Corporate cleaner production strategy development and environmental management accounting: A contingency theory perspective

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Abstract
Despite the popularity of environmental management accounting as an approach to support corporate cleaner production measures, so far, how the environmental management accounting implementation differs according to the stage of cleaner production strategy development is largely unknown. This study thus sought to identify how the uses of environmental management accounting and information characteristics vary among organizations at different stages of cleaner production strategy development. Drawing on the contingency theory view of environmental management accounting system sophistication, cleaner production strategy development stages, and environmental management accounting uses, it developed an analytical framework. Based on eighteen case studies of business in Sri Lanka, the study analyzed the different domain-based and functional uses of environmental management accounting and their characteristics according to their cleaner production strategy development (i.e., reactive, preventive and proactive stages). Overall, the study found that environmental management accounting uses to be limited and fragmented in organizations at the reactive and preventive stages except for using environmental management accounting for cost savings and efficiency improvements. However, the findings suggest that as and when organizations progress into higher levels of cleaner production strategy development, there is a relatively high level of use of environmental management accounting in terms of integrative tools, and for control and stewardship purposes.

Keywords: Cleaner production, contingency theory, corporate sustainability, environmental management accounting, Sri Lanka

1. Introduction

In order to support corporate decision making for cleaner production[1] measures, organizations have sought the support of various new approaches and tools. One method that has received increasing academic and practical attention is environmental management accounting (EMA) (Burritt et al., 2009, 2019; Gunarathne and Lee, 2019a; Schaltegger et al., 2008). As the interface between management accounting and corporate environmental strategies, including cleaner production, EMA plays a crucial informational role in corporate sustainable development (Burritt and Schaltegger, 2010; Gunarathne and Lee, 2015; Ferdous et al., 2019).

[1] By following the recent developments in the field, this study adopts a broader definition for the scope of cleaner production. Accordingly, in the context of this study, cleaner production is postulated as a business strategy contributing to sustainable development with measures for overall resource efficiency, reduced costs and risk to humans and environment, increasing business profitability, and enhanced competitiveness (da Silva and Gouveia, 2020; Hens et al., 2018).

In particular, when pursuing cleaner production strategies, EMA, with a set of accounting tools, provides the relevant economic and environmental information for managers to make decisions and evaluate performance (Burritt et al., 2019; Gunarathne and Lee, 2019a; Schaltegger et al., 2012).

With the growth of EMA in practice, various studies have examined the current state of EMA applications in multiple industries and country settings (Lee and Schaltegger, 2018). Among these, the exploration of the factors that decide the current status of EMA is an important aspect of research. Using various theoretical lenses such as the institutional theory (Christ, 2014; Jalaludin et al., 2011; Ferdous et al., 2019; Gunarathne et al., 2021; Windolph et al., 2014), theory of diffusion (Burritt et al., 2019) and contingency theory (Christ, 2014; Christ and Burritt, 2013; Mokhtar et al., 2016; Qian et al., 2018a), these studies have pointed to factors that decide the development or implementation of EMA. Prior studies that have followed a contingency theory perspective show that environmental strategy is a significant contingent factor that determines the implementation of EMA practices within an organization (Christ and Burritt, 2013; Qian et al., 2011; 2018a). As EMA uses are closely associated with environmental management strategy, the stage of cleaner production strategy development can shape how EMA information is used in an organization. However, so far, no study has specifically examined how EMA uses vary according to the level of cleaner production strategy development organizations.

The level of cleaner production strategy development can determine the organizational structures, information collection, use, and decision-making (Buysse and Verbeke, 2003; Gunarathne and Lee, 2019a; Kolk and Mauser, 2002). However, due to the ignorance of cleaner production strategy development, EMA tools have been posited as static tools applied to any organization. This has the danger of reducing the practical value and applicability of EMA tools. This study sought to identify how the uses of EMA and their information characteristics vary among the organizations at different stages of cleaner production strategy development through a multiple case study approach. Informed by the contingency theory, cleaner production strategy development and EMA uses, an analytical framework was developed to address the following research question: *how are the uses and characteristics of EMA information contingent on the development stages of cleaner production strategy*?

Answering the above research question, this study makes several contributions. First, it connects corporate cleaner production strategy development (or broadly environmental management) literature with EMA. This connection is significant as cleaner production or environmental strategy development and EMA have established themselves in their own right but with limited dialogue despite the apparent connection. Second, this study broadens the scope of EMA implementation by empirically exploring their environmental focus areas (or domains) and functional uses. Third, it expands the theoretical understanding of EMA by providing insights into how the development stage of cleaner production strategy influences the development and implementation of EMA systems from a contingency theory perspective. As Tilemma (2005) stresses, there is a need for more insightful research that considers the mechanisms through which contingency factors influence management accounting system sophistication. Hence, it addresses the concerns of Bouma and van der Veen (2002) and Christ and Burritt (2013). They highlight the need for theoretically informed studies that intensely focus on the current state of EMA development. Finally, this study provides insights on cleaner production and EMA from a developing country perspective, Sri Lanka. This is also important as most studies on corporate cleaner production, and EMA are based on developed countries with different socio-economic, environmental, and institutional contexts.

The remainder of the paper is organized as follows. Section Two presents the recent literature on the cleaner production strategy development and EMA, followed by Section Three that provides the study's theoretical framework. Section Four offers the method used, and Section Five covers the results. Section Six provides the discussion and the final section the conclusion.

