since any innovation or evolution of established operations is accompanied by enormous costs and high risks for large companies, it is much easier and faster for small businesses to change their activity structures.
- 2) Healthy competition. Due to small- and medium-sized businesses' ability to adapt quickly to changes in con-

sumer demand, they can actively compete with large companies that usually need much more time to reorganize their structures.

- 3) They are maintaining the openness of the economy. Small- and medium-sized businesses can quickly adapt to the demands of the consumer market, which is why this form of business can quickly and actively occupy profitable niches, especially in the export of goods and services.
- 4) The fight against unemployment. More than half the population of developed countries is employed in small and micro businesses.
- 5) Small- and medium-sized businesses are more susceptible to greening, which can affect the environmental situation in the region and optimize the process of using natural resources.

In many countries, comprehensive environmental policies have begun to take shape, and the state has implemented them in all spheres of economic activity. SMEs usually take the lead in embarking on risky and promising innovation, as they tend to be naturally agile and can quickly adjust to business environment changes. The more prominent the company is, the more it is subject to legislation. Therefore, small- and medium-sized businesses should become primary agents in the creation of an ecological or green sector of the economy, as SMEs must identify new business ideas as a recipe for their success.

Companies are affected by both external and internal factors. Regulatory acts and legislation related to environmental pollution, using renewable energy sources, waste recycling, or implementing socially effective programs are examples of controlling external factors. Companies analyze the additional costs to be incurred and the revenues to be earned from the use or non-use of “green” technologies and production principles. Environmental charges encourage entrepreneurs to reduce harmful emissions to a level where the marginal costs of implementing environmentally friendly technologies will equal ecological taxes and fees. Tax incentives for investments in nature protection can be a stimulating external factor in the greening of businesses. The task of environmental benefits is to stimulate companies to make their technological processes less harmful. Many countries have mechanisms to encourage entrepreneurs to use greening approaches actively. Among them are energy tax benefits and reduced electricity rates when using renewable energy sources; compensation for the purchase of solar panels and other equipment for using solar energy; a floating transport tax that considers the amount of carbon dioxide emissions per kilometer; and differentiated environmental tax rates depending on energy efficiency.

In addition, for small businesses, awareness of their customers’ attitudes toward the company’s activities is crucial; enterprises need to know who their customers are and how much they value the company’s “greenness”. The zero-waste and eco-friendly product movement has recently become

popular; therefore, clients can choose companies that use green technologies and reflect their own life principles. In global practice, the eco-business is becoming more competitive and in demand because consumers have begun to prefer environmentally friendly and high-quality products. The green industry aims not only to generate income from producing environmentally friendly products and providing environmental services but also to preserve the environment and conserve natural resources. The last two to five years have witnessed many changes. Several sustainable business models that are both lucrative and environmentally friendly are already available. These business models are based on the CE, sharing economy, and resource recovery, and regard the product as a service. Some examples of businesses with a broad environmental focus are eco-education, landscaping territories considering their ecological characteristics, using alternative energy sources, manufacturing resource-saving equipment, green construction, and eco-tourism [39].

The SME owner’s sense of social responsibility is an example of the internal factors that affect the employment of environmental practices. If the owner’s principles include an interest in reducing the negative environmental impact, then external economic instruments would be of additional influence. Conversely, if the owner’s principles differ, prevailing green laws and increased punitive taxes would be an external incentive for running a green business. SMEs have comparatively fewer inflexible enterprise-level practices, so less time and resources are required to become more eco-friendly. Many SMEs work naturally with lean practices as they are resource-limited; however, this does not directly mean their practices are eco-friendly. It means that many SMEs will likely produce less waste and emissions per person working in the company.

One theoretical gap in the current studies of the environmental activities of SMEs is the need to understand better the success factors of environmental performance among these firms. While there is a growing body of research on the drivers of environmental practices of SMEs and the barriers that prevent them from doing so, less is known about the successful factors that lead SMEs to adopt environmentally sustainable practices [12], [22], [34], [40], [41].

Another gap is the lack of attention to the social dimensions of sustainability. While many studies have focused on the environmental dimensions of sustainability in the context of SMEs [30], [42], relatively little attention has been paid to the social dimensions of sustainability, such as the impacts of SMEs on local communities and the well-being of workers. This is an important theoretical gap, as SMEs can have significant social impacts, and addressing these impacts is crucial to achieving sustainable development. Some studies have suggested that SMEs are less likely than larger firms to adopt environmentally sustainable practices due to factors such as limited resources, lack of knowledge, fewer possibilities to collaborate with research units like Universities, and the perception that environmental initiatives are not a priority for their business [43], [44]. However, other studies have shown

that SMEs can be highly motivated to adopt environmentally sustainable practices, especially when they are linked to financial benefits, such as cost savings or increased market opportunities, and can be fast in developing new and fresh digitalization-based solutions for sustainability [5], [9], [45].

There is limited focus on the role of networks and collaborations: SMEs often operate close to one another and may have the opportunity to collaborate on sustainability initiatives. However, there has been relatively little research on the role of networks and collaborations in promoting sustainability among SMEs. Understanding how networks and collaborations can facilitate sustainability initiatives among SMEs could be an important area for future research and can share resources for thriving innovation.

To address these theoretical gaps, future research could focus on exploring the success factors of environmental performance among SMEs. Study the role of the social dimensions of sustainability and the values and beliefs of business owners and managers. This research could help to identify effective models for environmentally sustainable practices among SMEs and could contribute to the development of more targeted and effective policies and programs to support sustainable development in the SME context.

In this study, we tried to systemize current knowledge about environmental activities and practices in SMEs and to identify current trends and the most promising areas of the development of environmental activities in the SME context.

II. MATERIALS AND METHODS

We performed a systematic mapping study (SMS), following the established guidelines and procedures proposed by [46] and [47]. An SMS helps get a comprehensive overview of a particular research topic, presents an unbiased assessment of the current literature, identifies research gaps, and collects evidence for future research [48], [49]. Research using SMS methodology is used primarily for exploration, obtaining general information about a topic and its conceptual understanding; it does not focus on narrower issues and includes top-level descriptions and analyses of existing research. The following is the rationale for this study:

- 1) Clarification of the topic as presented in published literature.
- 2) Identification of critical characteristics or factors related to the topic being studied.
- 3) Study of research methodology (designs used, methods, techniques, software) in the context of SMEs and environmental activities.
- 4) Identification and analysis of the gaps in existing scientific knowledge to plan further scientific research effectively.
- 5) Preparation for a future systematic review.

The SMS eliminates researcher-bias, as it is reproducible, increases reliability, and is devoid of a priori assumptions. The general steps taken in conducting the SMS in this

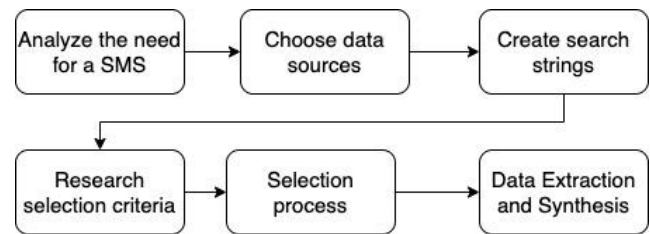


FIGURE 2. Overview of the general steps for the systematic mapping study (SMS).

study are presented in Figure 2. To reduce the possibility of researcher-bias, the steps described in the review process [49] were followed in stages: (1) analyze the need for an SMS, (2) choose the data sources to be used, (3) create search string(s) based on the research objectives and questions, (4) define research inclusion/exclusion, i.e., selection criteria, (5) perform study selection, and (6) perform data extraction and synthesis. The process was conducted in three stages (Fig. 2): planning (steps 1, 2, and 3), execution (steps 4, 5, and 6), and reporting the findings. The following sections describe these stages and our actions in detail.

A. NEED FOR THE SMS

There is a twofold purpose of the SMS. First, we aimed to find recent trends and patterns in environmental practices. Second, we intended for this study to have practical implications for SMEs by answering questions like “What are the current examples of successful SMEs in environmental practices, particularly waste and recycling management?” We explored the patterns and trends in the environmental activities of small and medium businesses by analyzing the results of recent studies.

Research questions were compiled to narrow the focus of the SMS to an acceptable size. The systematic research aims to explore the examples of successful environmental practices by SMEs based on the following research question: “What are the current models of successful environmental practices employed by SMEs, particularly in waste and recycling management?” The main research question has been divided into detailed sub-research questions:

- 1) RQ1: What types of environmental practices exist in SMEs that contribute to the research area?
- 2) RQ2: Which are the successful countries involved in waste management and recycling for SMEs?
- 3) RQ3: What are the successful models for SMEs’ environmental activities and practices?
- 4) RQ4: What industries contribute and participate the most in environmental activities?

The rationale for researching successful practices/approaches is to discover studies that discuss successful environmental methods, eco-innovations, and sustainable approaches in SMEs. The terms “Waste” and “Recycling” management were used to narrow the search to all papers related to waste and recycling practices.

TABLE 1. General search string used in the study.

