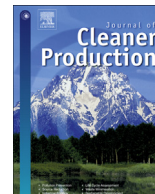




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## Material Flow Cost Accounting (MFCA) enablers and barriers: the case of a Malaysian small and medium-sized enterprise (SME)

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### ABSTRACT

The introduction of Material Flow Cost Accounting (MFCA) to five companies under the Malaysia Productivity Corporation (MPC) project has shown that these companies have indeed achieved simultaneous benefits of economic gains and environmental sustainability. This paper highlights the experience of one of the companies, emphasising how one can leverage enablers and also overcome barriers to implementing MFCA in a small and medium-sized enterprise (SME) in Malaysia. Driven by the diffusion of innovation (DOI) theory, the case company found most of its enablers within MFCA's own attributes. Additionally other factors such as the team composition, interpersonal communication, and efforts of the change agents were instrumental in the success of the MFCA implementation. However, the company was also constrained by its suppliers. More importantly, it is envisaged that a potential hurdle for MFCA advancement is when performance management issues are not addressed by higher management. Drawing upon the company's experience and the theoretical literature, other barriers that may also be encountered by SMEs in Malaysia are also discussed. These include for example, overcoming the traditionalist view held by most SMEs, persevering the implementation processes on their own without the direct assistance from MPC and several others.

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### 1. Introduction

In Malaysia over a number of years there has been an overall increase in air pollution, water pollution and scheduled waste levels (DOE, 2010). Because small and medium-sized enterprises (SMEs) in Malaysia comprise 97% of total business establishments (DOS, 2011), their operations are highly likely to have a significant impact on the natural environment, as has occurred in Europe, where SMEs contribute approximately 64% of industrial pollution (Constantinos et al., 2010). What can SMEs in Malaysia do to ensure that they are economically sustainable and, at the same time, environmentally responsible? One environmental management accounting tool that has now become an international standard (ISO 14051), Material Flow Cost Accounting (MFCA), is promoted as a tool that can help companies address both environmental and profitability issues. MFCA was introduced into Malaysia in 2010

under a project organised by the Malaysia Productivity Corporation (MPC) in five SMEs.

The MFCA project under MPC was initiated by the Asian Productivity Organization (APO) and the Japan Productivity Center for Socio-Economic Development (JPC-SED) with their invitation to MPC to join the Member Country Support Program (MCSP) in May 2010. The representative from JPC-SED came to Malaysia and discussed the prospects and details with MPC, and also mentioned that most of the expenses would be funded by APO and JPC-SED. The project would be carried out under the Green Productivity strategic arm of APO, aiming for sustainable development.

The objective of this paper is to highlight the facilitating factors and barriers experienced by one of these companies in the hope of providing some insights that may be used by other companies that wish to adopt MFCA. The study is pertinent for several important reasons. Firstly, the study promotes the application of MFCA to SMEs in Malaysia because the case company sets an example to other SMEs that MFCA can be embarked on with relative ease, and indicates perhaps an inexpensive cost of implementation. Secondly, it enhances MFCA literature by contributing to the discussion on implementation issues. Thirdly, the study highlights that SMEs can

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also play a role in achieving better environmental quality, despite their smaller size and lower capital base.

The remainder of this paper is organised as follows. Section 2 discusses the relevant literature on implementation issues specific to MFCA and, on a broader scope, of environmental management accounting (EMA) implementation. Section 3 explains the theoretical framework applied, which is Rogers (2003) diffusion of innovations (DOI) theory. Section 4 describes the research methodology, an explanatory case study on Alpha, a Malaysian automotive parts company, and section 5 highlights the findings. Section 6 discusses future prospects and challenges for MFCA in Malaysian SMEs, drawing from the enablers and barriers in the findings and theoretical literature, and finally section 7 concludes.

## 2. Material Flow Cost Accounting (MFCA)

Kokubu and Tachikawa (2013) contend that “MFCA is one of the major tools of environmental management accounting” (p.352). Burritt et al. (2002), Herzig et al. (2012), METI (2002), and Schaltegger and Burritt (2000) also support this contention. MFCA is a tool that physically traces material flows into the process through to the final output of its positive and negative products (Jasch, 2009; Kokubu et al., 2009). MFCA involves detailed quantification of material and energy mass and the costs attached to them. MFCA can be flexibly applied according to the company's own capabilities by determining the boundary (ISO, 2011). The boundary of MFCA can be a single process, multiple processes, a single product, multiple products, the entire plant, the whole company and even to the extent of the supply chain (ISO, 2011).

The resulting transparency and significant portion of material losses made visible by MFCA allows the firm to identify any process or material inefficiency problems. Subsequently, organisations need to work on possible improvements or Kaizen solutions. Only when the problems are resolved will the organisations achieve waste reduction, productivity improvement and cost savings (Kokubu et al., 2009).

Given its main objective of supporting organisations to improve their environmental and economic performances concurrently, MFCA has the potential to attract the business community, particularly those members for whom profit seeking is their primary corporate objective. Generally, this section of the business community tends to assume, consistent with the traditionalist view (Wagner et al., 2001), that any effort expended towards environmental sustainability will affect profit negatively. However, a tool that would help them achieve their economic goals, while at the same time attain environmental sustainability without further additional resources, would be something worth considering. This is because companies with good environmental practices mostly have a better corporate image compared to those without good environmental practice. Consequently, companies with MFCA can possibly improve their environmental corporate image, even though it was not their initial intention to do so.

Technically, MFCA can be regarded as an efficiency tool, targeting the optimisation of material use. MFCA has been used in both manufacturing and non-manufacturing sectors by several Japanese and European companies (Jasch, 2009; METI, 2011) However, implementation issues will always be of concern when an innovation or new tool is introduced into the organisation. Depending on the organisation's context, various types of factors can either alleviate the problematic issues or aggravate them. Additionally, a particular factor can either facilitate the implementation or hinder it, again, depending upon the context. The following sub-sections discuss the implementation issues with MFCA, highlighting enablers that can be leveraged on and barriers to overcome, arising from the literature.