2. Cleaner production strategies and environmental management accounting

2.1 Cleaner production: a strategy development perspective

There are different taxonomical explanations on how a company progresses in its environmental management measures/strategies[2], including cleaner production. It is usually explained as development/maturity stages (Buysse and Verbeke, 2003; Jabbour and Santos, 2006; Kolk and Mauser, 2002; Gunarathne and Lee, 2019b). The purpose of these taxonomies is to systematize the various aspects of the relationship between companies and the environment, and these models explain how organizations integrate the environmental and cleaner production measures into the management activities of an organization (Jabbour and Santos, 2006). These diverse maturity models range from environmental reactivity, in which companies only meet the regulatory requirements for environmental proactivity, in which companies take voluntary measures to reduce the ecological impacts (González-Benito and González-Benito, 2006). All these development perspectives reflect a higher level of environmental and cleaner production strategy integration over time, encompassing a wide range of organizational activities while investing substantial organizational resources (Kolk and Mauser, 2002; Gunarathne and Lee, 2019b).

The development stage can decide the organizational structures and systems, reporting boundaries, information collection and uses, and decision making (Primc and Cater, 2016; Buysse and Verbeke, 2003; Gunarathne and Lee, 2019b). These development stages all show that the evolution of environmental management and cleaner production measures tends to go through similar patterns in virtually all companies (Kolk and Mauser, 2002; Primc and Cater, 2016). Most of these taxonomical models assume three stages of corporate environmental management and cleaner production strategy development: reactive, preventive and proactive. The salient features of the environmental and cleaner production strategy development model can be summarized as follows (see Fig. 1).

[2] There are different environmental management classification methods with a diversity of labels such as strategies, responses, development/maturity stages or performance (Kolk and Mauser, 2002).

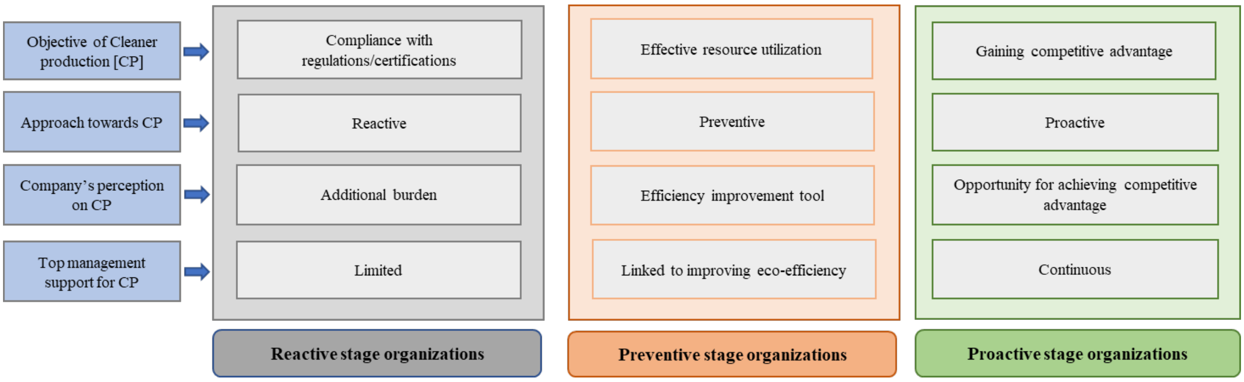

Fig. 1. Salient features of cleaner production strategy development (Jabbour et al., 2010).

2.2 Environmental management accounting

EMA provides a pragmatic solution to the limitations of conventional management accounting systems that have failed to give the organizational decision-makers adequate information on the explicit environmental costs or benefits (Burritt et al., 2002; Burritt, 2004; Christ and Burritt, 2013). While overcoming these limitations, EMA systems also "activate the convergence of diverse environmental performance management systems within organizations, and [to] articulate internal performance management to external reporting" (Ferdous et al., 2019, p. 985).

Although there is no universally accepted definition of EMA, it is broadly identified as the identification, collection, analysis, and use of physical information on the use, flows and destinies of energy, water, and materials (including waste) and monetary information on environment-related costs, earnings and savings for internal decision making (UNDSD, 2001; Burritt et al., 2002; Lee and Gunarathne, 2019a). The above definition of EMA highlights two essential aspects of EMA information. First, EMA provides information regarding various environmental focus areas (or domains) such as energy, water, materials, carbon, waste and biodiversity. Second, EMA information on these multiple domains can be physical and monetary (Jasch and Savage, 2005; Burritt et al., 2002).

Prior research has identified the implementation of EMA as the application and use of various EMA tools in general for multiple decision-making purposes and in different environmental domains (Burritt et al., 2002; Christ and Burritt, 2013; Jalaludin et al., 2011; Ferreira et al., 2010; Qian et al., 2018b). Based on previous studies and the rich management accounting literature, a discipline from which EMA has developed (Christ and Burritt, 2013), this study delineates two specific approaches to understanding the uses of EMA: a) analyzing the domain uses of EMA applications and b) examining the functional uses of EMA. The next section discusses these two approaches in detail.

2.1.1 Domain uses of EMA

This approach to EMA uses analyses the fields of application of EMA tools (Burritt et al., 2019) or the environmental focus areas dealt with by EMA tools. Accordingly, two types of EMA tools can be identified: a) specific EMA tools and b) integrative EMA tools. The specific EMA tools deal with a single environmental domain such as energy, carbon, or water. These tools include various tools such as energy accounting (Burritt et al., 2002; EPA, 1995; Mokhtar et al., 2016), water management accounting (Christ, 2014), carbon management accounting (Lee, 2012; Qian et al., 2018b; Schaltegger and Csutora, 2012), and accounting for materials, material flow cost accounting and waste (Mokhtar et al., 2016; Yagi and Kokubu, 2019). Conversely, the integrative tools deal with a combination of environmental domains to link and balance several environmental aspects of management (Windolph et al., 2014). More specifically, the application of integrative tools requires the inputs provided by several specific EMA tools. These tools include environmental capital budgeting, life cycle accounting, sustainability balanced scorecard and eco-control (Burritt et al., 2002; EPA, 1995; Figge et al., 2002; Jasch and Savage, 2005; Lee, 2012; Gunarathne and Lee, 2015; Windolph et al., 2014).

