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Sustainable R&D and Competitiveness of Moroccan Industrial Companies

Ossama Aouane[1], Nadir El Boubkari[2], Faycal Mimouni[3], Abdelilah Chahid[4], Zouhair Ibn Batouta[5*]

[1]Laboratoire LAMSO, ENCG Casablanca, Université Hassan II, Casablanca, Maroc
[2]Laboratoire LERITEDA, Faculté Polydisciplinaire de Nador, Université Mohammed Premier, Oujda, Maroc
[3]Laboratoire ISA, ENSA & EST, Université Ibn Tofaïl, Kénitra, Maroc
[4]École Normale Supérieure de l'Enseignement Technique, Casablanca, Maroc
[5]Laboratoire LTI, Faculté des Sciences Ben M'Sik, Université Hassan II, Casablanca, Maroc
Email: *zouhair.ibnbatouta@gmail.com

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Abstract

This article analyzes the role of sustainable R&D in strengthening the competitiveness of Moroccan industrial companies. The study is employing a deductive approach and qualitative analysis involving interviews with company managers using Sphinx software. The results have shown that sustainable R&D improves product differentiation, optimizes production costs, and facilitates access to international markets through compliance with environmental standards (ISO 14001). It also enhances economic resilience by reducing energy costs and improving access to green financing. However, SMEs face difficulties accessing financing and limiting the adoption of sustainable technologies. The study recommends strengthening public policies, encouraging tax incentives, and promoting partnerships between companies and research centers to facilitate the transition to a sustainable industrial model.

Keywords

Sustainable R&D, Industrial Competitiveness, Innovation, Sustainable Development, Green Financing, Smes, Economic Resilience, Environmental Standards

1. Introduction

In a global context where environmental and social concerns are becoming increasingly important, Moroccan industrial companies are in need to adopt sustainable practices to remain competitive.

By exploring these dimensions, our communication seeks to make a significant

contribution to understanding the role of sustainable R&D in strengthening the competitiveness of Moroccan industrial companies, while providing practical guidance for the stakeholders involved.

Integrating sustainable R&D not only optimizes the use of natural and energy resources, but also increases the added value of products and services, thus promoting better positioning in international markets. Furthermore, it constitutes a key asset for the attractiveness of investments and strategic partnerships, thus strengthening the economic sustainability of companies engaged in this transition.

The question is: To what extent can sustainable R&D improve the competitiveness of Moroccan industrial companies?

To address this issue, our study adopts a deductive method with a qualitative approach. The analysis is based on two main hypotheses (as shown in Figure 1):

Hypothesis 1 (H1): Integrating sustainable R&D into the strategies of industrial companies helps improve their competitiveness on national and international markets.

- **H1.1:** Innovation from sustainable R&D enables companies to improve their product differentiation.
- **H1.2:** Adopting sustainable technologies improves operational efficiency and optimizes industrial performance.
- **H1.3:** Compliance with environmental standards and certifications (ISO 14001, EcoLabel, etc.) increases the competitiveness of companies internationally.

Hypothesis 2 (H2): Sustainable R&D reduces exposure to economic risks.

- **H 2.1:** Sustainable R&D leads to reduced energy costs
- **H 2.2:** It strengthens access to financing and subsidies.
- **H 2.3:** It improves resilience to economic and regulatory crises.

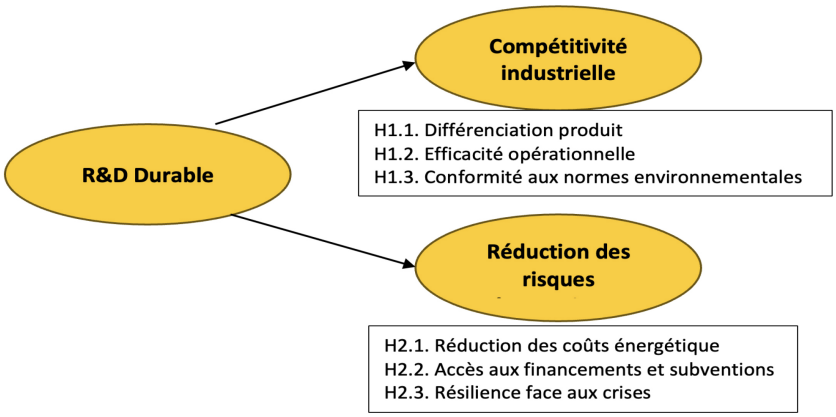

Figure 1. Conceptual framework.

