Impacts of energy management practices on energy efficiency and carbon emissions reduction: A survey of Malaysian manufacturing firms

Yudi Fernando\textsuperscript{a,b,c}, Wei Lin Hor\textsuperscript{c}

\textsuperscript{a} Governance and Integrity Centre, Faculty of Industrial Management, Universiti Malaysia Pahang, 26300, Pahang, Malaysia
\textsuperscript{b} BINUS Online Learning, BINUS University, 11530 Jakarta Barat, Indonesia
\textsuperscript{c} Graduate School of Business, Universiti Sains Malaysia, 11800, Penang, Malaysia

\textbf{A B S T R A C T}

Carbon dioxide (CO\textsubscript{2}) is the most prevalent Greenhouse gas (GHG) produced by human activities. Industrialization has been among the primary factors for increased CO\textsubscript{2} production, mostly through the consumption of electricity and the burning of fossil fuels. To investigate the current practices of energy management in Malaysian manufacturing firms, this study collected survey data from ISO 14000 certified firms. The study found that energy management practices are still very much in their infancy, and concern for carbon emissions is limited in the Malaysian manufacturing context. A lack of competitive pressure for developing environmentally friendly management practices generally prevails among industrial firms, although marginal improvements in energy management practices and energy efficiency are evident. The study found that energy audit and energy efficiency are two critical factors for reducing carbon emissions. The study also found that energy awareness, knowledge, and commitment are related to energy efficiency. One key outcome of the study was the development of a new theoretical model of energy management practices. The findings of this study have opened new research and development opportunities to identify alternatives to monetizing environmental concepts such as carbon emissions and energy efficiency.

1. Introduction

Atmospheric CO\textsubscript{2} concentration levels have been rising since tracking began in 1958. The data show that the burning of fossil fuels contributes about 67% of the total worldwide of CO\textsubscript{2} emissions into the atmosphere today. CO\textsubscript{2} is absorbed partly by the world’s oceans, but, as emissions have climbed, the resultant acidification of those same oceans is increasingly leading to ecological and biological changes while the continuously rising atmospheric concentration leads to global warming and climate change (Cubasch et al., 2013). While CO\textsubscript{2} is not the only greenhouse gas contributing to the problem, it is the most abundant greenhouse gas produced by human activities (IPCC, 2005).

CO\textsubscript{2} is classified as a greenhouse gas and is created as a by-product of consuming non-renewable fossil fuels such coal, petroleum and natural gas as energy sources (Thollander et al., 2007). Environmental damage from CO\textsubscript{2} emissions leads to climate change, which further exacerbates economic risks from severe weather events such as floods that can, in turn, lead to the disruption of the supply chain and operational losses (Halldórsson and Kovács, 2016). The threat of economic loss and destabilization of global supply chains due to global warming and climate change has created a vested interest by both governments and the public to become aware of the downsides of unmanaged CO\textsubscript{2} emissions (Dincer, 1999). Because of the evaluation of the environmental and economic costs (Lam et al., 2010), international agreements on climate change have been signed. One example is the Kyoto Protocol and Intergovernmental Panel on Climate Change (IPCC), which created a commitment to reducing greenhouse gases emissions for the signatories.

Because evidence points to rising energy consumption as a primary cause of increased CO\textsubscript{2} production, managing energy efficiency is one key to creating more sustainable economic growth while simultaneously minimizing environmental and social impacts (Saboori et al., 2012). On the one hand, energy has been a critical driver of economic activities and rising energy consumption has traditionally been seen as a sign of strong national economic growth (Tugcu et al., 2012). On the other hand, evidence shows causal links between energy consumption and environmental and social health degradation. Some nations have been wary of making severe changes that upset the balance between economic growth and the well-being of its citizens and the environment (Ang, 2008).

\textsuperscript{*} Corresponding author at: Governance and Integrity Centre, Faculty of Industrial Management, Universiti Malaysia Pahang, 26300, Pahang, Malaysia.

E-mail addresses: yudi@ump.edu.my, yudhitjoa@gmail.com (Y. Fernando), weilin.hor@gmail.com (W.L. Hor).

http://dx.doi.org/10.1016/j.resconrec.2017.07.023

Received 17 January 2017; Received in revised form 3 July 2017; Accepted 17 July 2017

Available online 29 July 2017

0921-3449/ © 2017 Elsevier B.V. All rights reserved.