2.1.2 Functional roles of EMA

Another approach to analyzing the uses of EMA is to look at their various functional roles. In interpreting the role of management accounting (or EMA), traditionally planning, decision making, controlling, and performance evaluation functions have been considered (CIMA, 2005; Drury, 2009; Bhimani et al., 2011). Scholars (Drury, 2009; Bhimani et al., 2011; Tillema, 2005) broadly divide these functions into accountability (control or stewardship) and decision-making. This study also extends these functional dimensions to EMA. The specific accounting tasks that come under these functional roles of EMA are given in Fig. 2.

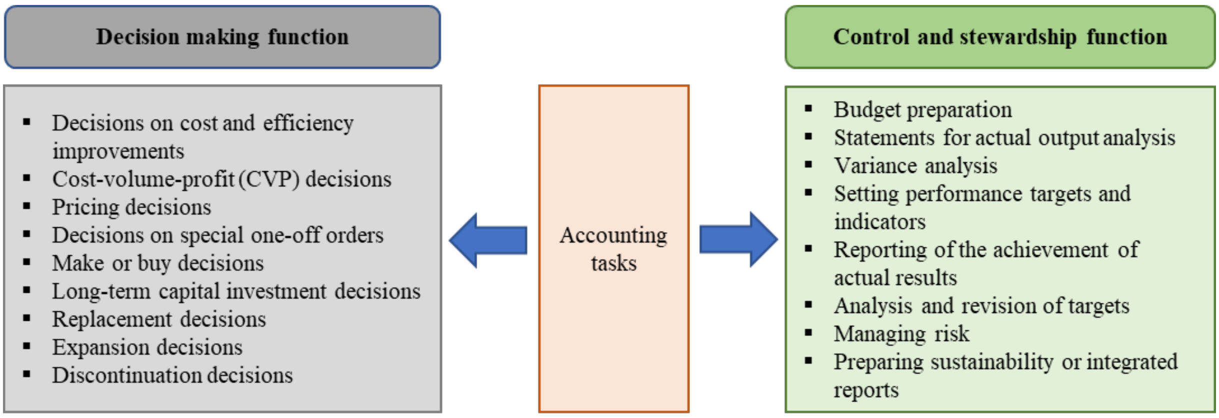

Fig. 2. Accounting tasks of EMA (Tillema, 2005; Bhimani et al., 2011; Drury, 2009; Langfield-Smith et al., 2012; Gunarathne and Lee, 2019a).

3. Theoretical framework

Despite the activities extended in promoting EMA and the increasing trend towards adoption of EMA in practice, there is a lack of theoretically informed studies that focus on the current state of EMA development (Burritt, 2004; Bouma and van der Veen, 2002; Christ and Burritt, 2013; Qian et al., 2011, 2018a). As organizational actions do not solely depend on external constituents, it is necessary to consider organizational contextual factors such as constraints and management procedures to better understand EMA practice in the field (Christ and Burritt, 2013; Qian et al., 2018a). Hence, with a view to understanding the EMA practice and development in organizations, scholars have suggested the use of contingency theory lenses (Bouma and van der Veen, M, 2002; Qian et al., 2011; 2018a; Christ and Burritt, 2013; Mokhtar et al., 2016). In this study, the use of contingency theory is two-fold: first, it is used to provide a general theoretical background for the study, and second, it is used to identify the sophistication of EMA system dimensions.

First, the differences in EMA uses, and their information characteristics are theoretically anchored on the contingency theory by considering the environmental strategy as a contingency factor of EMA. The contingency view suggests that the design and use of management accounting systems, as in this case EMA, are contingent upon the context of the organizational setting in which these accounting systems and controls operate and function (Fisher, 1995; Otley, 2016). Previously it has been suggested that several contingent factors such as environmental uncertainty, strategy, structure, interdependence, and span of control determine the use and development of management accounting systems (Otley, 2016, Chenhall, 2006, Mia and Chenhall, 1994, Chenhall and Morris, 1986, Tillema, 2005). While these contingent factors have been discussed generally in management accounting literature, it has been identified explicitly that "environmental strategy" is associated with EMA (Christ and Burritt, 2013; Qian et al., 2011; 2018a; Qian and Burritt, 2009). Although these studies have examined environmental strategy among other variables in determining the use of EMA in practice, they have not analyzed how the EMA practices differ in line with the development of environmental management strategies.

The second use of contingency theory in this study is to identify the information characteristics in the sophistication of EMA systems. Chenhall and Morris (1986) suggest four dimensions of information characteristics of management accounting systems (MAS): scope, timeliness, aggregation, and integration. Accordingly, the scope of MAS refers to the focus, quantification, and time horizon[3]. The second dimension of timeliness is management accounting systems' ability to provide information in two aspects: the ability to provide information on request and the frequency of reporting (Chenhall and Morris, 1986). The final two dimensions, aggregation, and integration identify MAS's ability to provide information regarding a range of time periods and organizational units, and in suitable formats for decision-making (Chenhall and Morris, 1986). Drawing from these MAS dimensions, the information characteristics of EMA systems can be identified as follows (see Table 1).

Table 1.
EMA system sophistication based on information characteristics.

MAS dimension	Measurement
Scope	EMA tools provide information relating to possible future events [time horizon].
	EMA tools provide non-financial production information [quantification].
	EMA tools provide information on the broad factors external to an organization [focus].
Timeliness	EMA tools provide requested information to arrive immediately upon request.
	EMA tools provide reports frequently on a systematic, regular basis.
Aggregation and integration	EMA tools provide information on the different sections/functions of an organization.
	EMA tools provide information in formats suitable for input into decision models.

