Asian Journal of Accounting and Governance **8**: 107–121 (2017) Special Issue ISSN 2180-3838
(https://doi.org/10.17576/AJAG-2017-08SI-10)

Material Flow Cost Accounting, Perceived Ecological Environmental Uncertainty, Supplier Integration and Business Performance: A Study of Manufacturing Sector in Malaysia

KHALED M.A. SALIM, AMIZAWATI MOHD AMIR & MALIAH SULAIMAN

ABSTRACT

This article seeks to explore the implementation of Material Flow Cost Accounting (MFCA) across the manufacturing sector. The paper aims to understand the role of perceived ecological environmental uncertainty (PEEU) and supplier integration (SI) on MFCA implementation, and thus subsequently examines the effect of MFCA implementation on firms' environmental and economic performance. The research model was empirically tested based on online-survey. The questionnaires were emailed to 1200 randomly selected industrial firms. The usable responses was 123 firms. The data was analysed using a structural equation modelling (SEM) approach through partial least square (PLS) software. The main results from survey of 123 companies showed low level of MFCA implementation. Further, the analysis of PLS indicated that companies which recognise bigger ecological environmental uncertainty are less motivated to implement MFCA. Tthe study also found that SI has a direct positive impact on MFCA implementation since companies which decided to implement MFCA were more likely able to achieve better environmental and economic performance. Thus, companies perceive the importance of being ecologically responsible and that such practice will increase companys' prosperity in many ways, ecologically and economically.

Keywords: Material Flow Cost Accounting; Perceived ecological environmental uncertainty; Supplier integration; Environmental performance; Economic performance.

INTRODUCTION

The excessive consumption of scarce natural resources has negatively impacted the environment (Moors et al. 2005). Resources such as materials and energy represent 50% of the total operating costs in the manufacturing industry (Sygulla et al. 2011). More importantly, the operating costs of any organisations are usually ineffectively exploited in the production processes, since 20% of it are converted to waste or negative products, which are considered environmental costs (Doorasamy 2015; Jasch 2009). Unfortunately, these environmental costs are often obscured into general overhead costs in traditional accounting systems, rendering managers to incapable observing them (Ferreira et al. 2010). To address this problem, the material flow cost accounting (MFCA) system was developed to provide advanced cost analysis by identifying, classifying, and allocating these costs to reduce the level of negative products, which effectively reduced the costs by 5% or more (Hyrslova et al. 2008). MFCA is a basic tool of Environmental Management Accounting (EMA) (Kokubu & Tachikawa 2013). It was developed to be a standard ISO 14051, and it was published officially in 2011 (Kokubu et al. 2009). The success of the implementation of MFCA is however dependent on the circumstances surrounding the corporations, according to contingency theory perspective (Chenhall 2003). These include size of company, environmental ecological uncertainty, production technology, corporate strategy and supplier integration (Chenhall 2003; Flynn et al. 2010; Pondeville et al. 2013). Better the MFCA fits with the contingency factors in the context of an organisation's day-to-day operations, the higher the implementation of MFCA is likely to succeed, and the higher the organisational environmental and economic performance is likely to be achieved (Qian et al. 2011). This paper chooses perceived ecological environmental uncertainty (PEEU) and supplier integration (SI) as factors that significantly influence the implementation of MFCA. Both factors are considered as external factors that can influence the extent to which managers plan their buying activities (Agbejule & Burrowes 2007).

The association between PEEU, SI and management accounting information is of high interest to both academicians and practitioners alike. As the external environment and type of buyer-supplier alliances changes, the scope of conventional management accounting information, which only focus on 'cost and profitability', are found to be insufficient. Therefore, companies are demanded to obtain wider information that captures quality, reliability, and waste (Agbejule & Burrowes 2007; Jasch 2009). Uncertainty, or the degree of change and unpredictability in the organization's markets, describes the range of contingencies to which a company must respond, both currently and in the future (Pondeville et al. 2013). In a highly ecological environmental that is uncertain and competitive, companies are compelled to simultaneously reduce waste, decrease cost, improve quality, and reduce delivery times. Accordingly, MFCA, provides an expanded scope of data that managers can control, monitor, and make decisions on pertaining to their respective organisational transactions (Agbejule & Burrowes 2007; Jasch 2009). Supplier integration strategy is broadly recognised as significant determinants of success (Agbejule & Burrowes 2007; Pondeville et al. 2013), because suppliers directly affect the quality and quantity of the material (Ragatz et al. 2002). Usually, over 50% of the total cost of goods sold in manufacturing companies are represented as purchased raw materials, while the adoption of MFCA often requires the manufactures to change the characteristics of their raw materials. Nevertheless, little discussion has been espoused on the significant factors that explain MFCA adoption (Al-Omiri & Drury 2007; Christ & Burritt 2014). Various studies ascertain that better environmental performance leads to decreasing risks and improved profitability (Russo & Fouts 1997). Prior empirical studies have reported that implementing MFCA has helped save USD 72,000 annually in a sugar cane company in Argentina (Christ & Burritt 2014). More studies such as Schmidt and Nakajima (2013), found that 20-30% of costs were non-product output costs due to the implementation of MFCA at the main manufacturing sites of Canon Ltd. In 2007, the profitability increased to JPY 1.3 billion. Therefore, implementing MFCA motivates decision makers to strive for opportunities to simultaneously generate financial benefits and reduce negative environmental impacts.

Generally, many companies in developed countries realise the seriousness of environmental threats (Pondeville et al. 2013). These companies are firmly convinced that with a high environmental performance responsibility, they are capable of being economic pioneers with strong competition in the market (Sulaiman & Ahmad 2006). However, in developing countries such as Malaysia, most of them do not see the influence of their business activities on the environment (Gadenne et al. 2008). Despite the fact that Malaysia is one of the eight countries that participated in the evolution of ISO 14051 (Sulong et al. 2015). This problem is perhaps related to environmental management measures due to the lack of an advanced systematic approach such as MFCA in recognising, managing, and measuring environmental issues that will cause a risk of great loss of creativity, profitability, competitiveness, and firm performance (Burnett & Hansen 2008; Petcharat & Mula 2012). Accordingly, current study seeks to examine the extent of MFCA implementation across Malaysian manufacturing. Further, it attempts to examine the influence of contingent factors namely, PEEU and SI on MFCA design, and subsequently examines the effect of MFCA implementation on firms' environmental and economic performance. Thus, this study contributes to management accounting literature by empirically addressing the influence of PEEU and supplier integration on the implementation of MFCA and investigating the impact of MFCA on the environmental and economic performance for the manufacturers operating in Malaysia. The remainder of current article is organised as follows: section 2 provides a brief review of the previous studies in this topic. Section 3 describes the theoretical framework and hypotheses development, while section 4 presents the data and methodology used in this study. Then, section 5 discusses and analyses the results, the last section elaborates on the concluding remarks.

