AN INVESTIGATION OF HOW MANAGEMENT ACCOUNTING SUPPORTS CORPORATE ENVIRONMENTAL STRATEGY: CASE STUDIES OF AUSTRALIAN BUSINESSES

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ABSTRACT

This study investigates how management accounting (MA) contributes to corporate environmental strategy (ES) in a sample of six Australian companies. An ES-MA conceptual framework is developed to explore the companies' ES-MA linkages. Under the framework, ES is converted into ES programs for strategic development and implementation, whereas MA is seen as employing EMA applications to generate physical EMA (PEMA) and monetary EMA (MEMA) information. MA supports ES if this EMA information matches the information required by management to make decisions on the ES programs.

Case study method is selected as the main methodological approach. Case studies not only address well a "how" research question but also allow an in-depth investigation of the sample companies' potential ES-MA linkages. Furthermore, this method considers the companies' comprehensive backgrounds, their specific ES and MA practices. Also, case studies are more often chosen for qualitative research in MA than in other accounting areas.

There is convincing evidence that the case companies' MA supports ES. Their ES-MA linkages range from strong to weak, being represented by the varying volume and richness of useful MEMA and PEMA information for ES decision making. Some companies are found to seek external EMA services or to engage non-MA units in their ES processes.

This study contributes to the existing ES and MA literature by developing an ES-MA conceptual framework for exploring the connectedness between ES and MA. Major implications hinge on four major points: 1) a company should involve its MA personnel, alongside environmental professionals or consultants, in its ES processes, 2) an environmentally proactive company should establish a separate EMA function and should take necessary EMA training, 3) outsourcing is a practical solution for companies with inadequate MA capability to support their ES, and 4) policy makers should consider companies' characteristics when planning new environmental legislation and policies.

1. Introduction

With climate change representing a topical issue across the political, business and community agendas in the 2000s, sustainable development has become a strategic priority for a growing number of companies. Sustainable development is a development process that meets current generations' needs without compromising those of future generations (The Brundtland Report 1987). By this definition, sustainable development means limiting the consumption of natural resources, which constitute the environment, to the extent that these resources can be sufficiently reproduced. The implication is that companies need to consider environmental issues when conducting their activities, which can be achieved through developing appropriate environmental strategies or long-term environmental approaches, and undertaking prompt actions to minimise their environmental impact. Furthermore, companies can discharge their environmental accountability through environmental reporting (Birkin and Woodward 1997a). Birkin and Woodward's (1997a) view that companies' accountants are the responsible individuals in the reporting process foreshadows possible connections between corporate environmental management and accounting.

Gray and Bebbington (2001 pp.12-13) suggested two reasons why accountants should be involved in environmental management. First, accounting forms an integrated business function and so should contribute to a highly prioritised environmental agenda adopted by a business. Second, environmental issues can substantially affect a business' overall costs and profits being conventionally determined by accountants. However, the responsibility for measuring, analysing and reporting environmental consequences, which ultimately result in costs and profits, has not been mandated for the accounting profession. In a business, it is common for non-accountants such as sustainability and environmental officers or specialists to prepare the environmental reports that are required by the internal and external stakeholders for their decision making processes.

While accounting researchers have incorporated contemporary strategic environmental practices into their studies, only a few have explored the supporting role played by management accounting in developing and implementing corporate environmental strategy. That is, the linkage between environmental strategy and management accounting represents a gap in the existing accounting literature. This study identifies the gap and is dedicated to examining Environmental Strategy (ES) in connection with Management Accounting (MA) for a sample of Australian companies using the case study method. Particularly, it aims to answer the following question

> *How can management accounting contribute to the development and implementation of corporate environmental strategy in Australian businesses?*

This question reflects the observation by Gray, Walters, Bebbington and Thompson (1995) that investigating the possibilities and potential contributions provided by "greener accountancy" to sustainable development constitute significant research topics.

This paper differs from prior studies, which have also responded to this call and explored how the accounting profession contributes to corporate environmental management, in the way that it focuses on the directional flow from MA to corporate ES, specifically how MA contributes to corporate ES. The remainder of this paper is divided into seven sections. Section 2 provides the background to this study. Section 3 reviews prior research on ES and

MA with the outcomes being used to develop an ES-MA conceptual framework in Section 4. Section 5 discusses the selected research methods and Section 6 highlights the main findings. The contributions, implications and limitations of this study are covered in Section 7. Section 8 identifies some future research topics and Section 9 concludes this paper.

2. Background

When companies started to incorporate environmental sustainability into their business agenda in the 1970s and into their corporate strategy in the 1990s (Epstein 1996b), the limitations associated with conventional accounting were identified regarding the measurement, analysis and reporting of environmental information for corporate decision making. Conventional accounting systems fail to provide adequate information on environmental issues which possibly cause substantial costs and damages to a business (Gray 1992, Burritt and Schaltegger 2002). Particularly, conventional balance sheets are not structured to represent natural resources. Also, conventional accounting neither depreciates these resources nor considers potential environmental damages until these damages lead to financial consequences (Burritt and Schaltegger 2002 pp.77-8). Furthermore, conventional accounting systems tend to ignore various environmental information types required by different stakeholder groups (Burritt, Hahn and Schaltegger 2002 pp.39-50).

Conversely, Environmental Accounting (EA) originates from conventional accounting but incorporates environmental costs and information into accounting practices (USEPA 1995a, Graff, Reiskin, White and Bidwell 1998). ES considers environmental issues from the internal and external perspectives based on both monetary and physical measures (Burritt et al. 2002 pp.39-50). EA mainly comprises Environmental Management Accounting (EMA) and Environmental Financial Accounting (EFA).

EFA largely provides environmental information for decision making by external stakeholder groups. Prior EFA literature mainly concerns external environmental disclosure (e.g. Deegan and Rankin 1997 & 1999, Gibson and Guthrie 1995, Tilt 1998 & 2001, Wilmshurst and Frost 2000), environmental reporting compliance (e.g. Burritt 2002), environmental case studies (e.g. Guthrie 2007, Isack and Tan 2008, McElroy 2006), and financial accountants' responsibility in environmental reporting (e.g. Bebbington, Gray, Thompson and Walters 1994, Deegan, Geddes and Staunton 1995, Frost and Wilmshurst 1996, Lehman 1998, McGowan, Powell and Lehman 2002, Wilmshurst and Frost 1998 & 2001, Wycherley 1997).

EMA is defined differently by academic researchers, practitioners and regulators. Nevertheless, all agree on the main characteristic of EMA being a MA area that provides information on environmental issues to internal decision makers (Birkin 1996, Burritt, Schaltegger, Kokubu and Wagner 2003, Graff, Reiskin, White and Bidwell 1998, Gray and Bebbington 2001, Henri and Journeault 2008, Jasch 2003 & 2006, Parker 1999, Stone 1995, UN DSD[1] 2001). EMA applications have evolved from early costing tools and techniques to more complex frameworks, models and processes. For example, the basic EMA applications include activity-based costing, lifecycle costing and analysis, full cost accounting, and total cost assessment (Bebbington, Gray, Hibbitt and Kirk 2001, Boer, Estes and Klammer 1994, Ditz, Ranganathan and Darryl 1995, Epstein 1994, Gray and Bebbington 2001, Kreuze and Newell 1994, Parker 1999, Russell, Skalak and Miller 1994, USEPA 1995b). The more complex EMA applications comprise a "cloverleaf" sustainable development matrix,

[1] United Nations Division for Sustainable Development (2001)

environmental cost framework and approaches, and EMA frameworks (Birkin & Woodward 1997b, Boer, Curtin & Hoyt 1998, Parker 2000, Burritt et al. 2002).

EMA information for decision making has broadened significantly from basic environmental expenditure and revenues to more complex financial and non-financial information (for example Al-Hazmi 2010, Burritt, Herzig and Tadeo 2009, CIMA 2002, Epstein and Roy 1998, Gale 2006a & 2006b, GEMI[2] 1994, Jasch 2003 & 2006, Larrinaga-Gonzalez and Bebbington 2001, Staniskis and Staniskiene 2006, Newell, Kreuze and Newell 1990, Saka and Burritt 2005, Scavone 2006, Schaltegger and Burritt 2000, UN DSD 2001, USEPA 1995a). Financial or monetary information refers to environmental costs and revenues, while non-financial information includes physical and qualitative measures. Through using EMA applications to measure, analyse and report environmental information, MA can assist management in making decisions on environmental costs, capital investments, process and product design, and performance management.

The MA contribution to environmental sustainability has not attracted as much research attention although potential contributions have been alluded to such as in cost quantification. This study fills this gap by exploring how MA can contribute to ES through providing the necessary information for making strategic environmental decisions. A full review of the relevant studies on ES, MA and EMA is covered in Section 3 below.

3. Literature Review

This section firstly reviews prior studies on environmental strategy and explains how ES is converted into ES programs for development and implementation (Section 3.1). Section 3.2 is dedicated to management accounting, discussing the EMA practices that generate physical and monetary EMA information. This information, if useful for making decisions on the relevant ES programs, will represent an ES-MA linkage under the ES-MA conceptual framework developed in Section 4.

3.1. Environmental Strategy

Corporate ES refers to long-term directions taken by an organisation, which range from regulatory compliance activities to voluntary practices to reduce the environmental impacts of business operations (Aragon-Correa 1998, Aragon-Correa and Rubio-Lopez 2007, Gallhofer and Haslam 1997, Piasecki 2004, Sharma 2000, Sharma and Vredenburg 1998, Yakhou and Dorweiler 2004).

ES can be classified as *reactive, defensive, accommodative* and *proactive* based on the degree of a business' involvement in environmental activities (Carroll 1979, Henriques and Sadorsky 1999, Hunt and Auster 1990, Wartick and Cochran 1985). *Reactive strategies* require no management support for, or engagement in, environmental issues. Businesses in this profile do not appoint environmental managers, provide no environmental training to employees and assume no environmental reporting responsibility. *Defensive-strategy* businesses assume minimal management and employee involvement, and little staff training. These businesses only deal with environmental issues when necessary or simply comply with environmental regulations. Businesses adopting *accommodative strategies* require some top management and employee involvement in environmental issues, setting up an environmental management

[2] Global Environmental Management Initiative (in References)

division and providing internal reporting with very limited external reporting. By contrast, in businesses with *proactive strategies*, top management strongly supports and gets involved in environmental matters. These businesses consider environmental management as a separate and important function, preparing both internal and external environmental reports, and encouraging employees to participate in environmental training and practices.

Alternatively, ES is classified as "*market strategies*" or "*non-market strategies*" by Maxwell et al. (1997) and Piasecki (2004). Businesses that adopt *market strategies* go beyond compliance with regulations and standards to develop products and services with environmental aspects, which create a competitive advantage through cost reductions and higher profits. Conversely, businesses that embark on *non-market strategies* strengthen relationships with different stakeholders to improve their performance and public image.

During strategy development, ES choices are influenced by stakeholders' interest, environmental industries and investments (Aragon-Correa and Rubio-Lopez 2007), different external and internal barriers (Murillo-Luna et al. 2007), environmental regulations and consumers' concerns among different industries (Banerjee 2001, Cater et al. 2009, McKay 2001), firm size and industry characteristics (Dahlmann et al. 2008).

