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From Green to Lean: Firms' Waste Management Practices and Their Impacts on Business Performance

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ABSTRACT

Public concern for environmental preservation has made solid waste management one of modern society's most relevant issues. The objectives of this study are to investigate the relationship between green practices and lean practices, and examine their impact on business performance. Green and lean practices have both been proven by many researchers to be able to reduce waste in an efficient and effective way. However, there has been a lack of empirical evidence to support the claim that these two practices are highly related to each other and can result in an improvement in business performance. Based on the data collected from 119 manufacturers in Malaysia, correlations and a multiple regression analysis were used to test the claims mentioned. The results indicate presence of significant positive relationships between different components of green and lean practices. The elements of environmental cooperation with the customer and supplier, investment recovery, and business waste management in green practices are comparable and significantly related to supplier relationships, housekeeping (5S), and waste elimination in the lean philosophy. Both practices were also found to be significantly related with business performance. This study has implications for both theory and practice.

Keywords: Business performance, green practices, lean practices, manufacturing companies, waste management

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INTRODUCTION

Solid waste is a major environmental problem in Malaysia. Currently, of the 33,000 tons of solid waste collected daily, only 10.5% is recycled while the rest is disposed at disposal sites. Meanwhile, a

40% reduction of garbage sent to disposal sites is being enforced and this is expected to increase the rate of recycling to exceed 22 per cent by the year 2020. This increase is due to an increase in population, economic growth, infrastructure and public attitude, among others (New Straits Time, 2015). Waste generated daily by construction and industries contribute 26000 and 13000 tons, respectively (The Star, 2014). Thus, manufacturing companies in Malaysia urgently need to take preventive action to reduce solid waste generated by industry. As such, there is a constant need for research investigating the practice of green management within the context of the manufacturing industry in Malaysia.

Previous research has provided empirical evidence that green practices cannot reduce the hazardous impact on the environment, although it can bring economic value through waste reduction. In terms of lean, the concept of waste reduction has long been the core practice in the lean philosophy. While the two concepts are highly related to each other, there has been a lack of research on the relationship between green and lean practices. Most previous research has studied lean and green practices in isolation (Dües, Tan & Lim, 2013; Galeazzo, Furlan & Vinelli, 2013). For example, studies by Taj & Morosan (2011) and Ghosh (2013) only looked at the impact of lean operations on Chinese and Indian manufacturing performance, respectively. Azevedo, Carvalho & Cruz Machado (2011) only focused on the influence of green practices on supply chain performance within the context of the Portuguese automotive sector.

Although previous researchers have indicated some overlapping concepts between green and lean practices, there has been a lack of empirical research regarding these issues, especially from the perspective of the manufacturing industry in Malaysia. The following questions are central: are green practices significantly associated with lean practices? does lean mediate the relationships between green practices and business performance? This paper highlights the issue of firms' waste management regarding both green and lean practices and discusses its empirical findings on the relationship between green and lean practices and the mediation effect of lean on the relationships between green practices and business performance.

LITERATURE REVIEW

Green Practices

The scope of green practices covers the entire product life cycle. This scope includes environmental practices such as eco-design, clean production, recycling and reuse with the focus on minimizing the expenses associated with manufacturing, distribution, use and disposal of products (Wong, Lai, Shang, Lu & Leung, 2012). Environmental management covers item development to the final delivery and the ultimate disposal of the item (Yang, Hong, & Modi, 2011). Hajmohammad, Vachon, Klassen, & Gavronski (2013) defined environmental practices as the level of resources invested in exercise and expertise improvement that

leads to pollution reduction at the source. It includes efforts to implement environmental management systems (e.g. ISO 14001), waste reduction or material recycling. Meanwhile, researchers like Abd Rahman, Ho, & Rusli (2014) and Eltayeb & Zailani (2009) focused on greening the entire supply chain as part of environmental protection practices.