Dimensions	Alternative terms
SME	((("Small & medium") OR ("Small and medium")) AND ((enterprise*) OR (business*)))
AND	
Sustainability	((recycl*) OR (waste) OR (sustain*))
AND	
Success	((succes*) OR (advantage*) OR (benefit*))

B. DATA SOURCES AND SEARCH STRINGS

Five databases, ACM, IEEE, Scopus, Science Direct, and Web of Science, were covered in this SMS. The databases were chosen to ensure the liability and credibility of the search results and to obtain a wide variety of papers, as advised by Kitchenham's guidelines [49]. The current SMEs' waste management and environmental activities topic is multidisciplinary, which is present in different sources, like business, sustainability and environmental journals and conferences. Scopus, Science Direct, and Web of Science are three of the most popular and valued multidisciplinary citation databases. IEEE focuses on technical literature in engineering and technology, and the ACM database covers computing and information technology. Before inclusion, we searched IEEE and ACM with trial keywords to ensure the relevant results for the study. The identified filters utilized were: English only, with publication years from 2015 to 2022. We decided to use 2015 as a filter due to the adoption of the 2030 Agenda for Sustainable Development, with 17 SDGs issued by the UN General Assembly in 2015 [23]. We assumed and noticed an increase in research on environmental enterprises and sustainability after that year. We also limited the searches to peer-reviewed articles, conference proceedings, books, and book chapters. Grey literature was excluded from the search to focus on peer review academic content.

The keywords were created based on three dimensions: business size, sustainability, and outcomes. We broadened the search strategies and terms to identify as many eligible studies as possible. Search terms were modified with an asterisk (a wildcard symbol that broadens a search by finding words with the same beginning) and combined with Boolean operators. The keywords between dimensions were connected with the AND operator to include all three dimensions, and the OR operator was used inside each dimension to embrace more relevant studies. The applied search is presented in Table 1.

The search was performed using the Title, Abstract, and Keywords fields or the closest to these. Each database uses these differently. For example, the search field in IEEE is called Metadata (including the abstract, index terms, and bibliographic citation data such as the document title, publication title, and author); in Web of Science, the field is named Topic. Scopus and Science Direct have separate search fields "TITLE-ABS-KEY"; in ACM, we have a combined search for title, abstract, and keywords in the command line.

TABLE 2. Database search strings, search fields and filters.

Database	Search field	Keyword string
ACM	Title, keywords, Abstract	[[All: "small & medium"] OR [All: "small and medium"]] AND [[All: recycl*] OR [All: waste] OR [All: garbag*] OR [All: sustain*]] AND [[All: succes*] OR [All: advantage] OR [All: benefit]]
IEEE	All Metadata	("All Metadata": "Small & medium" OR "All Metadata": "Small and medium") AND ("All Metadata": business* OR "All Metadata": enterprise*) AND ("All Metadata": recycl* OR "All Metadata": waste OR "All Metadata": garbag* OR "All Metadata": sustain*) AND ("All Metadata": succes* OR "All Metadata": advantage* OR "All Metadata": benefit*)
Scopus	TITLE-ABS-KEY	TITLE-ABS-KEY((("Small & medium") OR ("Small and medium")) AND ((enterprise*) OR (business*)) AND ((recycl*) OR (waste) OR (sustain*)) AND ((succes*) OR (advantage*) OR (benefit*)))
Web of Science	Topic	((("Small & medium") OR ("Small and medium")) AND ((enterprise*) OR (business*)) AND ((recycl*) OR (waste) OR (sustain*)) AND ((succes*) OR (advantage*) OR (benefit*)))
Science Direct	Title, abstract or author-specified keywords	(("Small & medium") OR ("Small and medium")) AND ((enterprise?) OR (business?)) AND ((recycl?) OR (waste) OR (sustain?)) AND ((benefit?) OR (advantage?)) AND (("Small & medium") OR ("Small and medium")) AND ((enterprise?) OR (business?)) AND ((recycl?) OR (waste) OR (sustain?)) AND ((succes?) OR (advantage?))
Year filter	Publication year	2015-2022
Type filter	Document Type	Articles, conference papers, books, book chapter
Language filter	Language	English

We faced a small challenge with the Science Direct database. The maximum permissible is eight operators, but we have nine in our final keywords string. After that, we used the string for two searches with different last keywords in each search. We checked the search results for duplicates in the two searches and combined the results from all the databases. The final search strings and search fields are presented in Table 2.

The summarized outcome of the database searches (2872 papers) was imported to the reference management software to conduct a duplicate search. Duplicates were removed, and the results were exported to Excel for the inclusion and exclusion process. Two thousand one hundred sixty-five papers were identified after duplicate removal for further analysis.

C. INCLUSION/EXCLUSION OF THE STUDIES, ELIGIBILITY CRITERIA, AND QUALITY ASSESSMENT

Two researchers performed the inclusion/exclusion process. The article selection process was organized in two rounds: 1st excluding irrelevant papers based on titles and 2nd inclusion of eligible papers based on abstracts.

Research papers that met at least one of the criteria below were excluded (automatic exclusion):

- Duplicate study or research from different sources.
- (Short) Papers of a few pages (up to 4).
- Papers are written in a language other than English.
- Papers written before 2015.

Research papers whose titles met at least one of the criteria below were excluded (manual exclusion):

- No mention of SME
- No mention of sustainability
- No mention of recycling/recycle/waste

First, the researchers skimmed the papers by title, searching for SMEs with success in environmental activities, particularly waste management/recycling. The business should directly relate to the recycling/waste management sector or present operating sustainable environmental activities. The article was not included in the abstracts skimming stage if there was no mention of SME, waste/environment/recycle, or sustainability in the title. The search result was evaluated for inclusion or exclusion by considering the title, summary, and keywords. After skimming titles, we had 311 papers for the second step, and 1756 results were excluded as they did not match the selection criteria. All discrepancies were resolved by consensus between the researchers.

In the second step, the papers' abstracts were read and scanned for inclusion criteria. Papers were excluded if there was no mention of SME, waste, environment, recycling, or the main topic was not environmental. For example, was sustainability the mainstay or just a side effect of economic growth? Technical papers that explained tool creation were also excluded. Such publications were excluded as they did not fit the final goal of the study. Finally, 138 articles were included for the full text read and data extraction.

To evaluate the quality of the final selected studies and extract the desired data, the researchers performed a quality assurance evaluation based on the research goal, a question, and access to the full text. Thus, 17 papers and book sections were eliminated from the study. Elimination criteria were the following:

- They did not directly contribute to the research questions of the review and mapping study and did not cover the SME context, just an overview, and discussion of possible activities.
- Three items were about green supply chain management, not particularly in the SME context.
- The full text was not available for reading.

Fig. 3 presents the number of studies excluded in each criteria and the final number of primary studies included.

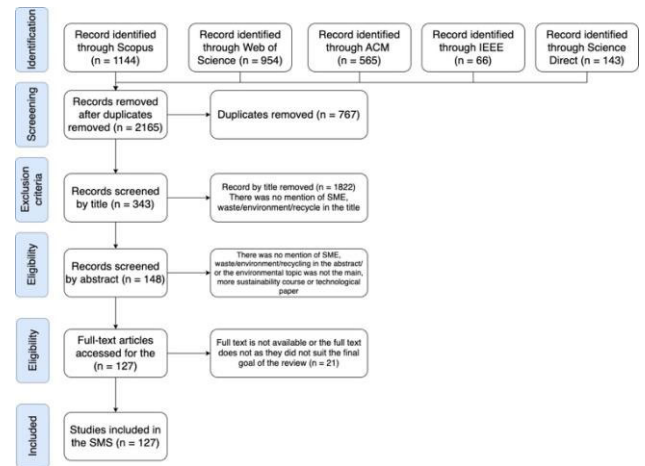


FIGURE 3. A flowchart explaining the methodology and items for the systematic review (adapted from PRISMA).

Appendix B Table 7 presents all the papers included in the SMS (n = 127).

D. DATA EXTRACTION STRATEGY

Properties extracted from the full text helped find research gaps and identify possible future studies. Research questions were answered using extracted properties. Moreover, the bibliographic data of the papers (such as pages, document type, citations, and journal) were analyzed to reveal the most popular journals for publication and the appropriate number of pages with examples of proper articles. The gathered elements, as connected to each research question, are explained in Table 3 below.

Results and environmental sustainability methods were used only for the analysis, not for visualization.

E. DATA EXTRACTION PROCESS

Two researchers conducted data extraction from 127 papers based on the extraction categories and recorded their findings in a Microsoft Excel table for analysis, conclusions, and visualization of the results.

Microsoft Excel software was used for data analysis. The following diagrams were created to answer the research questions and are presented in section III:

- 1) Articles published by year in the context of SMEs and environmental activities
- 2) Journals that publish the most on SMEs and environmental activities
- 3) The countries that publish the most on SMEs and environmental activities
- 4) Document types about SMEs and environmental activities that are most published
- 5) Most cited authors, countries, documents, and journals
- 6) Research of SMEs by sector
- 7) Top types of the paper/sectors
- 8) Research methods and sample sizes that are used in the papers on SMEs and environmental activities

TABLE 3. Properties extracted for each paper in the SMS.