Literature Review and Theoretecal Framework

MATERIAL FLOW COST ACCOUNTING

Jasch (2009, p. 116) pointed out that, "MFCA is an accounting tool for measuring the flows of inputs for a firm, a production process or product in both physical and monetary units. It is based on an input-output analysis of material flows, but applies a different cost allocation procedure". At the time that sustainability and environmental issues seem to be a part of an organisation's strategic concern, it is assumed that MFCA, as an innovative approach, can be used as a strategic cost management and an organisation's strategic planning process due to its ability to overcome crises in conventional management accounting (Cinquini & Tenucci 2010; Contrafatto & Burns 2013). Consequently, MFCA functions in a manner that is different from conventional cost accounting. The key distinctions between conventional cost accounting and MFCA is its ability to separate the outputs of the production process to finished products and wastes (Jasch 2009). Conventional cost accounting records the total outputs as finished products, while waste is assigned to the processing cost as a general overhead. Thus, the cost associated with waste is systematically overlooked. However, MFCA splits the output to products and waste. It reassembles the material flows within a quantity centre, and checks the data in order to identify which parts flow to the products, and which parts are left as material losses (Hyršlová et al. 2011). In consequence, MFCA increases the ability to determine material loss which the conventional accounting system is unable to do so (Doorasamy 2015).

Chompu-inwai et al. (2014) showed the practicing of MFCA in timber products manufacturing company in northern Thailand, and how MFCA influenced the minimisation of raw materials consumptions, and reduced waste in the company. They found that before using the MFCA approach, the total negative product was 11300 Thai Baht, which was roughly equal to 69% of the material inputs. After implementing MFCA, the proportion of negative products was reduced to approximately 54% in monetary terms. Thus, the company saved about 9,480 Thai Baht. A case study of a Sugar Cane company in Argentina was done by Scavone in 2006. Because of the positive role of MFCA in waste reduction, it was proven the efficiency of the approach. The results achieved improvement in resource optimization, health and safety and process efficiency about 13%, 8.34% and 55.33% respectively. Whilst, material losses, water consumption, effluent and energy were reduced to around 23.33%, 23.60%, 45% and 11.40%. Christ and Burritt (2014) highlighted the fact that the survey-based research related to MFCA practice is almost negligible. Thus, this study attempts to bridge this gap by investigating the practices of MFCA across Malaysian manufacturing companies. Table 1 summarises some literature on the implementation of MFCA.

PEEU AND MFCA

PEEU it is one of the most broadly employed external environmental variable in contingency-based researches (Chenhall 2003). Several scholars investigated the influence of PEEU on the design of the management accounting systems, and found that it is highly correlated with the usefulness of the broad scope information. PEEU reflects the degree of a corporation, categorised by uncertainty or unpredictable (Parker 1997). The recognition of environmental uncertainty, which is related to nature, could instantly influence the decision of directors towards adopting innovative management accounting tools, such as MFCA, in order to collect or allocate environmental costs and enhance environmental performance (Chang 2007).

Parker (1997) was the first scholar who adopted ecological environmental uncertainty as a contingent factor to investigate the management accounting tool for corporate environmental strategy (Qian et al. 2011). He confirmed that corporations typically increase their dependence on information when facing increasing environmental uncertainties. With a low ecological environmental quantity and environmental costs, a corporation is more likely to move towards an extended hybrid of environmental performance measures and multiple environmental cost classifications (Parker 1997). Lafontaine (1998) also pointed out that a corporation faces ecological environmental uncertainty usually induces recourse to implement an environmental management system to perceive and expect evolutions in regulatory frameworks and appraise the ecological risk of their respective activities. On the other hand, Chang (2007) examined the ecological environmental uncertainty as an independent factor that influences the adoption of EMA. It was found that there is an overall shortage in EMA adoption across universities, which could be due to the simple level of ecological environmental uncertainties in these universities. In a more recent study, Pondeville et al. (2013) reported no impact caused by PEEU on environmental management control systems design in Belgian manufacturing companies. This finding negated their expectation, which was that the level of PEEU should encourage the development of EMS. This expectation was built upon the argument that companies prefer to follow a systematic rather than chaotic reaction to confront changes (Pondeville et al. 2013). Generally, the influence of ecological environment uncertainty as a contextual factor on the development of environmental management accounting system has not been broadly explored (Chang 2007; Pondeville et al. 2013; Thongrattana & Perera 2010;). Moreover, not many studies addressed the impact of ecological environment uncertainty on the implementation of MFCA (Christ & Burritt 2014). In consequence, this study bridges the aforementioned gap by empirically identifying the impact of PEEU on the implementation of MFCA.

Incorporating the natural environment into business operational activities plan can be realized by MFCA by explicitly recognizing material and energy flows within business operations, as well as understanding how these flows are linked to different areas of business expenses (Christ & Burritt 2014). Accordingly, companies with greater PEEU are more likely to improve a proactive environmental strategy, environmental information system,

TABLE 1. Selected literature on MFCA implementation

Author	Sample size	Research Approach	Findings
Scavone (2006)	A Sugar cane company in Argentina	A case study	MFCA implementation achieved improvement in resource optimization, health and safety and process efficiency about 13%, 8.34% and 55.33% respectively. a company's efficiency has improved and it was able to save USD 72,000 every year.
Hyršlová et al. (2011)	A company in ceramic tiling in the Czech Republic.	In-depth case study	Cost analysis after implementing MFCA showed that, the costs of material losses amounted to roughly USD 36.41 million. These material losses occurred throughout the drying process.
Chompu-inwai et al. (2014)	A timber products manufacturing company in north of Thailand	A case study	The percentage of negative products was reduced to approximately 54%. In monetary terms, it is translated to 9,480 Thai Baht
Chang et al. (2015)	A metal processing company in Taiwan	A case study with depth interview	The study proved that MFCA is able to assist managers to reduce the potential of dysfunctional decision-making. The result showed that over than 80% which equal $38,177 of the total negative costs was generated from material negative costs.
Doorasamy 2015	Kwa-Zulu Natal a south African Company, which operates in paper and pulp industrial	A case study	2% and 29% of coal used were not combusted. The ash was disposed to landfill. By adopting in-house training program to improve operating and management skills of employees involved in operating the boilers, coal consumed reduced by 27% resulting in a savings of roughly $65,000. An added benefit was decreased ash disposal to landfill by 275 tons per year

or formal environmental management control system. Contingency literature indicates a positive link between perceived environmental uncertainty and proactive and innovative strategies (Pondeville et al. 2013). Pondeville et al. (2013), studied the practices of environmental management control systems in manufacturing companies in Belgian. They used Lewis and Harvey (2001) scale 'the extension of Miller's (1993) scale' to measure the PEEU proposing that the level of PEEU relatively and positively affect the development of a formal environmental management control system. Although their findings contradict their expectations, they are convinced of the positive effect for PEEU via their recommendation for future studies for measuring specific dimensions of PEEU. Other studies, such as (Chenhall & Morris 1986; Lafontaine 1998), reported a positive influence for PEEU on management accounting system. This level of PEEU should encourage the implementation of MFCA. Accordingly, the following hypothesis is proposed:

H_1: The level of PEEU is positively associated with the MFCA implementation.