There are many definitions of practices that are indicators of green initiatives. This study uses indicators of green practices widely used in previous research. The first is the cooperation with the customer. It is important for the manufacturer to consider the price of their products. Additionally, the customer's requirement regarding green attributes may not be aligned with their genuine purchasing behaviour. Thus, harmonizing these factors presents a big challenge for the manufacturer (Lin, Tan, & Geng, 2013). The second is internal environmental management. Basically, a good top management will encourage the company to handle environmental issues, utilization of internal and external reporting as well as employee training and involvement (Menguc & Ozanne, 2005). The third is cooperation with suppliers. Govindan, Diabat, & Madan Shankar (2015) revealed that green supply chain practices have a higher impact on suppliers than on customers. Nevertheless, there is the argument regarding supplier efficiency; where if the supplier base is big, then it is hard to create long haul connections and incorporation with the firms (Vachon & Klassen, 2006). The fourth is investment recovery, especially through the recycling process. In China, the government switched from resource subsidies to levying taxes for some resources such as coal and natural gas. However, in China this investment recovery has received less attention compared to in the USA and Germany (Zhu & Sarkis, 2004). The final indicator is green products. The development of green products is becoming both a need and an opportunity for firms to reduce the negative influences of production on the environment while gaining a competitive advantage over their competitors (Lin et. al., 2013).

Lean Practices

The concept of lean manufacturing was pioneered by a Japanese automotive company, broadly known as Toyota Production System (TPS) (Nordin, Deros, & Wahab, 2010). It focused on waste reduction to increase the actual added value in order to fulfil customers' needs and maintain profits (Carvalho, Duarte, & Machado, 2011).

Several practices are described in this study such as customer involvement, employee involvement, supplier relationship, continuous improvement, 5S and waste elimination. In order to add value for a product, the lean approach finds a way to achieve efficiency against traditional systems practiced in a firm (Hines, Holweg, & Rich, 2004). In the lean principle, close relationships between a firm and its customers help commercialize and market the firm's products in a stable way (Wahab, Mukhtar, & Sulaiman, 2013). However, differences in culture can lead to lean failures even though the firms have

strong human skills such as communication, problem solving and leadership (Bhasin & Burcher, 2006).

Bhasin & Burcher (2006) state that an organization needs to actively develop links with suppliers and work closely with them in order to achieve mutual benefits. Long term cooperation with a supplier can be achieved by having a good quality product, improving the purchasing order system and management, and using a better strategic partnership (Habidin & Yusof, 2013). Continuous improvement can lead to a competitive advantage if the firm understands what lean is. This is because only a few firms have succeeded as they often discover that improvements remain localized and this makes them unable to innovate (Anand & Kodali, 2010).

In the lean journey, the firms need to enhance 5S, which can be described as: sort through items, keep what is needed and dispose what is not; straighten by organizing and labelling everything; shine is clean, which can also concern exposure to abnormal and pre-failure conditions; standardize the development of regulations and maintain the first three S'; sustain a stabilized workplace and apply continuous improvement when needed (Aziz & Hafez, 2013).

Green and Lean as Waste Management Practices

Studies by Dües et al. (2013) have shown that both green and lean practices are the most efficient way to reduce waste. As such, these two practices can be classified as waste management practices. Lean is a practice that helps companies identify and eliminate seven types of waste, namely overproduction, waiting, transportation, defects, inappropriate processing, unnecessary inventory and unnecessary motion (Chen, Li, & Shady, 2010). Meanwhile, waste considered as an environmental issue are: excessive water usage, excessive power usage, excessive resource usage, pollution, rubbish, greenhouse effects and eutrophication (Verrier et al., 2014). When a company implements green and lean practices to eradicate waste, it seems that they give the company more advantages in terms of performance.

Lean orientation may help firms adopt environmental management practices that aim to reduce waste and pollutants (Yang et al., 2011). Pampanelli, Found, & Bernardes, (2014) found that lean and green practices have the potential for cost savings which can result in 5% to 10% potential reduction in the total cost of mass and energy flows. Lean manufacturing and environmental management practices are synergistic in terms of their focus on reducing waste and inefficiency (Yang et al., 2011). In addition, the similarities of lean and green practices are seen in terms of waste reduction, which includes various areas such as tools and practices, supply chain relationship, lead time reduction, a focus on people and the organization and also the use of techniques for eliminating waste (Pampanelli et al., 2014). In fact, waste is a common denominator in both lean

and green management (Hajmohammad et al., 2013).

Business Performance

In this research, business performance has been categorized into three : operational performance, financial performance and customer satisfaction. The most basic operational performance measurements are inventory levels, manufacturing cost, cycle time, quality levels and performance of delivery (Mackelprang & Nair, 2010). Moori, Pescarmona, & Kimura (2013) looked at market share, ROI (return on investment) and ROA (return on assets) while Nawanir, Teong, & Othman (2013) considered profit margin and return on investment, sales growth and market share of sales.

