The influence of lean management and environmental practices on relative competitive quality advantage and performance

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Abstract

Purpose – Firms are adopting strategies to advance product quality and environmental sustainability to achieve improved profitability and shareholders' wealth. The study investigates strategies that create a superior quality performance to competitors and improve both environmental and business performances. This paper explores the direct and indirect influence of lean management and environmental practices on relative competitive quality advantage, environmental performance and business performance.

Design/methodology/approach – The study uses a quantitative method where data is gathered from 259 manufacturing firms in Ghana. The data is gathered through customized questionnaires. The partial least squares structural equation modeling (SmartPLS 3.2.8) is used to analyze the data. Firm size, industry type and importance of environmental issues are used as control variables in this study.

Findings – The findings of the study indicate that both lean management and environmental practices create relative competitive quality advantage and improve environmental performance and business performance. Environmental performance and relative competitive quality advantage mediate the influence of lean management and environmental practices on business performance. The results further indicate that lean management creates a higher relative competitive quality advantage than environmental practices, while environmental practices have more potency to enhance environmental performance than lean management.

Originality/value – The study develops and proposes a comprehensive theoretical framework that examines the potency of environmental practices and lean management in creating a relative competitive quality advantage and improving environmental performance and business performance from a Ghanaian perspective, which is an emerging economy in Africa. Lean management and environmental practices may jointly help firms create relative competitive advantage and improve environmental performance to enhance business performance.

Keywords Organizational performance, Lean manufacturing, Sustainable production, Total quality management, Environmental management, Green operations

Paper type Research paper

1. Introduction

Quality management and environmental practices are fundamental approaches used by firms to satisfy customers' needs, create sustainable competitive advantage and improve performance. According to Honda *et al.* (2018), several leading manufacturing firms consider quality as a critical source of competitive advantage. Firms adopt environmentally friendly practices to reduce environmental impacts of their operations and enhance the green features and quality of their products to strategically position themselves ahead of their competitors (Halid *et al.*, 2015). Abele and Reinhart (2011) suggest that there is a need for firms to be lean and flexible to strengthen their competitive positions due to demand variations and

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adaptability. Lean management (LM) has become a vital source of creating competitive advantage and performance improvement through superior quality offerings. Losonci and Demeter (2013) argue that LM is one of the critical approaches adopted by several leading firms in the world to create and sustain their competitive positions. The fundamental principle of LM is to create an efficient and effective system of production that produces quality products to satisfy customer needs and improve environmental performance (EP) through waste reduction or elimination (Womack and Jones, 1996). According to Dow *et al.* (1999), not all quality management practices adopted by firms have the propensity to achieve the expected quality performance goals. Hence, there is the need to explore other strategies to create and maintain relative competitive quality advantage (RCQA) (Flynn *et al.*, 1995) and improve both EP and business performance (BP).

Environmental practices (EPs) are considered as an effective approach to creating and maintaining RCQA. Extant studies suggest that EPs have a significant positive impact on operational performance (Corbett and Klassen, 2006), improve green reputation of firms among environmentally friendly customers and advance BP. Narasimhan and Schoenherr (2012) suggest that EPs create both actual and perceived relative competitive quality advantages through the development of a right corporate image among customers. Zaid *et al.* (2018) argue that internal EPs have a positive influence on firm performance. Practitioners and academicians have shown a high interest in EPs and LM due to environmental requirements of customers and potency of LM–green links on sustainability (Abreu *et al.*, 2019). Klassen and McLaughlin (1996) claim that LM and EPs have conflicting objectives. Despite the existence of myriad literature on the synergy between LM and EP, Salvador *et al.* (2017) demand further investigation into gaps, real bonds and overlaps between them. This has ignited a need to explore the extent to which these strategies help in achieving environmental and economic goals in our current globalized and competitive market. Besides, most of the studies conducted to examine the influence of LM and EPs on performance have mostly concentrated on automobile manufacturing plants in developed countries. This study is conducted in four different manufacturing industries to deepen the understanding of the influence of EPs and LM on EP, RCQA and BP.

The natural resource-based view theory, which is mostly used in green and sustainability (social, environmental and economic) studies, forms the theoretical foundation of this research. The natural resource-based theory focuses on how protection of environment, conservation of energy and resources and reduction of waste create a competitive advantage. The effective implementation of EPs and LM reduces energy consumption, greenhouse emissions and waste and creates valuable, rare, inimitable and nonsubstitutable capabilities that may serve as a source of sustainable competitive advantage for firms (Barney, 2001). The study will further contribute to the literature by developing a research model connecting EPs, LM, RCQA, EP and BP. Consequently, this study may contribute to operations and environmental management literature by testing the mediating effects of RCQA and EP between LM, EPs and BP. This is among the few studies or possibly the first study that simultaneously explores the direct and indirect paths between EPs, LM, RCQA, EP and BP. The practical foundation of this study is that firms need to create a RCQA in order to survive and remain relevant in the current internationalized and competitive market. This calls for a need for firms to develop or adopt strategies that are appealing to the needs of the majority of consumers in order to create RCQA and improve both EP and BP. The findings of this study may guide managers to effectively choose and invest in strategies that create RCQA and improve BP. The above-identified gaps have led to the development of the research questions:

(1) What relationships exist between LM, EPs, RCQA, EP and BP?

(2) Do RCQA and EP mediate the link between LM, EPs and BP?

The introduction forms the first part of the study and subsequently followed by a literature review, hypotheses development, research methodology, analysis and results, discussions and conclusion in that order.

