The Nexus of Innovation and Sustainable Development: An econometric study of Algerian SMEs

العلاقة بين الابتكار والتنمية المستدامة: دراسة قياسية للمؤسسات الصغيرة والمتوسطة بالجزائر

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Abstract:

This study uses the least squares method to estimate a linear regression model to determine the impact of innovation on the economic, social, and environmental dimensions of sustainable development in small and medium enterprises (SMEs) in Algeria. Data from the period 2010-2021 were analyzed using EViews-12 software. The results show that innovation in SMEs has a significant positive impact on the economic dimension of sustainable development. However, there is a weak statistical correlation between innovation in SMEs and the social dimension of sustainable development. Finally, we find no correlation between innovation in SMEs and the environmental dimension of sustainable development. These results suggest that innovation in (SMEs) is an important driver of economic growth in Algeria, but it does not necessarily lead to improvements in social or environmental sustainability.

Keywords: Algeria; innovation; linear regression; SMEs; sustainable development.

JEL Classification Codes : C13, L25, O31, Q56

ملخص:

تستخدم الدراسة طريقة المربعات الصغرى لتقدير نموذج الانحدار الخطي لتحديد أثر الابتكار على الأبعاد الاقتصادية والاجتماعية والبيئية للتنمية المستدامة في المؤسسات الصغيرة والمتوسطة بالجزائر. تم تحليل البيانات من الفترة 2010-2021 باستخدام برنامج EViews-12. تظهر النتائج أن الابتكار في المؤسسات الصغيرة والمتوسطة له تأثير إيجابي مهم على البعد الاقتصادي للتنمية المستدامة. ومع ذلك، هناك ارتباط إحصائي ضعيف بين الابتكار في المؤسسات الصغيرة والمتوسطة والبعد الاجتماعي للتنمية المستدامة. أخيرًا، لم نجد أي ارتباط بين الابتكار في المؤسسات الصغيرة والمتوسطة والبعد البيئي للتنمية المستدامة. تشير هذه النتائج إلى أن الابتكار في المؤسسات الصغيرة والمتوسطة هو محرك مهم للنمو الاقتصادي في الجزائر، لكنه لا يؤدي بالضرورة إلى تحسينات في الاستدامة الاجتماعية أو البيئية.

كلمات مفتاحية: الجزائر، انحدار الخطي، ابتكار، تنمية مستدامة، مؤسسات صغيرة ومتوسطة.

تصنيفات JEL: C13،L25 ،O31 ،Q56

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INTRODUCTION:

Innovation in small and medium enterprises (SMEs) plays a vital role in promoting sustainable development. In the words of Ban Ki-moon, the former UN Secretary-General, "We need to think outside the box and innovate to find solutions to the challenges of sustainable development"(KI-MOON et al., 2017, p. 48). However, much is still not understood about the relationship between innovation in SMEs and sustainable development. Small and medium-sized enterprises (SMEs) are a significant driver of sustainable development, playing a vital role in most economies around the world, especially in developing and emerging nations. Over the last ten years, studies as (Bouazza, 2015; Teneggi & Zandonai, 2017; Kim et al., 2018; Romanowski, 2021) have shown that by enhancing innovation within SMEs, sustainable development can be achieved through various means. Firstly, it promotes economic growth by creating new opportunities and fostering job creation. Moreover, innovation improves business competitiveness, leading to enhanced efficiency, reduced environmental impacts, and increased social responsibility. Furthermore, innovation in SMEs and enterprises contributes to economic balance, resulting in a more stable and sustainable economy. In this way, innovation in small and medium enterprises has a significant impact on sustainable development, and therefore it is important to understand the relationship between innovation in small and medium enterprises and the achievement of sustainable development in its three dimensions (economic, social and environmental).

Taking the case of Algeria as an example, it is evident that the country recognizes the significance of creativity and innovation within SMEs. Algeria, like many other nations, proactively endeavors to promote and encourage innovation in SMEs, acknowledging its vital role in enhancing competitiveness, growth, and sustainability. By fostering innovation, Algeria aims to reap the positive effects of economic growth, job creation, profitability, and sustainable development.

On this basis, the study problem can be formulated as follows:

Does promoting innovation in Algerian small and medium enterprises (SMEs) contribute to achieving sustainable development?

Our study is based on the hypothesis that innovation in small and medium enterprises (SMEs) can drive the adoption of sustainable practices and technologies, leading to sustainable development in Algeria across economic, social, and environmental dimensions.

The study aims to provide a comprehensive understanding of the role of innovation in SMEs in achieving the Sustainable Development Goals (SDGs). It does this by examining the current state of innovation in SMEs and its impact on sustainable development. The study also identifies the key challenges and opportunities facing SMEs in terms of innovation and sustainable development.

The importance of the study lies mainly in the attempt to model a mathematical equation linking the dimensions of sustainable development and innovation in small and medium enterprises, in addition to determining the role that enterprises play in sustainable development. So that understanding how innovation within small and medium enterprises can promote sustainable development. Understanding the relationship between innovation and sustainable development can help organizations make informed decisions about how to invest

in sustainable practices and technologies. Finally, a study in this area can also provide insight and guidance on how to measure the impact of innovation and sustainable development and establish a framework for monitoring progress and evaluating the effectiveness of policies and programs supporting SMEs.

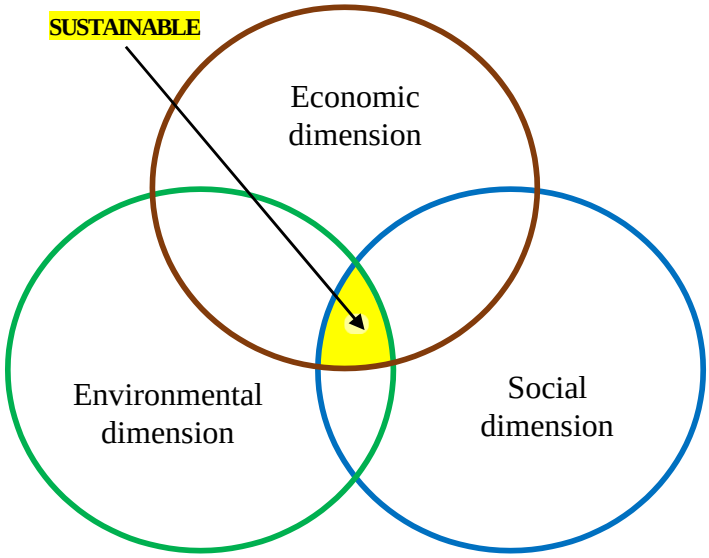
The paper is organized into five main sections. Section1 provides an overview on the theoretical foundations. Section 2 focuses on the previous literature on the topic. Section 3 provide the reality of small and medium (SMEs) enterprises in Algeria. Section 4 outlines the empirical framework used in the study. Section 5 presents and discusses the quantitative outcomes of the research, followed by a conclusion that offered recommendations based on these findings.

