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Environmental Management System Practices and Operational Efficiency Among Manufacturing Companies

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Abstract

Environmental management systems (EMS) have become increasingly important to manufacturing firms seeking to balance environmental responsibility with operational performance. This study examined Environmental Management System practices and operational efficiency among selected manufacturing companies in Biñan City, Laguna. Specifically, it assessed EMS practices in terms of structure, process, and continual improvement; evaluated operational efficiency in terms of resource utilization, process efficiency, and quality control; and determined the relationships between these dimensions. A descriptive, cross-sectional, correlational research design was employed. Data were collected from 200 manufacturing officers using an adapted and validated questionnaire. The instrument demonstrated excellent internal consistency, with Cronbach's alpha coefficients of .975 for EMS and .955 for operational efficiency. Descriptive statistics and Spearman's rank correlation were used for data analysis. Results showed that EMS practices were frequently implemented across all dimensions, while operational efficiency practices were likewise rated highly. Significant positive relationships were found between all EMS dimensions and operational efficiency indicators, with correlation coefficients ranging from rho = .692 to .860 ($p < .001$). The strongest relationship was observed between continual improvement and process efficiency. The findings indicate that more developed EMS practices are associated with stronger resource utilization, process efficiency, and quality control. The study underscores the managerial value of strengthening environmental monitoring, internal audits, technology adoption, employee participation, and continual improvement practices to support environmental sustainability and operational performance in manufacturing organizations.

Keywords: *environmental management system; operational efficiency; sustainable manufacturing; resource utilization; process efficiency; quality control.*

1. Introduction

Industrial development creates substantial economic value but also intensifies pressures on natural resources, energy systems, waste management, and environmental quality. The Sustainable Development Goals (SDGs) adopted by the United Nations emphasize that economic development should proceed alongside environmental protection, particularly through responsible production, resource efficiency, pollution prevention, and climate action (United Nations [UN], 2015). For manufacturing organizations, this creates a dual managerial challenge: firms must remain productive and competitive while controlling the environmental consequences associated with production activities.

This challenge is particularly relevant to the Philippine manufacturing sector. Manufacturing accounted for approximately 23.6% of national gross domestic product in 2022 and remained an important source of employment and export activity (Philippine Statistics Authority [PSA], 2023; World Bank, 2022). The sector is therefore strategically significant to national economic development. However, manufacturing activity is also associated with substantial resource consumption, emissions, waste generation, and potential impacts on air and water quality. These conditions reinforce the need for management systems that allow firms to pursue operational performance without separating economic objectives from environmental responsibility.

One organizational response to this challenge is the Environmental Management System (EMS). An EMS provides a structured framework through which organizations establish environmental policies and objectives, identify environmental risks, allocate responsibilities and resources, implement operational controls, monitor performance, undertake corrective and preventive actions, and pursue continual improvement. ISO 14001 provides an internationally recognized framework for these activities, emphasizing systematic environmental management rather than isolated compliance measures (ISO, 2015). Through such systems, manufacturers can integrate resource efficiency, pollution prevention, waste reduction, monitoring, and organizational accountability into routine operations (Crespin-Romero et al., 2018).

The relevance of EMS has expanded beyond environmental compliance. Environmental management increasingly intersects with operational strategy because many environmental inefficiencies are simultaneously operational inefficiencies. Excessive energy or water consumption increases operating costs; inefficient use of raw materials creates waste and reduces production yield; poorly controlled processes can generate defects, rework, and emissions; and ineffective monitoring may limit management's ability to identify operational losses. Accordingly, environmental management practices can be examined alongside operational efficiency, particularly in terms of resource utilization, process efficiency, and quality control.

Modern EMS practices increasingly incorporate environmental performance measurement, organizational learning, and digital technologies for monitoring and decision-making (Sharma et al., 2019). These developments suggest that environmental management can form part of a broader organizational capability involving management commitment, cross-functional coordination, systematic process control, data use, and continual improvement. In manufacturing settings, these capabilities are potentially relevant not only to environmental performance but also to the reliability and efficiency of operations.

For Philippine manufacturers, the strategic importance of these systems is intensified by the combination of regulatory requirements, international market expectations, supply-chain pressures, and exposure to environmental and climate-related risks. Effective environmental management can support sustainability objectives including more efficient water use, responsible consumption and production, and the reduction of environmentally harmful production practices. At the organizational level, however, the usefulness of EMS depends on how effectively environmental practices are embedded into management structures and operational processes rather than on the mere existence of environmental policies.

Previous studies have generally reported favorable relationships between environmental management practices and operational or organizational performance (Crespin-Romero et al., 2018; Kumar et al., 2017). At the same time, developing-country and regional manufacturing studies identify implementation challenges involving resources, organizational capability, environmental knowledge, and the integration of environmental practices into supply-chain and operational processes (Wong & Lai, 2015). These conditions indicate that the performance of EMS cannot simply be assumed to be uniform across organizational and national contexts.

An important empirical issue therefore concerns how specific EMS practices are associated with operational outcomes within Philippine manufacturing organizations. Much of the conceptual rationale for EMS is well established, yet evidence remains comparatively limited regarding the relationship between the organizational structure of EMS, its operational processes, and continual improvement practices and concrete dimensions of operational efficiency within local manufacturing settings. Examining these relationships is particularly relevant in industrial locations such as Biñan City, Laguna, where manufacturing organizations operate within a competitive production environment while simultaneously responding to environmental and regulatory expectations.