Element	Description	Research question	How the data was used
Document Type	Journal article, conference paper, book, or book chapter	Bibliometric data	To identify the most frequent type
Publication Year	Publication year	Bibliometric data	To identify the most frequent publication year
Publisher	Journal name, conference name or publisher name	Bibliometric data	To identify the most frequent journal where the results can be disseminated
Category	Type of the research paper	RQ1	To categorize publications in the mapping study
Subcategory	Another type of research paper if it can be categorized into several types	RQ1	Additional subcategory for dividing papers
Research Methodology	The methodology that was applied in research, the type of data collection, methods, and techniques	Methodology data	To validate the results and find the most suitable method
Sample	The number of SMEs participated in the research, case study, interview, survey	Methodology data	Compare the sample size of the results
Country area	Country for conducted research/origin country of the researched SMEs	RQ2	To identify the countries in waste management and recycling for SMEs
Generalized region	Region of the country	RQ2	To identify the region in waste management and recycling for SMEs
Size of the business	Small, medium, and large	RQ4	To understand if the results are scalable
Sector	Industry in which SMEs are operating	RQ3	To identify the industries contributing and participating the most in the environmental activities
Method of environmental sustainability	How the research paper archived the result		To identify the models for the environmental activities and practices in SMEs

TABLE 3. (Continued.) Properties extracted for each paper in the SMS.

		RQ3	To identify the models for the environmental activities and practices in SMEs
Results	What was the outcome of the research paper		
Number of pages	Number of pages in the research article	Bibliometric data	To compare paper size and citations
Citation	Citation in Google Scholar	Bibliometric data	To compare paper size and citations
Citation/per year	Citation/per year in Google Scholar	Bibliometric data	To identify the most cited publications

- 9) Length of papers with the most material on SMEs and environmental activities
- 10) Authors who publish the most on SMEs and environmental activities

F. QUALITY ASSURANCE AND THREATS TO VALIDITY

The PRISMA guide has been utilized for searching and selecting the papers for the study. PRISMA is an evidence-based approach showing the minimum items required for systematic reviews and meta-analyses. An international group of clinical researchers developed a PRISMA publication guide to improve the quality of systematic reviews and meta-analyses publications. The final version of the PRISMA checklist contains 27 items that help researchers in their work. The current study followed the PRISMA checklist for the field's search, selection, and data analysis stages [50].

III. RESULTS AND FINDINGS

RQ1: What are the current examples in studies of successful environmental practices by small and medium enterprises, particularly in waste and recycling management?

This first research question aims to identify the existing studies that explicitly considered successful environmental practices by SMEs, particularly in waste and recycling management, and review their contribution to the field. These studies are listed below in Table 7, identified by the key used in Appendix B. The contributions of the chosen primary studies are outlined in Table 4. Overall, there are 20 papers with the successful practical implementation of environmental practices.

According to the Ellen MacArthur Foundation (EMF), circular products and materials are categorized as biological and technical [51]. Three basic principles of circular economy (CE) proposed by the EMF are: regenerating natural systems, designing waste and pollution elimination systems, and keeping products and materials in use [52]. The basic principles of CE are presented in Figure 4.

TABLE 4. The synthesis of main ideas, based on SMS finding.

Publication and Principles of CE	Main ideas
[53] Biological: Producing biodiesel using design out waste and pollution, keeping products and materials in use.	The authors optimized the process requirements and fabricated a Small and Medium-sized Enterprises (SME) level plant to produce biodiesel from waste cooking oil. The results can be used instead of petroleum diesel for automotive and industrial-level applications without any environmental effects.
[63] Biological: Creating energy with anaerobic digestion using design out waste and pollution keep products and materials in use.	The authors highlighted how SMEs could use biological waste materials for converting waste to energy by obtaining nutrient-rich compost for agriculture through anaerobic digestion. It helps to generate clean energy in an environmentally friendly way.
[57] Technical: Creating eco-design packages to recycle using regenerating natural systems and keeping products and materials in use.	The authors presented the case of a small-medium enterprise that implemented a decision-making process to rethink frozen food packaging design following eco-design and Life Cycle Thinking to prevent plastic packaging.
[58] Technical: Eco-design follows reuse and recycle principles with a focus on regenerating natural systems and keeping products and materials in use.	The authors studied a small Italian enterprise, Ecobabydesign, as an example of green choices and innovation. Enterprise is inspired by green principles, from materials to recyclability. Ecobabydesign is a successful example of a green company.
[54] Biological: usage of biogas production for designing out waste and pollution, keeping products and materials in use.	The authors explored the success factors in an agricultural network in which biogas is produced at four farms in Sweden with distribution by pipeline to a refinery for purification and conversion to vehicle fuel.
[59] Technical: Recycling of concrete follows designing out waste and pollution and keeping products and materials in use.	The authors identified the main challenges to concrete recycling in construction projects in small and medium enterprises and large companies.
[60] Technical: Recycling of concrete follows designing out waste and pollution and keeping products and materials in use.	The authors identified the critical success factors of concrete recycling in construction projects in small and medium enterprises and large companies.
[61] Technical: Reusing and recycling tires and resin for new material to design out waste and pollution and keep products and materials in use.	The authors presented a case study of producing flexible tiles from rubber powders obtained from automobile tire waste using polyurethane resin as a binder matrix. The company is a successful example of contributing to green and environmental practices.
[64] Technical: Recycle scrap iron to design out waste and pollution and keep products and materials in use.	The authors provided model-based atmospheric dispersion estimates for gaseous pollutants (SO ₂ and NO _x) released from a scrap-iron recycling factory, comparing the emissions into the air from polluting sources with American Meteorological Society guidelines.
[65] Technical: Reusing wastewater to regenerate natural systems and design out waste and pollution.	Authors proposed an intermediate-scale water reuse option termed 'sewer-mining', which could be considered a reuse scheme at the neighborhood scale. The study developed a new modeling toolkit for sewer mining upscaling at a city level.

TABLE 4. (Continued.) The synthesis of main ideas, based on SMS finding.

[56] Biological: Solid biofuel into the energy to design out waste and pollution and keep products and materials in use	The authors evaluated harnessing solid biofuels from agricultural and forestry residues in SMEs to represent an alternative contributing to the industrial sector's decarbonization.
[66] Technical: Reusing faecal sludge to produce briquette making to regenerate natural systems and design out waste and pollution.	The authors highlighted local experiences, opportunities, and common challenges faced by micro- and small-sized businesses in Resource Recovery and Reuse. The study presented initiatives to use faecal sludge for a potential briquettes market. The authors analyzed 105 startups and SMEs working on marine plastic management and presented business solutions for marine plastic management.
[67] Technical: reusing plastic and creating new eco-plastic packages to design out waste and pollution and keep products and materials in use.	The authors studied conditions for realizing new plants for recycling all categories of wasted printed circuit boards.
[62] Technical: Recycle wasted printed circuits to design out waste and pollution and keep products and materials in use.	The authors presented the concept of renewable fuel production based on local biomass with the addition of a specific portion of carbonized biomass, which is feasible to be implemented in most communities in Poland.
[55] Biological: using biomass and biofuel to design out waste and pollution and to keep products and materials in use.	The authors studied 5 Italian SMEs and their experience in eco-design and eco-sustainable development. They assisted and tutored them along the way creating new approach for companies.
[68] Technical: using eco-design practices to prolong and control the lifecycle of the materials with a focus on keeping products and materials in use.	The authors created framework for sustainable energy consumption. The approach was tested in India, and two companies successfully mitigated CO ₂ emissions and reduced production costs.
[69] Technical: reusing and optimizing energy consumption with a focus on keeping products and materials in use.	The author created a guide on regenerative management systems in agriculture and presented his ways of ecological farming.
[69] Biological: regenerating agricultural recourses and reverse grassland.	The author successfully implemented the replacement of traditional flood cooling with Minimum Quantity Liquid.
[70] Technical: reusing resources and decreasing the loses to design out waste and pollution and keep products and materials in use.	The authors proposed recycling strategies for a company in the pharmaceutical industry that produces homeopathic veterinary medicines.
[71] Technical: recycling strategy for waste disposal and waste management with a focus on design out waste and pollution.	

In the presented articles, various applications of CE principles and the usage of biological/technical materials are apparent. For example, four studies [53], [54], [55], [56] propose using biomass and biofuel as energy sources, and

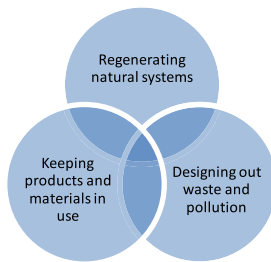


FIGURE 4. Basic principles of CE.



FIGURE 5. Simple weighted word cloud created in WordCloud using abstracts of primary studies.

several other articles give solid approaches for recycling and reusing [57], [58], [59], [60], [61], [62]. However, in the current sample, there are neither sustainable examples of eco-farming or eco-collection of resources nor how such resources can be regenerated. From a technical perspective, there are no cases of sharing resources or materials and using remanufacturing effectively. We recommend further research for successful examples of environmental activities by SMEs in these areas. Researchers should explore eco-farming or eco-collection of resources and resource regeneration methods, opportunities, and challenges in the context of SMEs and large companies. The sharing of resources or materials and effective use of remanufacturing approaches by SMEs are additional subjects for future research. Figure 13 in Appendix C presents CE activities' biological and technical divisions.