1- Theoretical foundations:

1-1 Concepts of Sustainable Development

Sustainable development has gained significant attention in recent years, particularly in the context of economic growth and progress. Sustainable development was defined by the United Nations World Commission on Environment and Development (commonly referred to as the 'Brundtland Report') as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs"(UN, 1987). It encompasses the notion of meeting present needs while safeguarding the ability of future generations to fulfill their own needs. It is necessary to ensure that the economy meets the needs of its citizens while also providing for future generations. (Hall & Vredenburg, 2003, p. 43). It is a long-term structural strategy for the world's economic and social systems, which aims to reduce the burden on the environment and on natural resources to a permanently viable level, while still maintaining economic growth and social cohesion (Kirkby et al., 2023, p. 7). Sustainable development consists of three dimensions: economic growth, social inclusion, and environmental protection. These dimensions are integrated and indivisible, and balance is sought among them.

Fig (1): The three components of sustainable development



Source: prepared by the authors.

The economic dimension of sustainable development aims to ensure that economic growth occurs in harmony with nature and that all human beings can enjoy prosperous and fulfilling lives. It is concerned with promoting economic growth and creating jobs while ensuring that economic activities are sustainable and do not harm the environment (Ahmed, 2010, p. 239). The social dimension of sustainable development aims to foster peaceful, just, and inclusive societies that are free from fear and violence (Pawłowski, 2008, p. 89). It is concerned with promoting social inclusion, reducing inequality, and ensuring that all people have access to basic services such as health care, education, and clean water. The environmental dimension of sustainable development aims to protect the planet and its natural resources (Koseoglu et al., 2022, p. 979). It is concerned with promoting environmental protection, reducing greenhouse gas emissions, and preserving biodiversity.

1-2 Concepts of small and medium-sized enterprises (SMEs)

Small and medium-sized enterprises have received significant attention and interest from various international organizations and economic researchers. They are recognized as one of the key drivers of economic development due to their agility and other distinctive characteristics. These enterprises play an effective role in fostering economic growth, making them an essential component of any economy. They generate a substantial number of jobs and contribute significantly to overall economic advancement. Moreover, they promote healthy competition, that leads to the development of superior products and services for consumers.

The exact definition of what constitutes an SME can vary depending on the country or region, but is generally determined based on factors such as number of employees and annual revenue. For example, in the European Union, an SME is defined as an enterprise with fewer than 250 employees and annual revenues of less than €50 million (Kraemer-Eis & Passaris, 2015, p. 97). In the United States, the Small Business Administration (SBA) defines a small enterprise as one that is independently owned and operated, not dominant in its field, with a maximum of 500 employees and up to $7.5 million in average annual revenues (Dilger, 2016, p. 59). As for the definition of the European Commission: “The small enterprise is the one that includes between 10 and 49 workers, wage-earners, while the medium enterprise is the one that employs between 50 and 250 workers and is characterized by its independence”(Kurek & Rachwał, 2011, p. 403).

According to articles 5-7, the Algerian law defines these institutions as follows: For a small enterprise: it is defined as an enterprise that employs 10 to 49 people, its turnover does not exceed 200 million DZD, total annual budget not exceed 100 million DZD. For the medium enterprise: It is defined as an institution that employs 50 to 250 people, and its turnover ranges between 200 million and 2 billion DA, and its total annual budget ranges between 100 million and 500 million DA.

Table (1): Classification of small and medium enterprises in Algeria

Standard	very small or mini	small	medium
Number of workers	From 01 to 09 people	From 10 to 49 people	From 50 to 250 people
Business Number	Less than 40 million DZD	does not exceed 400 million DZD	From 400 million to 04 billion DZD
annual tally	Not exceeding 20 million DZD	does not exceed 200 million DZD	From 200 million to one billion DZD

Source: Ministry of Industry and Pharmaceutical Production, available at: https://www.industrie.gov.dz/soutien-pme/

1-3 Definition of Innovation

Innovation and creativity are key concepts for the success and growth of small and medium enterprises (SMEs). Innovation refers to the introduction of new or improved products, services, processes, or business models that lead to increased efficiency, effectiveness, or competitiveness (Gil-Gomez et al., 2020, p. 2738). On the other hand, creativity refers to the ability to generate new ideas and think outside the box (Mazla et al., 2020, p. 214). Together, innovation and creativity can help SMEs differentiate themselves from their competitors and create a sustainable competitive advantage. Small and medium enterprises are often considered to be at the forefront of innovation, as they are more flexible and able to respond quickly to changes in the market. They are also more willing to take risks and try new ideas, which can lead to the development of new products and services. Additionally, SMEs often have a closer relationship with their customers, which can provide valuable insights into customer needs and preferences, enabling them to develop products and services that are more in line with customer needs.

Innovation is important for small and medium enterprises, as it allows them to come up with new solutions to problems. It enables SMEs to develop new products and services, as well as improve existing products and services, in order to meet the changing needs of their customers. In addition, creativity also helps SMEs to develop new business models, which can enable them to operate more efficiently and effectively. In addition, it can help them increase their market share by establishing new markets and expanding into new geographies. Moreover, by innovating and creating new products and services, SMEs can also increase their revenues and profits, which can contribute to their long-term sustainability. However, it is important to note that innovation and creativity are not always easy to achieve and require a culture of innovation, where employees are encouraged to think creatively and take risks. Moreover, it requires resources, such as time, money, and access to information, to support the development and implementation of new ideas.