During strategy implementation, the various environmental activities can be categorised into four groups (Table 1). These groups are identified in prior research during the ES processes and thus used in this study to examine ES. Group 1 includes operating activities that are often run daily (Banerjee 2001, Dahlmann et al. 2008). Group 2 comprises long-term capital projects (Hart 1997, Marcus and Geffen 1998). Group 3 focuses on those activities related to environmentally friendly products and processes (Hart 1995 & 1997, Maxwell et al. 1997, Piasecki 2004). Group 4 contains activities associated with environmental performance (Aragon-Correa and Rubio-Lopez 2007).

Table 1: Environmental Activity Groups

ES Activity Group	Environmental Activities
Group 1 Operating Activities (Banerjee 2001, Dahlmann et al. 2008)	- recycling - managing waste - saving on water usage - saving on energy consumption - minimising air emissions - preventing pollution - complying with environmental regulations - conducting consumer education programs and employee training
Group 2 Capital investment (Hart 1997, Marcus & Geffen 1998)	- developing and investing in contemporary technologies and ideas that contribute to environmentally sustainable operations - budgeting for environmental projects - evaluating environmental projects
Group 3 Product and process design (Hart 1995 & 1997, Maxwell et al. 1997), Piasecki (2004)	- develop environmentally friendly products that can be easily recovered, reused and recycled - designing environmentally differentiated products that eventually increase revenues - embarking on environmentally efficient production processes - engaging suppliers and customers in analysing product life cycles
Group 4 Performance management (Aragon-Correa and Rubio-Lopez 2007)	- creating monetary and non-monetary environmental performance indicators - analysing and reporting eco-efficiency measures

Table 1 will be re-visited in Section 4 when an ES-MA conceptual framework is developed to examine ES-MA linkages. Now that the aspects of ES have been covered, Section 3.2 will review diverse MA applications, as well as the extent to which these applications are employed to generate useful environmental information for strategic environmental purposes.

3.2. Management Accounting

Management accounting provides useful information for internal decision makers (Chakravarthy 1982, Jasch 2006, USEPA 1995a). From an environmental management perspective, financial or monetary information mostly refers to environmental costs and benefits, while non-financial information includes physical and qualitative measures. Section 3.2.1 firstly defines the EMA concept and subsequently Section 3.2.2 identifies EMA applications that produce diverse information for making strategic environmental decisions.

3.2.1. Environmental Management Accounting (EMA)

The concept of EMA has been defined in various ways in prior environmental accounting literature. One definition is that EMA broadly originates from conventional MA but contributes specifically to environmental issues (Birkin 1996, Burritt et al. 2003, Stone 1995). Jasch (2003) views EMA as a process that converts mass balances, financial and cost accounting data into information useful for making decisions to increase material efficiency, to minimise environmental effects and risks, and to reduce environmental protection costs.

Alternatively, the United Nations Division for Sustainable Development's EMA Working Group (UN DSD 2001) sees EMA an integral part of MA. In particular, EMA is a branch of traditional MA, which focuses on physical information about the use and flows of resources, and on monetary information about environmental costs, revenues and environmental protection projects (Graff et al. 1998, Jasch 2003 & 2006).

Slightly different, Henri and Journeault (2008) consider EMA as a part of an environmental management system (EMS), which comprises life-cycle costing, full-cost accounting, benefit assessment and environmental strategic planning. Coopers and Lybrand (1993) explained further that an effective EMS should incorporate environmental policies and objectives, as well as a detailed plan and an organisational structure to allocate responsibility for environmental performance, procedures for environment related activities, procedures for handling abnormal or emergency situations, processes for assessing and auditing environmental performance, and a mechanism for regular review of the system components. EMA represents a part in an effective EMS if the EMA practices and information support the environmental responsibility allocation and environmental performance evaluation.

3.2.2. EMA Applications and Information for Environmental Decision Making

EMA applications are divided in two groups. The first group comprises EMA costing tools and techniques, of which the most commonly used are activity-based costing or ABC, life-cycle costing and life-cycle analysis or LCA, full cost accounting or FCA, total cost assessment or TCA, and cradle-to-grave costing(e.g. Bebbington et al. 2001, Boer et al. 1994, CIMA 2002, Ditz et al. 1995, Epstein 1994, GEMI 1994, Gray and Bebbington 2001, Gray et al. 1993, Kreuze and Newell 1994, Parker 1999 & 2000, Russell et al. 1994). The second group includes EMA frameworks, matrixes and approaches. For example, these include a 'cloverleaf' sustainable development matrix, environmental costing framework, and a five-tier cost system (Birkin and Woodward 1997b, Epstein 1996a, Parker 1999 & 2000).

Prior EMA studies have identified several types of information provided by EMA applications for making environmental decisions. This study divides EMA information into five groups, namely physical environmental measures, environmental costs, capital investments, design of processes and products, and environmental performance.

Physical Environmental Measures

EMA mass balances represent physical quantities of inputs (materials, water and energy), outputs (products and wastes), leakages and emissions from business activities (Gray and Bebbington 2001, Jasch 2003). Based on the principle that total inputs should equal total outputs plus leakages, analysing and reporting EMA mass balances enable management to identify losses from production processes. Another type of EMA mass balances is ecological balances such as tonnes of greenhouse gas emission, kilojoules of electricity consumption, and litres of water usage, which indicate how efficiently a business runs its environmental activities.

Environmental Costs

The components of environmental costs vary depending on business nature and activities (CIMA 2002 p.8). For example, Jasch (2003) and Gale (2006a) define four categories of environmental costs. These comprise waste disposal and emission treatment costs, prevention

and environmental management, wasted material purchase value, and production costs of non-product output.

Environmental costs deserve management attention for seven reasons (USEPA 1995c). First, many environmental costs that provide no added value to processes or products can be significantly reduced or eliminated if management can identify these costs (Jasch 2002 p.41 & 2003). Second, most environmental costs, and major cost savings, may be bundled in overhead accounts, overlooked or arbitrarily allocated across business divisions or cost centres based on inaccurate, sometimes misleading, measures such as machine or labour hours (Jasch 2002 p.41, CIMA 2002 p.8). Consequently, financial liabilities for cleanup or remediation of contaminated sites, and legal costs for environmental violation are not accounted for by businesses (Boer et al. 1994, Russell et al. 1994). Environmental costing draws managers' attention to environmental costs and benefits, which assists them in planning strategically to minimise the company's possible future environmental risks and liabilities (CIMA 2002 p.19).

The other reasons are summarised as 3) many environmental costs can be offset by environmental revenues; 4) better cost management can improve environmental performance and benefit human health (Ranganathan and Ditz 1996); 5) understanding environmental costs results in more accurate product costing and pricing, and better design of environmentally friendly processes and products, 6) these green processes and products can create competitive advantage (Graff et al. 1998), and 7) accounting for environmental costs and performance forms part of an organisation's environmental management system required under ISO14001.

Capital Investments

Environmentally responsible corporations must integrate environmental concerns into capital investments (Epstein 1994). Capital investments are strategic in nature as the associated returns are received over time, which affects a business' long-term profitability. EMA incorporates future environmental earnings and expenses, both monetary and non-monetary, into capital investment appraisals. These mainly include initial investment costs, annual operating costs, future risk and liability costs and savings potential (Jasch 2002 p.49).

Informed decisions are required on environmental capital investments for two reasons (Epstein and Roy 1998). First, incorporating environmental costs and benefits into capital decisions greatly determine a project's success. The uncertainty and timing of environmental contingent liabilities represent a common reason for failing to account for environmental costs in capital investment analysis. Rather than being allocated to specific capital projects, these costs are often bundled into overhead accounts (Boer et al. 1994). Second, external factors are putting greater pressures on businesses' greener processes. For example, these are numerous international and industry-based environmental standards, government legislative frameworks, consumers, competitors' environmental initiatives, public scrutiny, market globalization, technological advances and ethical investments.

Process and Product Design

Management accountants should be involved in new product design (Hertenstein and Platt 1998). Specifically, EMA should assist management in designing environmentally responsible processes and products in different ways (USEPA 1995b). One practice is to

estimate the market price for and costs of making a product, which helps to determine profit and thus provides a basis for designing green processes and products (Graff et al. 1998).

Environmental Performance

EMA information is useful for environmental performance decisions (Bennett and James 1998, Burritt et al. 2003, Wilmshurst and Frost 2001). Incorporating environmental considerations into performance evaluation is a "must" for environmentally responsible businesses (Epstein 1994). Hence, companies should consider setting up suitable systems that measure their environmental performance in both monetary and non-monetary terms, and that may employ EMA applications such as lifecycle analysis, activity-based costing, and cost-benefit analysis (Wilmshurst and Frost 2001).

EMA applications can effectively measure and report environmental performance (Staniskis and Staniskiene 2006). These applications analyse the short, medium and long-term effects of the possible changes in government policies, legislations and regulations, supply and market conditions, social attitudes and competitor strategies (Bennett and James 1998). Alternatively, EMA information can potentially be used for individual performance appraisal (Burritt et al. 2003). Furthermore, MA applies environmental indicators to analyse environmental costs and benefits (Saka and Burritt 2005). For example, an environmentally balanced scorecard (EBS) converts environmental strategy into monetary and non-monetary indicators across four perspectives, namely the financial perspective, customer perspective, internal perspective, and learning and development perspective (Scavone 2006).

4. ES-MA Conceptual Framework

While many studies indicate that MA can potentially provide useful information for decision making on environmental issues (e.g. Epstein 1996a, Gray and Bebbington 2001, Oliver 2001, Parker 2000, Schaltegger and Burritt 2000, Smith and Lambell 1997, Wilmshurst and Frost 2001), prior research has not explored the supporting role played by management accounting in developing and implementing ES. Most significantly, Gray and Bebbington (2001 p.9) recommended management accountants help managers to plan for environmental costs and revenues, to evaluate environmental costs and benefits associated with capital investments, to analyse the environmental aspects related to those programs on environmental efficiency, and to report on environmental performance. This is because the accountants traditionally participate in corporate decision making processes through providing the necessary financial information for planning and evaluation purposes (Wilmshurst and Frost 2001). With these contributions, management accountants become "strategic accountants" or "business partners" who add value to management decision making by communicating with non-accounting areas such as the environmental function (Oliver 2001). The research gap on the ES-MA linkage has been identified by several researchers, and the accounting literature has largely overlooked the interplays between environmental management and management accounting (Parker 2005), or has not focused on the involvement of MA and accountants in corporate sustainability management (Zvezdov et al. 2010). Only limited literature addresses the strategy-MA relationship and minimal research has been done on the extent to which MA provides strategic information (Al-Hazmi 2010). This paper addresses this gap through exploring possible support provided by MA to corporate ES.

Developing a conceptual framework to investigate how MA supports ES processes represents a key component of this paper. The proposed conceptual framework is illustrated in Figure 1,

which explores the ES-MA linkages by considering whether MA provides useful environmental information needed to develop and implement the ES programs that represent a company' ES.

