Energy Policy 118 (2018) 418–428

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Understanding the effects of energy management practices on renewable energy supply chains: Implications for energy policy in emerging economies

Yudi Fernando[a,e], Poh Swan Bee[b], Charbel Jose Chiappetta Jabbour[c,*], Antônio Márcio Tavares Thomé[d]

[a] Faculty of Industrial Management, Universiti Malaysia Pahang, 26300 Pahang, Malaysia
[b] Graduate School of Business, Universiti Sains Malaysia, Penang 11800, Malaysia
[c] Montpellier Business School, Montpellier Research in Management, 2300, avenue des Moulins, 34185 Montpellier Cédex 4, France
[d] Industrial Engineering Department, Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio), Rua Marquês de São Vicente, 225. Sala 952L - Gávea, Rio de Janeiro, RJ 22451-000, Brazil
[e] Management Department, BINUS Online Learning, Bina Nusantara University, 11530, Indonesia

ARTICLE INFO

Keywords:
Energy efficiency
Renewable energy
Sustainable supply chain
Energy audit
Emerging economy

ABSTRACT

Drawing from the resource-based view (RBV) and complexity theories, we test the effects of energy management practices on renewable energy supply chain (RESC) initiatives in 151 certified (ISO 14001 and ISO 50001) manufacturing firms in Malaysia. Our results showed three dimensions of energy management practices (EMP) – top management commitment, energy awareness, and energy auditing – which were positively associated with the development of RESC initiatives. We found that insufficient knowledge of energy efficiency means firms struggle to manage energy effectively, constraining opportunities such as converting waste into energy to support business' targets. Our work has implications for energy policy. For example, we suggest that the transfer of energy efficiency management knowledge and technology from multinational to local companies could help to improve energy usage, and that local companies could generate renewable energy through supply chain networks. The findings of this work shed light on how to further develop energy efficiency policy in emerging economies, with implications for academics, practitioners and decision-makers. This work makes the case for an integrated discussion of energy management and renewable energy supply chains.

1. Introduction

Drawing on the resource-based view (RBV) and complexity theories, in this work we test the effect of energy management practices on renewable energy supply chain (RESC) activities in the Malaysian manufacturing sector. The manufacturing industry is responsible for approximately 36% of global CO_2 emissions and consumes nearly 50% of the global energy supply (Rahman et al., 2016). Based on statistics from the Asian Pacific Energy Center (APEC), CO_2 emissions from energy consumption in Malaysia are anticipated to grow by around 4.2% annually, reaching 414 million tonnes of CO_2 in 2030 (Hosseini et al., 2013). Developing countries such as Malaysia have focused on industrialisation to achieve higher economic growth (Li and Wei, 2015), and this industrial sector is currently searching extensively for ways to reduce energy consumption.

Despite a plethora of campaigns and policies directed towards energy efficiency and renewable energy (RE), Malaysia has so far had limited success in achieving energy efficiency; challenges and opportunities remain and need to be fully understood (Yatim et al., 2016; Hosseini et al., 2013). A number of studies have shown the fragility of energy efficiency adoption in the manufacturing sector due to a lack of employees with adequate knowledge and training for energy efficiency (Prindle, 2010; Turesky and Connell, 2010), an absence of awareness of energy consumption patterns (Shrouf and Miragliotta, 2015), structural uncertainty and the risk of impacting on the quality of products (Lunt and Levers, 2011), energy efficiency not being a priority due to a lack of management commitment (Turesky and Connell, 2010; Lunt et al., 2014), and hesitation on investment due to limited financial resources and delayed payoffs (Eichhammer, 2004; Rohdin et al., 2007).

The advantages of practicing energy management have been well studied in developed countries such as Sweden (Brunke et al., 2014; Backlund et al., 2012a, 2012b), America (Moran et al., 2005), Finland (Sivill et al., 2013) and Germany (Kannan and Boie, 2003). Nevertheless, developing countries tend to face financial constraints (Painuly

* Corresponding author.
E-mail addresses: yudi@ump.edu.my, yudi.fernando@binus.ac.id (Y. Fernando), swanny880801@gmail.com (P.S. Bee), cjabbour@gmail.com (C.J.C. Jabbour), mt@puc-rio.br (A.M.T. Thomé).

https://doi.org/10.1016/j.enpol.2018.03.043
Received 13 August 2017; Received in revised form 3 February 2018; Accepted 16 March 2018

et al., 2003) and a lack of accessible information (Lunt et al., 2014) when pursuing energy efficiency (Painuly et al., 2003).

Existing literature on energy efficiency has emphasized environmental management, carbon management (Mohanty, 2012), and barriers to energy management, such as high initial costs, knowledge of energy conservation, among others. (Brunke et al., 2014). There is still a lack of empirical studies testing the effects of energy management practices on RESC in manufacturing industries in emerging economies such as Malaysia. RE is part of the driving force to enhance energy efficiency, protect natural resources and improve quality of life (Wee et al., 2012). Similar to other supply chains, RESC includes elements such as physical information and financial flows (Cucchiella and D'Adamo, 2013).