### 2.1. MFCA enablers

The literature outlines the following enablers or facilitating factors for MFCA implementation: firstly, the technical advantages of MFCA (Jasch, 2009; Kokubu and Kitada, 2010); secondly, data availability (Strobel and Redmann, 2002); thirdly, top management commitment (Lee et al., 2005); and, finally, compatibility with existing management systems (Nakajima, 2008).

The specific technical advantage of MFCA as an accounting tool is the main enabler. MFCA recognises waste as a non-product output or negative product which has its own costs (Jasch, 2009). Accordingly, more accurate waste cost information is obtainable through MFCA as compared to conventional cost accounting, which places waste costs into general overhead (Fakoya and van der Poll, 2013; Jasch, 2009). These two features allow a more transparent reporting of costs and wastages of production to top management (Fakoya and van der Poll, 2013), influencing them to perform activities to reduce the waste (Jasch, 2009). Since reduced waste both improves environmental quality and achieves cost savings, MFCA demonstrably provides economic and environmental benefits concurrently (Hyrsova et al., 2011; Kokubu and Kitada, 2010; METI, 2011). Hyrsova et al. (2011) noted that their case company achieved environmental benefits even though these were not its initial intention. Economic rationality is typically the dominant motivation to initially adopt an EMA tool for a company (Herzig et al., 2012), but the outcomes achieved are not limited to only economic advantages. Companies may initially target cost savings, but by employing MFCA they are able to facilitate environmental benefits as well as reducing costs.

The second enabler is the availability of data. Jasch (2009), Nakajima (2008) and Strobel and Redmann (2002) found that the companies in their studies had data required for material flow analysis readily available in their records. For such companies, this availability of data may obviate the need for major data collection tasks, hence enabling MFCA to be implemented more easily.

The third enabler, top management commitment, is another critical enabler. Lee et al. (2005), in their study on EMA, emphasised that senior management involvement and commitment to EMA is important in various decision-making and empowerment situations. Apart from the possible monetary investments necessary for EMA projects, there is also the need for effective participation from multiple departments. Without the directives, interest and support from higher management, other departments may not be able to see clearly how important EMA is for the organisation. Without top management commitment, EMA projects, and hence MFCA projects, are likely to encounter substantial challenges and obstacles (Lee et al., 2005).

The final enabler, compatibility of MFCA to the existing management systems, facilitates smooth implementation. In his study, Nakajima (2008) found that MFCA supplemented the company's existing system of Total Productive Maintenance (TPM) and Total Quality Management (TQM). This, in fact, allowed the company to implement MFCA more easily.

### 2.2. MFCA barriers

Implementation issues for MFCA also involve barriers. These mainly relate to perception challenges (Kokubu and Kitada, 2010; Nakajima, 2004), team cooperation (Lee et al., 2005), performance appraisal (Burritt, 2004, 2005) and technical knowledge and training (Burritt, 2004, 2005).

The first of the barriers is perception challenges in two aspects. The first aspect is in terms of the perception organisations may have towards the uniqueness of MFCA. In other words, how is MFCA different from other tools already used in the company (Nakajima,

2004) and the “way of seeing things, making decisions and acting” (Jasch, 2009, p. 119). MFCA is clearly different from conventional cost accounting and other tools, but there is a tendency for business enterprises to misunderstand and become confused with its concept and practical functionality (Nakajima, 2004). The second aspect of the perception challenge is the view that the primary corporate objective is profit-seeking (Kokubu and Kitada, 2010). This is typically because the economic objectives of companies are perceived to be in conflict with environmental objectives (Kokubu and Kitada, 2010). This is the traditionalist viewpoint (Wagner et al., 2001). Specifically, the traditionalist viewpoint assumes that improvement in environmental performance will lead to a reduction in financial performance. By contrast, the revisionist viewpoint argues that environmental performance and financial performance are positively related, a view that aligns with MFCA. As a consequence of these perceptual challenges, companies may be unmotivated to embark on MFCA. The companies' scepticism towards the outcomes from MFCA may, for example, lead company managers to choose opportunities for new sales over a reduction of losses via MFCA with the same value. Given this decision, they will redirect resources to the acquisition of new sales opportunities and MFCA implementation will become hindered. Hence the full potential of MFCA achieving both economic and environmental objectives is not maximised (Kokubu and Kitada, 2010).

The second barrier is lack of team cooperation. This refers to the cooperation needed across multiple departments as well as cooperation within the MFCA team itself, and as a number of studies on EMA implementation have shown, lack of this cooperation has resulted in less effective implementation. Typically, environmental costs are available in the environment department, material and other production costs in the production department, design costs in the engineering department, and professional knowledge on accounting practices in the accounts department. Without the cooperation of these various departments, it may be difficult to effectively measure and allocate environmental costs (Lee et al., 2005). For instance, the Korean companies in Lee et al. (2005) study faced challenges in encouraging the accounting departments to be actively involved in the EMA project, while in relation to team cooperation, Argentina's experience of an obstacle was changes in the working team (Scavone, 2005).

The third barrier revolves around performance appraisal. Performance appraisal of both the individual and departments involved in EMA generally excluded environmental impacts (Burritt, 2004, 2005). It was also too narrow and too short-term focused, which resulted in the manipulation of material cost data (Burritt, 2004, 2005). Additionally, performance appraisals which did not include environmental impacts were not able to produce behaviour, particularly that related to environmental issues, desired by top management (Burritt, 2004, 2005). Kokubu and Kitada (2010) highlighted the controllability issue. In their study, it was found that the expansion of the production manager's span of accountability towards losses beyond conventional losses constituted a barrier because a conflict between departments occurred. It was argued by the production manager that the extended losses arising from MFCA were not completely under his exclusive control and therefore he should not be made fully responsible for them. He argued that the loss involved others, such as those in process or product design units. Since MFCA involves employees from multiple units such as environmental management, production, engineering and costing, clear lines of responsibility and authority must be made (Jasch, 2009). Without these clear lines, MFCA implementation is made less effective.