2. Literature review

2.1 Lean management (LM)

According to Hajmohammad *et al.* (2013) and Narasimhan and Schoenherr (2012), LM involves the integration of just in time (JIT) into production systems to enhance quality and delivery time. Krafcik (1988) proposed LM, which was associated with the production system of Toyota. According to AlManei (2017), LM is an integrated sociotechnical system, which mainly eliminates waste by concurrently reducing or minimizing supplier, customer and internal variability. LM involves a methodical removal of wastes from operations of firms through a careful combination of work practices to ensure the production of goods and provision of services at a level of demand (Fullerton and Wempe, 2009; Simpson and Power, 2005). LM includes JIT, total quality management (TQM), productive maintenance, total preventative maintenance, human resource management, employee involvement, low setup and controlled processes (Swink *et al.*, 2007; Womack *et al.*, 1990). Several scholars posit that adoption of LM reduces manufacturing cycle time or manufacturing costs and customer lead time and improves labor productivity, quality and operational performance (Stenman, 2015; De Treville and Antonakis, 2006). For this research, LM is defined as a combination of a set of philosophical and production practices that focus on reducing wastes and removing activities that do improve product value from a firm's manufacturing operations (Taj, 2008; Browning and Heath, 2009; Narasimhan and Schoenherr, 2012) to enhance environmental and quality performances of the products to achieve business gains. This study employs items such as reduction of inventory, focus on a single supplier, employee involvement and training, elimination of waste, cycle time reduction and use of new process technology to explore the influence of LM on EP, RCQA and BP across different manufacturing industries.

2.2 Environmental practices (EPs)

EPs involve techniques, procedures and policies used by firms to curtail or remove adverse impacts of goods and services on the natural environment (Montabon *et al.*, 2007, p. 998) through pollution prevention, waste reduction and recycling (Narasimhan and Schoenherr, 2012). EPs involve all the strategies employed to reduce the undesirable influence of firms' activities and products on the environment (Klassen and McLaughlin, 1996). Klassen and Whybark (1999) categorize EPs into three mutual groups: management systems, pollution prevention and pollution control. According to Klassen and Whybark (1999) and Sroufe (2003), EPs begin from product development and end at product delivery and disposal. This suggests that EPs seek efficiency beyond the confines of a firm (Kleindorfer *et al.*, 2005) to protect the natural environment. Narasimhan and Schoenherr (2012) and Hajmohammad *et al.* (2013) suggest that environmental management system (EMS) such as ISO 14001 standards assist firms to assess, manage, coordinate and monitor their environmental activities. This study employs items such as environmental factors integrated into an internal performance evaluation system, design of products to reduce material/energy consumption, allowing environmental audits, providing environmental training and education for employees, monitoring and evaluating environmental practices and policies and commitment of senior managers to explore the influence of EPs on RCQA, EP and BP.

2.3 Relative competitive quality advantage (RCQA)

Several firms have adopted strategies that create and sustain competitive advantage to ensure their survival and remain relevant in current competitive and globalized market space. One of the key weapons used by firms to stay relevant to their existing customers and attract

potential customers is the application of manufacturing strategies that ensure superior product quality performance and protect the environment. According to Narasimhan and Schoenherr (2012), an RCQA is created when a firm's product produces superior quality performance relative to its competitors. For this study, RCQA is defined as the ability of a firm to produce superior quality goods, satisfy customers' needs, create a competitive edge over its competitors and improve performance through environmentally friendly production processes and products. RCQA could be both actual and perceived. The actual RCQA is created when the quality performance and EP of a firm's product outwit those of its competitors, causing customers to buy the products. However, a perceived RCQA is created when the application of sound strategies and practices creates a superior quality perception about a firm's products in the minds of customers, causing customers to choose the products ahead of the products of competitors. EP and LM may create RCQA, eliminate waste, reduce environmental pollution, minimize consumption of energy and hazardous substances and eliminate the adverse impact of products on the environment.

2.4 Performance

Performance is very crucial to the top-level management of every firm. According to Agyabeng-Mensah *et al.* (2019a, b, c) and Agyabeng-Mensah *et al.* (2020a, b), performance involves financial and nonfinancial outcomes of a combined application of business processes, activities, policies and resources. Firm performance is a complex construct that involves several measurement items. However, for this study, EP and BP are considered. EP involves the outcome of a firm's effort toward the reduction or removal of externalities created by their activities on the environment. EP is defined as the extent to which firms apply both nonfinancial and financial resources to reduce the negative impact of their operations and products on the environment through pollution reduction, less consumption of harmful materials, reduction in environmental accidents and conservation of energy and resources (Agyabeng-Mensah *et al.*, 2020a, b). BP involves the responsibilities of firms to achieve profit maximization to meet shareholders' needs (Rappaport, 2006). Similar to other extant literature, this study uses items that cover market and financial performances to measure BP (Menor *et al.*, 2007; Yang *et al.*, 2011; Agyabeng-Mensah *et al.*, 2020a, b). Financial and market performance items are used to measure BP due to the availability of data and the conspicuous influence of LM, EPs, RCQA, EP on BP. According to Abreu *et al.* (2019), green–lean synergy advances sustainability and overall performance of firms. Other scholars argue that both traditional and nontraditional quality management practices such as LM and EPs seem to achieve similar objectives (EP, RCQA and BP) (Klassen and McLaughlin, 1996). This study explores the influence of LM and EPs on RCQA, EP and BP from a developing country's perspective, specifically Ghana, to strike a balance between literatures. Figure 1 shows the relationships existing between LM, EPs, RCQA, EP and BP.

3. Development of hypotheses

3.1 The link between LM and RCQA

LM involves the removal of non-value-added activities from a production process to conserve energy and eliminate waste. LM ensures continuous improvement of quality performance of products. Again, involvement and training of employees in quality planning equip employees with requisite knowledge and skills to eliminate waste in the production process of a product. This reduces adverse impact of a product on the environment through less resource usage and energy consumption. This may create RCQA for firms. LM ensures quality conformance, creates product superiority and generates a competitive advantage for firms (Douglas and Judge, 2001). LM may cause firms to source quality raw materials for production, which may

