An Analysis of Environmental Management in Developing Countries: Rubber Production in Sri Lanka

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12.1 Introduction

The greatest environmental degradation of the planet started with the Industrial Revolution. At that point, environmental issues were not included in the global economic debate. Climate change is a universal challenge for the human race, requiring it to confront the significant challenges posed by reduction of carbon intensity from man-made activities in order to avoid irreversible catastrophic effects (Agan et al. 2013). In the broader perspective of sustainability, the natural environment is the pivot of the argument for organizations and their operations (Sarkis et al. 2010). Businesses need to consider the variety of events that may pose risks and take adequate steps to mitigate them. This will serve as an investment for the future of mankind, as well as a current need for organizations to contribute to environmental management (EM). EM is a management discipline and it should be protected by human beings by monitoring environmental hazards in order to minimize environmental degradation. It is highly politicized globally due to its value-laden nature, and it reflects the exercise of power by some groups over others. Barrow (2004, p. 8) posed a series of questions: "What exactly is environmental management? Is it a single field or discipline? Is it a process? Is it an agreed approach? Is it supposed to identify and pursue goals? Perhaps a philosophy? Or is it environment and development problem solving?" Sarkis et al. (2010) argued that environmental management has become a universal philosophy where individuals are involved in "greening"

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their business organizations. There are many voices highlighting the importance of taking into consideration the restrictions imposed by environmentalists on the development of business activities (Salvadó et al. 2012).

Climatic changes produce major risk components that adversely affect businesses. Physical changes in the climate are anticipated risks in macro-circumstances which lead to extreme weather patterns and gradual transfiguration of the climate, which could affect the change in the equilibrium of businesses. It has already manifested itself in the sensitive rubber manufacturing process. Manufacturing has a role to play in both climate change mitigation and adaptation. Rubber is an essential agricultural commodity in the economy of Sri Lanka. The Central Bank report of Sri Lanka in 2014 highlighted that the foreign exchange earnings from rubber were 6 billion rupees in 2014. At present, the country ranks among the world's top ten largest producers and the seventh largest exporter in natural rubber. Unpredictable weather conditions and irregular seasonal changes created due to changes in the climate will adversely trigger irregular yields in raw rubber extraction. Organizations in the rubber sector are susceptible to weather sensitivity in the raw material stage.

12.1.1 History of the Rubber Industry

Though indigenous rainforest dwellers of South America have been using rubber for generations, it was not until 1839 that rubber had its first practical application in the industrial world. In the 1860s, Henry Wickham, a British citizen, smuggled some of the seeds from these rubber plants out of Brazil and sent 70,000 seeds to Sri Lanka for planting as commercial rubber in 1883. In 1998 the rubber industry was deemed to have produced equal amounts of raw rubber exports and quantity-wise the same for domestic consumption. It can be considered a remarkable year for the industry by being contingent or dependent on the use of latex for domestic purposes rather than for foreign trade. While domestic consumption has increased, the fluctuation of rubber prices may have caused a shift of the process to finished products and to get more value additions to 1 kg of processed rubber. The advancement of agro-based industries such as rubber is known to generate enormous quantities of solid and liquid waste. Environmental destruction is an inevitable consequence of human beings and has become more complex and multidimensional due to heavy utilization of resources and mounting up of by-products at a phenomenal rate, leading to high global pollution of air, land and water in the environment.

12.1.1.1 Climate Transition Risk in the Rubber Industry

The rubber manufacturing process is heavily dependent on heating which is the main cause of climate change due to emissions. Insufficient hydroelectric power and low rainfall in hydro catchment areas subject to weather changes have compelled industries to use furnace oil. Burning fossil fuel is a governing factor in increasing emissions (Gunathilaka and Gunawardana 2015). Environmental pollution, through the use of water in the industry, is yet another major concern. Environmental authorities have given organizations very strict norms to follow and are much more vigilant, as this issue has caused many problems in the recent past. Gunathilaka and Gunawardana (2015) found double the emission of conventional rubber compared to organic cultivation while operating other process parameters under the same conditions. The other danger associated with rubber cultivation highlighted by Houghton and Hackler (1999) is deforestation and burning of natural forest to convert land to rubber growth, which has reduced carbon stocks above- and below-ground, increasing the rate of carbon emissions (Table 12.1).

Rubber processing is categorized as one of the major polluting industries according to the published records by the CEA of Sri Lanka (Ranaweera 1991, as cited in Edirisinghe 2013). Edirisinghe (2013) stated that 40–50 l of effluents were discharged on average for 1 kg of rubber production. Further, due to total production of 114,700 metric tonnes in 2006, 4.5–5.7 billion litres of effluent have been produced and discharged to the environment (see Fig. 12.1). There are three main grades of natural rubber produced: ribbed smoked sheets (RSS), crepe rubber and centrifuge latex. Effluents generated by such production processes contain 30–40% rubber and 60–70% serum substances (Edirisinghe 2013). Rubber serum substances contain amino acids, carbohydrates and lactic acid. Substances required for plant growth and some chemicals such as sodium sulphite, ammonia or formalin, formic acid, acetic acid, oxalic acid, sodium bisulphite, metabisulphite and xylyl mercaptan are added in the processing of centrifuging. The most adverse effect that may be created due to influents is the pollution of groundwater. Effluents cannot be used for other purposes (Kudaligama et al. 2004, cited in Edirisinghe 2013). Heavy usage of energy is another factor in the industry contributing to more energy consumption. Another point of concern is solid and liquid waste generated from manufacturing operations. Thus, it is worthwhile investigating the real reasons for environmental transition from both environmental management and the environmental performance in the rubber industry.

Table 12.1 Central Environment Authority (CEA) standards for raw rubber processing effluent

Parameter	RSS	Crepe	TSR	Latex concentrate	Foam products	Dipped products	Regulatory standards
p^H	4.9	5.0	5.7	3.7	7.8	7.2	6.5–8.5
Settable solids	50	45	155	100	180	200	<250
Suspended solids	140	130	237	190	220	241	100
Total solids	3745	3500	1915	7576	2300	2457	1500[a]/1000
C.O.D	3300	3500	2740	6201	3500	2011	400
B.O.D	2630	2500	1747	3192	1700	1336	50/60[a]
Ammoniacal nitrogen	75	80	66	401	120	126	300[a]/40
Total nitrogen	500	550	147	616	156	180	300[a]/60
Sulphates	–	–	–	1610	69	72	1000

Source: Adapted from Seneviratne

[a]CEA standards centrifuged latex processing effluent (all values are in mg/l except for pH)

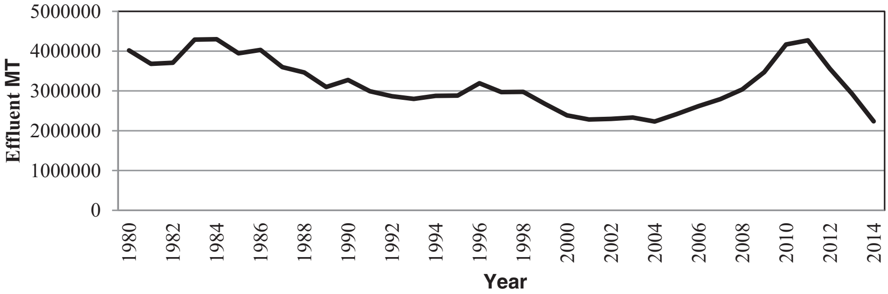

Fig. 12.1 Effluents discharged due to raw rubber processing. (Source: Author elaboration based on Rubber Development Department records)

One of the main targets of corrective action for climate change is to grow more rubber trees. The drive to grow more trees is now categorized under secondary "forest cover". This would certainly have better financial implications for the industry in general. Houghton and Hackler (1999) stress that burning of natural forest to convert land into rubber is feasible. Malhi et al. (2008) discuss the change in biomass carbon stocks. According to the Department of Census and Statistics, rubber cultivation has declined in recent years. In 2014, 134,000 hectares were cultivated, and in 2015 it was 135,000 hectares, showing a slight increase and a 0.7% growth compared to 2013/2014. The adverse weather conditions caused by climate change also resulted in calamitous landslides. Growing more rubber trees is considered a feasible solution that helps to reduce climate risks, while helping to reduce atmospheric carbon. This can be viewed as a good financial investment, as more rubber means better prices and also less interruption to manufacturing.

Montabon et al. (2007) emphasized that the contradiction between environmental management and solid performance has been of great interest in research literature. Whether or not EM improves on performance (Yang et al. 2011), knowledge of the topic is still limited and must grow to allow a unified theory to emerge. To some extent, results are isolated and conflicting. Some positive, others negative, some show mixed or no result, which is somewhat confusing. In recent literature there is a discrepancy in empirical findings within the framework to obtain the significant determinants of EM. Nevertheless, a few studies have investigated the role of environmental investment (EI) within the adoption of EM. The aim of this paper is to provide further insight into the role of EI in the adoption of EM to achieve business performance (BP) based on a four-concept balanced scorecard. We start with the relationship between BP and EM. We then present an integrated framework that includes EM, EI and BP. In the next section we provide a research model and a conceptual framework that presents key variables based on literature reviews. In the hypotheses development section, the inter-relationships between variables are defined and explained. We analyse whether the adoption of EM enhanced by BP is moderated by EI efforts within the organization. The results overwhelmingly show that, for the Sri Lankan rubber manufacturing industry, environmental investments negatively moderate the relationship between EM and BP. In subsequent sections we discuss the literature, research methodology and results, the theoretical and managerial implications, limitations and future research directions.

