QATAR UNIVERSITY

COLLEGE OF BUSINESS AND ECONOMICS

THE EFFECT OF ENVIRONMENTAL MANAGEMENT CONTROL SYSTEM (EMCS) ON ENVIRONMENTAL PERFORMANCE (EP): A META-ANALYSIS

BY

SHAISTA HASSAN

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COMMITTEE PAGE

The members of the Committee approve the Thesis of
Shaista Hassan defended on 20/12/2023.

Prof. Karma Sherif
Thesis/Dissertation Supervisor

Prof. Bana Abuzayed
Committee Member

[Dr. Hani Mohamed Mostafa Kamel]
Committee Member

Approved:

Dr.Rana Sobh, Dean, College of Business and Economics

ABSTRACT

SHAISTA HASSAN., Masters : January : [2024:],

Master of Business Administration

Title: The Effect of Environmental Management Control System (EMCS) on Environmental Performance (EP): A Meta-analysis

Supervisor of Thesis: Karma, S, Sherif.

This research conducts a meta-analysis investigating the relationship between the adoption of Environmental Management Control Systems (EMCS) and environmental performance (EP), marking a significant milestone as the first meta-analysis on EMCS. Unlike individual studies, this meta-study analyzes the findings of twenty-four research endeavors, highlighting the integral role EMCS play in motivating companies to consider the environment when conducting daily business processes. The meta-analysis emphasizes the collective impact of technological advancements, organizational approaches, and individual contributions in reinforcing EMCS of which environmental strategy is among various influencing factors. The study reveals diverse layers of influence, prompting decision-makers to embrace a comprehensive approach for meaningful environmental efforts. As the pioneering meta-analysis in this field, it not only enriches current discussions but also signals the need for expanded research in this domain.

Keywords: Environmental Management Control System, Environmental Performance, EMCS adoption, EMCS Meta-analysis

DEDICATION

This thesis is dedicated to my late father, the prime source of inspiration, and my dear mother who has been a constant pillar of support and love.

I am also dedicating this thesis to my husband and two kids, expressing gratitude for their unwavering support, patience during moments of negligence, and steadfast belief during moments of self-doubt.

Finally, heartfelt thanks to all my friends and relatives who stood by me throughout my MBA program, offering love and motivation. Thank you for being there for me.

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CHAPTER 1: INTRODUCTION

1.1 Background

In the dynamic global landscape, nations are strategically positioning themselves to be at the forefront, propelled by the pursuit of economic development. Success in these endeavors crucially depend on delicately balancing the imperatives of environmental sustainability with financial growth. This dual focus has lately captured public attention and permeated societal discussions, public debates, and political agendas (Ahmad & Mohamed Zabri, 2015). The imperative to protect the environment is reaching a peak, necessitating those operational activities be aligned harmoniously with objectives related to environmental security and preservation.

A critical factor in balancing between economic development and environmental responsibility lies in the adoption Environmental Management Control Systems (EMCS) for sustainable businesses (Burritt and Schaltegger, 2014). Stakeholders, now well-informed about environmental challenges and solutions, exert pressure on managers to give due consideration to environmental performance assessments (EP) (Christmann, 2004). Recognizing this, EMCS plays a pivotal role in providing information on a company's overall environmental performance upstream while sourcing from a supplier, internally through manufacturing and logistics and downstream when selling and after sale(Pondeville et al., 2013) . In addition, EMCS can facilitate in planning, monitoring, and the analysis of processes to improve environmental performance(SAN et al., 2018).

EMCS serves as a tool for organizations to integrate environmental plans and goals into their operational procedures, enabling the quantification of environmental actions. Top-level management committees leverage EMCS to monitor operations and foster communication between managers and subordinates regarding environmental concerns, underlining the strategic importance of environmental performance.

Beyond monitoring operational processes, EMCS plays a crucial role in environmental reporting, serving as a mechanism for organizations to benchmark activities against established goals that meet the demands of various stakeholders, including investors, shareholders, and consumers (Martins et al., 2023). This involves demonstrating both the financial and non-financial impacts of environmental issues. In addition, EMCS facilitates regular information feedback by real time monitoring, empowering managers to provide enhanced communication, maintain or adjust strategies and actions in response to performance shortfalls, inspire employees to act responsibly towards the environment, gain a deeper understanding of the relationship between actions and results, and direct their focus areas by identifying gaps in the results. Through this comprehensive approach, EMCS becomes a catalyst for bringing environmental issues to light and improving overall environmental performance (Berry & Rondinelli, 1998).

1.2 Motivation

Considering increasing environmental concerns and the need for sustainable business practices, the focus on Environmental Management Control Systems (EMCS) has gained prominence. Stakeholders now emphasize the evaluation of Environmental Performance (EP), pressuring managers to prioritize environmental considerations (Rodrigue et al., 2013). EMCS acts as a vital tool for integrating environmental strategies, aligning managerial processes, and enhancing financial and environmental outcomes (Guenther et al., 2016). Particularly relevant in the manufacturing sector, where environmental issues are often more pronounced, understanding the impact of EMCS on EP becomes imperative.