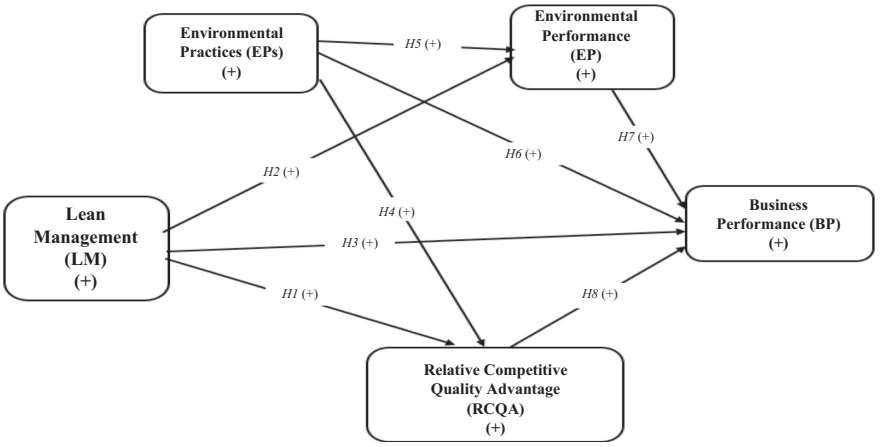


Figure 1.
Research model

result in a production of superior quality products. Tupamahu *et al.* (2019) found a positive relationship between LM and competitive advantage. From the earlier discussion, we hypothesize that:

H1. LM has a significant and positive influence on RCQA.

3.2 The link between LM and EP

Hajmohammad *et al.* (2013) argue that LM influences EP through waste reduction. According to Fernández-Viñé *et al.* (2013), LM is associated with waste reduction, less energy consumption, pollution prevention and less use of natural resources. According to Moreira *et al.* (2010), LM positively influences EP through disposal of less waste into the environment. Further, implementation of LM reduces energy consumption and eliminates waste from firms' operations to improve EP. Rothenberg *et al.* (2005) posits that "zero waste," which forms the main principle of LM, ensures environmental efficiency. Dieste *et al.* (2019) found a positive relationship between LM and EP. Inman and Green (2018) suggest that LM positively influences EP. Hence, we hypothesize that:

H2. LM has a significant and positive influence on EP.

3.3 The link between environmental practices (EPs) and environmental performance (EP)

Firms adopt EPs to achieve environmental sustainability goals. This has been empirically tested by several extant pieces of literature (Jabbour, 2015; Agyabeng-Mensah *et al.*, 2019a, b, c, 2020a, b; Zaid *et al.*, 2018; Longoni *et al.*, 2018). Scholars suggest that design for environment and development of eco-friendly products reduce waste and adverse impact of products on the environment (Abreu *et al.*, 2019). Studies have revealed that EPs enhance market performance through customer satisfaction, customer acquisition, customer retention and market growth (Agrawal *et al.*, 2016). The adoption of ISO 14001 certification improves EP through implementation of procedures and policies that limit or eliminate improper waste management and disposal. EPs such as environmental audit assist firms to examine how well they are executing environmental strategies to achieve environmental sustainability goals (Baah *et al.*, 2019). Agyabeng-Mensah *et al.* (2020a, b) found that EPs such as green logistics management practices have a significant influence on EP. Hence, we posit that:

H5. EPs have a positive and significant influence on EP.

3.4 The link between EPs and RCQA

Narasimhan and Schoenherr (2012) suggest that EPs have a significant and positive relationship with actual quality performance. Hanson *et al.* (2017) posit that EPs enhance EP to improve firm reputation and create perceived RCQA. Narasimhan and Schoenherr (2012) argue that customers perceive high innovativeness associated with EPs as quality, which creates perceived RCQA. According to Alexander and Buchholz (1978), introduction of EP into quality management processes of a firm creates significant RCQA. Darnall (2006) claims that EPs create a competitive advantage. Narasimhan and Schoenherr (2012) posit that implementation of EPs results in both actual and perceived RCQA. Hence, we develop the hypothesis:

H4. EPs have a positive and significant influence on RCQA.

3.5 The link between LM, EPs and BP

Several scholars have established a positive relationship between LM and BP. Henao *et al.* (2019) found that LM reduces setup time and work in progress inventory, which improves market performance. Abdallah *et al.* (2019) claim that LM provides an opportunity for efficient prevention of pollution through cost-saving. The findings of extant literature (Fullerton and Wempe, 2009; Yang *et al.*, 2011) reveal that there is a significant and positive relationship between LM and financial performance. Fullerton and Wempe (2009) argue that LM creates operational efficiency and effectiveness and improves BP. According to Yang *et al.* (2011), LM advances financial performance through improved productivity. Büyüközkan *et al.* (2015) discovered a positive relationship between LM and BP. Considering the influence of LM on financial performance and market performance, we posit that:

H3. LM has a positive and significant influence on BP.

Several studies have obtained conflicting results regarding the relationship between EPs and BP. Walley and Whitehead (1994) argue that EPs prevent the execution of other financially viable projects due to scarcity of resources, which negatively influences BP. Increased EPs may negatively affect market performance due to low resource allocation to marketing activities (Reimann *et al.*, 2010). Yang *et al.* (2011) found a negative relationship between EPs and performance. However, Agyabeng-Mensah *et al.* (2020a, b) discovered that EPs, such as internal green supply chain practices, have a significant positive influence on BP. Moreover, Agyabeng-Mensah *et al.* (2020a, b) found a positive relationship between green logistics management practices and both market and financial performances (BP). Hart and Ahuja (1996) argue that EPs reduce gas emission, on-site waste treatment and prevent waste, which may significantly influence BP. The confusing and conflicting results obtained by extant literature require further exploration of the relationship between EPs and BP. Thus, we posit that:

H6. EPs have a positive and significant influence on BP.

3.6 The link between RCQA, EP and BP

Hart (1995) asserts that improved EP boosts the profitability of firms through market growth. According to Feng *et al.* (2018), EP significantly and positively influences financial performance. Yang *et al.* (2011) found that EP has a positive impact on financial performance. Improvement in EP may cause higher market performance through an improved corporate

image (Luo and Bhattacharya, 2009). According to Agyabeng-Mensah *et al.* (2020a, b), EP has a positive and significant influence on both market and financial performances. This suggests that firms that improve EP increase their market size, sales and profitability. Considering the influence of EP on BP, we posit that:

H8. EP has a positive and significant influence on BP.