Customer satisfaction can be obtained through customer involvement in the decision-making process of the firm. The study by Sun & Kim (2013) showed that customer satisfaction can have a positive impact on financial performance indicators such as return on investment (ROI) and return on asset (ROA).

RESEARCH FRAMEWORK AND HYPOTHESES DEVELOPMENT

This research conceptualizes a firm where green practices are positively related to lean practices. Meanwhile, business performance of firms are not directly influenced by their green practices, but rather by being lean. This means that when firms are practicing green, they have taken the entire operation to be on waste reduction. In this sense, waste reduction due to lean practice can be considered an organizational-process attribute of a sustainable resource under the Resource Based View Theory (RBVT). Waste reduction has long been proven to be cost minimization and efficiency in lean philosophy. Consistent with the resource of a firm, sustainability and competitive advantage are much easier to achieve if the firms' organizational processes enable them to achieve valuable, rare, and imperfectly imitable capabilities (Barney & Hesterly, 2012). The essential notion of the RBVT is that all assets, capabilities, organizational processes, information, and knowledge controlled by a firm are considered valuable if they enable the firm to develop and implement strategies that can lower costs and improve efficiency and effectiveness (Barney & Clark, 2007). The research framework is as follows:

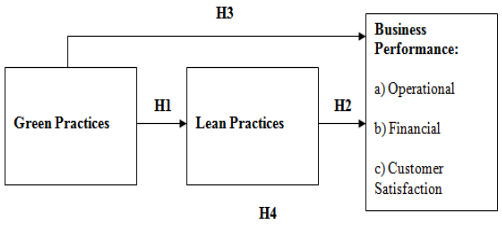

Figure 1. Research Framework

The concept of waste reduction is the core practice of the lean philosophy. Therefore, lean can also be identified with green through the reduction of excessive water usage, excessive power usage, excessive resource usage, pollution, waste, greenhouse effects, eutrophication and poor health and safety (Verrier et al., 2014). In addition, the lean concept has been viewed from different

perspectives. Carvalho et al. (2011) define lean as minimizing waste in the downstream supply chain while making the right product available to the customer at the right place and time. A lean supply chain is also one that employs kaizen efforts that focus on eliminating waste or non-value added steps along the chain (Reichhart & Holweg, 2007). In addition, the enablers of the production of small quantities, profitability, cost reduction and manufacturing flexibility are the internal manufacturing efficiency and setup time (Carvalho et al., 2011). Meanwhile, not all lean practices, procedures and waste reduction efforts are positively related to environmental performance, and lean practices in themselves cannot address all environmental issues (Dües et al., 2013). With these arguments, the following hypotheses are proposed:

H1: There is a positive relationship between green practices and lean practices of a firm.

Past studies have explored the operational performance and critical success factors of lean manufacturing in the food processing sector. These studies highlighted that productivity and quality are the factors that improve the operational factors. Thus, quality improvement helps a company to increase its efficiency (Dora et al., 2013). The implementation of lean practices is associated with higher operational performance such as a reduction in customer lead time, manufacturing cycle time or manufacturing costs and improvement in labour productivity and quality (Hajmohammad et al., 2013). However, this was not the case in the study by Taj & Morosan (2011). Their study dealt with manufacturing in China and showed that lean practices, such as human resources and supply chains, have a significant positive effect on performance factors such as flow and flexibility but not on the quality factor.

H2a: There is a positive relationship between lean practices and the operational performance of a firm.

The study by Moori et. al., (2013) found that there is a significant relationship between lean manufacturing and business performance in terms of profitability. This was different with the findings by Molina-Azorín, Claver-Cortés, Pereira-Moliner, & Tarí (2009), where the financial performance of the firm depended on the size of the firm. Larger companies can achieve better financial performance because of the availability of more resources. Another finding showed that there is no significant relationship between lean production practices and firm profitability (Hofer, Eroglu, & Hofer, 2012).

H2b: There is a positive relationship between the lean practices and the financial performance of a firm.