1-4 The relationship between sustainable development and innovation in SMEs

Many countries consider small and medium enterprises as the backbone of their economy, as they constitute the majority of businesses and employment opportunities. But, the relationship between sustainable development and innovation in small and medium enterprises is complex, as these enterprises can play positive and negative roles in achieving the goals of sustainable development. On the one hand, it can contribute to sustainable development by providing goods and services and contributing to economic growth.

On the other hand, they can also contribute to the negative impact on sustainable development by exploiting resources, polluting the environment, and engaging in unethical business practices. However, SMEs are well placed to contribute positively to sustainable

development, as they are often more flexible, adaptable, and responsive to market changes. They can also be more connected to their local communities and have a greater ability to respond to local needs. Additionally, SMEs often have a closer relationship with their customers, which can provide valuable insights into customer needs and preferences, enabling them to develop products and services that are more in line with customer needs (Abderrezzak et al., 2016).

2- literature review:

The last decade has witnessed an increase in focus on innovation in small and medium enterprises as a solution to achieving sustainable development. The study by Subhan et al. (2013) examines the impact of innovation in small and medium enterprises (SMEs) on economic development in Pakistan. The study uses data from 1980 to 2013 to assess the relationship between process innovation and economic development. The study identifies several factors that can help to promote process innovation in SMEs, including government support, access to finance, and a skilled workforce. The findings of the study suggest that there is a positive relationship between the two variables, meaning that as process innovation increases, so does economic development. The argues that government policies that promote process innovation in SMEs could help to boost sustainable economic growth in Pakistan.

The work of Rochdi et al. (2017) explores the relationship between entrepreneurial orientation, innovation effectiveness, and SMEs performance in Algeria. The study aims to determine whether innovation effectiveness plays a mediating role in the relationship between entrepreneurial orientation and SMEs performance and its effect to economic growth. The concept of entrepreneurial orientation refers to the strategic orientation of SMEs, characterized by their propensity to take risks, be innovative, and have a proactive and competitive mindset. The study investigates how this orientation influences the performance of SMEs in Algeria. The conclusions reached by the researchers that innovation effectiveness may act as a mediator in this relationship. Innovation effectiveness refers to the ability of SMEs to successfully implement innovative practices and transform them into tangible outcomes, such as new products, services, or improved processes.

The research conducted by Malik and Jasińska-Biliczak (2018) examines the role of innovations and other processes in the sustainable development of small and medium enterprises (SMEs) in emerging regional economies. The study finds that SMEs in emerging regional economies are increasingly adopting innovations and other processes that contribute to sustainable development. These innovations and processes include: (product innovations that reduce the environmental impact of products and process innovations that improve the efficiency of production and reduce waste). The results obtained by the authors indicate that there are a number of factors that can help SMEs in emerging regional economies to adopt innovations and other processes that contribute to sustainable development.

Another study by Kim et al. (2018) analyzes the impact of SMEs' R&D capability on patent and new product development. The authors cite several previous studies and aim to identify and analyze the impact of new product development on company performance. The authors find that there is a positive relationship between innovation type and R&D capability, and that both of these factors are positively related to patent and new product development.

The study's findings suggest that SMEs can increase their patent and new product development by focusing on improving their capability and adopting product innovation, which in turn can contribute to achieving sustainable development. By emphasizing R&D capability and product innovation, SMEs can enhance their competitiveness, generate economic growth, and promote long-term sustainability. This is because sustainable development encompasses not only economic prosperity but also social and environmental dimensions. By developing new products and technologies, SMEs can contribute to job creation, social well-being, and environmental sustainability, aligning with the principles of sustainable development. The paper authored by Abdelouahab (2018) has examines the impact of innovation on the performance of small and medium enterprises (SMEs) in Algeria. The study uses data from a survey of SMEs in Algeria to assess the relationship between innovation and performance. The study finds that there is a positive relationship between innovation and performance in SMEs in Algeria. This means that SMEs that are more innovative are more likely to perform better than SMEs that are less innovative.

The study's findings suggest that innovation can be a valuable tool for SMEs in Algeria to improve their performance. However, the study also suggests that not all types of innovation may contribute to economic growth. The analysis performed by OUADI and OUAIL (2020) examines the role of the purple economy in sustainable development in Algeria. The study defines the purple economy as "the Innovation activities that contribute to the protection and enhancement of the natural environment and the development of human well-being." The study then identifies the requirements and challenges of the purple economy in Algeria. The study finds that the purple economy has the potential to contribute to support innovation activities of SMES and that contribute to sustainable development in Algeria. The investigation carried out by Rodhiah and Mujio (2021) has provides insights into sustainable development innovation and how SMEs can improve their resource competence. The study discusses the development of an organizational competency analysis framework for SMEs based on sustainable development theories. The purpose of the framework is to increase SME competence in resource aspects, which is essential for sustainable development. They suggest that these organizations can help SMEs to adopt sustainable development innovation. In addition, Sustainable development innovation can help SMEs to improve their resource efficiency, reduce their environmental impact, and create new market opportunities.

The study undertaken by Philbin et al. (2022) examines how innovation digital can enable small and medium enterprises (SMEs) to achieve sustainable development. The study conducted a systematic literature review of 64 articles to identify the key enablers and barriers to digital transformation for sustainable development in SMEs. The study also finds that there are a number of barriers to digital transformation for sustainable development in SMEs, including:(lack of awareness, lack of resources, lack of skills, lack of support). The study's findings suggest that digital innovation can be a valuable tool for SMEs to achieve sustainable development. The analysis performed by Benabbes and Laouar (2022) highlight the role of Algerian SMEs in achieving sustainable development and their effective contribution to the economy, including their potential to promote innovation, creativity, and social responsibility. If small and medium enterprises can overcome obstacles and increase innovation, they can play role in achieving sustainable development in Algeria. The last years has witnessed an increase in focus on innovation in small and medium enterprises (SMEs) in Algeria as a