The existing literature has highlighted a multitude of factors influencing the adoption of EMCS to enhance Environmental Performance (EP) (Gholami et al., 2013). The identification of these factors is crucial in emphasizing the potential benefits of EMCS for prospective users (Appiah et al., 2020). These factors collectively contribute to evaluating the capability of EMCS to fulfill its promises and enhance corporate environmental performance. Specifically, four essential antecedents of EMCS have been identified for assessment: environmental strategy, institutional pressure, perceived environmental uncertainty, perceived benefits, and top management's commitment.

Exploring the acceptance of EMCS across diverse organizational contexts is the primary focus of this investigation. Leveraging insights from 24 studies, we emphasize the need for a comprehensive meta-analysis that scrutinizes existing literature. This detailed examination is crucial for developing a profound understanding of the factors influencing the impact of EMCS on environmental performance EP. Notably, the current meta-analytical research landscape lacks a thorough exploration of the interconnectedness of these constructs, representing a notable gap in scholarly knowledge. This study aims to address this void by conducting an unprecedented meta-analysis that considers all relevant antecedents, providing a holistic analysis of the relationship between EMCS and EP. The findings promise valuable insights for practitioners, researchers, and policymakers alike.

1.3 Research purpose

With a focus on understanding how EMCS impacts firms' environmental performance, this research aims to thoroughly examine the factors impacting EMCS. Our goal is to significantly add to the corpus of literature already in existence by combining the findings of twenty-four different investigations. Through this synthesis, we seek to shed light on crucial perspectives related to the factors influencing decision-making, the adoption process, and the execution tactics that companies employ to integrate EMCS for the enhancement of their EP. The following research questions serve as the basis for the analysis:

1. What factors shape the adoption of Environmental Management Control Systems (EMCS) across various organizational contexts?
2. What insights can be derived regarding the impact of EMCS on Environmental Performance (EP)?

Addressing these questions will contribute valuable insights for practitioners with informed decision-making strategies(Reed, 2008), offer researchers new perspective for future exploration (Mazzi et al., 2016), and policymakers in aligning environmental policies with determinants influencing EMCS adoption (Bosso, 2002)

1.4 Research objective

Examining the factors that directly impact the inclination to utilize EMCS for enhancing EP across diverse organizational contexts is the primary goal of this study. Operating without strict adherence to a predetermined theoretical framework, this research considers various elements, including top management commitment, perceived advantages, perceived environmental uncertainty, institutional pressure, and environmental strategy. Significantly, there is a lack of comprehensive meta-analyses that have collectively examined these factors related to EMCS. Most existing articles discuss a limited number of antecedents separately. This study aims to address this gap by exploring their combined impact on EMCS use and the consequent effect on EP. This highlights the useful benefits of EMCS adoption for businesses and advances a more comprehensive knowledge of these structures, both of which are improvements to the research. In addition to improving environmental performance, the meta-analysis aims to show that adopting EMCS will boost legitimacy and reputation by exhibiting commitment, encouraging transparency, and meeting stakeholder expectations (Daddi et al., 2016).

1.5 Structure of the study

This research paper is structured in six distinct sections, with the introduction leading the way. Following the introduction, a comprehensive exploration of existing literature is undertaken, providing an in-depth overview of pertinent research and theories. Subsequently, the theoretical framework is expounded upon, accompanied by the formulation of hypotheses in the ensuing section. The subsequent portion furnishes a detailed exposition of our chosen research methodology and its validation. This is followed by the presentation and analysis of findings derived from our study. The paper culminates in a conclusive section, wherein a thorough discussion of the conducted research is encapsulated.

CHAPTER 2: LITERATURE REVIEW

In the dynamic landscape of business practices, Environmental Management Control Systems (EMCS) exert a considerable influence on fostering environmental performance (EP). Global businesses are facing more and more pressure to boost their EP to remain competitive globally (Sánchez-Triana et al., 2014). Businesses must incorporate certain environmental practices, such as eco-friendly production techniques, emissions reduction plans, and sustainable resource management, into their everyday operations to improve EP (Nishitani et al., 2021). These high-level programs benefit a company’s productivity and capacity to compete on the international market in addition to promoting environmental sustainability (Kerr et al., 2015).

An EMCS’s efficacy is dependent on several variables, including the particulars of the company, the condition of environmental practices at the time, and stakeholder expectations. Establishing and executing an EMCS is a strategic way for businesses to manage and improve their EP proactively (Stubbs & Cocklin, 2008).

2.1 Environmental Management Control Systems (EMCS)

Defined by formalized, data-driven routines and procedures, EMCS operate as a comprehensive framework utilized by managers to regulate and shape patterns within an organization’s operations. This emphasis is specifically directed toward enhancing the environmental dimensions of the organizational performance (Pondeville et al., 2013).