The present study addresses this issue by examining Environmental Management System practices and operational efficiency among selected manufacturing companies in Biñan City, Laguna. Rather than treating EMS solely as a compliance mechanism, the study considers it as an organizational management system comprising structural arrangements, environmental processes, and continual improvement practices. Operational efficiency is correspondingly examined through resource utilization, process efficiency, and quality control. This framing allows the study to assess whether stronger environmental management practices are systematically associated with stronger operational practices while avoiding causal conclusions that cannot be established through a cross-sectional correlational design.

The findings may provide practical value to manufacturing managers by identifying EMS areas that are most closely associated with operational efficiency and by indicating specific areas requiring further improvement. They may likewise provide useful evidence for organizational decision-makers and policymakers seeking to promote resource-efficient and environmentally responsible manufacturing. From a research perspective, the study contributes context-specific evidence concerning the relationship between environmental management and operational performance in a developing-economy manufacturing setting.

Objectives of the Study

This study aimed to assess Environmental Management System practices and operational efficiency among manufacturing companies in Biñan City, Laguna. Specifically, it sought to:

1. describe the participating manufacturing companies in terms of number of employees and annual budget allocation for Environmental Management System and operational-efficiency initiatives;
2. assess Environmental Management System practices in terms of structure, process, and continual improvement;

3. evaluate operational efficiency in terms of resource utilization, process efficiency, and quality control;
4. determine the relationship between Environmental Management System practices and operational efficiency; and
5. develop an action plan intended to strengthen Environmental Management System practices and operational efficiency among manufacturing companies.

2. Review of Related Literature

2.1 Environmental Management Systems as Strategic Organizational Systems

Environmental Management Systems provide organizations with a systematic framework for identifying, controlling, monitoring, and improving environmental performance. Within manufacturing, EMS extends beyond isolated environmental programs because it integrates policies, responsibilities, operational procedures, monitoring mechanisms, and corrective actions into organizational processes. Crespin-Romero et al. (2018) associated environmental management systems with environmental innovation and operational performance, suggesting that environmental management can function as part of a broader organizational capability rather than merely as a compliance mechanism. Similarly, Sharma et al. (2019) examined EMS within an integrated performance framework, reinforcing the view that environmental management practices can interact with organizational and operational outcomes.

This broader interpretation is consistent with ISO-oriented environmental management, in which environmental objectives are incorporated into planning, implementation, monitoring, review, and continual improvement (ISO, 2015). For manufacturing firms, this creates an institutional mechanism through which resource consumption, waste generation, pollution prevention, process controls, and environmental responsibilities can be coordinated within ordinary management practices.

The effectiveness of such systems nevertheless depends on organizational conditions. Asif and Searcy (2018) emphasized that EMS implementation is shaped by organizational motivations, pressures, resources, and expected benefits. Consequently, formal adoption alone does not necessarily establish an effective environmental management system. The practical value of EMS depends on whether environmental responsibilities are supported by management, incorporated into operational processes, adequately resourced, and reinforced through monitoring and improvement activities. This distinction is especially relevant in manufacturing environments where environmental objectives must coexist with production requirements, cost pressures, quality expectations, and competitive performance.

2.2 EMS Structure, Process, and Continual Improvement

The literature contained in the source manuscript supports the treatment of EMS as a multidimensional organizational system composed of structure, process, and continual improvement. Structural elements concern management responsibility, allocation of resources, organizational coordination, communication, and the establishment of accountable environmental functions. Asif and Searcy (2018) emphasized that effective EMS implementation requires organizational support and the availability of resources necessary to sustain environmental programs. Without these institutional foundations, environmental policies may remain disconnected from daily manufacturing operations. Evidence from a Philippine tertiary-hospital accreditation setting similarly indicates that standards-based improvement can be constrained by staffing, budget, equipment, documentation, and process-management capacity, illustrating how implementation climate can determine whether formal requirements become workable organizational routines (Garcia & Atento, 2026).

The process dimension concerns the mechanisms through which environmental risks and performance are managed. These mechanisms include identification and assessment of environmental risks, corrective and preventive actions, performance measurement, monitoring, and reporting. Such processes make environmental management operational by translating policy commitments into observable procedures and controls. Becerra-Fernandez et al. (2020) linked environmental management systems with the integration of circular-economy strategies, underscoring the importance of organized management processes in converting sustainability objectives into operational practices.

Continual improvement extends EMS beyond compliance with current requirements. It involves reviewing performance objectives, conducting audits, learning from previous interventions, sharing practices, and modifying systems in response to observed results. Knowledge sharing is particularly important because environmental improvement frequently requires cooperation across organizational functions rather than action by a single department. Preuss (2020) emphasized the role of sustainability-oriented knowledge-sharing platforms in facilitating organizational learning and dissemination of practices. Accordingly, EMS effectiveness depends not only on formal structures and procedures but also on an organization's capacity to review experience, learn systematically, and embed improvement into subsequent environmental decisions. In another Philippine organizational context, work-environment support was strongly associated with employee productivity, suggesting that improvement systems may be more effective when training, feedback, recognition, and enabling conditions reinforce employee participation (Espelita & Atento, 2026).