The article is structured around two main axes:

A theoretical axis devoted to the analysis of concepts and the study of the theoretical relationship between sustainable R&D and industrial competitiveness.

An empirical axis focused on the state of sustainable R&D in Morocco and a qualitative analysis based on interviews with managers of Moroccan industrial companies via the Sphinx software.

2. Theoretical Approach to Sustainable R&D and Competitiveness of Industrial Companies

2.1. Definition and Evolution of Sustainable R&D

Clarifying fundamental concepts is a crucial step in structuring any scientific inquiry. It not only establishes the basis for a coherent analytical framework but also guides a more accurate interpretation of the phenomena under study.

First, the conceptual dimensions related to sustainable innovation are examined in order to better understand its scope within a context of economic transformation. Second, the theoretical foundations of industrial competitiveness are mobilized, as this notion is central to evaluating business performance and understanding strategic positioning in a competitive environment.

2.1.1. Definition of Sustainable R&D

Sustainable Research and Development (R&D) refers to all scientific, technological, and organizational activities carried out by businesses, institutions, and governments to develop innovative solutions that address environmental and social challenges while improving economic competitiveness. Unlike conventional R&D, sustainable R&D incorporates the principles of sustainable development, seeking to reconcile technological progress, economic profitability, and respect for natural resources.

2.1.2. Historical Evolution of Sustainable R&D

The evolution of sustainable R&D has been built in several phases:

1) First environmental initiatives (1960s-1980s):

- Awareness of the environmental impacts linked to industrialization.
- Implementation of the first environmental regulations in developed countries (Clean Air Act in the United States, European laws on industrial pollution).
- Research into clean technologies and renewable energy begins.

2) Integration of sustainable development into R&D (1990s-2000s):

- Adoption of the concept of sustainable development after the Brundtland (1987) Report.
- Appearance of the first environmental labels and ISO 14000 standards.
- Rise in societal concerns (eco-design, corporate social responsibility).

3) Generalization and transition to the circular economy (2000s-2020s):

- Development of green innovations in various sectors (transport, energy, agri-food).
- Implementation of public incentive policies in favor of sustainable R&D (Kyoto, Paris, European Green Deal agreements).
- Growth in funding dedicated to sustainable innovations (grants, green bonds, ESG investment funds).

4) Sustainable R&D and digital transformation (2020 - today):

- Development of artificial intelligence and big data in the service of eco-innovation.
- Rise of clean technologies: green hydrogen, CO_2 capture, digital circular economy.
- Acceleration of carbon neutrality objectives and adaptation of industries to new international regulatory requirements.

Sustainable R&D is therefore today an essential lever for ensuring a transition to a more resilient and competitive industrial model, capable of meeting global ecological and economic challenges. Sustainable R&D refers to all research and innovation activities aimed at developing products, services, or processes that minimize environmental impact while improving the economic and social performance of companies.

2.2. Definition and Evolutions of Industrial Competitiveness

Industrial competitiveness is defined as a company's ability to maintain or improve its market position by optimising its economic, technological, and organizational performance. It is measured by several indicators such as productivity, innovation, access to international markets, and resilience to economic shocks.

Theoretical foundations of industrial competitiveness

Industrial competitiveness is based on several theoretical approaches which help explain the mechanisms of differentiation and growth of companies:

- Competitive advantage (Porter, 1985):

- According to Michael Porter, competitiveness is based on two main strategies: differentiation (innovation, product quality) and cost reduction (process efficiency, economies of scale).
- Sustainable innovation, resulting from R&D, is a key factor enabling companies to position themselves favorably on the market while respecting new environmental constraints.