With the target to map the research focus areas of the found articles and generalize the current big picture of research in this context, a weighted word cloud (see Fig. 5) was generated based on the primary studies' abstracts. This was made with WordCloud [72], which uses a stemming algorithm to filter textual input. Observing the density of terms, the most frequently used are recycling, waste, SME, innovation, enterprises, concrete, challenges, and environmental.

These papers presented environmental activities that would benefit future practitioners. SMEs can use their resources to

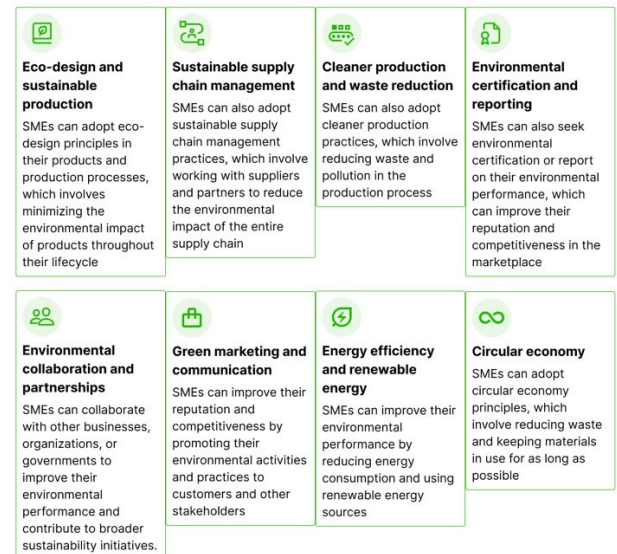


FIGURE 6. Successful models for small and medium enterprises (SMEs) of environmental activities and practices based on the findings.

produce energy from biogas or biomass or recycle packaging and tires for new materials and re-usage. We focused on successful examples of environmental activities by SMEs, covering the biological and technical aspects of their approaches. These can serve as recommendations and opportunities for small and medium businesses to contribute to the CE and impact resource savings. Cost reductions could be a beneficial outcome of these environmental activities.

In Figure 6, eight popular models of environmental activities by SMEs are presented across the literature.

- 1) Eco-design and sustainable production: This can include reducing the use of raw materials, improving energy and resource efficiency, and using recyclable or biodegradable materials.
- 2) Cleaner production and waste reduction: This can include implementing recycling programs, reducing the use of toxic substances, and improving energy efficiency.
- 3) Sustainable supply chain management. This can include working with suppliers to reduce waste, improve energy efficiency, and use sustainable materials.
- 4) Following environmental certification and reporting: Certification schemes such as ISO 14001 and EMAS provide a framework for environmental management, while reporting frameworks such as the Global Reporting Initiative (GRI) provide guidelines for reporting on environmental performance.
- 5) Energy efficiency and renewable energy: Involves implementing energy-efficient technologies, such as LED lighting or smart energy management systems, and using renewable energy sources, such as solar or wind power.

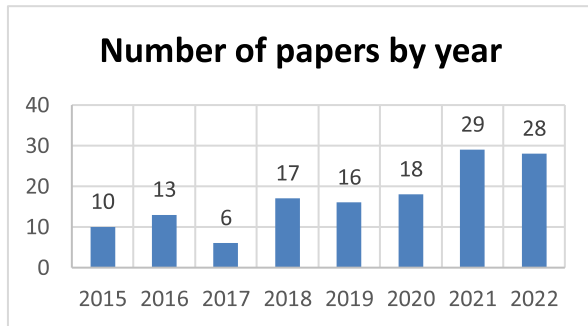


FIGURE 7. Publishing year (2015–2022) based count of SMS contributing studies.

- 6) Circular economy: This can include implementing closed-loop systems, such as product take-back schemes or material reuse programs and designing products for disassembly and recycling.
- 7) Green marketing and communication: Involves green marketing strategies, such as eco-labeling or green branding, and communicating about environmental performance through sustainability reporting or social media.
- 8) Environmental collaboration and partnerships: Involves participating in industry associations, working with non-governmental organizations (NGOs) on environmental programs, or partnering with government agencies on environmental initiatives.

These eight environmental practices and activities can be implemented separately or combined in the SMEs for a successful joint outcome.

A. ARTICLES PUBLISHED BY YEAR IN THE CONTEXT OF SMEs AND ENVIRONMENTAL ACTIVITIES

We analyzed the number of studies published each year, as illustrated in Fig. 7.

The results show that from 2015, publications related to SMEs and environmental practices grew at a constant and stable rate, except in 2017. The low number of publications in 2017 is quite interesting. It is also worth noting that this mapping study conducted early in 2022 shows a slight decrease for 2022. However, the total number of papers in 2022 should be higher or equal to the previous year. Our search yielded the most studies in 2021, which can be attributed to environmental improvements made during COVID-19, as a lot of production was stalled. This allowed the researchers to direct attention to the suitability question.

B. JOURNALS THAT PUBLISH THE MOST ON SMEs AND ENVIRONMENTAL ACTIVITIES

Further, we investigated the publication titles of the papers. Well-known journals in the field, such as the Journal of Cleaner Production, Business Strategy and the Environment, and the Journal of Environmental Management with more than one publication each, are listed in Table 6 in the Appendix. The published journals were studied to understand

TABLE 5. Advantages and disadvantages of environmental entrepreneurship.

Advantages of environmental entrepreneurship	Disadvantages of environmental entrepreneurship
<ul style="list-style-type: none"> Promotion of environmental protection measures. Strengthening of scientific and technological developments in the field of innovative technologies. The opportunity to take a leading position in the global production of environmentally friendly products. 	<ul style="list-style-type: none"> High probability of ruin; administrative barriers; The problem of selling products in small batches. Higher cost compared to traditional technologies.

Chronological distribution of the publications

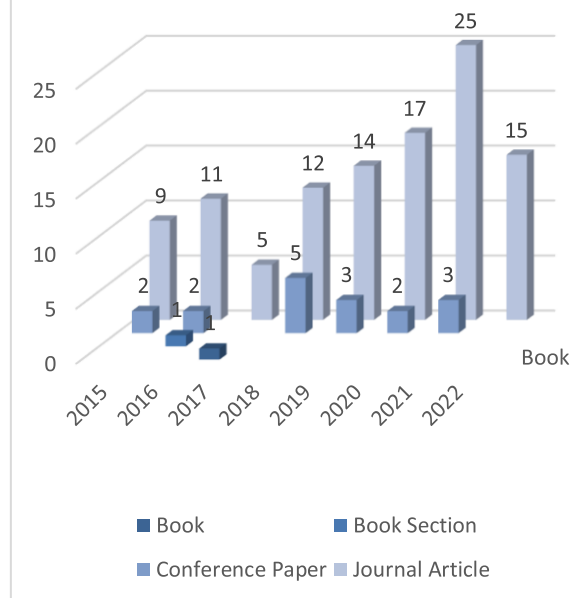


FIGURE 8. Chronological distribution of the publications.

the dissemination opportunities of our results and similar works. The table is presented in Appendix A.

C. DOCUMENT TYPE THAT IS PUBLISHED THE MOST ABOUT SMEs AND ENVIRONMENTAL ACTIVITIES

In Figure 8, chronological distribution based on publication type is presented. Most of the studied papers are journal papers due to the narrow topic and directly connecting with the goals and aims of the journals. Conference papers are in second place. Book and book chapters are minors.

D. MOST CITED COUNTRIES IN WHICH THE SMEs ARE LOCATED

As shown in Fig. 9, the most cited countries are India, Brazil, and Europe (no specific country, just the general region),

TABLE 6. Journals investigated.

Source	Selected papers
Journal Of Cleaner Production	23
Sustainability	8
Business Strategy and The Environment	7
Journal Of Environmental Management	3
Corporate Social Responsibility and Environmental Management	2
IEEE Transactions on Engineering Management	2
International Journal of Environmental Research and Public Health	2
Journal Of Business Research	2
International Journal of Sustainable Engineering	2
IOP Conference Series: Earth and Environmental Science	2
Journal Of Manufacturing Technology Management	2
Management Of Environmental Quality	2
Production Planning & Control	2
Sustainability (Switzerland)	2
The 2021 7th International Conference on Industrial and Business Engineering	2
2016 IEEE International Conference on Information and Automation for Sustainability (Iciafs)	1
2018 2nd International Symposium on Small-Scale Intelligent Manufacturing Systems (SIMS)	1
2018 7th International Energy and Sustainability Conference (IESC)	1
48th International Conference on Computers and Industrial Engineering (CIE 48)	1
American Scientific Publishers	1
Applied Sciences-Basel	1
Asia Pacific Journal of Tourism Research	1
Bled 2019 Proceedings	1
Case Studies in Construction Materials	1
Clean Technologies	1
Clean Technologies and Environmental Policy	1
Cogent Environmental Science	1
Construction Innovation-England	1
Desalination And Water Treatment	1
Energies	1
Energy, Sustainability and Society	1
Environment Development and Sustainability	1
Environmentasia	1
European Urban and Regional Studies	1
Food Research	1
Global Journal of Environmental Science and Management-Gjesm	1
Groundwater For Sustainable Development	1
Ieee International Technology Management Conference	1
Industria Textila	1
Industrial Management & Data Systems	1
International Association for Management of Technology	1
International Conference on Sustainable Energy	1
International Journal of Innovation Science	1

TABLE 6. (Continued.) Journals investigated.