The final barrier to be discussed here is the lack of technical knowledge and training. Challenges which have risen include the inaccurate identification of environmental costs (Burritt, 2004,

2005). This is primarily due to different definitions and scope of environmental costs and also a perception that environmental costs are not important, being, for example, grouped together under general business overheads (Burritt, 2004, 2005). Furthermore, there has been a narrow focus on manufacturing operations for the application of EMA (Burritt, 2004, 2005). This mistaken view of EMA's applicability limits the coverage of environmental costs when, in fact, EMA can also exist in non-manufacturing operations such as support departments and the supply chain (Jasch, 2009; METI, 2011). In a study specifically on MFCA, Hyrslova et al. (2011) discovered a technical knowledge barrier to implementation in the identification of material flows. Their case company encountered difficulties in identifying material flows for quantity centres (QNCs), receiving inputs that were pre-processed from other centres. This had led to the loss of important data, time-consuming collection of relevant data and loss in money spent.

The theoretical framework is discussed next.

### 3. Diffusion of innovations (DOI) theory and MFCA

#### 3.1. MFCA as an innovation for SMEs in Malaysia

Rikhardsson et al. (2005, p.2) regard EMA as a managerial technology, which “combines knowledge, methodology and practice and applies these to linking environmental management and economic results.” They also regard EMA as an innovation, arguing that innovation does not necessarily relate to something technical, such as a new product or production technology, but can also refer to new ideas, methodologies and concepts. This is indeed in line with the prominent innovation theorist, Everett M. Rogers, who has defined innovation as “an idea, practice, or object perceived as new by an individual or other unit of adoption” (Rogers, 2003, p.36). Bringing this into the context of MFCA in SMEs in Malaysia, and given that MFCA is an EMA tool, one can thus regard MFCA as an innovative managerial technology. The diffusion of innovation theory as the theoretical framework for this study is discussed next.

#### 3.2. DOI as a theoretical framework for MFCA implementation enablers and barriers

Given that MFCA is a managerial innovation, the diffusion of innovations (DOI) theory offers a potential explanation of influencing factors that can serve as either facilitators of or barriers to MFCA implementation in organisations. A theory helps clarify the details and provide a basis for developing the questions and explanation during the analysis (Scapens, 2008), and the DOI model by Rogers (2003) theorises the relationship between five groups of variables and the rate at which an innovation is adopted. These groups of variables will influence the speed with which the innovation is adopted into the organisation. While Rogers (2003) classified 5 categories of adopters (i.e. innovators, early adopters, early majority, late majority and laggards), our focus is primarily on the groups of variables affecting the rate of adoption (as these can either help or hinder the organisation to implement MFCA). Specifically, these groups of variables are (1) perceived attributes of innovation, (2) type of innovation-decision, (3) communication channels, (4) nature of the social system, and (5) the extent of the change agent's promotional efforts. The overall model for Rogers' DOI theory is depicted in Fig. 1 and a brief description of the variables follows.

The first group of variables is the perceived attributes of the innovation. In our context, it refers to the features of MFCA itself. Under this group, there are five sub-variables. The first one is relative advantage. Relating it to MFCA, it refers to the extent to which MFCA is perceived to be better than the tools readily

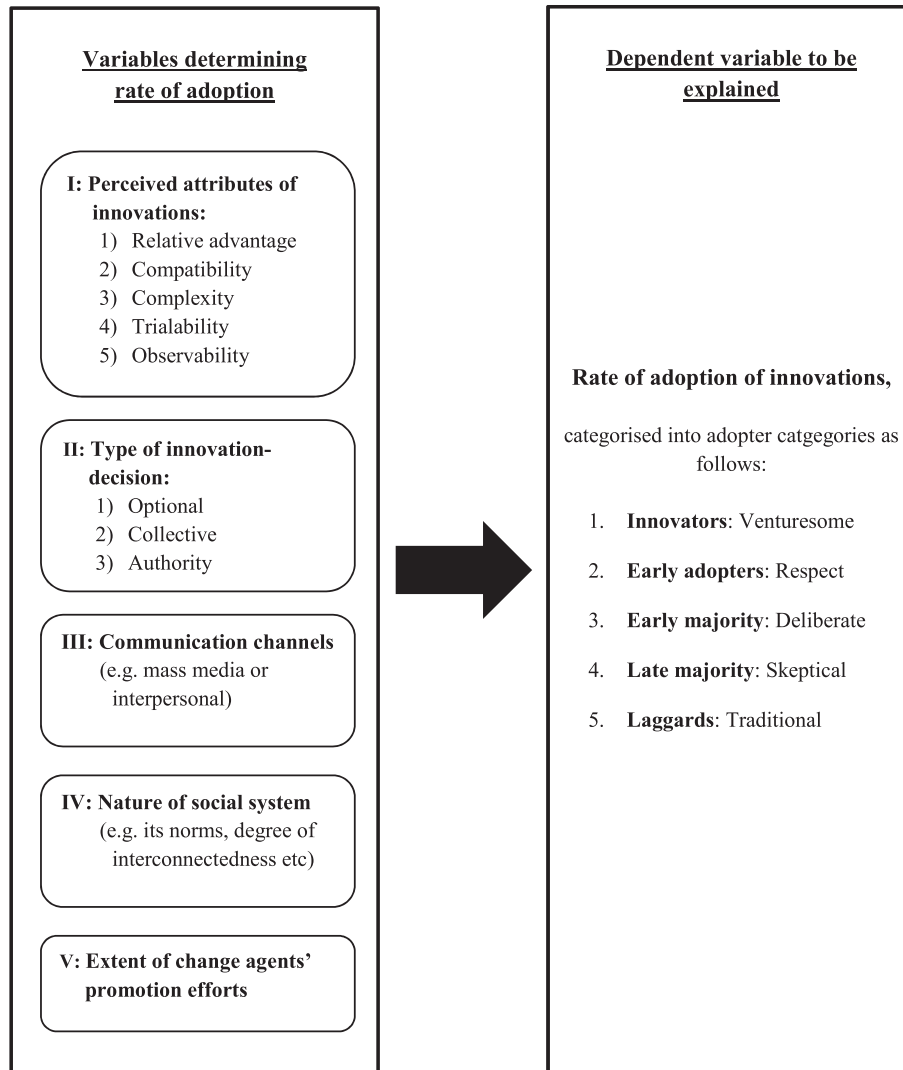


Fig. 1. Diffusion of innovations (DOI) model (Rogers, 2003).