12.2 Theoretical Basis of the Study

12.2.1 Ostrom's View on the Collective Action Theory and Climate Change

In a study of the ecological system, Ostrom's theory is considered appropriate to address present-day ecological challenges. Ostrom (2008a) emphasizes that in the future, many of the pressing problems faced are more on a global scale, posing difficulty in establishing an effective governance arrangement on a global base rather than on a local scale and ignoring the protection of a common heritage. The challenge is to common-pool resources (CPRs) and the tragedy for human beings, the failure to halt massive overfishing of oceans, major deforestation and excessive emission of carbon dioxide to the atmosphere from works and much more. Protecting these resources without violating CPR through minimum impact on the environment will clearly improve environmental performance in the global context. Separateness of use is a characteristic derived from CPR, which means that used units of atmosphere, water and climate are a challenge for future generations to facilitate using units and/or joining use of nature due to rapid degradation. Failure to distinguish between the subtracting of used units and the joining of the natural resource system has contributed to confusion in the past about the attributing common-pool resources (Ostrom 1985). Water courses, air basins and global atmospheric sinks have a comparable capacity to absorb pollutants, but Ostrom (2010) argued atmospheric greenhouse gas (GHG) sinks fulfil the first priority more than water and air basins of CPR due to the use of units of sink services being different or deductible.

Thus the concept of maximum sustainable yield is important in the analysis of CPR management for environmental performances at the global level. Ostrom (2008a, b) defined CPRs as "the maximum numbers of use units that can be obtained from year to year while still maintaining the resource system's capability to continue to yield these units" (p. 5). Paavola argued that, with the distribution of sustainable capacity among the competing users to avoid deterioration of the atmosphere (damp yard) from global heat escalating, owing to the uncertainty of practice and the "crowding effect" or "over-use", the problem of air, the atmosphere and water problem, etc. do not occur in regard to the use of such collective goods (Ostrom 1985). The cost associated with exclusion of the tragedy of global climate change or environmental degradation depends on the type of resource system, technology associated with exclusion, entry and exit rules and resource boundaries (Ostrom 1985). Also, the condition of being a CPR is exclusion of unauthorized users and avoiding dumping (Paavola 2008b). The absence of clear borderlines and perfect mixing of emissions of GHGs in the atmosphere contribute to the difficulty of exclusion (Ostrom 2008a, b).

Ostrom suggested the requirement of analyses of macro-interface between humanity and the biosphere to get a better understanding of the social context of post-environmental change and the complexity of conceptualization of socially constructed and politicized biosphere in modern climate and environmental change. The atmosphere remains abstract in conceptualization. Social construction is difficult to communicate and is socially fragmented. Therefore it is very difficult to signify and is imbued with meaning (Rabinowitz 2010), but obstacles are associated with atmospheric conditions. Social science intervenes with the importance of implementing a better theoretical analysis to understand a coherent picture of climate change. The other aspect is that three decades of effort have been put into gaining theoretical insight into the abstract syndrome. Solving global climate change problems is not by acting alone. If one country solves that problem, there will be absence or dearth of wealthier countries participating to reduce risk in climate change (Ostrom 2010). Hence, it requires cooperation between countries through an internationally recognized framework and strong urgent collective action.

12.2.2 Ostrom's Institutional Behaviour and Environmental Change

Ostrom was preoccupied with paradoxes and contradictions surrounding human beings and their choices. She focused on communities' interface with their ecosystem and internal dynamics associated with securing long-term sustainable yields (Rabinowitz 2010). Empirical work on CPRs conducted by Ostrom provides a basic list of institutional characteristics that affect improvement of commonly held resources. Ostrom's list includes a clearly defined system of boundaries to the exclusion of non-members and rules governing resource usage which are suitable for local conditions and wide participation of local stakeholders in the design and implementation of rules and decisions governing the system. Ostrom generally was aware of social and cultural factors, "her work often seems to skim the surface of observable social and cultural data in linear, mono dimensional fashion" (Rabinowitz 2010, p. 106). Rabinowitz (2010) was disappointed in results when theorizing the global commons and the atmosphere through institutional analysis of CPR systems and defined the atmosphere and environment as an open access of universal commons. Paavola (2008a) explains atmospheric sinks for GHGs as a CPR. Her sinks are stock resources with the economics label "core variable" meaning "stock variable" of GHGs and the fringe variable which explains the flow variable as used units that mean GHGs embedded in the atmosphere.

A tertiary pressure is rooted in institutional sociology which proposes that firms respond to institutional pressure. Institutional theory places particular emphasis on the legitimation process and tendency for institutionalized organizational structures and procedures to be taken for granted, regardless of their efficiency implications (Hoffman and Ventresca 2002). Further emergence of global principles and standards is changing public expectations of companies, and triple-bottom-line reporting has increased demands for accountability, transparency and emphasis on financial, social and ecological performance. Jennings and Zandbergen (1995) were among the first to apply institutional theory to explain firms' adoption of EM practices. They argue that, because coercive forces, primarily in the form of regulations and regulatory enforcement, have been the main impetus for EM practices, firms in each industry have implemented similar practices.

Levy and Rothenberg (2002) describe several mechanisms by which institutionalism can encourage heterogeneity. First, they argue that institutional forces are transformed as they permeate organizational boundaries, because they are filtered and interpreted by managers according to firms' organizational unique history and culture. For example, "a firm's history with environmental technology influenced the degree to which future technological options were viewed as an opportunity or a threat". Second, they describe how an institutional field may contain conflicting institutional pressures that require prioritization by managers. Third, they describe how multinational and diversified organizations operate within several institutional fields both at social and organizational levels which expose them to different sets of institutionalized practices and norms. Hoffman (2001) cited nine institutional actors whom we believe most likely to directly influence environmental practices at the facility level, such as politicians, regulators, customers, competitors and local communities. Considering these points, institutional pressure is critical in converting a balanced scorecard into a green concept. This must be added into institutional theory because it shows the diversity of the institutions driving environmental pressures, including external and internal pressures to the organization and within each organization.

12.2.3 Ostrom's Conventional Collective Action Theory and Stakeholder Participation

Millions of actors favourably affect the global environment. All receive benefits from reduced greenhouse gas emissions, treated waste water, avoiding air pollution and protecting drinking water resources, but the problem is whether they benefit or not, do they pay any of the costs. In other words, the beneficiaries cannot be excluded from the benefit of cleaner air. Trying to solve the problem of providing good for the public is a classic collective action dilemma—and potentially the largest dilemma the world has ever knowingly faced (Ostrom 2009). Ostrom is asserting the fact of wide participation of local stakeholders, and Ostrom's social and cultural data combining with Paavola's (2011) collective ownership and management as well as the widely shared values associated with individual behaviour and voluntary engagement to mitigate atmospheric sinks for GHGs and degradation of CPRs encourage ascertaining who is having a stake in this issue and who are the interested parties that influence that matter in order to change to individual behaviours through wide participation of local stakeholders by combining social and cultural data in stakeholder network. The most interesting part highlighted by Rabinowitz (2010) is "like those of the other institutional analysts, it is admirably effective in shedding light on the dynamics governing the interface between the local groups and their immediate common" (p.108).

It further emphasizes the significance of social relationships among interested parties and individual social participation in network with better theoretical analysis to understand the coherent picture of environmental change. Social network analysis will give light to the theoretical analysis and empirical understanding to determine who the stakeholders are that have involved themselves in the present climate revolution issues and how the tie relationship is among each participant in the network. The constraint is the cultural and behavioural consideration among individual members who do not contribute any support to intensify the strength of the theoretical framework in the development of the debate on climate crisis. As the definition given by Freeman, public participation is increasingly embedded in national and international environmental policy, and it is necessary to identify who is affected by the action and decision-making that they take and which one has the power to influence their outcome (cited by Davis et al. 2009). Starik considered environment as a part of SH during the categorization among other SHs. Stakeholder theory also cannot satisfactorily treat enterprise in an environmentally ethical and responsible fashion considering the increasingly important problems of managing business enterprise in an environmentally ethical and responsible fashion, and Starik states most definitions of the concept of "stakeholder" include only human entities. This paper advances the argument that the non-human natural environment can be integrated into the stakeholder management concept. This argument includes the observations that the natural environment is finally becoming recognized as a vital component of the business environment, that the stakeholder concept is more than a human political/economic one and that non-human nature currently is not adequately represented by other stakeholder groups.

12.2.4 Natural Resource-Based View (NRBV) of the Firm and the Environment

The detailed analysis of firms' environmental management practices and their commitment towards the environmental achievement of the organization is needed to successfully tackle the socioeconomic challenges in society. Therefore, appropriately addressing environmental challenges imposed by a natural environment, researchers focus on two main theoretical streams:

1. The natural resource-based view (Hart 1995). This theoretical approach is the cornerstone of a researcher's argument; it attempts to answer to the challenge of sustainable development by taking a resource-based view as a reference.
2. Resource-based view of the firm (Peteraf 1993 as cited in Salvadó et al. 2012). The incorporation of environmental arguments to process, products and organizational modes to the firm require the development of a number of specific resources and capabilities.

Oliver (1991) discussed that organizations can have power over others by controlling scarce resources and argued that impacts of achieving institutional belief instead of scarce resources. Further, Oliver emphasized that organizational choice is controlled by a variety of external pressures as described in resource dependency and institutional perspectives. Using this theory in the fields of environmental performance started with Hart (1995), who presented the first theoretical paper that addressed the RBV (resource-based view) theory in the corporate environmental phenomenon. Hart is very concerned about the natural environment and thought that it has totally ignored the concept in the RBV. Hart believes that the NRBV approach is one of the major contributions to the field of environment/sustainability. NRBV emphasized that resource management and eco-development assumptions are combined in firms, in order to achieve competitive advantages through sustainable economic development. This theory attempts to combine the RBV with the constraints imposed by the natural environment. NRBV incorporates some of the important assumptions used by neoclassical logic when referring to competitive advantages through low-cost strategies. His argument was that cost reduction can be achieved by pollution prevention, waste management, recycling, emission control and other kinds of activities. Hart's theory is based on the condition that the three interrelated strategies, namely, pollution prevention, product stewardship and sustainability development, are used. Hart further mentioned that NRBV goes beyond pollution prevention and it incorporates eco-development. To fulfil the gap between resource management and eco-development, NRBV has proffered a better contribution. This theory delineated that proactive environmental management is a critical source for firm performance. Empirical research conducted by several researchers, namely, Russo and Fouts (1997), empirically found that higher levels of corporate environmental performance (CEP) relate positively to superior financial performances. This theory considers the natural environment as a source of new and imaging business opportunities and firms that are able to adapt their activity to those constraints will drive the economy of the future.