SUPPLIER INTEGRATION

Integrating the competent supplier to the decision of installing sophisticated technology is crucial, since the suppliers may have greater experience in judging and providing accurate opinions on the success of technology being implemented in a company (Handfield et al. 1999). Furthermore, a competent supplier is occasionally seen as someone who is capable of upgrading and maintaining their capability to improve upon the raw material requested by the buyer (De Toni & Nassimbeni 2000). Accordingly, supplier integration can be defined as "The degree to which a manufacturer strategically collaborates with its supplier and collaboratively manages intra- and inter-organization process" (Flynn et al. 2010).

Basically, supplier integration might range from merely consultation on design ideas, to making the suppliers entirely responsible for the design of the components, systems, processes, or services that they will supply (Ragatz et al. 2002). Geffen and Rothenberg (2000) pointed out that despite the variety of supplier involvement across manufacturing companies, they are imperative, which forces companies to implement innovative environmental technology (e.g MFCA), especially if they realise that this technology will also benefit them. A few prior studies, such as (Petersen et al. 2003; Petersen et al. 2005; Ragatz et al. 2002; Tsai et al. 2012) sought to explore the effect of supplier integration or collaboration into the development of new products (i.e. coordinating product, process and management accounting tool design). They reported a positive impact for supplier integration in designing new product and systems. Sulong et al. (2014) reported that one of the major factor that facilitated Alpha Malaysian group implement MFCA successfully is the supplier co-operation. According to Sulong et al. highlighted that (2014 p 6) "Alpha has agreed with their suppliers to supply the new pre-cut material size", an agreement between Alpha and their suppliers which has a great effect on their mother coil production and distribution Any delay in the procurement of new pre-cut material may have an adverse impact on the material flow analysis. Meanwhile, an empirical study by Flynn et al. (2010) in examinng the practice of supply chain integration across industrial sectors in China revealed a moderate affect between SI and supply chain integration.

The procurement department rely on suppliers to obtain new materials. Suppliers often modify current materials to produce new ones, which will inevitably affect their prices (Sulong et al. 2014). Handfield et al. (1999) confirmed that companies realized important enhancements in projects and product development when the suppliers are successfully integrated. It should also be pointed out that sometimes, modifying raw materials would need 2-3 months, as suppliers need to amend their respective internal operations to meet the demand of providing these new raw materials (Sulong et al. 2014). Generally, companies that implement environmental management system (EMS) could very well implement environmentally sustainable management techniques by accounting for their environmental influences beyond organisational boundaries (i.e. suppliers) (Darnall, Jolley & Handfield 2008). Furthermore, the experiences of Canon, Alpha, and other companies underlined the importance of supplier integration and co-operation in order to successfully implement MFCA (Schmidt & Nakajima 2013; Sulong et al. 2014). Therefore, the degree of the supplier's integration plays a significant role in the implementation of MFCA. Consequently, the second hypothesis is proposed:

H_2: The level of SI is positively associated with the MFCAimplementation.

THE INFLUENCE OF MFCA ON FIRMS' ENVIRONMENTAL AND ECONOMIC PERFORMANCE

Corporations that decide to adopt MFCA are more likely to report better environmental and economic performance than those that do not (Hyršlová et al. 2011). This is because MFCA provides data that is used towards the reduction of material loss and waste, which leads to effective cost reduction (Sulong et al. 2014), thereby increasing the corporations' profits (Jasch 2009). Few studies indicated that environmental costs can reach 20 per cent or above a corporation's total operating costs (Ferreira et al. 2010). The costs generated from material loss are significant and not limited. This involves all materials financed, energy, depreciation, labours and other economic resources, which are not incurred by the finished products, but are left unused as wastes (Doorasamy 2015). To improve material and energy efficiency, MFCA increases transparency on material and energy flow via the provision of their respective costs; supporting organisational decisions in areas such as process engineering, production planning, quality control, product design, and supply chain management, and in improving coordination and communication on material and energy use within organisations (Fakoya 2014). The positive impact on environmental performance is recognized even if it is not a deliberate intention of an enterprise (Hyrslova et al. 2008).

Reduction of material losses is not the only feature of MFCA that could impact the corporation's environmental and economic performance, but the performance evaluation index relating to material productivity is also seen as another essential feature of MFCA, because it provides substantial physical and monetary information about the value of low quality products and wastes, such as negative product outputs and the expenses of their disposal (Hyršlová et al. 2011). Negative product outputs are a main cost factor for corporations (Doorasamy 2015). When negative product outputs are minimised, then the cost of the positive products will decrease, which in turn improve market competition, realise customer satisfaction, and increase the products sales level and market share. Furthermore, waste cost-saving effectively improve the corporate image and reputation, which satisfies stakeholders (Ferreira et al. 2010). Doorasamy (2015) claimed that usually, the percentage of negative product output costs ranges between 10-30% of the total production costs of a company, and implementing MFCA reduced the aforementioned costs by 5% (Hyrslova et al. 2008). Eventually, the broader spread of MFCA application is essential, because it helps improve the environmental performance on a larger scale via better exploitation of natural resources and increasing the level of productivity, which lead to improved environmental performance as well as economic performance. Therefore, based on this reasoning, the third and the fourth hypotheses are suggested:

H_3: MFCA implementation is positively associated with environmental performance.

H_4: MFCA implementation is positively associated with economic performance.

Accordingly, the proposed research framework is as follows:

RESEARCH METHOD

SAMPLE

The sample was selected with a stratified sample of randomly extracted from the database of the Federation of Malaysian Manufacturers of Malaysia. A random sample featured 1200 Malaysian manufacturing business units that comprise six different sectors, namely chemical and wood, electrical, plastic and rubber, automotive and machinery, food and tobacco pharmaceutical and medical equipment (FMM 2015). Table 2 comprises a summary of the sectors and sizes of the surveyed corporations. The chemical and wood, automotive and machinery, food and tobacco represent 73% of sample's study; they also are the most representative industries in terms of added value (Pondeville et al. 2013). In this study, manufacturing sectors were selected due to characteristics such as the complexity and diversity in several areas, differentiating them from other sectors and their high level of environmental impact (Jusoh et al. 2008; Pondeville et al. 2013).

Data were collected by the online-survey questionnaire administered to CEOs and general managers in Malaysian manufacturing companies. They were preferred because they are considered as the most likely to be able to provide accurate and useful data on green issues, green innovation initiatives, and continuous green progress in the environmental performance of the manufacturing firms (Pondeville et al. 2013). The initial request was supported by three reminder emails, following which, of the 133 responses received 10 were unusable, mainly due to the duplicate (frequent) answers, 123 usable responses were received, the final response rate was roughly 10%. There was no recording to any missing data particularly for fundamental survey measurements, because the overall web-survey items were provided with a compulsory answer feature, which hinders survey data submission unless all items are responded (Wright 2005). Time-trend exploitation approach was undertaken to assess for potential non-response bias. By using an independent-samples t-test, the contrast between the first and last 30 respondents showed no significant variances in their variable responses.