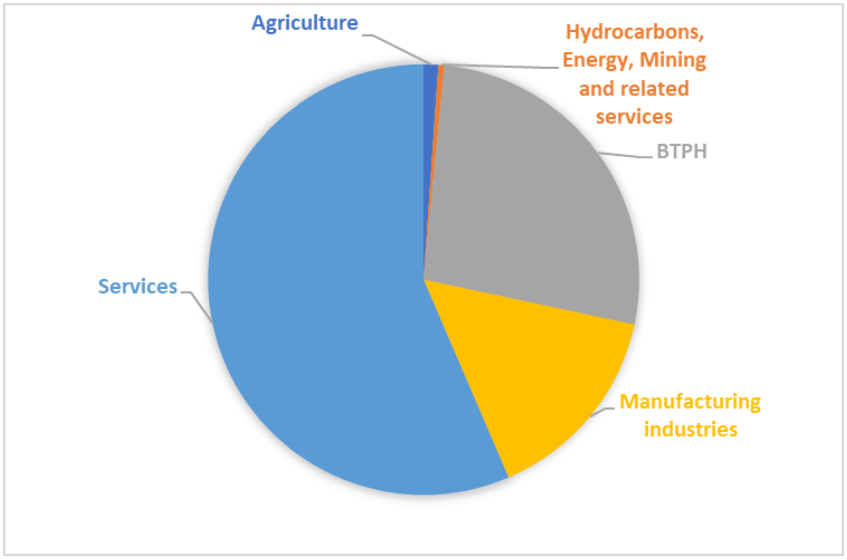
solution to achieving not just economic growth but lead to social media development and environment protection. However, none of the studies mentioned in the literature review have studied the impact of innovation in SMEs on separate sustainable development dimensions. Therefore, this particular study stands out as it explicitly addresses the impact of innovation in SMEs on separate dimensions of sustainable development, providing valuable insights into the potential benefits and implications for economic, social, and environmental sustainability.

3- The reality of small and medium (SMEs) enterprises in Algeria:

In 2011, the authorities launched a national program worth AD380bn ($3.2bn) to revamp the country's SME sector, with a target of more than tripling the number of SMEs. In 2017, Algeria passed a law that establishes specific support mechanisms for SMEs in terms of industrial development. Small and medium-sized enterprises (SMEs) play a crucial role in Algeria's economy by contributing to reducing the unemployment rate, raising the gross domestic product, creating added value to the economy, and increasing the proportion of international trade exchanges. Where the Algerian authorities have taken many measures to support small and medium-sized enterprises. Among these procedures is the establishment of several agencies to finance them, as we find among these agencies: the National Agency for the Support and Development of Entrepreneurship, the National Agency for the Management of Microcredit, the Algerian Agency for Investment Promotion(349ص،2023 تلي و حرمه،) .

As a result, their statistics are now reflecting the country's economic dynamism. In 2022, 80,531 new SMEs were created in Algeria, employing a total of 3,307,821 people. with a total workforce of 3,307,821 agents were legal persons registered with CNAS12, and 42,599 were natural persons registered with CASNOS. At the end of 2022 Total SMEs in Algeria 1,359,803 (72,318 Very Small Enterprises), 982 (Small Enterprises), (138 Medium).

Fig (3): The distribution of SMEs in Algeria by sector (2022)



Source: prepared by the authors based on the Statistical Information Bulletins for Small and Medium Enterprises.

Figure 3 shows a clear distribution of SMEs in Algeria, it is skewed towards the services sector, with 56.45% of SMEs operating in this sector. The Algerian government needs to do more to promote the growth of SMEs in other sectors, such as agriculture, hydrocarbons, energy, mining and related services, and manufacturing industries, which only account for 1.10%, 0.45%, 26.80%, and 15.19% of SMEs respectively.

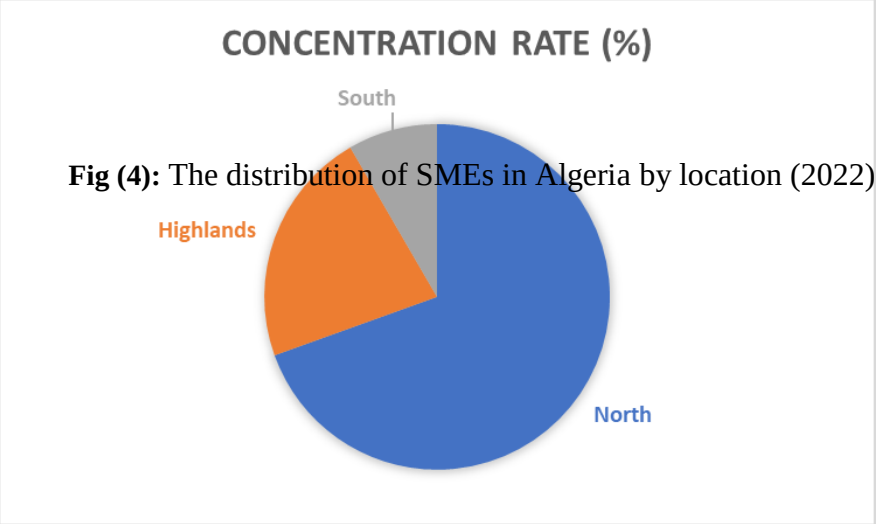
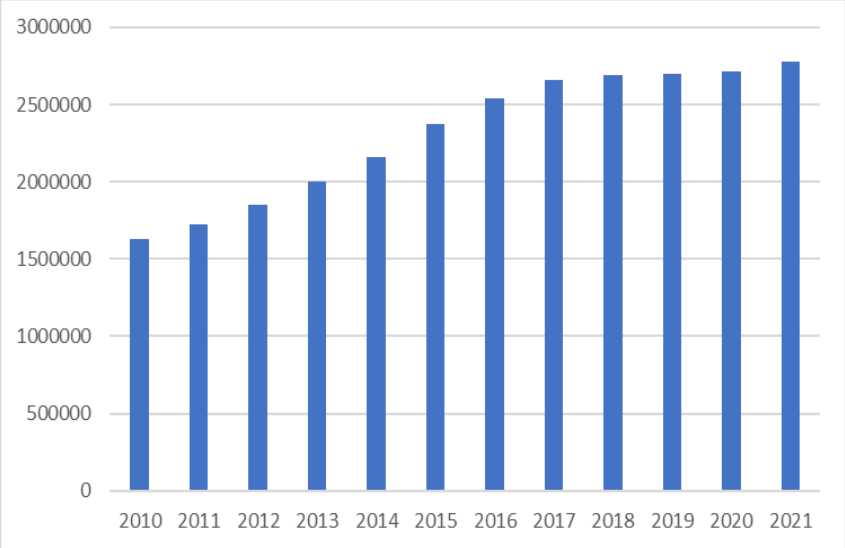


Fig (4): The distribution of SMEs in Algeria by location (2022)

Source: prepared by the authors based on the Statistical Information Bulletins for Small and Medium Enterprises.