12.2.5 The Relationship Between Stakeholder Theory, BSC and BP

Orts and Strudler (2002) discussed that, however anyone redefines stakeholder's (SHs) and however one may balance SHs interest, the SH theory does not provide any detail for managers in the sense of how to do what is right. Based on this argument, we built up a rationale about "balancing stake holders" which is more vital than managing stakeholders.

Balance scorecard (BSC) is introduced by Norton and Kaplan in which a score system for managers is available to maximize stakeholder values. In particular, firms adapted it to the SH theory which politicized the firms. This will be a handicap for rivals due to the nature of empowerment of performance to exercise their own functions by spending resources of the firm. Jensen (2001) stated that at the same time, companies apply the so-called BSC approach as a managerial equivalent of stakeholder theory as a performance measurement system. Further, Jensen suggested that managers should be encouraged to use drivers of performance measures to comprehend how to improve their scores. With no way to keep scores, the stakeholder theory will lead to keeping managers unaccountable for their action or task to be performed. It is conscious that such a theory will encourage internal stakeholders to motivate self-interest in their firms. Cooperate purpose or vision and value maximization is not a technique to create energy and enthusiasm of employees and managers. The assessment of the success and the failure of the firm depends on the long-term market value which becomes the scorecard of managers, directors and others who are used to assess success or failure of the organization. The value maximization is a complement from corporate vision, strategy and tactics as a cooperate scorecard to withstand the rigours of present competitiveness. The abovementioned previous knowledge of stakeholders encourage the BSC concept in applying measuring performance in the organization.

The sub-section below (discussion under the construct and core concepts) discusses a comprehensive review of the BSC as a theory to measure firm's performance by incorporating environmental performance activities into cooperate scorecards. According to the researcher's discernment, the BSC has not discussed all aspects where the stakeholders are involved in the underlying issues, the internal performance perspectives it covered regarding internal stakeholders, learning and growth perspectives, the internally interested actors who involve themselves with the process, customer perspectives that go beyond the internal SHs and the more discussions on externally influencing parties, financial perspectives that cover the institutions' involvements with financing and other bodies who are engaged with profit maximization. But what is lacking here are the communities and other actors such as neighbour organizations who are interested with the issue to control environmental performances in organizations. There is a discrepancy in applying the SH theory into the BSC concept due to lack of participation of some interested actors in measuring performance through BSC. Further, it is critical to consider on how to incorporate environmental aspects to BSC as a separate perspective or include it into the current four perspectives. Based on the institutional aspects, the researcher aspires to investigate the theoretical aspects involved with institutionalism and their influence on organizations. Institutional theory has explained the theoretical basis.

12.3 Hypothesis Development

In this research, we have defined each construct in terms of essential characteristics with the support of the relevant literature base. Table 12.2 is a summary of each construct (definitions and supporting literature). Figure 12.2 is a research framework that represents how EM, environmental management practices (EMPs), environmental performance (EP) and business performance are related.

12.3.1 Environmental Management

According to Sharma and Vredenburg (1998), SMEs perform both proactively and reactively environmental practices towards elimination of environmental pollutants or waste. Further mentioned in some papers, such activities have ranged from waste

Table 12.2 Definitions and supporting literature

Variables	Definition	Supporting literature
Environmental management	The system that anticipates and avoids, or solves, environmental and resource conservation issues	
Environmental management practices	A set of programs to improve environmental performance of processes and products in the forms of environmental management system, life-cycle analysis, design for environment, environmental certification	Montabon et al. (2007)
Environmental performance	The degree to which an organization improves its performance in respect to its environmental responsibilities	Montabon et al. (2007)
Waste treatment	Stabilization, preferably by accelerated degradation, so that the final residues produced are either non-toxic and incapable of further change, that is, they are completely mineralized, or able to find ready entry into the various natural bio-geochemical (elemental) cycles that govern materials cycling in the environment, without causing distortion in any cycle relative to another	Hamer (2003 as cited in Agan et al. 2013)
Reduction	Focusing on preventing pollution at the source (in products as well as manufacturing process) rather than managing it	Srivastava (2007 as cited in Agan et al. 2013)
Internal recycling	The reuse of materials from returned products without conserving the product identity	Kapetanopoulou and Tagaras (2011, as cited in Agan et al. 2013)
Remanufacturing	The degree to which the firm rebuilds a product where some of the parts or components are recovered or replaced	Montabon, Sroufe and Narasimhan (2007)
Environmental design	Using environmentally sensitive design process does in fact result in greater product innovation and thus higher firm performance	Montabon et al. (2007)
Environmental management system	Supplier environmental relations, knowledge base of team members, environmental cost systems, environmental impact assessment, impact reduction and environmental training	
Environmental investment	Realized decisions to deploy resources and commitment to environmental management	
ROA	Profit before interest and tax (PBIT)/total assets (total equity + total debt)	
ROS	Profit before tax (operating profit)/total sales	
ROI/ROE	Profit after tax (PAT − profit for the year)/ total equity	

Source: Author’s own elaboration

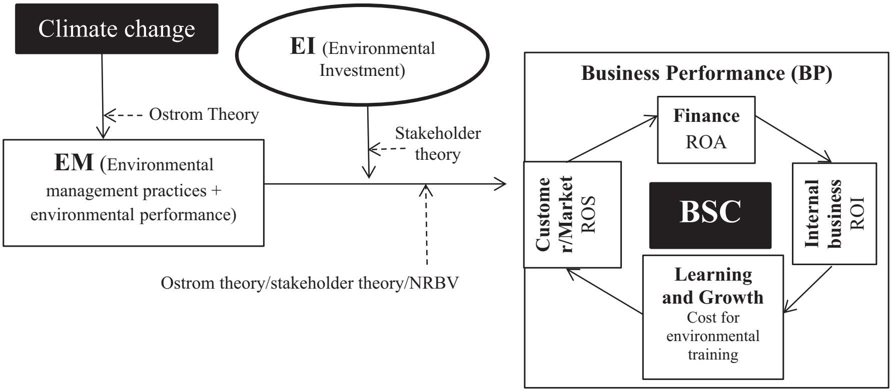

Fig. 12.2 Theoretical framework: climate change, EM, EI and BP. (Source: Authors' own elaboration)

treatment to developing sophisticated environmental management practices. Argan cleared that in the past literature, these activities were labelled as actions, performance, behaviours, applications, practices or systems. In the same paper, the researcher has discussed it as "process" because it fits their process framework. In this study the researcher categorized and labelled the term as "practices". The practices discussed in this paper are waste treatment, emission reductions, recycling, environmental innovations and environmental management system. Environmental management system (EMS) is a systematic approach to managing the environment which is reflected in the company's vision, mission, policy, strategies and actions. In addition to that, companies take it as top priority activity in environmental process to establish a standard EMS within boundaries. White et al. (1995) considered recycling, alternative energy and waste reduction in their research. Cohen et al. (1995) yet again highlighted that toxic emissions as Hart with different other variables such as superfund sites, environmental litigation, accident frequency and regulatory compliance record. Most researchers selected emission as an environmental performance variable in their research. Nonetheless some of them mixed it with other parameters as well. According to their selected variables, it is clear that there are different choices in selection of environmental variables.

12.3.2 Business Performance

Santos and Brito (2012) found six dimensions in connection with measuring firm performance and invited researchers to use subjective indicators to measure firm performance across industry. They stressed that "the dimensional structure" could also help scholars select performance indicators – for specific research problems that comprehensively cover the relevant dimensions of performance related to their investigation. Operating performance is the performance of a company based on the profit recorded in their financial statements. It is measured by return on equity

(ROE) and return on assets (ROA). ROE and ROA indicate how efficiently the company generates profits or earnings based on shareholders' equity and company's total assets, respectively. These ratios are the most basic and fundamental in analysing the profitability and performance of the company not only in empirical research but also by practitioners such as auditors, financial analysts and bankers. Moreover, many researchers also use these measurements as proxies for business performance.

Throughout the analysis, two different types of firm performance measures were used such as return on assets (ROA), return on sales (ROS) and return on equity (ROE). Market analysts widely used return on assets as a measurement tool for the firms' performance. Return on equity (ROE) is a measure of the performance of the firm relative to shareholder investment. Since the measure of shareholder returns is important, rather than overall firm profitability, interest expenses are subtracted out of income for this measure. As a test of robustness, an alternative formula was also used, where ROA is defined as income before extraordinary items, divided by average total assets plus accumulated depreciation. The researcher believes that if a company can implement good environmental practices, the company will indeed achieve benefits in operations. However, some may build an argument to say that to operate in an environmentally friendly manner, it has to incur additional expense in certification, annual audits, inspections, etc. that brings nothing in return. The author believes that the return on such investments cannot be measured by the profit which is only a tangible indication of the organization. Good will, reputation, market demand, competitiveness and the value passed on to the society are intangibles that will register the organization in the hearts of its customers, employees, the community and society and also as a global leader (Fig. 12.3).

12.3.3 Environmental Management and Business Performance

Material consumption, waste and emissions are problems associated with industrialization, and companies should have to represent an opportunity for companies to improve their capabilities in the field of pollution prevention and ecological efficiency (Hart and Milstein 2003). "Companies that carry out pollution prevention strategies focusing on environmental innovation have a resource base that enhances their ability to generate profits and also makes them able to protect themselves against future risk" (Shrivastava 1995, cited in Salvadó et al. 2012, p. 80). Environmental concern in strategic decision-making is relevant in incorporating with the natural environment. Reduction of waste emissions will enable to reduce cost and increase profits (Sharma and Vredenburg 1998) (Fig. 12.4).

