Competitive Cost Advantage: An Application of Environmental Accounting and Management Approach with reference to Bangladesh

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Abstract

In today’s world, advanced nations are enthusiastically performing environmental activities to capture the definitive attainment of financial advantage. Emerging and developing nations are also capturing them gradually. The adoption of environmental management systems and the application of environmental accounting practices are the key tools to meet the financial advantage through increasing the cost advantage. This paper examines the impact of the adoption of environmental management systems and the application of environmental accounting practices with an environmental cost advantage. We gather 268 responses from the respondents by the convenient sampling method and employ the Structural Equation Modelling (SEM) technique to find the effect. We use Smart PLS version 3.3. to conduct the analysis. We find robust evidence that the more the adoption of environment systems (e.g., Pollution-prevention, the innovation of technologies, early adoption of environmental issues), the higher the cost advantage. We also find the robustness with evidence that the higher practices of environmental accounting defense the cost and boosted the cost advantage. In the empirical analysis, we further check the robustness with an alternative estimation method (e.g., hierarchical regression analysis), which also implies the same findings. It infers that environmental management systems and environmental accounting, which enable to concurrently protect the environment and reduce costs. These findings have authoritative implications for the regulatory bodies of organizations, academicians, and policymakers.

Keywords: Environmental Accounting, Environmental Management Systems, Cost Advantage, EMS, Pollution-prevention, Hierarchical regression.
Introduction

The massive global fact of the matter is environmental issues and concerns. The future of mankind has many big environmental challenges, including excessive consumption and extreme air pollution non-sustainable resources (Jones, 2010). A substantial amount of work was conducted in the advanced nations on environmental management systems and inventiveness (Hsiao et al., 2014). The design of environmental management programs and their development process are still uncertain. We thus concentrate on our analysis of developing economies such as Bangladesh. Sands, Lee and Gunarathne (2015) support by affirming that environmental accounting development stages have not been reviewed empirically sufficiently. It is also essential to evaluate and illustrate how companies have perpetually developed and implemented environmental policies through their environmental management pursuits. Sands, Lee, Qian, et al. (2015) added that the emphasis was on highly polluting and energy-intensive sectors of environmental management systems and environmental studies. Muhammad Jamil et al. (2015) add that the position and paybacks of environmental accounting have been stated by observed studies. However, the level of adoption and implementation of environmental accounting practice is still weak in many countries, especially in developing countries like Bangladesh. Thus, in this paper, we empirically examine the impact of the adoption of environmental management systems and the application of environmental accounting on the environmental cost advantage. More specifically, we answer the main research question: Does the environmental management systems and the environmental accounting influence the environmental cost advantage?

Traditional management accounting systems and processes have been recorded to be incapable of adding value in providing adequate and sufficiently practical information that would assist with environmental administration and environmental overheads (Vasile & Man, 2012). This contributed to the underestimation of costs and benefits that can usually be gained by companies adopting or implementing effective resources for environmental management systems (Christ & Burritt, 2013). The environmental management system is increasingly being investigated in order to fill this gap. However, Chan and Wong (2006), and Mensah (2014) point out that there are several factors that enable and/or limit the implementation of environmental management systems tools. Gale (2006) argues that conventional management accounting systems and practices often do not provide adequately exact information for environmental management and environment-related cost managing. In 1998, the United Nations Commission for Sustainable Development created the Expert Working Group, whose responsibility included consultations and agreements on environmentally friendly practices, due to the weaknesses associated with traditional management accounting (Jasch, 2003).

Mehenna Yakhou and Vernon P Dorweiler (2004) have stated that an inclusive area of accounting is environmental accounting. This provides reports for both internal uses, collecting environmental information to help guide pricing decisions, managing overhead and capital budgeting, and external usage, reporting public and financial community environmental information of interest. Environmental cost accounting imposes a cost directly on every component of the environment and calculates the cost of all related actions. Environmental actions include the prevention of pollution, environmental planning, and controlling the environment. Previous environmental impact policies were focused largely on the costs of environmental maintenance and previous product disposal. A broad view of environmental accounting and the EMS includes the application of management decision-making techniques and procedures, performance measurement, identification and recording of liabilities and contingencies, capital market responses to accounts reports, and taxes (Bebbington, 1997).

