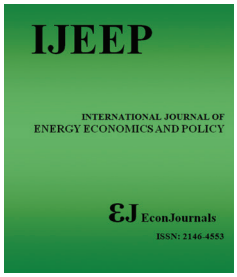

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The Impact of Management Accounting Systems, Eco-innovations and Energy Efficacy on Firm's Environmental and Economic Performance

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ABSTRACT

The current study aims to explore the effect of ecological innovations, energy efficiency and management accounting systems in influencing firms' environmental performance of Indonesian manufacturing companies. The study further analyzed the relationship of ecological innovation, energy efficiency, and management accounting system with an organization's economic performance. The present study is therefore novel in addressing the vital connection of technology with organizations' performance in ecologically driven settings. The total valid sample for the present study is 310. The results of PLS-SEM confirm that all selected variables have a positive and significant impact on economic performance and environmental performance in the manufacturing sector in Indonesia. Moreover, the outcomes of the PLS-SEM confirm that economic and environmental performances have positively and expressively impacted by management accounting system, energy efficiency, and ecological innovations. The outcomes of partial least square structural equation modeling also indicate that efficient and better utilization of energy and management accounting system provide an improve economic and environmental condition for the Indonesian manufacturing sector. The study further recommended that the government needs to regulate some policy in which adoption of the management accounting system for all small, medium and large firms are compulsory in order to get sustainable development and environment.

Keywords: Management Accounting System, Energy Efficiency, Environmental Performance, Indonesia
JEL Classifications: Q55, Q43

1. INTRODUCTION

Technological advancement is an eminent part of the Modern World. Technology development has made many vital contributions to society, industries, and economies (Lages, 2016). In the business sector, technological progressions have resulted in causing numerous positive influences in organizational operations. Regardless of company size, technical advancements are the reason for producing tangible and intangible benefits that help organizations to reduce costs, enhance operational revenues and manufacture according to consumer demands. In addition, technologies also have a critical impact on organization culture, effectiveness and relationship management. In the current era of enhanced environmental consciousness, the role of ecological innovations is prime to strengthen the firm's motive of sustainable development and performance improvement (Przychodzen and Przychodzen, 2015). In this regard, advancements in the eco-driven technical invention in products and processing provide higher operational efficiency with declined environmental burdens and costs (Ryszko, 2016; Chang'ach, 2018). This enables companies to improve their environmental and economic performances along with betterment in the corporate image that can help in gaining superior competitive advantages (Hojnik and Ruzzier, 2016).

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Similarly, the development of accounting technologies has been the prime reason for organizations to be able to manage internal and external information that can support managerial decision making. In this regard, the role of management accounting systems (MAS) is notable (Uyar and Kuzey, 2016). The competence derived from accurate, reliable and timely accounting information and reports can help to reduce company's cost, improves the efficiency of the organization by enabling time management and help organizations to enhance productivity through smooth operations (Mia and Clarke, 1999). Efficient utilization of MAS can boost a company's performance and provide the organizations supreme competitive edge. In addition, the role of MAS is not merely internal. The proper utilization of MAS can aid to identify external trends and changing environments and help to improve a company's environmental performance. In the present era of environmentalism, effective use of MAS can support managers to pinpoint rising environmental consciousness and highlight organizations environmental costs. With the objective of achieving sustainable business practices, the usage of MAS can be directed in findings solutions to reduce organization's environmental pressures in terms of providing information about firm's energy dependence, energy costs, and waste disposals, etc. In this way, MAS can be utilized to support the firm's ecological commitment to sustainable environmental quality.

Similarly, the role of energy is vital for businesses, households and the overall country's economy. The significance of energy in driving industrial performance along with fulfilling basic needs of society have been the reasons of country's supreme focus on energy production and generation (Ayres et al., 2007; Mikučionienė et al., 2014). As an input, energy consumption drives development and growth. However, the rising globalization, technological advancements, and industrial development have escalated the country's energy dependence. Growing intensification in energy consumption and production have brought several ecological burdens. The discharge of harmful gasses as a result of fossil fuel burning in energy utilization has enhanced the levels of greenhouse gasses. The toxic emanation of carbon dioxide, sulphur dioxide, nitrogen dioxide, etc. carried many hostile impacts on environmental health by affecting the ozone layer. In addition, resource depletion resulted in enhanced energy usage also affects the environment and natural habitat adversely. Knowing the vital role of energy in business and societal growth, it is dreadful to be avoided entirely. However, finding solutions for reducing energy dependence and eco-friendly energy usage can be favorable for the ecological condition.

