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 coverage (Gordić et al., 2010; Turner and Doty, 2007; Sorrell, 2007). Hence, in order to ensure consistency with existing energy management standards, as well as to analyse and continuously improve levels of energy management, a practical framework is necessary.

Much research has shown that energy management is not purely a technical process of optimising energy consumption, but is practicable and multidisciplinary in nature and combines knowledge of architecture, engineering, management, finance, and housekeeping (Lee et al., 2011; Kannan and Boie, 2003). Successful implementation of energy management in manufacturing firms depends on the size and structure of the organisation, business strategy, energy policy and energy auditing strategy. Manufacturing firms are advised to conduct feasibility studies before making decisions on energy investment.

Although energy management appears to be cost-effective, there is still a lack of adoption in the industry due to the energy efficiency paradox (Brunke et al., 2014; Backlund et al., 2012a, 2012b; Hirst and Brown, 1990). The energy efficiency paradox refers to organisational behaviours. Despite the industry understanding the business yield from energy efficiency, measures are often not implemented due to the high initial investment and lack of availability of knowledgeable employees. Providing sufficient energy management training for employees is critical to successful energy management implementation (Abdelaziz et al., 2011).

One of the most commonly cited barriers is a fear of production failure or technical risks, as new technology may disrupt production and quality due to a lack of technical knowledge in energy management execution (Brunke et al., 2014; Venmans, 2014; Thollander and Ottosson, 2010). Without effective managerial commitment energy management is hard to implement, as top management possess skills and knowledge of production processes, raw materials and other methods for maximising the efficiency of manufacturing, and their involvement therefore significantly influences the adoption of energy management practices (Blass et al., 2014). The degree of energy management adoption and motivation in an organisation tends to increase along with increasing energy intensity, and vice versa (Christoffersen et al., 2006).

Indeed, different industries face various energy efficiency barriers, and thus, to overcome the gap, existing drivers need to be further improved by re-examining and re-testing them, and importantly by ensuring that recommended practice is acceptable and practical for all sectors (Thollander et al., 2013; Ang, 2008). The essential factor for successful implementation and operation of energy management is commitment from top management, and without that commitment, strategies will likely fail (Turner and Doty, 2007; Capehart et al., 2003). In addition, Antunes et al. (2014) also agree that management commitment and better communication about energy conservation are important in creating awareness throughout an organisation. Awareness can also be increased through training and courses with top management support (Abdelaziz et al., 2011). Energy auditing is a key factor for decision-making in energy management, and helps to obtain knowledge about energy flows within an organisation (Abdelaziz et al., 2011).

According to Kannan and Boie (2003), commitment itself is not enough for successful energy management practice; it must be coupled with energy audits, which play an important role in identifying the energy saving possibility of the organisation. The availability of effective energy measurement outcomes for manufacturing firms is a critical point to be highlighted during energy auditing (Schulze et al., 2016). Backlund et al. (2012a, 2012b) and Brunke et al. (2014) propose that energy audits can also increase awareness of unexploited energy efficiency potential in organisations, as audits are able to identify energy flows and allocate necessary financial resources, leading to increased awareness of energy efficiency in the organisation. Abdelaziz et al. (2011) strongly recommend energy auditing as a preliminary requisite for energy management adoption. It should begin with management commitment and firms' ability to create energy awareness among employees; firms should then be able to identify the scope of energy saving.

2.4. Renewable energy supply chain

A supply chain is an interconnected network which includes the whole sequence of activities from distribution of a service or product to its end use and disposal, comprises multiple actors, operating on different scales and locations, and also includes the material or product's manufacture, assembly and delivery (Hoggett, 2013). According to Vachon (2007), through supply chain management (SCM) and with collaboration on environmental issues, it possible to monitor reverse flows of materials, share techniques and knowledge with supply chain partners, collaborate to control environmental risk and produce environmentally friendly products.

Today SCM plays an important role in producing renewable energy. Sustainable SCM (Sarkis and Zhu, 2017) is essential for energy security in industry as the extensive consumption of energy, resource scarcity, energy price fluctuations and the transition from fossil fuel-based energy generation to RE resources have real implications for supply chains (Halldórsson and Svanberg, 2013). By integrating SCM with RE, the effectiveness of RE will be boosted throughout the chain. According to Wee et al. (2012), RESC includes the physical flow of RE products, which involves the movement of goods and services from the point of production to the point of consumption. Aslani et al. (2013) highlight that RESC is comprised of five components: supply, generation, transmission, distribution and demand, as shown in Fig. 1. These components cover the process of RESC from raw materials (input) to end user product (output).

RESC is a process of transforming raw energy into usable energy. According to Halldórsson and Svanberg (2013), RESC management involves a set of effective management principles covering the flows between the points of consumption (demand, transmission of energy to end users) and the point of origin of raw material (acquisition of energy resources). According to Hoggett (2013), RESC comprises various interrelated sub-chains relating to vendors and customers, based on types of energy, technologies and the infrastructure that links to them, and the resources, labour, equipment, installation and operation systems needed for development. The integration of SCM with RE not only improves energy accessibility, but also simplifies fossil fuel replacement with systems of supply and RE conversion (Halldórsson and Svanberg, 2013).

The performance of RESC can be enhanced by increasing the flexibility of SCM and improving cost control in supply chains, with the aim of making RE more price competitive (Cucchiella and D'Adamo, 2013). The industrial sector can increase awareness of the benefits of energy saving, thus relating energy efficiency to RESC (Edenhofer et al., 2011). Fig. 2 demonstrates pure RESC processes from supply, manufacturing, and distribution to demand. Energy flow is portrayed as an example of this RESC flow to illustrate the relationship between energy production and consumption. In the RESC, technology is a key factor to enhance efficiency and to improve the distribution network. For demand, the commercialisation of RE would be an important step towards replacing conventional energy. Thus, efficient RE generation and storage

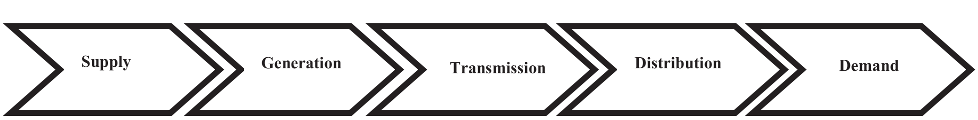

Fig. 1. Domain of renewable energy supply chain.
Source: Aslani et al. (2013)