MEASUREMENT OF VARIABLES

Multiple indicators were employed through multi-item constructs on five-point Likert scales in order to

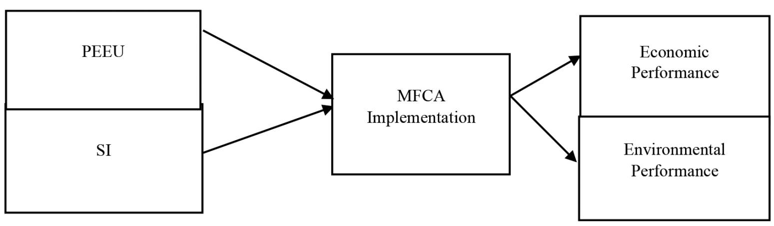

FIGURE 1. Theoretical Framework

TABLE 2. Description of the respondents

Industry Group	Sample	Proportionate Sample	Percentage
Automotive and Machinery	325	37	28%
Chemical and Wood	296	32	24%
Food and tobacco	218	28	21%
Plastic and rubber	67	20	15%
Electrical	149	13	10%
Pharmaceutical and medical equipment	45	3	2%
Total	1200	133	100%

measure the variables. Extensive pilot testing was used to improve the content validity of the measures. the online-questionnaire was pre-tested on a rigorous review process containing seven academic experts in management accounting, environmental management accounting, MFCA and three business managers. The final measures were then improved and refined. The measuring instrument can be referred in Appendix.

The Extent of MFCA Implementation - MFCA considers as an EMA framework which traces, tracks, identifies, and measures the flow and stock of materials, that involve raw materials, parts and components in the production process, in terms of both physical and monetary units, in order to separate waste costs into good product and negative product. These costs are categorised as material costs, system costs, transportation costs and waste treatment costs (Fakoya 2014). The extent of the implementation of MFCA scale involving 27-item with three subscales modified from Mokhtar et al. (2015), was determined through: i. Inclusion of waste-related information (INC subscale); ii. Stand-alone MFCA procedures (STA subscale); and iii. Waste-related information cost-benefit analysis (ECA subscale). Respondents were asked to indicate their company's level of usage of the items on a five-point Likert scale, ranging from 1 (Never) to 5 (very often).

PEEU - Lewis and Harvey's (2001) scale, which is regarded as a grounded scale in environmental management and accounting studies, was adopted by Chang (2007); Pondeville et al. (2013) to identify levels of PEEU. The scale of Lewis and Harvey's (2001p. 227) comprises of seven dimensions, where each dimension is measured using several items. However, Pondeville et al. (2013) merely applied seven items related to environmental legislation and politics, environmental demand, and green competition. Thus, this research adopted items selected by Pondeville et al. (2013). Respondents are requested to indicate if they are predictable (easy to predict) or unpredictable (difficult to predict) as per Table 3.

SI - Recent researches adopted the scale reported by Flynn et al. (2010), which comprises 13 items. Such scale, to a large extent, pinpointed the relationship between the company and its major supplier in terms of sharing information between each other. Respondents were asked to indicate the extent of integration or information sharing between their organisation and their respective main suppliers (1= totally disagree; 5= totally agree).

Environmental Performance - Environmental performance is viewed from the scope of contamination control efficiency (Jalaludin et al. 2010; Wagner & Schaltegger 2004). Environmental performance involves evaluating the reduction of companies' environmental influence in a number of environmental performance dimensions. The respondents were requested to evaluate items that are related to their company's current environmental performance.

Environmental Performance - Wagner and Schaltegger (2004) see economic performance in the context of environmental competitiveness, where it states that part of overall firms competitiveness and economic performance of the corporation is generated and affected by environmental management (Jalaludin et al. 2010). A list of items was used to represent economic performance. The respondents were asked to assess these items in relation to their company's current economic performance on a scale of 5 Likert scale ranging from 1(Not at all) to 5(very much).

DATA ANALYSIS – PARTIAL LEAST SQUARE (PLS)

The data was analysed using SmartPLS-structural equation model (SEM) (Chin 2001). The study obtained partial least squares (PLS) estimates for both the measurement and structural parameters in our structural model. The PLS software does not demand multivariate normal data, sets minimum requirements on measurement levels, and is appropriate for small samples (Chin 1998), which is very common in management accounting researches (Ylinen & Gullkvist 2014). Furthermore, the PLS method is more suitable for models comprising of complicated relationships, such as many indicators, variables, and relationships (Pondeville et al. 2013). Bootstrapping was also conducted to determine the level of significance of each item (Ferreira et al. 2010). Bootstrapping is recommended for small samples that do not follow a multivariate normal distribution (Ylinen & Gullkvist 2014). In bootstrapping, a great number of subsamples are drawn, including replacement from the original set of data (Hair

TABLE 3. Psychometric properties of measures using smart PLS

Construct	Items	Factor Loading	Cronbach's Alpha	Composite Reliability	AVE
PEEU	PEEU1	0.922	**0.951**	**0.959**	**0.771**
	PEEU2	0.913			
	PEEU3	0.872			
	PEEU4	0.793			
	PEEU5	0.885			
	PEEU6	0.874			
	PEEU7	0.879			
SI	SI1	0.780	**0.950**	**0.955**	**0.619**
	SI2	0.689			
	SI3	0.870			
	SI4	0.838			
	SI5	0.828			
	SI6	0.826			
	SI7	0.839			
	SI8	0.788			
	SI9	0.719			
	SI10	0.793			
	SI11	0.820			
	SI12	0.716			
	SI13	0.696			
ECA	ECA1	0.823	**0.932**	**0.943**	**0.622**
	ECA2	0.861			
	ECA3	0.834			
	ECA4	0.728			
	ECA5	0.877			
	ECA6	0.742			
	ECA7	0.696			
	ECA8	0.739			
	ECA9	0.795			
	ECA10	0.773			
INC	INC1	0.862	**0.965**	**0.970**	**0.783**
	INC2	0.894			
	INC3	0.888			
	INC4	0.884			
	INC5	0.909			
	INC6	0.915			
	INC7	0.883			
	INC8	0.895			
	INC9	0.828			
ENP	ENP1	0.826	**0.964**	**0.968**	**0.720**
	ENP2	0.796			
	ENP3	0.740			
	ENP4	0.854			
	ENP5	0.869			
	ENP6	0.890			
	ENP7	0.897			
	ENP8	0.910			
	ENP9	0.834			
	ENP10	0.909			
	ENP11	0.863			
	ENP12	0.775			

(continue)

Continued (TABLE 3)

Construct	Items	Factor Loading	Cronbach's Alpha	Composite Reliability	AVE
ECP	ECP1	0.850	**0.970**	**0.973**	**0.692**
	ECP2	0.804			
	ECP3	0.717			
	ECP4	0.869			
	ECP5	0.840			
	ECP6	0.804			
	ECP7	0.848			
	ECP8	0.791			
	ECP9	0.773			
	ECP10	0.745			
	ECP11	0.852			
	ECP12	0.829			
	ECP13	0.912			
	ECP14	0.905			
	ECP15	0.910			
	ECP16	0.837			

et al. 2014). Each subsample is then used to estimate the model. This exertion used 123 cases and 5000 bootstraps from the original sample in order to test the hypotheses of the current research. The 5000 bootstrapped samples were run to confirm that the entire model parameter has empirical sampling distribution and to obtain its standard error. By utilising a similar approach, the path coefficients were evaluated by employing t-statistics.