International Journal of Innovation, Creativity and Change	1
International Journal of Life Cycle Assessment	1
International Journal of Production Economics	1
International Journal of Six Sigma and Competitive Advantage	1
International Journal of Social Ecology and Sustainable Development	1
International Journal of Sustainable Development and World Ecology	1
Journal Of Advanced Manufacturing Technology	1
Journal Of Business Strategy	1
Journal Of Engineering and Technology Management	1
Journal Of Enterprise Information Management	1
Journal Of Science and Technology Policy Management	1
Journal Of Strategic Marketing	1
Journal Of Sustainable Tourism	1
Journal Of the Knowledge Economy	1
Journal Of Transport and Supply Chain Management	1
Home Ecology & Brooklet Farm Education	1
Local Economy	1
Maderas-Ciencia Y Tecnologia	1
Management Of Environmental Quality: An International Journal	1
Marine Pollution Bulletin	1
Materials Today: Proceedings	1
MATEC Web Of Conferences	1
Proceedings Of The 2019 5th International Conference on Industrial and Business Engineering	1
Proceedings Of The 7th International Conference on Management of Computational and Collective Intelligence in Digital Ecosystems	1
Proceedings Of the International Conference on Engineering and Information Technology for Sustainable Industry	1
Promoting Sustainable Practices Through Energy Engineering and Asset Management	1
Recent Developments in Vietnamese Business and Finance	1
Refrigeration Science and Technology	1
Resources, Conservation and Recycling	1
Romanian Biotechnological Letters	1
Social Responsibility Journal	1
Springer Proceedings in Business and Economics	1
Supply Chain Forum	1
Sustainable Development	1
Sustainable Energy Technologies And Assessments	1
Technology In Society	1
Wpom-Working Papers On Operations Management	1

which means environmental activities are gaining popularity. Fig. 9 illustrates the 44 cited countries in this sample. India has the highest number, with a total of 438. India is one of the

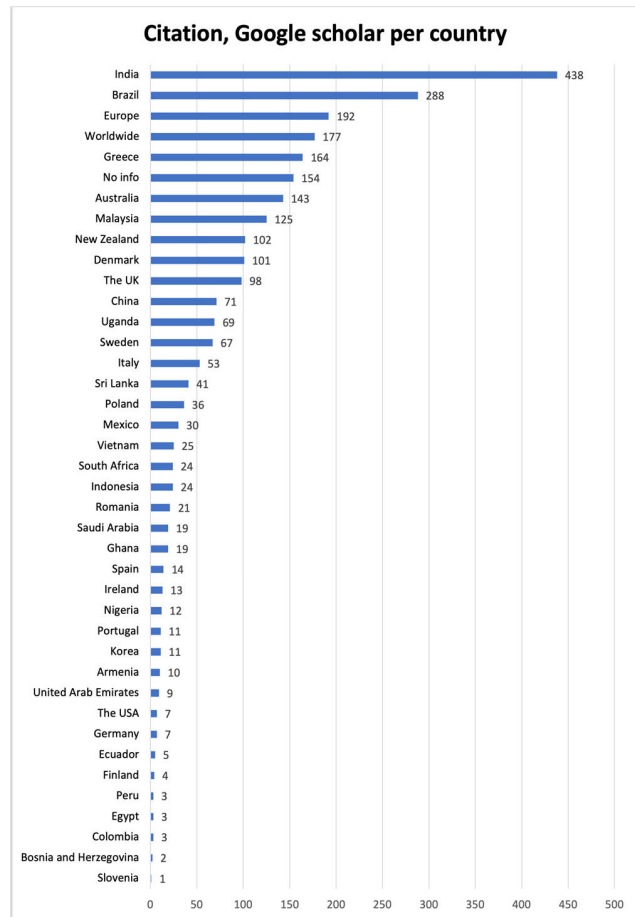


FIGURE 9. Graph of most cited countries of the research area. The citation was gathered using Publish or Perish software.

countries that generate the most articles and has a large rural economy with a high potential for sustainable technologies. In second place is Brazil, with 288 citations. Europe has 192 citations highlighting the importance of the topic.

RQ2: Which are the successful countries involved in waste management and recycling for SMEs?

E. THE REGIONS THAT OPERATE THE MOST ON ENVIRONMENTAL ACTIVITIES IN SMEs

Fig. 10 shows ten generalized regions where SMEs are located and research was conducted. Europe's lead seems to indicate the widest attention to environmental activities there. Southeast Asia is 2nd, with Indonesia and Malaysia having successful examples of environmental activities by SMEs.

RQ4: What industries contribute and participate the most in environmental activities?

F. DIVISION OF SMEs BY SECTOR

Figure 11 presents the division of papers by industry. The most significant industry with environmental activities is manufacturing. Production is generally associated with a negative impact on the environment. Some industries are distin-

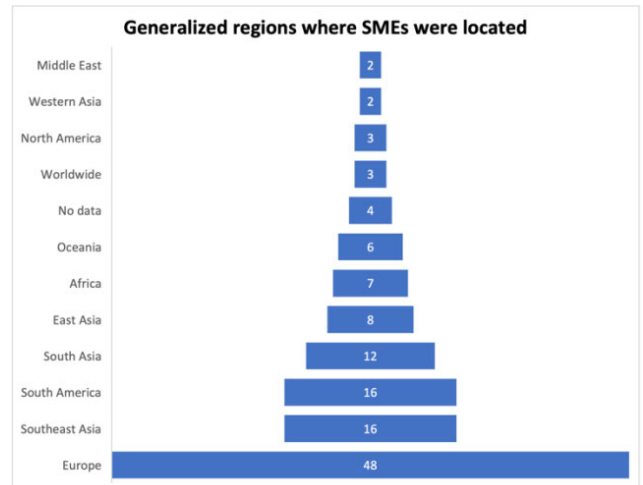


FIGURE 10. Generalized regions where SMEs were located.

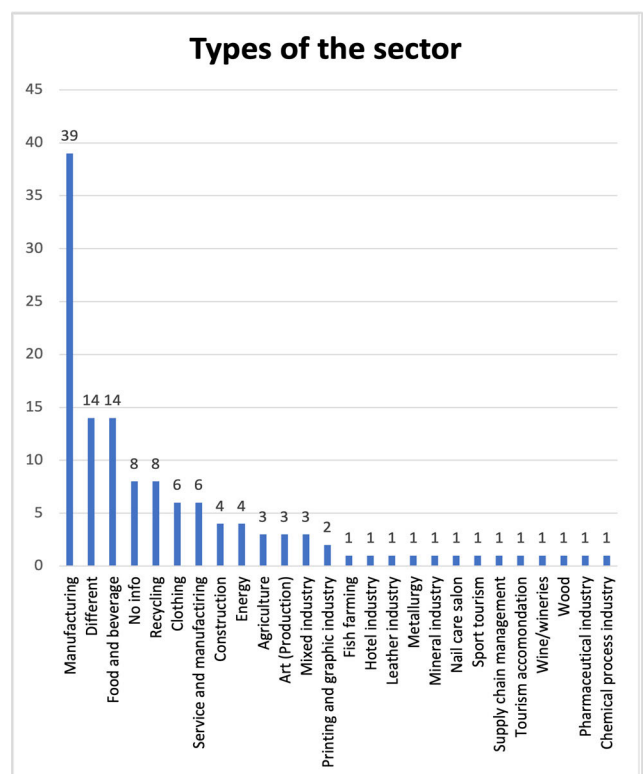


FIGURE 11. Types of the SMEs sectors.

guished by the significant harm they cause to nature, while others are somewhat less. Manufacturing can be singled out as the industry that causes tremendous environmental damage. According to modern trends, the sector includes three types of economic activity: mining; manufacturing; production, and distribution of electricity, gas, and water. Enterprises of all three of these sectors cause damage to the environment to one degree or another. Therefore, manufacturing is one of the highest polluting industries, and it is not surprising that it is also the first to implement environmental activities.

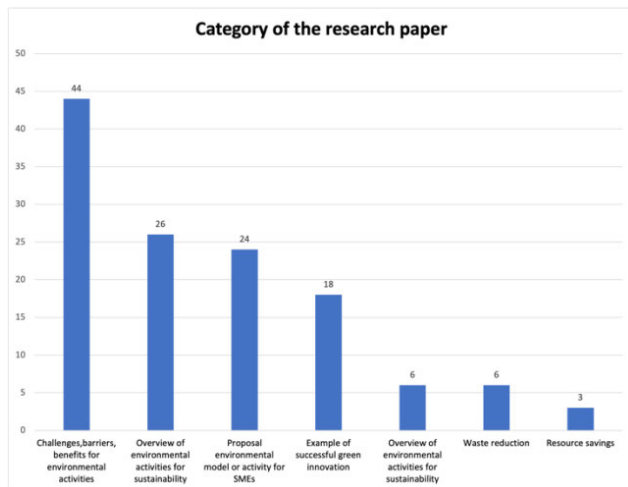


FIGURE 12. Categories of environmental topics in the research papers.