In compliance, modern businesses and economies are keen to avail energy efficiency (Shin et al., 2018). This enables companies and governments to promote ecologically driven energy usage. In doing so, an organization at present, are articulating policies and methods to control and implement energy efficient practices in business operations. In addition, the control over energy efficiency is achieved by encouraging customary actions such as usage of fluorescent or light-emitting diodes, renewable energy, installing programmable thermostats, regulating energy auditing, etc. Thus, the benefits resulted from firm's adoption of energy efficient processing not only likely to improve firm's environmental performance but also decline company's' costs and increase margins; leading to improve organizations operational performance from enhanced efficiency and greater productivity (Martin et al., 2012; CHE and Sundjo, 2018).

Therefore, seeing the vital role of technological advancements in improving firm's capacities for sustainable development, the current examination aims to explore the effect of ecological innovations (ECI), energy efficiency practices (EEP) and management accounting systems (MAS) in influencing firms' environmental performance of Indonesian manufacturing companies. In addition, the study also keen to identify what impact such technical inventions carry on organizational operations and productivity? More often, it is implied that the adoption of technologies, especially related to the environment is an obstacle for the firm's future development and abrupt growth (Dawabsheh et al., 2019; Chen, 2008). Thus, the study further analyzed the relationship of ECI, EEP, and MAS with an organization's economic performance. The present study is therefore novel in addressing the vital connection of technology with organizations' performance in ecologically driven settings. The expected outcomes may provide value addition to the existing environmental literature along with providing supplementary guidelines to the firm's vision for sustainability.

After the introduction, section two of the current study has presented theoretical and empirical literature followed by hypotheses development. Section three defined methods of data collection, sampling and constructs information. Section four provided empirical results and their interpretations (Jermsittiparsert et al., 2019). Lastly, section five summarized the study with a conclusion, policy implication, and future recommendation.

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

2.1. Management Accounting System (MAS)

In business management, MAS has proved to be vital for the firm's efficient decision making that leads to enhancing its performance and competence. In the existing literature, many studies aimed to analyze the role of information management in supporting the firm's use of technologies. Addressing the importance of management control systems, Bedford (2015) studied the role of management control systems in driving innovation performance. Utilizing the data of 400 enterprises, the study found that levels of control systems offer improved information management that strengthens decision making and thus enhances the organization's performance. In another investigation, Uyar and Kuzey (2016) inspected management accounting, cost system layouts, and firm performance. In order to perform empirical analysis, the authors utilized structural modeling method (Ahmed et al., 2017; Chiang and Hsu, 2017). The findings of the study established that management accounting has a significant positive impact on firm performance. In addition, the findings suggested that management accounting also influence the association of cost design on a firm's performance.

Focusing on strategic business units (SBUs), Mia and Clarke (1999) examined the relationship between MAS, firm's competence and business unit's performance. Utilizing the method of path analysis, the results of the study found that MAS is significant to impact SBU performance. On the other hand, the results established the insignificant impact of intensity to compete on performance. Similarly, Prasad and Green, (2015) also studied the role of accounting information systems (AIS) in influencing organizational potentials to enhance value addition. In this regard, the study utilized the novel framework of dynamic capabilities proposed by Teece, (2007). The findings of the study established that AIS has a significant positive association with the firm's performance. In particular, the findings reported that AIS capacities in terms of flexibility, business intelligence system, mechanical competency are significant to augment organizational performance. Therefore, we hypothesize that;

H_1: Management accounting system is significant to impact the firm's economic performance

H_2: Management accounting system is significant to impact firm's environmental performance

2.2. Energy Efficiency (EE)

The utilization of energy is crucial for a firm's survival and future growth. Even after witnessing, the severe impact of energy in degrading ecological conditions and spreading global warming, the use of energy is considered unavoidable for businesses and economies. However, finding solutions for limiting energy usage, improves its efficiency and using the alternative of fossil fuel-based energy can be beneficial for the motives of sustainability and can control environmental deterioration. Firms can achieve higher levels of energy efficiency to supplement its environmental performance and also probable to improve economic performance through cost reductions and operational productivity. Several investigations have analyzed the crucial role of energy efficiency with economic growth and sustainability. These included the studies of Zhou et al. (2016); Ayres et al. (2007), Mikučionienė et al. (2014), etc.