available (Rogers, 2003). The better MFCA is perceived to be, the faster it will be implemented. This is mainly related to the technical advantages of MFCA itself. For example, if companies perceive that the concept of 'negative' product for waste under MFCA makes MFCA better than other tools or conventional cost accounting, then MFCA is expected to be implemented at a faster rate. Similarly if companies perceive that MFCA can actually achieve both economic and environmental objectives simultaneously, where other tools may not, then MFCA implementation is expected to be faster.

The second innovation attribute is compatibility, which is the degree to which MFCA is perceived "consistent with the existing values, past experiences and needs of potential adopters" (Rogers, 2003, p.240); the higher the perceived compatibility, the greater chance of faster adoption. In addition to the existing values, past experience or needs of the company, compatibility can also be evaluated in terms of how MFCA is consistent or can complement the information systems or managerial tools already existing in the company.

The third innovation attribute is complexity. Complexity refers to the extent to which MFCA is perceived to be "relatively difficult to understand and use" (Rogers, 2003, p.257). If MFCA is perceived to be complex, then it is expected this will hinder the implementation process.

The fourth innovation attribute is trialability, which is the extent to which MFCA "can be experimented with on a limited basis" (Rogers, 2003, p.258). This refers to whether MFCA firstly can be tested, and secondly whether it can be tested in parts as opposed to whole. This is important for organisations because they will want to evaluate MFCA's feasibility before adopting it. Therefore, a lesser level of trialability is expected to slow down MFCA's implementation process.

The final innovation attribute is observability. This is the degree to which the results of MFCA "is visible to others" (Rogers, 2003, p.258). This refers to whether MFCA results are easily observed and communicated to others. The more difficult it is to show and describe the results to others, the more difficult it is to convince them of MFCA's benefits. Consequently, the implementation process will also be hindered.

The second group of variables is communication channels. This refers to the means by which the message regarding MFCA is transmitted from one individual to another (Rogers, 2003). The nature of the exchange of the information is also important; in other words, how the information is exchanged among the individuals. There can be mass media channels as well as interpersonal channels. There is also the issue of heterophily and homophily, which refers to the degree of which two or more

individuals in the process of interaction are similar in certain personal attributes such as belief, education, socioeconomic status and others (Rogers, 2003). Homophily is where the individuals have similar attributes, whereas heterophily is where they are different. Typically, homophilous communication is more likely than heterophilous communication to be effective for implementation processes due to the shared interests or 'language' in a homophilous interaction.

The third variable group is the nature of social system. It refers to a set of interrelated units which are bound together by a common goal and are engaged in solving problems jointly (Rogers, 2003). The social system members "can either be individuals, informal groups, organisations and/or subsystems" (Rogers, 2003, p.23). If MFCA fits into the existing social system, or the social system is able to adapt to MFCA requirements easily, the implementation process will also be easier.

The fourth group of variables relates to the extent of the change agent's promotion efforts in the process of implementing MFCA within the organisation. The relationship between change agent efforts and the rate of adoption, however, "may not be direct and linear" (Rogers, 2003, p.223). Change agents are normally those external to the organisation, introducing the innovation to the organisation. For them to be able to promote the innovation's adoption by the company, they would need to buy-in the opinion leaders first.

The final group of variables which has influence on the rate of innovation adoption is the type of innovation-decision made: whether it was optional, collective or authority. An optional innovation-decision is made by the individual independent of decisions by other members in the social system (Rogers, 2003, p.403). For organisations, collective or authority innovation-decisions are more common (Rogers, 2003). Collective decisions are where the decision to adopt or reject an innovation is made by consensus, whereas an authority one is made by a few individuals in the system who have relatively stronger power, higher social status or better technical expertise (Rogers, 2003, p.403). Rogers (2003) did not hypothesise on which type of innovation-decision would increase the rate of adoption, because the suitability of the type of decision is very much dependent on the context of the organisation and its members.

Askarany (2003) and Wejnert (2002) reclassified this group of variables into three main categories: characteristics of innovations, characteristics of innovators and the social system or environmental context. This alternative to better understand the influencing factors for implementation processes is also acceptable.

For the purpose of this paper, the original model from Rogers (2003) will be drawn upon and the focus will be on investigating in-depth the factors influencing the implementation of MFCA (i.e. "variables determining rate of adoption" as used in Rogers (2003)). As mentioned earlier, this theoretical framework will help explain the enablers and barriers encountered by a Malaysian SME in its implementation of MFCA.

#### 4. Methodology

The use of a case study methodology for this research is deemed most suitable as it helps describe the enablers and barriers of MFCA implementation in a Malaysian SME context. More importantly, given that case studies are distinctly advantageous in answering the 'how' and 'why' questions for research, and as the researcher has no control over the phenomenon and its context (Yin, 2009), this methodology best fits the objectives of this study. Specifically, this study was conducted using an explanatory case study as per classification by Scapens (2008). Given MFCA is an accounting tool, an explanatory case study, as opposed to an exploratory case study,

is more suited to explain the specifics of the MFCA practices in great depth (Scapens, 2008). Under this type of case study, the focus is on the specific details of the case, and theory is used to understand and explain those specifics (Scapens, 2008). In this case, DOI theory used as the theoretical framework for this study, described in Section 3, is used to inform the study, and not to produce generalisations to a population (Scapens, 2008; Yin, 2009).