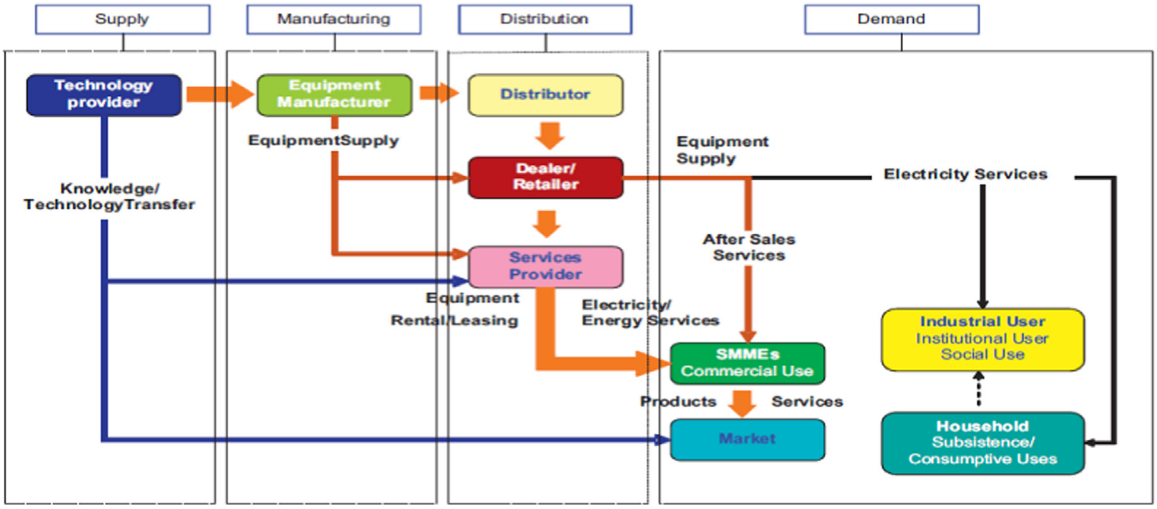

Fig. 2. A pure renewable energy supply chain flow.

technologies are crucial innovations for RE.

The United Nations Development Programme (UNDP, 2012) states that RE activities involve five key stakeholder groups: investors, end users, policymakers, utilities and supply chains. Each stakeholder faces a number of challenges that can hinder them in the RE technology implementation process. The manufacturing sector plays the role of investor, with government as regulator, creating policy that supports the achievement of RE in the long run and encourages the end user to support, utilise and pay for RE technologies. To prevent barriers, it is therefore important for all five types of stakeholder to be taken into consideration. Table 1 demonstrates the five key stakeholder groups for an RE barrier assessment.

3. Theoretical framework

The theoretical framework for this study is based on the hypotheses shown in Fig. 3. The RBV theory is the basis for this framework and claims that an organisation's capabilities are resources and that through these capabilities competitive advantage is strengthened (Vachon and Klassen, 2008). The RBV theory influences the independent variable in order to enhance the deployment of RESC. The second theory is Complexity Theory, which explains the challenge of managing EMP and the deployment of RESC, as the strategy for implementing EMP is complex. Both theories are used to build the theoretical framework. This framework aims to guide research efforts and provide an in-depth understanding for industries in the field of energy management practice. RESC also plays an important role in the acceleration of energy management practices, with regard to meeting energy security within the supply chain network and enhancing energy efficiency, as well as minimising CO_2 emissions with the use of clean energy (Fig. 4).

3.1. Development of hypotheses

The effectiveness of energy management depends on the types of energy systems with which it is integrated. (Olatomiwa et al., 2016). Based on a study by Olatomiwa et al. (2016) and Al-Nory and El-Beltagy (2014), integrating energy management with RE can ensure its optimisation, the stability of energy supply, a reduction in operational cost and accelerated energy efficiency. RE plays a role in enhancing energy management's fundamental objectives: the improvement of energy efficiency, the reduction of CO_2 emissions, and the encouragement of green practices (Mohanty, 2012). According to Fernando and Yahya (2015), management commitment and RE adoption are interconnected, as the success of setting up RE in organisations is heavily reliant on the support and commitment of management. Management commitment is a prerequisite for an organisation to move towards sustainability (Eccles et al., 2012).

Management commitment is important as it provides a strong foundation for staff involvement in energy management. Top management can inspire others throughout their organisation by expressing long-term views during decision-making, providing clear direction, and exhibiting a high level of technical knowledge in the integration of energy management with business (Rauter et al., 2015). Energy knowledge is the key factor for organisations to gain competitive advantages in RE; however, as the adoption of RE technology is complex, both technical knowledge and information sharing are required to tackle the uncertainty and challenges it presents (Seetharaman et al., 2016; Lee et al., 2015).

In terms of Complexity Theory, integrating RESC with energy management is complicated as RESC requires knowledgeable personnel with an in-depth understanding of RE functions as well as the skills to

Table 1
Five key stakeholder groups for a renewable energy barrier assessment.
Source: UNDP (2012).

Stakeholder	Description/barriers
Project developers and investors	The barriers faced by project developers and investors in RE, such as a lack of track records on the performance of RE technologies, uncertainties in local energy markets and politics.
End users	The RE-related barriers encountered by end users consist of a lack of awareness regarding RE and its potential and lack of financial ability to afford cleaner energy technologies.
Policymakers	This group comprises individuals in charge of creating the rules and regulations that manage the energy industry. The challenges encountered by policymakers include a lack of government support, a lack of incentives and limited information to inform potential policies.
Utilities	Utilities denotes entities that produce and transmit power or electricity. Challenges faced by utilities include a lack of experience in planning and managing RE generation, lack of technical know-how about RE technologies and economic conflicts of interest.
Supply chain	The Supply Chain includes firms that manufacture, distribute, install and maintain RE technologies. Supply Chain stakeholders face challenges such as lack of expertise in RE technologies and low demand for RE equipment.

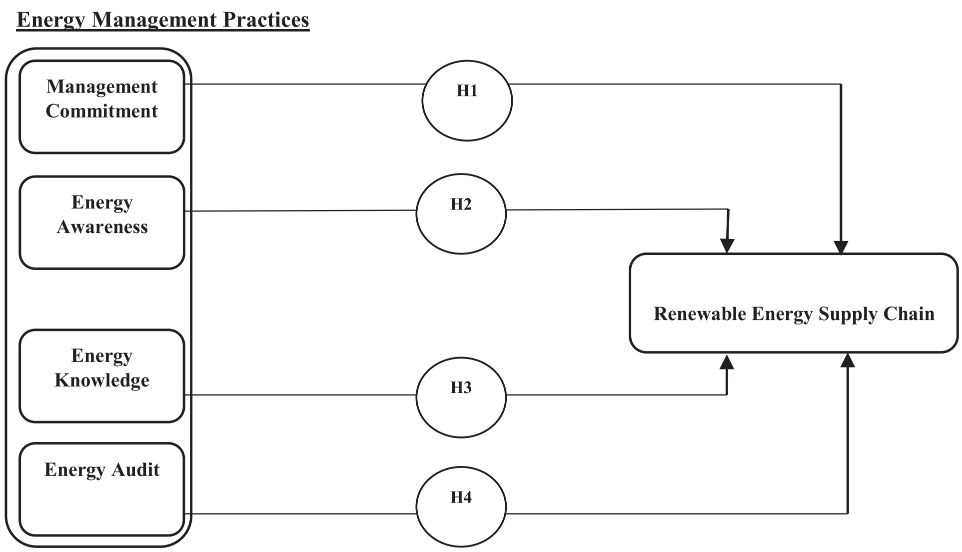

Fig. 3. Proposed theoretical framework.
Source: Wee et al. (2012)

implement them. Management must have a strong commitment to staff training and energy audits in order to understand the complex flow of RE, and must make continuous improvements to avoid jeopardising productivity. Based on the literature reviewed, which links EMP and RESC, the following hypotheses are proposed:

H1. Management Commitment has a positive and significant relationship with RESC

H2. Energy Awareness has a positive and significant relationship with RESC

H3. Energy Knowledge has a positive and significant relationship with RESC

H4. Energy Auditing has a positive and significant relationship with RESC

3.2. Research methods

The sample population in this study is manufacturing firms in Malaysia. The sample is based on firms listed in the Federation of Malaysian Manufacturers (FMM) directory (2015) which are ISO 14001 and ISO 50001 certified. The unit of analysis is at the organisational

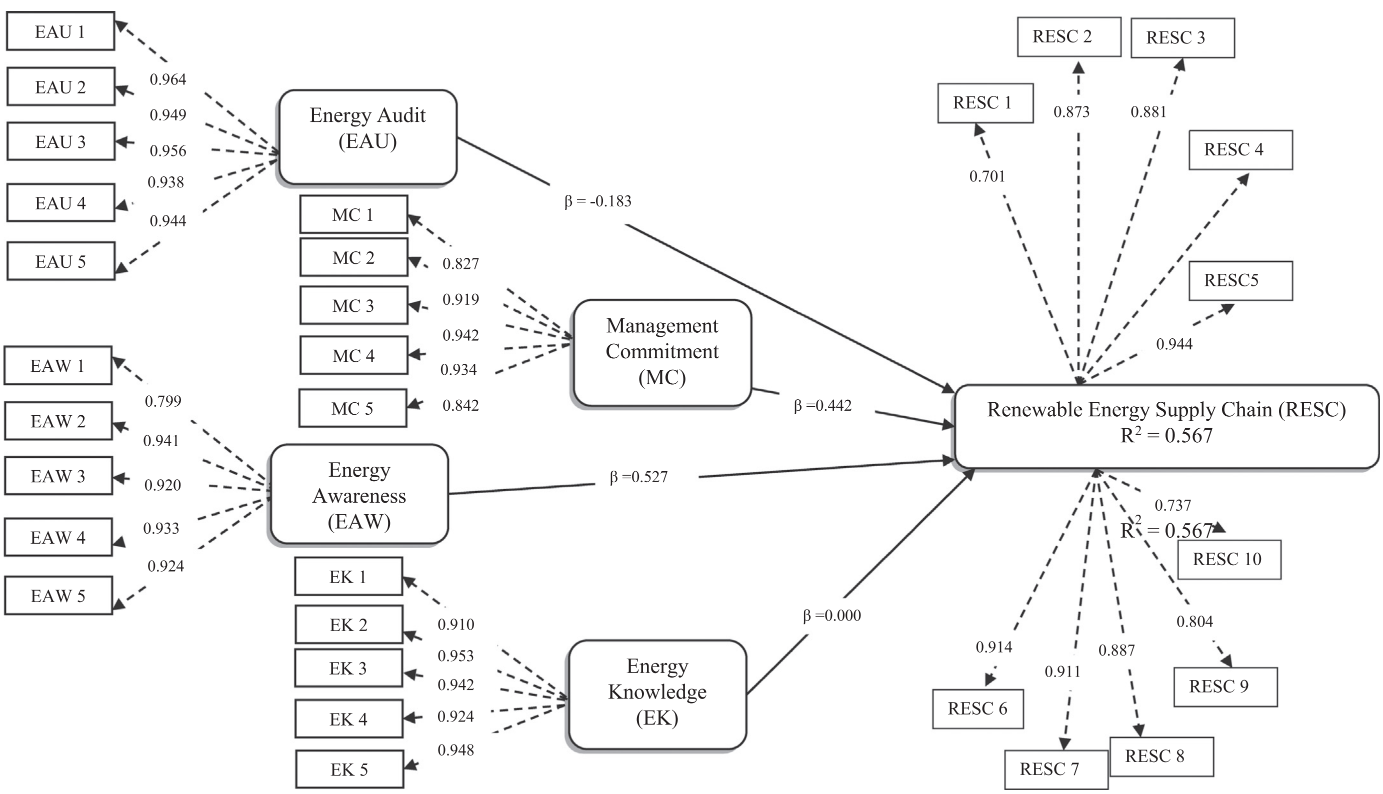

Fig. 4. Structural model for energy management practices and its effect on RESC.

level, where the target respondents were drawn from the senior executive level and above, i.e. senior executives, managers, senior managers, directors, general managers, vice presidents and CEOs, as they have the necessary knowledge and information to represent their firm. Data was collected using structured questionnaires distributed via an online survey.

This study used two statistical approaches: IBM SPSS software version 24 and Smart Partial Least Squares (SmartPLS) in Structural Equation Modelling (SEM) software version 3.2.4. SmartPLS was used to analyse the data collected for this study. Its main calculation functions, such as PLS Algorithm and Bootstrapping, were used to determine the viability of the model and test the hypotheses using the identified variables (Hair et al., 2014a, 2014b). However, the summary of respondents' demographics was generated using IBM SPSS. A stratified random sampling method was used, as the manufacturing firms possess heterogeneous characteristics and combine multiple elements. The stratified random sampling first involved a process of segregation, which was followed by random selection of subjects from each stratum (Sekaran and Bougie, 2016).

3.3. Pre-testing survey instrument

Before disseminating the survey questionnaire to target respondents, a pre-test was run in order to identify any major issues with the survey questions and descriptions (Haron et al., 2017). To ensure there were no fundamental problems with the questions or difficulty understanding the concepts, a pre-test was conducted by nine academics and industrial practitioners. Based on the comments received from the group of pre-test respondents, questions and descriptions were added or altered; in particular, explanations of key terms, language and grammar. Respondents' feedback showed that the online survey tools were easy and convenient to use.

3.4. Pilot test

After pre-testing was completed, a pilot test was conducted before the actual distribution of the questionnaire to the target respondents. The objective of the pilot test was to ensure the internal validity of the questionnaire and to avoid measurement error. It is important to note that a pilot test must capture the simplicity of the statements used in the questionnaire. According to Hertzog (2008), appropriate sample size for a pilot test ranges from 10 to 40 per group, who are tested for their adequacy and ability to provide estimates precise enough to meet a variety of possible objectives. Convenience sampling, which is a non-probability sampling method, was used to conduct the pilot test, as this method collects data from a population who are convenient in their suitability and availability to participate in the study. Through convenience sampling, a total of 20 questionnaires were distributed to the targeted respondents of the pilot test, who were all middle-range managers in manufacturing firms in Malaysia. This study used middle management as pilot study respondents because middle management was thought to have equivalent knowledge to top management.

Questionnaires were distributed face-to-face by making an appointment with the top management after getting their approval for their middle managers to participate in a pilot test. All respondents' feedback showed that they were satisfied with the language used in the questionnaire. There were no significant changes made to the questionnaire, only a few minor changes to grammar and sentence structure. All the pilot test respondents were excluded from the final data analysis. Subsequently, all the responses were analysed using IBM SPSS Statistics Version 24 to test the reliability of the questionnaire based on Cronbach's Alpha values. The questions for each variable were tested and results showed Cronbach's alpha values greater than 0.800.