Focusing on firm resources, Hanley et al. (2009) studies energy efficiency and its potentials in enhancing firm performance. The findings of the investigation suggested that energy efficiency could recover environmental quality and improve performance. However, the authors stressed that policies of energy efficiency should be cautioned with additional policies as the mere emphasis on energy efficiency is insufficient to sustain the environment and could end up in increasing energy demand. Similarly, Shin et al. (2018) analyzed green sources of energy and its impact on a company's monetary performance. The authors used the data from the period of 2007 to 2013 and established that renewable energy consumption augments the company's monetary performance.

In another study, Martin et al. (2012) investigated the role of management practices such as energy efficiency in affecting firm performance. In doing so, the authors used the data of 190 manufacturing companies of the United Kingdom. The results of the analysis reported that eco-friendly managerial practices improve the company's energy efficiency, reduced energy dependence and thus increases firm productivity. Moreover, Dangelico and Pontrandolfo, also examined drivers of organization performance by using energy efficiency, pollution, and renewable power. In doing so, the authors used the data of 122 Italian firms. The results of the analysis established that all the variables strengthen an organization's performance in terms of improving their market share and reputation. Therefore, we hypothesize that;

H_3: Energy efficiency is significant to impact the firm's economic performance

H_4: Energy efficiency is significant to impact firm's environmental performance

2.3. Eco-innovation

The manner in which the organization reacts and responds towards environmental rising burdens and strategizes accordingly strengthen its competitiveness and performance. In doing so, the role of ecological innovations is substantial (Ryszko, 2016; Cholily et al. 2019). Several studies examined the impact of eco-innovations on performance (Haseeb et al., 2019**)**. Among them, Lee and Min (2015) analyzed the contribution of ecological innovation in curtailing carbon emission and improving firm performance. For doing this, the study used the data of manufacturing sector of Japan from the period of 2001-2010. The results of the investigation reported that Research and development practices for eco-innovation significantly declined carbon footprints. Further, the outcomes found that eco-innovation research is vital to bring positive effects on an organization's financial performance. For Polish and Hungarian firms, Przychodzen and Przychodzen (2015) analyzed the role of eco-innovation in affecting an organization's financial performance. Using the data of 439 companies between 2006 and 2013, the findings of the study concluded the significance of eco-innovation in influencing financial performance.

In the field of supply chain, Costantini et al. (2017) investigated the connection between eco-innovation and environmental performance. Analyzing the data of European firms, the findings of the study established that eco-innovation has a direct and indirect influence on environmental performance. In particular, the findings suggested that eco-innovation significantly reduce ecological risks and thereby enhance performance. Similarly, Ryszko, (2016) also examined eco-innovation and performance association in Poland. Using the data of 292 Firms, the findings of the study established that eco-innovation is significant to impact firm performance. In particular, the results suggested that an increase in a firm's eco-innovation improve a firm's operational as well as financial performance.

For Slovenian firms, Hojnik and Ruzzier, (2016) examined the link between eco-innovation and performance (Haseeb et al., 2019). Using the sample of 223 companies, the authors applied the methods of SEM approach for performing the empirical analysis. The outcomes of the study found that eco-innovation has a significant positive association with the firm's performance and competitive benefits. In China, Cai and Li (2018) inspected the link of ecological innovations with the firm's environmental and economic performance. Utilizing six drivers of eco-innovation, the results from SEM suggested the significant role of innovation in enhancing environmental performance. On the other hand, the

study failed to find the significance of eco-innovation in influencing a firm's economic performance. Lastly, the results suggested the significant contribution of environmental performance in driving the firm's economic performance. Therefore, we hypothesize that;

H_5: Eco-innovation is significant to impact the firm's economic performance

H_6: Eco-innovation is significant to impact firm's environmental performance

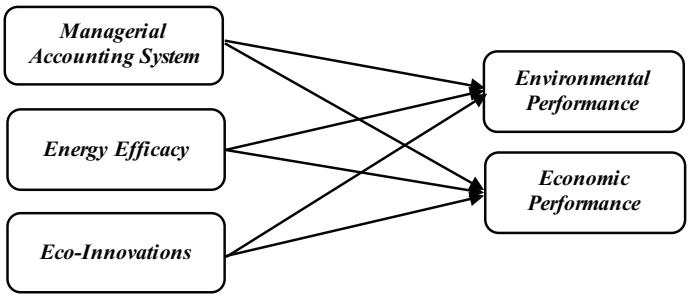
Figure 1 portrayed the conceptual model of the study.