Firms that have gained the commitment of top-level management toward adoption of LM and EPs may advance their competitive positions through customer satisfaction, which may improve BP. Firms may produce eco-friendly products to attract environmentally conscious customers who perceive green products as more quality than products without green features. Giving employees training about EPs and lean management may help them develop rare, hard-to-substitute and imitable capabilities to produce environmentally friendly and quality products to satisfy customers, which may lead to improved BP (Barney, 2001). Firms developing high-quality standards can develop and produce products that have superior environmental and quality performance to achieve both perceived and actual RCQA to advance BP. Hence, we posit that:

H7. RCQA has a positive and significant influence on BP.

3.7 Mediating effects of RCQA and EP

Several scholars have investigated the relationships between both LM and EPs and BP in different industries and countries with varying outcomes. Indeed many of them have come out with favorable findings to support the existing positive relationships between LM, EPs, EP and BP (Sueyoshi and Goto, 2010; Green *et al.*, 2012; Yang *et al.*, 2011; Feng *et al.*, 2018). However, mediating effects of RCQA and EP have not been sufficiently explored. The implementation of LM and EPs may help a firm develop and produce goods and services that demonstrate superior quality performance and EP to the products of competitors. This may enhance the reputation of firms, create RCQA and improve BP. Besides, Caldera *et al.* (2017) suggest that lean and green thinking reduce waste disposal and gas emission and conserve energy, which may improve BP. Similarly, other scholars argue that, traditional quality management practices and EPs seem to achieve similar objectives (Klassen and McLaughlin, 1996). We then hypothesize that:

H9. EP mediates the relationship between LM and BP.

H10. RCQA mediates the relationship between LM and BP.

H11. EP mediates the relationship between EPs and BP.

H12. RCQA mediates the relationship between EP and BP.

4. Research design

4.1 Sample size and data collection

The employees of manufacturing companies in Ghana are used as respondents of this study. We sampled four hundred and sixty-three (463) manufacturing companies from the database of the Registrar's Department of Ghana, which contains complete information about manufacturing firms in Ghana. The database contains a population of seven hundred and seventy-seven (777) manufacturing firms. Four hundred and sixty-three (463) companies agreed to participate in the study. The questionnaires, coupled with letters of purpose explaining the academic intent of the study, were administered to the respondents through mail. The respondents were given a one-month (July 18–August 18, 2019) duration to complete the questionnaires. Moreover, regular five-day interval reminder messages were

sent to late respondents after first 15 days to increase participation. We received an active response of 259 questionnaires at the end of the period, which constituted 33.33% of the population. The 33.33% is relatively adequate for management researches since extant literature suggests a minimum of 20% response rate (Darnall *et al.*, 2010; Agyabeng-Mensah *et al.*, 2020a, b; Pagell *et al.*, 2004). The respondents include quality managers (23%), supply chain managers (22%), environmental experts (20%) and managing directors (35%). The manufacturing industries included detergents (15%), food and beverage industry (36.68%), shoe manufacturers (20.46%) and plastics manufacturers (27.03%).

4.2 Measures and questionnaires

This study employs a first-order reflective model to analyze LM, EPs, RCQA, EP and BP. The structured questionnaires used to gather data for this study were developed by following procedures recommended by literature (Brace, 2018). LM is operationalized using six measuring items. The study employs a five-point Likert-type scale (from 1 = low implementation to 5 = full implementation) to measure the level of implementation of LM in the respondents' firms over the past four years. The items are adopted from Jain *et al.* (2015) and Sahoo and Yadav (2018).

EPs are operationalized using six measuring items. The study employs a five-point Likert-type scale (from 1 = low implementation to 5 = full implementation) to measure the level of implementation of LM in the respondents' firms over the past four years. The measurement items are adopted from Longoni *et al.* (2018), Baah *et al.* (2019) and Zaid *et al.* (2018).

RCQA is measured using four items. A five-point Likert-type scale (from 1 = strongly disagree to 5 = strongly agree) is used to measure RCQA where respondents are asked to choose their preference to show their disagreement or agreement with their products, creating a RCQA over the last four years since the implementation of LM and EPs. The items are adopted from Narasimhan and Schoenherr (2012) and Swink and Song (2007).

Consequently, EP is measured by capturing respondents' perceptions concerning the improvement of EP over the past four years. Five items are used to measure EP using a five-point Likert-type scale (from 1 = strongly disagree to 5 = strongly agree) to determine the degree to which respondents disagree or agree with improvements in EP over the last four years since the implementation of EPs and LM.

Finally, BP is measured using market growth, sales growth, profitability, returns on investment and returns on assets. A five-point Likert-type scale (from 1 = strongly disagree to 5 = strongly agree) is used to measure BP, where respondents are asked to choose their preference to show the extent to which they disagree or agree to the improvement in BP over the last four years since the implementation of LM and EPs. The items are adopted from Agyabeng-Mensah *et al.* (2020a, b) and Santis *et al.* (2016).

Lastly, large firms are believed to have internal resource to fund LM (Shah and Ward, 2003; Yang *et al.*, 2011) and organize environmental training programs (Aragon-Correa *et al.*, 2007), which are likely to improve EP (Wilkinson *et al.*, 2005) and create RCQA to enhance BP. The manufacturing industry is known to contribute significantly to environmental pollution, which attracts stricter and more cogent rules to regulate its operations more than the service industry (Sampson and spring, 2011). This compels firms to adopt practices such as LM and EPs, which improve EP and BP. In a business setting where stakeholders place high relevance on environmental issues, firms adopt EPs and LM to reduce waste and improve quality to create RCQA, which may improve EP and BP. Hence, firm size, importance of environmental issues and industry type are used as control variables.

4.3 Nonresponse bias and common method bias

We followed the recommendation of Armstrong and Overton (1977) to test nonresponse bias. The responses were categorized into early and late responses. The results of the test between

early 155 responses (received within the first 15 days) and late 104 responses (received within the last 15 days) using the *t*-test show that nonresponse bias should not be a problem in this study since the two waves of responses are not substantially different at 5% significance level.