2.3 Operational Efficiency in Sustainable Manufacturing

Operational efficiency in manufacturing concerns the organization's ability to transform resources into outputs while controlling waste, cost, process losses, and quality problems. The literature incorporated in the thesis connects these concerns with environmental management because inefficient use of energy, water, materials, and production capacity often carries both economic and environmental consequences. Preuss (2005) examined the relationship between environmental management and operations performance, providing an important basis for viewing environmental practices and operational outcomes as interconnected rather than independent managerial domains.

Resource utilization represents one element of this relationship. Improved measurement and control of energy, water, raw materials, and waste can allow firms to identify losses and opportunities for efficiency improvement. Environmental practices that reduce unnecessary consumption may therefore have implications for operating costs as well as environmental performance. Melnyk et al. (2013) similarly positioned environmental and supply-chain concerns within manufacturing management, suggesting that environmental performance is increasingly integrated with broader production and resource-management decisions.

Process efficiency provides another connection. Green supply-chain and environmental management practices can encourage greater attention to standardized procedures, waste reduction, process monitoring, and operational coordination. Chen et al. (2020) linked green supply-chain management with operational efficiency in manufacturing firms, while Sarkis et al. (2011) emphasized the integration of environmental considerations into supply-chain and operational management. In this sense, environmental control can complement process improvement when both seek to eliminate unnecessary resource consumption and production losses.

Quality control constitutes a third dimension. Quality and environmental systems share several managerial mechanisms, including monitoring, inspection, corrective action, standardized procedures, documentation, and continual improvement. Corazza et al. (2020) linked quality management with circular-economy principles, indicating that product quality and environmental sustainability need not be treated as competing objectives. When effectively integrated, quality and environmental management may reinforce manufacturing consistency while reducing waste and environmentally undesirable outputs. Related Philippine evidence from a localized quality-management-system setting also linked management-system implementation with operational performance, highlighting the relevance of human factors and organizational practices when quality-oriented systems are translated into day-to-day service efficiency (Gamasan & Atento, 2026).

2.4 Digitalization, Organizational Learning, and Sustainable Operational Improvement

Contemporary environmental management increasingly relies on technologies that enable more precise measurement, analysis, and control of production activities. The literature used in the thesis identifies digitalization as an important mechanism for strengthening both environmental monitoring and operational decision-making. Azzaro-Pantel et al. (2020) examined the relationship between digitalization and corporate environmental performance, indicating that technological capability can affect how organizations monitor and manage environmental outcomes. Technologies such as sensors, automated monitoring systems, data analytics, and integrated information platforms can provide more timely information on resource consumption and process conditions.

Digital technologies may also support operational improvement by moving environmental management from periodic observation toward continuous monitoring. The source manuscript specifically discusses the value of real-time information for identifying resource-use patterns and directing interventions. Singh et al. (2021) discussed digital-twin applications in manufacturing, whereby virtual representations of production systems can support simulation and operational optimization. Such technologies potentially allow firms to assess process alternatives before implementing physical changes, thereby connecting environmental objectives with production efficiency. Research on technology adoption in Philippine SMEs similarly indicates that digital tools operate within a broader configuration of technological, organizational, and environmental conditions, while practitioner-focused research on AI-enabled accounting emphasizes that automation reshapes workflows, judgment, and decision support rather than functioning as a purely technical substitution (Bendal et al., 2026; Carandang et al., 2026).

Technology, however, does not operate independently of organizational capability. Environmental information must still be interpreted, communicated, and incorporated into managerial decisions. Preuss (2020) emphasized knowledge sharing as a component of sustainability learning, while Sharma et al. (2019) situated environmental management within a broader organizational-performance framework. Thus, digitalization is most relevant when accompanied by employee capability, cross-functional participation, management commitment, and systematic learning. Conceptual and strategic studies in other regulated sectors likewise frame digital value realization as dependent on data integration, analytics capability, decision quality, organizational alignment, and the capacity to reconfigure established strengths for digital transformation (Atento & Atento, 2025; Atento et al., 2025).

This interaction between technology and organizational learning is particularly important for continual improvement. Environmental data can identify inefficiencies, but improvement requires organizational mechanisms capable of responding to those findings through corrective actions, redesigned processes, employee involvement, investment decisions, and revised operating practices. Sustainable manufacturing therefore depends not simply on acquiring advanced technologies but on integrating them with environmental governance and operational improvement processes.

2.5 Synthesis and Research Gaps

The literature collectively presents Environmental Management Systems as organizational mechanisms capable of connecting environmental objectives with manufacturing operations. Existing studies associate EMS with organizational performance, resource management, process control, environmental innovation, and broader operational outcomes (Crespin-Romero et al., 2018; Preuss, 2005; Sharma et al., 2019). The literature also indicates that successful implementation depends on institutional support, adequate resources, systematic processes, monitoring, organizational learning, and continual improvement rather than formal EMS adoption alone (Asif & Searcy, 2018; Becerra-Fernandez et al., 2020).