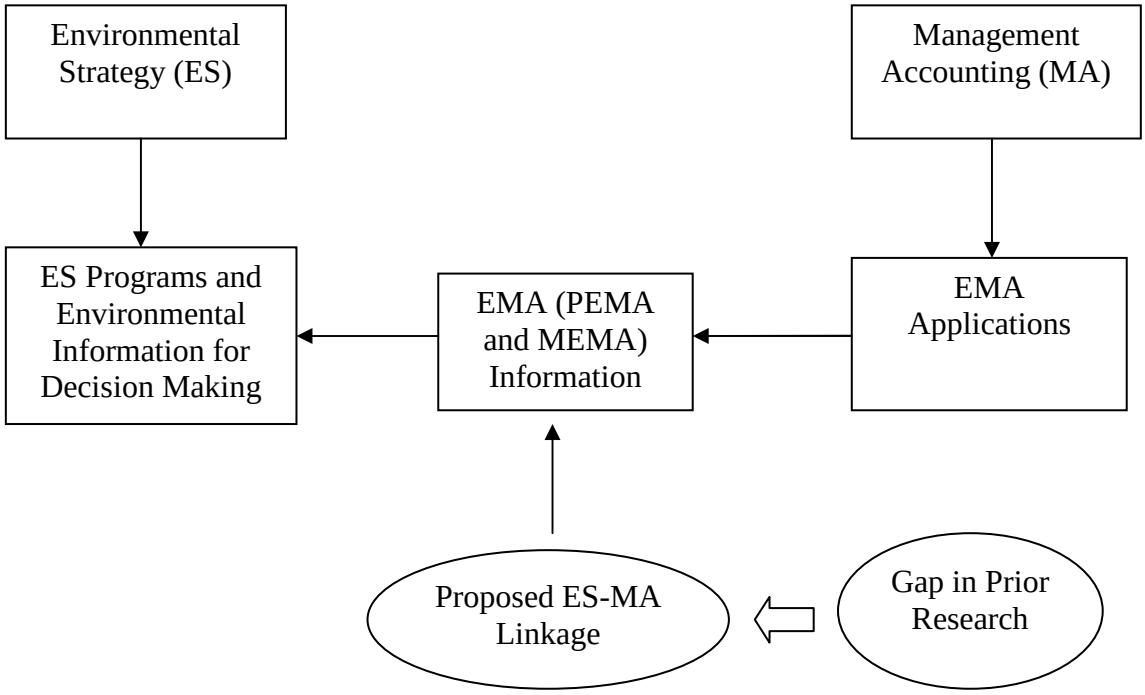

Figure 1: Proposed ES-MA Conceptual framework

ES and MA comprise two pillars in the ES-MA framework, which are connected by EMA information that matches the environmental information required by management for making ES decisions. Sections 4.1 and 4.2 explain the approaches used to analyse ES and MA, followed by Section 4.3 that considers ES-MA linkages, and Section 4.4 that introduces an EMA framework to classify the EMA information for making ES decisions at three management levels.

4.1. The ES Pillar

The approach to examine ES is developed from the literature review in Section 3.1. Al-Hazmi (2010) recommends that developing and implementing ES involves converting the strategy into environmental programs and activities, for which managers need useful information to plan, coordinate and control. The ES programs represent top management's expected activities and behaviours towards business units, and a means to achieve the effective coordination and control among the headquarters and lower management levels (Epstein and Roy 2007).

Table 1 in Section 3.1 suggests four groups of diverse environmental activities identified in prior research for ES development implementation. These groups are used in this study to examine ES and are referred to as the ES Program 1 Operations (Group 1), ES Program 2 Capital Investments (Group 2), ES Program 3 Product and Process Design (Group 3), and ES

Program 4 Environmental Performance (Group 4). Environmental activities range from compulsory compliance with international and national regulations (*reactive* ES) to voluntary initiatives (*proactive* ES), or focusing on green products (*market* ES) and the relationships with stakeholders (*non-market* ES). Undertaking these activities requires decisions on controlling environmental costs, appraising capital projects, designing green processes and products, and evaluating the environmental outcomes.

4.2. The MA Pillar

The MA system is traditionally regarded as the most significant information source for the decision making managers (Schaltegger and Burritt 2000). Similarly, Parker (2005) suggested that management accountants can determine the most useful information for managers, either physical or monetary, historical or predictive, so management can identify the areas and magnitude of environmental costs as well as the potential benefits of controlling these costs.

MA can employ suitable tools and techniques to assist management in converting ES into quantifiable objectives for implementation, and in monitoring environmental performance (Epstein 1996a, Smith and Lambell 1997). As MA conventionally supports management through the provision and use of accounting information, it makes sense that MA should be involved in sustainability-related management activities, which include environmental activities (Zvezdov et al. 2010). When supporting environmental decision making, MA is referred to as EMA.

Thus, it is logical to study the MA pillar in Figure 1 through examining what EMA applications are employed by a company's MA, what EMA information is generated, and if this EMA information matches the company' environmental information needs. The potential EMA applications and information useful for decisions on ES programs combines physical measures (PEMA) and monetary information (MEMA) on environmental costs, capital investments, process and product design, and environmental performance.

4.3. The ES-MA Linkage

Section 3.2 suggests a number of EMA applications that generate MEMA and PEMA information for making decisions on ES programs. For example, EMA costing tools can be employed to generate the EMA information on costs. These applications allow MA prepare budgets for environmental activities, analysing and reporting the actual quantities and associated costs for resources consumed and products sold. Alternatively, MA can use the capital evaluation techniques to help management determine a project's financial and non-financial feasibility. This EMA information is particularly useful if a capital project spans many years and MA has to prepare certain reports on the project's annual revenue and expenses. Regarding product and process design, the LCA and FCA techniques enable MA to analyse the expected environmental costs and benefits associated with a new product or process. Finally, MA can create KPIs such as the EBS, which provides EMA information for periodic performance reports.

The first column in Table 2 below represents the ES pillar in Figure 1 above and summarises the four ES programs based on which a company's ES is investigated. The environmental information required for making decisions on these four ES programs are labeled ES 1, ES 2, ES 3 and ES 4, respectively. The third column refers to the MA pillar in Figure 1, listing possible EMA applications employed by a company's MA and five types of EMA

information generated by these applications for making ES decisions. These are Type 1 (PEMA) physical environmental measures, Type 2 (MEMA) environmental costs, Type 3 (MEMA) capital investments, Type 4 (MEMA) process and product design, and Type 5 (MEMA) environmental performance. The middle column shows the proposed ES-MA linkages represented by the potential matches between the required ES information for each ES program and the EMA information provided by MA.

- The ES-MA linkage for ES Program 1 exists if Type 1 (PEMA) and Type 2 (MEMA) information match the required environmental information for making decisions on ES Program 1 (ES 1).
- The ES-MA linkage for ES Program 2 exists if Type 1 (PEMA) and Type 3 (MEMA) information match the required environmental information for making decisions on ES Program 2 (ES 2).
- The ES-MA linkage for ES Program 3 exists if Type 1 (PEMA) and Type 4 (MEMA) information match the required environmental information for making decisions on ES Program 3 (ES 3).
- The ES-MA linkage for ES Program 4 exists if Type 1 (PEMA) and Type 5 (MEMA) information match the required environmental information for making decisions on ES Program 4 (ES 4).

Table 2: Proposed ES-MA Linkages

Environmental Strategy	ES-MA Linkage	Management Accounting
Program 1 Operations and Information required (ES 1)	ES 1 – Type 1 (PEMA) ES 1 – Type 2 (MEMA)	**EMA applications:** • activity based costing (ABC) • life-cycle analysis (LCA • full cost accounting (FCA) • total cost assessment (TCA) • costing frameworks • others **EMA Information:** Type 1 PEMA - physical environmental measures Type 2 MEMA - environmental costs Type 3 MEMA - monetary information about capital projects Type 4 MEMA - monetary information associated with the green processes/products Type 5 MEMA - monetary environmental performance measures
Program 2 Capital Investments and Information required (ES 2)	ES 2 – Type 1 (PEMA) ES 2 – Type 3 (MEMA)	
Program 3 Product and Process Design and Information required (ES 3)	ES 3 – Type 1 (PEMA) ES 3 – Type 4 (MEMA)	
Program 4 Environmental Performance and Information required (ES 4)	ES 4 – Type 1 (PEMA) ES 4 – Type 5 (MEMA)	

Once the potential ES-MA linkages have been identified, the ES-MA conceptual framework suggests the EMA framework developed by Burritt et al. (2002 pp.39-50) be used by three management levels to select appropriate EMA applications and information for making strategic environmental decisions. For example, in a study by Burritt et al. (2009), the EMA

framework provides useful information for managers to determine the most beneficial projects that mitigate environmental and social impact from the rice milling process. In another study by Burritt and Saka (2006), the EMA framework identifies the appropriate PEMA and MEMA information for measuring eco-efficiency in six Japanese companies. These studies provide evidence that the EMA framework is useful in analysing EMA information for strategic environmental purposes.

4.4. The EMA Framework

The EMA framework (Table 3) recognises PEMA and MEMA information based on time frame (past oriented/future oriented), length of time frame (short term/long term), and routineness of information (ad hoc/routine) produced (Burritt et al. 2002)).

Table 3: The EMA Framework (Burritt et al. 2002 pp.39-50)

		Environmental Management Accounting (EMA)			
		Monetary Environmental Management Accounting (MEMA)		Physical Environmental Management Accounting (PEMA)	
		Short-term Focus	**Long-Term Focus**	**Short-term Focus**	**Long-Term Focus**
Past Oriented	Routinely generated information	Environmental cost accounting (e.g. variable costing absorption costing, activity based costing)	Environmentally induced capital expenditure and revenues	Material and energy flow accounting (short term impacts on the environment – product, site, division and company levels)	Environmental (or natural) capital impact accounting
	Ad hoc information	Ex post assessment of relevant environmental costing decisions	Environmental life cycle (and target) costing Post investment assessment of individual projects	Ex post assessment of short term environmental impacts (e.g. of a site or product)	Life cycle inventories Post investment assessment of physical environmental investment appraisal
Future Oriented	Routinely generated information	Monetary environmental operational budgeting (flows) Monetary environmental capital budgeting (stocks)	Environmental long term financial planning	Physical environmental budgeting (flows and stocks) (e.g. material and energy flow activity based budgeting)	Long term physical environmental planning
	Ad hoc information	Relevant environmental costing (e.g. special orders, product mix with capacity constraint)	Monetary environmental project investment appraisal Environmental life cycle budgeting and target pricing	Relevant environmental impacts (e.g. given short run constraints on activities)	Physical environmental investment appraisal Life cycle analysis of specific project

Three management groups are identified by Burritt et al. (2002) as EMA users together with their needs for environmental information and choices of suitable EMA tools. These are top management, production managers and other divisional managers. Top management often requires strategic, long-term accounting information for decisions at the corporate level. Their choice would be MEMA tools to assist with strategic decisions on regular long-term monetary capital investments, or with appraisal decisions for ad hoc individual environmental projects involving substantial capital expenditures. They may also choose routine long-term MEMA planning tools for environmentally driven research and development plans, or ad hoc short-term investment appraisal tools such as NPV for large single projects.

On the other hand, production managers only require accounting information that is specifically related to production. As production managers primarily plan and control physical rather than monetary processes, their required information is normally expressed in physical terms such as units of products, tonnes of raw materials, joules of energy or litres of water. Thus, production managers tend to prefer PEMA tools, especially short term PEMA tools that provide routine material and energy flow information. Lastly, divisional managers are accountable to top management for their own performance and their divisional performance, which often involves assessing costs and revenues. Thus, MEMA tools are their preferred options to deliver short-term routine key performance indicators for both individuals and divisions.