4. Findings

A total of 480 questionnaires were distributed based on the manufacturing firms in Malaysia listed in the Federation of Malaysian Manufacturers (FFM) list of companies.

4.1. Profile of manufacturing firms

There are more than 2600 manufacturing and service firms registered with the FMM. For the purpose of this study, the 480 manufacturing firms certified with ISO 14001 and ISO 50001 were selected as target respondents. The highest number of responses came from the Electrical & Electronics sector, representing 52.3% of respondents, while the other sectors had relatively equal distribution. ISO 14001 is an industry standard and framework which allows organisations to set up an effective environmental management system; however, it does not state requirements for environmental performance. ISO 50001 provides a stronger framework compared to ISO14001, facilitating organisations to incorporate energy management into their overall efforts to improve quality and environmental management. 151 of the companies which responded (100%) have been certified with ISO 14001 Environment Management Systems (EMS), and 15 (9.93%) have ISO 50001 Energy Management certification (Table 2).

4.2. Construct validity

The construct validity indicates that all the items used show sufficient loading on their respective constructs. Hair et al. (2013) suggests that factor loading should be used to assess construct validity. 0.5 is used as a cut-off value for significant loading, while any item with a value greater than 0.5 in two or more factors is considered to have significant cross-loading (Hair et al., 2014a, 2014b). The individual items are each highly loaded within their own construct. The cross-loading values are lower than the main loadings, therefore the construct is considered valid (Table 3).

4.3. Convergent validity

Table 4 shows all the factors evaluated in this study, including factor loadings, composite reliability and average variance (AVE). Convergent validity indicates the extent to which multiple items measuring the same concept are in agreement. Based on Hair et al. (2013), factor loadings, composite reliability and AVE should be used to assess convergent validity. Composite reliability is a measure of internal consistency, and should give values higher than 0.7, which indicate higher levels of reliability. AVE is the degree to which a latent construct explains the variance of its indicators, and its value should be above 0.5

Table 2
Profile of manufacturing firms.

	Frequency	Percentage
Industrial type		
Automation & Machinery	10	6.60%
Electrical & Electronics	79	52.30%
Fabrication & Metal	13	8.60%
Rubber	12	7.90%
Chemicals	10	6.60%
Oil & Gas	9	6.00%
Health Care	5	3.30%
Food & Beverages	8	5.30%
Paper & Pulp	5	3.30%
ISO14001 Certification		
Yes	151	100%
No	0	0%
ISO50001 Certification		
Yes	15	9.93%
No	136	90.07%

Table 3
Loading and cross loading.

Variable		EAU	EAW	EK	MC	RESC
Energy audit	**EAU1**	**0.964**	0.675	0.669	0.773	0.527
	EAU2	**0.949**	0.665	0.676	0.751	0.526
	EAU3	**0.956**	0.673	0.651	0.757	0.529
	EAU4	**0.938**	0.678	0.634	0.791	0.481
	EAU5	**0.944**	0.667	0.623	0.743	0.520
Energy awareness	**EAW1**	0.567	**0.799**	0.530	0.607	0.581
	EAW2	0.681	**0.941**	0.638	0.649	0.671
	EAW3	0.722	**0.920**	0.655	0.637	0.638
	EAW4	0.639	**0.933**	0.672	0.612	0.655
	EAW5	0.582	**0.924**	0.667	0.667	0.653
Energy knowledge	**EK1**	0.620	0.668	**0.910**	0.657	0.524
	EK2	0.657	0.654	**0.953**	0.709	0.552
	EK3	0.696	0.695	**0.942**	0.733	0.562
	EK4	0.580	0.612	**0.924**	0.677	0.509
	EK5	0.647	0.646	**0.948**	0.686	0.522
Management commitment	**MC1**	0.679	0.575	0.587	**0.827**	0.523
	MC2	0.685	0.592	0.641	**0.919**	0.567
	MC3	0.764	0.656	0.701	**0.942**	0.624
	MC4	0.755	0.654	0.697	**0.934**	0.668
	MC5	0.699	0.651	0.676	**0.842**	0.574
Renewable energy supply chain	**RESC1**	0.390	0.458	0.372	0.390	**0.701**
	RESC10	0.251	0.454	0.354	0.344	**0.737**
	RESC2	0.574	0.697	0.509	0.580	**0.873**
	RESC3	0.578	0.709	0.509	0.643	**0.881**
	RESC4	0.545	0.690	0.533	0.586	**0.906**
	RESC5	0.511	0.643	0.544	0.637	**0.944**
	RESC6	0.467	0.624	0.549	0.661	**0.914**
	RESC7	0.475	0.623	0.529	0.632	**0.911**
	RESC8	0.437	0.570	0.531	0.629	**0.887**
	RESC9	0.358	0.535	0.414	0.498	**0.804**

Note: Bolded numbers indicate the highest loadings and are above the recommended values of 0.5.

for all constructs.

In this study, all measurement items gave factor loading values above 0.5, hence no items needed to be removed. According to Hair et al. (2013), composite reliability values should be higher than 0.708. The composite reliability values in this study range from 0.952 to 0.979, exceeding the recommended value. The AVE values for this study range from 0.737 to 0.903, which means that on average, the construct explains more than half of the variance of the indicators. Thus, it can be confirmed that the measurement model has an adequate level of convergent validity.

Table 4 summarises the measurement results of this model. The results show that all constructs – namely energy audits, energy awareness, energy management, energy knowledge, energy commitment and RESC – meet the convergent validity criteria. The t-statistics in Table 4 indicate that all measurement model loadings are statistically significant (< 0.05) (Hair et al., 2013).

4.4. Discriminant validity

Discriminant validity denotes the extent to which one construct is truly distinct from other constructs, in terms of how much it correlates with other constructs as well as to what extent indicators represent only a single construct. According to Gefen and Straub (2005), each item should load heavily within its own construct, the average variance shared between items of the same construct should be greater than the average variance shared with other constructs, and the square root of the average of the construct should be larger than 0.707.

The diagonal elements in Table 5 represent the average variance extracted, and the values below these diagonal elements show the correlation amongst the variables. Discriminant validity can be assumed if the diagonal elements are higher than the other off-diagonal elements in their respective rows and columns. Table 5 shows that the squared correlation of all constructs is lower than the square root of average variance extracted from measurement items.

According to Henseler et al. (2015) the Fornell-Larcker criterion and assessment of cross-loadings have low sensitivity in detecting discriminant validity problems. In fact, the Fornell-Larcker criterion does not depend on inference statistics and, thus, no technique for

Table 4
Result of measurement model.