At the same time, operational-efficiency literature suggests that environmental and production concerns increasingly overlap. Resource utilization, process efficiency, quality management, digital monitoring, and supply-chain practices can simultaneously affect environmental and operational performance (Chen et al., 2020; Corazza et al., 2020; Sarkis et al., 2011). Digital technologies further strengthen this intersection by improving the availability of information for monitoring and operational decision-making (Azzaro-Pantel et al., 2020; Singh et al., 2021). Across adjacent Philippine settings, sustainability-oriented transformation has similarly been framed as requiring institutional embedding and strategic integration with digitalization rather than stand-alone initiatives (Atento, 2025; Teodosio et al., 2025).

Despite these connections, an empirical gap remains concerning how specific dimensions of EMS - particularly structure, process, and continual improvement - are associated with distinct operational-efficiency dimensions within Philippine manufacturing organizations. Much of the literature cited in the source manuscript derives from international or broader manufacturing contexts. The present study responds to this gap by examining the relationships between EMS practices and resource utilization, process efficiency, and quality control among manufacturing companies operating in Biñan City, Laguna.

3. Methodology

3.1 Research Design

The study employed a quantitative, cross-sectional, descriptive-correlational research design to examine Environmental Management System (EMS) practices and operational efficiency among manufacturing companies. The descriptive component was used to characterize the participating companies and assess the reported levels of EMS practices and operational efficiency, while the correlational component examined the direction and strength of the relationships between the EMS and operational-efficiency dimensions. No variables were experimentally manipulated.

3.2 Participants and Study Setting

The participants consisted of 200 manufacturing officers from selected manufacturing companies in Biñan City, Laguna. The respondents occupied positions associated with organizational and operational decision-making, including directors, department heads, chiefs, managers, and supervisors. Their organizational roles made them appropriate respondents for assessing environmental-management practices and operational-efficiency activities within their respective companies.

The sample size was calculated using the Raosoft sample-size procedure, with an additional 10% contingency incorporated into the target sample. The source manuscript identifies the companies as selected manufacturing organizations but does not specify the particular probability or non-probability sampling technique used to select either the participating firms or individual respondents.

3.3 Research Instrument

Data were collected using an adapted questionnaire based on the instruments reported by Sharma et al. (2019) and Wong and Lai (2015). The adapted instrument was evaluated by three external industry validators who were not included among the study participants.

The questionnaire consisted of three principal components. The first gathered organizational information, including company size and budget allocation for environmental-management and operational-efficiency initiatives. The second measured Environmental Management System practices across three dimensions: structure, process, and continual improvement. Structure covered top-management commitment, cross-functional collaboration, and resource allocation. Process addressed environmental-risk assessment, corrective and preventive actions, monitoring, and performance measurement. Continual improvement covered environmental objectives, review and audit activities, organizational learning, and knowledge sharing.

The third component assessed operational efficiency through resource utilization, process efficiency, and quality control. Resource utilization included resource tracking and measurement, resource-reduction strategies, and financial outcomes. Process efficiency covered process analysis and improvement, automation and technology, employee training, and employee involvement. Quality control included quality-management practices, inspection, and testing.

The reported instrument contained 18 EMS items and 19 operational-efficiency items. Internal-consistency testing produced high reliability coefficients. For EMS, Cronbach's alpha was .928 for structure, .934 for process, and .958 for continual improvement, with an overall coefficient of alpha = .975. For operational efficiency, Cronbach's alpha was .928 for resource utilization, .928 for process efficiency, and .896 for quality control, with an overall coefficient of alpha = .955. These values indicate strong internal consistency for the measures used in the study.

3.4 Data Gathering Procedure

The adapted questionnaire, together with an informed-consent form, was pretested online from March 5 to March 8, 2024. The instrument was subsequently reviewed and reformatted where necessary based on the pretesting process. Reliability testing was reported as having been completed on March 14, 2024 using SPSS Version 28. Following instrument preparation, the questionnaire was administered to the target manufacturing officers, after which the collected responses were cleaned and validated prior to statistical analysis.

3.5 Data Analysis

Descriptive and inferential statistical procedures were employed. Frequencies and percentages were used to summarize company characteristics, while weighted means and ranks were used to describe EMS practices and operational-efficiency indicators. The questionnaire results were interpreted using the frequency categories Very Often, Often, Sometimes, Seldom, and Never.

Spearman's rank-order correlation coefficient (rho) was used to determine the strength and direction of the associations between the three EMS dimensions - structure, process, and continual improvement - and the operational-efficiency dimensions of resource utilization, process efficiency, and quality control. Statistical significance was evaluated using a criterion of $p < .05$.

3.6 Ethical Considerations

The source manuscript reports that an informed-consent form accompanied the questionnaire distributed to the participants. Participation therefore proceeded with respondent consent. The manuscript does not provide additional information concerning formal institutional ethics-review approval, an ethics protocol number, or specific procedures for confidentiality and data protection.

4. Results and Discussion

4.1 Characteristics of the Participating Manufacturing Companies

The participating manufacturing companies were predominantly larger organizations. Of the companies represented in the study, 58.0% employed 201 or more workers, while 24.5% had 0-100 employees and 17.5% had 101-200 employees. This distribution indicates that the study primarily reflects the environmental-management and operational practices of relatively large manufacturing organizations.