Source: Adapted from Tillema (2005), Chenhall and Morris (1986), Gul (1991), Moores and Yuen (2001)

[3] MAS that provide internal, monetary, and historical information are referred to as *narrow scope MAS,* while *broad scope MAS* provide information related to the provision of external, non-monetary and future-oriented information (Chenhall and Morris, 1986; Mia and Chenhall, 1994).

4. Method

This study employed a multiple case study approach to allow for an in-depth analysis of the phenomenon, i.e., the use of EMA in different stages of cleaner production strategy development, using multiple sources of data (Yin, 2013). In particular, the case study methodology offers a viable research strategy for the in-depth analysis of decision making and accounting practices in the context of EMA by exploring "how" and "why" research questions (Burritt et al., 2019; Gunarathne and Lee, 2019a).

The sample consisted of Sri Lankan companies listed on the Colombo Stock Exchange (CSE), members of the Ceylon Chamber of Commerce (CCC), the National Chamber of Commerce Sri Lanka (NCC), and the International Chamber of Commerce Sri Lanka (ICC). We first pilot surveyed all these companies to check their willingness to participate in the study. Although twenty-one companies initially expressed their willingness to participate, we had to finally select only eighteen companies as three companies did not agree to provide access to the key internal company personnel and organizational documents (see Fig. 3 for more details of the case study companies).

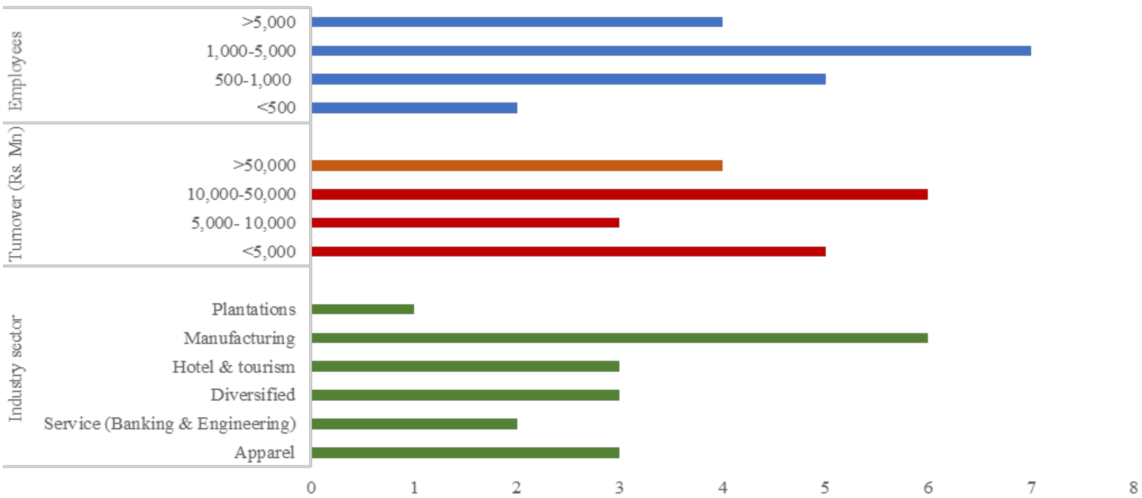

Fig. 3. Profiles of the case study companies.

The data was collected from multiple sources, including interviews, on-site visits, and document analysis, facilitating the triangulation of data sources to ensure reliability (Golafshani, 2003; Yin, 2003; Tellis, 1997; Voss et al., 2002). Semi-structured interviews were conducted with at least two parties of each organization, one from environmental-related functions and the other from accounting functions as recommended by Voss et al. (2002). A mix of accounting and other professionals from other functions is essential to gather a comprehensive account of EMA in an organization, as prior studies submit EMA as a transdisciplinary undertaking (Christ and Burritt, 2013; Bartolomeo et al., 2000). Accordingly, we first interviewed the main person/s responsible for the organization's environmental (or sustainability) management practices. As we conducted the interviews after the pilot survey, the analysis of the survey responses also informed the selection of the most suitable respondent from each company. The respondents we interviewed had different designations such as

Sustainability Manager, Engineer, Production Manager, General Manager or Environmental Health and Safety Manager, and Manager Special Project. Second, as advocated by Burritt et al. (2002) and Jalaludin et al. (2011), we also interviewed the accountants (or finance professionals) in order to obtain precise evidence of EMA tools, information characteristics and their functional uses. All the interviews, which lasted from twenty minutes to one-and-a-half hours, were tape-recorded with the respondents' prior consent and later transcribed.

Besides, we also collected data by making on-site observations of fourteen case companies. These on-site observations and informal discussions with company employees were essential data sources for supporting and synthesizing the data collected from other sources (Golafshani, 2003; Voss et al., 2002; Yin, 2009). Various company records and documents such as web sites, sustainability or integrated reports, energy, carbon footprint, waste and water records, and performance review reports were also referred. With a view to improving the validity of the study, several approaches were employed, such as conducting interviews with different horizontal and vertical categories of employees, personally observing the environmental-related practices, keeping records and taking photographs, using probing questions and extensive content s of the secondary data (Golafshani, 2003).

By combining the cleaner production strategy development stages and EMA information uses and characteristics, the study developed an analytical flow model as presented in Fig. 4. It shows that organizations at three different levels of cleaner production strategy development (i.e., reactive, preventive and proactive stages) can exhibit two different uses of EMA: a) domain-based uses (by using specific and integrative EMA tools), and b) functional uses (for decision making, and control and stewardship purposes) [*however, these two uses of EMA are not mutually exclusive and hence overlapping, which is indicated by the two-headed dash line*]. Anyway, these two uses of EMA are characterized by different information dimensions, as outlined in the contingency theory view of EMA system sophistication.

