

Enhancing Energy Efficiency In Moroccan Industry: The Role Of Energy Audits

Mehdi Bensouda^{1*}, Mimoun Benali¹, and Ghada Moufdi²

¹Laboratory of Research and Studies in Management, Entrepreneurship and Finance (LAREMEF), National School of Commerce and Management of Fez, Sidi Mohamed Ben Abdellah University, Fez 30050, Morocco

²Studies and Research in Management of Organizations and Territories (ERMOT), Faculty of Legal, Economics and Social Sciences, Sidi Mohamed Ben Abdellah University, Fez 30050, Morocco

Abstract

This short report presents a summary derived from an original research titled “Energy Audit as an Instrument to Tackle Internal Barriers to Energy Efficiency: Lessons from Moroccan Industrial Firms”. The main objective of the research was to explore the effect of energy audits on addressing internal barriers to energy efficiency within industrial companies in Morocco. The research uncovered significant findings regarding the benefits of energy audits, and implications for both policymakers and researchers. This short report discusses the method, the existing literature, the results, outlines the limitations and suggests avenues for further research. By offering a condensed overview of original study, this report is a readily available for research interested in the importance of energy audits in promoting energy efficiency practices.

Introduction

At the center of Morocco's industrial scene, a transformation is stealthily taking place. It promises not only to enhance the country's competitiveness but also its sustainability. Energy, the cornerstone of economic and social development, and the core of industry is considered as a valuable resource and an imminent challenge. As the world moves to embrace energy efficiency practices as a solution to cope with the twofold pressures to stimulate economic growth and conserve energy, Moroccan industrial companies are facing numerous barriers to implement energy efficiency practices. In this report, we delve into the

pivotal role of energy audits in tackling internal barriers to energy efficiency, and we underline the critical role of this understudied device for a more competitive and sustainable industry.

In an era where the increase of energy consumption is causing both draining fossil fuels and aggravating climate change, energy efficiency has become an inherent part element of the global sustainability agenda, transcending geographical boundaries. Within this global framework, energy efficiency represents both a considerable opportunity, but also an emerging challenge for Moroccan industrial companies (Bensouda and Benali, 2023).

The Moroccan industry is characterized by its weighty contribution to the country's national economic development (Boutbirt and Adaskou, 2023), but also by its consequent energy consumption "24% of the country's total energy production" (Bensouda and Benali, 2022).

Therefore, the Moroccan industrial sector is vital to decrease the nations' energy consumption. However, energy efficiency practices within Moroccan industries are hindered by various obstacles and challenges. These energy efficiency barriers could be divided into two main categories. While external barriers generally include obstacles out of companies' control, internal barriers are inherently managerial/organizational challenges.

Internal barriers could be related to competing interests within companies, the lack of information, and the low technical competence. To overcome these internal barriers, it is important to explore actionable tools tackle these internal barriers.

Energy audits is a pivotal tool that enable companies to uncover energy efficiency opportunities which ultimately lead to optimizing energy consumption. By underlining energy-saving opportunities and providing actionable recommendations, energy audits are likely to reduce the intensity of internal barriers to energy efficiency by underlining opportunities and providing actionable recommendations.

The main objective of this report is to provide summarized overview of the insights derived from our previously published research paper which established energy audits as a pivotal means to tackle internal barriers to energy efficiency within the Moroccan industrial sector. This report dissects the core results, recommendations, and

implications outlined in our original work. By emphasizing the integral part played by energy audits, we aim to stress their valuable contribution to reducing the intensity of internal barriers and fostering energy efficiency, thereby supporting Moroccan industrial companies' long-term sustainability and competitiveness.

As we outline the summarized results of our study, we shall revisit the main research question and research sub-questions that helped us appreciate the importance of energy audits: Do energy audits have a positive effect on reducing the intensity of internal barriers to energy efficiency?

In the following sections, we will begin outline the relevant prior research. Then, we will present a concise overview of the methodology adopted. Subsequently, we will summarize the main findings of our study. Finally, we will highlight the main findings which underline the importance of energy audits in fostering energy efficiency, the implications, the limitations and future research directions.

Literature Review

In the forthcoming section, we present the existing literature regarding energy audits as a means to tackle internal barriers to energy efficiency. The aim of this review is to offer an overview of previous research in this field.

Internal barriers to energy efficiency have received particular focus in the literature. Cattaneo (2019) identified several internal barriers such as individual preferences and behaviors within companies (Cattaneo, 2019). Awareness issues, as highlighted by Zuoza and Pilinkienė (2018), also hold a key role in obstructing energy efficiency (Zuoza and Pilinkienė, 2018). Organizational systems' deficiencies, explored by Jalo et al. (2021), is another internal barrier that inhibits energy efficiency within industrial companies (Jalo et al., 2021).

The crucial role of energy audits in industry has been an important research topic. Kalantzis and Revoltella (2019) highlighted the importance of energy audits for identifying energy-saving opportunities in industry (Kalantzis and Revoltella, 2019). Bruni et al. (2023) shed the light on energy audits as a tool of enhance industrial companies' energy performance, by monitoring energy and understanding energy consumption and potential of facilities (Bruni et al., 2023).

Energy audits is considered by previous literature as a considerable element in tackling internal barriers to energy efficiency. Zafar (2021) reported that energy audits enable companies to overcome several internal barriers, such as the inappropriate use of technology (Zafar, 2021). Chiaroni et al. (2017) reported that energy audit programs help companies to overcome behavioral barriers and competence-related barriers (Chiaroni et al., 2017).