Budget allocation also indicated substantial organizational attention to both Environmental Management System (EMS) and operational-efficiency initiatives. For EMS, 47.0% of the participating companies allocated 11% or more of their annual budget, 25.0% allocated 6%-10%, and 28.0% allocated 0%-5%. A comparable pattern was observed for operational-efficiency initiatives: 45.5% allocated 11% or more, 38.0% allocated 6%-10%, and 16.5% allocated 0%-5%.

These descriptive results establish the organizational context in which the subsequent EMS and operational-efficiency assessments were made. However, the data do not establish that company size or budget allocation caused the reported EMS or efficiency levels because no comparative or causal analysis involving these profile variables was undertaken.

4.2 Environmental Management System Practices

Environmental Management System practices were assessed through structure, process, and continual improvement. Table 1 consolidates the three separate EMS summary results reported in the source manuscript.

Table 1. Environmental Management System Practices

EMS Dimension	Weighted Mean	Interpretation	Rank
Process	4.38	Often	1
Continual Improvement	4.26	Often	2
Structure	4.19	Often	3

Note. Scale: 4.50-5.00 = Very Often; 3.50-4.49 = Often; 2.50-3.49 = Sometimes; 1.50-2.49 = Seldom; 1.00-1.49 = Never.

Process received the highest composite mean (M = 4.38), indicating that environmental-management procedures were frequently practiced. Among the individual process indicators, preventive actions intended to minimize future environmental problems received the highest mean of 4.45. Analysis and reporting of environmental-performance data also received a relatively high rating (M = 4.40), followed by implementation of corrective actions for environmental nonconformities (M = 4.37). Environmental-risk assessment and identification were each rated 4.35. The comparatively lowest process indicator concerned comprehensive and well-defined procedures for monitoring environmental-performance indicators (M = 4.34), although this remained within the Often range.

Continual improvement registered a composite mean of 4.26. The strongest practice within this dimension was the setting of clear and measurable environmental-performance objectives (M = 4.35). External audits or certifications and the promotion of a culture of continuous learning each received a mean of 4.28. Knowledge sharing across departments or organizations was rated 4.26, while review and updating of environmental objectives was rated 4.25. Internal audits received the lowest mean within this dimension (M = 4.17), indicating an area in which the participating organizations may strengthen the systematic review of their environmental-management practices.

Structure obtained a composite mean of 4.19. Top-management involvement and support received the highest structural rating (M = 4.35), followed by the allocation of adequate financial and human resources (M = 4.31). The presence of a dedicated environmental manager or team (M = 4.27), interdepartmental collaboration (M = 4.22), and regular communication concerning environmental issues (M = 4.15) were likewise frequently reported.

One structural item asked whether companies experienced challenges in securing resources for EMS initiatives and obtained a mean of 3.87. Because this item is negatively framed relative to most other EMS items, it should be interpreted independently rather than as evidence of weaker EMS implementation. The result indicates that resource constraints were nevertheless reported with some frequency despite generally favorable ratings for management commitment and resource allocation.

Overall, the findings indicate that EMS practices were regularly embedded in the participating companies, particularly through environmental processes involving risk management, corrective and preventive action, and performance reporting. This pattern is consistent with literature portraying EMS as an organizational system requiring management support, structured processes, monitoring, and continual improvement rather than mere formal adoption (Asif & Searcy, 2018; Crespin-Romero et al., 2018).

4.3 Operational Efficiency

Operational efficiency was assessed through resource utilization, process efficiency, and quality control. The consolidated results are presented in Table 2.

Table 2. Operational Efficiency of the Participating Manufacturing Companies

Operational-Efficiency Dimension	Weighted Mean	Interpretation	Rank
Quality Control	4.45	Often	1
Resource Utilization	4.39	Often	2
Process Efficiency	4.24	Often	3

Note. Scale: 4.50-5.00 = Very Often; 3.50-4.49 = Often; 2.50-3.49 = Sometimes; 1.50-2.49 = Seldom; 1.00-1.49 = Never.

Quality control obtained the highest composite mean (M = 4.45). Product inspection and testing was practiced very often (M = 4.56), while collection and analysis of customer feedback regarding product quality was likewise rated very often (M = 4.52). Integration of the Quality Management System with the EMS received a mean of 4.47, and the use of customer feedback to inform product design, manufacturing processes, or quality-control procedures was rated 4.38. The use of advanced quality-control technologies or techniques received the lowest rating within this dimension (M = 4.32), indicating a comparatively greater opportunity for technological strengthening.

Resource utilization followed with a composite mean of 4.39. The participating companies reported very frequent measurement of energy (M = 4.61), water (M = 4.59), and raw-material consumption (M = 4.57). Evaluation of return on investment from resource-efficiency initiatives was also rated very often (M = 4.52). Resource-reduction strategies (M = 4.36) and technology-supported resource monitoring and optimization (M = 4.24) were practiced often. Companies also reported challenges in implementing resource-reduction strategies (M = 3.89). As with the negatively worded EMS resource item, this indicator should not be interpreted in the same direction as the positively worded practice indicators.

