



Analysis model of the sustainability development of manufacturing small and medium- sized enterprises in Taiwan

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ABSTRACT

To maintain competitiveness in the marketplace, enterprises have considered sustainability development as an important goal and initiated numerous strategies for sustainability. The three main dimensions, namely, economic, social and environmental aspects, have become the focus of the sustainable development of enterprises while serving as vital indicators for enhancing competitiveness. However, prior studies on sustainable development primarily emphasised theoretical discussions, and few scholars have conducted quantitative data analysis, especially in the small and medium-sized enterprises (SMEs) area. Given this research gap, this study developed an integrated multi-attribute decision analysis model to evaluate the sustainability development of manufacturing SMEs in Taiwan. The present research identifies key sustainability indicators that play a vital role in boosting the sustainable performance of manufacturing SMEs.

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1. Introduction

With the advancement of science and technology, the demand for high quality of life has increased gradually, resulting in considerable usage of resources for production and consumption. However, the intensive use of resources has triggered adverse effects on the environment, causing climate change, which is considered the greatest danger to the world (Dincer and Rosen, 1999; Goldemberg, 2006). As cited in Broman and Robèrt (2017), Steffen et al. (2015) indicated that if humans continued to disregard the damages to ecosystems and increase the risk to the biosphere, then human civilization will be seriously affected. Trianni et al. (2017) highlighted the need to improve the sustainability of manufacturing sector because existing production models presents a non-sustainable development trend; hence, technology, management, organisation, and behavior of the production system require adjustment and change (Blok et al., 2015). Mazzarol et al. (1999) emphasised that small and medium-sized enterprises (SMEs) play a key role in national economic development. Hillary (2004) estimated that SMEs can be responsible for up to 70% of all pollution worldwide. Determining the appropriate management

system to ensure sustainable development is an important issue for SMEs, not only because of pressure from stakeholders but also from the enterprise development perspective of the supply chain management (Burke and Gaughran, 2007). SMEs require an appropriate management method and a practical framework for the identification and implementation of sustainable development plans.

Moore and Manring (2009) also pointed out that many factors have gradually led SMEs to take the initiative in introducing sustainable development practices. Given the characteristics of SMEs, their sustainable development strategies, such as personalized management, lack of funds, resource constraints, flexibility, horizontal structure, small number and concentration of customers, narrow market, and lack of expertise, are different from that of large enterprises (Alshawi et al., 2011; Ciliberti et al., 2011). SMEs should develop practical implementation knowledge or establish management tools for sustainability (Burke and Gaughran, 2007).

Promoting SME participation in sustainable development (SD) becomes an inevitable strategy. Loucks et al. (2010) revealed that SMEs tend to take a passive view of sustainable development, and pay little attention to examining their impact on the environment. This tendency causes the implementation of sustainable development in SMEs to be considered as slower than that in large enterprises. Unlike large corporations, SMEs often lack financial resources, time, personnel, technological expertise and the

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organisational structure for implementing sustainable development (Nicholas et al., 2011; Schulz et al., 2011). Moreover, they generally have less knowledge on the environmental impact of SMEs and do not comprehend fully the benefits of sustainable development and the tools for developing sustainability strategies and practices (Aykol and Leonidou, 2015; Lawrence et al., 2006). Perrini et al. (2007) also noted that SMEs had difficulty participating in sustainable development.

According to Shields and Shelleman (2015), many companies have become increasingly concerned with the sustainability of their efforts and have also gradually recognised the potential benefits of sustainability reporting. Sustainability development has been acknowledged as a competitive strategy of enterprises (Ciasullo and Troisi, 2013; Schaltegger, 2011; Conway, 2014). Severo et al. (2017) stated that SD may provide a competitive advantage over competitors (Bhupendraa and Sangleb, 2016; Lukena et al., 2016). The benefits of sustainable development efforts are reflected not only in quantifiable financial performances and other economic indicators (Conway, 2014; Brammer et al., 2012) but also in many managerial ways. Hsu et al. (2017) mentioned that sustainable development improves corporate reputation (Lee, 2012), obtains legality of management decisions (Hart and Milstein, 2003), promotes labor relations, attracts resources, and reduces the pressure of stakeholders to the enterprise (Hardjono and Marrewijk, 2001).

However, many SMEs may be unaware of these benefits (Lawrence et al., 2006). Given their lack of financial support, related knowledge background and human resources, SMEs are relatively less concerned with environmental impacts. As a result, major companies and governments have focused their attention on sustainability development for SMEs (Jenkins, 2009), because many SMEs act as supply chain partners for large companies.

