THE DETERMINANTS OF THE INTENTIONS TO ADOPT ENERGY EFFICIENT TECHNOLOGY (EET) IN THE SABAH PALM OIL INDUSTRY

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In Loving Memory of my beloved father, Lee Swee Swee, you are my Hero.

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ABSTRACT

Among the many sustainable development agenda, producing sustainable energy is an ongoing dilemma for most country including Malaysia. Throughout Malaysia, more than 90 percent of the electricity generated is from coal and natural gas collectively. Realizing this, The United Nation introduced the 2030 agenda which listed 17 Sustainable Development Goals (SDG) in which one of the goal is to provide access to affordable and clean energy. This study came up with a framework for the intentions to adopt Energy Efficient Technology (EET) in the Palm Oil industry in Sabah, which is one of the state in Malaysia. The Technological, Organizational and Environmental (TOE) model was used as the main theory to test the proposed relationship. This study consisted of 15 exogenous latent variables and one endogenous variable. The Sustainable Technological elements consisted seven latent variables, which are perceived compatibility, perceived relative advantage, perceived affordability, perceived production quality, perceived product quality, perceived service quality and perceived accessibility. The Organizational elements consisted of two latent variables, which are top management support and social responsibilities. In the Environmental context, there are another two latent variables, which were perceived competitive pressure and environment openness. Finally, the Individual elements consisted of two latent variables, which were manager's innovativeness and empowerment. Knowledge of Sustainability and Knowledge of Technology acted as the moderator effect. This research applied a quantitative approach that uses a cross-sectional questionnaire survey base in order to test all the proposed hypotheses. A total of 101 palm oil mills under the state of Sabah were finalized as the sample for this study. Partial least squares (PLS) and structural equation modeling (SEM) tool were used to examine the relationship between the variable. It also measured the moderating effect of knowledge of sustainability and knowledge of Technology on the adoption of EET.The model managed to provide some important findings, such as manager's innovativeness was found to be the most influential predictor towards EET adoption and the second most important predictor is empowerment. Both of this predictor were from the individual characteristics and popular among scholars, individual characteristics completes the missing link of the TOE framework. The influence of perceived relative advantage was found to be the weakest but significant factor towards EET adoption. Furthermore, this study also found that higher manager innovativeness promotes higher intention to adopt EET. Findings were useful for theory and knowledge where it was empirically proved that future TOE framework model must not ignore the individual context as they are the real agent in knowledge processes in understanding adoption intention. Also, in terms of practise wise, manager with high level of innovativeness was found to help contribute towards the progress of sustainable technology in the palm oil industry.