Sharma et al. (1999) encouraged environmental features of a product and how that could add value to business (environmental design: environmental performance of products, packaging and sustainable business management). Small medium enterprises (SMEs) perform both proactively as well as reactively, and Environmental management practices towards elimination of environmental pollutants or waste (Sharma and Vredenburg 1998); Correa et al. 2008 as cited Agan 2013). Further

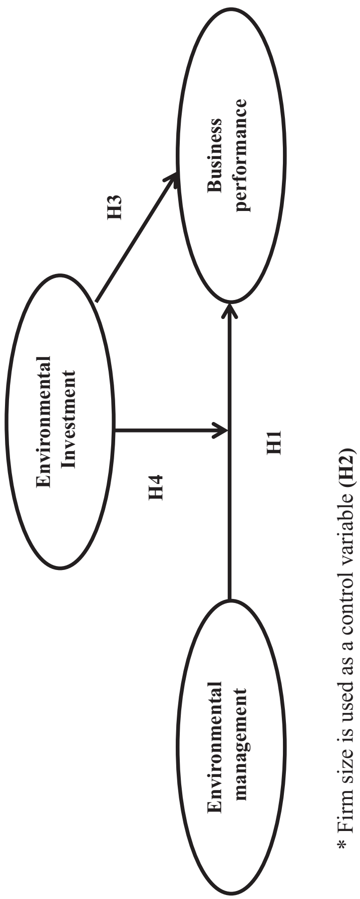

Fig. 12.3 Research model

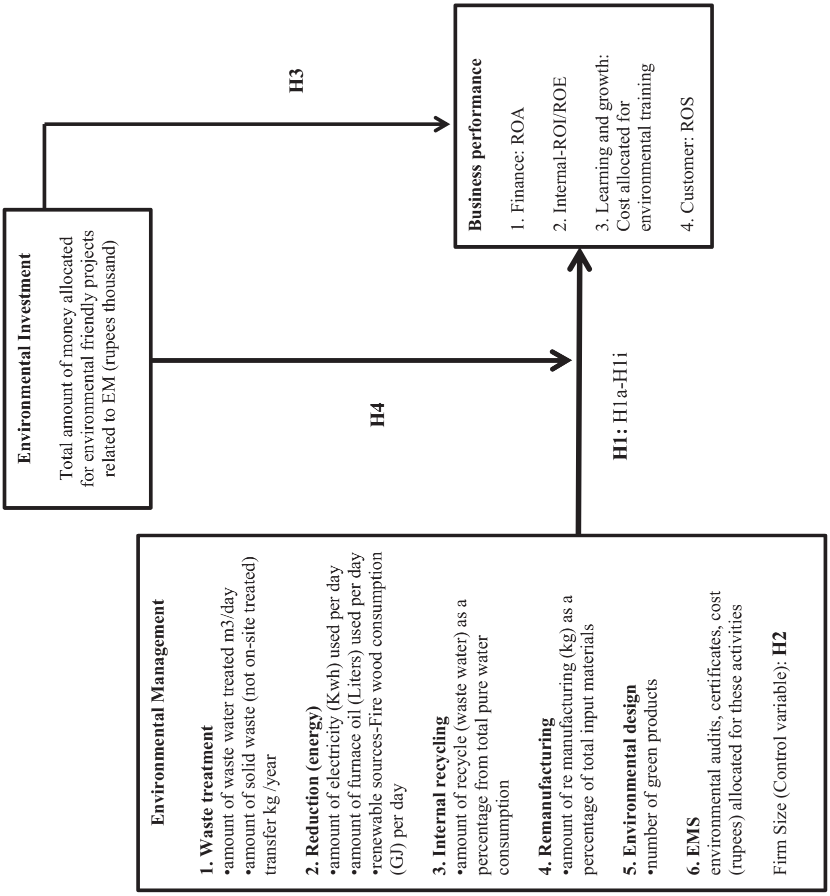

Fig. 12.4 Measurement framework

mentioned in some papers, such activities have ranged from waste treatment to developing sophisticated environmental management practices.

The determinants used to measure EM in this paper are waste treatment, energy reductions, recycling, environmental design and environmental management system (environmental training, certificates and audits). Environmental management system (EMS) is a systematic approach to manage the environment which is reflected in the company's vision, mission, policy, strategies and actions; in addition to that, companies take it as a top priority activity in environmental process to establish a standard EMS within boundaries. In 1992, the first EMS standard was applied in the UK. In 1996, the first EMS standard on the international scale, known as the ISO 14001, was introduced and further reviewed in 2004.

Therefore, the hypotheses are:

- *H1a: There is a significant relationship between amount of waste water treated m3/day and business performance.*
- *H1b: There is a significant relationship between solid waste (not on-site treated) transfer/kg/year and business performance.*
- *H1c: There is a significant relationship between amount of electricity (Kwh) used per day and business performance.*
- *H1d: There is a significant relationship between amount of furnace oil (litres) used per day and business performance.*
- *H1e: There is a significant relationship between renewable sources-firewood consumption (GJ) per day and business performance.*
- *H1f: There is a significant relationship between amount of recycled (waste water) as a percentage of total pure water consumption and business performance.*
- *H1g: There is a significant relationship between amounts of remanufacturing (kg) as a percentage of total input materials and business performance.*
- *H1h: There is a significant relationship between environmental design (number of green products) and business performance.*
- *H1i: There is a significant relationship between* EMS (*environmental training and audits, certificate, cost (rupees) allocated for these activities) and business performance.*

12.3.4 Environmental Management, Environmental Investment and Business Performance

Murovec et al. (2012) suggest that investments associated with environmental aspects have become very essential in today's context. Delmas and Pekovic (2015) stress that firms must reduce their natural resource consumption by investments in reusing and recycling of raw materials and waste management, due to the current environmental degradation. Financial viability of climate change mitigation and the associated financial risk in the performance of capital stock and business model portfolios need attention for long-term feasibility in business ventures. Testa et al. (2014) stress that requirements of best environmental management practices to mitigate negative environmental externalities are not yet settled. Figge and Hahn (2013) stress that environmental investment associates with company environmental growth, promotion of innovation, increasing productivity and resource efficiency. Lefebvre et al. (2003) emphasize that a higher amount of investments on environmental aspects and proactive environmental management issues may affect to create a positive association between the environmental performance in business and managerial actions. Heidrich and Tiwary (2013) emphasize the requirement of introducing environmental investment for achieving environmental performance by addressing small and micro firms. Ateş et al. (2012) tested the relationship between proactive environmental strategy and the large amount of environmental investment. The researcher found that environmental investments mediate the relationship between proactive environmental strategy and environmental performance. Cheng and Liao (2012) stress that financial allocation for environmental problems mitigation and adoption has often been contradicted in small companies; therefore, promoting environmental awareness and efficient environmental operation is necessary.

- *H2a: There is a significant relationship between environmental investment and firm performance.*
- *H2b: There is a significant relationship between environmental management practices and firm performance that grows stronger as environmental investment increases.*

12.4 Research Methodology

12.4.1 Research Database

In order to test the proposed hypotheses, we use the six determinants of EM. Secondary data was taken from 30 rubber manufacturing organizations from the time period 2012–2016, in Sri Lanka.

12.4.2 Research Design

We selected to conduct panel data to examine the driving effect of EM on BP. Prior studies are employed with event study, structural equation techniques and other statistical techniques based on perception measures of respondents, and only few studies had been carried out based on panel data techniques. Environmental measures should be better considered in long perspectives through different cross-sections (time series cross-sectional data). Therefore, we adopted the panel regression method to evaluate the impact of EM on BP from 30 rubber manufacturing companies from 2012 to 2016. The researcher decided to employ two different panel estimation methods: fixed effect (FE) and the random effect (RE) models to evaluate the relationships among variables.

12.4.2.1 Econometric Specifications

The analysis of the empirical relationship of environmental and business performance of organizations involves an estimation procedure based on panel data evaluation. Given the nature of the research work and the quantum of data, research studies data properties from econometric perspectives with the help of descriptive statistics and unit root test. This will help us by applying a random effect panel data model and a fixed effect panel data model. The model is derived in the traditional manner from the production function; the performance of a business is expressed as a function of environmental management such as furnace oil consumption, waste water treatment, waste water recycling, etc. Consequently the random effect model for specifying business performance is expressed as follows:

$$y_{\mathrm{it}} = \beta_0 + \beta x_{\mathrm{it}} + \mu_{\mathrm{j}} + \varepsilon_{\mathrm{it}} \tag{12.1}$$

$$\begin{aligned} y_{\mathrm{it}} = \beta_0 + \beta_1 \mathrm{Size}_{\mathrm{it}} + \beta_2 \ \text{waste water treated} \\ + \beta_3 \ \text{solid waste transfer} + \beta_4 \ \text{electricity use} \\ + \beta_5 \ \text{furnace oil use} + \beta_6 \ \text{fire} - \text{woodconsumption} \\ + \beta_7 \ \text{recycling} + \beta_8 \ \text{remanufacturing} \\ + \beta_9 \ \text{environmental design} + \beta_{10} EMS + \mu_j + \varepsilon_{\mathrm{it}} \end{aligned} \tag{12.2}$$

The equations of the model are grouped into two, Eqs. 12.2 and 12.3; Eq. 12.1 of the models signifies that the data are non-stationary meaning it cannot be co-integrated to convert the data to stationary; Eq. 12.3 was formed with first difference (Δ) on each variable which shows that the model is converted to first difference and the data has now become stationary.