5. Methods

Qualitative research strategy was selected in this study to typically address "how" ES processes originate and occur, which distinguishes it from quantitative research that focuses on measuring and analysing causal relationships between variables (Denzin and Lincohn 2008 p.14). Furthermore, this study examines possible linkages between ES and MA, a topic has been neglected in previous studies (Al-Hazmi 2010, Parker 2005, Zvezdov et al. 2010), thus represents "a problem or issue that needs to be explored" (Creswell 2007 p.39) and "a concept or phenomenon needs to be understood because little research has been done on it" (Creswell 2009 p.18). Each company's ES and MA practices are considered within its individual context without the researcher's influence. That is, the study aims to look at "things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them" (Denzin and Lincohn 2005 p.3) in order to "get a better understanding of the subject matter at hand" (Denzin and Lincohn 2008 p.5). Hence, the qualitative approach is suitable.

The case-based method is seen as the best fit for studies seeking to address a "how" question (Yin 2003 pp.5-9), and as a qualitative inquiry tool commonly employed to discover a process, program, or individuals in depth (Stake 1995 & 2008 p.119). Case studies are useful if the researcher "deliberately wanted to cover contextual conditions – believing that they might be highly pertinent to your (the researcher's) phenomenon of study" but has no control over these matters (Yin 2003 pp.5-13). Moreover, multiple cases allow comparing and contrasting the cases' findings (Creswell 2007 p.76). These features exist in this study.

Case study method is also more frequently selected for management accounting research than for other accounting areas (Cooper and Morgan 2008). Major strands of management accounting studies, which employ the case approach, address a number of significant topics. Examples include: 1) how accounting information relates to business strategy and strategic management accounting (SMA) (e.g. Al-Hazmi 2010, Henri 2006, Jorgensen and Messer

2010, Langfield-Smith 1997, Roberts 1990, Roslender and Hart 2003, Skærbæk and Tryggestad 2010, Tillman and Goddard 2008), 2) the implementation of managerial accounting systems, tools and techniques to account for environmental issues (e.g. Agbejule 2006, USEPA 1995b, USEPA 1997), 3) the application of EMA practices (e.g. Burritt et al. 2009, EPA Victoria 2003, Graff et al. 1998, ICF Incorporated 1996, Scavone 2006, Shields, Beloff and Heller 1996), 4) management accounting changes (e.g. Barbera 1994, Guerreiro, Pereira and Frezatti 2006, Vaivio 1999, Waweru, Hoque and Uliana 2004), and 5) critical comments on case study methodology in management accounting (e.g. Ahrens and Dent 1998, Baxter and Chua 1998 & 2003, Keating 1995, Merchant and Van der Stede 2006). Given this study embarks on a significant MA topic, it makes sense to choose the case-based approach.

Additionally, the mixed research method is used to the extent that a preliminary questionnaire survey was conducted to gather broad information on ES and MA adopted by a large number of Australian companies[3]. Since the ES-MA linkage has attracted insufficient research attention, the questionnaire responses are likely to provide evidence on how these companies manage their environmental issues and whether their management accounting supports their environmental management. The questionnaire is also a means to identify voluntary companies for the multiple case studies.

Accordingly, this study was conducted in three phases. Phase 1 involved the preliminary questionnaire. Phase 2 comprised three pilot companies, aiming to test the application of the ES and MA themes and codes established later in this section, and of the ES-MA conceptual framework developed in Section 4. Lastly, Phase 3 researched six final companies based on data collected from the semi-structured interviews with these companies and their written documents.

5.1. Case Company Selection

The case study companies were selected using a combination of convenience and snowball sampling. Given the difficulty in obtaining permission from potential companies to participate in the multiple case studies, convenience and snowball sampling methods were appropriate (Biernacki and Waldorf 1981, Devie, Josua and Yohanes 2008, Handcock and Gile 2011, Trow 1957).

Six companies in the sample were chosen in three steps. The first step involved the structured questionnaire being sent to 123 Australian companies across twenty four industry sectors listed in the Osiris database in 2009. Osiris is a comprehensive database that lists companies, banks and insurance companies around the world (Bharat Book Bureau 2011). The questionnaire concluded with a question asking whether the participating companies would like to take part in a case study. Three companies were selected as possible study cases following their confirmation to participate as stated in the returned questionnaire. One company was dropped out since the contact person left the company after all arrangements had been made for an interview and work visit. However, a private company was personally introduced to the researcher and thus selected as the substitute.

Next, an introduction letter was sent to the Australian companies listed in the "Energy" (234 companies) and "Utilities" (37 companies) sectors on the Australian Stock Exchange (ASX) as at June 2010 (ASX 2010), requesting their voluntary participation in a case study. Three

[3] The questionnaire is available from the author.

energy companies indicated their willingness to participate. Finally, six companies were decided for the study sample, with three belonging to the banking, packaging and manufacturing sectors while the other three are in the energy sector. Except for the manufacturing company, the other five are listed on the ASX.

5.2. Data Collection

Data is often collected from four main sources, which include a structured preliminary questionnaire, three pilot studies, semi-structured interviews with the companies' Chief Finance Officers and/or Sustainability Managers, their written documents, and corporate websites (Creswell 2007 p.143, Yin 2003). The questionnaire was pre-tested for errors and clarity and to make sure the questions were carefully-developed and understandable prior to use (Al-Omiri 2007 p.512). The questions were drawn from prior literature on ES and MA covered in Section 2.

The diverse data types allow a researcher to triangulate findings within each case and across different cases, which improves the possibility of drawing valid conclusions from a case and strengthens the research credibility (Stake 2008 p.133, Yin 2003 pp.97-101). Moreover, combining data from the large-scale questionnaire survey (quantitative) and multiple case studies (qualitative) characterises the mixed research method employed as a supporting method in this study (Creswell and Plano Clark 2007 p.5).

As the final case companies requested complete confidentiality, they are labeled as Case Company 1 to 6 (CC 1-6) in this study. Eight in-depth interviews were conducted with the interviewees' positions described in Table 4.

Table 4: Case Company Interview Profiles

Company	Interview and Interviewees	Industry Sector
Company 1 (CC1)	One interview: Group Manager – Sustainability & Environment	Banking
Company 2 (CC2)	Two interviews: Chief Finance Officer	Packaging
Company 3 (CC3)	One interview: Chief Finance Officer	Manufacturing
Company 4 (CC4)	One interview: Chief Finance Officer	Energy
Company 5 (CC5)	Two interviews: Manager – Environmental Sustainability and Manager – Environmental Reporting	Energy
Company 6 (CC6)	One interview: Chief Finance Officer	Energy

The application of the conceptual framework developed in Section 4.3 requires data to be collected from the case companies' regarding how these companies develop and implement their ES, and whether they undertake MA systems and techniques that provide useful information for ES decision making. These kinds of ES and MA information are normally supplied by management personnel who are not easily accessible. As a result, on average only one interview with either the sustainability manager or the CFO was given for each company despite an interview request being previously made to both management groups.

The interviews lasted between 30 minutes and 2 hours. The interviews were digitally recorded with the interviewee's permission and transcribed to effectively capture data for

qualitative analysis (Heyes and Mattimoe 2004). Notes were taken during the interviews and additional notes were written down once each interview had finished (Jorgensen and Messner 2010 p.190). The list of interview areas was sent to the interviewees before each interview took place[4].

The data provided by the pilot questionnaire, pilot studies and interviews was triangulated with the case companies' documents on ES and MA as well as their websites. These predominantly comprise online annual financial reports, voluntary and regulatory sustainability and environmental reports, statements on environmental policies and guidelines, specific-purpose environmental reports, and other website data published over three years between 2009 and 2011. Some other documents were supplied by the interviewees during or after the interviews.

5.3. Data Analysis

Yin (2003) views the analysis of case study evidence as among the least defined and hardest part in undertaking a case study, and suggested one way to analyse case data is for it to be based on the research objectives. Similarly, de Vaus (2001 p.249) states the analytical methods used in case studies are "less systematically developed than are the techniques for analysing data collected with other types of research designs".

This study acknowledges the difficulty associated with the analytical aspect of case studies, combining Yin's (2003) suggestion and establishing the themes and coding terms to examine ES and MA aspects as recommended by Creswell (2003), Teddlie and Tashakkory (2009). Accordingly, the collected data was organised into two groups based on the ES and MA research objectives. The ES group contains the themes regarding the companies' level of interest in environmental issues, whether they have an ES, how they classify their ES, and their environmental programs during ES development and implementation. Each environmental theme requires the identification of the relevant coding points. The themes and corresponding coding points for the ES group are shown in Table 5.

Table 5: ES Themes and Codes

[4] The interview topics are available from the author.

ES Theme	Coding Concepts
Level of interest for environmental issues	- based on four levels: *highly interested, interested, partly interested,* and *not interested* Indicators of interest: - a separate department or functional area dealing with environmental issues - management support for and involvement in environmental issues - environmental training - environmental regulatory compliance - environmental reporting - environmentally competitive advantages - stakeholders' environmental engagement - green product and process design - environmental performance management
Having an ES?	Yes or No response
ES classification	- 1st classification based on the degree of an organisation's involvement in environmental management: *reactive, defensive, accommodative*, and *proactive*, or - 2nd classification based on a focus on green products/processes or a focus on stakeholder relationships: *market strategies*, or *non-market strategies*
Environmental programs	**Program 1: operation** Examples include recycling, waste management, resource savings, greenhouse gas emission reduction, pollution prevention, environmental regulatory compliance, consumer education programs, staff training, environmental awareness **Program 2: capital investment** Examples include research and development, environmentally sustainable operations, environmental budgeting, project evaluation **Program 3: product and process design** Examples include environmentally differentiated products, environmentally efficient processes, product life cycle analysis **Program 4: performance management** Examples include financial and non-financial environmental performance indicators, eco-efficiency measures, sustainability and environmental balanced scorecard

The MA group comprises information on MA. MA themes include whether the companies have a MA function and if yes, whether their management accounting processes and techniques generate useful information (EMA information) that assists management in making strategic environmental decisions. EMA information is divided into five categories, namely environmental mass balances, environmental costing, capital investments, design of products and processes, and environmental performance. The EMA information is subsequently classified based on three dimensions using the conceptual framework. Similar to the ES group, each MA theme requires the identification of the relevant coding points. Table 6 shows the MA themes and codes.