Variable	Items	Loadings (standardized estimate)	t-value	Composite reliability	Average variance extracted	Cronbach alpha
Energy audit	**EAU1**	0.964	29.532	0.979	0.903	0.973
	EAU2	0.949	26.434			
	EAU3	0.956	30.726			
	EAU4	0.938	17.573			
	EAU5	0.944	22.124			
Energy awareness	**EAW1**	0.799	15.292	0.957	0.819	0.944
	EAW2	0.941	25.767			
	EAW3	0.920	25.311			
	EAW4	0.933	26.505			
	EAW5	0.924	23.044			
Energy knowledge	**EK1**	0.910	18.739	0.972	0.876	0.964
	EK2	0.953	22.342			
	EK3	0.942	22.554			
	EK4	0.924	18.124			
	EK5	0.948	26.169			
Management commitment	**MC1**	0.827	15.130	0.952	0.799	0.936
	MC2	0.919	22.390			
	MC3	0.942	24.816			
	MC4	0.934	24.325			
	MC5	0.842	15.710			
Renewable energy supply chain	**RESC1**	0.701	7.642	0.965	0.737	0.959
	RESC10	0.737	7.510			
	RESC2	0.873	19.307			
	RESC3	0.881	20.839			
	RESC4	0.906	20.148			
	RESC5	0.944	23.617			
	RESC6	0.914	19.576			
	RESC7	0.911	19.872			
	RESC8	0.887	18.593			
	RESC9	0.804	13.947			

Table 5
Discriminant validity of constructs (Fornell-Larker Criterion).

	[1]	[2]	[3]	[4]	[5]
Energy Audit [1]	**0.950**				
Energy Awareness [2]	0.707	**0.905**			
Energy Knowledge [3]	0.685	0.701	**0.936**		
Management Commitment [4]	0.803	0.701	0.741	**0.894**	
Renewable Energy Supply Chain [5]	0.544	0.708	0.571	0.665	**0.858**

Note: Diagonals (in bold) represent the average variance extracted, while the other entries are the squared correlations.

statistically testing discriminant validity has been developed to date. As a solution, Henseler et al. (2015) propose that a Heterotrait-Monotrait (HTMT) criterion should be used as an alternative measure of discriminant validity, by which the model meets the criterion if the HTMT value is below 0.9 for reflective indicators. Table 6 indicates the result of the HTMT criterion test. As all the HTMT criterion values are below 0.90, discriminant validity is established. Overall, the measurement model demonstrates adequate convergent validity and discriminant validity, hence the discriminant validity is confirmed and acceptable for hypothesis testing.

4.5. Hypothesis testing

The next step was to test the hypotheses of the study by running PLS Bootstrapping in SmartPLS 3.2.4. The R-square (R^2) value of RESC is 0.567, meaning that 56.7% of variance can be explained by energy management practices. Our R^2 value has moderate power, as the rule of thumb for an acceptable R^2 value is 0.25 for weak, 0.5 for moderate and 0.75 for substantial (Hair et al., 2014a, 2014b). For the purpose of hypothesis testing, the critical value for a one-tail *t*-test was applied. The t-value on a one-tailed test of statistical significance must be greater than 1.645 when tested at < 0.05 p-value level of significance (Table 7).

Our main hypothesis predicts that energy management practices will have a positive relationship with RESC, and consists of 4 more specific hypotheses. H1 (t-value = 4.288) and H2 (t-value = 7.424), which predict the influences of management commitment and energy awareness, are positively related to RESC and are found to be statistically significant at $p < 0.05$. Therefore, H1 and H2 were accepted. H3 predicts that energy knowledge is positively related to RESC, while the results show that it is statistically insignificant at $p < 0.05$ (t-value = 0.003); therefore, H3 was rejected. H4 proposes that energy auditing is positively related to RESC and was found to be statically significant at $p < 0.05$ (t-value = 2.312). Hence H4 was accepted.

5. Discussion

It is clear that management commitment has become a key capability for implementing green supply chain management (GSCM) practices in an organisation, as consistent managerial support is important in motivating staff to practice GSCM and enhancing green manufacturing capabilities (Luthra et al., 2016; Gavronski et al., 2011). According to Fernando and Yahya (2015), top management support is the main driver for the success of RE deployment in an organisation. This finding is consistent with existing literature, where the relationship between management and RESC is supported. This study emphasises that the management commitment dimension of energy management practices is important in RESC deployment. With full management commitment and support for RE deployment, a successful energy management outcome is expected, according to this study.

Energy awareness was found to be one of the most important variables impacting the deployment of RE, supporting Liu et al. (2010) suggestion that if management are aware of the benefits of energy efficiency but reluctant to implement them, this will lead to poor results in environmental management implementation and achieving sustainable business performance. Thus, this finding is consistent with hypothesis H2, as energy awareness has a positive relationship with RESC. Furthermore, energy auditing was also found to have a significantly relationship with RESC (H4). This is aligned with the finding by Moya et al. (2016) that energy auditing techniques help to increase knowledge of energy flows and develop practical findings in the study of RE. This knowledge can then be used to guide manufacturing firms to replace their dependence on current conventional energy and make energy management more efficient.

6. Final remarks and limitations

6.1. Final remarks and implications for energy policy in emerging economies

This work indicates that the internal structure of an organisation plays an essential role in implementing and adopting energy management practices and strengthening competitive advantage in the manufacturing sector. Four crucial elements of energy management practice have been identified within the literature (management commitment, energy awareness, energy knowledge and energy auditing) and specific findings relating to each key element have been discovered.

The results identified energy management – i.e. management commitment, energy awareness and energy auditing – as having a significant effect on RESC. Energy knowledge is still not sufficient among manufacturing firms, as can be seen from the insignificant relationship between knowledge and RESC. It is important for manufacturing firms to understand the need to achieve competitiveness in the long run by incorporating RESC into energy management in order to enhance energy efficiency. Incorporating RESC into energy management practice enables organisations to reduce dependency on conventional energy. Hence, it is crucial to understand the positive outcomes of RESC through practical implementation of energy management practices. In a nutshell, this study contributes to the industrial sector's understanding of best practice in energy management and how adopting RESC can help firms. Lastly, it is hoped that this study's framework will contribute effectively to strategic energy management in the manufacturing sector,

Table 6
Results of HTMT criterion for discriminant validity.

	[1]	[2]	[3]	[4]	[5]
Energy audit [1]					
Energy awareness [2]	**0.738** [0.649–0.815]				
Energy knowledge [3]	**0.706** [0.594–0.814]	**0.733** [0.641–0.822]			
Management commitment [4]	**0.741** [0.787–0.889]	**0.747** [0.670–0.812]	**0.778** [0.698–0.845]		
Renewable energy supply chain [5]	**0.554** [0.463–0.633]	**0.737** [0.661–0.806]	**0.588** [0.499–0.667]	**0.687** [0.612–0.758]	

Table 7
Path coefficient and hypothesis testing.

Hypothesis	Path	Coefficient	t-value (1 tailed)	Accepted
H1	Management Commitment → Renewable Energy Supply Chain	0.442	4.288	**Yes**
H2	Energy Awareness → Renewable Energy Supply Chain	0.527	7.424	**Yes**
H3	Energy Knowledge → Renewable Energy Supply Chain	0.009	0.003	No
H4	Energy Audit → Renewable Energy Supply Chain	0.183	2.312	**Yes**

reducing carbon emissions in the long run and achieving sustainable business performance.