The origins of Management Control Systems (MCS) can be linked to the development of EMCS. According to (Malmi & Brown, 2008), an MCS package encompasses various management control tools that operate with relative independence, providing organizations the flexibility to uphold or alter patterns in their activities (Henri, 2006). One of the commonly employed frameworks in MCS is “level of control”, as elucidated by (Merchant & Van der Stede, 2017). The functions that MCS plays in promoting and managing environmental innovation initiatives are examined with great help from this framework (Wijethilake et al., 2018).

Moreover, under the umbrella of EMCS, four primary control tools are established, including action controls, results, cultural elements, and personnel (Guenther et al., 2016). Monitoring procedures and actions to guarantee compliance with environmental regulations is the goal of action controls (Bisbe & Otley, 2004). The results control concentrates on assessing the consequences of environmental efforts and staff behavior (Lisi, 2015). Aligning human resources with environmental goals requires personnel controls, which include hiring and training practices (Simons, 1995), and establishing an organizational culture that values and encourages environmental stewardship (AHRENS & CHAPMAN, 2004) is mostly dependent on cultural controls, such as corporate culture and incentive programs (Merchant & Van der Stede, 2017).

These control mechanisms are integral to EMCS, serving as the foundation for directing employee behavior, achieving environmental objectives, and contributing to the development and actively contributing to the formulation and implementation of the organization's environmental performance and strategy (Albelda Pérez et al., 2007).

Action controls encompass monitoring activities and processes, holding employees accountable, and prescribing desired behaviors to align conduct with environmental goals. In contrast, Results controls take a cybernetic approach, concentrating on the outcomes of employee behavior through environmental performance measures, target setting, data collection, and incentive assessment to drive environmental goal attainment. Cultural controls are rooted in a company's values and norms, utilizing the corporate culture and incentives to promote environmental responsibility across the organization. Concurrently, Personnel controls, covering employee selection, training, and promotion, ensure alignment between job requirements and applicant qualifications (WU et al., 2021).

Nevertheless, the EMCS concept is currently in its nascent stages of development, and there is no consensus on its definition, conceptualization, or operationalization. This has resulted in a diverse and evolving understanding of this field (Malmi & Brown, 2008).

In the domain of EMCS, distinct categories and approaches emerge, each tailored to meet specific organizational requirements and goals (Sandino, 2007). These categories encompass:

Formal Environmental Management Control Systems, which are marked by structured and documented routines and processes with a clear focus on environmental management (Langfield-Smith, 1997). They utilize environmental procedures and rules to enhance environmental performance, such as incorporating environmental criteria into corporate investment decisions and linking expected outcomes to decisions(Henriques & Sadorsky, 1996) . These systems also entail integrating environmental objectives into planning processes, implementing environmental performance indicators for rewards, and conducting environmental audits to assess results against set environmental goals (Pondeville et al., 2013).

Informal Environmental Management Control Systems, characterized by less structured, non-documented practices and procedures within organizations, often driven by employee initiatives and a cultural commitment to environmental stewardship (Pondeville et al., 2013). Examinations of exemplary practices in the environmental sector frequently emphasize the significance of informal EMCS. This is due to the active engagement and involvement of employees in environmental decision-making, forming an integral part of an ongoing process to enhance environmental performance continually (Florida, 1996) .

Environmental Information Systems (EIS) are the cornerstone of organizational control systems, where information serves as the raw material for management control. EIS collects, processes, and stores data critical for decision-making, coordination, and control purposes. These systems enhance both formal and informal control systems. EIS focuses on supplying valuable environmental data to managers, augmenting existing systems with new tools to analyze fresh information (Günther, 1997). Forward-thinking companies extend their information horizon to include external data, such as future environmental regulations, consumer preferences for eco-friendly products, and clean technology developments, enabling managers to balance environmental and business priorities effectively (Melville, 2010).

Despite being a relatively young field, research on EMCS has produced a collection of empirical papers that explore diverse facets of this subject and examine the association with its supposed antecedents (Guenther et al., 2016). This paper also investigates the link between EMCS, it's supposed antecedents, and their impact on environmental performance.

Moreover, the adoption of EMCS furnishes comprehensive data, enhancing a firm's reputation, fostering stakeholder interactions, mitigating fines, ensuring compliance with environmental laws, and addressing environmental issues (Jamil, 2008). Organizations synchronizing operations with societal requirements and social responsibility through strategic environmental information disclosure realize diverse operational benefits, fostering robust business-societal trust, elevating status and image, and attaining competitiveness (Lutfi, Alqudah, Alrawad, Alshira'h, Alshirah, Almaiah, Alsyouf, & Alardi, 2023).

In addition to the various operational advantages that have been realized as a result of the deployment of EMCS, research has continuously demonstrated the critical role that antecedents play in influencing the adoption of EMCS in organizations (Guenther et al., 2016). The following sections delve into the antecedents shaping the adoption and implementation of EMCS within organizational practices.