ABSTRAK

PENENTUAN INTENSI PENERIMAAN TEKNOLOGI JIMAT TENAGA (EET) DALAM INDUSTRI MINYAK KELAPA SAWIT DI SABAH

Di antara banyak agenda pembangunan lestari, menghasilkan tenaga lestari adalah dilema berterusan bagi kebanyakan negara termasuk Malaysia. Di seluruh Malaysia, lebih daripada 90 peratus elektrik yang dihasilkan adalah dari arang batu dan gas asli secara kolektif. Menyedari hal ini, Pertubuhan Bangsa Bersatu (PBB) memperkenalkan agenda 2030 yang menyenaraikan 17 Matlamat Pembangunan Lestari (SDG) di mana salah satu tujuannya adalah untuk memberi akses kepada tenaga yang berpatutan dan bersih.Pertubuhan Bangsa Bersatu (PBB). Kajian ini merangka satu model melalui intensi penerimaan Teknologi Lestari menerusi penggunaan Teknologi Jimat Tenaga (EET) dalam industri Minyak Sawit di Sabah, iaitu salah satu negeri didalam Malaysia. Dengan menggunakan Model Teknologi, Organisasi dan Persekitaran (TOE) untuk menguji hubungan yang dicadangkan. Kajian ini terdiri daripada 15 pembolehubah bebas dan satu pembolehubah bersandar. Unsur-unsur Teknologi terdiri daripada tujuh pembolehubah yang terdiri daripada kesesuaian, kelebihan relatif, kemampuan, kualiti produksi, kualiti produk, kualiti perkhidmatan dan akses. Unsur-unsur Organisasi terdiri daripada dua pembolehubah yang merupakan sokongan pengurusan atasan dan tanggungjawab sosial. Dalam konteks persekitaran, terdapat dua lagi pembolehubah iaitu tekanan persaingan dan keterbukaan persekitaran. Akhirnya, elemen Individu terdiri daripada dua pembolehubah yang merupakan inovasi pengurus dan pemberdayaan. Pengetahuan tentang Kemampanan dan Pengetahuan Teknologi bertindak sebagai kesan moderator. Kajian ini menggunakan pendekatan kuantitatif yang menggunakan pangkalan soal selidik rentas keratan untuk menguji semua hipotesis yang dicadangkan. Sebanyak 101 kilang minyak kelapa sawit di negeri Sabah digunakan sebagai sampel kajian ini. Alat pemodelan persamaan struktur (PLS-SEM) digunakan didalam kajian ini untuk mengkaji hubungan antara pembolehubah. Ia juga mengukur kesan penyederhanaan pengetahuan tentang kemampanan dan pengetahuan Teknologi mengenai penggunaan EET. Model ini berjaya memberikan beberapa penemuan penting, seperti inovasi pengurus yang didapati sebagai peramal yang paling berpengaruh terhadap penggunaan EET dan peramal kedua yang terpenting adalah pemberdayaan. Kedua-dua peramal ini adalah dari ciri-ciri individu dan popular di kalangan sarjana, ciri individu melengkapkan pautan yang hilang dari rangka kerja TOE. Pengaruh kelebihan relatif dilihat sebagai faktor yang paling lemah tetapi signifikan terhadap penggunaan EET. Kajian ini juga mendapati bahawa pengurus dengan daya inovasi lebih tinggi akan mampu mendorong niat yang lebih tinggi untuk menerapkan EET. Secara empirikal, kajian ini membuktikan bahawa model kerangka TOE tidak boleh mengabaikan konteks individu kerana mereka adalah agen sebenar dalam proses pengetahuan dalam memahami niat adopsi. Dari segi praktik, pengurus dengan tahap inovasi yang tinggi didapati dapat membantu menyumbang ke arah kemajuan teknologi lestari dalam industri minyak sawit.

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LIST OF ABBREVIATIONS

DOI	-	Diffusion of Innovation
DOE	-	Department of Environment
EET	-	Energy Efficient Technology
IASAM	-	Integrated Acceptance & Sustainability Assessment Model
IT/IS	-	Information Technology / Information System
MDG	-	Millenium Development Goals
MPOB	-	Malaysian Palm Oil Board
MPOC	-	Malaysian Palm Oil Council
PLS-SEM	-	Partial Least Square-Structural Equation Modeling
SD	-	Sustainable Development
SDG	-	Sustainable Development Goals
SESB	-	Sabah Electricity Sdn Bhd
TOE	-	Technological, Organizational & Environmental Framework
WCED	-	World Commission on Environment and Development

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CHAPTER 1

INTRODUCTION

1.1 Background of the study

"We need a tax on carbon, an end to fracking and massive investment in renewable energy. We want to leave this planet healthy and habitable"

(Bernie Sanders, 2106, web archived)

The emergence of renewable energy technologies have spurred a lot of interest among researchers, policy maker and industry players towards capitalizing the economic value of this new source of energy (Kim, Park, Kwon, Ohm and Chang, 2014). With the current technology update, more and more business organization has invested in new technology in order to survive and stay competitive (Ellitan, 2002). Not only these new technology provide the competitive edge, it also takes into consideration for the need of a sustainable technology that addresses issues pertaining to the sustainability of the technology itself (Nguyen, Greenland, Lobo and Nguyen, 2019).

In the recent years, the demand for renewable energy has grown drastically and interest for sustainable energy shows that the world are concerned of achieving "universal access to modern energy services by 2030" (Ki-moon, 2011; Groh, Pachauri and Narasimha, 2016). The effort for a more sustainable energy has lead to the introduction of Energy Efficient Technology (EET). EET is any technology that utilize energy in an effective way to carry out a manufacturing process or provide a service typically maximizing the benefit of energy use while minimizing the cost and

impact on the environment. In Malaysia, being a country with an economic growth that is mostly driven by the industrial sector, the availability of energy is vital (Koh and Lim, 2010). Malaysia's over dependency on fossil fuel for electricity generation must be alleviated (Lau, Choong, Wei, Seow, Choong, Senadjki and Ching, 2020). The need for Malaysia to adopt renewable energy is crucial as electricity consumption is expected to increase over time (Basri, Ramli, Aliyu, 2015).