The costs of protecting the environment for companies in the United States have risen exponentially since the 1970s and are predicted to exceed even further in the future (Carlin, 1991; Keller & Levinson, 2002). The tremendous essence of the costs of environmental protection implies that strategies affecting those costs are an important indicator of the competitive position of a firm. The evidence on environmental management indicates that businesses can boost their competitiveness and at the same time the harmful effects of their operations on the natural environment by introducing such “Environmental cost advantages” (Cairncross, 1992; Hart, 1995; Schmidheiny &
A number of studies on environmental management established these “Environmental cost advantages” from case studies of companies that successfully developed competitive advantages through their environmental strategies, such as 3M (Shrivastava, 1995b) or Dow (Smart, 1992). However, current work has not given insights into how specifically these case-study companies handle the method of applying the environmental management’s “Environmental cost advantage” to achieve the desired benefits—as such, developing a deeper understanding of the process of implementing these “Environmental Cost Advantages” seems to be key in determining whether such practices can attain competitive advantage on all adopting firms or only on those firms that have existing assets that enable them to capitalize on such practices. In other words, the successful case-studies companies that are not representative of a large population of companies, and can, therefore, be generalized, may have something proprietary or unique.

The body of knowledge that environmental cost is the product of the business activities that produce an environmental cost, which in turn adversely affects companies (interior), communities, and individuals (externally) and environmental costs (internal and external). These are the result of environmental quality activities and can be represented in both monetary and non-monetary ingredients (Bouten & Hoozée, 2013; De Beer & Friend, 2006; Papaspyropoulos et al., 2012). Whatever the types of environmental costs, to promote internal decision-making, it is necessary to incorporate them into internal cost accounting (Janković & Krivačić, 2014). External microeconomic ecological accounting provides information on environmental costs, environmental risks, production processes, eco-products, and the consequences of eco-actions and facilitates corporate decision making. As a consequence, the idea has been developed to track their efficiencies and potential for environmental betterments through modern environmental management accounts, resource accounting, data on usage, flow and energy, water, material, and waste information (Miller et al., 2016).

This study discovers the robust evidence that firstly, the better the pollution prevention, the greater the environmental cost advantage. Secondly, the more innovation in technologies, the higher the environmental cost advantage. Thirdly, early adoption of environmental issues doesn’t have a significant influence on environmental cost advantage across our study. Fourthly, the higher the practices of environmental accounting, the higher the environmental cost advantage. The alternative method also discovers the same result. Thus, we argue that the adoption of environmental management systems and the application of environmental accounting have a significant positive influence on environmental cost advantage.

**Literature Review and Hypothesis Development**

This paper is associated with the studies investigating the connection of environmental management systems and environmental accounting practices with the environmental cost advantage.

Environmental accounting is defined as the mechanism for defining, gathering, reviewing, analyzing, reporting internally, and using the information on energy and resources, environmental costs, and other environmental data for decision-making purposes (Vasile & Man, 2012). Environmental Accounting is a collective tactic for transferring data from financial, cost, and material accounting to increase material use efficiency, to reduce environmental impact, and to record environmental costs. It has a financial and physical dimension (Jasch, 2003). Environmental management accounting (EMA) is characterized as producing, analyzing, and using financial and related non-financial information, in support of management within a company or enterprise (Bartolomeo et al., 2000). Schaltegger et al. (2012) argue that even the EMA system, as with various environmental accounting methods introduced, does not clarify processes in the design of environmental information management and usage processes by corporate decision-makers. Even the importance of environmental accounting is empirically reviewed in the literature review section of Rahman and Rahman (2020). They take some observation in the context of Bangladesh and prove environmental accounting as a tool of environmental sustainability.

The problem of environmental conservation or the company’s impact on the eco-system is one of the prevailing factors of potential business threats in all fields of industry and of raising the responsibility for the resulting environmental harm. A corporation or administration must be observable and clear in avoidance of adverse environmental impacts (Shen,
Management must, therefore, not only formally respect environmental regulatory requirements, but also have a specified long-term value generation strategy (Pešić-Tomić & Andrijašević, 2014). Enterprise management under ecological management is an effort to minimize the negative environmental impacts during its life cycle of products and production processes (Klassen & McLaughlin, 1996). The ecological management of many disciplines within the company involves the creation of a cost-effective system to guide and monitor production activities according to ecological and economic requirements. Any negative impact on the environment or pollution is a form of economic inefficiency, and thus every effort is required to prevent these negative impacts (Burnett & Hansen, 2008). Beredugo and Mefer (2012) considered that sustainable development concerns pollution reduction technologies, energy mix monitoring technologies, people's contribution to environmental degradation, and modern biomass, wind, and solar power technology, reducing the ecological and environmental risk. Researchers submitted that sustainable development concerns technologies for a reduction in pollution. Environmental accounting provides information on all environmental factors. It includes environmental spending, commodity environmental benefits, and sustainable operations information (Ahnad & Lutz, 1989).