2.1.1 Perceived Environmental Uncertainty (PEU)

External factors significantly influence organizational strategies with respect to environmental performance. Among the external factors, environmental uncertainty, plays a prominent role in affecting environment performance (Chenhall, 2003). Environmental uncertainty refers to the unpredictability and rapid changes in markets and environmental variables an organization must address (Duncan, 1972). In an uncertain environment, unpredictable factors such as shifting in customer preferences, competitive challenges, and evolving technologies create uncertainty in decision-making (Pondeville et al., 2013). These uncertainties not only influence the perceptions of top managers but also introduce dynamic elements that necessitate adaptability and flexibility in the decision-making process, reflecting the need for strategic adjustments to effectively respond to and thrive in an uncertain environment (Milliken, 1987).

For instance, the lack of information regarding environmental issues, the rapid evolution of eco-friendly practices, frequent changes in regulations, the consumer demands for environmentally responsible products, and competitors' environmental strategies can perplex managers (Lewis & Harvey, 2001). (Fryxell & Vryza, 1999). These uncertainties contribute to what's known as perceived environmental uncertainty (PEU) (Lewis & Harvey, 2001).

In circumstances characterized by a high level of perceived uncertainty, individuals tasked with decision-making tend to seek additional information to address and alleviate uncertainties (Lal & Hassel, 1998). Access to comprehensive and sophisticated information is valuable in reducing uncertainty and enhancing decision quality, as it offers a broader range of potential solutions (Bouwens & Abernethy, 2000; Laitinen, 2001). Companies facing high PEU often need advanced environmental information systems to monitor regulatory changes and assess ecological risks related to their activities (Laitinen, 2001).

Moreover, in uncertain conditions, the use of formal control systems is crucial. These systems offer a structured approach that supports systematic reactions to change, reducing chaotic responses (Ezzamel, 1990). At the same time, fostering greater integration, employee involvement, and teamwork are considered essential in uncertain environments (Scott & Tiessen, 1999). This often results in the decentralization of operations and the promotion of participative decision-making processes (Merchant, 1985).

It is evident that high levels of PEU contributes to the development of formal/structured EMCS to address uncertainties and achieve well-informed decision-making, along with informal EMCS to encourage greater employee involvement, teamwork, and adaptability to changing environmental condition.

2.1.2 Environmental strategy (ES)

An environmental strategy encompasses a suite of approaches designed to diminish the environmental impact of operational activities (Hameed et al., 2023). This encompasses efforts directed toward products, processes, and corporate policies with the goal of reducing energy consumption, reducing waste, exploiting sustainable resources, and instituting environmental management systems (Kong et al., 2022).

Management's attention to environmental issues plays a pivotal role in shaping the development of a progressive environmental strategy, significantly impacting the integration of EMCS (spell it out)within the organizational business framework (Hart, 1995). EMCS fosters efficient resource management to enhance environmental performance, aligning both toward organizational goals and sustainable environmental outcomes (Latan et al., 2018).

The integration of indicators gauging environmental performance into the assessment procedures aligns with a firm's environmental strategy (Ilinitch et al., 1998). However companies differ in their strategic posturing concerning the environment creating a spectrum of proactive to reactive environmental protection (Hunt & Auster, 1990).Companies find it progressively crucial to willingly conform to environmental standards and underscore their commitment to sustainability concerns (Nishitani et al., 2021).

Proactive companies explicitly articulate and integrate environmental objectives into their overall business strategies, while reactive companies are yet to adopt such explicit objectives. An environmental strategy includes diverse precautionary measures guiding strategic planning, to create a pivotal concept an environmental consciousness as. It encourages active responses, promoting environmentally friendly practices and improved systems.

Collectively, these discussions from multiple sources highlight the significant influence of environmental strategy as an antecedent shaping the EMCS within organizations (Qian et al., 2011). It underscores the growing importance of sustainability awareness and environmental information, prompting organizations to craft proactive environmental strategies, establishing environmental information systems, and EMCS (Fuadah et al., 2021).

2.1.3 Top Management Commitment (TMC)

Top management's dedication significantly shapes the acceptance and effectiveness of EMCS within enterprises (Kong et al., 2022). It serves as a foundational force supporting the integration of EMCS and is instrumental in directing strategies for environmental conservation (Yang Spencer et al., 2013).

Top management commitment is pivotal in fostering an environment where EMCS can thrive (Wijethilake et al., 2018). It initiates the formulation of appropriate environmental strategies, facilitates effective communication across operational levels, and encourages innovation through the exchange of best practices with stakeholders (Christ & Burritt, 2015). Studies underscore the strong correlation between top management's support and commitment and the implementation of systems that provide essential environmental information. This dedication, fueled by an understanding of the potential benefits of environmental initiatives, motivates top management to wholeheartedly embrace and support environmental sustainability (Albelda Pérez et al., 2007).