According to Nawanir et al., (2013) lean practices significantly improve business performance including customer satisfaction. In order to add value to the

customer, the lean approach helps firms achieve efficiency (Hines et al., 2004). Meanwhile, customer involvement in the process of product development leads to customer satisfaction and the reduction of costs (Khanchanapong, Prajogo, Sohal, Cooper, Yeung, & Cheng, 2014). A closer relationship with the customer helps firms to commercialize and market its products in a stable manner (Wahab et al., 2013). In essence, the involvement of the customer in a firm's decision making is the pillar of the lean practices, whereby it helps companies focus on the customer's needs and wants (Dora et al., 2013).

H2c: There is a positive relationship between the lean practices of a firm and its customer satisfaction.

According to Galeazzo et al., (2013) an environmental management system has an effect on operational performance either directly or indirectly through the environmental design practices and environmental waste practices. In the case of the container terminal industry, Lun (2011) stated that the element of cost savings, such as productivity or lower operating cost, can be used as operational indicators. Among the elements of operational performance, quality and efficiency measures have the most significant relationships with green practices (Azevedo et al., 2011). Jabbour, Jabbour, Govindan, Teixeira, & Freitas (2013) found that environmental management influences operational performance but that the relationship tends to be weak.

H3a: There is a positive relationship between the green practices and the operational performance of a firm.

According to Lun (2011), is important for the firm to adopt green management practices since these help improve the firm in terms of profitability, efficiency and cost-effective operation. González-Benito & González-Benito (2005) found that environmental proactivity does not have a relationship with the profitability of the firm in the short term. Although the majority of studies found a positive impact of environmental performance on firms' financial performance, a lack of consensus means that the debate is not yet over (Aragón-Correa, Hurtado-Torres, Sharma, & Garcia-Morales, 2008). According to Sambasivan, Bah, & Ho (2013), more research is needed on the impact of environmental proactivity on firm performance in order to provide a solid base for the industry practitioner regarding how to achieve a triple bottom line (operational, environmental and financial performance).

H3b: There is a relationship between the green practices and the financial performance of a firm.

Azevedo et al. (2011) found that green practices have a positive effect on customer satisfaction, quality and efficiency. However, Govindan et al. (2015) revealed that green practices have a higher impact on suppliers than on customers. Therefore, Lo (2014) found that lean and green practices are

not necessarily mutually exclusive. Green practices can reduce the operating cost of a firm in the long-term, thus enhancing the firm's profitability by improving customer satisfaction and loyalty. In addition, designing green products improves the brand image and automatically increases customer satisfaction (Lo, 2014).

H3c: There is a positive relationship between the green practices of a firm and its customer satisfaction.

Ahmad, Zakuan, Jusoh, & Takala (2012) found that lean practices mediate the relationship between total quality management and business performance. Meanwhile, a study has shown that environmental practices mediate the relationship between lean practices and environmental performance (Martínez-Jurado, Moyano_Fuentes, & Gornez, 2013). A study by Yang et al., (2011) found that environmental management practices mediate the relationship between lean manufacturing and environmental performance.

H4: Lean practices mediate the relationship between green practices and performance.

MEASURES AND DATA ANALYSIS

Data Collection and Measurement

The sample was drawn from the Federation of Malaysian Manufacturers (FMM) directory. A questionnaire survey was emailed to all companies listed in the FMM directory, which served as a sampling frame. The questionnaire was addressed to the production manager or management involved in manufacturing decisions and processes. 119 usable responses were used for further analysis. The scales used to measure green practices, lean practices and business performance came from earlier research in the field. They are summarised as follows:

Table 1
Measurement scales

Measurement scale	Adopted from
Green Practices	
Cooperation with customer and internal environmental management	Perotti, Zorzini, Cagno, & Micheli (2012)
Environmental collaboration with supplier	Green, Zelbst, Bhadauria, & Meacham (2012)
Investment recovery	Zhu, Cordeiro, & Sarkis (2013)
Green products	Lin et al. (2013)
Business waste	Azevedo et al. (2011)
Lean practices	
Customer involvement and employee involvement	Hofer, Hofer, Eroglu, & Waller (2011), Habidin and Yusof (2013)
Supplier relationship	Habidin and Yusof (2013), Nawanir et al. (2013)
Continuous improvement (kaizen)	Chauhan and Singh (2012)
5S	Jain, Bhatti, & Singh (2014)
Waste elimination	Manzouri, Rahman, Saibani, & Zain (2013)
Business performance	Nawanir et al. (2013).