Process efficiency obtained the lowest, although still favorable, composite mean (M = 4.24). The strongest indicator concerned the use of approaches to analyze and improve production processes (M = 4.47), followed by reported reductions in waste, cycle time, and other inefficiencies arising from process-improvement efforts (M = 4.41). Identification of production inefficiencies was rated 4.38. Employee training and empowerment to suggest improvements received a mean of 4.20, while the use of automation and technology for process efficiency was rated 4.18. Employee incentive and recognition programs for process-improvement initiatives received the lowest rating (M = 3.82).

The results therefore suggest that the participating manufacturing companies were strongest in quality-control and resource-tracking practices but had comparatively greater opportunities to strengthen automation, technology-supported monitoring, advanced quality-control technologies, and employee incentive systems. These areas are consistent with the broader literature linking digital technologies, organizational learning, and systematic monitoring with sustainable operational improvement (Azzaro-Pantel et al., 2020; Preuss, 2020; Singh et al., 2021).

4.4 Relationship Between Environmental Management System Practices and Operational Efficiency

Spearman's rank-order correlations were used to examine the relationships between the three EMS dimensions and the three dimensions of operational efficiency. Table 3 presents the complete correlation matrix.

Table 3. Relationships Between Environmental Management System Practices and Operational Efficiency

EMS Dimension	Operational-Efficiency Dimension	Spearman rho	p
Structure	Resource Utilization	.790	< .001
Structure	Process Efficiency	.754	< .001
Structure	Quality Control	.692	< .001
Process	Resource Utilization	.723	< .001
Process	Process Efficiency	.721	< .001
Process	Quality Control	.741	< .001
Continual Improvement	Resource Utilization	.768	< .001
Continual Improvement	Process Efficiency	.860	< .001
Continual Improvement	Quality Control	.785	< .001

All nine relationships were positive and statistically significant at $p < .001$. The coefficients ranged from rho = .692 to rho = .860, indicating consistently substantial positive associations between EMS practices and operational efficiency.

The strongest relationship was observed between continual improvement and process efficiency (rho = .860, $p < .001$). Continual improvement was also strongly associated with quality control (rho = .785) and resource utilization (rho = .768). These findings indicate that companies reporting stronger practices related to environmental objectives, audits, review, learning, and improvement also tended to report stronger process-efficiency, quality-control, and resource-utilization practices.

EMS structure showed a particularly strong relationship with resource utilization (rho = .790), followed by process efficiency (rho = .754) and quality control (rho = .692). This pattern suggests that organizational foundations such as management commitment, environmental responsibility, cross-functional collaboration, communication, and resource allocation tend to accompany stronger operational practices.

The EMS process dimension was likewise significantly associated with quality control (rho = .741), resource utilization (rho = .723), and process efficiency (rho = .721). Thus, organizations reporting stronger environmental-risk assessment, preventive and corrective action, monitoring, and performance reporting also tended to report stronger operational-efficiency practices.

The findings should be interpreted as associations rather than causal effects. Although the strength and consistency of the correlations demonstrate that EMS and operational efficiency move together within the sample, the cross-sectional correlational design does not establish that changes in EMS practices independently cause changes in operational performance.

4.5 Proposed Managerial Action Priorities

The original study developed an action plan from the comparatively weaker indicators identified in the descriptive results. For journal presentation, the original multi-page action plan is consolidated into six managerial priority areas in Table 4. The targets presented are proposed implementation targets, not outcomes already achieved by the participating companies.

Table 4. Proposed Action Priorities for Strengthening EMS and Operational Efficiency

Priority Area	Principal Strategies	Proposed Performance Targets
EMS resource support	Collaborate with suppliers on sustainable materials and supply-chain environmental initiatives; track resulting environmental benefits	At least five supplier projects within 12 months; 10% reduction in identified supply-chain environmental impact within 18 months; quarterly tracking system within six months
Environmental monitoring	Implement a digital monitoring platform; conduct monitoring audits; train personnel in environmental-data collection and analysis	Platform operational within eight months; 15% reduction in data-collection errors; 90% of relevant personnel trained within four months
Internal auditing	Conduct quarterly EMS audits; standardize audit checklists; implement corrective action	Four audits annually; standardized checklist within two months; 95% of identified gaps closed within 30 days
Resource reduction	Conduct material-yield analysis; standardize material use; examine product lightweighting opportunities	12% reduction in material scrap within 12 months; 8% material-cost savings within six months; 10% product-weight reduction where applicable within 18 months
Employee incentives	Revise incentive systems; recognize environmental and process-improvement contributions; monitor participation and satisfaction	Revised program within four months; 25% increase in employee participation within eight months; at least 80% positive satisfaction at 12 months
Advanced monitoring technologies	Conduct cost-benefit analysis; pilot appropriate sensor and monitoring technologies; integrate real-time operational data	Technology assessment within three months; pilots completed within nine months; 20% reduction in targeted resource consumption within 18 months

The proposed priorities correspond to specific areas identified in the empirical findings, particularly resource constraints, monitoring procedures, internal-audit frequency, resource-reduction implementation, employee incentives, and technology utilization. Their inclusion translates the descriptive findings into managerial interventions while retaining the distinction between observed study results and proposed future performance targets.

4.6 Discussion

Taken together, the results indicate a close alignment between environmental-management practices and operational-management practices among the manufacturing companies studied. EMS was frequently implemented across structure, process, and continual improvement, while operational efficiency was likewise frequently practiced across resource utilization, process efficiency, and quality control. More importantly, every EMS dimension was positively and significantly related to every operational-efficiency dimension.