- Dynamic Capabilities Theory (Teece, Pisano & Shuen, 1997):

- This approach highlights the need for companies to continually adapt their skills to remain competitive.
- Sustainable R&D helps improve these dynamic capabilities by developing innovations that strengthen the flexibility and adaptability of companies in the face of market changes.

- The circular economy and sustainable competitiveness (Stahel, 2016):

- Integrating the principles of the circular economy (waste reduction, recycling, resource optimization) promotes long-term sustainable competitiveness.
- Companies that adopt circular business models reduce their costs and increase their attractiveness to investors and consumers concerned about their environmental impact.

- The impact of public policies on industrial competitiveness:

- Environmental regulations and tax incentives influence business competitive-

ness by encouraging investment in sustainable R&D.

- Policies supporting green innovation (grants, dedicated funding) play a key role in the ability of companies to develop competitive technologies that comply with international standards.

Thus, industrial competitiveness no longer relies solely on traditional factors such as production costs and productivity, but now incorporates strategic dimensions related to innovation, sustainability, and adaptation to environmental and societal requirements. Competitiveness is defined as a company's ability to maintain or improve its market position through innovation, productivity, and adaptation to economic and technological developments.

3. Theoretical Relationship between Sustainable R&D and Industrial Competitiveness

According to Porter & van der Linde (1995), green innovation allows companies to gain a competitive advantage by improving access to new markets through eco-designed products. By integrating sustainable R&D, companies can differentiate themselves by offering environmentally friendly solutions that meet the expectations of consumers and regulators.

3.1. Operational Efficiency and Process Optimization

According to Teece (2018), sustainable innovation improves business flexibility and performance by reducing production costs through energy optimization and the use of renewable raw materials. Companies adopting cleaner production processes also benefit from increased productivity and reduced industrial losses.

3.2. Environmental Standards and Certifications

Nidumolu et al. (2009) show that companies that can obtain environmental certifications benefit from greater attractiveness to foreign investors and customers. Adherence to ISO 14001 standards or eco-labels constitutes a strategic asset that promotes access to international markets and strengthens the credibility of companies on the global stage.

3.3. Sustainable R&D as a Factor of Economic Resilience

3.3.1. Cost Reduction and Resource Management

Companies that adopt sustainable R&D processes reduce their energy consumption, allowing them to stabilize their costs during periods of fluctuating raw material prices (Zhou & Martinez, 2023). Optimising inputs and recycling materials also contribute to improving economic efficiency and limiting dependence on scarce resources.

3.3.2. Access to Funding and Subsidies

According to Smith et al. (2022), companies committed to sustainability more easily attract international funding dedicated to green innovation. Many investment funds and banks favor companies that meet ESG (Environmental, Social,

and Governance) criteria, thus improving access to grants and preferential credit.

3.3.3. Resilience to Economic and Regulatory Crises

Elkington's (1997) work shows that companies incorporating sustainable innovations adapt more quickly to crises thanks to flexible and sustainable business models. The ability to anticipate and respond to regulatory changes and stakeholder expectations allows companies to limit the risks associated with new environmental legislation and seize new market opportunities.

4. Using Empirical Analysis of Sustainable R&D and Competitiveness in Morocco

After establishing the conceptual foundations necessary for understanding the key notions, it becomes essential to deepen the analysis by focusing on the operational and strategic dimensions of the subject. This second axis aims to explore in a structured manner the practical implications and underlying mechanisms that connect theoretical principles to their real-word implementation.

With this in mind, attention will be directed toward dynamic factors, organizational choices, and actionable levers that, enhance coherence between objectives, practices, and performance outcomes.

4.1. State of Play of Sustainable R&D in Morocco

Sustainable R&D in Morocco is booming, supported by public policies and increasing investments in green technologies. However, it still faces several challenges, particularly in terms of financing, regulation, and adoption by industrial companies.