From Figure 4, it can be noted that the concentration of SMEs in Algeria is skewed towards the North region. This suggests that the Algerian government needs to do more to promote the growth of SMEs in the Highlands and South regions. North: The North region accounts for 69.51% of SMEs in Algeria. This is the largest region, and it suggests that the North is the most important region for SMEs in Algeria. Highlands: The Highlands region accounts for 22.12% of SMEs in Algeria. This is the second largest region, and it suggests that the Highlands are also an important region for SMEs in Algeria. South: The South region accounts for 8.38% of SMEs in Algeria. This is the smallest region, and it suggests that the South is the least important region for SMEs in Algeria.

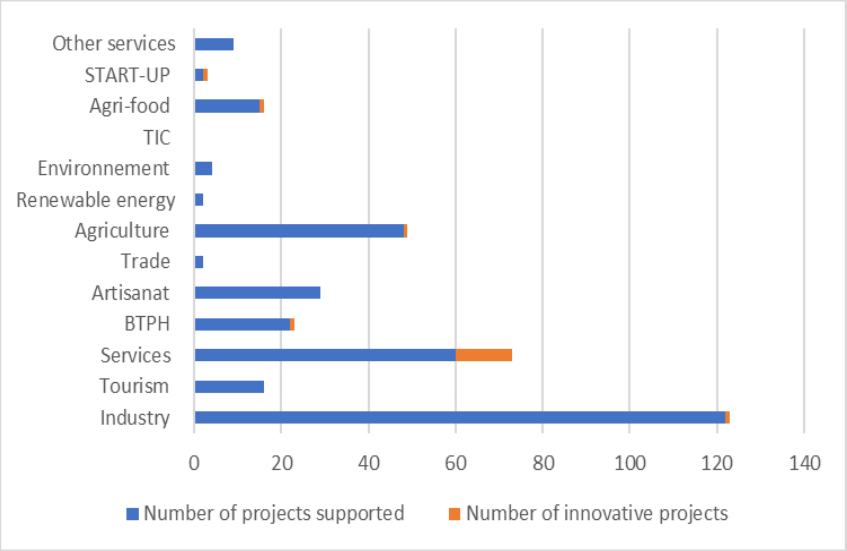
Fig (5): business incubators by sector of activity (2022)



Source: prepared by the authors based on the Statistical Information Bulletins for Small and Medium Enterprises.

As shown in Figure 5, the industry sector received the most support, with 122 projects supported. However, only 1 of these projects was considered innovative. This suggests that the Algerian government needs to do more to support innovative projects in the industry sector. The services sector received the second most support, with 60 projects supported. Of these projects, 13 were considered innovative. This suggests that the Algerian government is doing a good job of supporting innovative projects in the services sector. The BTPH sector (building, public works and housing) received the third most support, with 22 projects supported. Of these projects, 1 was considered innovative. This suggests that the Algerian government is doing a good job of supporting innovative projects in the BTPH sector. The other sectors received less support, with a total of 69 projects supported. Of these projects, 3 were considered innovative. This suggests that the Algerian government needs to do more to support innovative projects in these sectors. Overall, the Algerian government is doing a good job of supporting innovative projects in some sectors, such as the services sector and the BTPH sector. However, the government needs to do more to support innovative projects in other sectors, such as the industry sector and the renewable energy sector.

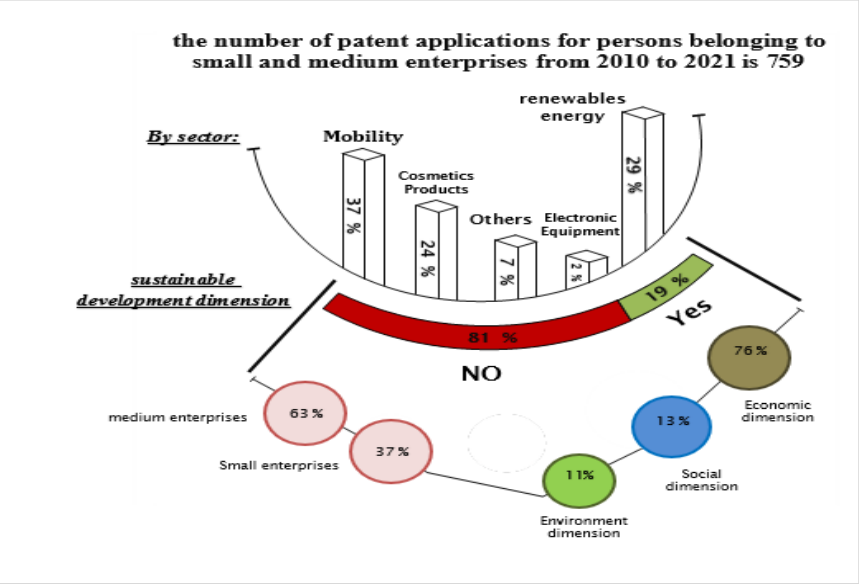
Fig (6): Evolution of employment in Algerian SMEs (Private & Public SMEs)



Source: prepared by the authors based on the Statistical Information Bulletins for Small and Medium Enterprises.

As can be seen in Figure 6, the number of employees in Algerian SMEs has been increasing steadily over the past decade, with the exception of a slight decline in 2017.The overall growth rate is 8.1%, which is a healthy rate of growth. The largest increase in employment took place between 2010 and 2015, when the number of employees in Algerian SMEs increased by 47.3%. The number of employees in Algerian SMEs peaked in 2021, with a total of 2,775,260 employees. A vast majority of private sector companies in Algeria are small businesses. In fact, 99.5% of these companies have less than 10 employees. 69.9% have 1 to 4 employees and 29.6% have 5 to 9 employees. Only 0.5% of private sector companies in Algeria have 10 or more employees (Saim, 2023,p 588).