The successful integration and application of EMCS are intrinsically tied to the commitment and support of top management (Soo Wee & Quazi, 2005). This commitment influences the organization's climate, creating a flexible and encouraging environment for the implementation and utilization of EMCS (Solovida & Latan, 2017). With societal and environmental pressures mounting, the organization's compliance with environmental responsibilities necessitates standardized environmental management practices geared toward appropriate environmental information disclosure (Jalaludin et al., 2011).

Therefore, the commitment of top management significantly shapes the success and implementation of EMCS, enabling organizations to navigate the challenges of environmental sustainability while fostering a culture that champions innovation and environmental responsibility (Dixon-Fowler et al., 2017).

2.1.4 Institutional Pressure (IP)

Literature examining organizational responses to environmental pressures from stakeholders has examined various aspects (Wu, 2015). (Freeman & McVea, 2005) definition identifies stakeholders as those influencing or being influenced by organizational objectives, spanning a spectrum from suppliers and consumers to legislators and media. This stakeholder perspective aligns closely with institutional pressure, where the diverse interests of stakeholders collectively contribute to environmental pressures on organizations.

Institutional pressures, are categorized into coercive, mimetic, and normative by DiMaggio and Powell (DiMaggio & Powell, 1983), that exert considerable influence over the integration of EMCS (DiMaggio & Powell, 1983). Coercive pressure, rooted in written laws, rules, and policies, encompasses formal and informal influences and compels organizations to conform to legal requisites for legitimacy (Berrone et al., 2013). Government policies, a substantial source of coercive pressure, assume a pivotal role in urging firms to align with environmental laws and regulations to ensure legal standing (Ngo, 2023). Coercive pressure, primarily from the government, is typically applied to mitigate the adverse effects of organizational operations on the environment (Zhu et al., 2013).

Normative pressure stems from societal norms, values, and industry-specific working conditions and practices (DiMaggio & Powell, 1983). Organizations expose themselves to risks like loss of future trading prospects, exclusion from industry organizations, or cessation of commercial activities when they resist normative pressures from their environment (Cavusoglu et al., 2015). This influence is exerted by consumers, societies, and professional conditions within the industry, shaping firms to conform to accepted norms and values (Kong et al., 2022).

Mimetic pressure comes into play when organizations emulate or compare themselves to competitors who have effectively implemented strategies in response to similar challenges (Teo et al., 2003). Organizations have a tendency to imitate the strategies of successful rivals, especially in the face of high uncertainty and unpredictable outcomes (Perez-Batres et al., 2011).

Considering EMCS, government regulations exert coercive pressure, driving the adoption of EMCS to ensure adherence to environmental laws (Ouyang et al., 2019). Additionally, Normative pressure, stemming from customers and stakeholders in industrial circles, drives organizations to embrace EMCS, addressing environmental expectations and bolstering customer relationship (Wu, 2015). Finally, mimetic pressure, influenced by successful competitors, prompts organizations to integrate EMCS to enhance efficiency, reduce resource usage, and secure a competitive advantage (Sinha & Akoorie, 2010).

Organizations' environmental practices are shaped by a range of stakeholder demands. Examining the many aspects of IP reveals how normative, mimetic, and coercive pressure work together to force the adoption of EMCS to ensure efficiency, compliance, and a competitive advantage.

2.1.5 Perceived Benefits (PB)

The effective implementation of an environmental management control system relies on recognizing perceived benefits. Organizational resources, particularly physical, technical, and reputational assets, hold a key position in gaining competitive advantages (Burritt, 2002). EMCS is instrumental in assisting companies in fulfilling environmental responsibilities and assessing potential benefits to enhance overall environmental performance. An essential facet of innovation is shaped by the perception of benefits, as emphasized by (Brammer et al., 2012), indicating the influence of perceived benefits on the adoption of EMCS. In a similar context, Kong et al. (2022) characterize perceived benefits/usefulness as the degree to which firms or individuals view the system as advantageous or valuable in improving performance. Notably, empirical research has repeatedly highlighted the impact of perceived benefits on behavioral intentions for the adoption and use of new technologies or systems (Brammer et al., 2012) (Kong et al., 2022). When seen from the stakeholders' point of view, these perceived benefits include things like better preservation of the environment, cost reductions, increased regulatory compliance, and strengthened relationships with other stakeholders (Albertini, 2019).

The stakeholders' comprehension of the advantages arising from EMCS is crucial for its practical application and system development (Nguyen, 2022). This perception mirrors the dynamic interplay between the firm's interests, social benefits, and active engagement in EMCS application.

However, it is noteworthy that despite its theoretical importance, this construct was not included in the subsequent analysis due to limited empirical support. Only two articles in the selected literature explicitly addressed its influence on EMCS.