Further, several measures were put in place to reduce common method bias. We tested the carefulness and respondents' bias by inserting repeated items on each page of the questionnaires. Again, we sought to reduce common method bias by placing endogenous variables before exogenous variables in the questionnaires to help reduce impact of consistency artifacts (Podsakoff *et al.*, 2003). Further, Podsakoff *et al.* (2003) claim that a test for common method bias involves the use of exploratory factor analysis (EFA). EFA test considers all observed variables, and when a single factor displays a value ≥ 0.50 (i.e. ≥50%), there is a common method bias. The EFA test performed on the variables produces a result of 0.4112 (41.12%), which is below 50% threshold suggested by Podsakoff *et al.* (2003). Hence, it is reasonable to claim that this study is free from common method bias.

4.4 Data analysis

The study uses partial least square structural equation modeling (PLS-SEM) to analyze the data and test the hypotheses (Hair *et al.*, 2013). PLS-SEM is suitable for explorative and predictive studies (Hair *et al.*, 2017). This has increased its use in management research in recent times (Peng and Lai, 2012). The study employs a first-order reflective model to test the relationship between constructs, which requires an assessment of reliability and validity of measurement items (Henseler, 2017). The analysis follows a two-step analysis procedure recommended by Anderson and Gerbing (1988). First, measurement model is evaluated to ascertain reliability and validity of measurement scales by calculating the partial least square algorithm with 300 samples (Henseler *et al.*, 2017). Subsequently, the structural model (hypotheses testing) is examined to ascertain validity of the relationship between the constructs by calculating bootstrapping with a subsample size of 5,000. The steps are explained further. The thresholds used for analysis are shown in Table 1.

4.5 Assessment of the measurement model

Cronbach's alpha and composite reliability are used to examine internal consistency reliability (Henseler *et al.*, 2017). The range of values for Cronbach's alpha (0.747–0.809) and composite reliability (0.835–0.901) are far above the thresholds >0.70 and > 0.70, respectively. The range of values for average variance extracted (AVEs) (0.559–0.745) used to measure convergent validity meet the threshold of >0.50 suggested by Hair *et al.* (2019). Though some of the factor loadings (0.627–0.900) do not meet the minimum threshold of ≥0.708 (Hair *et al.*, 2019), the items with loadings above 0.600 are not removed since they improve the validity and the strength of the model. The values for composite reliability, factor loading, AVEs and Cronbach's alpha are shown in Table 2.

Table 1. Measurement criteria thresholds

Measurement criteria	Recommended threshold
Factor loading (Henseler, 2017)	>0.70
Composite reliability (Henseler, 2017)	>0.70
Average variance extracted (Rodgers and Pavlou, 2003)	>0.50
Cronbach's alpha (Henseler, 2017)	>0.70
HTMT ratio (Hair *et al.*, 2013)	<0.85
P-value	<0.05
VIF (Kock, 2015)	<3.3

Construct	Measuring items	Items	Factor loadings	CA	AVEs	CR	Item source
Eps	(1) Environmental factors are integrated into the internal performance evaluation system	EPs1	0.784	0.832	0.745	0.897	Yang *et al.* (2011), Longoni *et al.* (2018), Zaid *et al.* (2018)
	(2) Design of products for reduced consumption of material/energy	EPs2	0.900				
	(3) Allowing environmental audits	EPs3	0.779				
	(4) Providing environmental training and education for employees	EPs4	0.679				
	(5) Monitoring and evaluating environmental practices and policies	EPs5	0.721				
	(6) The commitment of senior managers to environmental practices	EPs6	0.627				
LM	(1) Reduction of inventory	LM1	0.732	0.747	0.559	0.835	Panwar *et al.* (2015), Sahoo and Yadav (2018)
	(2) Focusing on a single supplier	LM2	0.761				
	(3) Employee involvement and training	LM3	0.691				
	(4) Eliminate waste	LM4	0.801				
	(5) Cycle time reduction	LM5	0.761				
	(6) Use of new process technology	LM6	0.681				
RCQA	(1) Improved product quality conformance relative to competing products	RCQA1	0.872	0.809	0.639	0.875	Narasimhan and Schoenherr (2012), Swink and Song (2007)
	(2) Our product was superior to competing products in terms of meeting customers' need	RCQA2	0.742				
	(3) Improved social reputation of the firm's product relative to competing products	RCQA3	0.872				
	(4) Reduced product effects on the environment relative to competing products	RCQA4	0.772				

Table 2.
Measurement properties of reflective construct

(*continued*)

Construct	Measuring items	Items	Factor loadings	CA	AVEs	CR	Item source
EP	(1) Reduction in energy and resource usage	EP1	0.864	0.858	0.649	0.901	Baah *et al.* (2019), Zaid *et al.* (2018)
	(2) Reduction in the production of solid wastes	EP2	0.721				
	(3) Reduction in raw material consumption	EP3	0.843				
	(4) Reduction in the frequency of environmental accidents in the company	EP4	0.864				
	(5) Improvement in the company's environmental situation	EP5	0.843				
BP	(1) Increase in market share	BP1	0.712	0.852	0.688	0.897	Agyabeng-Mensah *et al.* (2020a, b), Longoni *et al.* (2018), Santis *et al.* (2016)
	(2) Growth in sales	BP2	0.877				
	(3) Growth in net profit margin	BP3	0.889				
	(4) Increase in return on assets	BP4	0.889				
	(5) Increase in return on equity	BP5	0.692				

Table 2.

Subsequently, discriminant validity of the model is determined using Fornell–Larcker criterion and Heterotrait–Monotrait Ratio (HTMT). Fornell–Larcker criterion is dependent on an opinion that square roots of AVEs should be higher than correlations between the constructs in the model. The values in Table 3 suggest that the model has achieved discriminant validity since the Fornell–Larcker criterion has been met.

According to Henseler *et al.* (2017), HTMT ratios may also be used to determine discriminant validity of a model. The range of HTMT ratios (0.622–0.774) indicates that LM, EPs, EP, RCQA and BP have achieved discriminant validity since HTMT ratios are far below the threshold of 0.85 (Ringle *et al.*, 2018). The result is shown in Table 4.