Fig (7): Patent applications & innovative products in Algerian SMEs in context of sustainable development



Source: prepared by the authors.

Figure 7 shows an increase in the number of patents filed by SMEs in Algeria is a positive development. One way of measuring innovation is by the number of patents filed by SMEs. According to the Algerian Patent Office, the number of patents filed by SMEs has increased steadily in recent years. This increase is largely due to the government's efforts to promote innovation, such as the introduction of tax breaks for SMEs that file patents. The increase in the number of patents filed by SMEs is a positive development, as it suggests that these businesses are becoming more innovative. However, it is important to note that the number of patents filed is not the only measure of innovation. Other important indicators include the number of new products and services launched by SMEs, the amount of R&D spending by SMEs, and the number of SMEs that export their products and services.

The number of patents and innovative products in sectors like renewable energies, mobile applications, generative industry, cosmetics, and the food industry underscores their commitment to driving economic growth and profitability. However, not all innovations within these sectors align seamlessly with the goals of sustainable development. Recognizing this nuanced relationship is crucial for stakeholders seeking to balance profit motives with environmental conservation. The rise of sustainable innovation is a positive development. However, it is important to note that not all innovations are truly sustainable.

3- Research Methodology:

3-1 Data and variables

It is important to note that sustainable development does not only mean economic growth, but also social and environmental development, so it is important to measure the impact of innovation in small and medium enterprises on all dimensions of sustainable development. In this study, we tried to find out the type of relationship between innovation in small and medium enterprises, and achieving sustainable development in its dimensions in Algeria during the period from 2010 to 2021. We relied on the ordinary least squares method in simple linear regression analysis. There are many indicators that can be used to express innovation. in Small and Medium Enterprises (SMEs). So that we used an independent variable representing patent applications, and the dependent variable represented by the dimensions of sustainable development (economic, social and environmental).

3-2 Model specification

After a detailed review of previous studies, we worked on formulating a simple linear regression equation, which reflects the relationship between innovation in small and medium enterprises with the achievement of sustainable development in its three dimensions (the economic dimension, the social dimension, and the environmental dimension).

$$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i \quad \textbf{(1)}$$

Where Y is the dependent variable used to express the dimensions of sustainable development (economic, environment, and human development) for the economic dimension it is represented by the contribution of small and medium enterprises (SMEs) to the Gross Domestic Product (SME/GDP), for the social dimension it is represented by the Human Development Index (HDI) As for the environmental dimension, it is represented by the

carbon footprint. (CO2e).

Independent Variable X Patent Applications (PA) is the independent variable, this indicator measures the number of patent applications filed by a company. It can be used to indicate the level of innovation, as organizations that file more patent applications are more likely to develop innovative new products or processes. Where to scale is the best indicator to measure innovation in small and medium enterprises. Provides a comprehensive overview of the innovation landscape. t represents the years analyzed (2010-2021), $\beta 0$. β1 is a parameter and "Ɛ" the error term.

-The simple linear regression equation that reflects the promotion of innovation in small and medium enterprises and the economic dimension of sustainable development:

$$\text{SME/GDP}_t = \beta_0 + \beta_1 \text{PA}_t + \varepsilon_t \quad \textbf{(2)}$$

Where: (SME/GDPt) represents the contribution of small and medium enterprises (SMEs) to the gross domestic product (GDP), and (PA) represents the number of patent applications filed by small and medium enterprises in Algeria.

The contribution of SMEs to the Gross Domestic Product (GDP) is an economic dimension of sustainable development that measures the economic impact of SMEs on a country's economy. Gross domestic product is a measure of the total value of goods and services produced within a country in a given period of time, usually a year. Small and medium enterprises are an important contributor to GDP because they represent a large portion of economic activity in many countries. They are often considered the backbone of the economy because they provide jobs, stimulate innovation, and stimulate economic growth. In addition, small and medium-sized companies are more flexible and adaptable to change than large companies, making them more resilient in the face of economic downturns. Therefore, the contribution of SMEs to the GDP is an important indicator of a country's economic health and stability, and it can be used to measure the economic dimension of sustainable development. In addition, it can be used to define the policies and programs needed to support the growth and development of small and medium enterprises, which can contribute to the overall sustainable development of the country.

- The simple linear regression equation that reflects the promotion of innovation in small and medium enterprises and the environmental dimension of sustainable development:

$$\text{CO2e}_t = \beta_0 + \beta_1 \text{PA}_t + \varepsilon_t \quad \textbf{(3)}$$

Where: Carbon Footprint (CO2e): measures the total amount of greenhouse gases emitted by an organization, and measures the amount of waste an organization produces and its efforts to reduce, recycle, or compost it. (PA) represents the number of patent applications filed by small and medium enterprises in Algeria.

The carbon footprint of an individual, household, organization or product can be calculated. It can include emissions from activities such as transportation, energy use, industrial processes, waste disposal, and land use changes. In a business context, an organization's carbon footprint can be measured by assessing the direct and indirect emissions generated by its operations, products, and supply chain. Knowing and measuring an organization's carbon footprint is important because it allows organizations to identify areas

where they can make changes to reduce their emissions and help mitigate the effects of climate change. In addition, measuring a carbon footprint can help organizations develop strategies and action plans to reduce carbon emissions, which can lead to cost savings and improved environmental performance.

- The simple linear regression equation that reflects the promotion of innovation in small and medium enterprises and the social dimension of sustainable development:

$$HDI_t = \beta_0 + \beta_1 PA_t + \varepsilon_t \quad \textbf{(4)}$$

Where: (HDI) represents the human development index, (PA) represents the number of patent applications filed by small and medium enterprises in Algeria. Overall, the use of the Human Development Index in a study on innovation in SMEs can provide valuable insights into how innovation contributes to sustainable development from a social perspective. Studying innovation in small and medium enterprises using the Human Development Index will be able to assess the impact of innovation on the social dimension of sustainable development, by looking at how innovation affects the standard of living of the population.