The most damage is caused to nature by industrial enterprises producing chemical and metallurgical products, coke, and petroleum products, rubber and plastic products, electricity, and oil and gas. There is an inverse relationship between the level of industrial development of a city or region and its environmental situation. Cities with powerful industrial complexes are characterized by intense pollution of atmospheric air, water bodies, and territory.

RQ3: What are successful models for environmental activities and practices in SMEs?

With 44 out of 127 (34.7%) documents relating to challenges/barriers/drivers for environmental activities, these emerged as the main topics of research (Fig. 12). Another topic of interest in environmental activities is the overview of sustainable environmental activities; with proposals for environmental models and activities for SMEs, representing 20% and 19% of the publications, respectively. The other positions are associated with waste reduction, management, and resource savings. As future research topics, examples of real-world waste management practices or applications of resource savings can be studied. Research can be narrowed to a specific size of enterprise or industry.

IV. CONCLUSION

The impact of SMEs on the environment is significant, even though it may not be immediately apparent. The benefits of environmentally friendly production are becoming increasingly evident to more enterprises: raw and other materials costs are reducing, and with the observance of environmental standards, customer relations and the images of companies are improving. Despite this, however, the capabilities of such enterprises are often limited, and not all businesses understand the competitive advantages that good environmental practices can bring.

Increased attention to the problems of preserving the environment, reducing the negative impact of economic activity, and developing a “green” economy has become a global

trend. Modern businesses should interrelate economic, social, and environmental achievements in a sustainable manner. Businesses and the government should play a leading role in this. The government can motivate businesses to cause less harm to the environment.

The study discusses examples of environmental practices and their role and position in SMEs. The papers considered demonstrate the relevance and potential of this topic. In many articles, the concepts of “green” economy, eco-innovation, and environmental practices are defined; barriers, drivers, and challenges in the transition to environmentally oriented activities of enterprises are identified; and the experience and directions of eco-business are considered. We have identified eight environmental practices: eco-design, cleaner production, sustainable supply chain management, following environmental certification and reporting, energy efficiency and renewable energy, circular economy, green marketing and communication, environmental collaboration, and partnerships. We have found the most popular examples of successful models for SMEs’ environmental activities and practices. The most effective approach for a particular SME will depend on its specific context and goals.

The societal implications of the existing solutions provided by environmental practices lend a better understanding of their usage in SMEs. This study tries to increase awareness and heighten future interest in development and research on this topic. The practical implications of the paper allow businesses to study and learn about the various opportunities available for sustainable economic, social, and environmental development. SME owners can use our findings as motivation and ideas on how to be more sustainable and cause less harm to the environment. The theoretical implications lie in exploring and structuring existing knowledge on environmental practices in the SME context and finding research gaps and future research topics.

The current trends and most promising areas of environmental development activities and sustainable business practices in the SME context are identified in this study. The data were collected using the PRISMA methodology, and the Kitchenham methodology was used for the SMS. Five databases were used and searched for the study.

As the number of papers increases each year, the issue of sustainable development for SMEs is being pursued widely. Companies have adjusted their business strategies according to environmental considerations and sustainable goals.

During our research, we identified several focus areas in the development of environmental activities in SMEs; it is necessary and exciting to focus the attention and effort of the professional community on their practical applications for SMEs, startups, and academics. We identify the following promising areas for the development of eco-innovation and environmental activities in research:

- Biogas, biofuel, and biomass usage for energy production.

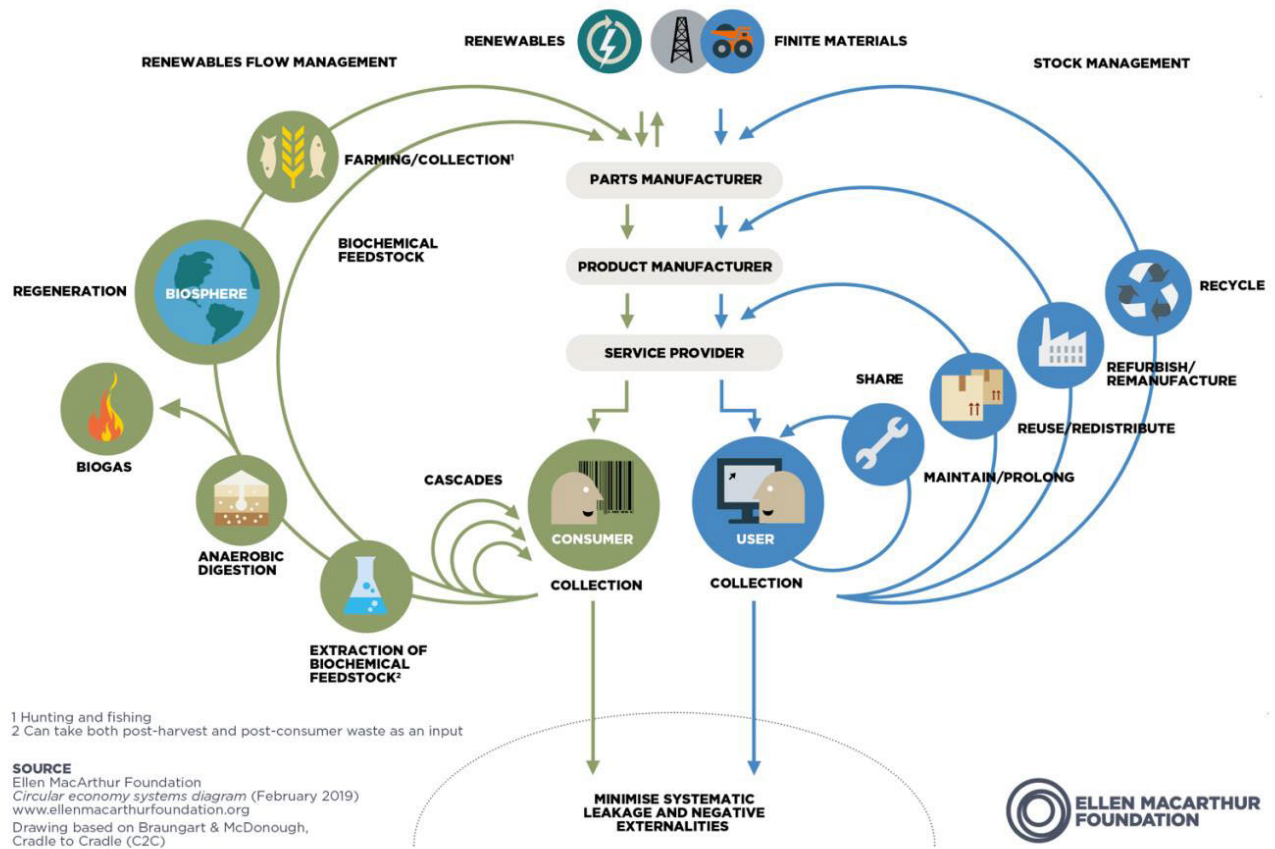


FIGURE 13. Biological and technical material created by ellen MacArthur foundation [52].

- Recycling and reusing packaging, tires, and other materials to create new components.
- Concrete recycling.
- Eco-designing.
- Reuse of wastewater.
- Recycling of printed circuits.

As future research topics, examples of real-world waste management practices or applications of resource savings can be studied. Research can be narrowed to a specific size of enterprise or industry. We recommend researching successful examples of SMEs in these areas. The fact that these examples were not presented in our sample does not mean that they do not exist in academia or as real-world examples; it only means they did not meet the criteria of our keyword search. Future research can relate to eco-farming or eco-collection of resources or their regeneration; opportunities, challenges, and success and failure factors can also be studied. Sharing resources or materials and using remanufacturing approaches effectively in SMEs are other topics for future research.

It is possible to identify a small group of countries and regions that are the main environmental SME actors; this would serve as segmentation for researchers to know where they can visit and gather information easily. The research

development shows that countries like India, Brazil, and several European countries have many eco-innovations.

Thus, examples of functioning green businesses are presented in the literature, but they are still in their infancy. It should be remembered that the rapid development of any business, including the environment, is possible, provided it is economically efficient and sustainable. The task of the government is to support eco-business more actively and effectively, which will further facilitate the transition of enterprises and companies to a green economy. In conclusion, we outline the main advantages and disadvantages of environmental entrepreneurship. This would help identify the most promising actions for public authorities in activating green businesses.

In the presented literature, we highlighted exciting findings on what can be done to increase initiatives on environmental practices [73], [74], [75], [76], [77], [78]. The company can request an audit from a qualified agency to examine and identify bottlenecks and possible eco-innovations [77]. It is necessary to raise awareness among companies about the optimization and reduction of water, heat, and electricity consumption. There are successful implementations of available technologies for wastewater treatment and atmospheric emissions [64], [74], [79]. The company may try to reduce the total

TABLE 7. Papers investigated.