4.1.1. Public Policies and Institutional Initiatives

The Moroccan government has implemented several initiatives to encourage sustainable R&D, notably through:

- National Sustainable Development Strategy (SNDD): Adopted in 2017, it aims at integrating the principles of sustainable development into all industrial sectors.
- Green Economy programme: Finances innovative projects focused on renewable energy, water resource management and CO_2 emissions reduction.
- Industrial Development and Investment Fund (FDII): In 2023, this fund allocated more than 3.5 billion dirhams (MMDH) to sustainable R&D projects.
- IRESEN (Institute for Research in Solar Energy and New Energies): Supports research into renewable energy and finances innovative startups in the field.
- Cluster Green Energy Park: A collaborative research centre on green technologies, allowing Moroccan companies to experiment with new sustainable solutions.

4.1.2. Main Sectors of Investment in Sustainable R&D

Morocco has targeted several strategic sectors where sustainable R&D plays a key

role:

➢Renewable energies: With an installed capacity of more than 4,500 MW in 2023, solar (Noor Ouarzazate) and wind (Tarfaya) projects are at the heart of sustainable innovation.

The Moroccan Agency for Sustainable Energy (Masen) is a key player in the energy transition, with R&D projects on renewable energies.

Sustainable R&D initiatives:

- Noor Ouarzazate solar power plant:

- One of the largest solar complexes in the world, combining photovoltaics and concentrated solar thermal power (CSP).

- Use of thermal storage system to extend production after sunset.

- Green hydrogen and energy innovation:

- Development of technological solutions for energy storage and improving the performance of solar panels.

Results and impacts:

- Reduction of 760,000 tons of CO_2 per year thanks to Noor Ouarzazate.

- Providing clean electricity to over one million homes.

- Positioning Morocco as a leader in solar energy in Africa and internationally.

- Increased attractiveness for foreign investment in renewable energies.

➢Automotive industry: Renault and Stellantis have invested in greener production processes, reducing energy consumption per vehicle produced by 20%.

Renault is a major player in the Moroccan automotive industry with its factories in Tangier and Casablanca, integrating principles of sustainable production and technological innovation.

Sustainable R&D initiatives:

- Tangier factory: a model of green industry:

- The world's first automotive factory operating with zero CO2 emissions using renewable energy (wind, solar, biomass).

- 70% reduction in industrial water consumption through a recycling and treatment system.

- Development of electric vehicles:

- Renault Maroc is involved in the development and assembly of electric vehicles, such as the Dacia Spring, one of the most affordable electric cars in Europe and Africa.

- Optimization of supply chains:

- Reducing the carbon footprint of transport by using rail instead of road transport (rail link between Tanger Med and the assembly units).

Results and impacts:

- 94% reduction in CO2 emissions from the Tangier plant.

- Increased production with more than 400,000 vehicles per year, strengthening Morocco's position as an automotive hub.

- Lower energy costs thanks to sustainable infrastructure.

- International recognition for its eco-responsible industrial model.

- OCP Group Morocco: Fertilizers and phosphates sector.

The Office Chérifien des Phosphates (OCP) is the world leader in phosphates and a key player in the ecological transition by integrating sustainable R&D into its industrial model.

Sustainable R&D initiatives:

- Circular economy and water management: OCP has implemented an ambitious policy of desalination and reuse of wastewater in its production units, thus reducing its impact on water resources.
- Renewable energies: The group is investing heavily in solar and wind power to power its factories, with the goal of being carbon neutral by 2040.
- Smart and sustainable fertilizers: OCP develops controlled-release fertilizers, allowing better absorption by plants, thus reducing soil pollution and optimising the use of inputs.
- Innovation Laboratory: The group created the Mohammed VI Polytechnic University (UM6P), which collaborates with international research centers to develop innovative and sustainable agricultural solutions.