RESULTS

MEASUREMENT MODEL: ASSESSING PSYCHOMETRIC PROPERTIES

Usually, the measurement model extracted by smart PLS is investigated through evaluating its reliability, convergent validity, and discriminant validity (Chin 1998; Pondeville et al. 2013). The reliability in current research was evaluated by employing cronbach's alpha, composite reliability and average variance extracted (AVE) (Chin 1998; Hair et al. 2006). The cronbach's alpha for all the constructs were above 0.90 which is considered good (Sekaran 2000). Further, as it is exhibited in Table 3, the composite reliability scale is ranging between 0.943 and 0.973, in surplus of the cut-off value of 0.7. Regarding of the AVE, it is ranged from 0.619 to 0.783 and accordingly above the 0.5 cut-off value (Pondeville et al. 2013).

Tables 3 reflects good convergent reliability, because all items loaded to their respective constructs are almost equivalent or exceeded the recommended value of 0.70 (Hair et al. 2014). Discriminant validity can be assessed using Fornell-Larcker criterion approach. This approach is based on comparing the square root of the AVE values with the latent variable correlations. Particularly, the square root of each construct's AVE ought to be greater than its highest correlation with any other construct. However, Hair et al. (2014) stated that, if certain construct is found higher than the square root of the AVE, the researcher can decide to eliminate this construct that its value found higher than the square root of the AVE in order to more closely meet the Fornell-Larcker criterion and to increase the reliability or discriminant validity. But, the researcher must also consider that the removal process does not affect the measurement of content validity. Since the correlation was found 0.951 for STA and 0.885 for the AVE square root of INC as well as 0.936 for STA and 0.789 for the AVE square root of the ECA. Thus, STA was eliminated. Regarding the remaining variables as Table 4 reveals, the construct intercorrelations in the model did not override the square root of the AVE for the constructs. Consequently, the psychometric properties of the instruments were acceptable to support the study's explanation of the structural model.

DESCRIPTIVE STATISTICS

PEEU shows a mean of 3.4704. It indicates a condition of high uncertainty among the companies for the influence of their business activities toward the nature, and it is almost similar to Pondeville et al. (2013) who recorded a mean of 3.58. The finding suggests that the level of PEEU between Malaysian and Belgian manufacturing firms is relatively similar. While, the supplier integration mean of 3.859 is slightly higher than Flynn et al.'s (2010) study with a mean of 3.51 done in China manufacturing sector. With regards to MFCA implementation, both INC and ECA recorded mean values of 2.3216 and 2.5187 respectively reflecting a low level of MFCA implementation.

It appears that the role of the respondents related to the environmental matters is not perceived as significant in supporting the environmental management techniques of the companies, especially in ensuring the process of waste reduction or waste related efficiency (Jalaludin et

TABLE 4. Correlation of latent variables and square root of AVE (on Diagonal) after omitting STA

CONSTRUCTS	1	2	3	4	5	6
1. PEEU	0.878					
2. SI	0.017	**0.787**				
3. ECA	-0.326	0.297	**0.789**			
4. INC	-0.178	0.205	0.447	**0.885**		
5. ENP	-0.158	0.191	0.432	0.418	**0.848**	
6. ECP	-0.137	0.422	0.338	0.299	0.573	**0.832**

Bold diagonals represent the average variance extracted while the others represent the squared correlations.

al. 2010). These measures are quite similar to the means of Jalaludin et al. (2010) and Ferreira et al. (2010) studies, which recorded 2.329 and 2.33 respectively. On the other hand, a mean of Mokhtar et al. (2015) shows a moderate extent of EMA implementation among the responding companies at about 3.15 for INC and 3.28 for ECA. In terms of both environmental performance as well as economic performance, current research reported a moderate level for environmental performance mean of 3.4980. Whilst, a high level for economic performance mean of 3.9634, compared to Jalaludin et al. (2010) reported mean, i.e. 3.433 (environmental performance) and 3.594 (economic performance). In spite of the minor variances, the means are generally similar to prior studies reported means and thus, this places the study within contemporary management accounting tools or system which is related to the environmental issues. Since approximately the overall of standard deviation values were below than 1.00 it can be concluded that a substantial amount of differences do exist as most responses covered the theoretical ranges of the measurement scales.

RESULTS

This section presents the PLS results related to SEM including t-values for each path coefficient to investigate the relationship between PEEU, SI and the extent of MFCA implementation (peroxide by INC and ECA) and the relationship between MFCA implementation and environmental and economic performance as reported in Table 6. The significance level of the t-value was estimated by one-tailed distribution (Hair et al. 2014). A one-tailed assessment is suggested if the coefficient is proposed to have a sign of positive or negative, which should be mirrored in the hypothesis that refers to the corresponding association. If no hypotheses are assumed to have a coefficient sign, a two-tailed test is recommended (Kock 2015). In the situation where one-tailed test is estimated, the significance level of t-value of 10% is more than or equal to 1.282, at 5% is more or equal to 1.645, while at 1% is greater or equal to 2.326. On the other hand, any value of t-statistics lesser than what is stated, is regarded as insignificant (Hair et al. 2014).

Regarding the first hypothesis, Table 6 shows a significant path coefficient with a t-value of 3.563. However, it was found that the influence of PEEU has a negative relationship ($\beta = -0.300$, $p < 0.001$) with MFCA implementation, which implies that the results do not support H1. This result is almost similar to the findings of Pondeville et al. (2013). Since they also found a negative effect of PEEU on the development of an environmental information system at coefficient correlation of -0.303 with significant correlation at 0.01 level. Thus, it might be concluded that companies are less likely to implement MFCA when the environment is perceived to be more uncertain. Further, companies in current study sample seem to follow a wait and see attitude in highly uncertain circumstances (Pondeville et al. 2013). While, the result displayed a statistically significant correlation between supplier integration and MFCA implementation ($\beta = 0.304$, $t = 4.035$ $p < 0.001$). Same results were found in

TABLE 5. Descriptive statistics analysis

Variables	Actual Range*		Mean	S.D
	Minimum	Maximum		
PEEU	1.71	5.00	3.4704	.84490
SI	2.31	5.00	3.8593	.70534
INC	1.00	5.00	2.3216	1.01893
ECA	1.00	5.00	2.5187	.90094
ENP	1.67	5.00	3.4980	.86691
ECP	2.63	5.00	3.9634	.69371

Theoretical range for all the variables is between 1 to 5.