6.2. Limitations of this study and further developments

There are certain limitations which need to be highlighted to provide guidance to future scholars. Some organisations rejected participating in this study because they were receiving too many survey questionnaires from researchers and did not have the time and personnel to assist. Others had organisational policy constraints and thus were unable to participate in this study. Additionally, the FMM directory is not up to date on companies' details, such as some email addresses and contact numbers. In addition, the contact details provided in the directory are mostly customer service contact numbers; thus, in order to obtain senior management contact details, there is often a need to visit the respective company's website, which is time consuming. Our study did not aim to understand the main motivations of the surveyed companies in adopting sustainability practices (Paulraj et al., 2017).

We also suggest that it is important to shed further light on emerging topics in supply chain management which, somehow, have been neglected when it comes to energy supply chains. For example, issues such as the use of big data (Gunasekaran et al., 2017), agility (Dubey et al., 2018), resilience (Ivanov et al., in press), and quality management can help to better understand supply chain management in the energy industry. Additionally, emerging topics in sustainability, such as the circular economy (Koh et al., 2017), sustainable performance management (Dubey et al., 2017), the base of the pyramid (Gold et al., 2013), and the human side of sustainability supply chains (Jackson et al., 2014) could be further explored. We suggest that it is important to understand how to transfer knowledge from academia to practitioners (MacIntosh et al., 2017) in the field of sustainable supply chains.

Lastly, while all organisations participating in this study are ISO 14001 certified, only a few are ISO 50001 certified. This points to a neglect of genuine energy saving concern, as ISO 14001 is more concerned with environmental sustainability. This limitation would provide a good opportunity to look at the success of ISO 14001 and ISO 50001 certification in Malaysia and their performance in energy saving.

Acknowledgements

The authors convey their appreciation to the Division of Research & Innovation, Universiti Malaysia Pahang (RDU grant no: RDU1703138), Universiti Sains Malaysia (incentive grant and short term grant no: 304/PPAMC/6313108) and Research Technology Transfer, Binus University for funding the research (Grant No: OMN-02). The authors acknowledge the support of the following Brazilian agencies: National Council for Scientific and Technological Development (CNPq), Grant # 304931/2016-0 and 404682/2016-2, and the Research Support Foundation of the State of Rio de Janeiro (FAPERJ), Grant # E-26/203.252/2017.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.enpol.2018.03.043.

References

Abdelaziz, E.A., Saidur, R., Mekhilef, S., 2011. A review on energy saving strategies in industrial sector. Renew. Sustain. Energy Rev. 15 (1), 150–168.
Al-Nory, M., El-Beltagy, M., 2014. An energy management approach for renewable energy integration with power generation and water desalination. Renew. Energy 72, 377–385.
Amit, R., Schoemaker, P.J., 1993. Strategic assets and organisational rent. Strateg. Manag. J. 14 (1), 33–46.
Antunes, P., Carreira, P., da Silva, M.M., 2014. Towards an energy management maturity model. Energy Policy 73, 803–814.
Ang, J.B., 2008. Economic development, pollutant emissions and energy consumption in Malaysia. J. Policy Modeling *30* (2), 271–278.
Aslani, A., Helo, P., Feng, B., Antila, E., Hiltunen, E., 2013. Renewable energy supply chain in Ostrobothnia region and Vaasa city: innovative framework. Renew. Sustain. Energy Rev. 23, 405–411.
Backlund, S., Broberg, S., Ottosson, M., & Thollander, P. 2012a. Energy efficiency potentials and energy management practices in Swedish firms. In Summer Study on energy efficiency in industry (eceee 2012), European Council for an Energy Efficient Economy, 11–14 September, Arnhem, Netherlands.
Backlund, S., Thollander, P., Palm, J., Ottosson, M., 2012b. Extending the energy efficiency gap. Energy Policy 51, 392–396.
Barney, J., 1991. Firm resources and sustained competitive advantage. J. Manag. 17 (1), 99–120.
Blass, V., Corbett, C.J., Delmas, M.A., Muthulingam, S., 2014. Top management and the adoption of energy efficiency practices: evidence from small and medium-sized manufacturing firms in the US. Energy 65, 560–571.
Brunke, J.C., Johansson, M., Thollander, P., 2014. Empirical investigation of barriers and drivers to the adoption of energy conservation measures, energy management practices and energy services in the Swedish iron and steel industry. J. Clean. Prod. 84, 509–525.
Cagno, E., Trianni, A., 2013. Exploring drivers for energy efficiency within small-and medium-sized enterprises: first evidences from Italian manufacturing enterprises. Appl. Energy 104, 276–285.
Capehart, B.L., Turner, W.C., Kennedy, W.J., 2003. Guide to Energy Management. The Fairmont Press, Inc.
Chakravarthy, B., 1997. A new strategy framework for coping with turbulence. MIT Sloan Manag. Rev. 38 (2), 69.
Chatzimouratidis, A.I., Pilavachi, P.A., 2009. Technological, economic and sustainability evaluation of power plants using the Analytic Hierarchy Process. Energy Policy 37 (3), 778–787.
Christoffersen, L.B., Larsen, A., Togeby, M., 2006. Empirical analysis of energy management in Danish industry. J. Clean. Prod. 14 (5), 516–526.
Cucchiella, F., D'Adamo, I., 2013. Issue on supply chain of renewable energy. Energy Convers. Manag. 76, 774–780.
Day, G.S., Wensley, R., 1988. Assessing advantage: a framework for diagnosing competitive superiority. J. Mark. 1–20.
Dincer, I., 2003. On energy conservation policies and implementation practices. Int. J. Energy Res. 27 (7), 687–702.
Dubey, R., Altay, N., Gunasekaran, A., Blome, C., Papadopoulos, T., Childe, S.J., 2018. Supply chain agility, adaptability and alignment: empirical evidence from the Indian auto components industry. Int. J. Oper. Prod. Manag. 38 (1), 129–148.
Dubey, R., Gunasekaran, A., Childe, S.J., Papadopoulos, T., Hazen, B., Giannakis, M., Roubaud, D., 2017. Examining the effect of external pressures and organisational culture on shaping performance measurement systems (PMS) for sustainability benchmarking: some empirical findings. Int. J. Prod. Econ. 193, 63–76.
Eccles, R.G., Perkins, K.M., Serafeim, G., 2012. How to become a sustainable company. MIT Sloan Manag. Rev. 53 (4), 43.
Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Seyboth, K., Matschoss, P., Kadner, S., von Stechow, C., 2011. IPCC special report on renewable energy sources and climate change mitigation. Prepared By Working Group III of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK.
Eichhammer, W., 2004. Industrial energy efficiency. In: Cleveland, C.J. (Ed.), Encyclopedia of Energy. Elsevier, New York, pp. 383–393.
Energy Efficiency and Renewable Energy (EERE), 2012, Case Study – The Challenge: ImprovingVentilation System Energy Efficiency in a Textile Plant. Energy Efficiency and Renewable Energy, US Department of Energy, Industrial Technologies Program, Washington, DC. Retrieved from 〈http://energy.gov/sites/prod/files/2014/05/f16/case_study_ventilation_textile.pdf〉.
Federation of Malaysia Manufacturers (FMM), 2015. Malaysian Industries. Retrieved from 〈http://federation-of-malaysian.epaperflip.com/v/2015-eDirectory/〉.
Fernando, Y., Yahya, S., 2015. Challenges in implementing renewable energy supply chain in service economy era. Procedia Manuf. 4, 454–460.