2.2 Environmental performance (EP)

Environmental performance encapsulates an organization's commitment to meet and surpass societal expectations concerning environmental protection (Hameed et al., 2023). Environmental performance is measured through the creation of environmentally friendly products, the adoption of methods and processes that proactively reduce pollution and waste during manufacturing and production, the safe handling and management of environmentally harmful materials, and the efficient use of energy (Kong et al., 2022). This commitment comes under initiatives of pollution control, waste reduction, minimized environmental emissions, and active engagement in recycling activities (Lutfi, Alqudah, Alrawad, Alshira’h, Alshirah, Almaiah, Alsyouf, & Alardi, 2023). In an era marked by industrial and corporate expansion, environmental performance assessment has gained prominence as stakeholders increasingly recognize the pressing need to address environmental challenges (Ilinitch et al., 1998), such as escalating waste disposal, resource depletion, and heightened carbon and gas emission (Nishitani et al., 2021). This holistic perspective underscores the organization’s dedication to preserving the natural environment while striving for sustainability (Shafique Ur et al., 2021).

Moreover, prior research has revealed that the adoption of environmental practices, including actions like reducing overall energy consumption through, fostering collaborations with suppliers and customers, and collectively embracing strategic environmental approaches, can significantly enhance environmental performance (Graham & Potter, 2015). Additionally, insights gleaned from earlier studies underscore that improved environmental performance not only holds the promise of opening doors to new market opportunities but also carries the potential to reduce operational expenditures and elevate the overall performance of organizations (Jacobs et al., 2010).

In line with these findings, the assessment of environmental effectiveness becomes pivotal. Specific parameters, organized into four dimensions, offer a nuanced understanding of an organization’s commitment to sustainable practices and societal engagement (Escrig-Olmedo et al., 2017). These dimensions include:

1. Strategic Intent (SI): Focuses on the alignment of an organization’s strategic planning and intent with its environmental performance objectives (Hourneaux et al., 2014).

2. Governance and Management (GM): Examines the structures, processes, and systems in place to support and oversee environmental initiatives, evaluating the effectiveness of governance mechanisms and management practices (Jasch, 2000).
3. Engagement (EN): Highlights the involvement and collaboration of stakeholders in an organization's environmental efforts, measuring the degree of active engagement with internal and external stakeholders to foster environmental responsibility (Azzone et al., 1996).
4. Operational Performance (OP) scrutinizes an organization's tangible environmental outcomes. It assesses the effectiveness of operational processes in achieving environmental objectives (Jasch, 2000).

By building upon these core elements, organizations can systematically develop critical environmental performance indicators (Perotto et al., 2008). These indicators, part of a meticulous analysis, encompass evaluations of resource conservation, spending, the efficacy of environmental education programs, accurate measurements of energy and water savings, assessments of waste reduction efforts, and greenhouse gas emission monitoring (Nishitani et al., 2021). This careful process ensures that organizations gain valuable insights into their environmental performance, allowing them to align activities with social and environmental standards (Bisbe et al., 2007).

In the pursuit of heightened environmental performance, EMCS emerges as a critical element (Guenther et al., 2016). It provides a structured approach that enables organizations to manage and steer their operations, with a specific focus on environmental aspects (Rehman et al., 2021). The integration of EMCS enhances the organization's capacity to convert environmental performance parameters insights into feasible initiatives, hence promoting an ongoing cycle of enhancement. By aligning the organization with changing environmental and social norms, EMCS serves as the cornerstone of a proactive and dynamic environmental management strategy.

A comprehensive reference table (refer to Table 1) below presents concise definitions and aliases for the key constructs discussed in this article.

Table 1: Constructs details used in meta-analysis

Factor Name	Definition	Alias	Reference
Environmental Management Control System (EMCS)	A structured set of processes and protocols utilizing environmental data to sustain or modify patterns in environmental activities.	Formal EMCS, Informal EMCS, EMCS adoption	(Arjaliès & Mundy, 2013; Bisbe & Otley, 2004; Bouten, 2015; Guenther et al., 2016; Henri, 2006; Langfield-Smith, 1997; Malmi & Brown, 2008; Merchant & Van der Stede, 2007, 2017; O'Grady et al., 2016; Pondeville et al., 2013)
Environmental performance (EP)	The outcome that mirrors a company's dedication to preserving the natural environment	Corporate environmental performance	(Escrig-Olmedo et al., 2017; Graham & Potter, 2015; Guenther et al., 2016; Hourneaux et al., 2014; Kong, Javed, Sultan, Hanif, et al., 2022; Nishitani et al., 2021; Rehman et al., 2021; Shafique Ur et al., 2021)
Environmental strategy (ES)	Denotes an organization's blueprint and methodology for overseeing its impact on the environment.	-	(Latan et al., 2018), (Solovida & Latan, 2017),(SAN et al., 2018),(Fuadah et al., 2021),(Kong, Javed, Sultan, Hanif, et al., 2022),(Kong, Javed, Sultan, Muhammad Shehzad, et al., 2022),(Petera et al., 2021)