The analysis shows that environmental issues in developed economies are less severe (Kang et al., 2012). In Brazil, for example, modification of EMS systems, including EMA, is still limited in comparison with developed countries (De Oliveira et al., 2010). Massoud et al. (2010) support this assumption by noting that the implementation of the EMS constitutes a marginal proportion in the developed countries of Central and Eastern Europe. The advantages of an EMS using ISO 14000 give a global competitive advantage. Competitive advantage is compared to companies with such an EMS which do not have good environmental efficiency. Reinhardt (1998) argued that the implementation of the environmentally responsible policy would not allow all companies to create a competitive benefit and that the conditions under which responsible environmental strategies lead to competitiveness must receive more attention. His examples of environmental product differentiation indicate that it is mainly external contingencies, such as industry structure and product market characteristics in which the company competes that an enterprise can gain an advantage in terms of distinction by its environmental responsibility. This document is complemented by the external contingency emphasis of (Reinhardt, 1998), which studies how internal factors influence environmental and competitive interactions within the organization. An increasing array of environmental management literature is focused on identifying environmental management systems and accounting practices that, at the same time, reduce the adverse environmental impacts of business activities, and contribute to the competitive advantage of the product markets that benefit the environmental costs. The adoption of environmental policies and the application of environmental accounting practices influence various kinds of competitive advantage, according to this literature. Porters (1980) distinguished between cost and diversity advantages, which has previously been used to categorize types of competitive advantages shaped by firms’ environmental strategies; Stead and Stead (1995) and Shrivastava (1995c) offer a useful outline for deliberating these belongings. Environmental cost advantage can result from adopting environmental management systems and environmental accounting practices that focus on firms’ production processes (Hart, 1995; Stead & Stead, 1995). Process-oriented adoptions of the environmental management system include the redesign of manufacturing processes as less polluting, substituting less polluting materials, recycling plant by-products, and creating less polluting processes (Ashford, 1993; Dechant & Altman, 1994; Florida, 1996). Such activities are designed to minimize production costs by increasing the performance of production processes and reducing the cost of supply and waste disposal (Newman & Breeden, 1992; Shrivastava, 1995b, 1995c; Smart, 1992; Stead & Stead, 1995). Empirical outcomes show that the key financial motive for employing process-focused environmental practices is a firm’s wish to cut costs (Stead & Stead, 1995). More comprehensive approaches to environmental management, which take account of the environmental impact of companies’ operations over the entire life cycle of their products, may also lead to environmental cost benefits, from product design to manufacture, usage and disposal. These approaches include inventory selection by Hart (1995) and eccentric supervision (Shrivastava, 1995a), features...
such environmental practices as life-cycle-analysis by Davis and Davis (1993), “cradle-to-grave” design, strategy for disassembly by Shrivastava (1995c) and plan for the environment by Hart (1997). We expect that environmental accounting practices increase the cost advantage. Thus, the initial hypothesis of this study is as follows:

\[ H-1: \text{Environmental accounting practices increase environmental cost advantage.} \]

The literature primarily described the use of organizations actively implementing environmental management programs through case studies. Most case studies assess process-oriented implementation and aim to calculate the cost savings associated with it. Cases such as 3M’s (Minnesota Mining and Manufacturing) Pollution Protection Pays (PPP) system focused on emissions prevention, natural-resource management, and continuing progress include cases where businesses have achieved environmental cost advantage through process-driven adoption (Hart, 1995; Stead & Stead, 1995). The PPP package has kept 3M $810 million since its commencement in 1975 (Company, 1998). Many environmental initiatives, including Dow’s Waste Reduction Always, Pays (WRAP), or Chevron’s Save Money and Eliminate Toxin (SMART) systems, also have substantial cost savings (Stead & Stead, 1995). With a range of innovations, businesses have the ability to reduce the adverse environmental impact of their operations. Such techniques can be listed using emission control methods. Contamination may be minimized by avoidance or monitoring (Hart, 1995). Preventing pollution aims at reducing, modifying, or preventing emissions and effluents by improving household management, material substitution, recycling, or improvements in the manufacturing process (Willig, 1994). Emissions control technology, also known as source-reduction technology or sustainable technology, minimizes the manufacturing cycle of pollution and waste. Pollution control aims through the use of pollution control devices to capture, transport, handle, and dispose of contaminants and effluents. After adding equipment to existing production processes, pollution and waste were reduced. Such devices, including incinerators and scrubbers, are also known as end-of-the-pipe technologies. Hence, the second hypothesis of this study is as follows:

\[ H-2: \text{Pollution prevention initiatives increase environmental cost advantage.} \]

The literature on environmental protection emphasizes the use of pollution reduction technologies as an important application of environmental management systems. The use of pollution reduction technologies will improve production output (Schmidheiny & Timberlake, 1992; Smart, 1992). Efficiency increases are due to reduced input costs by using inputs better or replacing less costly inputs, reducing waste disposal costs, and reducing recycling or reutilizing materials. Pollution control can also minimize cycle time by simplifying or eliminating unnecessary operational measures or reduction in downtime by improved monitoring equipment (Porter & Van der Linde, 1995). However, technology to avoid pollution will reduce emissions well below the necessary emissions rates, thereby reducing enforcement and liability costs. On the other hand, pollution control technology is investing in non-productive goods; additional costs which have little potential to improve production output.