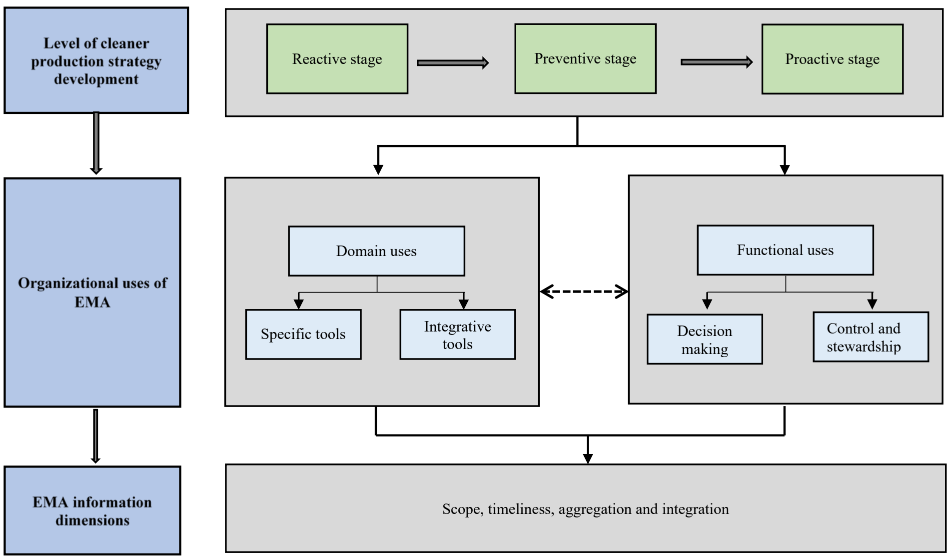

Fig. 4. Analytical flow model of the study.

The collected data was analyzed based on this analytical flow model in several steps. Firstly, the eighteen companies were categorized under three cleaner production strategy development stages, using the procedure recommended by Murillo-Luna et al. (2011) and Jabbour (2015). The principal respondents were asked to identify their organization's cleaner production strategy development by using the instrument of Jabbour and Santos (2006) and Jabbour et al. (2010) (see Table 2). By following Gunarathne and Lee (2020), the respondents' categorizations were checked with the interview and other secondary data sources to measure consistency and validity. The final determination of each company's level of cleaner production strategy development was finally agreed upon by all the respondents.

Table 2.
Categorization of organizations based on cleaner production strategy development.

Cleaner production strategy development stage	Characteristics of corporate cleaner production practices	No. of companies
Reactive	• Focus is to follow environmental legislation • Environmental management (EM) is predominantly linked to production or operational activities • Majority of EM activities is related to the adoption of cleaner technologies at the end of the production process	6
Preventive	• Focus of EM is the efficient use of inputs • Majority of EM activities is linked to the substitution and more efficient use of supplies/raw materials • Support of EM from other company departments has started to be received	7
Proactive	• The focus of EM is to explore competitive advantages [e.g., the creation of environmentally friendly products and access to new markets] • EM activities are diffused through the supply chain, influencing the suppliers • Environmental dimension influences the company's strategy and its long-term objectives	5

Source: Jabbour et al. (2010), Jabbour and Santos (2006)

After this step, the transcribed interview data was analyzed thematically using NVivo software as per the 'organizational uses of EMA' and 'EMA information dimensions' of the analytical flow model. In doing so, the three main themes illustrated in the analytical flow model were considered: a) domain uses of EMA (specific and integrative tools), b) functional uses of EMA (decision making and control and stewardship), and c) information dimensions of EMA (scope, timeliness, aggregation and integration). The data collected from various other sources were compared for data triangulation (Denzin, 2017; Shenton, 2004).

5. Results

In this section, the findings pertaining to the domain-based and functional uses of EMA are presented under the three stages of cleaner production strategy development, i.e., a) reactive, b) preventive, and c) proactive stage. Under these headings, the EMA information characteristics are also discussed.

5.1 Organizations in the reactive stage

5.1.1. Domain-based uses of EMA and information characteristics

As these organizations' focus is on maintaining the minimum level of environmental compliance, their EMA practices are confined to the material ecological aspects stipulated in the legislation and certifications. These organizations commonly focus on general EMA practices such as energy, material, waste and wastewater, which are covered in legislation such as the environmental protection license (EPL)[4]. Accordingly, these organizations implement specific EMA tools such as energy accounting, accounting for materials, and accounting for waste. Although these are the standard EMA practices depending on the industry and the relevant certification standard, some differences can be observed. For instance, the plantation sector exhibits the development of some physically-oriented biodiversity accounting to cover biodiversity management (particularly to comply with the Rainforest Alliance certification requirements), while in the manufacturing and apparel industry, the use of environmentally sustainable materials has been considered in EMA.

While most of these accounting aspects represent past-oriented and more confirmable accounting aspects for compliance (Burritt and Scahltegger, 2010), it also provides evidence that the industry is a determinant of EMA practices as opined by Christ and Burritt (2013) and Ferreira et al. (2010).

A common feature of these EMA practices is their limited scope as the focus is mainly on physical and past-oriented information with an internal orientation (Burritt et al., 2002). According to Burritt et al. (2002), this can be viewed as an ad-hoc use of EMA tools to meet the legislation/certifications requirements. Since the use of EMA is to satisfy the requirements from time to time as and when the need arises, there is no continuous application of these tools.

5.1.2. Functional uses of EMA and information characteristics

Concerning the decision-making functional role, the only application witnessed was the use of EMA tools for cost savings and efficiency improvement decisions. In terms of the control and stewardship functional role, organizations set up key performance indicators (KPIs) for material environmental aspects such as energy, raw materials, water, and waste and monitor the actual results as long as it is a requirement in the legislation/certifications. In these organizations, an explicit exception was witnessed concerning the use of energy. Due to the significance of energy cost within the overhead cost, these organizations considerably focus on energy efficiency. Accordingly, energy costing is used in budget setting and variance analysis on a regular basis.