The case company, Alpha, was selected out of the five companies involved in the MPC MFCA project. Alpha manufactures metal parts for the automotive industry. It was chosen, firstly, because the automotive industry is reported to be among the top five contributors to scheduled waste in Malaysia (DOE, 2010). Secondly, Alpha is perceived to be the best MFCA practising company among the five based on the cost savings Alpha achieved in the presentation by MPC during the MFCA seminar in March 2012. Thirdly, Alpha was chosen because the researchers had a prior introduction to the case company during an earlier technical visit that the researchers had the opportunity to attend. Hence the researchers gained an initial social acceptance into the company.

Prior to data collection, permission was obtained and granted from MPC and Alpha to conduct the research. The sources of data were interviews with the MFCA team members of Alpha, and MPC's main liaison officer for the project, and documents related to the MFCA implementation. Six interviews were conducted between April 2012 and May 2012, and were held at the interviewees' premises. The related documents reviewed included the ISO 14051, the costing sheets for MFCA activities, presentation slides, MFCA guide books and documents relating to the background of this project. Informal discussions and observations also took place during meetings, site visits, company presentations, an MFCA seminar and a training workshop organised by MPC.

Interview scripts and informed consent letters were developed to help guide the conduct of the interview. The questions from the interview script were used as a guide and further prompting and probing were done during the interview session itself to obtain the in-depth understanding required. Interview sessions were recorded using an audio-recorder. However, written notes were also taken during the interviews to note down the explanations on the whiteboard as well as to serve as backup in case of low quality recording. Written notes were also used for informal communication and observations. Since the interviews were conducted predominantly in the Malay language, the interview data were firstly transcribed verbatim in Malay using Poland (1999) transcription symbols and then translated within context into English.

Using DOI as the theoretical framework, initial coding and thematic schemes were developed for the purpose of analysis. The interview and document data were then analysed using thematic-networks (Attride-Stirling, 2001), against this initial coding and thematic schemes. Subsequently, any emerging issues arising from the data were added into the schemes to be further analysed. Finally, after a comparison and pattern analysis, the findings were summarised and discussed with reference to the existing literature.

#### 5. Alpha, a Malaysian automotive parts company and MFCA

##### 5.1. Background of Alpha, the case company

Alpha, the case company, is an SME established in March 1988. Its main business is manufacturing automotive metal stamping parts. Alpha serves two major customers in automotive assembly, Epsilon and Gamma. Alpha's MFCA team members included those from the production, engineering, purchasing and costing departments. Alpha was mainly interested in MFCA because the company produces an annual scrap volume of 1.8 tonnes, which is equivalent to RM7.2 million. It was keen to transform this scrap into

cost savings and could see that MFCA has great potential to assist it to do so. The following sub-sections highlight the enablers and barriers specifically encountered by Alpha.

### 5.2. Enablers for Alpha's MFCA implementation

In relation to the group on innovation attributes, MFCA was firstly found to have a relative advantage over the existing tools used by Alpha. By implementing MFCA, Alpha could visualise clearly where their hidden profits were, and so they could strongly justify relevant improvement initiatives. As commented by a costing executive:

[...with] this MFCA, so the scrap is smaller [...] Before (the implementation of MFCA), the scrap was larger [...] that is, what people say had slow (ed) down the job [...]

Furthermore, material flow analysis under MFCA was able to provide relevant information to fulfil the role of management accounting to direct management's attention to important issues. When the equivalent costs of material losses were calculated, it immediately attracted the management's attention. Prior to this it would have been hidden within overheads.

Secondly, MFCA was seen to be consistent with the existing business environment of Alpha. MFCA was compatible with Alpha's use of tools such as total quality management (TQM), lean production system (LPS) and Budomari. Alpha's certification of ISO 14000 Environmental Management System (EMS) also helped. The compatibility experienced helped Alpha's organisation members to adopt MFCA more readily. The Head of Operations had this to say:

[...] We set up another team [...] We still proceed with MFCA. We will do it on our own [...] They (Budomari team) may target for one part, whereas we have another hundred.

Thirdly, MFCA's level of complexity is also reasonable, so much so that employees from various units in the company were able to understand the concepts in MFCA comparatively easily. MFCA was designed in such a way that non-accountants need not be apprehensive about MFCA's 'cost accounting' terminology. This is apparent because there was not a full-fledged accountant in the MFCA team, and they were still able to implement MFCA and achieve their cost savings and scrap reduction. The team member with competency closest to accounting was their costing executive, who provided input regarding the costs of items analysed. An assistant purchasing manager commented that:

[...] Sometimes we think that we cannot do that thing (MFCA). But actually when we think about it, when we brainstorm in the team, it will work out [...]

An engineering executive expressed a similar sentiment:

[...] we become more experienced. We now know better, you know. More efficient, quick to learn things [...] We get to feel [...] I have done something, and then others approve it. And then it gets to enter production [...] I feel, "Even though I am new here, I can also do it" I feel like, great!

Trialability is the fourth sub-variable for the innovation attributes. To recall, trialability influences the rate an innovation is adopted positively if the innovation is able to tested, and to be tested in smaller, separate portions before a full-scale adoption. Alpha was able to experiment with MFCA, beginning by applying it to the relatively simple process of small press stamping, and then

moving on to medium press stamping. The Head of Operations commented.

[...] We will have three trial sizes. Since we do not have a concrete system, we have to conduct using trial and error. Ok, so we take the best out of the three [...]

The point to highlight under this variable, is not so much that the trial runs were successful, but more so that Alpha was able to conduct trial runs at all. The trialability feature of an innovation is important for a company because they would want to evaluate whether the innovation will fit their context of operations or not. The easier they can perform a trial run and obtain the trial results, the faster they can make a decision whether to adopt the innovation or not. Some innovations may not be breakable into smaller portions for trial runs, thus may delay companies in making final decisions about the innovation. The boundary element under MFCA may have been a contributing factor to this positive trialability. This is because companies can determine their own boundary of where MFCA wants to be implemented. It can be for a single product, a single process, multiple process, or even the whole plant or supply chain, depending on their capabilities and resources (ISO, 2011).