Another important source of competitive advantages from environmental approaches literature focuses on pollution reduction innovation (Ashford, 1993; Porter & Van der Linde, 1995). Technology advancement varies profoundly from the use of technologies that have already been developed (Ashford, 1993). Initial emission reduction technology innovation can, in a variety of ways, add to the cost-profit of the business. First, managers can become more aware of inefficiencies in existing production processes and/or products not recognized beforehand in the creation of new pollution reduction technologies that increase the potential for cost-saving improvements to performance (Porter & Van der Linde, 1995). Furthermore, pollution reduction in engineering can lead to cost-saving improvements in the production process. Thirdly, companies are likely to earn rentals generated by internal technology to avoid emissions because these technologies are proprietary to the client. Security by means of imitability obstacles, including the above-described barriers to imitating pollution preventing technologies, as well as secretiveness and legal security through patents, are the proprietary nature of these systems. Thus, the third hypothesis of this study is as follows:

\[ H-3: \text{Innovation of technologies increases the environmental cost advantage.} \]

The environmental benefit can be predicted to start tackled sooner than rivals and before environmental
legislation is implemented. A strategy to anticipate future regulation of the environment and to implement technologies to comply with it prior to the adoption of the regulation reduces the costs of a company complying with the regulation. This is because anticipation minimizes output disturbances in connection with the creation and deployment of enforcement technologies (Ashford, 1993). Organizations that respond to protocols late might face time firmness diseconomies (Dierickx & Cool, 1989; Nehrt, 1996) because they need to implement environmental technologies sooner, which might result in more interruptions of the production process. Therefore, only companies that anticipate future regulations can introduce pollution prevention technologies when new regulations give businesses only a short time to adapt (Nehrt, 1996) because it takes longer than emissions control systems to incorporate such systems—addressing environmental issues earlier than competition would allow businesses to reap cost-benefit from learning curve effects (Lieberman & Montgomery, 1988). The faster a corporation decides to tackle environmental concerns and down the environmental technology learning curve, the lower the cost of environmental management is at a time compared to its rivals. Thus, the last hypothesis of this study is as follows:

\[ H-4: \text{Early adoption of environmental issues increases the environmental cost advantage.} \]

**Sample, Variables, and Methodology of the study**

**Sample**

For empirical examination, the authors collected the primary data from Bangladeshi manufacturing firms listed in Dhaka Stock Exchange (DSE) through questionnaires by employing a convenient sampling method. To acquire a suitable sample, we set aside up to a maximum of 329 respondents from 30 manufacturing firms, for instance, cement (1), ceramics (1), food and allied (1), pharmaceuticals and chemicals (5), paper and printing (1), and textile (8). We select these firms as they directly deal the environment and natural resources. But the authors deleted the 61 respondents because of partial response, non-response, and incomplete responses. Finally, we set aside 268 respondents for this study. Joseph F Hair et al. (1995) suggested that sample sizes should be 100 or greater. Several textbooks (Gorsuch & Hillsdale, 1983; Joseph F Hair et al., 1995; Pett et al., 2003; Tabachnick et al., 2007) cite the work of Comrey and Lee (2013) in their guide to sample sizes: 100 as poor, 200 as fair, 300 as good, 500 as very good, and 1000 or more as excellent. We use the 7 Point Likert scale in the questionnaire to collect the primary data. Point 7 indicates the higher score, and point 1 indicates a lower score on the scale. On several indices of reliability, validity, discriminating power, and respondent preference, a seven-point scale is preferable as compared to a five-point scale or less (Preston & Colman, 2000). The collected data was arranged and tabulated for examination under the objectives of the study.

**Variables (Constructs measurement)**

This paper uses the environmental cost advantage (ECA) as the dependent variable. The environmental cost advantage is measured from the five items (ECA1, ECA2, ECA3, ECA4, ECA5) designed in the questionnaire. We adopt these statements from Christmann (2000).

Four independent variables are used in this study. First, pollution prevention technology (PP) is measured by the three items (PP1, PP2, PP3) constructed in the questionnaire adopting from Shen (1995). Second, the innovation of technologies (INN) is measured by the four constructs (INN1, INN2, INN3, INN4) established in the questionnaire adopting from Bhupendra and Sangle (2015) and Christmann (2000). Third, the early adoption of environmental issues (EAE) is measured from the two items (EAE1, EAE2) designed in the questionnaire adoption from Christmann (2000). Finally, environmental accounting practice (EAP) is measured by the fifteen constructs (EAP1 to EAP15) designed in the questionnaire adopting from Christmann (2000), Burritt and Christ (2016), Mehenna Yakhou and Vernon P. Dorweiler (2004) and Gale and Stokoe (2001).