3. METHODOLOGY

The methodology of data accumulation in the current study is finished by gathering information from the manufacturing sector of Indonesia. Moreover, we select 89 distinctive small, medium and large firms in the manufacturing area of Indonesia. For quick and smooth data collection procedure, we make a translation of our instrument into the English language and disseminate to the chose various small, medium and large manufacturing firms of Indonesia. In total, a sum of 357 review instrument was received to utilizing both on the printed and soft copy of the study instrument. The strategy for information gathering acquired time of pretty much one hundred and 92 days and got 319 responses with the reaction rate of 89.3%.

On the other hand, the progressing research examines the effect of the managerial accounting system, energy efficacy and eco-innovations on economic performance and environmental performance in the Indonesian manufacturing sector. So as to accomplish this objective, we examine the research structure concentrated on prior studies, and the model is displayed in Figure 1. The principal features of the selected factors are clarified by using the Likert scale system from 1 (strongly disagree) to 5 (strongly agree). Generally speaking, the present examination utilizes five factors. Also, the variables used into this investigation are the managerial accounting system (MAS), energy efficacy (ENE), eco-innovations (ECO), economic performance (ECP) and environmental performance (ENP). In the current study, we have four items of MAS are adopted from the research of Gordon and Narayanan (1984). In addition, the four constructs of ENE are adopted from the prior study of Worrell et al. (2009). The six items of ECO are embraced from the research of Lee and Min (2015). Moreover, the present investigation utilizes four items of ECP which are taken from the study of Zhu et al. (2016). Finally, the current research took four items of ENP from the research of Zhu et al. (2013).

Figure 1: Conceptual model



4. DATA ANALYSIS AND DISCUSSION

In this examination, the information analysis is finished by utilizing two statistical software which is the SmartPLS Version 3.2.8 (Ringle et al., 2015; Ebire et al., 2018) and Statistical Package for Social Sciences (Version-23). Final data taken for the current examination is 310 subsequent to excluding univariate and multivariate anomalies. The procedure for identifying of univariate and multivariate anomalies are Z-test score and Mahalanobis distance (D2) by utilizing SPSSS (Version-21) and remaining of the information examination is done by using SmartPLS. Demonstrated Table 1 is the structure and arrangement of the final response of the gathered information used in this examination. Additionally, Table 2 clarify the mean and Pearson's correlation of the factors used in the present examination. Moreover, to handle the issue of multicollinearity, the current research applies to Hair et al. (2010) initiate that by a correlation coefficient in Pearson's correlation examination ought to underneath 0.90. Therefore, affirming the absence of multicollinearity among the components (Hair et al. 2013; Frooghi et al. 2015).

Besides, content validity is approved if the items utilizing in the information examination load with higher correlation power in their particular factor interestingly with other items showed up in the model, while inner consistency is affirmed if the estimation of Cronbach's alpha and composite reliability parameter found more noteworthy than 0.7 (Hair et al., 2013; Waseem et al., 2013). Factor loadings and composite reliability values appeared in Table 3 which show that a gigantic parameter of the items factor loading is more than 0.7. In addition, these loadings show up in their individual parts which confirming the inner model consistency of the chose items.

Additionally, convergent validity instructs to what degree an item with respect to a particular factor created and loaded to a connecting variable where they supposed to be loaded (Mehmood and Najmi,

Table 1: Results of descriptive statistics

Valid	Frequency	Percent (%)
Gender		
Female	104	34
Male	206	66
Total	310	100
Age		
20-30 years	56	18
31-40 years	166	54
41-50 years	52	17
51 and above	36	12
Total	310	100
Working experience		
1-5 years	42	14
6-10 years	190	61
11-15 years	48	15
More than 15 years	30	10
Total	310	100
Education		
Undergraduate	26	8
Graduate	243	78
Post graduate	15	5
Others	26	8
Total	310	100

Source: Authors estimation

2017; Afshan et al., 2018). In this exploration, convergent validity is introduced by utilizing an average variance extracted (AVE) for each factor (Fornell and Larcker, 1981). They provided the cutoff of more basic than and showed up distinctively in connection to 0.5 for confirming up to the convergent validity. As prerequisites seem to be, AVE in Table 3 is avowing the key measures.