$$\begin{aligned} \Delta y_{\mathrm{it}} = \beta_0 + \beta_1 \Delta(\mathrm{Size})_{\mathrm{it}} + \beta_2 \Delta(\text{waste water treated}) \\ + \beta_3 \Delta(\text{solid waste transfer}) \\ + \beta_4 \Delta(\text{electricity use}) + \beta_5 \Delta(\text{furnace oil use}) \\ + \beta_6 \Delta(\text{fire} - \text{wood consumption}) + \beta_7 \Delta(\text{recycling}) \\ + \beta_8 \Delta(\text{remanufacturing}) + \beta_9 \Delta(\text{environmental design}) \\ + \beta_{10} \Delta(\text{training and audits}) EMS + \mu_j + \varepsilon_{\mathrm{it}} \end{aligned} \tag{12.3}$$

where i denotes the firm (i = 1…n, n = 30 units under observation); j shows the industry = rubber industry and t (t = 1…t = 5) years/time period of data collected. In this equation μ is the industry-related fixed effects; ε is the standard error term, where y_{it} denotes the observation of the dependent variable (business performance) of a firm I in a period of t. X_{it}, represents the set of time-variant independent variables (regresses), and $\boldsymbol{\mu j}$ is the time-invariant explanatory variables. Then the explanatory variables, size represents the firm size, and as the proxies for environmental management, the researcher takes furnace oil consumption, waste treatment, recycling, electricity use, furnace oil use, firewood consumption, remanufacturing, environmental design and environmental training and audits (EMS), respectively. Δ y_{it} is the first difference of firm performance; Δ (furnace oil) is the first difference of furnace oil consumption; Δ (waste treatment) is the Δ of waste water treatment; and Δ recycle is Δ of recycle of material. The same principle applies for the four aspects of BSC (finance, ROA; internal, ROI/ROE; sales, ROS; and cost allocated for environmental training and audit, T&D). In this analysis, two models of random and fixed effects were used, where the fixed effect model has the same issue of correlated time-invariant effects in repressors, but it does not appear in the random effect model. For the specification of fixed effects, panel data model is as follows,

$$\varepsilon_{\text{it}} = \xi i + \dot{\eta}_{\text{it}} \tag{12.4}$$

where $\acute{\eta}_{\text{it}}$ is composed of the disturbance ξ_i reflecting left-out variables that are remaining broadly over each firm over the time period and idiosyncratic error (considered as time-persistent). The main assumption in fixed effect model is that individual effect ξ_i is correlated with time-variant independent variables X_{it}. In here ξ_i is a constant or dummy variable for each unit in analysis. In this model ξ_i is assumed to be time-variant independent variables.

12.5 Data Analysis and Results

12.5.1 Descriptive Statistics

This study mainly employed a quantitative approach; unit of analysis is rubber manufacturing firms. Figure 12.5 depicted that 90% of companies registered under BOI, and out of 90% of the companies, 70% were located inside the BOI promisors.

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Figure 12.6 shows that of 30 companies, 14 produce gloves, 5 produce tyres, 3 produce natural foam, 7 produce centrifuge latex, etc. Seventeen percent of the companies manufactured dry rubber, and the other companies were manufacturing latex-based products.

12.5.2 The Summary of Statistics

In the econometric analysis, the researcher built up a panel data based on 30 rubber manufacturing companies in Sri Lanka from 2012 to 2016. Table 12.3 depicts the mean, the standard deviation, the maximum, the minimum and the number of observations for each of the variables and elaborates the correlation coefficients between the dependent, independent and control variables along with correlation matrix. Table 12.3 depicts the positive correlation between IV-D2-M2 and ROA, providing evidence to justify H1d. The correlation between IV-D1-M2 and ROA is negative, and the correlation between IV-D3 and ROA is positive, providing evidence to support Hb and Hf, respectively.

The mean and median in Table 12.4 were computed to find the central tendency of each variable for the 30 firms in the sample. The standard deviation indicates the

Fig. 12.5 Company (%) registered under Board of Investment and location (internal/out) BOI

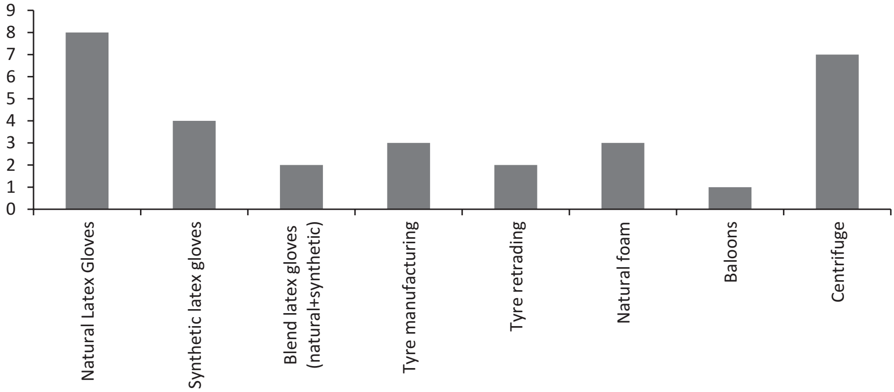

Fig. 12.6 Company (%) categorization – goods of manufacturing

sample's dispersion level of the variables. According to the above table, the average return on assets (ROA) is 31.2% which means about 31% of the return on assets of private sector rubber companies during 2012–2016. Further the average return on sales is almost 10.59% (median 2.6%) in private sector rubber companies in Sri Lanka over 2012–2016. When considering average waste generated -m^3 per day of the companies (IV-D1-M1), the average cubic meters of waste generated per day is 274.96 cubic meters which means that 275 m^3 of waste water was discharged from private sector rubber companies in Sri Lanka during the period 2012–2016 (Table 12.5).

Table 12.3 The correlation between dependent and independent variables (first-difference variables)

DV-D1	1.000000														
DV-D2	0.015561	1.000000													
DV-D3	0.02456	0.04780	1.00000												
DV-D4	−0.135372	0.120145	−0.242120	1.00000											
IV-D1-M1	0.043434	−0.062226	0.105678	−0.111911	1.000000										
IV-D1-M2	−0.090707	−0.008892	0.098726	0.346445	0.080969	1.000000									
IV-D2-M1	0.221537	0.228304	−0.261320	0.070618	−0.114696	0.219260	1.000000								
IV-D2-M2	0.006853	0.011842	0.006853	0.155025	−0.089261	0.076453	−0.111911	1.000000							
IV-D2-M3	0.046548	−0.085295	0.052367	0.146686	0.016811	−0.006513	0.146686	−0.466247	1.000000						
IV-D3	0.070618	0.001071	0.150624	−0.139060	0.004525	0.261055	0.024412	0.018896	0.012535	1.000000					
IV-D4	0.308826	0.098726	0.033412	0.152614	0.012602	−0.116083	0.193792	−0.261320	0.070675	−0.115211	1.000000				
IV-D5	0.101525	0.209533	0.007834	0.124412	0.066989	0.050385	0.248280	−0.049943	0.086124	−0.073708	0.284199	1.000000			
IV-D6	−0.089261	0.076453	−0.031372	0.361145	0.070618	0.001071	0.004525	0.261055	−0.114696	0.219260	−0.109060	0.346445	1.000000		
CONV	0.143693	0.062241	0.146686	0.014366	0.069773	0.099080	0.177025	0.114366	−0.087584	−0.031372	0.150624	0.150784	−0.087584	1.000000	
MV	0.007478	0.060362	0.123781	−0.009060	−0.005956	−0.027799	−0.092442	−0.109060	0.346445	0.001368	0.012326	0.023667	0.346445	−0.038427	1.000000
	DV-D1	DV-D2	DV-D3	DV-D4	IV-D1-M1	IV-D1-M2	IV-D2-M1	IV-D2-M2	IV-D2-M3	IV-D3	IV-D4	IV-D5	IV-D6	CONV	MV

Table 12.4 Descriptive statistics of variables

	DV-D1 ROA	DV-D2 ROI/ROE	DV-D3 ROS	DV-D4 Cost-environmental training	IV-D1-M1 Waste water treated	IV-D1-M2 Solid waste transfer	IV-D2-M1 Electricity use	IV-D2-M2 Furnace oil use	IV-D2-M3 Firewood consumption	IV-D3 Internal recycling raw material	IV-D4 Remanufacturing	IV-D5 Environmental design	IV-D6 Environmental audits-ISO	CONV Firm size	MV Environmental investment projects
Mean	31.212	12.679	10.59	1.86	274.96	2636.65	2404	366.5	197	8.74	6.145	10.59	1.66	9705	10.587
Median	31.5	9.0	2.6	1.4	120	2800	355	0	0	4.5	5	2.6	1.3	7500	2.6
Standard deviation	9.116	14.84	19.9	2.13	391.6	1211.5	2997.6	792.3	293.1	10.68	4.87	19.9	1.54	10,874	19.91
Minimum	11	−26	0	0	17	100	0	0	0	0	0	0	0	440	0
Maximum	49.57	91	120	11	1480	5800	8247	4500	1300	37	27	120	15	55,000	120
Observations	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150

Table 12.5 Clarification of descriptive statistics for dependent and independent variables

Dependent and independent variables	Statistical classification of descriptive statistics
Dependent variable measurement 1: return on assets (ROA)	The standard deviation indicates the sample's dispersion level of the variables. According to the above table, the average return on assets (ROA) is 31.2% which means that about 31% of the ROA of private sector rubber companies in Sri Lanka was achieved return due to assets during 2012–2016
Dependent variable measurement 2: return on investment (ROI)	The average return on investment (ROI) is 12.679% which means about 12.7% of the return due to investments over 2012–2016 in private sector rubber companies in Sri Lanka
Dependent variable measurement 3: return on sales (ROS)	The average return on sales (ROS) is 10.6% which means about 10.6% of the return due to sales was achieved by private sector rubber companies in Sri Lanka over 2012–2016
Dependent variable measurement 4: environmental training and development (T&D)	The average cost for training and development (T&D) is 1.86% which means about 1.86% of the cost invested for T&D over 2012–2016 in private sector rubber companies in Sri Lanka
Independent variable 1 measurement 1: amount of waste water generated m^3 (cubic meters) per day (IV11)	Further, the amount of waste water generated m^3 (cubic meters) per day is almost 274.96 cubic meters (median 120 m^3) in private sector rubber companies in Sri Lanka over 2012–2016
Independent variable 1, measurement 2: amount of solid waste (not on-site treated) transfer kg per month (IV12)	The average 2636.65 kg of solid waste transfer per month in private sector rubber companies in Sri Lanka over 2012–2016
Independent variable 2, measurement 1: electricity (kwh) used per day (IV21)	The average electricity consumption per day is 2404 kwh per day in private sector rubber companies in Sri Lanka over 2012–2016
Independent variable 2, measurement 2: amount of furnace oil (litres) used per day (IV22)	Further the average furnace oil consumption is almost 366.5 l (median 0) in private sector rubber companies in Sri Lanka over 2012–2016
Independent variable 2, measurement 3: renewable sources-firewood consumption (GJ) per day (IV23)	Renewable sources-firewood consumption (GJ) per day is 197 GJ per day, and maximum and minimum consumption in a rubber company is 1300 and 0 GJ
Independent variable 3, dimension 1: amount of recycle (waste water) as a percentage from total pure water consumption (IV3)	The average of waste water recycle as a percentage from pure water per day in private sector rubber companies in Sri Lanka over 2012–2016
Independent variable 4: amount of remanufacture (kg) as a % from total input materials (IV4)	The average amount of remanufacturing as a percentage from total input is 6.145% in private sector rubber companies in Sri Lanka over 2012–2016
Independent variable 5: environmental designing (IV5)	The total average cost allocated for green environmental design is 10.59 million rupees in private sector rubber companies in Sri Lanka over 2012–2016