Gavronski, I., Klassen, R.D., Vachon, S., do Nascimento, L.F.M., 2011. A resource-based view of green supply management. Transp. Res. Part E: Logist. Transp. Rev. 47 (6), 872–885.
Gefen, D., Straub, D., 2005. A practical guide to factorial validity using PLS-Graph: tutorial and annotated example. Commun. Assoc. Inf. Syst. 16 (1), 5.
Gold, S., Hahn, R., Seuring, S., 2013. Sustainable supply chain management in "Base of the Pyramid" food projects—a path to triple bottom line approaches for multinationals? Int. Bus. Rev. 22 (5), 784–799.
Gordić, D., Babić, M., Jovičić, N., Šušteršič, V., Končalović, D., Jelić, D., 2010. Development of energy management system–Case study of Serbian car manufacturer. Energy Convers. Manag. 51 (12), 2783–2790.
Grant, R.M., 1991. The resource-based theory of competitive advantage: implications for strategy formulation. Calif. Manag. Rev. 33 (3), 114–135.
Gunasekaran, A., Papadopoulos, T., Dubey, R., Wamba, S.F., Childe, S.J., Hazen, B., Akter, S., 2017. Big data and predictive analytics for supply chain and organisational performance. J. Bus. Res. 70, 308–317.
Hair Jr, Joseph F, Hult, G Tomas M, Ringle, Christian, & Sarstedt, Marko. 2013. A primer on partial least squares structural equation modeling (PLS-SEM): SAGE Publications, Incorporated.
Hair Jr, F., J, Sarstedt, M., Hopkins, L., G. Kuppelwieser, V., 2014a. Partial least squares structural equation modeling (PLS-SEM) An emerging tool in business research. Eur. Bus. Rev. 26 (2), 106–121.
Hair, J.F., Henseler, J., Dijkstra, T.K., Sarstedt, M., 2014b. Common beliefs and reality about partial least squares: comments on Rönkkö and Evermann. Organ. Res. Methods 17 (2), 182.
Halldórsson, Á., Svanberg, M., 2013. Energy resources: trajectories for supply chain management. Supply Chain Manag.: Int. J. 18 (1), 66–73.
Haron, H., Khalid, S.N.A., Ganesan, Y., Fernando, Y., 2017. A Handbook for Business Research Method, Second edition. Pearson, Malaysia.
Hart, S.L., 1995. A natural resource-based view of the firm. Acad. Manag. Rev. 20 (4), 986–1014.
Hart, S.L., Dowell, J., 2011. A natural-resource-based view of the firm: fifteen years after. J. Manag. 37 (5), 1464–1479.
Henseler, J., Ringle, C.M., Sarstedt, M., 2015. A new criterion for assessing discriminant validity in variance-based structural equation modeling. J. Acad. Mark. Sci. 43 (1), 115–135.
Herrmann, C., Zein, A., Thiede, S., Bergmann, L., Bock, R. 2008. Bringing sustainable manufacturing into practice–the machine tool case. In: Proceedings of the 6th Global Conference on Sustainable Product Development and Life Cycle Engineering, Busan, Korea pp. 272–277.
Hertzog, M.A., 2008. Considerations in determining sample size for pilot studies. Res. Nurs. Health 31 (2), 180–191.
Hirst, E., Brown, M., 1990. Closing the efficiency gap: barriers to the efficient use of energy. Resour. Conserv. Recycl. 3 (4), 267–281.
Hitt, M.A., Hoskisson, R.E., Kim, H., 1997. International diversification: effects on innovation and firm performance in product-diversified firms. Acad. Manag. J. 40 (4), 767–798.
Hoggett, R., 2013. Supply chains and energy security. In: New Challenges in Energy Security (pp.161-181). Palgrave Macmillan UK.
Hosseini, S.E., Wahid, M.A., Aghili, N., 2013. The scenario of greenhouse gases reduction in Malaysia. Renew. Sustain. Energy Rev. 28, 400–409.
Ivanov, D., Dolgui, A., Sokolov, B., 2018. Scheduling of recovery actions in the supply chain with resilience analysis considerations. Int. J. Prod. Res. 1–18 (in press).
Jackson, S.E., Schuler, R.S., Jiang, K., 2014. An aspirational framework for strategic human resource management. Acad. Manag. Ann. 8 (1), 1–56.
Kannan, R., Boie, W., 2003. Energy management practices in SME—case study of a bakery in Germany. Energy Convers. Manag. 44 (6), 945–959.
Koh, S.L., Gunasekaran, A., Morris, J., Obayi, R., Ebrahimi, S.M., 2017. Conceptualizing a circular framework of supply chain resource sustainability. Int. J. Oper. Prod. Manag. 37 (10), 1520–1540.
Lee, S.K., Teng, M.C., Fan, K.S., Yang, K.H., Horng, R.S., 2011. Application of an energy management system in combination with FMCS to high energy consuming IT industries of Taiwan. Energy Convers. Manag. 52 (8), 3060–3070.
Lee, A.H., Chen, H.H., Chen, S., 2015. Suitable organization forms for knowledge management to attain sustainable competitive advantage in the renewable energy industry. Energy 89, 1057–1064.
Lewin, R., Parker, T., Regine, B., 1998. Complexity theory and the organisation: beyond the metaphor. Complexity 3 (4), 36–40.
Li, H., Wei, Y.M., 2015. Is it possible for China to reduce its total CO_2 emissions? Energy 83, 438–446.
Lieberman, M.B., Dhawan, R., 2005. Assessing the resource base of Japanese and US auto producers: a stochastic frontier production function approach. Manag. Sci. 51 (7), 1060–1075.
Liu, Z., Yang, Y., Zhang, Y., Geng, Y., 2010. Environmental awareness of enterprises in industrial eco-system. In: International Conference on Management Science and Engineering.
Lunt, P., Levers, A., 2011. Reducing Energy Use in Aircraft Component Manufacture-Applying Best Practice in Sustainable Manufacturing (No. 2011-01-2739). SAE Technical Paper.
Lunt, P., Ball, P., Levers, A., 2014. Barriers to industrial energy efficiency. Int. J. Energy Sect. Manag. 8 (3), 380–394.
Luthra, S., Kumar, S., Garg, D., Haleem, A., 2016. Comparative evaluation of GSCM practices in automotive components manufacturing firms of India: a fuzzy TOPSIS approach. Int. J. Logist. Syst. Manag. 25 (3), 358–390.
MacIntosh, R., Beech, N., Bartunek, J., Mason, K., Cooke, B., Denyer, D., 2017. Impact and management research: exploring relationships between temporality, dialogue, reflexivity and praxis. Br. J. Manag. 28 (1), 3–13.
Mathiesen, B.V., Lund, H., Connolly, D., Wenzel, H., Østergaard, P.A., Möller, B., Hvelplund, F.K., 2015. Smart energy systems for coherent 100% renewable energy and transport solutions. Appl. Energy 145, 139–154.
Mohanty, M., 2012. New renewable energy sources, green energy development and climate change: implications to Pacific Island countries. Manag. Environ. Qual.: Int. J. 23 (3), 264–274.
Moran, M., Berman, M., Morasch, L., 2005. Energy management: how to deliver cost savings in a time of rising rates. J. Facil. Manag. 3 (1), 27–40.