Table 6: MA Themes and Codes

Theme	Coding Concepts
Having a management accounting function?	- Yes or No response - whether management accounting separates from or forms part of the overall accounting unit
MA processes and techniques	- costing approaches: activity based costing (ABC), full cost accounting (FCA), total cost assessment (TCA), other costing frameworks, life-cycle analysis or assessment (LCA), product pricing, budgeting , others - evaluating capital investments: net present value, payback period, internal rate of return, others - designing business processes and products: environmental management system (EMS), cleaning production, green products, others - setting environmental performance indicators: sustainability and environmental balanced scorecard, eco-efficiency measures, others
EMA information	Type 1: mass balance or physical quantities of inputs, outputs, leakages and emissions Type 2: environmental costing - diverse environmental costs (resources, emissions, waste, maintenance costs, environmental charges and liabilities, clean-up provisions), and environmental revenues (subsidies, awards, others) Type 3: capital investments - discount rate, capital budgets, cash flow information, investment choices Type 4: process and product design – cost and benefit analyses of environmental friendly processes and products Type 5: environmental performance - financial and non-financial measures
Dimensions of MA process, techniques and information	- Length of time frame: short-term focus, long-term focus - Information routineness: ad hoc, routinely generated - Time frame: past oriented, future oriented

For each case company, confidentiality is requested regarding the pilot questionnaire responses and interviews, while most document viewings rely on a range of publicly available reports. This poses a challenge to the researcher during the analytical process to conceal the company names. Thus, the published reports, although explicitly referring to the specific companies, were stated in a way that hides the companies' identity.

6. Findings and Discussion

The findings and discussion are divided into those for the pilot phase, which include the preliminary questionnaire and three pilot cases, and the six final cases.

6.1. Pilot Phase: Preliminary Questionnaire and Pilot Cases

This section analyses the findings from the preliminary questionnaire survey and three pilot cases, and draws the implications for the final case design and data collection procedures.

6.1.1. Preliminary Questionnaire

The survey response rate is about 18% with 15 among 123 companies completing the questionnaire. The low response rate is practically justified given the main purpose of the preliminary survey being to gain an overview on the companies' ES and MA, with the research focus being the final case studies. The survey findings are related to the research question and three implications are drawn for the final case design.

First, the evidence on ES covers all environmental themes and codes, proving a reasonable expectation that these themes and codes would be applicable to the ES practices undertaken by the final case companies. Second, a company may have an interest in environmental issues but does not develop and implement an ES. Although it is almost impossible to deduct any reason from the survey results, the reasons are likely to be obtained from the interviewees who represent six case companies. Lastly, no detailed information was given for four environmental programs by the survey participants. While the survey questions were not originally designed to receive such details, the information is needed for applying the ES-MA conceptual framework and eventually achieving the study objectives. Thus, careful attention is required to ensure sufficient information on various ES programs is included in the multiple-source data collected for six case companies.

6.1.2. Three Pilot Cases

The pilot studies involved three Australian companies. These are BlueScope Steel Limited (BlueScope Steel), CSR Limited (CSR), and Telstra Corporation Limited (Telstra), which operating in the materials, capital goods, and telecommunication services industry, correspondingly. These pilot cases do not form part of the final case studies. The pilot cases serve the principal purpose of testing the coding and analysis techniques, and thus represent an early attempt to explore the ES-MA association.

Four implications were drawn from the pilot companies for the final cases. First, the pilot cases indicate diverse ES and MA practices adopted by the pilot companies. Thus, their ES-MA linkages differ among companies and across industries. Hence, compared to the single-case design, the multiple-case design would likely earn substantial analytical benefits from comparing and contrasting ES and MA among companies if they were selected from different industries.

The second implication relates to the trial application of the ES-MA conceptual framework. As discussed in Section 4, the ES-MA framework requires matching MEMA and PEMA information provided by MA applications to the information required by management to make strategic environmental decisions. In the pilot cases, the matches reveal the varying extents of concentration and nature in their ES-MA linkages. However, the focus is solely on the PEMA-ES link and nothing was found for the MEMA-ES link. This indicates that these companies tend not to provide the monetary measures for their environmental accounting and rely predominantly on the physical measures. That is, data collected from the pilot companies' publicly available documents are insufficient for the ES-MA framework application. Thus, the interviews and internal document viewing in the final case studies should be particularly planned to obtain relevant information for analyses and subsequently to conclude on any potential ES-MEMA connection.

Third, it appears that analysing the pilot companies' published data can easily determine whether an ES exists, their ES classification, ES programs, and environmental information

needs. It is largely unlikely, however, to reflect on their MA themes and codes due to a lack of MA data found in their externally disclosed documents. Hence, it is crucial to employ the multiple data sources for the final cases with a special focus on the interviews and internally circulated documents. These data sources would enable a thorough understanding of both ES and MA aspects in each case company.

Finally, consideration should be given to flexible interview questions. This is because the pilot case findings reveal a great diversity in three companies' environmental programs. There is a possibility that their MA activities may differ although the findings offer no indication on this aspect. To accommodate these potential differences, the interview schedule should only specify ES and MA topics, from which the interview questions would be raised and adjusted where needed to reflect the individual case company's circumstances.

6.2. Final Case Companies

This section will discuss the final case companies' findings with the companies being labeled CC1, CC2, CC3, CC4, CC5 and CC6 to preserve confidentiality. The companies are divided into the well-established group and the newly formed group. The established companies (CC1, CC2 and CC3) operate in the financial, packaging, and manufacturing industries, respectively. The newly formed group (CC4, CC5 and CC6) belongs to the energy industry.

6.2.1. Case Company 1 (CC1)

CC1 is a well-established Australian financial services company listed on the ASX. The group company employs more than 40,000 employees and has about two thousand branches in Australia and overseas. CC1 outsources its EMS, environmental reporting system (ERS) and selected financial services.

The findings indicate that CC1's *proactive* and *market* ES is largely influenced by its background factors. First, being a financial services provider means the environmental impact of CC1's operations distinguishes it from that caused by a manufacturing company. Second, the multinational structure requires CC1 to incorporate the country-specific environmental legislations and practices into its ES programs. Third, being a listed company implies CC1's stronger commitment to undertake environmentally sustainable practices for a better public image and eventually higher profits. Fourth and last, as a well-established and large company, CC1 has or is able to acquire sufficient resources for running its diverse ES programs and environmental activities.

When developing and implementing its ES, CC1 converts its ES into the ES programs, being the ES Program 1 Operations, Program 2 Capital Investments, Program 3 Process and Product Design, and Program 4 Environmental Performance. Specifically, CC1 outsources its ERS to an external company (CC1Ex). The ES-MA conceptual framework, ES and MA themes and codes are capable of capturing the company's four ES programs (Appendix 1).

There is strong evidence of CC1's ES-MA linkages, which is indicated by the sufficient and appropriate PEMA and MEMA information for making strategic decisions on its four ES programs. The ES-MA link is minimal for the ES Program 3 and only relates to Type 1 PEMA without Type 4 MEMA. The link is stronger for the other three programs, which exists for both Type 1 PEMA and Types 2, 3 and 5 MEMA.

The EMA information is collectively provided by CC1's internal MA and outsourced ERS managed by CC1Ex. Compared to the external CC1Ex, CC1's internal MA mostly generates the MEMA information on capital project evaluation for the ES Program 3 and thus plays a less significant role in CC1's ES processes. By contrast, CC1's outsourced ERS generates both PEMA information for all ES programs and MEMA information for the ES Programs 1 and 4 with the PEMA information dominating the MEMA types. From this aspect, the ERS is more advanced than CC1's internal MA in supporting the company's ES by generating the physical measures that are not provided by the conventional MA. Collectively, the internal MA function and external ERS resemble an EMA system that stores, analyses and reports adequate PEMA and MEMA information for strategic decision making.

6.2.2. Case Company 2 (CC2)

CC2 is an Australian packaging company with the head office located in Australia, and is listed on the ASX. The company manufactures a diverse range of packaging products for industrial, commercial and domestic purposes. The group company operates in more than 45 countries and employs about 35,000 people. CC2's strong commitment towards sound environmental practices is demonstrated its dedication to develop an internal software program (ASSET) to manage the environmental impacts throughout its packaging products' lifecycle, as well as to implement an in-house resource database that generates financial and non-financial information for management decision making on the ES programs.

CC2's *proactive* and *market* ES is identified through four comprehensive ES programs on Operations, Capital Investments, Process and Product Design, and Environmental Performance (Appendix 2). The company's MA supports its ES by providing monetary environmental (MEMA) information for strategic decisions on the ES programs 1 and 2. Concurrently, the evidence indicates the contribution made by CC2's MA has not gone beyond the conventional MA role. Instead, the company's non-MA divisions make up the gap, collectively generating all PEMA and other MEMA information for the ES programs from the ASSET tool and in-house database. The associated ES-MA linkages are found between the four ES program regarding both MEMA and PEMA information.

CC2 seems to consider the MA function as just performing the conventional costing and budgeting tasks. In the long term, the company's management tends to rely on the ASSET tool and resource database managed by the non-accounting divisions to obtain sufficient physical environmental information to plan, coordinate and control its ES programs. The limited support provided by CC2's MA to its ES processes implies a weak ES-MA linkage for the company. Nevertheless, CC2's ASSET tool and in-house database managed by the non-MA units offer an alternative solution to broaden the inadequate ES-MA relationship.

6.2.3. Case Company 3 (CC3)

CC3 is a private Australian manufacturer. The company produces more than 1000 metal casting products to serve both domestic and overseas markets. Its *accommodative* and *non-market* ES comprises two ES programs on Operations and Capital Investments, but dominantly the ES Program 1 Operations. CC2's MA solely provides the useful EMA information for environmental decisions. The ES-MA linkages exist between both ES programs and Type 1 PEMA or Type 3 MEMA (Appendix 3).

6.2.4. Case Company 4 (CC4)

CC4 is a publicly listed Australian company operating in the energy sector. The company utilises the UCG technology to process the coal in the underground coal seams without having to bring it to the surface. The UCG technology is cost effective and environmentally friendly compared to the traditional method that converts coal into energy in a coal-fired power station.

CC4's case findings indicate the company is progressing through the setup stage in its business cycle. The lifecycle factor seems to have the biggest influence over CC4's *accommodative* and *non-market* ES compared to the other factors being its industry, company size, public listing status, and domestic operations. At the corporate level, the company's ES is developed to maintain a clean public image and to obtain an authoritative approval the commencement of its new green energy projects. Subsequently, its ES implemented through the only ES Program 1 Operations. MA does not perform outside its conventional costing and budgeting tasks, nonetheless supporting the company's ES by providing cost and budget information to make strategic decisions on the only ES program. This evidence represents an association between CC4's ES Program 1 and MEMA information (Appendix 4).

6.2.5. Case Company 5 (CC5)

CC5 is a publicly listed Australian company operating in the energy sector. The company has progressed towards becoming a world leading producer of sustainable renewable energy. CC5 produces biofuels from non-food and energy-dedicated crops grown on the marginal and waste lands. CC5's operations span Australia and overseas, collectively delivering more than 100 million gallons of biodiesel annually. The two core business areas are plantation and refining.

The case findings indicate CC5's *accommodative* and *non-market* ES which is converted into the ES Program 3 Product and Process Design where the whole production process is designed to be, and accredited as, environmentally sustainable (Appendix 5). However, the company's MA virtually provides no support to its ES development and implementation. The MA function only carries out its conventional tasks, preparing the standard financial and operational reports, which combine any possible EMA information into the company's ordinary revenues and expenses.

6.2.6. Case Company 6 (CC6)

The final company in the sample, CC6, is a publicly listed Australian energy company that focuses on exploring and developing the geothermal resources for future power generation. The company creates a competitive advantage through utilising an innovative exploration methodology, building a prospective on-grid geological setting, and coordinating with the downstream operators.

The case findings show CC6's informal and *accommodative* and *non-market* ES with a focus on the environmental compliance activities under the ES Program 1 Operations. The MA function in the accounting department carries out the activity-based costing and budgeting techniques, generating the useful MEMA information to support this only ES program (Appendix 6).