[4]As per the country's main environmental legislation, i.e., the National Environmental Act, No. 47 of 1980 and its subsequent amendments, every listed industrial organization must obtain an EPL annually. EPL covers some general environmental aspects such as use of energy and water, and discharge of waste and effluents.

5.2 Organizations in the preventive stage

5.2.1 Domain-based uses of EMA and information characteristics

The analysis suggests that these organizations commonly focus on environmental domains such as carbon in addition to energy, materials, waste, and water. Accordingly, they use carbon management accounting, accounting for materials, energy accounting, waste accounting, and water management accounting as EMA tools. The additional coverage of carbon management accounting as an EMA tool is visible in sectors such as manufacturing, diversified, and apparel, where they use several types of energy. Carbon management accounting enables these firms to curb carbon emissions associated with different kinds of energies and identify how carbon improvements can be achieved most economically (Lee, 2012; Schaltegger and Csutora, 2012). For instance, for diversified companies, carbon accounting provides management with a common yardstick to manage different types of energies in diverse business entities.

However, the carbon management accounting information used by these organizations is mainly physical, past-oriented with little future orientation, and used for long-term purposes. Hence, it represents an accounting practice that attempts to unveil the undesired "bad effects and problems and is designed to help them develop a corporate carbon account of un-sustainability" (Schaltegger, and Csutora, 2012, p. 7). These tools all represent domain-specific EMA tools, and the use of integrative tools by these organizations is only confined to capital budgeting when making substantial investments.

5.2.2 Functional uses of EMA and information characteristics

The analysis of these organizations suggests several functional uses of EMA. First, in terms of the decision-making functional role, the primary purpose of the use of EMA is cost and efficiency improvements (Jasch and Savage, 2005; Burritt and Schaltegger, 2010). Second, these organizations use EMA information for long-term capital investment decisions (Burritt et al., 2002; EPA, 1995). Next, in terms of the control and stewardship functional role, the use of EMA is visible in the areas of budget setting and setting up KPIs. Also, the analysis of variances is evidenced in these organizations for essential cost items such as raw materials, energy and water. However, the analysis of variances takes place on a monthly, and quarterly basis and hence represents more of a conventional budgetary control cycle.

A notable feature of either the domain-based EMA tools or functional uses is the heavy usage of physical EMA information such as energy units, waste quantities, liters of water, and tons of carbon. In these organizations, the monetization of physical information occurs only with energy, raw materials and water. Further, it was noted that various EMA tools still generate past information, mainly with some future-oriented information, particularly in the areas of energy and carbon (Burritt et al., 2002; Schaltegger and Csutora, 2012).

5.3 Organizations in the proactive stage

5.3.1 Domain-based uses of EMA and information characteristics

In terms of the domain areas of EMA, similar to those of the organizations in the preventive stage, these organizations have implemented EMA practices covering energy, waste, carbon, and wastewater. However, depending on the industry, EMA activities have been extended to include several other areas such as chemical management in apparel and manufacturing industries. Based on these EMA tools, all organizations have devised reduction targets together with measures for achieving them, reflecting ‘accounting for sustainability improvements’ (Schaltegger and Csutora, 2012).

Compared to the organizations in the preventive stage, a notable difference is their high level of use of integrative EMA tools. For instance, some aspects of the use of a sustainability balanced scorecard can be seen in these organizations by either integrating the environmental considerations into the existing performance measurement system or adding an additional environmental perspective (Figge et al., 2002). An environmental sustainability index has been adopted in an organization in the apparel sector by combining energy, water, waste, and carbon footprint.

These uses indicate the application of a multi-dimensional environmental composite index by synthesizing environmental sustainability performance information to guide sustainability improvements (Engida et al., 2018). The implementation and use of integrative EMA tools in these organizations have been facilitated by forming separate sustainability divisions or committees with the participation of employees from different disciplines who use sophisticated sustainability accounting and reporting systems. These specific divisions or committees have been able to mitigate the interdepartmental barrier to sustainability information communication (Burritt, 2004, Jasch and Savage, 2005; Gunarathne and Lee, 2015), which, in turn, facilitates the combination of several environmental domains to use integrative EMA tools. This has also enabled the organizations to regularly generate and utilize physical and monetary EMA information about past performance and future expected use.

5.3.2 Functional uses of EMA and information characteristics

In terms of decision-making functional use, EMA information is regularly used for efficiency and cost improvements. Since these organizations have developed measurement systems that continuously trace the sustainability performance at the business unit, division or facility level, decisions about efficiency improvements and cost reductions have become embedded in the corporate decision-making process (Gunarathne and Lee, 2015). Besides, in all long-term investment decisions and asset replacement and expansion decisions, EMA information plays a vital role.

In terms of the control and stewardship functional role, these organizations regularly use EMA information for a variety of purposes. Information on the cost of energy, material, water, and waste is used for budget setting purposes, setting up KPIs and performance targets and variance analysis. In these organizations, this control aspect of EMA is applied consistently, often linking it to managerial performance evaluation. Further, these organizations use EMA information to produce sustainability reports or integrated reports that highlight EMA's external communication aspects through a performance measurement system (Morioka and Carvalho, 2016).

The findings pertaining to the domain-based and functional uses of EMA tools can be summarised as follows (see Tables 3 and 4). The information characteristics that underlie the domain-based EMA tools and the functional uses of these organizations are summarized in Table 5.

Table 3.

Domain-based uses of EMA tools in the organizations in different cleaner production strategy development stages.

EMA tool	Cleaner production strategy development		
	Reactive	Preventive	Proactive
Specific tools			
■ Energy accounting	● Used heavily	■ Used heavily in combination with carbon management accounting	
■ Water management and waste accounting, and accounting for material	● Used if covered by legislation/standards	■ Used regularly for improving input utilization	● Used continuously for improving input utilization as a part of routine management practices
■ Carbon management accounting	■ Not used	■ Used as a tool for accounting for un-sustainability	● Used as a tool for accounting for sustainability improvements
Integrative tools			
■ Sustainability balanced scorecard, sustainability index, eco-control and life cycle accounting	● Not used	● Not used	● Used as a part of sustainability performance measurement system
■ Environmental capital budgeting	● Not used	■ Used when making major investment decisions	● Used for all investment decisions

Table 4.