In total, 29 measurement items were adopted from the study of Christmann (2000) and also from the authors’ idea for the environmental accounting practice constructs. There was no wrong response from the respondents. We will not be known to anyone for their privacy. For academic reasons, this work may be the most successful. Any business cannot exchange details. No details. Another critical problem was the response bias. The questionnaire was very carefully designed to prevent this. The questionnaire contained simple, direct, and understandable questions. There were only 29 simple questions.
Methodology
For methodological purposes, we specify the Structural Equation Modeling (SEM) technique to reach in the conclusion. Then, we estimate the impact of the adoption of environmental management systems and the application of environmental accounting on the environmental cost advantage. At the same time, we use the hierarchical regression analysis model as an alternative estimation method to check the robustness of our main analysis (Using SPSS version 25). These models evaluate the relationship between the environmental cost advantage with the adoption of environmental management systems and the application of environmental accounting. We use Smart PLS version 3.3 as the evaluation device for our study.

Empirical Analysis and Results
Demographic profile of the respondents
Fig. 1 briefly presents the demographic profile of the respondents. The sample represents rather an equal gender balance, with 51% (138) female and 49% (130) male respondents. In terms of education level, 26% (71) of the respondents are enrolled in a bachelor’s degree program and 28% (75) in a master’s degree program that means more than 50% of respondents have better professional knowledge. In terms of age group, 26% (71), 33.58% (90), and 19.40% (52) are over 22 years, which means they are practicing the profession at their fluent age, and we have strong, reliable responses.

Reliability and validity
In order to clarify the fundamental interaction of factors data declining and to prevent multi-co-ordinaries, the principal component analysis (PCA) was performed. The cut-off point in the PCA was 0.60, which guarantees the reliability of the questionnaire (absolute value less than 0.60 should be suppressed). As suggested, through the findings of PCA, eight items of “Environmental accounting practices” (EAP1 to EAP 7, and EAP 13) were removed due to the value of less than 0.60. Table 1 presents the Cronbach’s alpha (Cronbach, 1951), average variance extracted (AVE), rho, composite reliability (CR) and factor loadings. The rule of thumb for Cronbach’s alpha is greater than 0.70, and CR is greater than 0.70, AVE is greater than 0.50 (Hair et al., 2010; Nunnally, 1978). Further, the overall alpha for the 29 items is 0.91. In this study, the alpha values of each item are higher than the diagnosed rule of thumb, thereby indicating a good internal consistency. Table A1 in the Appendix A
shows the cross loadings. The convergent validity has been ensured as the AVE of all constructs are greater than 0.50 (Hair et al., 2010).