TABLE 6. PLS-SEM results: Path Coefficients, t-statistics, R^2

Hypothesis	Relationship	Coefficient	t-value	+/-	Results
H1	PEEU -> MFCA	-0.300	3.563	(-)	Not Supported
H2	SI -> MFCA	0.304	4.035	(+)	Supported
H3	MFCA -> ENP	0.504	8.750	(+)	Supported
H4	MFCA -> ECP	0.378	5.289	(+)	Supported
R^2(MFCA)		0.180			
R^2(ENP)		0.254			
R^2(ECP)		0.143			

harmony with the study of (Geffen & Rothenberg 2000) who pointed out that, the successful implementation of innovative environmental technologies is related to strong cooperation with suppliers. The R^2 value was 0.18 suggesting that 18% of the variance in extent of MFCA implementation can be explained by PEEU and supplier integration, which accordingly reflects a medium effect size, based on Cohen's criteria (Cohen 1988). H3 that represents the relationship between MFCA and environmental performance "reduction of negative environmental impact and reduction in usage of natural resources" was supported. The R^2 value of 0.254 which suggest that 25.4% of the variance in environmental performance can be interpreted by the extent of MFCA implementation, and there was a positive relationship ($\beta = 0.504$, $t = 8.750$ $p < 0.001$) between the extent of MFCA implementation and environmental performance. The association between MFCA and economic performance "security, business benefits, reputation" (i.e. H4) was also supported with a positive sign at ($\beta = 0.378$, $t = 5.289$ $p < 0.001$) with R^2 value of 0.143. Subsequently, based the study's sample examined, it can be concluded that, if the level of MFCA implementation increases, the environmental performance will also increases. Likewise, if the level of MFCA implementation rises up, the economic performance will also rises up. These results were found relatively in accord with Jalaludin et al. (2010) finding, which revealed a great correlation between EMA adoption and environmental and economic performance.

DISCUSSION AND CONCLUSION

This current study sought to achieve three research objectives. The first objective is related to the extent to which Malaysian companies implement MFCA. The second is to discuss the extent to which PEEU and supplier integration influencing MFCA implementation within manufacturing companies. Third, the study examined the effect of MFCA implementation on firms' environmental and economic performance It was proposed that companies with high level of PEEU are more likely to implement MFCA. To determine the level of PEEU, a scale proposed by Pondeville et al. (2013) was used as guidance. The research found a high level of PEEU in the study sample. Nevertheless, it did not recommend the companies to implement MFCA. Executives seem to perceive greatly uncertain environments as brakes on the MFCA development (Pondeville et al. 2013). Further, it seems that, managers are reluctant to invest on MFCA, possibly due to the unpredictability of changes in the green market and legislation. They might not believe that MFCA could help them collect reliable information. In this sense, higher PEEU causes executives to question the value of a probably inadequate MFCA. However, the results related to SI reinforce the importance of suppliers as sources of expertise in implementing MFCA in a complex manufacturing environment. The success of supplier involvement is dependent on the extent of supportive environment offered by the companies. This recommends that maximizing the benefit of suppliers require a broader

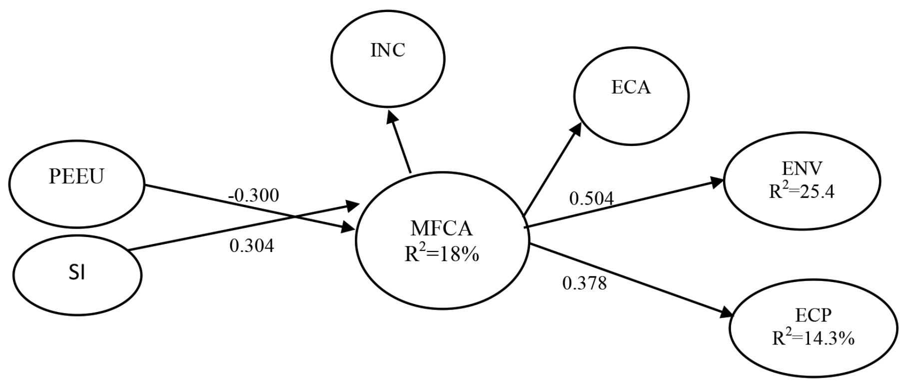

FIGURE 2. Algorithm model for variables effect

strategy for accessing capability and forming partnerships outside conventional company boundaries (Geffen & Rothenberg 2000).

The relationship between MFCA implementation and environmental performance as well as economic performance are hypothesized in hypothesis 3 and 4 which both expected a positive and significant relationship. In spite of the underrating scores for MFCA implementation, current studies' respondents have related MFCA implementation with better environmental and economic performance. This perhaps mirrors the consciousness of these respondents to the potential role of MFCA in carrying out better performance. Thus, the argument put forth by few critics that MFCA is only a formality that has no actual benefits is rejected by the results of recent study. In addition, respondents perhaps are perceived that even if there is any costs imposed by implementing MFCA, the benefits of MFCA will be far outweighed its costs.

The major contribution of this current paper is to provide evidence on the extent of MFCA implementation and the association between PEEU as well as SI with the practice of MFCA in the Malaysian companies. Issues regarding MFCA implementation and regarding PEEU and SI with MFCA implementation were not addressed by prior studies. Thus, it might provide evidence for better understanding on the influence of PEEU and SI on MFCA implementation and how that may affect environmental and economic performance. Conceptual and practical contributions can be derived accordingly. Recent study contributes to management accounting studies by endorsing the fit between SI and firm's MFCA system which interprets into an ecological environment framework (Pondeville et al. 2013). It also contributes to environmental cost studies by highlighting the respective roles of contextual contingent factors in the development of MFCA by manufacturing companies. In addition, the study confirmed what is attainable for companies in terms of implementing accounting systems for managing the costs of waste. Presumably, the research results and findings demonstrated a general absence of MFCA implementation within Malaysian manufacturing companies. Arguably, this is not a problem specific to Malaysia, but is one that is probably common to many other developing countries. It should be borne in mind that this study addressed many gaps that others studies have ignored to cover them. Overall, the results of this paper do highlight the potential usages of MFCA, and its ability to improve environmental and economic performance within companies. As in many management accounting research, this study includes numerous limitations that influence the statistical power as well as the explanation of the study's analysis. First of all, the major limitation of recent study is related to the low of response-rate that might affect the issue of generalizability, and may lead the study to be subjected to the risk of response bias. Although the process of data reliability, random sample, pre-tests, construct and content validity was conducted in order to ensure a low level of nonresponse bias. However, a further caution must be given in interpreting and generalizing the results. Another limitation which may also effect on generalizing the results is related to unequal distribution of the companies in the sample that was only concentrated on manufacturing sector listed on FMM. For instance, electrical automotive and machinery involves 30 companies, while plastic and rubber contains 18 companies and pharmaceutical and medical equipment includes only 3 companies.

In terms of the third limitation, the study only focused into two contextual external factors (PEEU and SI). Inspite of their important role to contemporary cost system design, other contextual factors can be examined by future studies such as (size, industry, intensity of the competitive environment, technology and others). In addition, future study can explore the role of strategic factors or the role of both contextual and strategic factors in the implementation of MFCA. Another useful trend for future research is to improve or to find alternative measures which are more objective in measuring the factors of the study. Thereby, providing more essential insight into the association proposed by this study. An additional suggestion for future study is to conduct a similar research across different countries which could increase the generalizability of current study.