Functional uses of EMA in the organizations in different cleaner production strategy development stages.

Functional role	Cleaner production strategy development		
	Reactive	Preventive	Proactive
Decision making			
▪ Decisions on cost and efficiency improvements	• Not regularly used except for energy and material	• Used regularly	• Used regularly
▪ CVP, pricing, special order, and make or buy decisions	• Not used	• Not used	• Not used
▪ Long-term capital investment decisions	• Not used	• Used for major investments	• Used for all investments
▪ Replacement, expansion and discontinuation decisions	• Not used	• Not used	• Used regularly
Control and stewardship			
▪ Budget preparation	• Confined only to energy and materials	• Covered all materials environmental aspects	• Used as part of the sustainability performance evaluation system
▪ Statements for actual output analysis	• Used at a minimum level	• Covered all materials environmental aspects	• Used as part of the sustainability performance evaluation system
▪ Variance analysis	• Used at a minimum level	• Performed on a monthly or quarterly basis	• Used as part of the sustainability performance evaluation system
▪ Setting performance targets and indicators	• Used absolute KPIs often	• Used absolute KPIs often	• Used composite and relative KPIs
▪ Analysis and revision of targets	• Not used	• Used infrequently	• Improved annually as a continuous improvement cycle
▪ Preparation of sustainability/integrated reports	• Not used	• Used infrequently	• Used as an external communication mechanism
▪ Managing risk	• Not used	• Not used	• Not used

Table 5.

EMA information dimensions of in the organizations in different cleaner production strategy development stages.

Information dimension	Cleaner production strategy development		
	Reactive	Preventive	Proactive
Scope			
▪ Nature of information	• Mainly physical [Note 1]	• Physical and monetary	• Physical and monetary
▪ Period of information	• Past-oriented	• Mostly past-oriented with some future-oriented information	• Future and past
▪ Internal or external	• Internal focused	• Internal focused	• Mainly internal
Timeliness			
▪ Frequency of information use	• Ad-hoc	• Ad-hoc and routine	• Ad-hoc and routine
▪ Time period of information	• Short-term	• Short (mainly) and little long term	• Short and long-term
Aggregation and integration			
▪ Presentation of information	• Fragmented	• Fragmented	• Integrated to a great extent

Note 1: However, there is the use of monetary information for energy and materials.

5. Discussion

The findings of this study lead to several important points of discussion.

First, concerning the domain-based uses of EMA, our findings show that all the organizations, despite their level of cleaner production strategy development, focus on energy accounting, material accounting, waste accounting, and water management accounting. These findings are similar to those of Mokhtar et al. (2016), who also found a high level of use of stand-alone EMA practices for waste, raw material use, and energy use in Malaysian companies. While there are several reasons for the use of a high level of energy and material accounting (see the discussion below), this is also suggestive of the influence of the regulations and accreditation standards that cover the common environmental aspects (Windolph et al., 2014; Jalaludin et al., 2011). However, as evidenced in the case study analysis, when organizations advance into higher levels of cleaner production strategy development, they expand the coverage of the scope of environmental management activities. This supports the view of Burritt et al. (2019), who opine "that managers start with one or a few tools and then expand their knowledge base and implement additional tools as they appear to be relevant" (p. 486). Thus, managers initially start with relatively few EMA tools, which lead to a situation that shows the relevance and potential of other tools as a result of a dynamic interplay between compliance, efficiency and strategic advantage.

Second, the findings indicate that the use of integrative EMA tools is deficient in the organizations in the reactive and preventive stages of cleaner production strategy development. A similar situation has been observed even in developed countries such as Germany and among the environmentally-sensitive industries (Windolph et al., 2014). Although the organizations generate requisite information from specific tools, they have failed to integrate the information to link and balance several environmental aspects simultaneously. This is suggestive of these organizations still following a fragmented approach to the use of EMA (Bartolomeo et al., 2000). This can be mainly due to the lack of coordination and communication between accounting and other departments that collect environmental information (Burritt, 2004; Jasch and Savage, 2005). It can also result from the absence of organizational systems and procedures that attempt to provide a holistic account of environmental management activities. Hence, these organizations are not yet ready to derive the full benefits of the integration of the information generated through different specific environmental tools by feeding them into integrative tools such as environmental capital budgeting, sustainability balanced scorecard or eco-control (Bartolomeo et al., 2000; Gunarathne and Lee, 2015; Windolph et al., 2014).

Third, concerning the functional uses, the findings reveal a low level of use of EMA for various decision-making purposes such as pricing, CVP analysis, and other short-term oriented decisions such as special one-off decisions and make or buy decisions irrespective of the level of development of the cleaner production strategy. This is contrary to the suggestions of many scholars who appreciated EMA as a decision-making tool (Burritt, 2004; Burritt and Schaltegger, 2010; Gunarathne and Lee, 2019a). However, it should be noted that these studies have considered the uses of EMA as an all-in-one basket of 'decision-making' rather than splitting them into 'decision-making' and 'control and stewardship' functional roles as followed in this study. The limited use of EMA in short-term-oriented decision making indicates that the companies may be driven by other urgent priorities such as on-time delivery, quality, customer relationship, and short-term profit gains in addition to environmental sustainability considerations. Besides, the absence of EMA information in pricing decisions suggests that environmental cost information is not used for differentiating between product pricing and product mix decisions (Burritt et al., 2002; Gunarathne and Lee, 2019a).