Observability is the fifth variable under the innovation attributes group, and Alpha achieved this, with the results on their MFCA implementation being clearly visible to others. The company achieved this in their presentation during Creanova 2012 in March. This seminar involved the five companies presenting their final outcomes and summaries of their MFCA experiences to other business entities and interested parties. Based on my observation during the question and answers session, and the conversations held between seminar participants and the company representatives during the networking session afterwards, many participants seemed to be interested in MFCA after listening to these presentations.

The second group of variables is communication channels, and the effectiveness of these, was important for the implementation of MFCA in Alpha. Their effective communication included constant meetings for improvement efforts and ensuring all team members were in agreement about the details of each MFCA Kaizen activity. Despite differences in terms of years of working experience and age, cooperation amongst the members was evident. An engineering executive talks about teamwork spirit:

What helps us is the teamwork, the cooperation from all involved.

The third group relates to the nature of the social system in the company. For Alpha, this was top management commitment and the team composition for MFCA. The top management were made aware of the MFCA projects and provided approval and support for these. This was most critical, as the ISO 14051 suggests. Meanwhile, the team members represented multiple relevant units and were of various levels of authority so that decision making could be done more easily. This is because the implementation of MFCA and the Kaizen activity will involve the whole operations division, and there are various units in charge of different elements of the production. For example, the engineering unit are experts on the design of the machinery, the production unit are better informed about the materials, manpower and time needed for each production, the purchasing unit deals with the suppliers regarding availability of material and its specifications and the costing unit would have better knowledge on the costs involved for the production process. The various levels of authority facilitated a smoother implementation because decisions could be made with fewer bureaucratic procedures. Alpha's MFCA team was comprised of the plant manager, operations head of division, assistant

manager of the purchasing department, and executives from engineering, stamping production and costing, and it had a dedicated team leader. As highlighted by the team leader during the MPC MFCA project.

Before this, I was a team leader for MFCA but I was also in charge of Safety. So the progress had been rather slow. It was two months for one part. Now, there is a dedicated person [...] it is two weeks for one part.

The fourth group relates to the extent of the change agent's promotional efforts. The changes in Alpha were also due to the influence of external parties. Among the parties were APO, JPC-SED, MPC, a Japanese technical expert, and local consultants. Each change agent played active roles in promoting the implementation of MFCA in Alpha. MPC was the overall organiser within the Malaysian context and was involved in the briefing to Alpha before it agreed to the actual roll-out of the project. The MPC liaison officer explained.

[...] In the beginning stage before the companies agreed to join the project, the MPC team visited each company to deliver a briefing (about the project and MFCA).

Because the project involved the technical expert from Japan and local consultants, MPC played the role of secretariat to organise technical site visits. There was a total of seven technical visits. The first two visits were primarily for fact finding, where each visit lasted about half a day and the third and following visits, which were referred to as the intervention phase, lasted for a whole day each. These visits entailed the Japanese expert guiding Alpha team members to perform MFCA and, potential Kaizen activities and offering possible solutions to problems encountered. The MPC liaison officer stated.

[...] The third visit was a longer, because the expert discovered that he needed more time for each of the companies during this intervention phase [...] intervention referring to direct contact with the company [...]

During these technical visits, the Japanese expert and Alpha team members were the focal point. Nevertheless, the MPC officers, the local academic consultants and local consultants from industry also actively participated by giving suggestions based on their extensive experience in their own field and the Malaysian context, in order to further facilitate the implementation process for Alpha.

Finally, the fifth group concerns the type of innovation-decision. Top management of Alpha decided to embark on MFCA, an authority innovation-decision. However, they strongly encouraged input and proposals from the MFCA team, and evaluated these in their management meetings in the presence of MFCA team representatives (i.e. the Plant Manager and the Head of Operations).

In relation to decision-making, the motivation to adopt can also be an influencing factor for a longer term implementation. Alpha's motivation to adopt MFCA was primarily financially driven, an economic rationality. The Head of Operations commented on the financial pressure Alpha experienced from their main client:

The issue with Epsilon is this. They have the idea, but they will leave it to the vendor to perform it by the end of the year. Then next year they will cut their sales (i.e. reduce their purchase value) from the vendor by 3% [...] "Whatever way you do it, I will cut your sales by 3%" (quoting a representative of Epsilon).

The additional attraction that MFCA has is its concurrent achievement of environmental and economic objectives. Although it is the economic advantage of MFCA that motivates the decision to implement it, its implementation inevitably delivers environmental advantage. In the Malaysian context, where financially driven motivations are common, having in place a tool which can help a company achieve both economic and environmental objectives together is an opportunity not to be missed.

### 5.3. Barriers for Alpha's MFCA implementation

Alpha's implementation of MFCA also encountered its own set of barriers. This is primarily related to the performance management system (PMS), which involves the issues of rewards, key performance indicators (KPI), performance evaluation and bonus distribution. Currently Alpha's PMS is only a potential barrier. The current PMS does not include measures for MFCA activities in terms of rewards, KPI targets or bonus distribution. PMS is an important issue to address if management wants to maintain the employees' motivation for excellent performance. Three out of the five team members interviewed highlighted the importance of this issue. Clearly, firms wanting to implement MFCA should pay particular attention to such issues, as these may become actual barriers to MFCA implementation. An executive in the Stamping Section had this to say:

If there is cost reduction involving material usage, there must be some rewards [...] for instance pay rise or bonus. However, this is not happening now. In my opinion, there must be a reward system because the cost reduction is high [...] yet there are no returns for the employees. The task is not easy. It involves thinking. Just saying thank you is not enough. It does not work because sometimes people may not be motivated to continue doing it.