For the state of Sabah, a case study on alternative options to meet the energy demand in Sabah was carried out in 2010 and seven alternatives was proposed (Koh *et al.,* 2010). One of the alternatives was to adopt EET through the installation of a biogas power plant (from palm oil waste) for all the palm oil mills. Sabah is the highest producer of palm oil in Malaysia and with more than 1.4 million hectares of palm oil plantation, this industry produce roughly 59.08 million ton of palm oil waste per year (Shuit, Tan, Lee and Kamaruddin, 2009; Koh *et al.,* 2010). Thus, the abundance of resource from palm oil waste that is available has a potential for large-scale power generation through the development of renewable energy (Umar, Jennings and Urmee, 2013).

Energy demand is the term used to describe the consumption of energy by human activity and this study refers to the use of electricity. In the palm oil milling industry, renewable energy can be produced through the installation of a biogas plant, in which the biomass is processed to produce biogas, which is a form of clean energy. Biomass is plant or animal materials used for energy production and energy produced from biomass is considered as a type of renewable energy. This study refers the biogas plant as a form of energy efficient technology (EET). Installation of a biogas plant is considered as an energy efficient technology (EET) because it helps reduce fuel consumption and reduce the impact on the environment through release of methane.

Even though EET is claimed to help produce cleaner energy, better management of waste and able to reduce environmental damage, worldwide, the adoption of EET is still considered low and slow (Kounetas, Mourtos and Tsekouras, 2012; Nguyen *et al.*, 2019). In an organization environment, the intention to adopt a technology occurs mainly in the primary stage in which the decision to adopt a technology is done on the management level (Leonard and Deschamps, 1988; Rocker, 2010). The success of technology adoption and implementation depends on the role of top management (Rocker, 2010). The direction of the business organization plays a very significant role towards adopting a new technology (Preece, 2018). New technology is useful and most of time, it is beneficial to the adopters (Mwangi and Kariuki, 2015). However, adopting a new technology just because it's new could risk a business organization having spent their resources and time with a technology that is not sustainable for their long-term goal.

Currently, research on intention to adopt a certain technology are applying one of the most popular model which is the Technological, Organizational and Environmental (TOE) framework developed by Tornatzky and Fleischer (1990). The framework provides a systematic classification of influencing factors and more recently, TOE has been widely applied in existing renewable energy technology adoption intention studies (Alharbi, Alahrbi and Alkhamali, 2020; Mohammed, 2020; Nel and Jokonya, 2020; Nkundabanyanga, Muhwezi, Musimenta, Nuwasiima and Najjemba, 2020). In addition to the three dimensions of context, scholar suggested to introduce individual factors (Rosli, Yeow and Siew, 2012; Kisanjara and Tossy, 2014; Rahayu, 2015; Anderson, Dassi, Mudambi and Pedersen, 2016) into the technology adoption framework, considering that adoption intention must first impact individual and then through them, the organization (Delone and McLean, 2016). Based on above, this study includes the individual context as the fourth dimension of factors for the TOE-based framework.

The new technology must be well integrated into the current business operation or risk jeopardizing the entire business process (Chung, Tan, Koh, Law and Ngai, 2007). The existing system and procedure must be able to cater for the new technology. Furthermore, the technology itself must be sustainable, which means that the attributes of the new innovation must take into consideration of the management perspective, the quality of the technology and the acceptance on the organizational level (Aizstrauta, Ginters and Eroles, 2015). Thus, combining the socio-economic and socio-technical aspects when adopting a technology remains a management challenge for organizations.

Intention to adopt a technology in an organization level requires top management support and the lack of encouragement from these group of decision maker will result in serious failure toward the adoption process (Hsu, Liu, Tsou and Chen, 2019). When the support is high, the direction, commitment and resources can be aligned towards the adoption intention (Hsu *et al.,* 2019). The intention to adopt also faces other organizational challenge such as the readiness of its entire organization towards the adoption. Among the challenges faced are understanding how the new technology could help the current operations and whether or not the organization has the necessary technical and managerial skills to implement the new technology (Kuan and Chau, 2001).