Moya, D., Torres, R., Stegen, S., 2016. Analysis of the Ecuadorian energy audit practices: a review of energy efficiency promotion. Renew. Sustain. Energy Rev. 62, 289–296.
Nath, P., Nachiappan, S., Ramanathan, R., 2010. The impact of marketing capability, operations capability and diversification strategy on performance: a resource-based view. Ind. Mark. Manag. 39 (2), 317–329.
Ngai, E.W.T., Chau, D.C.K., Poon, J.K.L., To, C.K.M., 2013. Energy and utility management maturity model for sustainable manufacturing process. Int. J. Prod. Econ. 146 (2), 453–464.
Olatomiwa, L., Mekhilef, S., Ismail, M.S., Moghavvemi, M., 2016. Energy management strategies in hybrid renewable energy systems: a review. Renew. Sustain. Energy Rev. 62, 821–835.
Painuly, J.P., Park, H., Lee, M.K., Noh, J., 2003. Promoting energy efficiency financing and ESCOs in developing countries: mechanisms and barriers. J. Clean. Prod. 11 (6), 659–665.
Paulraj, A., Chen, I.J., Blome, C., 2017. Motives and performance outcomes of sustainable supply chain management practices: a multi-theoretical perspective. J. Bus. Ethics 145 (2), 239–258.
Peteraf, M.A., 1993. The cornerstones of competitive advantage: a resource-based view. Strateg. Manag. J. 14 (3), 179–191.
Prigogine, L., 1984. Order out of Chaos. Random House, New York.
Prindle, W.R., 2010. From Shop Floor to Top Floor: Best Business Practices in Energy Efficiency. Pew Center on Global Climate Change.
Rahman, M.S., Noman, A.H.M., Shahari, F., Aslam, M., Gee, C.S., Isa, C.R., Pervin, S., 2016. Efficient energy consumption in industrial sectors and its effect on environment: a comparative analysis between G8 and Southeast Asian emerging economies. Energy 97, 82–89.
Rauter, R., Jonker, J., Baumgartner, R.J., 2015. Going one's own way: drivers in developing business models for sustainability. J. Clean. Prod.
Rohdin, P., Thollander, P., Solding, P., 2007. Barriers to and drivers for energy efficiency in the Swedish foundry industry. Energy Policy 35 (1), 672–677.
Sarkis, J., Zhu, Q., 2017. Environmental sustainability and production: taking the road less travelled. Int. J. Prod. Res. 1–17.
Sarkis, J., Zhu, Q., Lai, K.H., 2011. An organisational theoretic review of green supply chain management literature. Int. J. Prod. Econ. 130 (1), 1–15.
Schaltegger, S., Bennett, M., Burritt, R. (Eds.), 2006. Sustainability Accounting and Reporting 21 Springer Science & Business Media.
Schulze, M., Nehler, H., Ottosson, M., Thollander, P., 2016. Energy management in industry–a systematic review of previous findings and an integrative conceptual framework. J. Clean. Prod. 112, 3692–3708.
Seetharaman, A., Sandanaraj, L.L., Moorthy, M.K., Saravanan, A.S., 2016. Enterprise framework for renewable energy. Renew. Sustain. Energy Rev. 54, 1368–1381.
Sekaran, U., Bougie, R., 2016. Research Methods for Business: A Skill Building Approach. John Willey and Sons, New York.
Seliger, G., 2007. Sustainability in Manufacturing. Springer Publisher, Berlin (doi, 10, 978-3).
Shrouf, F., Miragliotta, G., 2015. Energy management based on Internet of Things: practices and framework for adoption in production management. J. Clean. Prod. 100, 235–246.
Siano, P., 2014. Demand response and smart grids—a survey. Renew. Sustain. Energy Rev. 30, 461–478.
Sivill, L., Manninen, J., Hippinen, I., Ahtila, P., 2013. Success factors of energy management in energy-intensive industries: development priority of energy performance measurement. Int. J. Energy Res. 37 (8), 936–951.
Song, M., Di Benedetto, C.A., Nason, R.W., 2007. Capabilities and financial performance: the moderating effect of strategic type. J. Acad. Mark. Sci. 35 (1), 18–34.
Sorrell, S., 2007. The economics of energy service contracts. Energy Policy 35 (1), 507–521.
Stigka, E.K., Paravantis, J.A., Mihalakakou, G.K., 2014. Social acceptance of renewable energy sources: a review of contingent valuation applications. Renew. Sustain. Energy Rev. 32, 100–106.
Thollander, P., Ottosson, M., 2010. Energy management practices in Swedish energy-intensive industries. J. Clean. Prod. 18 (12), 1125–1133.
Thollander, P., Backlund, S., Trianni, A., Cagno, E., 2013. Beyond barriers–a case study on driving forces for improved energy efficiency in the foundry industries in Finland, France, Germany, Italy, Poland, Spain, and Sweden. Appl. Energy 111, 636–643.
Trianni, A., Cagno, E., Farnè, S., 2014. An empirical investigation of barriers, drivers and practices for energy efficiency in primary metals manufacturing SMEs. Energy Procedia 61, 1252–1255.
Turesky, E.F., Connell, P., 2010. Off the rails: understanding the derailment of a lean manufacturing initiative. Organ. Manag. J. 7 (2), 110–132.
Turner, W.C., Doty, S., 2007. Energy Management Handbook. The Fairmont Press, Inc.
UNDP, 2012. Transforming On-Grid Renewable Energy Markets: A Review of UNDP-GEF Support for Feed-in Tariffs and Related Price and Market-Access Instruments. Retrieved from 〈http://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Climat%20Strategies/UNDP_FIT_Port_TransformingREMarkets_15oct2012.pdf〉.
Vachon, S., Klassen, R.D., 2006. Extending green practices across the supply chain: the

impact of upstream and downstream integration. Int. J. Oper. Prod. Manag. 26 (7), 795–821.
Vachon, S., 2007. Green supply chain practices and the selection of environmental technologies. Int. J. Prod. Res. 45 (18–19), 4357–4379.
Vachon, S., Klassen, R.D., 2008. Environmental management and manufacturing performance: the role of collaboration in the supply chain. Int. J. Prod. Econ. 111 (2), 299–315.
Venmans, F., 2014. Triggers and barriers to energy efficiency measures in the ceramic, cement and lime sectors. J. Clean. Prod. 69, 133–142.
Wee, H.M., Yang, W.H., Chou, C.W., Padilan, M.V., 2012. Renewable energy supply chains, performance, application barriers, and strategies for further development. Renew. Sustain. Energy Rev. 16 (8), 5451–5465.
Yang, J., 2010. The knowledge management strategy and its effect on firm performance: a contingency analysis. Int. J. Prod. Econ. 125 (2), 215–223.
Yatim, P., Mamat, M.N., Mohamad-Zailani, S.H., Ramlee, S., 2016. Energy policy shifts towards sustainable energy future for Malaysia. Clean Technol. Environ. Policy 1–11.