While the literature provides key perspectives, it also points to certain gaps. One notable gap, as identified by Ibn Batouta et al. (2023), resides in the limited studies regarding the effect of energy audits in alleviating barriers to energy efficiency within Moroccan industrial companies (Ibn Batouta et al., 2023). In our original study, we explored the effect of energy audits in tackling internal barriers to energy efficiency within Moroccan manufacturing companies (Bensouda et al., 2023). This short report serves to offer a summarized overview of the positive effect of energy audits in tackling internal barriers to energy efficiency, namely competing interest, the lack of information, and the low technical competence, as explored in our original study.

Methodology

This report is drawn from our original research: Energy Audit as an Instrument to Tackle Internal Barriers to Energy Efficiency: Lessons from Moroccan Industrial Firms. The study involved a quantitative survey approach. A structured questionnaire was employed to collect data from 193 Moroccan industrial companies from various sectors. We used the partial least square (PLS) method and SmartPLS3 software to test our various hypotheses. It is noteworthy that all participants provided informed consent.

Results

In the following section, we outline the main findings of our original study, providing a succinct overview of the results related to the effect of energy audits in tackling internal barriers to energy efficiency.

To test the effect of internal barriers on adopting energy efficiency measures within Moroccan industrial companies and the effect of energy audits on internal barriers to energy efficiency, we posed our first hypothesis.

- Hypothesis 1: Competing interests has a negative

effect on industrial companies' energy efficiency.

- Hypothesis 2: The lack of information has a negative effect on industrial companies' energy efficiency.
- Hypothesis 3: The low technical competence has a negative effect on industrial companies' energy efficiency.

The three (3) above-mentioned hypotheses examine the effect of internal barriers on inhibiting energy efficiency practices within Moroccan industrial companies. The data analysis supported these hypotheses, revealing that competing interest ($\beta = -0.331$; $p = 0.0$), the lack of information ($\beta = -0.136$; $p = 0.0$), and the low technical competence ($\beta = -0.191$; $p = 0.0$) have a negative effect on industrial companies' energy efficiency. Hypotheses 1, 2, and 3 are then supported, and they align with our expectations.

- Hypothesis 4: Energy audits have a positive effect on companies' energy efficiency.

Hypothesis 4 explore the potential positive effect of energy audits on enhancing energy efficiency practices within industrial companies. Based on the data analysis, this hypothesis is confirmed ($\beta = 0.425$; $p = 0.0$), it aligns with our expectations.

Hypotheses 1, 2, 3, and 4 are direct effect hypotheses, assessing the correlation between two variables. Hypotheses 5, 6, and 7 are direct effect hypotheses, identifying the relationship between three variables, and testing the moderation effect of energy audits on reducing the intensity of the relationship between internal barriers and energy efficiency barrier within industrial companies.

- Hypothesis 5: Energy audits mitigate the negative effect of competing interests on the adoption of energy efficiency.

Hypothesis 5 that state that energy audits mitigate the negative effect of competing interests and the lack of information on the adoption of energy efficiency practices within industrial companies is not supported ($\beta = 0.037$; $p = 0.076$), and it doesn't align with our expectations and the previous literature.

- Hypothesis 6: Energy audits mitigate the negative effect of the lack of information on the adoption of energy efficiency.
- Hypothesis 7: Energy audits mitigate the negative effect of the low technical competence on the adoption of energy efficiency.

Hypotheses 6, and 7 that state that energy audits mitigate the negative effect of the lack of information ($\beta = 0.365$; $p = 0.0$) and the low technical competence ($\beta = 0.321$; $p = 0.0$) on the adoption of energy efficiency practices within industrial companies are both confirmed. Hypotheses 6 and 7 also align with our expectations.

Discussion and conclusion

In this section, we discuss the results derived from our original research, we examine the implications, we discuss the limitations and offer further research directions. We conclude by highlighting the contributions of our study to the field of energy efficiency.

Based on our research' findings, Moroccan industrial companies face various internal barrier to energy efficiency, namely competing interests, the lack of information, and the low technical competence. In addition, energy audits reduce the intensity of the lack of information, and the low technical competence on the adoption of energy efficiency practices. However, energy audits don't mitigate the negative effect of competing interests on the implementation of energy efficiency practices within Moroccan industrial companies.

These findings outline the importance of energy audits in tackling internal barriers to energy efficiency. However, energy audits do not systematically reduce competing interests within companies, meaning that even if establishing energy audit programs helps reducing the negative effect of internal barriers, employees could still have divergent interests (e.g., production department vs energy management department).

We now transition to our implications, which offer workable perspectives that could provide researchers and policymakers with better informed strategies to overcome internal barriers to energy efficiency based on energy audits.

First, we present the theoretical implications. The study consolidates the existing literature by affirming the

centrality of energy audits in mitigating the effect of internal barriers to energy efficiency. Also, our study negates the fact that energy audits decrease the level of competing interests within companies. In this respect, our study prolongs previous literature.

Second, we present the policy implications. Given the critical role of energy audits in addressing internal barriers, governments could take the following steps:

- Help companies to establish energy audits by providing subsidies.
- Offer technical support and training programs to enhance employees' technical competence.

As we assess our original study's implications, we should similarly acknowledge certain limitations. We limited our analysis to the effect of energy audits on tackling three internal barriers to energy efficiency. Therefore, it would be interesting, as an avenue for further research to explore the effect of energy audits on overcoming other barriers to energy efficiency.

Another avenue for further research would profit from focusing on a specific industrial sector, which would lead to uncover unique barriers and more customized solutions. Furthermore, a longitudinal study would provide the long-term effect of energy audits in tackling internal barriers to energy efficiency.

In closing, this short report reviews the main findings derived from our original study titled: "Energy Audit as an Instrument to Tackle Internal Barriers to Energy Efficiency: Lessons from Moroccan Industrial Firms". Our impact of our findings could be deepened by future investigation. Therefore, we invite further research to explore these implications to foster energy efficiency for more sustainable and competitive companies.

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