The development and utilisation of RESC are still challenges in terms of energy conversion costs, geographical constraints, distribution networks, capital investment, lack of economies of scale and uneven government subsidies and taxes (Wee et al., 2012; Chatzimouratidis and Pilavachi, 2009). According to Cucchiella and D'Adamo (2013), there is a significant impact when supply chains are integrated with RE, such as better control of supply chain costs, in order to make RE more affordable and competitive. Although the initial investment in RE is currently more costly than conventional energy resources (Stigka et al., 2014), in the long term it will benefit from economies of scale once manufacturing firms are able to generate renewable energy. Costs will fall once demand for RE increases and supply improves, resulting in increased energy efficiency. Thus, the profits generated from RE efficiency will eventually cover the initial investment cost. RE is able to provide an energy solution which reduces the negative impact on the environment (Siano, 2014; Mathiesen et al., 2015).

Consequently, we aim to investigate the effect of EMP on RESC. The uniqueness of this research is based on: (1) the development of an original theoretical framework relating EMP to RESC; and (2) a test of this framework using original empirical data from Malaysian manufacturers with ISO 14001 and ISO 50001 certification.

This work is organised as follows. The next section reviews the literature on energy management practices and RESC. This is followed by a description of the data collection procedure and the variables used. Subsequently the results are presented and analysed. The paper ends with some conclusions, implications and suggestions for further research.

2. Theoretical development and research hypotheses

2.1. The resource-based view (RBV)

According to the RBV, organisations can develop capabilities and gain competitive advantage through the set of resources they possess (Vachon and Klassen, 2008). Resources comprise both tangible and intangible components (Grant, 1991; Amit and Schoemaker, 1993). RBV claims that organisations should possess diverse resources and different levels of capability, and that organisations' survival and competitive advantage hinges on their ability to create new resources, as well as to increase uniqueness in their capabilities (Nath et al., 2010; Day and Wensley, 1988). Competitive advantage cannot be obtained simply through possessing greater resources; however, competitive advantage can be achieved through the way an organisation employs its rare resources, puts it capabilities to best use, and invests in its current capabilities, which can lead to "immobility" in its resource-capability (Song et al., 2007; Peteraf, 1993). RBV posits that resources leading to sustainable competitive advantage should be valuable, rare, inimitable and non-substitutable (Barney, 1991). In its extension to the natural environment, the natural RBV (NRBV) bears that pollution prevention with limitation of emissions and wastes, product stewardship, and sustainable development minimising environmental burden are resources leading to sustainable competitive advantage (Hart, 1995; Hart and Dowell, 2011).

RBV proposes that each organisation has a unique set of resources and capabilities which, when used optimally, will have a greater impact on the firm's financial performance (Song et al., 2007). This impact is attributed to the efficiency with which an organisation is able to convert its resources into "valuable" and "hard to imitate" capabilities, obtain economies of scale through lower operational costs and achieve better financial performance (Lieberman and Dhawan, 2005; Hitt et al., 1997). In this study, RBV is the main theory used to identify and examine the internal capabilities of organisations, such as management commitment, energy knowledge, energy awareness, energy auditing and the utilisation of RESC as a potential resource to gain sustainable competitive advantage.

2.2. Complexity theory

Complexity theory presents an attractive metaphor for analysing organisational behaviour (Lewin et al., 1998). Heterogeneity and diversity in environmental factors – such as customers, suppliers, governments and technology – create complexity in an organisation (Chakravarthy, 1997). Manufacturing organisations find it more challenging to plan their strategy and foresee their organisational actions as business complexity increases (Sarkis et al., 2011). Pertaining to this study, the implementation of energy management and RESC in manufacturing involves various parties, such as organisation management and government. Extensive organisational complexities, such as organisational size, can be lead to intensified and hard-to-implement energy management and RESC projects (Vachon & Klassen, 2006).

Complexity theory proposes that organisations function in a system that comprises both order and disorder, where the performance results of the system are determined by the interactions of the involved parties (Sarkis et al., 2011; Prigogine, 1984). To diminish the uncertainty that arises from executing energy management and RESC activities (Sarkis et al., 2011), it is very important to maintain interaction among the involved parties for knowledge and information sharing as well as creation of meaning (Yang, 2010). In this study, complexity theory is used to investigate the relationship between energy management and RESC.

2.3. Energy management (EM)

Energy management is a solution which aims to utilise the unexploited potential of energy saving, overcome barriers of energy efficiency and spread the culture of energy saving and efficiency, bringing the benefits of reduced energy consumption within the organisation without affecting productivity and quality (Cagno and Trianni, 2013; Backlund et al., 2012a, 2012b; Thollander and Ottosson, 2010). Productivity and quality can be maintained if the manufacturing firms monitor energy consumption trends, review the results of energy data analysis and motivate and train their staff (Trianni et al., 2014). From a wider perspective, energy management helps sustainability management by incorporating economic, environmental and social factors into overall business practices (Schaltegger et al., 2006; Dincer, 2003). Energy management practices are able to improve results through installing energy efficiency technology (Seliger, 2007), promoting effective maintenance (EERE, 2012) and reducing load during non-productive phases (Herrmann et al., 2008), among other energy-optimising processes.

Energy management standards such as the Energy Star, ISO 14001 Environment Management System (EMS) standard, and the ISO 50001:2011 Energy Management System have been introduced globally. However, there is still a deficit in EM practice within organisations due to difficulties in benchmarking, the complexity of business activities and the resources required for firms to properly implement energy management (Ngai et al., 2013). Energy management practices differ from one industry to another, and depend on energy consumption and intensity, organisational size, quality management and geographical