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Business model for energy efficiency in manufacturing

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Abstract

The study proposes a business model for energy efficiency and provides a tool that describes how manufacturing companies create, deliver and capture value, and at the same time evidencing the energy inefficiencies, wastes and manufacturing performances that are critical to the business model. Accordingly, we analyze cause-effect relationships between manufacturing performances and business model performances, and patterns of business models that can be adapted to develop a new structure focused on energy efficiency. To achieve this, a case study in the rubber manufacturing industry is carried out for the development and validation of concepts.

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1. Introduction

Traditional manufacturing companies used to focus their business models on delivering high-quality tangible products at low costs. However, the competition rules in the industry have changed in the last decade since pure low cost strategies are not as effective as before. In that regard, sustainability has become a key strategy that not only returns benefits for the environment and society, but also provides significant opportunities for the companies to increase their competitive advantage, attract eco-friendly customers and reduce costs in the long term.

Improving energy efficiency is one way to start the journey toward sustainability, especially in energy-intensive manufacturing industries, as it returns higher productivity, increased competitiveness and lower costs, apart from the benefits associated with environment [1]. There is a growing global concern along with the powerful pressure on policy makers and the industry since global energy consumption, where the majority of supplied energy continues to be from carbon based sources, increased more than 25% in the last 20 years and a further 15-35 % increase is expected by 2030 [2]. Besides, the manufacturing sector accounts for one third of global primary energy consumption, corresponding to more than 38% of the direct and indirect CO₂ emissions [3]. Manufacturing units and factories therefore play a critical role in achieving these targets. A factory as a socio-technical system

combines factors such as labour, material, energy, information and machines for the purpose of value creation in forms of products and services. While a significant part of energy and resources are used to create value, significant parts are wasted in terms of emissions, heat, and other losses [4, 15].

Nevertheless, so far this concept has been approached mostly in technical and operational levels rather than managerial. Hence, this study intends to alter the notion of energy efficiency to a strategic level by proposing a business model for energy efficiency for manufacturing companies. With this aim in mind, we provide a tool that describes how manufacturing companies create, deliver and capture value, and at the same time evidencing the energy inefficiencies, wastes and manufacturing performances that are critical to the business model. Accordingly, we analyze cause-effect relationships between manufacturing performances and business model performances, and patterns of business models that can be adapted to develop a new structure focused on energy efficiency. To achieve this, a case study in the rubber manufacturing industry is carried out for the development and validation of concepts.

The research might benefit manufacturing companies that want to improve their business models by adopting an energy efficiency philosophy, as the model could enable a comprehensive view of the inherent business logic and

environmental impact, allowing top managers to take green decisions.

2. State-of-the-art

Over the past few decades, the increasing concern about climate change, scarcity of resources and energy supply has increasingly changed the attitudes of society and industry towards the environment. Industrial firms have been affected by growing energy prices, strict environmental regulations, customer demand and environmental awareness. Guided by this paradigm shift toward energy management in manufacturing due to global and industrial drivers, the issue of improving energy efficiency (EE) therefore gains more and more importance. Thus, companies have been feeling the pressure to single out the determinants of environmental performance for their manufacturing processes [5]. As a consequence of this, EE has become the new topic of interest for the industry and academia as it can reduce both economic and environmental impacts related to the consumption of energy [6].

Improving EE in production facilities has become a big challenge for managers regardless of the industry sector. For a shift toward energy efficient manufacturing systems, proper tools are required to model and assess energy consumption behaviour in a manufacturing environment [16]. Guided by this particular challenge, academicians and practitioners have been making attempts to provide efficient and reliable tools, and this field has become a rapidly developing area [7]. Hence, a significant number of tools have been proposed for this purpose [17].

Implementing energy efficiency like any other strategy needs a properly developed Business Model, that supports not only the company during its path to achieve energy efficiency but also to evaluate and improve manufacturing performance, not just in terms of traditional indicators, but also taking into account energy efficiency in response to the environmental problems and the accelerated climate change which increase customers' demand for eco-friendly products and trigger more strict regulations set by governments [1].

The current state and trend of environmental degradation (from regulatory, consumer, and moral positions) indicates a need for a change in manufacturing strategy, i.e. a fundamental shift in the way production systems operate. This requires an approach towards sustainability, achieved through significant reductions in energy and material use and a move away from one-time use and product disposal. The first step in such a shift is to extend the structure of the current one-way supply chain to a closed loop, including supply chain operations designed for end-of-life product and packaging recovery, collection, and reuse in the forms of recycling and remanufacturing [8].

Energy efficiency is considered as one of the most relevant sustainability archetypes. The potential of the energy efficiency programs is significant as only 37% of the primary energy is converted into useful energy [9]. Thus, this significance of energy efficiency strategies has been tested worldwide through the production of vehicles that require less fuel, home appliances and lamps which consume less electricity.

Nowadays, companies invest more and more to implement energy efficiency practices to compete in relation to added

value dealing with clients who demand eco and energy friendly products daily. Thus, explanatory guidelines and additional motivational factors are required to make companies implement energy efficiency strategies. Bowen et al. [10] state that organizations will adopt material and energy efficiency management practices if they identify that this will result in specific financial and operational benefits. Thus, this research investigates the potential link between the mentioned practices and the increasing of competitiveness and enhanced economic performance, to provide an impetus for organizations to green their supply chains. On the other hand, enterprises in practice need a guide and a model to achieve EE successfully. The model should aggregate the findings of the current literature and combine it with empirical findings to suggest a list of objectives, enablers and practices for EE in different levels of the supply chain.

In this context, the main portion of the literature missing till now is related to the inclusion of energy efficiency concept in a strategic tool such as a business model. Thus, this study addresses the following gap:

Gap: Lack of a widespread and precise business model for energy efficiency for manufacturing companies that can describe the companies' logic for generating revenue while implementing an energy efficiency approach

Doing this, the study determines the impacts of the energy efficiency performances in manufacturing companies, as well as defining the principal drivers of energy efficiency that impact the performance of this kind of companies. This analysis is carried out in order to create knowledge for the implementation of a more effective business model which supports manufacturing companies in entering the sustainable journey by considering all the enablers, variables and relationships that exist between energy efficiency and other manufacturing performances of companies.

3. Research framework

A research hypothesis is the first step of an academic research. According to Kothari et al. [11], research hypothesis is a logic statement of what will be investigated in the research and it has a supportive nature of predicting the relationship between variables. This research is based on two hypotheses. The first one is the preliminary hypothesis which predicts the additional value perceived by the customer that is generated by the design of the energy efficiency business model in companies, while the second one is the main hypothesis which predicts the positive impact of the energy efficiency business model on the manufacturing performances of a company.

The research framework is a key aspect for the researchers to choose the right research methods. The framework presented in Figure 1 is divided into three main sections: (i) enablers, (ii) business model for energy efficiency for manufacturing companies, and (iii) manufacturing performances.

The enablers are the influencing theories and factors that facilitate the knowledge creation. The most important enablers for the creation of the business model for energy efficiency for manufacturing companies originate mainly from the sustainability theory. In this context, May et al. [6] proposed 4 main enablers for energy efficiency: (i) strategic approach, (ii)

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