The prominence of the EMS process dimension suggests that environmental management in the participating organizations was most visible in operational activities such as risk assessment, corrective and preventive action, environmental-performance monitoring, and reporting. This is consistent with the conception of EMS as a system that embeds environmental considerations into routine organizational processes rather than treating sustainability as a separate administrative activity (Asif & Searcy, 2018; Crespin-Romero et al., 2018).

At the operational level, quality control obtained the highest composite assessment. Frequent inspection and testing, active use of customer feedback, and integration of QMS and EMS indicate that quality and environmental management were not necessarily treated as independent systems. This finding corresponds with literature suggesting that quality-management and environmental-management mechanisms can share common approaches involving process standardization, monitoring, corrective action, and continual improvement (Corazza et al., 2020).

Resource utilization was similarly prominent, particularly through very frequent measurement of energy, water, and raw materials. This suggests a substantial orientation toward measurable resource performance. However, lower ratings for technology-supported resource monitoring and the reported challenges encountered in resource-reduction implementation indicate that measurement capability does not necessarily imply complete optimization capability. Digital monitoring and analytical technologies may therefore represent an important next stage in developing more mature resource-management systems (Azzaro-Pantel et al., 2020; Singh et al., 2021).

Process efficiency presented the greatest relative opportunity for improvement among the three operational dimensions. While production-process analysis and waste or cycle-time reduction were frequently undertaken, automation and technology utilization and employee incentive programs received comparatively lower ratings. This distinction is managerially important: organizations may have established process-improvement routines without yet fully developing the technological and behavioral mechanisms that can sustain more advanced improvement.

The correlation findings reinforce this interpretation. Continual improvement had the strongest association with process efficiency (rho = .860), suggesting that the organizational routines used to review objectives, audit systems, share learning, and pursue improvements are closely aligned with more efficient production processes. The relationship does not demonstrate causation, but its magnitude indicates that continual environmental improvement and operational-process improvement are strongly interconnected within the participating companies.

The strong relationship between EMS structure and resource utilization (rho = .790) similarly suggests that efficient resource management occurs within an organizational context characterized by leadership support, defined environmental responsibilities, collaboration, and resource provision. Environmental objectives may therefore be more effectively operationalized when supported by organizational structures capable of assigning responsibility and sustaining implementation.

Across the findings, environmental management and operational efficiency appear less as separate managerial domains than as mutually aligned organizational practices. Resource measurement, environmental monitoring, quality systems, process improvement, management support, audits, and organizational learning represent areas in which environmental and operational objectives intersect. This supports the strategic relevance of EMS for manufacturing management while remaining consistent with the correlational nature of the evidence.

The practical implication is not that EMS automatically produces operational efficiency, but that organizations reporting more developed environmental-management practices also report stronger operational practices. For manufacturing managers, the results therefore support an integrated approach in which environmental governance, resource monitoring, digitalization, employee participation, internal auditing, quality management, and continual improvement are managed as complementary elements of operational strategy.

5. Conclusions, Recommendations, and Implications

5.1 Conclusions

The study examined Environmental Management System practices and operational efficiency among selected manufacturing companies in Biñan City, Laguna. Based on the findings, several conclusions are drawn.

First, the participating manufacturing companies were predominantly larger organizations, with most employing more than 200 workers. A substantial proportion of the companies also allocated 11% or more of their annual budgets to Environmental Management System and operational-efficiency initiatives. These results indicate that environmental management and operational improvement constituted identifiable areas of organizational investment among the participating firms.

Second, Environmental Management System practices were frequently implemented across the dimensions of structure, process, and continual improvement. Process emerged as the strongest EMS dimension, reflecting the regular application of environmental-risk assessment, corrective and preventive actions, monitoring, and performance reporting. Continual improvement was likewise frequently practiced through environmental objective setting, external review, learning, and knowledge sharing. Structural support was also evident through management involvement, resource allocation, dedicated environmental responsibilities, and interdepartmental coordination. Nevertheless, internal auditing, monitoring procedures, knowledge sharing, and access to resources represent areas that may be further strengthened.

Third, operational efficiency was frequently practiced across resource utilization, process efficiency, and quality control. Quality control obtained the highest overall assessment, supported by frequent inspection and testing and systematic attention to customer feedback. Resource utilization was characterized by strong monitoring of energy, water, and raw-material consumption. Process efficiency was likewise favorable, although comparatively lower ratings for automation, technology utilization, and employee incentive programs indicate opportunities for further operational development.

Fourth, Environmental Management System practices were positively and statistically significantly associated with all three dimensions of operational efficiency. The relationships ranged from rho = .692 to rho = .860, with all associations significant at $p < .001$. The strongest relationship occurred between continual improvement and process efficiency. These findings indicate that companies reporting more developed environmental-management practices also tended to report stronger resource utilization, process efficiency, and quality control.

The findings therefore support the view that environmental management and operational efficiency are closely aligned organizational practices within the participating manufacturing companies. However, because the study employed a cross-sectional correlational design, the results establish association rather than causation. The evidence does not demonstrate that EMS practices independently cause improvements in operational efficiency.