Another critical barrier concerns vendor constraints. Before the new production run, Alpha needs to get their vendors to agree to supply the new pre-cut material size. An agreement between Alpha and the vendors must be achieved because this affects their "mother" coil supply, distribution and prior order stocks. Sometimes the delay in procuring the new pre-cut material can take as long as 3 months, while the material flow analysis, Kaizen activity and trial runs were already completed within 2 weeks. This barrier was taken into account during Alpha's new production planning because the vendors themselves also have their own constraints and these were beyond Alpha's control.

When we change to a new material size, it will affect their "mother" coil. This is the reason they cannot give us the new material immediately. They will perform their own analysis, and if they were to bring in a new coil, it will actually take them about 2–3 months (Assistant Manager, Purchasing Department).

These two barriers can be considered as part of the social system. Barriers from the other groups of variables were not apparent. The following section will provide a discussion of future prospects and challenges for MFCA in other SMEs in Malaysia or even for future MFCA projects within Alpha.

## 6. Discussion

Having been enlightened by the findings from Alpha, the future for MFCA implementation in Malaysian SMEs appears promising.

One most promising prospect is MFCA's ability to help organisations achieve both economic and environmental goals, simultaneously. As [Wooi and Zailani \(2010\)](#) pointed out, SMEs in Malaysia primarily prioritised cost reduction programs over environmental initiatives. Indeed there was no awareness of MFCA at that time. Therefore there is likely to be more interest in MFCA if these companies are convinced that MFCA can help them achieve both economic and environmental goals at the same time.

A future prospect also holds if top management is fully committed to the MFCA projects ([ISO, 2011](#); [Lee et al., 2005](#)), and this involves being made aware of MFCA and seeing hard evidence. As this is the case, the MFCA team will need to prepare preliminary examples of the material flow analysis, highlighting the high percentages of material loss and the impact of ignoring these costs to the company's financial performance. Additionally, thanks to the MPC MFCA project, other companies will also be able to showcase the results achieved by Alpha as well as the other four companies in the project. Top management commitment may be regarded as a social system variable under DOI.

Lack of team cooperation was found to be a barrier from existing studies ([Lee et al., 2005](#); [Scavone, 2005](#)). However, as findings from Alpha show, team cooperation, composition, and communication can also be an enabler that other companies can leverage on for future MFCA implementation. Team cooperation falls under the social system as well as under communication channels. As evidenced in Alpha, a multiple unit and multiple level composition of MFCA team members facilitates smooth implementation. This is in line with recommendations from [Jasch \(2009\)](#) and [Nakajima \(2008\)](#). Good team co-operation across departments ([Lee et al., 2005](#)) and within the team itself ([Scavone, 2005](#)) is necessary for MFCA projects to succeed. Malaysian SMEs have the opportunity to leverage on these enablers because SMEs typically have fewer employees, making team projects easier to manage.

As well as these positive prospects, there are potential challenges that future Malaysian SMEs intending to embark on MFCA will need to consider. The first challenge relates to perception. Although Alpha did not outwardly encounter this as a barrier, there is potential that other companies may. One aspect of this is the perception towards environmental initiatives. As noted by [Wooi and Zailani \(2010\)](#) earlier, SMEs in Malaysia mostly prioritise cost reduction efforts as opposed to environmental ones. Arising from the view that the primary corporate objective is profit-seeking ([Kokubu and Kitada, 2010](#)), these SMEs may also be considered traditionalist view holders ([Wagner et al., 2001](#)). Their perception is that the two objectives, economic and environmental, are mutually exclusive, whereas via MFCA, both can be achieved simultaneously. Another aspect of the perception challenge is the uniqueness of MFCA itself. It may be perceived that MFCA is no different from traditional cost accounting and other tools such as activity-based costing (ABC), TQM, lean production system (LPS) and others ([Nakajima, 2004](#)). Recommendations to overcome a perception challenge include additional training and knowledge-sharing sessions ([Kovanicova, 2011](#); [Lee et al., 2005](#)). MPC already conducts training on MFCA as a continuous effort to promote MFCA to other companies. In addition, the local consultants from the MPC MFCA project have been in co-operation with the Malaysian Institute of Accountants (MIA) for training programs for MFCA or for publications in MIA resources.

The second challenge for MFCA implementation is with regards to performance appraisal issues. As highlighted by Alpha's experience and the literature, issues relating to the performance management system need to be handled with due care for MFCA implementation. Without proper planning and open discussion ([Burritt, 2004, 2005](#)), the intended outcome from MFCA may not be achieved. Issues such as scope of responsibility and authority,

extent of controllability, KPI measures, individual and departmental performance targets ([Jasch, 2009](#); [Kokubu and Kitada, 2010](#)) are among others that need to be addressed.

Thirdly, a challenge emerging from Alpha's experience is vendor constraint, a unique challenge compared to case findings from other studies. This is an important barrier that must be considered by future implementers of MFCA. This issue can relate to stakeholder power ([Mitchell et al., 1997](#)) and also the strength of the company within its supply chain. For Alpha, it had to adjust its new production run according to the vendor's supply availability, indicative of the relatively low bargaining power of Alpha. As a consequence of this, cost savings and waste reduction that could have been realised earlier were somewhat delayed. This issue, as suggested by [Mitchell et al. \(1997\)](#), may be addressed by identifying and analysing the company's stakeholders' power over their operations and decisions. Under DOI, this barrier encountered by Alpha can be classified under the nature of the social system.