Results and impacts:

- 30% reduction in water consumption thanks to new technologies.
- Reduction of CO_2 emissions thanks to renewable energies.
- Increasing agricultural productivity in Africa thanks to innovative fertilizers.
- Strengthening international positioning and strategic differentiation from competitors through green innovation.
- Agro-industry: Cosumar and Centrale Danone are developing more efficient production lines, with a 30% reduction in water consumption.
- BIC (France/Morocco): Consumer products sector

BIC, a company specializing in pens, lighters and razors, has developed a sustainable R&D strategy focused on eco-design and the circular economy.

Sustainable R&D initiatives:

- Eco-design of products:

- Development of refillable pens and recycled plastic products.
- Sustainable factory in Kenitra (Morocco):

- Integration of renewable energy and optimization of industrial processes to reduce energy and water consumption.

- Circular economy model:

- Collection and recycling of used products for a second life of new items.

Results and impacts:

- 50% reduction in CO_2 emissions from production since 2010.
- Transition to sustainable raw materials.
- Improved brand image among consumers and investors.
- Waste management and recycling: More than 60 companies are working on industrial waste recovery projects.

4.2. Empirical Study and Analysis of Results

4.2.1. Methodology and Data Collection

We adopted a purposive sampling strategy, targeting executives with significant experience in implementing R&D or sustainability initiatives within strategic industrial sectors in Morocco. The number of ten interviews was determined based on the principle of thematic saturation, which was reached by the eighth interview, as no new significant information emerged.

The study is based on a qualitative approach with a deductive method, using semi-structured interviews conducted with 10 managers of Moroccan industrial companies involved in sustainable R&D. The sample was selected based on the following criteria:

- Strategic sectors (renewable energies, automotive, agro-industry, recycling, etc.).
- Companies that have adopted sustainable innovations and obtained environmental certifications (ISO 14001, Label Green Morocco, etc.).
- Varied size (large companies and SMEs) to compare the impact of sustainable R&D according to organizational structure.

The interviews, lasting an average of 45 minutes to 1 hour, were conducted between January and March 2025 and explored the following themes:

- The role of sustainable R&D on competitiveness and financial performance.
- Challenges and opportunities associated with the adoption of sustainable R&D.

4.2.2. Analysis of Results with Sphinx Software

The interview guide was structured around three main themes (as shown in Table 1):

Understanding sustainable R&D, it strategic integration, and its effects on competitiveness and economic resilience.

The managers' responses were analysed using Sphinx, allowing for structured thematic coding based on the hypotheses formulated. The analysis relied exclusively on a deductive approach, where the analysis categories were defined based on the established theoretical framework.

Table 1. Validation or invalidation of hypotheses.

Assumption	Interview results	Validation
H1: Integrating sustainable R&D improves competitiveness	80% of executives say sustainable innovations have improved their market position.	Validated
H1.1: Innovation and product differentiation	70% of companies have seen an increase in market share thanks to eco-innovative products.	Validated
H1.2: Operational efficiency and process optimization	65% of companies report a reduction in their production costs thanks to sustainable innovations.	Validated
H1.3: Environmental standards and certifications	85% of large companies say that environmental certification has increased their attractiveness.	Validated

Continued

H2: Sustainable R&D reduces exposure to economic risks	60% of companies observed a reduction in their dependence on fluctuations in energy costs.	Partially validated
H2.1: Reduction of energy costs	50% of SMEs surveyed report substantial energy savings thanks to sustainable R&D.	Validated
H2.2: Access to financing and subsidies	40% of businesses received financial support, but SMEs remain under-represented.	Partially validated
H2.3: Resilience to economic and regulatory crises	55% of companies say that sustainable R&D has enabled them to better manage economic crises.	Validated

Source: Developed by the author.

- Discussion of results

The coding was carried out using Sphinx software following a thematic approach. To ensure reliability, independent double coding was performed on one-third of the interviews, resulting in an inter-coder agreement rate of 85%. Discrepancies were researchers.

The analysis of the results highlights several major trends and lessons on the impact of sustainable R&D on the competitiveness of Moroccan industrial companies.