**Table-I: Measurement items and their reliability**

<table>
<thead>
<tr>
<th>Constructs and their respective items</th>
<th>Factor loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Environmental Cost Advantage (ECA, Alpha: 0.807, rho: 0.814, CR: 0.867, AVE: 0.566)</strong></td>
<td>-</td>
</tr>
<tr>
<td>ECA1. The use of pollution preventive environmental technology reduces the internal environmental cost of the organization.</td>
<td>0.704</td>
</tr>
<tr>
<td>ECA2. The use of pollution preventive environmental technology reduces the external environmental cost of the organization.</td>
<td>0.754</td>
</tr>
<tr>
<td>ECA3. Does the use of innovative technology help to shape the strategy that reduces overall environmental cost?</td>
<td>0.719</td>
</tr>
<tr>
<td>ECA4. Early adoption of an environmental management system supports environmental cost savings.</td>
<td>0.847</td>
</tr>
<tr>
<td>ECA5. The environmental advantage can be achieved through the application of environmental accounting.</td>
<td>0.731</td>
</tr>
<tr>
<td><strong>Pollution-Prevention (PP, Alpha: 0.906, rho: 0.907, CR: 0.941, AVE: 0.842)</strong></td>
<td>-</td>
</tr>
<tr>
<td>PP1. Implementation of new cleaner processes.</td>
<td>0.907</td>
</tr>
<tr>
<td>PP2. Modification of existing processes.</td>
<td>0.939</td>
</tr>
<tr>
<td>PP3. In process recycling/recovery</td>
<td>0.907</td>
</tr>
<tr>
<td><strong>The innovation of technologies (INN, Alpha 0.854, rho: 0.859, CR: 0.901, AVE: 0.695)</strong></td>
<td>-</td>
</tr>
<tr>
<td>INN1. We address this issue mainly with technologies developed within the company.</td>
<td>0.829</td>
</tr>
<tr>
<td>INN2. To what extent your firm use innovativeness to design product and operation related technologies to minimize their environmental impact</td>
<td>0.815</td>
</tr>
<tr>
<td>INN3. To what extent your firm incorporates innovativeness between environmental management systems and environmental accounting practices</td>
<td>0.852</td>
</tr>
<tr>
<td>INN4. To what extent your firm use innovativeness to get improved products &amp; design, which reduce emissions and waste that leads to environmental efficiency.</td>
<td>0.839</td>
</tr>
<tr>
<td><strong>Early Adoption of Environmental Issues (EAE, Alpha 0.701, rho: 0.701, CR: 0.870, AVE: 0.770)</strong></td>
<td>-</td>
</tr>
<tr>
<td>EAE1. To what extent your firm adopt environmental management systems for getting environmental cost advantage.</td>
<td>0.877</td>
</tr>
<tr>
<td>EAE2. To what extent your firm early maintain the practices of environmental management systems for the assessment of environmental impact.</td>
<td>0.878</td>
</tr>
<tr>
<td><strong>Environmental Accounting Practices (EAP, Alpha 0.845, rho: 0.849, CR: 0.883, AVE: 0.519)</strong></td>
<td>-</td>
</tr>
<tr>
<td>EAP1. To what extent your firm recognized environmental accounting information for a wide range of stakeholders Dropped</td>
<td></td>
</tr>
<tr>
<td>EAP2. To what extent your firm focus on the assessment of environmental performance and increased efficiency through environmental accounting Dropped</td>
<td></td>
</tr>
<tr>
<td>EAP3. To what extent your firm focus on management attention to control and reduction of environmental cost Dropped</td>
<td></td>
</tr>
<tr>
<td>EAP4. To what extent your firm use environmental accounting for cost analysis through life cycle cost assessment, activity-based costing, and material flow accounting. Dropped</td>
<td></td>
</tr>
<tr>
<td>EAP5. To what extent your firm use investment appraisal as a technique of environmental accounting, for long-term and comprehensive analysis of future cost and benefits Dropped</td>
<td></td>
</tr>
<tr>
<td>EAP6. To what extent your firm use a balanced environmental scorecard as a technique of environmental accounting, for assessment of environmental performance. Dropped</td>
<td></td>
</tr>
<tr>
<td>EAP7. To what extent your firm allocates an environmental-related cost to the production process or products. Dropped</td>
<td></td>
</tr>
<tr>
<td>EAP8. To what extent your firm estimates environmental-related contingent liabilities (fines, penalties related to pollution)</td>
<td>0.726</td>
</tr>
<tr>
<td>EAP9. To what extent your firm use environmental accounting for improvement of cost management</td>
<td>0.773</td>
</tr>
<tr>
<td>EAP10. To what extent your firm develops and uses of environmental-related key performance indicators</td>
<td>0.678</td>
</tr>
<tr>
<td>EAP11. To what extent your firm use product inventory analysis for the specification of material used and energy required.</td>
<td>0.785</td>
</tr>
<tr>
<td>EAP12. To what extent your firm use product impact analysis (assessment of environmental effects on product design)</td>
<td>0.694</td>
</tr>
<tr>
<td>EAP13. To what extent your firm use product improvement analysis (to identify opportunities for reduction of environmental impact) Dropped</td>
<td></td>
</tr>
<tr>
<td>EAP14. Being environmentally conscious can lead to substantial cost advantage to your firm</td>
<td>0.655</td>
</tr>
<tr>
<td>EAP15. For achievement environmental accounting objectives, our firm invests in new eco-friendly technologies, process, and strategies</td>
<td>0.722</td>
</tr>
</tbody>
</table>

Source: Developed by the Authors based on Smart PLS 3.3. output
We use the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett’s Test of Sphericity. Prior to the extraction of the factors, several tests should be used to assess the suitability of the respondent data for factor analysis. These tests include Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy (Kaiser, 1970; Kaiser & Rice, 1974) and Bartlett’s Test of Sphericity (Bartlett, 1950). The KMO index, in particular, is recommended when the cases to variable ratio are less than 1:5. The KMO index ranges from 0 to 1, with 0.50 considered suitable for factor analysis (Joseph F Hair et al., 1995; Tabachnick et al., 2007). Bartlett’s Test of Sphericity should be significant (p<.05) for factor analysis to be suitable (Joseph F Hair et al., 1995; Tabachnick et al., 2007). Thus, we employed this test. Based on this test, it can be said that the value of KMO and Bartlett’s Test obtained is 0.876, with a significance of 0.000. Therefore, this study met the requirements of KMO greater than 0.5 (>0.5) and significance under 0.05 (<0.05). Using confirmatory factor analysis (CFA), we got five factors.