4- Results and discussion:

4-1 Results

4-1-1 Models results estimation

The objective of simple linear regression analysis is to estimate numerical values for the parameters of the simple linear regression model. To achieve this purpose, we apply the method of least squares, which makes the sum of squares errors as low as possible. Using EViews 12, we obtained the final equation for the simple linear regression model where:

- The final equation for promoting innovation in small and medium enterprises and the economic dimension of sustainable development (from equation 2):

$$SME/GDP_t = 0{,}4359 + 0{,}0087PA_t$$

From Appendix No. (01) we reduce the calculated correlation coefficient (r = 0.9710), the correlation coefficient of 0.8344 indicates that there is a strong positive linear relationship between the two variables (PA and SME/GDP). Hence the positive association and strong relationship.

- The final equation for promoting innovation in small and medium enterprises and the environmental dimension of sustainable development (from equation 3):

$$CO2e_t = 0{,}07142 + 0{,}0039\ PA_t$$

From Appendix No. (03) the calculated correlation coefficient (r = 0.000), the correlation coefficient of 0.000 indicates that there is no linear relationship between the two variables (PA and CO2e). Thus, there is no correlation between the two variables.

- The final equation for promoting innovation in small and medium enterprises and the social dimension of sustainable development (from equation 4):

$$HDI_t = 0{,}3711 + 0{,}0013\ PA_t$$

From Appendix No. (02) the calculated correlation coefficient (r = 0.043), the correlation coefficient of 0.043 indicates that there is a very weak positive linear relationship between the two variables (PA and HDI). Hence the confusion is positive and the strength of the relationship is very weak.

4-1-2 Models results estimation

Checking the statistical significance of results refers to the process of determining whether the results of a statistical analysis are significant or if they are due to chance. This is usually done by testing the hypothesis that the results are due to random chance, and if the hypothesis can be rejected with a high level of confidence, then the results are considered statistically significant. The Fisher F test is a statistical test used to determine whether the variance between two or more population groups is equal. In the context of checking the statistical significance of the results, the Fisher F test can be used to determine if the model's results are statistically significant, by comparing the variance of the observed data with the variance in the model's predictions.

According to Appendix No. (01), Fisher's test was 2.7191F = 1. The tabular value of the F criterion at the significance level is 0.05 and the number of degrees of freedom is 11 and 1. Thus, F>Ftable (2.71911>3.92), which testifies to the adequacy of this model, and the relationship between the signs is non-random (intrinsic). It is clear from the value of the determination coefficient (R2) of 0.943 that the independent variable represented by the number of patent applications explains 94.3% of the changes that occur in the dependent variable represented by the economic dimension of sustainable development, while the remaining 5.7% is due to other variables that were not included. In the simple linear regression model under study. Based on the foregoing, the result indicates the quality of the simple regression model for the data of the studied phenomenon, and that the regression model represented the phenomenon in the best way.

According to Appendix 02, Fisher's test was 4.0357F=. The tabular value of the F criterion at the significance level is 0.05 and the number of degrees of freedom is 11 and 1. Thus, F>Ftable (4.0357>3.92), which testifies to the adequacy of this model, and the relationship between the signs is non-random (intrinsic). It is evident from the value of the determination coefficient (R2) of 0.611 that the independent variable represented by the number of patent applications explains 61.1% of the changes that occur in the dependent variable represented by the social dimension of sustainable development, while the remaining 38.8% is due to other variables that were not included. In the simple linear regression model under study. Based on the foregoing, the result indicates the quality of the simple regression model for the data of the studied phenomenon, and that the regression model represented the phenomenon reasonably.

According to Appendix 03, Fisher's test was 4.0002F=. The tabular value of the F criterion at the significance level is 0.05 and the number of degrees of freedom is 11 and 1. Thus, F>Ftable (4.0002 > 3.92), which testifies to the adequacy of this model, and the relationship between the signs is non-random (intrinsic). It is clear through the value of the determination coefficient (R2) of 0.573 that the independent variable represented by the number of patent applications explains 57.3% of the changes that occur in the dependent

variable represented by the social dimension of sustainable development, while the remaining 42.7% is due to other variables that were not included. In the simple linear regression model under study. Based on the foregoing, the result indicates the quality of the simple regression model for the data of the studied phenomenon, and that the regression model represented the phenomenon reasonably.

4-2 Discussion of results

Through Appendix No. (01) and the final equation of the relationship between innovation in small and medium enterprises and the economic dimension of sustainable development in Algeria. Small and Medium Enterprises (SMEs) play a critical role in sustainable economic development by driving innovation and job creation in Algeria. Innovations in SMEs can come in many forms, such as developing new products or services, improving production processes, or finding more efficient ways to use resources. These innovations can increase productivity, competitiveness, and economic growth in Algeria. He notes that small and medium enterprises are also more flexible and adaptable than large companies in Algeria, allowing them to respond quickly to changes in the market and take advantage of new opportunities. However, SMEs often face challenges in terms of accessing finance, technology, and other resources.

Through Appendix No. (02) and the final equation of the relationship between innovation in small and medium enterprises and the social dimension of sustainable development in Algeria. It notes that innovation in small and medium enterprises (SMEs) can play a role in promoting the social dimension of sustainable development, which includes issues such as poverty reduction, social inclusion, and decent work creation. However, the relationship between innovation in small and medium enterprises and the social dimension of sustainable development is weak in Algeria. One reason for the weakness of this relationship is that the primary focus of many SMEs is on economic growth and competitiveness, rather than on social and environmental issues. In addition, many small and medium enterprises lack the resources and ability to invest in socially and environmentally sustainable practices. Moreover, many innovations in SMEs are driven by market demand and consumer preferences, which may not prioritize social and environmental considerations. For example, an SME may develop a new product that is more efficient and cost effective, but that product may not address social and environmental issues such as poverty reduction.

Through Appendix No. (03) and the final equation of the relationship between innovation in small and medium enterprises and the environmental dimension of sustainable development in Algeria. The relationship between innovation in small and medium enterprises and the environmental dimension of sustainable development is often considered weak or even non-existent, and this was confirmed by the results of the model. Many SMEs focus primarily on economic growth and competitiveness, rather than on environmental sustainability. In addition, many SMEs lack the resources and ability to invest in environmentally sustainable practices. Often the primary driver of innovation in SMEs is market demand and consumer preferences, which may not prioritize environmental considerations. For example, an SME may develop a new product that is more efficient and cost effective, but that product may not address environmental issues such as pollution or

resource conservation. Moreover, many SMEs face barriers to adopting environmentally sustainable practices, such as lack of access to technology and information, and lack of financial resources, which can make it difficult for them to invest in green innovations. In addition, environmental regulations and policies often focus on large industries, rather than small and medium-sized businesses, which can make it difficult for small and medium-sized businesses to comply with environmental regulations and standards. However, some SMEs are beginning to realize the importance of environmental sustainability and are taking steps to integrate environmental considerations into their business models.