The fourth challenge relates to MFCA attributes, particularly complexity and compatibility. The findings show that these two factors were enablers for Alpha. However, these may be potential barriers for other companies. For example, complexity issues can include issues regarding data collection ([Papaspypopoulos et al., 2012](#); [Scavone, 2005](#)), whereas compatibility issues can include system issues ([Fakoya and van der Poll, 2013](#)). Not all SMEs in Malaysia may have available physical (i.e. not monetary) records or existing information systems, as [Nakajima \(2008\)](#) and [Strobel and Redmann \(2002\)](#) have noted from companies in their studies. Malaysian SMEs may encounter problems such as those experienced by companies in Argentina ([Scavone, 2005](#)). For Argentinian companies, collection issues such as incomplete and scattered data on economic value of environmental impacts, lack of cost data on environmental activities and limited data collection capabilities raised problems for their implementation of EMA ([Scavone, 2005](#)). [Fakoya and van der Poll \(2013\)](#) in their study of MFCA implementation in South Africa found that the non-integration of MFCA into the company's existing enterprise resource planning (ERP) system prevented the company from enjoying the potential benefits from MFCA's waste information since waste-reduction decisions could not be made. Unfortunately the reasons for the non-integration were not studied. An educated guess may identify compatibility issues as a reason. To address these challenges, it was suggested by one local consultant from the MPC MFCA project that companies intending to embark on MFCA should begin with data that are typically available, such as raw material invoices, inventory stock-take, delivery orders, sales invoices, salary records, and electricity bills. Thereafter, companies can gradually improve their data collection and systems for better data accuracy in future. Similarly, initiating MFCA in simpler processes with relatively easier improvements is recommended ([Hyrslava et al., 2011](#); [METI, 2011](#)) because the burden of the implementation processes may be slightly reduced. This is encouraged so that companies can gradually acquire knowledge, experience and skills for future MFCA projects.

Finally, there are potential challenges relating to the change agent. Alpha was fortunate to have MPC, a Japanese technical expert and local consultants to assist it for its pilot projects on MFCA, but other SMEs may not be so fortunate. In fact, even Alpha itself may no longer have the privilege of this assistance for its own future and larger scale MFCA projects. This is an issue involving succession. Succession here refers to both the wider spread of MFCA's application to other companies ([Burritt, 2004, 2005](#)) and also the longer term implementation within the same company ([Rikhardsson et al., 2005](#)). The wider spread of MFCA application is important because this can help improve the environmental performance on a larger scale. No specific study on MFCA provided any



indication that lack of succession efforts will lead to ineffective MFCA implementation. However, in a study on EMA implementation that can be applied to MFCA, Mia (2005) highlighted how government ministries and agencies may help improve implementation of EMA. Among the roles that can be played include development of policy packages and guidelines relating to the environment and being more strict in assessing impacts (particularly environmental) before granting any financial assistance (Mia, 2005).

The longer-term application of MFCA in the company itself relates to the motivation for its initial adoption. Drawing from EMA studies, motivation for adoption may typically be either for economic rationality (Herzig et al., 2012) or institutional pressures (Rikhardsson et al., 2005). Applying the arguments of Herzig et al. (2012) and Rikhardsson et al. (2005) in an MFCA context, if the need to meet economic objectives is very strong for the organisation and MFCA can provide such information to achieve these objectives, the implementation of MFCA will run its course smoothly for a longer term. For example, for the cases studies in South-East Asia in Herzig et al. (2012), EMA was advantageous to companies as it was able to provide relevant information for purposes such as increasing material and energy efficiency, strategic investments in new environmental technologies and assets, and supply chain-related eco-efficient measures and improvements. For Alpha, its motivation was financially driven, an economic rationality. However, whether Alpha's adoption of MFCA will be for a longer term, a future study for this is recommended.

On the other hand, if the motivation for adoption is due to institutional pressures, for example from external parties such as regulators, competitors or professional bodies, the impact on MFCA implementation may vary depending on the strength and importance of these institutional pressures on the organisation (Rikhardsson et al., 2005). The argument here is that perhaps the initial stage of implementation may be smooth, but during the process the rate may be slower due to perceived lower institutional pressures, and longer term implementation of MFCA may not be apparent. However, if the perceived pressures are strong, this may facilitate organisations to implement MFCA at a faster rate and for a longer term (Rikhardsson et al., 2005). Bringing the issue into a Malaysian context, a study on Malaysian manufacturers on EMA adoption revealed that the most forceful pressure was normative, resulting from training and accounting body memberships (Jalaludin et al., 2011). However, this study did not investigate the relationship between motivation and the rate of adoption.

SMEs in Malaysia will subsequently need to fend for themselves in their MFCA projects in the future. However, it is fortunate for companies in Malaysia that MPC, being a government agency, will be available to extend help to companies wanting to implement MFCA. The MPC MFCA project involved local consultants, and these experts are able to provide general training as well as customised consultation for Malaysian companies. MPC has also diligently produced training manuals, guidebooks, organised training-for-trainers workshops, as well as engaging the local academics for collaboration in research, internship and education. This augurs well for MFCA in Malaysia.

## 7. Conclusion

SMEs in Malaysia can make a significant impact on environmental sustainability because they represent a major segment of the business community. Hence, encouraging SMEs to embark on environmental initiatives is crucial. However, the traditional view that investment in environmental initiatives will reduce financial performance may hinder these SMEs from doing so, especially since SMEs usually have limited financial resources.

Managerial innovations such as MFCA may help solve this problem. As experienced by Alpha, MFCA has helped to generate significant cost savings and waste reduction. MFCA was smoothly implemented in Alpha due to MFCA's own attributes such as its dual goal advantage, compatibility, lower complexity, trialability and observability. The MFCA team composition, their teamwork spirit and cooperation and assistance from MPC were also important enablers for Alpha's MFCA implementation. However, one key factor that may hinder the smooth implementation of MFCA is vendor constraints. Companies wanting to implement MFCA need to be well aware of this issue. In addition, learning from Alpha's experience, companies wanting to embark on MFCA should also provide a link between the performance measurement system and the MFCA and Kaizen activities so as to reward employees accordingly. Other challenges discussed include issues relating to perceptions, data collection, existing systems, succession and the role of the government. Finally, to be proactive on environmental issues companies must realize that there is a need to put in place a tool such as MFCA so that good environmental management can provide opportunities for reducing costs, enhancing environmental performance and improving the bottom line.

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