Finally, the identified areas for improvement provide an empirical basis for the proposed managerial action priorities involving environmental-resource support, improved monitoring, more systematic internal auditing, resource-reduction initiatives, employee participation, and greater utilization of appropriate technologies.

5.2 Recommendations

Manufacturing companies may further strengthen their Environmental Management Systems by prioritizing the comparatively weaker areas identified in the study. Management should reinforce environmental monitoring through reliable data-collection systems and, where feasible, adopt digital technologies that allow more timely monitoring of energy, water, raw-material consumption, and other environmental-performance indicators. Any technology investment should be supported by appropriate cost-benefit analysis and aligned with actual operational requirements.

Internal auditing should also receive greater organizational attention. Regular and systematic EMS audits can be incorporated into the continual-improvement cycle to identify implementation gaps, assess conformity with established procedures, and ensure that corrective actions are completed and monitored. Standardized audit protocols may help improve consistency across departments and reporting periods.

Manufacturing firms should consider strengthening resource-reduction initiatives by examining material yields, production losses, energy and water consumption, and opportunities for improved resource efficiency. Supplier collaboration may also be developed where environmental performance depends partly on externally supplied materials, production inputs, or supply-chain practices.

The comparatively lower ratings for automation and technology utilization suggest that companies may evaluate appropriate technologies for improving resource monitoring, process efficiency, and quality control. Adoption should be undertaken strategically rather than solely for technological modernization. Pilot testing, measurable performance indicators, and evaluation of operating benefits should precede wider implementation.

Employee participation in operational and environmental improvement should likewise be reinforced. Organizations may review incentive and recognition systems to encourage employees to identify process inefficiencies, propose sustainability improvements, participate in environmental initiatives, and contribute to continual-improvement activities. Training should complement incentive systems so that employees possess the technical knowledge needed to participate effectively.

Local government units and relevant industry-support institutions may facilitate environmental and operational improvement by providing technical assistance, knowledge-sharing opportunities, and appropriate programs that encourage the adoption of resource-efficient technologies. Collaboration among government, industry, and manufacturing organizations may help address technological and resource constraints that individual firms may have difficulty resolving independently.

The findings and proposed action priorities should be communicated to participating manufacturing companies so that each organization can determine which recommendations are applicable to its own operational circumstances. The proposed targets should be treated as managerial implementation benchmarks rather than as outcomes already demonstrated by the study.

Future researchers may extend the study through longitudinal designs capable of examining how EMS and operational-efficiency practices change over time. Comparative studies across manufacturing sectors, locations, organization sizes, and different levels of EMS maturity may also clarify whether the observed relationships are consistent across organizational contexts. Future work may additionally investigate the cost-benefit implications of environmental technologies, supplier collaboration, digital monitoring systems, and other sustainability interventions.

5.3 Implications of the Study

Managerial Implications

The findings have direct implications for manufacturing management. Environmental management should not necessarily be treated as an isolated compliance function because the EMS dimensions examined in the study were consistently associated with resource utilization, process efficiency, and quality control. Management attention to environmental governance, monitoring, auditing, learning, and continual improvement may therefore complement broader operational-management objectives.

The particularly strong relationship between continual improvement and process efficiency suggests that environmental and operational improvement systems may benefit from greater integration. Management reviews, internal audits, performance objectives, knowledge sharing, employee involvement, and corrective actions can be structured to address both environmental and operational outcomes rather than being administered through completely separate improvement systems.

Operational and Technological Implications

The findings also indicate an opportunity to move from resource measurement toward more advanced resource optimization. Participating companies frequently monitored energy, water, and raw-material consumption, yet technology-supported monitoring and automation received comparatively lower assessments. This suggests that some organizations may already possess basic measurement routines but still have scope to develop more integrated digital monitoring, analytics, automation, and advanced quality-control capabilities.

Technology adoption, however, should remain performance-driven. The managerial value of environmental technology depends on whether it improves information quality, reduces resource losses, strengthens process control, improves quality, or supports measurable environmental outcomes.

Institutional and Policy Implications

For local government units and industry-support organizations, the findings point to the potential value of programs that reduce barriers to environmental and operational innovation. Technical assistance, capability-building initiatives, information-sharing platforms, and support for resource-efficient technologies may help firms strengthen EMS implementation while improving production practices.

The results also suggest that environmental policy and industrial-efficiency policy need not necessarily be treated as competing priorities. Within the participating manufacturing companies, environmental-management practices and operational-efficiency practices were positively associated. Policies that encourage better monitoring, responsible resource use, continual improvement, and environmentally oriented process innovation may therefore be relevant to both sustainability and industrial competitiveness.

Research Implications

The study contributes context-specific evidence concerning the relationship between EMS practices and operational efficiency in a Philippine manufacturing setting. Rather than examining EMS as a single overall construct, the study demonstrates that structure, process, and continual improvement are each significantly related to resource utilization, process efficiency, and quality control.

At the same time, the cross-sectional and correlational design defines an important boundary of the contribution. The findings establish substantial associations but do not identify causal pathways or the direction of influence between environmental management and operational efficiency. Longitudinal, comparative, and explanatory research designs are therefore needed to determine whether improvements in specific EMS practices precede changes in operational performance and under what organizational conditions such relationships are strongest.

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