4.6 Assessment of structural model (testing of hypotheses)

After determining discriminant validity and reliability of the model, we assessed the structural model using correlation (r), predictive relevance (Q^2), effect size (f^2) and variance explained (R^2). The results indicate that EPs, EP, LM and RCQA jointly explain (64.5%) of BP, while LM and EPs jointly explain (52.80 %) and (48%) of RCQA and EP, respectively. Besides,

Constructs	BP	EP	EPs	LM	RCQA
BP	*0.830*				
EP	0.660	*0.806*			
EPs	0.642	0.637	*0.863*		
LM	0.704	0.600	0.599	*0.748*	
RCQA	0.696	0.564	0.611	0.681	*0.800*

Table 3.
Fornell–Larcker criterion

f^2 representing the effect size of the exogenous construct on endogenous constructs indicates that EPs have medium effect size on EP (0.230) while LM has a small effect size on EP (0.142). Again, LM has a substantial effect size on RCQA (0.329), while EPs have small effect size on RCQA (0.143). The Q^2 used to examine predictive relevance of independent variables on dependent variables, EP (0.259), RCQA (0.282) and BP (0.351), indicates that the model has excellent predictive relevance since all the values are > 0.000. Finally, correlations (r) between LM, EPs, RCQA, EP and BP suggest that there is a medium to strong relationships between the variables. This shows that the model is fit for this study. Table 5 and Figure 2 contain f^2, Q^2, VIFs and R^2, while Appendix contains r.

4.7 Results

The study explores direct and indirect relationships between LM, EPs, RCQA, EP and BP. The hypotheses are tested using the statistical significance of <0.05. First, we tested the significance of the direct paths between EPs, LM, EP, RCQA and BP. The results obtained from the test support hypotheses H1, H2, H3, H4, H5, H7 and H8 but do not support hypothesis H6. The findings suggest that LM significantly creates RCQA, which supports hypothesis H1 ($\beta = 0.492$, $t = 9.496$, $p = 0.023$). Besides, LM has a significant and positive influence on EP, which supports hypothesis H2 ($\beta = 0.341$, $t = 4.841$, $p = 0.041$). Moreover, the results support hypothesis H3 ($\beta = 0.281$, $t = 5.102$, $p = 0.041$), which states that LM significantly and positively influences BP. Further, the result supports hypothesis H4 ($\beta = 0.316$, $t = 5.884$, $p = 0.025$), which states that EPs positively and significantly influence RCQA. Besides, the study's result supports hypotheses H5 ($\beta = 0.432$, $t = 6.574$, $p = 0.000$) and H6 ($\beta = 0.154$, $t = 2.852$, $p = 0.004$). Subsequently, the findings suggest that RCQA has a positive and significant influence on BP, H7 ($\beta = 0.276$, $t = 5.893$, $p = 0.000$), which supports hypothesis H7. Again, the findings support hypothesis H8 ($\beta = 0.238$, $t = 5.025$, $p = 0.000$), which states that EP positively and significantly influences BP. The details of the direct effects are shown in Table 6.

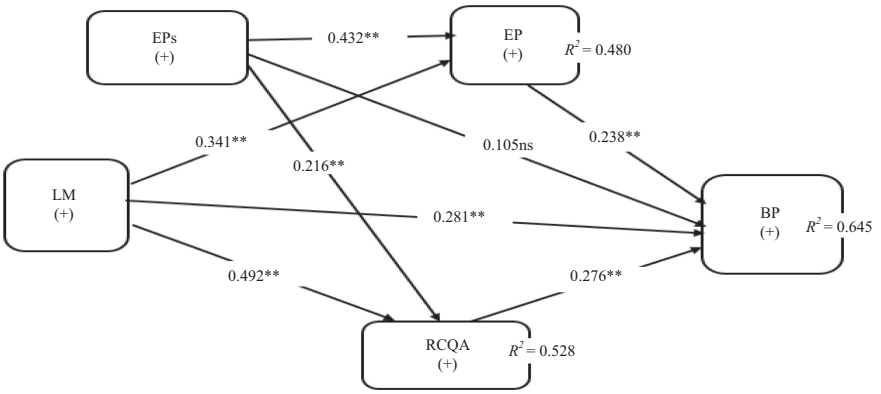
The study further analyzes the mediating effects of EP and RCQA through specific indirect paths, as suggested by Memon *et al.* (2018) and Zaid *et al.* (2018). PLS-SEM software 3.2.8 has the statistical power to calculate multiple specific indirect effects (mediation) simultaneously. The results confirm the mediating roles of RCQA and EP between LM and BP. This indicates that hypotheses H9 ($\beta = 0.081$, $t = 4.126$, $p = 0.023$) and H10 ($\beta = 0.136$,

Table 4. Heterotrait–monotrait ratio (HTMT)

Constructs	BP	EP	EPs	LM
EP	0.683			
EPs	0.657	0.715		
LM	0.757	0.686	0.739	
RCQA	0.721	0.622	0.657	0.774

Table 5. R^2, communality and redundancy, VIF and f^2

Construct	BP (f^2)	EP (f^2)	RCQA (f^2)	BP (VIF)	EP (VIF)	EPs (VIF)	LM (VIF)	RCQA (VIF)	Q^2	R^2	R^2adj
BP					2.503	2.834	2.688	2.586	0.351	0.645	0.640
EP	0.081			1.874		1.861	2.197	2.179	0.259	0.480	0.476
EPs	0.033	0.230	0.136	2.051	2.036		1.871	2.057			0.525
LM	0.100	0.143	0.329	1.961	2.176	2.053		2.244			
RCQA	0.099			1.953	2.558	2.433	1.982		0.282	0.528	



Note(s): ns = not significant; **=Significant path; EPs = environmental practices; LM = Lean Management; EP = environmental performance; RCQA = relative competitive quality advantage; BP = business performance