(continued)

Table 12.5 (continued)

Dependent and independent variables	Statistical classification of descriptive statistics
Independent variable 6: environmental training and audits (IV6), cost in rupees million	The total average cost allocate for environmental related training and development is 1.7 million rupees in private sector rubber companies in Sri Lanka over 2012–2016
Mediator variable (MV): amount of money (rupees in million) allocated for environmental friendly projects	The total average cost allocated for environmental friendly projects is 10.6 million rupees in private sector rubber companies in Sri Lanka over 2012–2016
Control variable (CONV): total sales (rupees in thousand)	The total average cost allocated for environmental friendly projects is 9705 rupees thousand in private sector rubber companies in Sri Lanka over 2012–2016

Source: Author's own elaboration

12.5.3 Empirical Results and Model Specification

12.5.3.1 Stationery Test (Unit Root Analysis)

In order to avoid spurious regressions, the researcher conducted the unit root test for panel data to assess stability before estimating panel regression. There are different estimation methods for unit root test in panel data. In this study two types were performed, that is, unit root test for the same root and different roots. Levin et al. (2002) explained that the Levin-Lin-Chu test (LLC test) can be applied for measuring the same root and a further Im-Pesaran-Shin test (IPS test) when different roots are considered. By performing unit root, taking all the data into a common platform is necessary to precede the analysis. Here the researcher intended to check whether all the variables are in the same order of interpretation. As per literature, Levin et al. (2002) stressed that H0 panel data has unit root (assuming common unit root process), while Ha panel data has no unit root. Im et al. (2003) mentioned that H0 panel data has unit root (assuming individual unit root process) (non-stationary), while Ha panel data has no unit root (stationary). The LLC and IPS tests revealed that all of the variables were statistically significant (see Table 12.6) at the first difference (Lag 1). Data was not stationary at level, but when it was converted into the first difference, it became stationary, and it means that data have no unit root in the first difference.

12.5.3.2 Diagnostics Tests

Multicollinearity Among Variables

The next step of the data analysis involves the relevant diagnostic tests to check on the regression assumptions. If there are any violations, the researcher could proceed with corrective actions to produce a robust model. Table 12.3 presents the correlation summary: according to the results, there is no multicollinearity among the variables since the inter-correlations among the explanatory variables are low. An

Table 12.6 Unit root test summary of all variables

Variable	LLC test probability (level-lo)	LLC test probability (level-l_1)	IPS test probability (level-lo)	IPS test probability (level-l_1)	Hadri test probability (level-l_1)
DV-D1	0.0000***	0.0000***	0.7115	0.0000	0.0158**
DV-D2	0.0000***	0.0003***	0.0579*	0.0000***	0.0000***
DV-D3	0.0000***	0.0000***	0.1509	0.0000***	0.0000***
DV-D4	0.2341	0.0000***	0.0144	0.0000***	0.0000***
IV-D1-M1	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
IV-D1-M2	0.0000***	0.0007***	0.8369	0.0001***	0.0000***
IV-D2-M1	0.0000***	0.0000***	0.0783+	0.0000***	0.0000***
IV-D2-M2	0.0000***	0.0000***	0.0553+	0.0470*	0.0000***
IV-D2-M3	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
IV-D3	0.0000***	0.0000***	0.5110	0.0007***	0.0000***
IV-D4	0.0000***	0.0000***	0.3760	0.0000***	0.0000***
IV-D5	0.1211	0.0000***	0.3421	0.0000***	0.0000***
IV-D6	0.0000***	0.0000***	0.8891	0.0000***	0.0000***
ICON	0.9959	0.0000***	1.0000	0.0604	0.0000***
MV	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***

***Indicates a significant level of 1%, **indicates a significant level of 5%, *indicates a significant level of 10%

examination of Pearson correlation showed that none of the independent variables in all models have a correlation of 0.9 or above, indicating that the multicollinearity problem occurred in this study. According to the results in Table 12.3, the highest correlation recorded was 0.466247 between firewood consumption and furnace oil consumption (considered independent variables only). To check further, another diagnostic test for multicollinearity is used, with the variance inflation factor (VIF) calculated for independent variables as follows: VIF = $1/(1-r^2)$, where r^2 is the squared multiple correlation coefficient between independent variables. When r^2 is equal to zero, then VIF has its minimum value. The closer the value of VIF to 1, the lower the degree of multicollinearity. Gujarati stressed that, if one of the VIFs is greater than 10, then the multicollinearity is a problem. Based on the results of VIF, values are much lower than 10. With an average value of 1.3, multicollinearity does not exist among the independent variables. This confirms the high discriminant validity of the current study.

Serial Autocorrelation Among Residuals

A Breusch-Godfrey serial correlation test was performed to test whether there is a serial autocorrelation. Since the p value (0.09477) is higher than the 0.05, the researcher could not reject the null hypothesis, and the results revealed that there is no serial autocorrelation among the residuals which is desirable. One of the major issues arising from panel data is the problem of heteroscedasticity; the Breusch-Pagan test revealed that the p value (0.07819) is greater than 0.05. Hence, the researcher could not reject the null hypothesis, implying that the residuals are homoscedastic (same scatter), which is desirable. The Ramsey RESET Test for

Model Specification revealed that the *p* value of *F*-statistics (0.065) is higher than 0.05, so the researcher could not reject the null hypothesis since the model has not omitted any variable. Hence, this result emphasizes that there is no significant evidence for model misspecification.

12.5.3.3 The Determinants of EMPs

With the purpose of having robust results, the researcher used the Hausman test (with ROA, ROI, ROS and cost for training and development) to check which model is suitable to interpret results. Thus, the Hausman test is selected as the appropriate model for the analysis. The Hausman test related to each determinant of dependent variable is respectively (ROA-P = 0.0068; ROI-P = 0.7939; ROS-P = 0.0468 and training and development-P = 0.00023) revealed that the p values are <0.005 for the three determinants of dependent variable and only one ROI indicate that $p > 0.005$, so the null hypothesis of the appropriateness of the cross-section random effect model could be rejected. Table 12.7 depicts the summary results of the fixed and random effect panel. Least squares test related to each determinant of the dependent variable.

Since the significant value of the *F*-statistic is less than 0.1 ($p < 0.1$) at the 10% level of significance, the regression model is significant in explaining the BP (ROA). The adjusted R-squared value implies that 11% of the ROA variation could be explained through the model. Since the DW value is much higher than 2 which reflects a negative serial autocorrelation, the researcher decided to check whether it is a time-dependent serial autocorrelation, and it depicts that the DW related to that (2.8794) value is higher than in the previous model. Hence the researcher inferred that a higher DW value does not implicate with the time-dependent serial autocorrelation. The fixed effect model summary depicted (see Table 12.7) implied that Δ electricity, Δ furnace oil, Δ firewood and Δ recycle (proxy for environmental management) are significant determinants of BP (ROA). According to Table 12.7, the coefficient value of the Δ recycle (162.3) shows the highest positive impact on ROA, while Δ furnace oil (0.052633) and Δ firewood (0.222892) also show positive relationships with the ROA. Furthermore, Δ electricity (−0.150528) indicated a negative impact on the ROA.

Since the significant value of the *F*-statistic is less than 0.1 ($p < 0.1$) at the 10% level of significance, the regression model is significant in explaining the FP (ROI). The adjusted *R*-squared value implies that 2.8% of the ROI variation could be explained through the model. The Durbin Watson (DW) statistic is not a suitable explanation for non-correlation of errors in panel data. Hence, it is recommended to proceed with the serial correlation LM test, since the DW value (3.3) is much higher than 2 which reflects a negative serial autocorrelation. The researcher administered the model again with the first difference dependent variable to check whether there is a time-dependent serial correlation, and the new model (see Table 12.7) depicted that it was due to the time relevance, because the DW value of the new model with the first difference dependent variable DW value is 2.070603 which is closer to 2. It implies that the present model DW value (3.303583) is much higher than 2 due to the time relevance correlation among independent variables. The random effect

Table 12.7 The impact of environmental management practices on firms' performance using static panel data analysis