Conclusion:

This study endeavors to elucidate the nature of the association between innovation in small and medium enterprises (SMEs) and sustainable development in Algeria. Utilizing the method of least squares, three simple linear regression models were constructed and scrutinized based on data spanning the period from 2010 to 2021. The findings of this study reveal that although innovation in SMEs can contribute to enhancing the economic facet of sustainable development, but there is a weak link between innovation in SMEs and the social dimension of sustainable development in Algeria. Moreover, no discernible connection between the environmental dimension and innovation in SMEs in Algeria was identified.

The study underscores the pivotal role played by innovation in SMEs in fostering economic development in Algeria through heightened productivity, competitiveness, and job creation. It is worth noting that the primary focus of many of these enterprises lies in profit generation, growth, and competitiveness, rather than addressing social and environmental concerns. Furthermore, numerous SMEs in Algeria encounter resource constraints and lack the capacity to invest in socially and environmentally sustainable practices. Nevertheless, a burgeoning number of Algerian enterprises are beginning to acknowledge the significance of the social dimension of sustainable development and are taking steps to integrate social and environmental considerations into their business models.

Importantly, it is imperative to recognize that innovation alone is insufficient in ensuring sustainable development across all three dimensions. SMEs in Algeria must also incorporate the social and environmental dimensions of sustainable development, including safeguarding fair and decent working conditions, assuming social responsibility, and mitigating their environmental impacts. Hence, it is crucial for policymakers, researchers, and business leaders in Algeria to collaborate in devising policies, programs, and support systems that foster and facilitate innovation in SMEs while concurrently promoting sustainable development. This can be accomplished through a multifaceted approach encompassing measures such as facilitating access to financing, providing training and cultivating an environment conducive to innovation and sustainable practices.

Study Recommendations:

-To foster innovation in SMEs, Algeria should prioritize initiatives that provide improved access to financing and support mechanisms such as grants, loans, and tax incentives.

-Algeria can promote innovation in SMEs by implementing measures to ensure access to technology and information, such as through training programs, research and development partnerships, and technology transfer initiatives.

-Algeria should focus on creating a conducive atmosphere by implementing clear regulations and standards while offering incentives for SMEs to adopt sustainable practices.
- Algeria should actively foster collaboration through the implementation of programs and initiatives that facilitate communication and co-creation among these key actors.

The study findings can help to inform policy makers, raise awareness, and build a network of stakeholders who are interested in promoting sustainable innovation in Algeria. By continuing to research this topic, we can gain a better understanding of how to promote sustainable innovation in SMEs and how to achieve sustainable development in Algeria. However, there are some limitations to the study. The study was conducted in a limited number of SMEs, so the findings may not be generalizable to all SMEs in Algeria. Additionally, the study only looked at a specific time period, so it is possible that the findings may not be applicable to future trends.

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Appendices

Appendix No. (01)

Table (02): The results of estimating the coefficients of the innovation regression model in SMEs and the economic dimension of sustainable development

Dependent Variable: SME/GDP				
Method: Least Squares				
Date: 28/01/23 Time: 21:37				
Sample: 2010 2021				
Included observations: 12				
SME/GDP=C(1)+ C(2)*PA				
	Coefficient	**Std. Error**	**t-Statistic**	**Prob.**
C(1)	0.435955	0.203791	2.13922	0.0000
C(2)	0.008729	0.002264	3.85565	0.0000
R-squared	0.943920	Mean dependent var.		4.140086
Adjusted R-squared	0.852883	S.D. dependent var.		0.649269
S.E. of regression	0.382527	Akaike info criterion		0.941488
Sum squared resid.	16.53497	Schwarz criterion		1.012702
Log likelihood	-51.60633	Durbin-Watson stat		2.044731

Source: Prepared by researchers based on the EVIEWS 12 software

Appendix No. (02)

Table (03): The results of estimating the coefficients of the innovation regression model in SMEs enterprises and the social dimension of sustainable development

Dependent Variable: HDI				
Method: Least Squares				
Date: 28/01/23 Time: 22:31				
Sample: 2010 2021				
Included observations: 12				
HDI=C(1)+ C(2)*PA				
	Coefficient	**Std. Error**	**t-Statistic**	**Prob.**
C(1)	0.371106	0.177504	2.09069	0.0000
C(2)	0.000134	0.003281	0.04841	0.0000
R-squared	0.611358	Mean dependent var.		5.650016
Adjusted R-squared	0.571763	S.D. dependent var.		0.345169
S.E. of regression	0.297893	Akaike info criterion		0.538323
Sum squared resid.	19.73103	Schwarz criterion		1.119716
Log likelihood	-43.91829	Durbin-Watson stat		2.074925

Source: Prepared by researchers based on the EVIEWS 12 software

Appendix No. (03)

Table (04): The results of estimating the coefficients of the innovation regression model in in SMEs enterprises and the environmental dimension of sustainable development

Dependent Variable: C02e				
Method: Least Squares				
Date: 28/01/23 Time: 22:57				
Sample: 2010 2021				
Included observations: 12				
CO2e=C(1)+ C(2)*PA				
	Coefficient	**Std. Error**	**t-Statistic**	**Prob.**
C(1)	0.071421	0.124333	0.57443	0.0000
C(2)	0.003952	0.005476	0.72169	0.0000
R-squared	0.573188	Mean dependent var.		8.195186
Adjusted R-squared	0.552473	S.D. dependent var.		0.441251
S.E. of regression	0.328172	Akaike info criterion		0.579214
Sum squared resid.	21.51915	Schwarz criterion		1.316151
Log likelihood	-48.02822	Durbin-Watson stat		2.034615

Source: Prepared by researchers based on the EVIEWS 12 software