In the accompanying step, discriminant validness is uncovered as how much an item of a clarified factor is discriminant and novel from different factors (Frooghi et al., 2015). According to Fornell and Larcker (1981), the discriminant validness is said to be announced if the AVE square root measurement is more than the pair-wise relationship of the unobserved factor. The outcomes showed up in Table 4, bold and italic values are the square root of AVE which is more than the off-diagonal values which are the pair-wise relationship of each factor (which are MAS, ENE, ECO, ECP, and ENP). In addition, Table 5 demonstrates the factor loadings of a different and separate factor, in this way, articulating the cut-off limited. Thus, the discriminant validness is in addition conferred if the Hetro Trait and Mono Trait values are lower than 0.85 as proposed by Henseler et al. (2015). The results in Table 6 revealed that all variables have Discriminant validness.

In the final step, we associated a partial least square framework with investigating the model structure and speculation testing which showing path coefficients, t-measurements, and probability values.

Table 2: Means and Pearson correlations

Variables	Mean	MAS	ENE	ECO	ECP	ENP
MAS	4.028	-				
ENE	4.129	0.311**	-			
ECO	3.894	0.309**	0.402**	-		
ECP	3.774	0.288**	0.332**	0.227**	-	
ENP	4.112	0.382**	0.391**	0.326**	0.284**	-

N=310. **Correlation is significant at the 0.01 level (2-tailed)

As appeared by Chin (1998) recommendation, a bootstrapping technique using 1000 sub-test was associated with attesting the quantifiable essential evaluations of the considerable number of values. Table 7 reveals beta coefficients, t-measurements, and their probability values with the comments about the hypothesis testing.

The results of the partial least square structural equation modeling are presented in Table 7. It established the outcomes of with regression path coefficient, t-statistics, probability values (P-values) and the remarks related to the theorized path. Overall, the results suggested that all selected variables have a positive and significant impact on economic performance and environmental performance in the manufacturing sector in Indonesia. Moreover, the outcomes of the PLS-SEM confirm that economic performance ($\beta = 0.382$, $P < 0.000$) and environmental performance ($\beta = 0.372$, $P < 0.000$) have positively and expressively impacted by management accounting system hence affirming H_1 and H_2. The outcomes of partial least square structural equation modeling also indicate that economic performance ($\beta = 0.283$, $P < 0.000$) and environmental performance ($\beta = 0.332$, $P < 0.000$) have also positively and noteworthy influenced by the energy efficiency, therefore, confirming H_3 and H_4. Finally, the results also specified that economic performance ($\beta = 0.201$, $P < 0.000$) and environmental performance ($\beta = 0.227$, $P < 0.000$) have significantly and positively affected by eco-innovations henceforth supporting H_5 and H_6. In general, the results of partial least square confirm that the three factors, i.e., management accounting system, energy efficiency, and eco-innovation are the positive and significant contributor to enhance the environmental and economic performances of the manufacturing firm in Indonesia.

5. CONCLUSION

Nowadays, technologies have a critical impact on organization culture, effectiveness and relationship management. In the

Table 3: Measurement model results

Variables	Items	Factor loadings	Cronbach's alpha	Composite reliability	Average variance extracted
Management accounting system	MAS1	0.897	0.932	0.902	0.602
	MAS2	0.866			
	MAS3	0.913			
	MAS4	0.879			
Energy efficiency	ENE1	0.876	0.954	0.912	0.611
	ENE2	0.841			
	ENE3	0.851			
	ENE4	0.845			
Eco-innovations	ECO1	0.814	0.967	0.893	0.594
	ECO2	0.832			
	ECO3	0.847			
	ECO4	0.825			
	ECO5	0.880			
	ECO6	0.797			
Economic performance	ECP1	0.858	0.958	0.868	0.584
	ECP2	0.816			
	ECP3	0.768			
	ECP4	0.816			
Environmental performance	ENP1	0.835	0.973	0.843	0.627
	ENP2	0.826			
	ENP3	0.798			
	ENP4	0.778			

Source: Authors estimation

Table 4: Discriminant validity Fornell-Larcker criterion

	MAS	ENE	ECO	ECP	ENP
MAS	0.776				
ENE	0.276	0.782			
ECO	0.501	0.332	0.771		
ECP	0.392	0.423	0.337	0.764	
ENP	0.482	0.396	0.406	0.511	0.792