6.2.7. Cross-Case Discussion

All six companies are highly interested in environmental management and dedicate their best effort to minimise the environmental impact. Their ES are determined by five factors: their industry, global operations, listing status, company size, and business lifecycle. These factors result in the companies' ES ranging from an *accommodative* to *proactive* level, and being converted into the different ES programs for development and implementation. Except for CC5 without any ES-MA linkage, the MA function in CC1-CC4 and CC6 utilises the limited EMA applications and provides some EMA information for decisions on their ES programs.

The established companies CC1-CC3 follow a more advanced ES with four ES programs mainly due to their long-term operations, larger size and multinational structure. These companies' EMA information ranges from Type 1 PEMA to all Types 2-5 MEMA. Conversely, the newly formed companies CC4 and CC6 show a limited ES-MA linkage between their ES Program 1 Operations and Type 2 MEMA on environmental costs. This finding is adequately explained by their *accommodative* ES, which is primarily influenced by their early lifecycle status and is converted into one ES program for development and implementation. Furthermore, their EMA information is minimal, with only Type 2 MEMA found for CC4 and CC6 but no evidence of any EMA type for CC5. Accordingly, CC1-CC3 demonstrate the significantly stronger ES-MA linkages compared to CC4-CC6. It is noted, however, that CC1's outsourcing option and CC2's non-MA units are considered in conjunction with their internal MA to derive their comprehensive ES-MA association.

The findings also imply a potentially stronger ES-MA linkage at CC3, CC4, CC5 and CC6. The opportunities for MA to get more involved in the ES process vary among these companies, being subject to the five factors previously identified. For example, future MA engagement could be to establish the environmental KPIs (CC3), to implement a more advanced costing technique that produces future-oriented PEMA and MEMA information (CC4), to set up the ES Program 4 Environmental Performance (CC5), to commence the ES Program 3 Process and Product Design and to employ some new capital project evaluation techniques (CC6). However, no matter what the companies' MA may do to support their ES, there is no indication that they will likely form a separate MA business unit.

7. Contributions, Implications, and Limitations

This study offers a range of contributions and implications, and is also bear some limitations as discussed below.

7.1. Theoretical Contribution: The ES-MA Conceptual Framework

This study contributes to the existing ES and MA literature through the development and successful application of an ES-MA conceptual framework to investigate the association between a company's ES and MA. The convenient and systematic features of the framework originate from the themes and codes that are designed to capture the various aspects of a company's ES and MA in order to logically identify its possible ES-MA linkages. Additionally, the study illustrates an extended version of the ES-MA framework through its application to the EMA information generated by an outsourced MA or by non-MA units.

Convincing evidence has been gathered to conclude that management accounting supports environmental strategy in the case companies. Under the ES-MA conceptual framework, management accounting is found to employ diverse EMA applications to generate useful

EMA information for ES decision making. The quantity and type of PEMA and MEMA information vary between the two groups and among the companies within each group. The established group with a finely developed ES and more ES programs is found to have undertaken or outsourced a full range of EMA applications to generate sufficient EMA information for management decision making. Furthermore, the EMA framework developed by Burritt et al. (2002) is successfully applied to classify the EMA information based on three dimensions to assist management in planning, coordinating and evaluating the ES programs.

The study findings indicate a possibility for applying the ES-MA conceptual framework to companies across industries, publicly listed or private, either in the developing or mature phases of a business lifecycle, and with varying organisational sizes and multinational structure. The key issue is to identify the relevant ES programs that represent a company's ES, and the appropriate EMA applications that create the EMA information needed for making decisions on its ES programs.

7.2. Implications

Since the study sample comprises six companies with different backgrounds, the findings offer comprehensive practical and policy implications to a wide range of business scenarios. These implications are discussed below.

An established company is better prepared to diversify its ES programs compared to an emerging company since the former has operated for a longer time, and thus is able to identify more opportunities to benefit the environment. An established company in any industry, if concurrently being a large and global company, is well positioned to undertake a variety of mandatory and voluntary environmental projects, and should consider a more advanced ES and operate more ES programs than a small, domestic and private company. This is because the former can often afford to spend more on the environment, faces both domestic and international environmental rules, and experiences a greater public pressure to be environmentally responsible. Conversely, it makes sense for an emerging, small and domestic company to initially focus primarily on complying with the relevant environmental legislation and regulations.

Once a company has decided on an ES and the related environmental programs, it should consider the practical value of the ES-MA conceptual framework developed in this study, and the EMA framework established by Burritt et al. (2002). At a strategic level, the ES-MA conceptual framework offers a systematic approach that enables a company to assess whether its MA contributes to ES development and implementation. The potential support is represented by useful EMA information provided by MA for ES decision making on the ES programs. Upon identifying the existing MA support, a company is able to decide whether it needs to seek professional EMA services externally, or to engage non-MA units internally in its ES processes. At an operational level, the EMA framework analyses each EMA information group based on the timeframe, length of timeframe, and information routineness to suit the specific environmental decisions made by the top, divisional and production managers. It is recommended by Burritt et al. (2002) and also implied from this study that when employing the EMA framework, a company provides its different management levels with a practical tool to comprehend and to select the appropriate EMA applications and information for effective decision making.

A potential area that exists for all companies regardless of their background features is to draw on MA's significant support to manage future environmental liabilities. The Australian carbon tax is a prominent example, which came into effect from the 1st July 2012. It was stressed by some interviewees that carbon tax may considerably affect their business profitability, and that they would have to involve MA to a larger extent to manage the carbon tax consequences[5]. Accordingly, a company's MA can help by determining the payback period for the carbon project and by using an appropriate costing technique such as ABC to allocate the associated costs to the relevant business units.

A variety of MA options selected by the case companies are available to other companies. For example, outsourcing is the most applicable if a company wishes to supplement its insufficient MA skills. This is because the contracted EMA practices undertaken by an external consultant gives the best professional support to the company's ES compared to those companies having an in-house EMA. An alternative solution is to allocate some EMA applications to the company's non-MA units. The EMA information generated collectively by its internal MA, contracted MA and non-MA units enables management to make informed environmental decisions on environmental costs, capital investments, green process and product design, as well as performance evaluation. However, if a company sets out its ES to simply comply with the relevant environmental laws, it is not necessary to adopt the outsourcing option or to involve non-MA units in ES processes. Instead, the company may just assign the MA tasks to a general finance or accounting division.

The findings from this study also provide environmental policy makers with a broad view of the diverse environmental strategies and programs undertaken by the case companies and potentially by other businesses. Awareness of this diversity enables policy makers to consider companies' characteristics when planning future environmental legislation and policies. Particularly, understanding what environmental issues are experienced by the companies and how they manage those issues would assist policy makers in initiating a range of environmental projects and incentives targeting raw material efficiency, energy consumption, water usage, and waste reduction.

Environmental regulators should consider setting certain industry benchmark for environmental performance management. The lack of industry environmental standards was seen by the financial service company's interviewed manager as posing a considerable difficulty for CC1 in evaluating its environmental outcomes. Sufficient environmental benchmarks not only assist individual companies in establishing their own performance targets but also stimulate fair competition within or across industries.

The diversity in companies' ES practices, insufficient mandatory monetary environmental reporting and inadequate industry performance benchmarks collectively represent a need for the authorities to regularly review the existing environmental legislations, policies and other regulatory requirements. These regular reviews not only recognise exemplary practices but also identify emerging environmental issues that need properly handling on a timely basis.

7.3. Study Limitations

[5] All interviews were conducted before 1st July 2012 when the Australian carbon tax came into effect.

While this study has a range of contributions and implications, it demonstrates three main limitations.

The case study approach represents a generic drawback. This is the limited opportunity to theoretically generalise the findings to the other companies in the same or across industries. Instead, proposition development would be the best option.

The study explores whether MA contributes to ES, thus looking at the directional flow from MA to ES and how MA is informed by ES. The question on whether ES is driven by MA is excluded, which is another limitation.

The case sample involves both publicly listed and private business. This imbalance affects the data collection and cross-case discussion for the case companies. The listed companies face more external reporting requirements and apparently ES information is publicly available in higher volume and greater detail on their websites than the private one. Also, attention is needed when explaining the comprehensive ES programs taken by two large listed companies, which is likely to be influenced by their marketing strategy and public image protection. These aspects are not accounted for in the study.

8. Future Research Directions

The study findings open up several topics for future research in ES and MA. These potential topics aim to overcome the above research limitations. One focus is to test the theoretical proposition, which is drawn from the findings that MA supports corporate ES, on a larger sample size or more companies in the same or across industries.

Future research may embark on the same topic but include an even number of the public and private companies in the study sample. One option is to select those companies from both environmentally low-impact and high-impact industries in Australia.

Prior studies discuss the environmentally balanced scorecard as a useful approach to evaluate environmental performance (Burnett and Hansen 2008, Burritt and Saka 2006, Scavone 2006, Schaltegger and Burritt 2000). Although none among the case companies currently applies the EBS, an interviewed CFO indicated his strong interest in learning the approach for future application. Thus, researchers may consider the EBS as a potential research topic.

Finally, future research can examine the factors that influence a company's decision to implement an EMA system. Some examples emerge from the interviewees' personal opinions on further support provided by their companies' MA to corporate ES. One environmental manager anticipated that the outsourced EMA functions would eventually be undertaken internally once the company's management accountants are adequately trained. Another environmental manager thought his company would never involve MA in the environmental management processes more than the current level because the company regards "environmental strategy" as just discharging its mandatory environmental responsibilities. While a CFO could see the value in adopting EMA at certain point in a company's life cycle, another CFO considers accounting should be an integral part of a business in order to report on good practices, to highlight the areas for improvement, and subsequently to provide useful information for implementing changes.

9. Conclusions

This study has gathered convincing evidence to indicate a supporting association between corporate ES and MA, where MA is informed by ES. The support varies among the case companies depending on the companies' backgrounds that influence their ES, environmental programs, MA and EMA applications.

An ES-MA conceptual framework has been developed and systematically applied to the diverse data collected from the case companies. The framework allows the researcher to fully capture the companies' diverse ES and MA practices, then to effectively identify and analyse their ES-MA linkages. This successful application is enhanced by the opportunity to extend the framework to accommodate the companies' outsourced MA and non-MA support to ES. Despite some inevitable limitations, this study contributes greatly to the ES and MA literature by addressing a gap in the ES and MA research on the interaction between MA and corporate ES. Furthermore, this study delivers a range of important messages to companies and policy makers. While companies should involve MA in their ES processes, policy makers should account for companies' diverse background and ES-MA association when setting future environmental regulations and guidelines.

The collective findings from the preliminary questionnaire, three pilot cases, and six final cases not only investigate the various aspects of ES and MA in the business world, but also open up abundant opportunities for future research. Potential studies can either address the limitations associated with this research or follow the different directions on the same ES and MA topics. With sustainable development and climate change remaining a topical issue across the political and business agendas, future research on the interaction between corporate environmental strategy and management accounting will be highly valuable.