1) Confirmation of the positive impact of sustainable R&D on competitiveness

The study shows that 80% of executives surveyed say that integrating sustainable R&D has strengthened their competitiveness. More specifically:

- **70% of companies** have observed an increase in their market share thanks to the introduction of products resulting from sustainable R&D.
- **65% of companies** report a reduction in their production costs linked to sustainable innovations.
- **85% of large companies** having obtained environmental certifications indicate greater attractiveness to international investors and customers.

These results confirm hypotheses H1 and its sub-hypotheses H1.1, H1.2 and H1.3, thus validating the key role of sustainable R&D in improving product differentiation, operational efficiency and compliance with international standards.

2) Disparities between large companies and SMEs

The study reveals a significant difference between large companies and SMEs in their ability to fully benefit from sustainable R&D.

- **Large companies** have easier access to green financing and public subsidies, which allows them to accelerate the integration of sustainable innovations.
- **SMEs** face difficulties in accessing financing and show slower adoption of sustainable innovations. Only 40% of the SMEs surveyed were able to benefit from financial support, which explains the partial validation of hypothesis H2.2.

3) The mixed effect of sustainable R&D on economic resilience

The impact of sustainable R&D on the economic resilience of companies is partially confirmed:

- **60% of companies** see a reduction in their dependence on fluctuating energy costs thanks to sustainable innovations.
- **50% of SMEs** indicate substantial **energy** savings, validating hypothesis H2.1.
- **However, only 55% of companies** report that sustainable R&D enables them to be more resilient to economic crises, partially validating H2.3.

4) Access to financing and regulatory issues:

One of the main challenges identified concerns access to funding for sustainable R&D:

- Only 40% of the companies surveyed were able to benefit from subsidies dedicated to sustainable innovation.
- The lack of a solid regulatory framework and sufficient tax incentives constitutes a major obstacle to investment in sustainable R&D, particularly for SMEs.

5) Prospects for improvement

To maximize the impact of sustainable R&D on business competitiveness, several levers can be activated:

- **Strengthening public policies** to facilitate access to green financing, particularly for SMEs.
- **Tax incentives** to encourage the adoption of sustainable technologies and the development of eco-innovative products.
- **Establishment of partnerships between companies and research centers** to improve the effectiveness of sustainable innovations and reduce their adoption cost.

This study has certain limitations, notably the small sample size and its self-selected nature, which may limit the generalizability of the findings. Moreover, the data collected are based on subjective self-reported statements, which may introduce a self-assessment bias. These factors call for caution in interpretation and highlight the need for confirmation through future quantitative studies.

5. Conclusion

The study conducted on sustainable R&D and its impact on the competitiveness of industrial companies highlights significant results. It is now proven that the integration of sustainable R&D constitutes a strategic lever for companies seeking to adapt to new economic, environmental, and societal requirements.

Main lessons of the study

1) Sustainable R&D improves industrial competitiveness: Companies that invested in sustainable innovations experienced gains in product differentiation, operational efficiency, and access to international markets. Hypothesis H1 and its sub-hypotheses were confirmed by the empirical data, notably with 70% of companies observing an increase in their market share and 85% of large companies benefiting from environmental certifications.

2) A variable impact depending on the size of the companies: While large com-

panies have been able to take advantage of sustainable innovations thanks to their easy access to financing and subsidies, SMEs still face difficulties investing in sustainable R&D. Hypothesis H2 is partially validated, due to the obstacles linked to financing and the implementation of green technologies within small structures.

3) A need for regulatory and financial support: Access to financing remains a major challenge for companies wishing to adopt sustainable R&D. Only 40% of the companies surveyed received financial support, which limits the widespread adoption of these practices. The regulatory framework and tax incentives remain insufficient to fully stimulate green innovation on a large scale.

4) Promising prospects for sustainable competitiveness: Despite these constraints, the rise of green financing, strengthened environmental standards, and new green technologies offer strategic opportunities. The growing integration of innovations based on artificial intelligence and the circular economy should strengthen business resilience in the face of economic and environmental crises.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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