### Table-2: Discriminant Validity

<table>
<thead>
<tr>
<th></th>
<th>EAE</th>
<th>EAP</th>
<th>ECA</th>
<th>INN</th>
<th>PP</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAE</td>
<td>0.877</td>
<td>0.234</td>
<td>0.307</td>
<td>0.215</td>
<td>0.841</td>
</tr>
<tr>
<td>EAP</td>
<td>0.181</td>
<td>0.720</td>
<td>0.861</td>
<td>0.679</td>
<td>0.298</td>
</tr>
<tr>
<td>ECA</td>
<td>0.232</td>
<td>0.717</td>
<td>0.752</td>
<td>0.604</td>
<td>0.338</td>
</tr>
<tr>
<td>INN</td>
<td>0.166</td>
<td>0.579</td>
<td>0.508</td>
<td>0.833</td>
<td>0.283</td>
</tr>
<tr>
<td>PP</td>
<td>0.750</td>
<td>0.265</td>
<td>0.294</td>
<td>0.251</td>
<td>0.918</td>
</tr>
</tbody>
</table>

Source: Developed by the Authors based on Smart PLS 3.3. output

Table 2 represents the discriminant validity of the constructs. The diagonal line is the square root of AVE. Below the diagonal, the correlation of the latent constructs exists. The correlation between the variables are lower than the diagonal value ensuring the discriminant validity. Above the diagonal, the HTMT (Heterotrait-Monotrait ratio) value has been presented. Further, The HTMT value (lower than 0.90) ensuring the discriminant validity.

**Common method bias**

Common way bias denotes to measurement errors due to methodological matters. For instance, having a shared measurement scale (e.g., a 7-point Likert scale) for all survey queries may lead to common method bias. Podsakoff et al. (2003) sketch a few statistical medications to common method bias, each of which comes with pros and cons. In this study, we use Harman’s single factor test, which is the most broadly used one. We perform unrotated exploratory factor analysis using the 29 items loading on one factor. The average variance explained by the single factor is only 35% (well below the recommended cut-off 50%). Thus, common method bias is not an issue in this study.

**Hypothesis testing**

Tables 3 represents the empirical result of the regression analysis. We calculate the value of R squared, which measured the proportion of the variation in the dependent variable explained by the model. R squared is the most common measure of how well a regression model fits the data. Thus, as it is shown below, the value of the R square is 0.538 (Adjusted R square 0.531), which means that 54% of the variation in the environmental cost advantage is explained by the independent variables. Therefore, the model moderately fits. Following Hair et al. (2010), the model is good fitted as SRMR value is 0.07 (less than 0.08), NFI value is 0.79 (greater than 0.70), RMSEA value is 0.05 (Threshold value 0.05). Thus, the model fits perfectly.

The coefficient of the pollution-prevention (PP) is (0.057) (e.g., Table 3), which is positive and significant at less than a 5% level of significance. Therefore, the environmental cost advantage has been increased by pollution-prevention technologies. It implies that environmental cost advantage is positively influenced by the pollution-prevention. It is consistent with our expectations; thus, this finding supports our second hypothesis (H2). Also, the coefficient of the innovation of technologies (INN) is (0.126) (e.g., Table 3), which is positive and significant at less than a 5% level of significance. Therefore, the environmental cost advantage has been increased by the innovation of technologies. It implies that environmental cost advantage is positively influenced by the innovation. It is also consistent with our expectations; thus, this finding supports our third hypothesis (H3). But, the coefficient of the early adoption of environmental accounting issues (EAE) is not significant across our
study. Thus, the environmental cost advantage has not been influenced by the early adoption of environmental accounting issues. Therefore, it is not consistent with our expectations; thus, this finding not supports our fourth hypothesis (H4). Finally, the coefficient of the environmental accounting practices (EAP) is (0.619) (e.g., Table 3), which is positive and significant at less than 0.1% level of significance. Therefore, the environmental cost advantage has been improved by environmental accounting practices. It implies that environmental cost advantage is positively influenced by environmental accounting practices. It is consistent with our expectations; thus, this finding supports our first hypothesis (H1).

Table 3 also represents collinearity statistics. We use the Variance Inflation Factor (VIF) to check the multicollinearity issues. There is no formal VIF value for defining the presence of multicollinearity. Some studies argue that a VIF<10 is acceptable (J. F. Hair et al., 1995), but others say that the limit value is 5 (Ringle et al., 2015). Thus, based on this, this study doesn’t have multicollinearity issues. According to Table 3, this study supports the H1, H2, and H3 hypotheses, but H4 is not supported because of insignificant coefficients.