Appendix 1

Case Company 1 (CC1) Findings

Table A1.1: ES Themes and Codes for Case Company 1 (CC1)

ES Theme	ES Codes
Level of interest for environmental issues	- *highly interested*
Having an ES?	- *Yes*
ES classification	1st classification: *proactive* 2nd classification: *non-market* ES
Environmental programs	**Program 1: Operations** A focus on the carbon neutral program (CNP) • Phase 1: aiming to reduce GHG emissions through reducing energy consumption, purchasing renewable energy, and offsetting remaining emissions • Phase 2: achieving resource efficiency through reducing water, paper and energy consumption, plus minimising waste • requiring environmental information on physical quantities and costs of utility usage, and GHG emissions **Program 2: Capital Investments** • facilitating GHG emission reduction activities • requiring information on utility usage and costs, GHG emission reduction, project budgets, expected costs and benefits, payback period, net present value **Program 3: Product and Process Design** • introducing environmentally sustainable products and services • requiring information on GHG emission reduction **Program 4: Performance Management** • creating and managing environmental KPIs on utility consumption and GHG emissions • requiring information on relative measure (utility usage & GHG emissions per FTE), absolute measures (utility savings & GHG emission reduction)

Table A1.2: MA Themes and Codes for Case Company 1 (CC1)

Theme	Management Accounting Codes
Having a MA function?	Yes – as part of the finance team (MA)
MA processes & techniques - Costing approaches - Capital investment evaluating - Product/process designing - Setting environmental KPIs	• Costing approaches: activity-based costing (CC1Ex) • Capital investments: payback period, project evaluation tool (MA) • Performance indicators: environmental balanced scorecard (CC1Ex)
EMA information Type 1: mass balance Type 2: environmental costs Type 3: capital investments Type 4: process and product design Type 5: environmental performance	**Type 1: Mass balances (PEMA)** (CC1Ex) Physical quantities of inputs, outputs, leakages and emissions. • actual and forecast GHG emissions (t CO_2-e) by Scope, region, generating activity, per FTE, emission source • actual and forecast carbon offsets (tonnes) • electricity (kWh), gas (gigajoules), diesel (Kl), paper (tonnes), green power purchased (kWh & percentage of total power sources) • recycled materials & waste (tonnes): recycled paper, printer cartridges, co-mingled recyclables, mobile phones, cardboard, food • transport & travel data: work-use vehicles (vehicle number), work-use vehicle travel (kms), air travel (pkms), hotel stays (nights) • water and trade effluent discharge (kL) • refrigerant leaks (grams) • targeted GHG emissions (tonnes): building energy (electricity, gas, diesel), and targeted paper use reduction per FTE (kg/FTE) • paper purchased with recycled content (%) • targeted water use increase per FTE • targeted waste reduction per FTE • building area (square meters) • GHG emissions (t CO_2-e) from sustainable products and services • paper purchased (kg) per FTE • stationary and transport energy per square meter (GJ/m2) • stationary and transport energy per FTE (GJ/FTE) **Type 2: Environmental Costs (MEMA)** (CC1Ex) • $ spent on energy consumption and savings • $ spent on green power purchases • $ spent on carbon offsets • $ spent on resources per annum **Type 3: Capital Investments (MEMA)** (MA) • allocated budgets, costs and savings of capital projects • payback period of capital projects **Type 4: Process and Product Design** Not available **Type 5: Environmental Performance (MEMA)** (CC1Ex) Environmental performance indicators: absolute and relative environmental KPIs in monetary term
Dimensions of MA process, techniques and information	• past and future oriented • long-term and short-term • ad hoc and routine

Table A1.3: ES-MA Linkages for Case Company 1 (CC1)

Environmental Strategy	ES-MA Linkage	Management Accounting
Program 1 Operations (ES 1) 1.1 Focus on the carbon neutral program (CNP) with two phases • Phase 1: reducing GHG emissions through reducing energy consumption, purchasing renewable energy, and offsetting remaining emissions • Phase 2: achieving resource efficiency through reducing water, paper and energy consumption, plus minimising waste **Information required (ES 1.1)** • physical units of utility and resource usage, and GHG emissions • costs of utility, resources including green power, and carbon offsets	ES 1.1 – Type 1 (1.1) PEMA ES 1.1 –Type 2 (1.1) MEMA	**EMA applications** • activity-based costing (CC1Ex) **EMA Information** **Type 1 (1.1) PEMA:** Physical quantities of resource usage and related GHG emissions • GHG emissions and carbon offset (tonnes) • energy and other resources used and purchased (absolute and relative units) • recycled materials (tonnes) • waste (tonnes) • transport and travel data in units • refrigerant leaks (grams) • building area (square meters) **Type 2 (1.1) MEMA:** environmental costs • $ spent on Phase 1 activities: energy reduction, renewable energy purchases, carbon offsets • $ spent on Phase 2 activities: energy efficiency (waste, water, and paper)
Program 2 Capital Investments (ES 2) Facilitate GHG emission reduction activities • green-star office buildings, data centres, tri-generation plant **Information required (ES 2.1)** • physical units of utility and resource usage, and GHG emission reduction • costs of utility and GHG emission reduction, • project budgets, expected costs and benefits • payback period, net present value of capital projects	ES 2.1 – Type 1 (2.1) PEMA ES 2.1 –Type 3 (2.1) MEMA	**EMA applications** • payback period, project evaluation tool (MA) **EMA Information** **Type 1 (2.1) PEMA:** physical quantities • building area (square meters) • GHG emissions (t CO_2-e) by Scope, region, generating activity, per FTE, and emission source • resource usage: energy (gigajoules) **Type 3 (2.1) MEMA:** monetary information for capital projects • budgets for environmental programs • payback period

Program 3 Product and Process Design (ES 3) • introducing environmentally sustainable products and services **Information required (ES 3.1)** • GHG emission reduction related to capital projects	ES 3.1 – Type 1 (3.1) PEMA No match: ES 3.1 – Type 4 (3.1) MEMA	**EMA applications:** • Not available **EMA Information:** **Type 1 (3.1) PEMA:** physical quantities • GHG emissions (t CO_2-e) from sustainable products and services **Type 4 (3.1) MEMA**: monetary information associated with the green processes/products • Not available
Program 4 Environmental Performance (ES 4) • creating and managing environmental KPIs on utility consumption and GHG emissions **Information required (ES 4.1)** • units of utility and resource usage per FTE • units of GHG emissions per FTE • absolute units of utility and resources savings • units of GHG emission reduction • absolute and relative costs of energy and resource usage, GHG emissions	ES 4.1 – Type 1 (4.1) PEMA ES 4.1 –Type 5 (4.1) MEMA	**EMA applications:** • environmental balanced scorecard (CC1Ex) **EMA Information:** **Type 1 (4.1) PEMA:** physical quantities • paper purchased (kg) per FTE • stationary and transport energy per square meter (GJ/m2) • stationary and transport energy per FTE (GJ/FTE) **Type 5 (4.1) MEMA:** $ equivalent of KPIs • absolute and relative environmental KPIs in dollars

Table A1.4: The EMA Framework for Case Company 1 (CC1)

		Environmental Management Accounting (EMA)			
		Monetary EMA (MEMA)		**Physical EMA (PEMA)**	
		Short-term Focus	Long-term Focus	Short-term Focus	Long-term Focus
Past Oriented	Routinely Generated Information	Type 2, 5	Type 2	Type 1	Type 1
	Ad hoc Information			Type 1	Type 1
Future Oriented	Routinely Generated Information	Type 2	Type 2	Type 1	Type 1
	Ad hoc Information		Type 3	Type 1	Type 1

Appendix 2

Case Company 2 (CC2) Findings

Table A2.1: ES Themes and Codes for Case Company 2 (CC2)

ES Theme	ES Codes
Level of interest for environmental issues	- *highly interested*
Having an ES?	- *Yes*
ES classification	1st classification: *proactive* 2nd classification: *market* and *non-market* ES
Environmental programs	**Program 1: Operations** • aiming to reduce GHG emissions and waste to landfill • achieving resource efficiency through reducing water and energy consumption • requiring information on physical quantities and costs of GHG emissions, waste to landfill, and resource (water and energy) usage • requiring information on environmental revenues from the sales of sustainable energy certificates • requiring information on environmental taxes, fines, and penalties **Program 2: Capital Investments** • facilitating GHG emission reduction, waste management and resource efficiency activities • requiring information on GHG emission reduction, waste minimisation, usage and costs, project budgets, expected revenues and costs, payback period, net present value, actual capital expenditure (CAPEX) **Program 3: Product and Process Design** • introducing environmentally sustainable packaging products and services • requiring information on GHG emissions during product lifecycle, allocated budgets **Program 4: Performance Management** • creating and managing environmental performance indicators (EPIs) on GHG emissions, waste, and resource consumption • requiring information on relative measure (resource usage & GHG emissions per FTE), absolute measures (resource savings & GHG emission reduction), financial and non-financial measures

Table A2.2: MA Themes and Codes for Case Company 2 (CC2)

Theme	Management Accounting Codes
Having a management accounting function?	Yes – as part of the finance team
MA processes and techniques - Costing approaches - Capital investment evaluating - Product/process designing - Setting environmental KPIs	• Costing approaches: activity based (MA) • Capital investments: payback period (MA) • Product and service design: product lifecycle assessment (LCA) (non-MA) • Performance indicators: environmental performance indicators (non-MA)
EMA information Type 1: mass balance Type 2: environmental costs Type 3: capital investments Type 4: process and product design Type 5: environmental performance	**Type 1: Mass balances (PEMA)** (non-MA) Physical quantities of inputs, outputs, leakages and emissions. • actual and forecast GHG emissions by Scope (tonnes) • actual and forecast resource usage: electricity (GJ), gas (GJ) • waste (tonnes) • water (litres) • GHG emission intensity (tonnes per production unit) • waste intensity (tonnes per production unit) • water use intensity (litres per production unit) • raw materials used and saved • recycled content and material recyclability (percentage) **Type 2: Environmental Costs (MEMA)** (MA) • $ spent on resource consumption and savings • $ spent on dumping and recycling waste • $ spent on water management activities **Type 3: Capital Investments (MEMA)** (MA) • allocated budgets for capital projects **Type 4: Process and Product Design** (non-MA) • $ spent on and savings on raw materials **Type 5: Environmental Performance (MEMA)** (non-MA) Environmental performance indicators: absolute and relative indicators
Dimensions of MA process, techniques and information	• past-oriented and future-oriented • long-term and short-term • ad hoc and routine

Table A2.3: ES-MA Linkages for Case Company 2 (CC2)