Figure 2.
Structural model

Path	Hypothesis	Beta (β)	*T*-statistics (|O/STDEV|)	*P*-values	Results
LM → RCQA	H1	0.492	9.467	0.023	Supported
LM → EP	H2	0.341	4.841	0.041	Supported
LM → BP	H3	0.281	2.102	0.045	supported
EPs → RCQA	H4	0.216	2.884	0.045	Supported
EPs → EP	H5	0.432	4.217	0.025	Supported
EPs → BP	H6	0.105	1.852	0.061	Not supported
RCQA → BP	H7	0.276	5.893	0.012	Supported
EP → BP	H8	0.238	5.025	0.001	Supported
Control variable					
Firm size → RCQA		0.263	3.133	0.031	Supported
Firm size → EP		0.553	4.048	0.040	Supported
Firm size → BP		0.252	7.021	0.023	Supported
Importance of environmental issues → RCQA		0.423	3.221	0.008	Supported
Importance of environmental issues → EP		0.253	8.420	0.020	Supported
Importance of environmental issues → BP		0.343	6.204	0.021	Supported
Industry → RCQA		0.259	7.282	0.002	Supported
Industry → EP		0.400	4.700	0.007	Supported
Industry → BP		0.207	3.425	0.010	Supported

Table 6.
Direct effect

$t = 4.775$, $p = 0.000$) are supported. The findings further confirm the mediating effects of RCQA and EP between EPs and BP. This shows that hypotheses H11 ($\beta = 0.103$, $t = 3.570$, $p = 0.000$) and H12 ($\beta = 0.087$, $t = 4.413$, $p = 0.000$) are supported. Table 7 contains the details of indirect paths (mediating effects) between LM, EPs and BP through RCQA and EP.

The results from the analysis of control variables suggest that firm size, industry type and importance of environmental issues influence LM and EPs, which create RCQA and improve BP. These variables were controlled to justify how environmental regulations in specific industries, firm size and importance of environmental issues may influence EPs, LM and BP in the same national context. The results suggest that EPs and LM influence BP, RCQA and EP in the face of employing firm size, industry type and importance of environmental issues as control variables. This gives credence to our findings. This indicates that LM and EPs can be used to improve EP regardless of firm size, the importance of environmental issues and environmental regulations in industry.

5. Discussions of findings

5.1 Direct effect

The findings of this study suggest that LM has a significant and positive influence on RCQA. This supports the first hypothesis (H1 in Table 6) in this study. However, Hajmohammad *et al.* (2013) found an insignificant positive relationship between LM and EP. Again, the findings show that LM has a significant and positive influence on BP, which supports the second hypothesis (H2 shown in Table 6).

Notwithstanding, LM does not have a strong positive influence on RCQA and EP. The aforementioned results may be due to an inappropriate application of LM, which may not cause a significant improvement in product quality, energy conservation and waste reduction to advance RCQA and EP. Employees' resistance to new policies hinders effective adoption of new strategies (Longoni *et al.*, 2018), which may hamper the effective implementation of LM in Ghanaian manufacturing firms and lead to a minor improvement in EP and RCQA.

Again, analysis of the result reveals that LM has a more capability to create RCQA than EP (see Table 5), which may be because LM is traditionally implemented to achieve higher quality performance than EP. This finding expands knowledge and understanding of the influence of LM on creating and sustaining competitive advantage and improving EP. Besides, the study establishes that LM has a significant positive influence on BP, which supports the third hypothesis (H3 shown in Table 6). The result is partially backed with the findings of Yang *et al.* (2011), Fullerton and Wempe (2009), which suggest that there is a positive relationship between LM and BP. This result is a crucial contribution to knowledge since it deepens understanding of literature on the influence of LM on BP. However, the significance of the influence of LM on BP is not strong. This may be due to inappropriate implementation of LM practices such as continuous training and involvement of employees in quality management practices, which may negatively affect its direct influence on sales, profit, returns on assets and returns on investment.

Further, the results of the analysis suggest that EPs have a positive and significant influence on RCQA. This supports the fourth hypothesis (H4 shown in Table 6). This finding is similar to the position of Narasimhan and Schoenherr (2012) and Baah *et al.* (2019), who indicate that EPs improve the green image firms and create RCQA. However, the findings of Narasimhan and Schoenherr (2012) failed to identify the strength of the relationship between

Table 7. Mediating effects

Path	Hypothesis	Beta	T-statistics (|O/STDEV|)	*P*-values	Results
LM → EP → BP	H9	0.081	4.126	0.026	Supported
LM → RCQA → BP	H10	0.136	4.775	0.020	Supported
EPs → EP → BP	H11	0.103	3.570	0.024	Supported
EPs → RCQA → BP	H12	0.087	4.413	0.037	Supported

EPs and RCQA. This shortfall is addressed in this study by this finding, which broadens the scope of existing knowledge and understanding.

The results further indicate that EPs have a positive and significant influence on EP. This supports the fifth hypothesis (H5 shown in Table 6). Nonetheless, the result shows that EPs moderately influence EP. The commitment of strategic management toward implementation of EPs is fundamental to achieving higher results (Zaid *et al.*, 2018). This means strategic managers are required to support the implementation of EPs to achieve significant environmental returns. The inadequate commitment of top-level management toward the implementation of EPs in most emerging economies hampers the effort to achieve environmental sustainability (Zaid *et al.*, 2018).

Besides, the study's findings claim that EPs have an insignificant positive influence on BP, which does not support the sixth hypothesis (H6 shown in Table 6). This is similar to the position of extant literature (Baah *et al.*, 2019; Afum *et al.*, 2019; Agyabeng-Mensah *et al.*, 2020a, b). EPs are capital-intensive projects, which have long-term and uncertain benefits (Baah *et al.*, 2019; Pagell and Wu, 2009). Hence, EPs may not have a significant influence on sales and profitability in the short and medium terms (Feng *et al.*, 2018; Agyabeng-Mensah *et al.*, 2020a, b). Moreover, EPs do not significantly influence BP because, most of the existing EPs in most manufacturing firms in developing countries are internally based and do not significantly address critical environmental problems (Zaid *et al.*, 2018; Longoni *et al.*, 2018).