Results

SPSS was used to analyse the data. Table 2 shows the profiles of the firms and respondents.

The category of company size that had the highest percentage was 101-300 employees (28.6%). Most of the companies had been established for more than 15 years

Table 2
Profile of sample firms and respondents

Variables	Total	Percentage
Total number of employees		
30 or less	27	22.7
31-70	24	20.2
71-100	8	6.7
101-300	34	28.6
301-500	17	14.3
501-700	5	4.2
701-1000	3	2.5
More than 1000	1	0.8
TOTAL	119	100.0
Company Establishment		
Less than 3 years	6	5.0
3 to 5 years	10	8.4
6 to 10 years	13	10.9
Between 11 to 15 years	9	7.6
More than 15 years	81	68.1
TOTAL	119	100.0
Ownership of the company		
Sendirian Berhad	113	95.0
Berhad	6	5.0
TOTAL	119	100.0
ISO 14000 Certification		
Yes	53	44.5
No	66	55.5
TOTAL	119	100.0
Position in the company		
Operations Manager	54	45.4
Operations Executive	8	6.7
Quality Manager	9	7.6
Others	48	40.3
TOTAL	119	100.0

(68.1%). Companies with the status of Sendirian Berhad contributed 95% of the total respondents. Meanwhile, 44.5% of the companies were ISO 14000 certified.

Table 3
Profile of green practices, lean practices and business performance dimensions

Dimensions	Mean	Standard Deviation	Cronbach's Alpha (α)
Green Practice			0.955
Cooperation with customer	3.51	.893	0.863
Internal environmental management	3.44	.833	0.953
Environmental collaboration with suppliers	3.17	.891	0.946
Investment recovery	3.26	.846	0.830
Green products	3.28	.857	0.929
Business waste	2.68	.821	0.812
Lean Practice			0.901
Customer involvement	3.92	.674	0.855
Employee involvement	3.79	.793	0.905
Supplier relationship	3.58	.714	0.888
Continuous improvement (kaizen)	3.56	.680	0.853
5S	3.89	.703	0.887
Waste elimination	2.71	1.082	0.950
Business Performance			0.965
Operational performance	3.64	.609	0.944.
Financial performance	3.32	.718	0.924
Customer satisfaction	3.93	.822	0.907

Table 3 provides the mean and standard deviation for all dimensions of green practices, lean practices and business performance. The most important dimension for green practices is cooperation with the customer (3.51). Meanwhile, customer involvement (3.92) and customer satisfaction (3.93) are the most important dimensions for lean practices and business performance, respectively. Overall, customer involvement is the most important dimension out of all dimensions. Meanwhile, the Cronbach's alpha coefficient of a scale were all above 0.7, indicating that the reliability tests for the variables used in the present study were all above the minimum acceptable level.

The correlation matrix is presented in Table 4 below. Meanwhile, Table 5 shows the result of the multiple regression analysis to test the hypotheses 1, 2, and 3. The data were checked for the possibility of multicollinearity. Collinearity diagnostics were performed and the tolerance values were all above the cut-off point of .20 and the VIF values were all below 4.0, indicating that the scales used in the present research appear to have no multicollinearity problems.

The table summary shows the R square, significance value and beta coefficients value. The value of R square of the hypothesis is between 0.106 and 0.457, which the model explains as 10.6% to 45.7% variance of the variables. The model is significant with a statistical significance of 0.000 with $p<0.05$. The positive symbol of beta coefficients indicates that all the hypotheses have a positive relationship between each variable.

Table 4
Correlation matrix of the variables

	1	2	3	4	5
1. Green practice	1	.665**	.387**	.350**	.383**
2. Lean practice	.665**	1	.573**	.469**	.571**
3. Business performance	.387**	.573**	1	.887**	.892**
4. Customer satisfaction	.350**	.469**	.887**	1	.693**
5. Operational performance	.383**	.571**	.892**	.693**	1

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

Table 5
Summary results of H1, H2, and H3

Hypothesis	R Square	t-value	Sig.	Beta Coefficients
H1	.457	6.607	.000a	.676
H2a	.327	4.975	.000a	.572
H2b	.178	3.326	.000a	.422
H2c	.197	3.548	.000a	.443
H3a	.241	4.125	.000a	.491
H3b	.106	2.214	.000a	.326
H3c	.137	2.541	.000a	.371

Table 6 indicates the results of analysis for hypothesis 4, which is that lean practices mediate the relationship between green practices and business performance.