Dependent (ROA),(ROI), (ROS), (T&D)	Fixed (ROA)	Random (ROI)	Fixed (ROS)	Fixed (T&D)
C	**−13.55769** (48.04649)	**−0.197776** (2.505363)	**−9.647747** (48.72069)	**0.922964** (2.903308)
D waste water	**0.133418** (0.133418)	**−0.012330** (0.027045)	**0.137521** (0.483964)	**−0.016497** (0.033680)
D solid waste	**0.143460** (0.390353)	**0.253240** (0.005925)+	**0.027967** (0.440248)	**0.001342** (0.008479)
D electricity	**−0.150528** (−0.150528)*	**−0.026874** (0.007591)	**−0.156879** (0.146446)	**0.006208** (0.004420)*
D furnace oil	**0.102633** (0.108742)**	**0.004433** (0.003831)*	**0.110013** (0.109942)+	**0.001009** (0.005156)
D firewood	**0.222892** (0.084599)+	**0.001894** (0.004403)	**0.218065** (0.085361)	**0.001320** (0.009262)
D remanufacturing	**−8.146912** (18.37208)	**0.033568** (0.989100)	**−9.092518** (18.52115)	**−1.039821** (1.200988)
D recycle	**162.3000** (48.85762)***	**0.889536** (2.084299)	**19.48431** (77.15059)	**0.889536** (2.219128)
D no of green products	**15.80222** (76.56781)	**6.120403** (3.167275)+	**165.9749** (49.47313)**	**0.001591** (0.008412)*
D environmental training and audits	**−7.121712** (15.31001)	**0.004534** (2.00976)	**−0.000180** (0.007113)	**−0.104114** (1.01775)
D firm size	**7.46E-05** (0.007070)	**−2.17E-05** (0.000369)	**0.903879** (1.568667)	**−2.17E-05** (0.000399)
R-squared	0.388178	0.397050	0.390707	−0.637973
Adjusted R-squared	0.112111	0.320727	0.193676	0.397050
Prob (F-statistic)	0.09198	0.000008	0.09108	0.320727
Durbin-Watson stat	2.345354	3.303426	2.147322	2.070603
Hausman test		0.7939		
F-statistic	1.088104	1.578703	1.315376	0.000008
Number of observation	150	150	150	150

Note: (1) Figures in parentheses are standard errors robust to heteroscedasticity. (ii) Hausman is the Hausman test for fixed effects over random effects. (iii) Serial correlation is the test for first-order serial correlation in fixed effect models presented by Baltagi. $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. D/Δ denotes fist difference

model summary stated in Table 12.7 implied that Δ furnace oil, Δ solid waste and Δ number of green products (proxy for environmental management practices) are significant determinants of FP (ROI). Accordingly, a second model is performed only with the significant variables. According to Table 12.7, the coefficient value of the Δ furnace oil (0.006208) shows the highest positive impact on ROI, while Δ solid waste disposed (0.001320) and Δ number of green products (0.001591) also show positive relationships with the ROI.

Since the significant value of the *F*-statistic is less than 0.1 ($p < 0.1$) at the 10% level of significance, the regression model is significant in explaining the FP (ROS). The adjusted R-squared value implies that 19% of the ROS variation could be explained through the model. The fixed effect model summary stated in Table 12.7 implied that *Δ furnace oil and Δ number of green products* (proxy for environmental management) are significant determinants of FP (ROS). Further the fixed effect model test summary related to T&D revealed that *Δ number of green products and Δ electricity* are proxy for environmental management. The determinant of EM based on ROA, ROI, ROS and T&D are named as D (electricity), D (furnace oil), D (firewood), D (recycle), D (solid waste) and D (number of green products).

12.5.3.4 Hypothesis Testing

The Impact of EM on BP (H1)

Environmental management impact on business performance is the first hypothesis (H1). The proposed relationship (H1) between environmental management and environmental performance is supported with six sub-hypotheses (H1b, H1c, H1d, H1e, H1f and H1h). H1a and H1b related to the waste treatment (the amount of waste water generated m3/day and amount of solid waste not on-site treated transfer kg/year). Only the amount of solid waste (not on-site treated) transfer had a significant determinant of BP. According to regression test result, it reveals that both measures of waste treatment have no significant relationship with BP. Further, correlation test results revealed that waste treatment (both solid waste transfer and waste water treatment) had a weak correlation with BP. Moreover, analysis shows that this variable (waste treatment-solid waste) has a significant relationship with BP in the category of ROI, indicating negative relationship between the amount of solid waste transfer and FP (see Table 12.8, ROA: $\beta = -0.131482$, $p > 0.1$; ROI: $\beta = -0.001215$, $p < 0.1$ and ROS, $\beta = -0.111202$, $P > 0.1$; T&D: $\beta = -0.001215$, $p > 0.1$), but waste water has no significant determinant for EM. Based on those results, the researcher rejected alternative hypothesis and accepted the null hypothesis of H1b and H1a.

This hypothesis of reduction consists of three sub-hypotheses of the electricity used per day (Kwh), furnace oil used per day (litters) and renewable sources-firewood consumption (GJ) per day had a significant relationship with BP. This study predicted a significant relationship between amount of electricity (kWh) used per day with a BP category of ROI, indicating positive relationship between the amount of electricity used per day and ROI (ROA: $\beta = 0.129029$, $p > 0.1$, ROI: $\beta = 0.009262$, $p < 0.05$; ROS: $\beta = -0.171028$, $p > 0.1$ and T&D: $\beta = 0.009262$, $p > 0.1$). Thus, the amounts of furnace oil (litres) used per day with BP had a significant relationship between. Analysis implies that variable has a significant relationship with BP categories of ROA/ROS and ROI, indicating positive relationship between the amount of furnace oil used per day and BP (ROA: $\beta = 0.189671$ $p < 0.05$; ROI: $\beta = -0.191167$, $p < 0.1$; ROS: $\beta = 0.002051$ $p < 0.05$ and T&D $\beta = 0.191167$ $p < 0.05$). However, renewable firewood consumption had a significant relationship with BP categories of ROI, indicating positive relationship between the amount of firewood used per day and BP (ROA: $\beta = 0.170537$, $p > 0.01$; ROI: $\beta = -0.108055$,

Table 12.8 Summary table – multiple regression outcomes with ROI/ROA/ROS and T&D: model 1

			ROS Fixed effect			ROI Random effect			ROA Fixed effect			T&D Fixed effect	
Variable	Hypo thesis	Coefficient	Std. error	Prob.	Coefficient	Std. error	Prob.	Coefficient	Std. error	Prob.	Coefficient	Std. error	Prob.
C		19.02995	47.12312	0.4010	2.150985	2.795498	0.4439	59.02995	46.61933	0.2090	2.150985	2.795498	0.4439
D (solid waste)	H1b	−0.111202	0.37686	0.8917	−0.001215	0.008185	0.8824	−0.131482	0.152686	0.3917	−0.001215	0.008185	0.8824
D (electricity)	H1c	−0.171028	0.120173	0.9538	0.009262	0.006269	0.1435	0.129029	0.112283	0.2538	0.009262	0.006269	0.1435
D (finance oil)	H1d	0.002051	0.015030	**0.0370***	0.191167	0.107649	0.0796+	0.189671	0.089460	**0.0370***	0.191167	0.107649	0.0496+
D (firewood)	H1e	0.211436	0.112242	0.7131	−0.108055	0.004876	0.04701*	0.170537	0.462242	0.7131	−0.108055	0.004876	0.04701*
D (recycle)	H1f	1.215943	1.215169	0.8219	−1.136351	1.172328	0.3353	−4.397913	19.47018	0.8219	−1.136351	1.172328	0.3353
D (no. of green products)	H1h	15.23241	41.05423	**0.0938+**	3.376838	0.013409	0.0368*	5.738755	81.14593	**0.0938+**	3.376838	0.013409	0.0368*
D (firm size)	H2	0.001214	0.014471	0.9771	−1.81E-05	0.003082	0.9623	0.000216	0.007492	0.9771	−1.81E-05	0.003082	0.9623
D (environmental investment)	H3	1.207326	2.54133	0.8926	−0.000435	0.004865	0.9290	0.222326	1.641223	0.8926	−0.000435	0.004865	0.9290
		R-squared- 0.424125		Prob. (*F*-statistic 0.08701	*R*-squared 0.423738		Prob. (*F*-statistic 0.0000	*R*-squared 0.304729		Prob. (*F*-statistic 0.052702	*R*-squared- 0.614125		Prob. (*F*-statistic 0.05701

Note: (1) Figures in parentheses are standard errors robust to heteroscedasticity. (ii) Hausman is the Hausman test for fixed effects over random effects. (iii) Serial correlation is the test for first-order serial correlation in fixed effect models presented by Baltagi. $^{+}p < 0.1$, $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. D/Δ denotes fist difference

$p > 0.01$; ROS: $\beta = 0.211436$, $p > 0.05$, T&D: $\beta = -0.108055$ $p > 0.01$); and despite this situation, there was only one sub-hypothesis (furnace oil) that has a significant relationship with BP, and two hypotheses related to reduction (electricity and firewood) do not have a significant relationship with BP.

The recycle of waste has no significant relationship with ROA, ROI, ROS and T&D (ROA: $\beta = -4.397913$, $p > 0.01$; ROS: ROI: $\beta = 1.215943$, $P > 0.05$; $\beta = 0.255183$, $p > 0.0.1$). Therefore, it can be said with regard to the hypothesis that recycling has no significant relationship with BP. Remanufacturing also does not have a significant relationship with BP. This study predicted that remanufacturing is not a determinant of EM. Based on that, both H1f and H1g alternate hypotheses were rejected. When considered into variables, environmental design shows a positive significant relationship with ROA, ROI, ROS and T&D (ROA: $\beta = 5.738755$, $p < 0.1$; ROI: $\beta = -3.376838$, $p < 0.1$, ROS: $\beta = 15.23241$ $p < 0.1$ and T&D: $\beta = 3.376838$, $p < 0.1$). In addition to that, the number of green products has a positive correlation with BP. Therefore, the researcher has rejected the null hypothesis. Further, EMS has not a significant relationship with BP, and also it is not a determinant of EM (Table 12.9).

The Impact of EI and Firm Size on BP (H3 and H2)

This study predicted a significant relationship between EI and BP. However, EI does not imply a significant relationship with BP categories of ROA, ROI, ROS and T&D (ROA, $\beta = 0.222326$, $p > 0.1$; ROI, $\beta = 0.000435$, $P > 0.1$, ROS, $\beta = 1.207326$, $p > 0.05$ and T&D, $\beta = -0.000435$, $P > 0.05$). There is one control variable in this study, namely, the size of the firm. This study found that company size has no significant impact on all the BP indicators. This is inconsistent with resource dependence theory which suggests that larger the firm it gives better resources advantage for the company to perform well. Possibly, with the explosion of technology, resources like assets and infrastructure may not give a significant advantage to make profit, but exploitation of the latest technology and information to create value on products and services contributed more to the company in winning business over competitors. Another reason for the result can be viewed from the perspective of earnings management. Empirical research shows that a small company has more opportunity to manage earnings and avoid showing a loss in the financial statement as compared to bigger-sized companies (Albrecht & Richardson, 1990). Hence, it may appear that small companies are better performers than the large companies. This study predicted a significant relationship between firm size and BP. However, findings suggested that this variable has no significant relationship with BP categories of ROA, ROI, ROS and T&D (ROA, $\beta = 0.001214$, $p > 0.1$; ROI, $\beta = -1.81E-05$, $P > 0.1$, ROS, $\beta = 0.000216$, $p > 0.05$ and T&D, $\beta = --1.81E-05$, $P > 0.1$). Therefore we have to reject the alternate hypotheses on both EI and firm size towards business performance.