Further, the outcome of the analysis indicates that EP and RCQA have a positive and significant influence on BP. These results support the seventh and eighth hypotheses (H7 and H8 shown in Table 6). The findings unveil that reducing waste, energy consumption and environmental accidents may reduce operational cost and prices of goods, improve product quality and ensure market and profit growth (Fernández-Viñé *et al.*, 2013).

5.2 The mediation (indirect effect)

This study models EP and RCQA as mediating constructs. This aims to establish the mediating roles played by RCQA and EP between LM, EPs and BP. This is done by comparing the directions of the direct paths and the corresponding specific indirect paths between LM, EPs, RCQA, EP and BP (Zhao *et al.*, 2010). The examination of the mediating roles played by EP and RCQA between EPs, LM and BP is another significant contribution of this study to literature. The results suggest that EP plays a complementary partial mediation role between LM, EPs and BP. This supports the ninth and eleventh hypotheses (H9 and H11 shown in Table 7). However, the significance of the mediating role played by EP between EPs and BP is stronger than its mediating influence between LM and BP. This suggests that the implementation of EPs improves a firm's BP through EP more than the influence of LM on BP through EP. Nonetheless, the findings reveal that implementation of both EPs (environmental employee training and motivation, green product design, environmental audit an assessment) and LM (employee involvement and training, waste elimination, use of new process technology and inventory reduction) reduces waste, energy consumption and environmental accidents, improves customer satisfaction and increases market share, sales, profit margin and returns on investment (Abreu *et al.*, 2019).

Subsequently, the results reveal that RCQA plays a complementary partial mediation role between LM, EPs and BP, which supports the tenth and twelfth hypotheses (H10 and H12 shown in Table 7). The findings suggest that other variables may mediate the relationship between EPs, LM and BP. Moreover, the results reveal that effective implementation of both EPs and LM creates RCQA, which may increase market size, sales and profit. The results further reveal that the mediation role played by RCQA between LM and BP is stronger than the mediation role played by RCQA between EPs and BP. This suggests that the implementation of LM creates stronger RCQA for a firm to increase market share, sales, profit

margin and returns on investment. The totality of the findings suggests that firms implement LM and EPs to achieve similar objectives of creating RCQA and improving EP and BP. That notwithstanding, LM is more potent at creating RCQA than EPs, while EPs improve EP more than LM.

6. Conclusion

6.1 Implications for theory and practice

The study has several contributions to literature. The study proposes a research model that tests relative potency of LM and EP in creating RCQA, achieving environmental sustainability and improving BP from an emerging country's perspective. Besides, the findings of this study confirm the complementary relationship between EPs and LM in achieving improved firm performance. Hence, the findings of this study confirm the lean–green synergy. Moreover, the study's findings unveil overlaps between LM and EPs by establishing relative potency of EPs and LP in creating RCQA and improving EP. This serves as a response to the request of extant literature (Salvador *et al.*, 2017) to investigate gaps, real bonds and overlaps between LM and EPs. In addition, the results of this study explain the natural resource-based view theory by unveiling the capabilities of EPs and LM in creating RCQA and improving EP and BP.

Regarding the implications for practice, the study's findings suggest that LM has higher relative potency to create RCQA. This means that firms may implement LM to improve the quality performance of their products to strengthen their competitive positions to increase market size, sales and profitability. Similarly, the findings suggest that EPs have relative higher potency to reduce waste, minimize environmental accidents and conserve energy to improve environmental sustainability and safeguard the ecology of the Earth. Further, the study urges managers to employ appropriate quality and environmental strategies to achieve desired environmental and quality performance goals. Consequently, since the study's findings suggest that EPs have a relatively higher capability to significantly reduce waste and conserve energy, while LM has relative higher potency to achieve higher RCQA, simultaneous implementation of these two strategies creates sustainable relative competitive advantage through superior product quality and environmental protection, which may improve BP. This suggests that firms, which adopt LM and EP at the same time, can reduce waste and conserve energy and resources to save operational costs. This may result in lower prices of goods and increase in market share, sales and profitability. Moreover, firms should adopt environmental policies that significantly address critical environmental problems to create sustainable competitive advantage.

Further, the study urges firms to implement LM and EPs simultaneously to address quality and environmental needs of customers to acquire a higher market share and improve profitability. This suggests that firms should incorporate LM and EPs into their operations at the same time to improve product quality and safeguard the environment to meet the environmental demands of customers to increase market share, sales and profitability. Moreover, the study offers managers a deep insight into the implementation of LM and EPs to achieve environmental sustainability goals. Also, this study's findings serve as pieces of evidence for managers to push for the implementation of EPs and LM in every facet of the supply chain to reduce the adverse impact of supply chain activities on the environment and protect the Earth from destruction. Finally, the study encourages policymakers to roll out a set of comprehensive environmental guidelines and regulations that will guide and coerce manufacturing companies to adopt EPs and LM to address immediate societal and environmental problems to ensure environmental sustainability, societal safety and protection of the Earth's ecology.

6.2 Research limitations and future directions

Despite the achievement of the objective of the study, certain limitations may characterize the findings of the study. The findings may suffer from generalizability since the data used in this study is collected from respondents from only manufacturing firms in Ghana. Future studies may test the model in more than one industry. Moreover, a common method and nonresponse bias may affect the study, although adequate tests have been performed to prove their nonexistence. This study explores the influence of EPs and LM on composite RCQA (actual and perceived) and BP (market and financial performances). Future studies may explore the influence of LM and EPs on actual RCQA, perceived RCQA, financial and market performances. Moreover, future studies could use covariance-based SEM to replicate the study's results by following a multimethod approach. This study explored the influence of the concurrent or parallel implementation of EPs and LM on EP, RCQA and BP. Future studies could explore the order with which EPs and LM could be implemented to achieve synergy between them.

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Appendix

Construct	BP	EP	EPs	LM	RCQA
Business performance	1.000				
Environmental performance	0.660**	1.000			
Environmental practices	0.642**	0.637**	1.000		
Lean management	0.704**	0.600**	0.599**	1.000	
Relative competitive quality advantage	0.696**	0.564**	0.611**	0.681**	1.000

Table A1. Correlation

Note(s): **Correlation is significant at the 0.01 level (two-tailed)

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