Also, as we transition into the new millennium, what will constitute "sustainable technology"? Sustainable technology is a technology that strives to meet the triple bottom line (People, Planet, Profit), in which its strategy is to make a positive impact on all the three areas. Meaning to say, sustainable technology helps organization align its business purpose with its obligation towards Mother Nature and its social responsibilities towards human being. Thus, getting everyone onboard is a heavy task as most shareholders remain staunch to the idea that business has only one main objective; to maximize profit (Schwartz and Saiia, 2012).

Around the world, societies are facing difficulties achieving sustainable development goals (SDG) introduced by United Nation (Hak, Janouskova and Moldan, 2016; Bebbington and Unerman, 2018). In the manufacturing industry, the cause of this difficulties include climate change, energy consumption, agricultural crises, among others, and this issues demand solutions such as improved policies as well as implementation of new technologies (Furstenau, Sott, Kipper, Machado, Lopez, Rohan and Imran, 2020). Energy efficient technology (EET) is one of the solutions towards achieving the SDG and research investigating elements that fall under the technological characteristics that constitute a sustainable technology would help link the concept of sustainability and technology (Ostergaard, Duic, Noorollahi, Mikulcic and Kalogiru, 2020).

1.2 Problem Statement

Data shows that more than 80 percent of the organizations are yet to adopt the energy efficient technology (EET) (Malaysia Energy Commission, 2015). While the aim of the nation to achieve biogas facilities in all palm oil mills in Malaysia by 2020, it might be worth pointing out that the total completed biogas plants in the country is only at 85 as of 2016, which is less than 20 percent (Loh, Nasrin, Azri, Adela, Muzzammil, Jay and Kaltschmitt, 2017). As of 2016, there are currently 453 palm oil mills operating in Malaysia and 131 are based in Sabah (Yien, Sharaai, Kusin and Ismail, 2015; Loh *et al.,* 2017). Under the National key Economic Area (NKEA), this low adoption of entry point project five (EPP5) which is to develop biogas trapping facilities at palm oil mill is asked. Thus, the question of why these organization fail to undertake EET through the installation of biogas plant motivates this study.

From the intention to adopt process, the Technological, Organizational and Environmental (TOE) model developed by Tornaztky and Fleischer in 1990 listed three dimensions that influence adoption process. TOE focuses on the processes of technology innovation and identifies three elements that contribute to understanding

the adoption of a technology; technological, organizational and environmental characteristics (Tornaztky and Fleischer, 1990). In adopting the TOE model, scholars argue that the TOE model only supports the element of organizational context and neglects the individual elements (Rosli, Yeow and Siew, 2012; Kisanjara and Tossy, 2014; Rahayu, 2015; Nilashi, Ahmad, Ahani, Ravangard and Ibrahim, 2016).

Intention to adopt a certain technology is recognized as one of the most important study for more than two decades now (Kardooni, Yusoff and Kari, 2016). Understanding the extent to which individual factor influence organizational intention to adopt sustainable technology is critical. According to one study, one will only be able to have a full understanding of the intention to adopt by combining individual factors and external socio-technical factors (Aizstrauta *et al.,* 2015). When studying intention to adopt at organizational level, scholars recognize that the adoption must first impact individuals and then through them, the organization (Delone *et al.,* 2016). Thus, there is a need for individual element to be included into the current model. Having said that, studying the factors that contribute to the intention to adopt EET among these late adopters will help encourage organizations to adopt EET.

Finally, the paradigm of a sustainable technology will not only concentrate to measure the construct that involve people, but also takes into consideration of the 3P's (people, planet and profit) of sustainable development (Curran, 2009; Gausemeier, Seidel, Riedelsheimer and Seliger, 2015). The Integrated Acceptance and Sustainability Assessment Model (IASAM) recognize that the sustainability of the technology is one of the most important elements (Ginters, Barkane and Vincent, 2010). Thus, integrating intention to adopt and assessment of the technology will enable researcher to evaluate the sustainability of the technology itself at any chosen point of time.