<table>
<thead>
<tr>
<th>Path Analysis</th>
<th>Coefficients</th>
<th>VIF</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1: Environmental accounting practices → Environmental cost advantage</td>
<td>0.619 (0.000) ***</td>
<td>1.539</td>
<td>Supported</td>
</tr>
<tr>
<td>H2: Pollution-prevention → Environmental cost advantage</td>
<td>0.057 (0.041) *</td>
<td>2.402</td>
<td>Supported</td>
</tr>
<tr>
<td>H3: Innovation of technologies → Environmental cost advantage</td>
<td>0.126 (0.046) *</td>
<td>1.527</td>
<td>Supported</td>
</tr>
<tr>
<td>H4: Early adoption of environmental issues → Environmental cost advantage</td>
<td>0.056 (0.472)</td>
<td>2.287</td>
<td>Not supported</td>
</tr>
</tbody>
</table>

Source: Authors’ development (p value in parenthesis. ***p < 0.001, **p < 0.01, *p < 0.05).

Robustness check: Hierarchical Regression

In this section, we use hierarchical regression analysis (e.g., Table 4) to check the robustness of our main findings, similar to the study of Wang et al. (2019). Hierarchical regression is a way to show if variables of our interest explain a statistically significant amount of variance in our dependent variable after accounting for all other variables. This is a framework for model comparison rather than a statistical method. The findings of hierarchical regression in Table 4 proves that the main findings in Tables 3 are consistent. To simplify the study, we did not include the firm size and firm age in the demographic profile section.
Table-4: Coefficients based on hierarchical model

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 1 (ECA)</th>
<th>Model 2 (ECA)</th>
<th>Model 3 (ECA)</th>
<th>Model 4 (ECA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm Size</td>
<td>0.072</td>
<td>0.073**</td>
<td>0.088**</td>
<td>0.091</td>
</tr>
<tr>
<td>Firm Age</td>
<td>0.097**</td>
<td>0.094</td>
<td>0.096*</td>
<td>0.090*</td>
</tr>
<tr>
<td>Independent Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>0.02100**(0.13)</td>
<td>0.10320**(0.01)</td>
<td>0.00540*(0.11)</td>
<td>0.22500**(0.09)</td>
</tr>
<tr>
<td>INN</td>
<td>0.00300*(0.14)</td>
<td>0.04400*(0.21)</td>
<td>0.13400**(0.06)</td>
<td></td>
</tr>
<tr>
<td>EAE</td>
<td>0.04720</td>
<td></td>
<td>0.04720 (0.32)</td>
<td>0.02600 (0.10)</td>
</tr>
<tr>
<td>EAP</td>
<td></td>
<td></td>
<td>0.12500****(0.02)</td>
<td></td>
</tr>
<tr>
<td>R Squared</td>
<td>33.5%</td>
<td>34.1%</td>
<td>34.7%</td>
<td>43.2%</td>
</tr>
<tr>
<td>Adjusted R Squared</td>
<td>31.3%</td>
<td>28.5%</td>
<td>32.3%</td>
<td>41.8%</td>
</tr>
<tr>
<td>Observations</td>
<td>268</td>
<td>268</td>
<td>268</td>
<td>268</td>
</tr>
</tbody>
</table>

Standard error in parenthesis. ***p < 0.001, **p < 0.01, *p < 0.05.

Source: Developed by authors based on SPSS 25 output

Concluding remarks and scope for further research

This study attempts to understand the relationship of the adoption of environmental management systems and the application of environmental accounting practices with an environmental cost advantage in Bangladesh’s perspective. The findings exposed that factors in adopting environmental management systems; first, pollution prevention technologies; second innovation of technologies; third early adoption of environmental issues; have a significant influence on environmental cost advantage except for the early adoption of environmental issues. Across our study, environmental issues early adoption is not significant. Higher Pollution prevention technologies increase environmental cost advantage. More innovation in technologies implies a higher environmental cost advantage. In the case of early adoption, this study implies that competitors’ early adoption of environmental issues doesn’t influence the cost advantage in our study. The findings also exposed that the application of environmental accounting practices has a significant positive impact on environmental cost advantage. It implies that the more the application of environmental accounting practices, the higher the cost advantage.

Although this study has a contribution toward understanding the factors of environmental management systems for adoption and the application of environmental accounting practices for determining the environmental cost advantage, there are some limitations. First, it is specific to one context (e.g., Bangladesh). Second, the data were collected using a convenient sampling method; the findings of this study will face the limitations of generalization. Third, the number of respondents is small. Future research is needed for a large sample for the study. Fourth, environmental management knowledge can be different for different demographic groups such as male, female, masters, honors, ages, etc. Demographic characteristics regarding environmental issues can be addressed in further studies to find an overall result of adopting environmental management systems. Since environmental management systems and environmental accounting are lively issues, they should be measured repeatedly. This study uses primary data; it is recommended that the future study would use a mixed study to get the relative influence of environmental management systems and environmental accounting with the cost advantage. Finally, the future study should use longitudinal data, as this study use cross sectional data.
References