Fourth, despite the low level of use for other decision-making situations, our analysis reveals that for the decisions on cost and efficiency improvements, EMA information is regularly used by the organizations in every stage of cleaner production strategy development. Notably, this decision-making use of EMA is mainly attributable to the use of information on energy and material, which can be due to several reasons such as materiality of cost, cost visibility and reductions in carbon footprint (see Fig. 5). Next, the analysis of these organizations also suggests that as the cleaner production strategy development level increases, organizations depict a higher level of use of EMA for control and stewardship purposes such as budget setting, setting up and revision of KPIs, variance analysis, and external reporting.

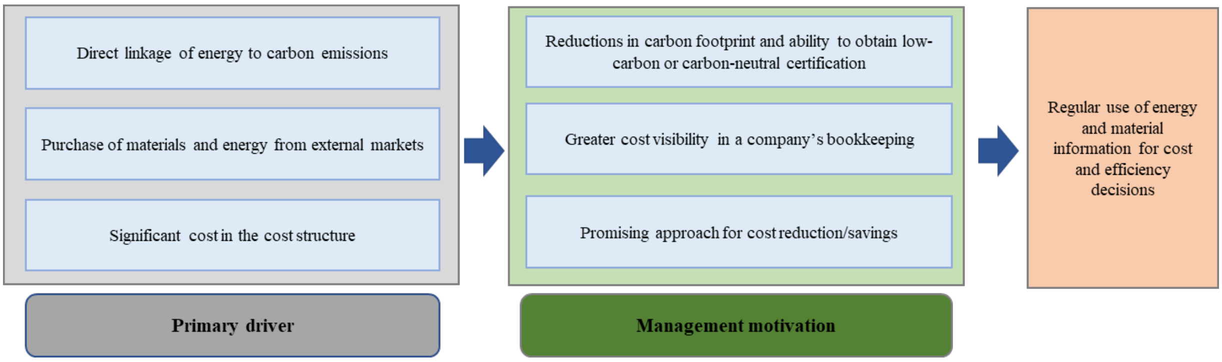

Fig. 5. Reasons for the high use of information on energy and material.

Further, the higher level of use of domain-based tools and functional uses by the organizations at the proactive stage of cleaner production strategy development underscores that they have developed dedicated systems and procedures of EMA to benefit from the increased investments and complexities in corporate environmental management activities. As we noted, these organizations have dedicated sustainability management teams or divisions and information collection and reporting systems. More importantly, one salient feature was that these organizations had developed a performance measurement system that embeds environmental or sustainability management in the formal organizational controls. This was evident in the use of a periodic budgetary control cycle (Drury, 2009; Langfield-Smith et al., 2012) in which organizations set their annual budgets incorporating the environmental cost items, report and monitor the actual performance and identify deviations through variance analysis with the use of environmental-related KPIs. Morioka and Carvalho (2016) observed that any organization that strives to be sustainable must develop a performance measurement system that incorporates sustainability performance measures to provide information for decision-makers, promote organizational learning and responsible behavior, and encourage more extensive stakeholder engagement.

The information characteristics that underlie the domain-based EMA tools and the functional uses of EMA show that the scope of the EMA systems expands with the development of organizational cleaner production strategy. Accordingly, organizations at higher levels of cleaner production strategy development use broad scope EMA systems that are characterized by the use of both physical and monetary information, and future and past-oriented information (Chenhall and Morris, 1986; Mia and Chenhall, 1994; Tilemma, 2005). Further, these organizations tend to use integrated EMA information for routine and ad-hoc decisions while focusing on both short-term and long-term time horizons. As already discussed, the use of broad scope EMA systems and timely information, and achievement of a higher level of integration by these organizations is realized by developing dedicated systems, management procedures, and reporting mechanisms. Hence, these organizations benefit from environmental management activities by making them a part of the routine organizational management, decision making and control systems (Gunarathne and Lee, 2015).

6. Conclusion

This study sought to identify how EMA uses differ among organizations at different levels of cleaner production strategy development. Overall, the study found that EMA uses are limited and fragmented in organizations at the initial stages of cleaner production strategy development with the exception of using EMA for cost savings and efficiency improvements. However, the high level of use of EMA for decisions on cost and efficiency improvements is mainly driven by accounting for energy and materials. The study also found that even in the organizations at the advanced levels of cleaner production strategy development, the use of EMA is mainly focused on control and stewardship functions with some limited uses for a variety of decision-making purposes such as pricing, CVP analysis and short-term oriented decisions. However, in general, the study finds that as and when organizations mature in their environmental management activities, there is a relatively high level of use of EMA in terms of integrative tools and control and stewardship purposes.

Consequent to these findings, a number of avenues for future research can be suggested. First, an opportunity exists for a more in-depth exploration of how the other individual contingent variables such as environmental sensitivity of the industry, organizational life cycle, environmental uncertainty, and competitive strategy affect the uses of EMA by extending the analytical framework developed in the study. Second, in light of the results of this study, which suggest that organizations irrespective of their level of cleaner production strategy development have limited uses of integrative EMA tools, and EMA for decision-making purposes, it will be valuable to identify the factors that contribute towards this profoundly. Third, it will also be interesting to identify how the EMA implementation can either support or inhibit the development of corporate cleaner production strategy by way of a longitudinal analysis.

Notwithstanding the useful insights, the findings of this study should be viewed mindful of its several limitations. First, the study uses a limited number of case studies in a few industries in Sri Lanka, which can reduce the generalizability of the findings. Future studies that cover a large sample from diverse industries and different geographical locations are therefore needed to obtain a broader perspective of EMA uses. Second, we have considered the companies listed on the CSE and members of the CCC, NCC and ICC, which fall into either large or semi-large categories. Hence, the findings of this study portray only the uses of EMA amongst the large and well-established companies and extending the findings beyond this context (e.g., for the small and medium-sized sectors) may prove problematic.

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