Author	Title
Ojeda-Safra, Orlando, et al.	A Model for Increasing Palm Oil Production Efficiency at an Agro-Industrial Company through Lean Manufacturing
Amalia, Nasyita Vivi, et al.	Determination of The Location Allocation For Recycling and Collection Centers of Batik Wastewater Treatment Equipment
Schroeder, Adriano Michelotti, et al.	Recycle and Reuse Process of E-Waste (Printed Circuit Boards) in Brazil: A Case Study
Rojas-Benites, Sergio, et al.	Reduction of Waste in an SME in the Meat Sector in Peru through a Lean Manufacturing Approach Using a Model Based on 5S, Standardization, Demand Forecasting and Kanban
Valverde-Curi, Harwi, et al.	Lean Management Model for Waste Reduction in the Production Area of A Food Processing and Preservation SME
A. A. Rumanti, et al.	Cleaner Production for Small and Medium Enterprises: An Open Innovation Perspective
C. Irvine, et al.	Environmental management toolkit for SMEs in the NPA — A model of engagement
G. F. Estupendo, et al.	“Life After Coal”: Renewable Energy Impacts on SME Conduct
L. Hilger, et al.	Use of smart technologies for energy efficiency, energy- and load management in small and medium sized enterprises (SMEs)
R. L. K. Lokuliyana, et al.	Process optimization for SME level biodiesel production from waste cooking oil
Bakos, J, et al.	An analysis of environmental sustainability in small & medium-sized enterprises: Patterns and trends
Baranova, P, et al.	Environmental capabilities of small and medium sized enterprises: Towards transition to a low carbon economy in the East Midlands
Vargas, B, et al.	Application Of Resource Efficient And Cleaner Production Through Best Management Practice In A Pallet Manufacturer Sawmill Located In The City Of Puyo-Ecuador
Cuc, S, et al.	Redesign and upcycling - a solution for the competitiveness of small and medium-sized enterprises in the clothing industry
Alfaro, MTB, et al.	Impact of Green Initiatives on the Financial Performance of Small and Medium Enterprises: The Case of Manufacturing Firm in Central Luzon
Meath, C, et al.	Barriers and motivators to the adoption of energy savings measures for small- and medium-sized enterprises (SMEs): the case of the ClimateSmart Business Cluster program
Reyes-Rodriguez, JF, et al.	Corporate Environmental Sustainability in Danish SMEs: A Longitudinal Study of Motivators, Initiatives, and Strategic Effects
Kurtagic, SM, et al.	Selection and implementation of pollution prevention techniques in small and medium enterprises in countries in transition
Sohal, A, et al.	Australian SME's experience in transitioning to circular economy
Lewis, KV, et al.	SMEs and the Potential for A Collaborative Path to Environmental Responsibility
Wielgorka, D, et al.	Eco-innovation of enterprises operating in Poland against the background of EU countries
Reyes-Rodriguez, JF	Explaining the business case for environmental management practices in SMEs: The role of organisational capabilities for environmental communication
Oncioiu, I, et al.	White biotechnology - a fundamental factor for a sustainable development in Romanian SMEs
Thekkoote, R	A framework for the integration of lean, green and sustainability practices for operation performance in South African SMEs
Reyes-Rodriguez, JF, et al.	Justifying environmental sustainability in small- and medium-sized enterprises: An analysis of complementary assets in the printing industry
Grigoras, G, et al.	An Advanced Decision Support Platform in Energy Management to Increase Energy Efficiency for Small and Medium Enterprises

TABLE 7. (Continued.) Papers investigated.

D'Souza, C, et al.	Small and medium size firm's marketing competitive advantage and environmental initiatives in the Middle East
Prashar, A	Eco-efficient production for industrial small and medium-sized enterprises through energy optimisation: framework and evaluation
Nunes, JRR, et al.	Cleaner Production in small companies: Proposal of a management methodology
Adomako, S	Environmental collaboration, sustainable innovation, and small and medium-sized enterprise growth in sub-Saharan Africa: Evidence from Ghana
Nguyen, NP, et al.	Stakeholder pressure for eco-friendly practices, international orientation, and eco-innovation: A study of small and medium-sized enterprises in Vietnam
Jo, D, et al.	Structure of Green Supply Chain Management for Sustainability of Small and Medium Enterprises
Knight, H, et al.	Firm resources and the development of environmental sustainability among small and medium-sized enterprises: Evidence from the Australian wine industry
Darmandieu, A, , et al.	How does it pay to be circular in production processes? Eco-innovativeness and green jobs as moderators of a cost-efficiency advantage in European small and medium enterprises
Abu, NH, et al.	The Best Malaysian Small and Medium Enterprises Practices in Solid Waste Management: A Case Study
de Guimaraes, JCF, et al.	The influence of entrepreneurial, market, knowledge management orientations on cleaner production and the sustainable competitive advantage
Pacheco, DAD, et al.	Eco-innovation determinants in manufacturing SMEs from emerging markets: Systematic literature review and challenges
Epoh, LR, et al.	Green supply chain management in small and medium enterprises: Further empirical thoughts from South Africa
Ashton, WS, et al.	Contribution of green manufacturing for realizing business performance in Indian small and medium scale organizations (SME's)
Demirel, P, et al.	Pathways to cleaner production in the Americas I: bridging industry-academia gaps in the transition to sustainability
Hussain, Z, et al.	Eco-innovation and firm growth in the circular economy: Evidence from European small- and medium-sized enterprises
Nikolaou, IE, et al.	Waste to energy and circular economy: the case of anaerobic digestion
Chan, W, et al.	The response of small and medium-sized enterprises to potential water risks: an eco-cluster approach
Munguia, N, et al.	Converted Heat Pumps for Small- and Medium-Size Hospitality Enterprises: More Energy Saving and Commercialization
Yfantidou, G, et al.	A more sustainable nail care service
Foschi, E, et al.	The Interest of Sport Tourism Enterprises in Green Practices
Cornejo-Canameres, M, et al.	Combining Eco-Design and LCA as Decision-Making Process to Prevent Plastics in Packaging Application
Carfora, A, et al.	Environmental objectives and non-technological innovation in Spanish manufacturing SMEs
Geng, DY, et al.	Determinants of environmental innovations supporting small- and medium-sized enterprises sustainable development
Majumdar, A, et al.	Eco-innovation and its role for performance improvement among Chinese small and medium-sized manufacturing enterprises
Wielgorka, D	Modeling the barriers of green supply chain management in small and medium enterprises A case of Indian clothing industry
Meegoda, JN, et al.	Environmental management in the aspect of sustainable development in micro-, small-, and medium-sized enterprises
	Community Based Pollution Prevention for Two Urban Cities-A Case Study

TABLE 7. (Continued.) Papers investigated.

Ghadimi, P, et al.	Analysis of enablers on the successful implementation of green manufacturing for Irish SMEs
Niemist, J, et al.	Benefits and challenges of streamlined life-cycle assessment for SMEs - findings from case studies on climate change impacts
Yang, D	What Should SMEs Consider to Introduce Environmentally Innovative Products to Market?
Khoja, F, et al.	How SMEs benefit from environmental sustainability strategies and practices
Dayaratne, SP, et al.	Carbon footprint reduction: a critical study of rubber production in small and medium scale enterprises in Sri Lanka
Rita, DIG, et al.	Proposal of a green index for small and medium-sized enterprises: A multiple criteria group decision-making approach
Campo, R, et al.	Think Green: the Eco-innovative Approach of a Sustainable Small Enterprise
Karlsson, NPE, et al.	Success factors for agricultural biogas production in Sweden: A case study of business model innovation
Grosse, M, et al.	Lessons Learned from Establishing the Energy-Informatics Business Model: Case of a German Energy Company
Yu, H, et al.	A Contemporary Issue of Micro-Foundation of CSR, Employee Pro-Environmental Behavior, and Environmental Performance toward Energy Saving, Carbon Emission Reduction, and Recycling
Siegel, R, et al.	Integrated green lean approach and sustainability for SMEs: From literature review to a conceptual framework
Onyido, TB, et al.	Developing SMEs as environmental businesses
Siegel, R, et al.	A framework for the systematic implementation of Green-Lean and sustainability in SMEs
Badraddin, AK, et al.	Main Challenges to Concrete Recycling in Practice
Badraddin, AK, et al.	Critical Success Factors for Concrete Recycling in Construction Projects
Cantu, A, et al.	Learning from Failure and Success: The Challenges for Circular Economy Implementation in SMEs in an Emerging Economy
Coles, T, et al.	Climate change mitigation and the age of tourism accommodation buildings: a UK perspective
Gao, S, et al.	Identifying critical failure factors of green supply chain management in China's SMEs with a hierarchical cause-effect model
Thanki, S, et al.	An investigation on lean-green implementation practices in Indian SMEs using analytical hierarchy process (AHP) approach
Mady, K, et al.	Drivers of multiple eco-innovation and the impact on sustainable competitive advantage: evidence from manufacturing SMEs in Egypt
Revelo, CF, et al.	Composite materials made of waste tires and polyurethane resin: A case study of flexible tiles successfully applied in industry
Catarino, J, et al.	Eco-efficiency in Portuguese companies of marble sector
Navarro, D, et al.	Circular economy: The case of a shared wastewater treatment plant and its adaptation to changes of the industrial zone over time
Cariola, A, et al.	Environmental sustainability policies and the value of debt in EU SMEs: Empirical evidence from the energy sector
Yacob, P, et al.	An empirical investigation of green initiatives and environmental sustainability for manufacturing SMEs
Gatto, F, et al.	Circular Bioeconomy Business Models to Overcome the Valley of Death. A Systematic Statistical Analysis of Studies and Projects in Emerging Bio-Based Technologies and Trends Linked to the SME Instrument Support
Maye, D, et al.	Transformative potential from the ground up: Sustainable innovation journeys, soft change and alignment of interests in urban food initiatives
Abiye, OE, et al.	Atmospheric dispersion modeling of uncontrolled gaseous pollutants (SO ₂ and NO _x) emission from a