Table 12.9 Summary table – moderator effect with ROA/ROI/ROS and T&D: model 2

			ROI			ROS			ROA			T&D	
Variable	Hypo thesis	Coefficient	Std. error	Prob.	Coefficient	Std. error	Prob.	Coefficient	Std. error	Prob.			
C		60.01925	42.34094	0.1600									
					−12.29445	44.25283	0.78117	−0.787865	2.373709	0.7408	−4.884773	3.076365	0.1152
D (furnace oil consumption)		0.183400	0.080929	0.0260*	0.219076	0.102967	0.03506	0.008950	0.004536	0.0308*	−0.010132	0.033209	0.7609
D (no. of green products)		27.93689	87.02588	0.0790+	−0.167142	0.072398	0.03105	0.036463	0.067186	0.5887	0.000711	0.009321	0.9393
D (firm size)		4.43E-05	0.007327	0.9952	0.437550	0.471895	0.35509	6.54E-05	0.000411	0.8738	−0.011215	0.007161	0.1202
D (furnace oil × Δ EI)	H4	0.002735	0.002383	0.0243*	0.105931	0.026907	0.01712	0.000170	0.000128	0.0279*	0.002931	0.005407	0.5888
D (no. of green products × ΔEI)	H4	0.260318	2.549827	0.0989+	0.149723	0.091023	0.05519	0.027091	0.013133	0.0872+	0.090584	0.024466	0.0003***
R-squared		0.228059	Prob(*F*-statistic)	0.041548	0.159799	Prob(*F*-statistic)	0.032653	0.287634	Prob(*F*-statistic)	0.099841	0.146004	Prob(*F*-statistic)	0.036330
Adjusted *R*-squared		0.05584	Durbin-Watson stat	2.046810	0.082716	Durbin-Watson stat	2.003147	0.090687	Durbin-Watson stat	2.181497	0.076131	Durbin-Watson stat	2.117007

Note: (1) Figures in parentheses are standard errors robust to heteroscedasticity. (ii) Hausman is the Hausman test for fixed effects over random effects. (iii) Serial correlation is the test for first-order serial correlation in fixed effect models presented by Baltagi. $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. D/Δ denotes fist difference

The Relationship Between EMPs and FP Grows Stronger as the EI Increases (H4)

Prior results of this study showed that the majority of the EMPs did not have a unique relationship with FP. Some have suggested positive relationships, but others have concluded with negative, no or mixed relationships. However, environmental investment documented a positive significant relationship with several of the environmental practice indicators. Based on this, it was expected that a positive environment was created by the environmental investment, and it will foster EMPs to enhance the performance of the financial situation of the company. Findings support the hypothesis in which the moderating effect of the environmental investment established a stronger relationship between EM and BP of the company. Thus, H4 was accepted. This relationship is significant for all the performance measures (ROA, ROI, ROS and T&D). For ROA, the beta value of EM beta values for (furnace oil reduced from 0.008950 to 0.000170, number of green products beta value decreased 0.036463 to 0.027091). The beta value of furnace oil ($p < 0.05$) and the number of green products ($p < 0.05$) was significant as well as the moderating effect of furnace oil (furnace oil × EI) ($P < 0.1$). Further moderating effect of the number of green products (no. of green products × EI) ($P < 0.1$) was significant. The same improvement was also documented by ROI: the beta value of furnace oil decreased from 0.183400 to 0.002735, and the number of green products reduced from 27.93689 to 0.260318. The beta value of furnace oil ($p < 0.1$) and the number of green products ($p < 0.01$) was significant. But the moderating effect (furnace oil × EI) ($P < 0.01$) and moderating effect of number of green products (no. of green products × EI) ($P < 0.01$). Further, the same improvement was also documented by ROS, the beta value of EMPs (furnace oil decreased from 0.219076 to 0.105931, the beta value of number of green products reduced from 0.167142 to 0.149723. The beta value of furnace oil ($p < 0.1$) and the number of green products ($p < 0.01$) was significant. But the moderating effect (furnace oil × EI) ($P < 0.01$) and moderating effect of number of green products (no. of green products × EI) ($P < 0.01$) and T&D was (furnace oil decreased −0.010132 0.002931). The beta value of furnace oil ($p > 0.05$) and the number of green products ($p > 0.05$) was not significant as well as the moderating effect of furnace oil (furnace oil × EI) ($P > 0.1$). Further moderating effect of the number of green products (no. of green products × EI) ($P < 0.1$) was significant. Therefore, we can conclude based on the three aspects of business performance indicators that environmental investment is a negative significant moderator between EM and business performance for the company. All the model specifications were significant at the 1% significant level (ROA: $R^2 = 0.287634$, adjusted $R^2 = 0.090687$, Prob F-statistic = 0.099841; ROI: $R^2 = 0.228059$, adjusted $R^2 = 0.05584$, Prob F-statistic =0.041548 and ROS: $R^2 = 0.159799$, adjusted $R^2 = 0.08271$, Prob F-statistic = 0.032653, T&D: $R^2 = 0.146004$, adjusted $R^2 = 0.076131$, Prob F-statistic = 0.036330). Based on test results, the researcher inferred that environmental investment is capable to lift weaker environmental management practices to a weak business performance for the company.

12.6 Concluding Remarks

There is growing literature that refers to environmental management becoming more important and paramount in the business environment at the present time. This study examined the relationship between environmental management and BP and the interaction between environmental investment and EM on BP for the Sri Lankan rubber manufacturing companies for the period of 2012–2016. It documented the evidence on the significant EM that contributes to BP and the influence of the EI to moderate this relationship. This study is intended firstly to determine significant determinants of environmental management and secondly to identify the impact of these significant environmental determinants on BP based on the four aspects of BSC. There were four measurements employed to determine and measure business performance, namely, ROA, ROI, ROS and T&D. With regard to EM, this study was carried out based on the six (6) principles, namely, (1) waste treatment, (2) energy reduction, (3) recycle, (4) remanufacturing, (5) environmental design and (6) EMS. These principles were further divided into some sub-principles: waste water treatment, solid waste transfer, electricity use, furnace oil use, firewood consumption, waste recycling, remanufacture of raw material, environmental design and EMS; altogether there were nine (9) environmental management determinants to examine whether these determinants contributed to the BP of the company. Out of these nine variables, only two variables were revealed to have a significant relationship with financial performance (furnace oil use and environmental design). The remaining six variables were found as not having any significant effect on BP. After conducting the statistical analysis and as per results, this study only accepted three sub-hypotheses and rejected nine sub-hypotheses. Out of the three sub-hypotheses accepted, two hypotheses are related to the relationship between independent variables and dependent variable, one hypothesis is associated with the moderator effect. The hypotheses accepted are related to energy reduction (H1d) and environmental design (H1h) and moderator effect of environmental investment between EMPs and FP (H4).

This becomes more critical when regulations and laws are unable to curb volatility in an uncertain business environment. The result of the study shows that only several principles contributed to the performance of the company. The secondary data analysis based on industry records (descriptive secondary data: Chapter 5.1) also shows that many companies do not take EMPs seriously. Many companies have yet to fully disclose the EMPs as required by regulations and local government authorities to comply with required compliance to protect the business in the long run. A majority of them failed to reach a minimum of 50% disclosure practices. Besides, certain principles were poorly explained by the companies.

Thus, the policy makers and regulatory authorities like the Sri Lanka Standards Institution, certification bodies, the Board of Investment (BOI), the Central Environment Authority (CEA), Sri Lankan shareholders and other relevant agencies need to enhance their efforts, both on promoting significant determinants of environmental management and at the same time providing stern reminders on the repercussion of non-compliance to the private and public listed companies. More explanations also need to be provided on the positive impact of EM like reputation, attractiveness to foreign investors and favourable image in the eyes of shareholders and public that help a company to survive in business. In contrast, lack of EM may lead to fraud, malpractices and risk of bankruptcy during a financial crisis due to mismanagement. For the practitioner and company itself, particularly the board of directors, improvement and effort need to be taken. The results show that not many companies are making an effort to establish their own version of environmental protection measures. The directors need to provide a good leadership example to the employees of the company including the top management team. This can be done via the establishment of environmental protection measures relevant for directors themselves and codes that bind not only the employee in the company but any entities that have business transactions with the company like suppliers, vendors, distributors and customers. Environmental protection measures also need to be strictly enforced with good promotion and explanation, easily accessible to everybody and supported with transparent mechanisms for disciplinary action for those who do not comply with environmental protection measures or those who violate the environmental management practices.

The ultimate objective of this study is to find out whereby EM has a positive statistically significant relationship with respect to BP. There are a number of limitations within which need to be overcome in the period of research, such as EM is a novel concept and lack of research in Sri Lanka. The fact that there is no constant, uniform relationship between EM and BP which could be waiting to be discovered between firms environmental and BP presents more implications for future studies. Variation in the relationship between cases and over time should have to be separated to find out consistency in relationship. Further to get more consistency in results, sample selection should be conducted at industry level. Based on the above findings, it is evident that determinants of EM are not independent issues among business problems, but they are tightly related to different areas in business strategies. This kind of research will be of immense value to society due to emerging environmental and climatic issues. Development of a precise model to find out relationships between environmental and business performance in organizations will be a valuable contribution in the field of research for further investigation by future researchers.

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