ACKNOWLEDGEMENT

The authors would like to thank the Malaysian Productivity Corporation for their assistance in collecting the data.

REFERENCES

Agbejule, A. & Burrowes, A. 2007. Perceived environmental uncertainty, supply chain purchasing strategy, and use of MAS information: An empirical study of Finnish firms. *Managerial Auditing Journal* 22(9): 913-927.

Al-Omiri, M. & Drury, C. 2007. A survey of factors influencing the choice of product costing systems in UK organizations. *Management Accounting Research* 18(4): 399-424.

Al-Tuwaijri, S.A., Christensen, T.E. & Hughes, K.E. 2004. The relations among environmental disclosure, environmental performance, and economic performance: A simultaneous equations approach. *Accounting, Organizations and Society* 29: 447-471.

Burnett, R.D. & Hansen, D.R. 2008. Ecoefficiency: Defining a role for environmental cost management. *Accounting, Organizations and Society* 33(6): 551-581.

Chang, H. 2007. *Environmental Management Accounting Within Universities: Current State and Future Potential (Doctoral dissertation, RMIT University).*

Chenhall, R. 2003. Management control systems design within its organizational context: findings from contingency-based research and directions for the future. *Accounting, Organizations and Society* 28(2-3): 127-168.

Chenhall, R. & Morris, D. 1986. The impact of structure, environment, and interdependence on the perceived usefulness of management accounting systems. *The Accounting Review* 61(1): 16-35.

Chin, W. 1998. The partial least squares approach to structural equation modeling. *Modern Methods for Business Research* 295(2): 295-336.

Chompu-inwai, R., Jaimjit, B. & Premsuriyanunt, P. 2015. A combination of Material Flow Cost Accounting and design of experiments techniques in an SME: the case of a wood products manufacturing company in northern Thailand. *Journal of Cleaner Production* 108: 1352-1364.

Christ, K.L. & Burritt, R.L. 2014. Material flow cost accounting: a review and agenda for future research. *Journal of Cleaner Production* 1-12.

Cinquini, L. & Tenucci, A. 2010. Strategic management accounting and business strategy: a loose coupling? *Journal of Accounting & Organizational Change* 6(2): 228-259.

Cohen, J. 1988. *Statistical power analysis for the behavioral sciences*. (Lawrence Earlbaum Associates, Ed.). Hillsdale.

Contrafatto, M. & Burns, J. 2013. Social and environmental accounting, organisational change and management accounting: A processual view. *Management Accounting Research* 24(4): 349-365.

Darnall, N., Jolley, J. & Handfield, R. 2008. Environmental Management System and Green Supply Chain Management : Complements for Sustainability? *Business Strategy and the Environment* 18(2006): 30-45.

De Toni, A. & Nassimbeni, G. 2000. Just-in-time purchasing: an empirical study of operational practices, supplier development and performance. *Omega* 28(6): 631-651.

Doorasamy, M. 2015. The Effectiveness of Material Flow Cost Accounting (MFCA) In Identifying Non-Product Output Costs And Its Impact On Environmental Performance In Paper Manufacturing Companies : A Case Study In Kwa-Zulu Natal. *Journal of Accounting and Management* 4(3): 51-70.

Drazin, R. & de Ven, A.H. Van. 1985. Alternative Forms of Fit in Contingency Theory. *Administrative Science Quarterly*, 30(4): 514. http://doi.org/10.2307/2392695

Fakoya, M.B. 2014. Adopting material flow cost accounting model for improved waste-reduction decisions in a micro-brewery. *Environment, Development and Sustainability* 17(5): 1017-1030.

Ferreira, A., Moulang, C. & Hendro, B. 2010. Environmental management accounting and innovation: an exploratory analysis. *Accounting, Auditing & Accountability Journal* 23(7): 920-948.

Flynn, B. B., Huo, B. & Zhao, X. 2010. The impact of supply chain integration on performance: A contingency and configuration approach. *Journal of Operations Management* 28(1): 58-71.

FMM, D. 2015. Malaysian industries 46th ed, Federation of Malaysian Manufacturers. Kuala Lumpur.

Gadenne, D.L., Kennedy, J. & McKeiver, C. 2008. An Empirical Study of Environmental Awareness and Practices in SMEs. *Journal of Business Ethics* 84(1): 45-63.

Geffen, C.A. & Rothenberg, S. 2000. Suppliers and environmental innovation: The automotive paint process. *International Journal of Operations & Production Management* 20(2): 166-186.

Hair, J.F., William, C., Babin, B.J. & Anderson, R.E. 2014. *Multivariate Data Analysis*. Pearson Education Limited.

Hair, J., Hult, G. T. M., Ringle, C. & Sarstedt, M. 2014. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). Long Range Planning* (Vol. 46).

Handfield, R., Ragatz, G., Petersen, K.J. & Monczka, R. M. 1999. Involving suppliers in new product development. *California Management Review* 42(1): 59-82.

Hyrslova, J., Bednarikova, M. & Hájek, M. 2008. Material Flow Cost Accounting. Only A Tool of Environmental Management or A Tool For Optimization of Corporate Production Process? *Scientific Papers of the University of Pardubice. Series A. Faculty of Chemical Technology* 14: 131-145.

Hyršlová, J., Vágner, M. & Palásek, J. 2011. Material Flow Cost Accounting (MfCA) – Tool for the Optimization of Corporate Production Processes. *Business, Management and Education* 9(1): 5-18.

Jalaludin, D., Maliah, S. & Nik Nazli, N.A. 2010. Environmental management accounting: an empirical investigation of manufacturing companies in Malaysia. *Journal of Asia-Pacific Centre for Environmental Accountability* 16(3): 31-45.

Jasch, C. 2009. *Environmental and material flow cost accounting: principls and procedures*.

Kock, N. 2015. One-tailed or two-tailed P values in PLS-SEM ? *International Journal of E-Collaboration* 11(2): 1-7.

Kokubu, K., Kos, M. & Campos, S. 2009. Material flow cost accounting with ISO 14051. *ISO Management System* 9(1): 15-18.

Kokubu, K. & Tachikawa, H. 2013. Material Flow Cost Accounting: Significance and Practical Approach. *Handbook of Sustainable Engineering*, (Springer Netherlands.), 351-369.

Lafontaine, J.P. 1998. L'implantation des systèmes d'information environnementale: un domaine en quête de théories. *19ème Congrès de l'Association Française de Comptabilité* 2: 884-899.

Lewis, G.J. & Harvey, B. 2001. Perceived Environmental Uncertainty: the Extension of Miller'S Scale To the Natural Environment. *Journal of Management Studies* 38(2): 201-233.

Mokhtar, N., Jusoh, R. & Zulkifli, N. 2015. Corporate characteristics and environmental management accounting (EMA) implementation: Evidence from Malaysian public listed companies (PLCs). *Journal of Cleaner Production* 136: 111-122.

Moors, E.H.M., Mulder, K.F. & Vergragt, P.J. 2005. Towards cleaner production: Barriers and strategies in the base metals producing industry. *Journal of Cleaner Production* 13(7): 657-668.