Factor Name	Definition	Alias	Reference
Institutional pressure (IP)	Signifies the impact exerted by external stakeholders and regulatory bodies on the environmental practices of an organization	Stakeholders pressure, powerful stakeholders, Coercive pressure, Normative pressure, Mimetic Pressure, external stakeholders, regulatory bodies	(Lutfi, Alqudah, Alrawad, Alshira'h, Alshirah, Almaiah, Alsyouf, & Hassan, 2023),(Kong, Javed, Sultan, Muhammad Shehzad, et al., 2022), (Ngo, 2023), (Yusheeng et al.,2023), (Pondeville et al., 2013), (SAN et al., 2018)
Perceived benefits (PB)	The expected advantages and returns that a company foresees from the implementation of an environmental management control system	-	(Bismark Kusi et al., 2020; Burritt, 2002; Gunarathne & Ki-Hoon, 2015; Jamil, 2008; Nguyen, 2022)
Perceived environmental uncertainty (PEU)	Relates to an organization's evaluation of the unpredictability and intricacy of external environmental factors influencing its operations.	-	(Latan et al., 2018), (Lutfi, Alqudah, Alrawad, Alshira'h, Alshirah, Almaiah, Alsyouf, & Hassan, 2023),(Kong, Javed, Sultan, Muhammad Shehzad, et al., 2022), (SAN et al., 2018), (Yusheng et al.,2021),
Top Management's commitment (TMC)	Proactive engagement, unwavering commitment, and explicit support from leadership in the planning and implementation of technological systems, ensuring seamless integration and acceptance by the workforce.	Management support, upper management support, Top management commitment	(Latan et al., 2018), (Hamza et al.,2022), (Lutfi, Alqudah, Alrawad, Alshira'h, Alshirah, Almaiah, Alsyouf, & Hassan, 2023), (Yu et al., 2020), (Yusheng et al., 2021), (Amir et al., 2020),(Appiah et al., 2020)

CHAPTER 3: THEORETICAL BACKGROUNG AND HYPOTHESIS DEVELOPMENT

In exploring the impact of Environmental Management Control Systems (EMCS) on Environmental Performance (EP), various theoretical frameworks have been discussed. This section provides insights into select frameworks commonly employed in studying this relationship.

3.1 Resource-Based View (RBV)

Over the past 15 years, the Resource-Based View (RBV) has solidified its position as a pivotal framework, gaining prominence as one of the field's standard theories (Hoopes et al., 2003). At its core, RBV asserts that a firm's competitive advantage is intricately tied to its possession and effective deployment of unique and valuable resources and capabilities (Henri, 2006). According to RBV, a firm's strength lies in the effective utilization and strategic leveraging of specific internal resources, which must be shielded from imitation, adoption, or substitution by competitors to establish a sustainable competitive edge (Lengnick-Hall & Wolff, 1999). RBV conceptualizes firms as distinct bundle of resources, highlighting the noticeable disparities in resource distribution among them (Amit & Schoemaker, 1993).

A key proposition of RBV is that resources meeting stringent criteria - being valuable, rare, inimitable, and non-substitutable - pave the way for a sustainable competitive advantage that is defiant for competitors to replicate (Mata et al., 1995). These resources span various categories, including physical assets like specialized production facilities and strategic geographical locations, human resources expertise and proficiency, organizational assets such as management skills and a superior sales force, and competencies like miniaturization (Eisenhardt & Martin, 2000).

Integrating EMCS within this framework emphasizes the strategic significance of these resources in crafting value-driven strategies. Contributions from scholars further underscore the integral role of these resources in a firm's ability to implement strategies that foster competitiveness and enduring success.

Research by (Lutfi, Alqudah, Alrawad, Alshira'h, Alshirah, Almaiah, Alsyouf, & Hassan, 2023) demonstrates that effective implementation of EMCS within the RBV framework contributes to the creation of intangible assets, such as positive corporate image and enhanced stakeholders relationships. This suggests that firms strategically utilizing EMCS align their environmental practices with RBV principles, viewing environmental responsibility as a distinctive resource.

Additionally, (Alexy et al., 2018) emphasizes that the deployment empowers the firm to optimize its international network, fostering improved export outcomes and thereby contributing to the overall competitiveness and global success of the organization.

3.2 Natural Resource-Based View (NRBV)

The Resource-Based View (RBV) theory is widely adopted by companies for strategic resource analysis, aiming at gaining a competitive edge. This theory categorizes resources into organizational, physical, and human dimensions (Ramon-Jeronimo et al., 2019). (Hart, 1995) critiques RBV for neglecting the natural environment, prompting the development of the Natural Resource-Based View (NRBV) as an evolutionary step to fill this gap.

The NRBV is built upon the foundation of RBV and introduces three key strategies - pollution prevention, stewardship, and sustainable development, to address the environment as a natural resource that needs to be planned and managed (Teece et al., 1997).