Source: Authors estimation

Table 5: Results of loadings and cross loadings

Variables	MAS	ENE	ECO	ECP	ENP
Management	0.897	0.384	0.535	0.260	0.544
accounting system	0.866	0.326	0.408	0.381	0.460
	0.913	0.160	0.299	0.345	0.516
	0.879	0.531	0.515	0.412	0.561
Energy efficiency	0.522	0.876	0.366	0.319	0.422
	0.435	0.841	0.423	0.326	0.358
	0.592	0.851	0.309	0.572	0.401
	0.381	0.845	0.351	0.427	0.518
Eco-innovations	0.469	0.489	0.814	0.410	0.374
	0.410	0.366	0.832	0.250	0.442
	0.504	0.412	0.847	0.328	0.453
	0.374	0.263	0.825	0.358	0.583
	0.598	0.263	0.880	0.330	0.512
	0.425	0.536	0.797	0.229	0.445
Economic performance	0.364	0.451	0.280	0.858	0.473
	0.520	0.572	0.566	0.816	0.488
	0.242	0.491	0.527	0.768	0.473
	0.501	0.522	0.437	0.816	0.408
Environmental	0.489	0.359	0.304	0.417	0.835
performance	0.401	0.292	0.442	0.517	0.826
	0.464	0.429	0.326	0.480	0.798
	0.403	0.422	0.314	0.548	0.778

Source: Authors estimation

Table 6: Results of HTMT ratio of correlations

	MAS	ENE	ECO	ECP	ENP
MAS					
ENE	0.583				
ECO	0.502	0.684			
ECP	0.433	0.478	0.634		
ENP	0.390	0.499	0.422	0.486	

Source: Authors estimation

Table 7: Results of path coefficients

Hypothesized path	Path coefficient	t-statistics	P-value	Remarks
ECP←MAS	0.382	5.643	0.000	Supported
ENP←MAS	0.372	5.329	0.000	Supported
ECP←ENE	0.283	4.443	0.000	Supported
ENP←ENE	0.332	7.443	0.000	Supported
ECP←ECO	0.201	5.345	0.000	Supported
ENP←ECO	0.227	3.894	0.000	Supported

Level of significance (5% i.e., 0.050)

current era of enhanced environmental consciousness, the role of ecological innovations is prime to strengthen the firm's motive of sustainable development and performance improvement. In this regard, advancements in the eco-driven technical invention in products and processing provide higher operational efficiency with declined environmental burdens and costs. This enables companies to improve their environmental and economic performances along with betterment in the corporate image that can help in gaining superior competitive advantages.

Moreover, the role of management accounting systems is notable. The competence derived from accurate, reliable and timely accounting information and reports can help to reduce company's cost, improves the efficiency of the organization by enabling time management and help organizations to enhance productivity through smooth operations. Efficient utilization of MAS can boost a company's performance and provide the organizations supreme competitive edge. On the other hand, modern businesses and economies are keen to avail energy efficiency. This enables companies and governments to promote ecologically driven energy usage. In doing so, an organization at present, are articulating policies and methods to control and implement energy efficient practices in business operations. In addition, the control over energy efficiency is achieved by encouraging customary actions such as usage of fluorescent or light-emitting diodes, renewable energy, installing programmable thermostats, regulating energy auditing, etc.

Therefore, seeing the vital role of technological advancements in improving firm's capacities for sustainable development, the current examination aims to explore the effect of ecological innovations, energy efficiency and management accounting systems in influencing firms' environmental performance of Indonesian manufacturing companies. Therefore, the study further analyzed the relationship between ECO, ENE, and MAS with an organization's economic performance. The present study is therefore novel in addressing the vital connection of technology with organizations' performance in ecologically driven settings. The total valid sample for the present study is 310. The results of PLS-SEM confirm that all selected variables have a positive and significant impact on economic performance and environmental performance in the manufacturing sector in Indonesia. Moreover, the outcomes of the PLS-SEM confirm that economic and environmental performances have positively and expressively impacted by the management accounting system. The outcomes of partial least square structural equation modeling also indicate that economic and environmental performances have also positively and noteworthy influenced by energy efficiency**.** Finally, the results specified that economic and environmental performance have significantly and positively affected by eco-innovations.

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