Parker, L.D. 1997. Accounting for Environmental Strategy: Cost Management, Control and Performance Evaluation. *Asia-Pacific Journal of Accounting* 4(2): 145-173.

Petcharat, N.N. & Mula, J.M. 2012. Towards a conceptual design for environmental and social cost identification and measurement system. *Journal of Financial Reporting and Accounting* 10(1): 34-54.

Petersen, K., Handfield, R. & Ragatz, G. 2003. A Model of Supplier Integration into New Product Development. *Journal of Product Innovation Management* 20(4): 284-299.

Petersen, K.J., Handfield, R.B. & Ragatz, G.L. 2005. Supplier integration into new product development: Coordinating product, process and supply chain design. *Journal of Operations Management* 23(3-4): 371-388.

Pondeville, S., Swaen, V. & De Ronge, Y. 2013. Environmental management control systems: The role of contextual and strategic factors. *Management Accounting Research* 24(4): 317-332.

Qian, W., Burritt, R. & Monroe, G. 2011. Environmental management accounting in local government: A case of waste management. *Accounting, Auditing & Accountability Journal* 24(1): 93-128.

Ragatz, G.L., Handfield, R.B. & Petersen, K.J. 2002. Benefits associated with supplier integration into new product development under conditions of technology uncertainty. *Journal of Business Research*, *55*(5): 389-400.

Ramayah, T., Lee, J.W.C. & In, J.B.C. 2011. Network collaboration and performance in the tourism sector. *Service Business* 5(4): 41-428.

Russo, M.V. & Fouts, P.A. 1997. A Resource-Based Perspective on Corporate Environmental Performance and Profitability. *Academy of Management Journal* 40(3): 534-559.

Schmidt, M. & Nakajima, M. 2013. Material Flow Cost Accounting as an Approach to Improve Resource Efficiency in Manufacturing Companies. *Resource* 2(3): 358–369.

Sulaiman, M. & Nik Ahmad, N.N. 2006. Towards a Sustainable Future. *Accountants Today* 29-33.

Sulong, F., Sulaiman, M. & Norhayati, M.A. 2015. Material Flow Cost Accounting (MFCA) enablers and barriers: the case of a Malaysian small and medium-sized enterprise (SME). *Journal of Cleaner Production* 108: 1365-1374.

Sygulla, R., Bierer, A. & Götze, U. 2011. Material Flow Cost Accounting–Proposals for Improving the Evaluation of Monetary Effects of Resource Saving Process Designs. *44th CIRP International Conference on Manufacturing Systems* (June):1-3.

Thongrattana, P.T. & Perera, N. 2010. Perceived Environmental Uncertainty Along the Thai Rice Supply Chain : An Empirical Approach. *An International Journal* 3(3): 117-133.

Tsai, K.-H., Tsai, M.-L. & Wang, J.-C. 2012. Supplier collaboration and new product performance: a contingency model. *Industrial Management & Data Systems* 112(2): 268-289.

Wright, K. 2005. Researching Internet based populations: Advantages and disadvantages of online survey research, online questionnaire authoring software packages, and. *Journal of Computer-Mediated Communication* 10(3): 00-00.

Ylinen, M. & Gullkvist, B. 2014. The effects of organic and mechanistic control in exploratory and exploitative innovations. *Management Accounting Research* 25(1): 93-112.

Khaled M.A. Salim
Fakulti Ekonomi dan Pengurusan
Universiti Kebangsaan Malaysia
43600 UKM Bangi Selangor
MALAYSIA
Email: khalid_isleem@hotmail.com,

Amizawati Mohd Amir*
Fakulti Ekonomi dan Pengurusan
Universiti Kebangsaan Malaysia
43600 UKM Bangi Selangor
MALAYSIA
Email: amiza@ukm.edu.my

Maliah Sulaiman
International Islamic University Malaysia
53100 Jalan Gombak
Kuala Lumpur
MALAYSIA
Email: maliah@iium.edu.my

*Corresponding author

APPENDIX: List of measurement items

The variable	Measurement items	Code
Inclusion of waste-related information	The costing system	INC1
	The budgeting system	INC2
	Capital budgeting and expenditure	INC3
	Investment appraisal	INC4
	Performance measurement and appraisal	INC5
	Internal reporting mechanisms	INC6
	Risk assessment	INC7
	Purchasing policy	INC8
	Plant maintenance	INC9
Waste-related information cost-benefit analysis	Energy efficiency	ECA1
	Workers efficiency	ECA2
	By product use	ECA3
	Recyclable containers/packaging	ECA4
	Waste management	ECA5
	Pollution minimization/prevention	ECA6
	Environmental contingent liabilities	ECA7
	Environmental compliance	ECA8
	Site contamination	ECA9
	Site cleanup	ECA10
Perceived ecological environmental uncertainty	National/international environmental laws	PEEU1
	Environmental tax policies	PEEU2
	Environmental regulations affecting the sector	PEEU3
	Availability of substitute environmental Products	PEEU4
	Environmental product demand	PEEU5
	Changes in the production process on the market	PEEU6
	Changes in the competitor's environmental strategies	PEEU7
Supplier integration	The level of information exchange with our main supplier through information network	SI1
	The establishment of quick ordering systems with our main supplier	SI2
	The level of strategic partnership with our main supplier	SI3
	Stable procurement through network with our main supplier.	SI4
	The participation level of our main supplier in the process of procurement and production.	SI5
	The participation level of our main supplier in the design stage.	SI6
	Our main supplier shares their production capacity with us	SI7
	Our main supplier shares available inventory with us.	SI8
	Our main supplier shares their production schedule with us	SI9
	We share our production plans with our main supplier.	SI10
	We share our demand forecasts with our main supplier.	SI11
	We share our inventory levels with our main supplier.	SI12
	We help our main supplier to improve its process to better meet our needs.	SI13

(continue)

Continued (APPENDIX)

The variable	Measurement items	Code
Environmental performance	Reduction in the use of water.	ENP1
	Reduction in the use of energy.	ENP2
	Reduction in the use of non-renewable resources.	ENP3
	Reduction in the use of toxic inputs.	ENP4
	Reduction of solid waste.	ENP5
	Reduction of soil contamination.	ENP6
	Reduction in waste water emissions.	ENP7
	Reduction in emissions to air.	ENP8
	Reduction of noise.	ENP9
	Reduction of smell/odour emissions.	ENP10
	Reduction of landscape damage.	ENP11
	Reduction in the risk of severe accidents	ENP12
Economic performance	Competitive advantage	ECP1
	Corporate image	ECP2
	Product image	ECP3
	Level of products sales	ECP4
	Market share	ECP5
	New market opportunities	ECP6
	Short-term profit	ECP7
	Long-term profit	ECP8
	Cost saving	ECP9
	Productivity	ECP10
	Insurance condition	ECP11
	Access to bank loans	ECP12
	Owner/shareholder satisfaction	ECP13
	Worker satisfaction	ECP14
	Management satisfaction	ECP15
	Recruitment and staff retention	ECP16