TABLE 7. (Continued.) Papers investigated.

	scrap-iron recycling factory in Ile-Ife, Southwest Nigeria
Singh, M, et al.	Analysis and prioritization of Lean Six Sigma enablers with environmental facets using best worst method: A case of Indian MSMEs
Rahmadyanti, E, et al.	IMPLEMENTING CLEANER PRODUCTION AS AN ENVIRONMENTAL MANAGEMENT EFFORTS IN SMALL INDUSTRIES OF CASSAVA CHIPS
Jiao, JL, et al.	What factors determine the survival of green innovative enterprises in China? --A method based on fsQCA
Shaharudin, MS, et al.	Low Carbon Footprint: The Supply Chain Agenda in Malaysian Manufacturing Firms
Diana, GC, et al.	Putting environmental technologies into the mainstream: Adoption of environmental technologies by medium-sized manufacturing firms in Brazil
Ramos, S, et al.	SENSE tool: easy-to-use web-based tool to calculate food product environmental impact
Makropoulos, C, et al.	Sewer-mining: A water reuse option supporting circular economy, public service provision and entrepreneurship
Ghadge, A, et al.	Implementing environmental practices within the Greek dairy supply chain Drivers and barriers for SMEs
Balasubramanian, S, et al.	Firm size implications for environmental sustainability of supply chains: evidence from the UAE
Lotito, AM, et al.	Biomethanization of citrus waste: Effect of waste characteristics and of storage on treatability and evaluation of limonene degradation
He, F; Miao, X, et al.	Contemporary corporate eco-innovation research: A systematic review
Ruiz-Carmona, O., et al.	Solid Biofuels Scenarios from Rural Agricultural and Forestry Residues for Mexican Industrial SMEs
Dragomir, M., et al.	How Well Are Manufacturing Companies in Transylvania, Romania Adapting to the Low-Carbon Economy in Order to Become Sustainable?
Errigo, A., et al.	Techno-economic-environmental impacts of industrial energy assessment: Sustainable industrial motor systems of small and medium-sized enterprises
Sharma, H.P., et al.	Developing and Implementing Environment Management Practices in Small and Medium Size Manufacturing Companies in India
Franco, M., et al.	Sustainable practices in SMEs: reducing the ecological footprint
Wysocki, J.	Innovative green initiatives in the manufacturing sme sector in Poland
Bagire, V., et al.	Waste as Business: Emerging Ugandan micro- and Small-sized Businesses in Resource Recovery and safe Reuse
Khalid, N.I, et al.	Stability of electrolyzed water: From the perspective of food industry
Noranartakun, P, et al.	Strategic implementation to enhance green industry practices in smes: Lesson learned from Thailand
Dijkstra, H. , et al.	In the business of dirty oceans: Overview of startups and entrepreneurs managing marine plastic
Joseph, S., et al.	Creating sustainable contribution to the environment: Case studies from MSMEs in Pune
Fadly, D.	Greening industry in Vietnam: Environmental management standards and resource efficiency in SMEs
Famiola, M., et al.	SMEs' social and environmental initiatives in Indonesia: an institutional and resource-based analysis
Sodhi, H.S., et al.	An empirical investigation to evaluate the relationship between success factors of Lean Six Sigma and waste management issues
Brezavšček, A., et al.	Impact of green IS practices on organizational benefits: The perspective of SMEs managers
Khan, M.P., et al.	The development of a sustainability framework via lean green six sigma practices in SMEs based upon RBV theory
Hampton, S., et al.	Growing greener: Creating a New Values-based Environmental Engagement Toolkit for SME Intermediaries

TABLE 7. (Continued.) Papers investigated.

D'Adamo, L., et al.	Towards sustainable recycling processes: Wasted printed circuit boards as a source of economic opportunities
Drobnik, P., et al.	Economic and environmental benefits from carbonized biomass use for energy purposes - Case study for the community from southern part of Poland
Namagembe, S., et al.	Green supply chain practice adoption and firm performance: manufacturing SMEs in Uganda
Pinheiro, E., et al.	Reverse logistics processes and textile waste: Study in a clothing cluster
Mirzoyan, N., et al.	Groundwater use and efficiency in small- and medium-sized aquaculture farms in Ararat Valley, Armenia
Zocca, R., et al.	Computational tool to foster systematic thinking and sustainable environmental conscience in the selection of energy sources systems in agrifood companies
Kamarudin, A.B., et al.	Characterizing SME sustainable (green) performance in the green economic transition through the adoption of green management
Susanty, A., et al.	Achieving cleaner production in SMEs batik toward innovation in production process
Conway, E.	Engaging small and medium-sized enterprises (SMEs) in the low carbon agenda
De Giorgi, Claudia, et al.	Development and results of a cross border network project, aimed at the engineering of eco-compatible products
Fonseca, Joana P.C., et al.	Analyzing determinants of environmental conduct in small and medium-sized enterprises: A sociotechnical approach
Matinaro, Ville; Liu, Yang, et al.	Extracting key factors for sustainable development of enterprises: Case study of SMEs in Taiwan
Nudurupati, Sai Sudhakar, et al.	Transforming sustainability of Indian small and medium-sized enterprises through circular economy adoption
Prashar, Anupama	Towards sustainable development in industrial small and Medium-sized Enterprises: An energy sustainability approach
Duncan, Tom	Chapter 4.3 - Case Study: Taranaki Farm Regenerative Agriculture. Pathways to Integrated Ecological Farming
Ginting, Yogie Rinaldy, et al.	Advancing Environmentally Conscious Machining
Barbieri, Renata, et al.	Sustainable business models and eco-innovation: A life cycle assessment
Parekh, Nishita, et al.	Influencing factors and challenges to energy management and energy efficiency for chemical process SMEs in India

amount of waste generated during production and the amount of waste transferred to landfills for disposal [73], [75]. For example, this can be achieved by returning scrap and waste to production and recycling it. In several industries, recycling more than 80% of waste, such as plastic, wood, cullet, tetra packs, and organic waste is already possible. The government can help with preferential taxes for environmentally friendly SMEs. We recommend that future researchers explore this topic, as it benefits SMEs, entrepreneurs, and business owners. The advantages and disadvantages are presented in Table 5.

Limitations of our research

- Limited to publications in English from 2015- 2022.
- Focusing only on academic publications: journals, conference proceedings, and peer-reviewed books.

A. FUTURE RESEARCH WORK

We have identified some research gaps. Many papers concentrated on the challenges, barriers, and benefits of environmental activities, and some focused on proposed models

of environmental actions for more sustainable companies. We recommend that future researchers focus on the successful examples of waste management and recycling innovation that SMEs have produced and integrate them for future use. Their implications and scalability can be examined.

As one of the goals of the current research was to provide future topics and study areas, we propose several research questions which can be explored in the context of environmental activities; these may aid future research that explores the role of both environmental practices and eco-innovations of SMEs. It can help SMEs reach their environmental missions and produce new ideas by combining existing solutions or collaborating with other companies.

These research questions can be a starting point for future research.

RQ1: What environmental practices exist in SMEs that can be produced or implemented? RQ2: How do SMEs in waste management and recycling become successful? RQ3: What are the successful models for SMEs' environmental activities and practices? RQ4: What are the challenges, barriers, and benefits of environmental and eco-innovations in SMEs? RQ5: What are the failure factors for the implementation of eco-innovation? RQ6: How can a company combine existing biological and technical techniques to become circular?

As future research topics, examples of real-world waste management practices or applications of resource savings can be studied. Research can be narrowed to a specific size of enterprise or industry. We advise researching successful examples of SMEs in these areas. The fact that these examples were not presented in our sample does not mean that they do not exist in academia or as real-world examples; it means they did not meet the criteria of our keyword search. Another suggestion can be the study of the model's synergy of environmental practices: what is the level and amount of environmental practices that should be applied in the company for total zero-waste production and sustainable development? Future research can relate to eco-farming or eco-collection of resources or their regeneration, opportunities, and challenges in this field, and success and failure factors can be studied. Sharing resources or materials and using remanufacturing approaches effectively in SMEs are other opportunities for future research.

APPENDIX A

See Table 6.

APPENDIX B

See Table 7.

APPENDIX C

See Figure 13.

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