Environmental Strategy	ES-MA Linkage	Management Accounting
Program 1 Operations (ES 1) 1.1 Program focuses on • GHG emission reduction • waste minimisation • resource efficiency through reducing water and energy consumption **Information required (ES 1.1)** • physical quantities of GHG emissions, waste to landfill, and resource (water & energy) usage • costs of GHG emissions, waste to landfill, and resource (water and energy) usage • environmental taxes, fines, and penalties	ES 1.1 – Type 1 (1.1) PEMA ES 1.1 –Type 2 (1.1) MEMA	**EMA applications** • activity-based costing (MA) **EMA Information** **Type 1 (1.1) PEMA:** Physical quantities of resource usage and related GHG emissions • actual and forecast GHG emissions (tonnes) by Scope • actual and forecast energy usage (GJ) • waste (tonnes) • water (litres) **Type 2 (1.1) MEMA:** environmental costs • $ spent on environmental activities
Program 2 Capital Investments (ES 2) • Capital projects to facilitate GHG emission reduction, waste management and resource efficiency activities **Information required (ES 2.1)** • quantity of GHG emission reduced, waste managed, water usage • costs of waste management • project budgets, expected revenues and costs, payback period, net present value, actual capital expenditure (CAPEX)	ES 2.1 – Type 1 (2.1) PEMA ES 2.1 –Type 3 (2.1) MEMA	**EMA applications** • payback period (MA) **EMA Information** **Type 1 (2.1) PEMA:** physical quantities • planned and actual GHG emission reduction brought by capital projects **Type 3 (2.1) MEMA:** monetary information for capital projects • budgets for capital projects • payback period • CAPEX funding
Program 3 Product and Process Design (ES 3) • environmentally sustainable packaging products and services **Information required (ES 3.1)** • GHG emissions during product lifecycle • project allocated budgets	ES 3.1 – Type 1 (3.1) PEMA ES 3.1 –Type 4 (3.1) MEMA	**EMA applications:** • product lifecycle assessment (LCA) (non-MA) **EMA Information:** **Type 1 (3.1) PEMA:** physical quantities • GHG emissions (tonnes) from environmentally sustainable products • raw material usage • recycled content (percentage) and recyclability of material **Type 4 (3.1) MEMA**: monetary information associated with the green processes/products • raw material costs

Program 4 **Environmental Performance (ES 4)** • creating and managing environmental performance indicators (EPIs) on GHG emissions, waste, and resource consumption **Information required (ES 4.1)** • financial and physical measures: relative term (resource usage & GHG emissions per FTE) • financial and physical measures: absolute term (resource savings & GHG emission reduction)	ES 4.1 – Type 1 (4.1) PEMA ES 4.1 –Type 5 (4.1) MEMA	**EMA applications:** • environmental performance indicators (non-MA) **EMA Information:** **Type 1 (4.1)PEMA:** physical quantities • GHG emission intensity (emissions per production unit) • waste intensity (waste per production unit) • water intensity (water usage per production unit) **Type 5 (4.1) MEMA:** $ equivalent of KPIs • $ equivalent of performance indicators

Table A2.4: The EMA Framework for Case Company 2 (CC2)

		Environmental Management Accounting (EMA)			
		Monetary EMA (MEMA)		**Physical EMA (PEMA)**	
		Short-term Focus	Long-term Focus	Short-term Focus	Long-term Focus
Past Oriented	Routinely Generated Information	Type 2, 4, 5	Type 2	Type 1	Type 1
	Ad hoc Information	Type 2, 5	Type 2	Type 1	Type 1
Future Oriented	Routinely Generated Information	Type 2, 4	Type 2	Type 1	Type 1
	Ad hoc Information	Type 2	Type 2, 3	Type 1	Type 1

Appendix 3

Case Company 3 (CC3) Findings

Table A3.1: ES Themes and Codes for Case Company 3 (CC3)

ES Theme	ES Codes
Level of interest for environmental issues	- *high interested*
Having an ES?	- *Yes*
ES classification	1st classification: *accommodative*
Environmental programs	**Program 1: Operations** • targeting regulatory compliance, GHG emission reduction, resource usage efficiency, and waste minimisation • requiring information on physical quantities and costs of resources used, costs of waste removal and recycling **Program 2: Capital Investments** • facilitating resource usage efficiency, waste management • requiring information on costs of resource, waste management, project budgets, expected revenues and costs, payback period

Table A3.2: MA Themes and Codes for Case Company 3 (CC3)

Theme	Management Accounting Codes
Having a management accounting function?	Yes – as part of the finance team
MA processes and techniques - Costing approaches - Capital investment evaluating - Product/process designing - Setting environmental KPIs	• Costing approaches: standard costing • Capital investments: budgeting, payback period
EMA information Type 1: mass balance Type 2: environmental costs Type 3: capital investments Type 4: process and product design Type 5: environmental performance	**Type 1: Mass balances (PEMA)** Physical quantities of inputs, outputs, leakages and emissions. • GHG emissions (tonnes) • resource usage (tonnes, kgs, litres, gigajoules) • raw materials (tonnes) • wastes (tonnes) • water consumption (gigalitres) **Type 2: Environmental Costs (MEMA)** • costs of materials • costs of resources • costs of waste removal and recycling **Type 3: Capital Investments (MEMA)** • allocated budgets • expected cash flows • payback period
Dimensions of MA process, techniques and information	• past-oriented and future-oriented • long-term and short-term • ad hoc and routine

Table A3.3: ES-MA Linkages for Case Company 3 (CC3)

Environmental Strategy	ES-MA Linkage	Management Accounting
Program 1 Operations (ES 1) 1.1 Program focuses on • targeting regulatory compliance, GHG emission reduction, resource usage efficiency, and waste minimisation **Information required (ES 1.1)** • physical quantities of resources used, waste removed and recycled • costs of resources used • costs of waste removal and recycling	ES 1.1 – Type 1 (1.1) PEMA ES 1.1 –Type 2 (1.1) MEMA	**EMA applications** • standard costing **EMA Information** **Type 1 (1.1) PEMA:** Physical quantities of resource usage and related GHG emissions • GHG emissions (tonnes) • resource usage (tonnes, kgs, litres, gigajoules) • raw materials (tonnes) • wastes (tonnes) • water consumption (gigalitres) **Type 2 (1.1) MEMA:** environmental costs • $ spent on production materials, resources, waste removal, and recycling
Program 2 Capital Investments (ES 2) • facilitating resource usage efficiency, waste management **Information required (ES 2.1)** • costs of resource, waste management • project budgets, expected revenues and costs, payback period	ES 2.1 – Type 1 (2.1) PEMA ES 2.1 –Type 3 (2.1) MEMA	**EMA applications** • budgeting, payback period **EMA Information** **Type 1 (2.1) PEMA:** physical quantities • quantity of resource savings • quantity of waste removed and recycled **Type 3 (2.1) MEMA:** monetary information for capital projects • budgets for capital projects • expected cash flows • payback period

Table A3.4: The EMA Framework for Case Company 3 (CC3)

		Environmental Management Accounting (EMA)			
		Monetary EMA (MEMA)		**Physical EMA (PEMA)**	
		Short-term Focus	Long-term Focus	Short-term Focus	Long-term Focus
Past Oriented	Routinely Generated Information	Type 2	Type 2	Type 1	
	Ad hoc Information				
Future Oriented	Routinely Generated Information	Type 2	Type 2	Type 1	
	Ad hoc Information		Type 3		

Appendix 4

Case Company 4 (CC4) Findings

Table A4.1: ES Themes and Codes for Case Company 4 (CC4)

ES Theme	ES Codes
Level of interest for environmental issues	- *highly interested*
Having an ES?	- *Yes*
ES classification	1st classification: *accommodative*
Environmental programs	**Program 1: Operations** • avoiding adverse environmental impact in the long run • creating a good public image • targeting legislative compliance • requiring information on technical and scientific testing and sampling, as well as compliance costs

Table A4.2: MA Themes and Codes for Case Company 4 (CC4)

Theme	Management Accounting Codes
Having a management accounting function?	Yes – as part of the accounting department
MA processes and techniques - Costing approaches - Capital investment evaluating - Product/process designing - Setting environmental KPIs	• Costing approaches: based on Excel spreadsheets
EMA information Type 1: mass balance Type 2: environmental costs Type 3: capital investments Type 4: process and product design Type 5: environmental performance	**Type 2: Environmental Costs (MEMA)** • budgets for environmental compliance activities • actual environmental compliance costs
Dimensions of MA process, techniques and information	• past-oriented (mostly) and future-oriented • long-term and short-term • ad hoc

Table A4.3: ES-MA Linkages for Case Company 4 (CC4)

Environmental Strategy	ES-MA Linkage	Management Accounting
Program 1 Operations (ES 1) 1.1 Program focuses on • adverse environmental impact avoidance • a good public image • legislative compliance **Information required (ES 1.1)** • technical and scientific testing and sampling • compliance costs	ES 1.1 –Type 2 (1.1) MEMA	**EMA applications** • Excel spreadsheets **EMA Information** **Type 2 (1.1) MEMA:** • budgets for environmental compliance activities • actual costs incurred on environmental compliance activities

Table A4.4: The EMA Framework for Case Company 4 (CC4)

		Environmental Management Accounting (EMA)			
		Monetary EMA (MEMA)		Physical EMA (PEMA)	
		Short-term Focus	Long-term Focus	Short-term Focus	Long-term Focus
Past Oriented	Routinely Generated Information				
	Ad hoc Information		Type 2		
Future Oriented	Routinely Generated Information				
	Ad hoc Information		Type 2		

Appendix 5

Case Company 5 (CC5) Findings

Table A5.1: ES Themes and Codes for Case Company 5 (CC5)

ES Theme	ES Codes
Level of interest for environmental issues	- *highly interested*
Having an ES?	- *Yes*
ES classification	1st classification: *accommodative*
Environmental programs	**Program 3: Process and Product Design** • operating an environmentally sustainable production process • requiring information on budgeted and actual environmental revenues and costs

Appendix 6

Case Company 6 (CC6) Findings

Table A6.1: ES Themes and Codes for Case Company 6 (CC6)

ES Theme	ES Codes
Level of interest for environmental issues	- *high interested*
Having an ES?	- *Yes* but informal ES
ES classification	1st classification: *accommodative*
Environmental programs	**Program 1: Operations** • regulatory environmental compliance • requiring information on the environmental liability regarding restoration costs and environmental bonds covering clean-up costs and future damages

Table A6.2: MA Themes and Codes for Case Company 6 (CC6)

Theme	Management Accounting Codes
Having a management accounting function?	Yes – as part of the finance team
MA processes and techniques - Costing approaches - Capital investment evaluating - Product/process designing - Setting environmental KPIs	• Costing approach: activity-based costing
EMA information Type 1: mass balance Type 2: environmental costs Type 3: capital investments Type 4: process and product design Type 5: environmental performance	**Type 2: Environmental Costs (MEMA)** • budgets for project-based environmental liability • actual restoration and clean-up costs associated with each project
Dimensions of MA process, techniques and information	• past-oriented and future-oriented • long-term and short-term • ad hoc

Table A6.3: ES-MA Linkages for Case Company 6 (CC6)

Environmental Strategy	ES-MA Linkage	Management Accounting
Program 1 Operations (ES 1) 1.1 Program focuses on • regulatory environmental compliance **Information required (ES 1.1)** • clean-up costs and future damages associated with environmental liabilities	ES 1.1 –Type 2 (1.1) MEMA	**EMA applications** • Excel spreadsheets **EMA Information** **Type 2 (1.1) MEMA:** • project-based actual restoration and clean-up costs • budgets for project-based environmental liabilities

Table A6.4: The EMA Framework for Case Company 6 (CC6)

		Environmental Management Accounting (EMA)			
		Monetary EMA (MEMA)		Physical EMA (PEMA)	
		Short-term Focus	Long-term Focus	Short-term Focus	Long-term Focus
Past Oriented	Routinely Generated Information				
	Ad hoc Information	Type 2	Type 2		
Future Oriented	Routinely Generated Information				
	Ad hoc Information	Type 2	Type 2		

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