Table 6
Mediated hierarchical regression analysis (lean practices)

Regression	R^2	R^2change	Beta	Sig	F	Conclusion
Green practices and lean practices	.457		.676	.000	98.434	Significant
Green practices and business performances	.215		.464	.000	32.020	Significant
Lean practices and business performances	.315		.562	.000	53.920	Significant
Green practices and lean practice with business performances	.328	.317	.154 .457	.000 .00	28.364	Significant (Partial mediated)

Note:*p<0.10, **p<0.01, ***p<0.001

The first three hypotheses showed a significant relationship between the variables. Thus, hypothesis 4 can be measured. Regression was conducted between the green practices (independent variable) and lean practices (mediator variable), with business performance. The R2 value is 0.328 and the R^2 change is 0.317. The results show that the model as a whole (which includes both blocks of variables) is significant ($p<0.010$). The beta value for green practices is 0154 while for lean practices it is 0.457. Therefore, the mediation effect exists in this relationship due to the significant value. Since the significant value between green practices and business performance does not drop to zero after lean practices are included, partial mediation is indicated. To test for partial mediation, a Sobel test was conducted. The test statistics provide support for partial mediation whereby the test statistic for the Sobel test is 6.13 and the p-value is 0.00. A partial mediation exists due to the non-significant result (Baron and Kenny, 1986). Thus, lean practices include at least one of the mediators in the relationship between green practices and business performance.

Table 7
Summary of research findings

No	Hypothesis relationships	Results
1	H1: There is a relationship between green practices and lean practices	Supported
2	H2a: There is a relationship between lean practices and operational performances	Supported
3	H2b: There is a relationship between lean practices and financial performances	Supported
4	H2c: There is a relationship between lean practices and customer satisfaction	Supported
5	H3a: There is a relationship between green practices and operational performances	Supported
6	H3b: There is a relationship between green practices and financial performances	Supported
7	H3c: There is a relationship between green practices and customer satisfaction	Supported
8	H4: Lean practices mediate the relationship between green practices and business performances	Supported

DISCUSSION AND CONCLUSIONS

The objective of this study was to investigate the relationship between green practices, lean practices and the business performance of manufacturing companies in Malaysia. The results indicate that green practices have a positive relationship with lean practices. This result is supported by Dües et al. (2013), who found that there is an overlap between lean and green practices in terms of waste elimination. There is a relationship between these two practices as both practices emphasize waste elimination. The findings of this study agree with that of Mollenkopf, Stolze, Tate, & Ueltschy (2010), who claimed that there is a major similarity between green and lean practices regarding reduction in waste.

Waste reductions that are the focus of green and lean practices lead to the maximization of profit for firms, giving them a competitive advantage in the market. The relationships between lean practices and business performance indicate they have significant relationship on operational performance. The operational performance factors measured in this study were quality, cost reduction, productivity, inventory minimization and lead time reduction. These results are supported by Shah & Ward (2003) who show that the implementation of lean practices is always associated with an improvement in labour productivity and quality, and a reduction in customer lead time and cycle time as well as a reduction in manufacturing costs. In addition to showing a significant relationship between lean practices and financial performance and that good relationship with suppliers helps firms to be sustainable and innovative (Habidin & Yusof, 2013). Both the supplier relationships and employee involvement in lean practices have a significant positive relationship with customer satisfaction.

In terms of the relationships between green practices and business performance, this study has found that green practices relate to operational and financial performance mainly through the investment recovery element of green practices. The results also show that there is a significant relationship between green practices and customer satisfaction. This finding is consistent with previous research by Özşahin, Sezen, & Cankaya (2013), who found a positive association between green practices and firm performance, in terms of return on investment, market share, profitability and sales of the firms. This study provides evidence that lean practices mediate the relationships between green practices and business performance. It signifies that the effect of green practices towards business performance is because a firm has lean practices at the same time. It can be concluded that the concept of being green is equivalent to most of the practices in the lean philosophy.

The findings from this study highlight several practical contributions in terms of managerial benefits and policy implementation. Its findings can help managers determine the practices that are most relevant for their firms. Future research focus on firms . This will provide a clear differentiation regarding both green and lean practices and more specific recommendations can be offered to better guide the industry.

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