Given the abovementioned role of SMEs, manufacturing SMEs are then the sector that requires sustainability improvement. Considering the relatively scarce resources of SMEs, academia should provide practical research on the method that can be implemented and identify key strategic factors that can be used to produce the greatest leverage of sustainability development for SMEs.

Based on the literature review, triple bottom line (TBL) performance indicators are developed in this study, which cover influencing factors on sustainability development. Then, sustainability performance indicators are selected using Fuzzy Delphi Method (FDM). The TBL performance indicators are constructed such that they can describe and evaluate the effectiveness of performing sustainability development. Furthermore, grey relational theory (GRA) and neighbourhood rough set theory (RST) are used to assess the implementation of sustainability development for SMEs. Finally, sensitivity analysis is employed to observe the change in the variables, thereby facilitating the exploration of critical factors that affect performance.

The remainder of this research is organised as follows. Section 2 identifies the sustainability development factors suggested in the literature and surveys related work on the fuzzy Delphi method (FDM), the grey relational analysis (GRA), and neighbourhood rough set theory (RST). Section 3 depicts the detailed approaches applied in this study, including FDM, GRA and RST. Section 4 demonstrates a case implementation. Finally, Section 5 discusses the conclusions of our findings.

2. Literature review

2.1. Sustainability development

Sustainability development has been defined as the ability to meet human needs without compromising the needs of future

generations (Brundtland Commission, 1987). In recent years, growing concern for the protection of the environment has led to the recognition of sustainability development as one of the most important goals, and attention has been paid to the operations management of enterprises, which has resulted in a extremely broad scope of the surveyed industry.

Liu et al. (2011) assessed the sustainable fisheries development in offshore and coastal fisheries in Taiwan and confirmed their potential problems, including employee numbers, incorrect statistical data and unacceptable institutional expense. Abdulrazak and Ahmad (2014) highlighted the attention to sustainable development in Malaysia, especially on the implementation of corporate social responsibility (CSR). Their paper introduced and discussed the viability of prominent CSR theories. Their conclusion is helpful for establishing sustainable development in Malaysia and facilitates the identification of a more appropriate CSR practice and program. On the basis of the sustainable development of agriculture in India, Chand et al. (2015) used the three dimensions of economy, society and ecology to identify the weak indicators of sustainability development that must be strengthened. Omri et al. (2015) addressed several issues related to the economic, social and environmental dimensions of mass production and fuel consumption. The solar energy case in Tunisia proved the significant effects of sustainable development on the three dimensions of economy, society, and ecology.

Focusing on the sustainable development of clean production, Khalili et al. (2015) suggested that higher education leaders should assess the necessity and urgency of design training programs to assist in the development of human capital for supporting sustainable development. Inclusion of the resource management theme in academic curricula is the foremost strategy, followed by the development of human capital, human system design, and sustainable economic development and prosperity. Sánchez (2015) established a framework for the impact of sustainability on the organisation to ensure it undertakes the right projects to meet its business strategy and stakeholder needs. Hsu et al. (2017) proposed a balanced scorecard (BSC) approach to ascertain the priority of sustainability development based on the limited resources of SMEs.

Different scholars, research areas and perspectives have generated various points of view, and these perspectives represent a wide range of variations. Omri et al. (2015) pointed out that literature on sustainable development has been growing continuously in recent years. Despite the abundance of literature and issues related to sustainable development, much controversy remains regarding this ambiguous and multifaceted concept, which makes the description of the concept of sustainable development by using a consistent and operational content extremely challenging. Osofsky (2003) attempted to explain the reasons for the vague concept of the term and emphasised that no unique, universally accepted definition of sustainability development exists (Munasinghe, 2001; Sedlacko and Gjoksi, 2009). Nevertheless, at least one consensus has been widely accepted by scholars, that is that the main dimensions of sustainable development include environmental, social and economic sustainability (Dyllick and Hockerts, 2002; Omri et al., 2015; Hsu et al., 2017; Thabrew et al., 2018; Aguiñaga et al., 2018).

Shields and Shelleman (2015) revealed that because of the growing attention devoted to sustainability development, SMEs face a potentially significant change in their operating environment and substantial impact on their strategic thinking. Bonn and Fisher (2011) suggested that to achieve sustainability in an organisation, managers must combine different factors and varied sustainability measures into their strategic decision-making process. Accordingly, such action will enable a company to identify opportunities for

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