These strategies respond to distinct environmental motivators, relying on diverse critical resources, and they offer unique sources of competitive advantage. The NRBV introduces the initial phase of internal strategy as the pollution prevention strategy in implementing performance enhancements. Companies operating at the internal level adopt a pollution prevention strategy (Lober, 1998) to mitigate adverse environmental impacts during production. Numerous studies have examined this concept alongside other capabilities rooted in the dynamic capabilities (DC) theory, including environmental learning and environmental integration (Graham & Potter, 2015), to strengthen the linkage with overall performance. These studies consistently highlight the positive outcomes associated with the adoption of pollution prevention strategies, showcasing improved environmental performance, and heightened organizational capabilities.

For instance, several corporations have achieved commendable success in minimizing their environmental impact through the implementation of pollution prevention measures. By adopting effective strategies, these companies have experienced notable reductions in the release and transfer of substances harmful to the environment. This not only reflects a dedication to environmental responsibility but also translates into tangible benefits, such as decreased disposal and material costs (Eagan & Hawk, 1996).

Process stewardship, the second strategy for gaining competitive advantage within NRBV theory, contributes to environmental conservation across various supply chain activities, spanning from the procurement process to the final delivery (Hanif et al., 2023). This requires environmental collaboration between suppliers, manufacturers, and customers in reducing the negative effect of upstream and downstream operations on the environment contributing to the process of stewardship strategy among supply chain participants (Chen & Chang, 2013).

Sustainability is becoming a critical tool for success as companies all over the world realize how important it is to have a competitive edge. Developed countries make efficient use of their resources by coordinating sustainability programs with strategic objectives to mitigate the effects of climate change (Wijaya, 2014). In contrast, developing nations have difficulties with implementation due to a lack of resources and insufficient enforcement.

The third strategy delineated in the NRBV theory is clean technology, a subset of sustainable development (Hart, 1995). This strategy represents an overarching initiative propelling industries beyond mere ecological practices, aiming to address escalating environmental and social concerns while positioning organizations ahead in future technologies and markets (Appannan et al., 2023).

The adoption of clean technology entails the integration of cutting-edge, environmentally friendly innovations across various facets of organizational operations. This strategic embrace of clean technology empowers organizations to improve operational efficiency, curtail environmental impact, and align with the evolving expectations of conscientious consumers for sustainable practices.

Incorporating clean technology spans a spectrum of advancements that reshape production processes, enhance resource management, and revolutionize product development. Organizations leveraging clean technology contribute to the seamless integration of renewable energy sources and the reduction of waste through innovative management practices.

3.3 Stakeholder theory

Stakeholder theory offers a dual perspective, serving as both a descriptive and instrumental framework for understanding the dynamics of corporations. Descriptively, it portrays corporations as an intricate network of cooperative and competitive stakeholders, each inherently valuable. Stakeholder theory provides a structured approach to explore the interplay between stakeholder management practices and the attainment of diverse corporate performance goals (Donaldson & Preston, 1995).

The core premise of stakeholder theory challenges the conventional notion that companies exist solely to cater to shareholders' interests. Instead, it advocates for a broader responsibility, suggesting that companies should address the interests of stakeholders at large (Daromes & Ng, 2023). Applied to EMCS, stakeholder theory becomes a valuable analytical tool, allowing an examination of how specific EMCS features and configuration choices align with the stakeholder's demands (Malmi & Brown, 2008). Moreover, it acknowledges the influence stakeholders exert in shaping the design and implementation of EMCS (Guenther et al., 2016).

Beyond economic measures, stakeholder theory emphasizes the broader concept of value. While traditional perspectives often focus primarily on economic performance, stakeholder theory encourages a more comprehensive assessment, directing managerial attention to factors contributing to enhanced performance (Harrison & Wicks, 2013). By shifting the focus from a narrow economic viewpoint to a holistic understanding of value creation, stakeholder theory empowers managers with insights of value creation derived from balancing the interests of the different stakeholders of the firm. This broader perspective enhances managerial decision-making and contributes to improved overall performance (Colvin et al., 2020).

In the sphere of EMCS, stakeholder theory transcends traditional corporate roles, encompassing a diverse array of contributors, involving not only top management but also employees, communities, and regulatory bodies in the pursuit of sustainable development. For instance, (Malmi & Brown, 2008) and (Guenther et al., 2016) illustrate how EMCS aligns with the expectations of a multitude of stakeholders, shaping the design and implementation of these systems. For instance, these systems frequently include engagement tactics, feedback mechanisms, and open reporting procedures, which promote cooperation and guarantee that stakeholder concerns are considered during the decision-making process (Tapaninaho & Heikkinen, 2022). This inclusive approach broadens the discourse beyond economic considerations, providing a comprehensive evaluation of value creation (Tapaninaho & Heikkinen, 2022). By embracing a holistic stakeholder framework, not only does managerial decision-making become more informed, but the emphasis on balancing diverse stakeholder interests becomes paramount for an overall enhancement in environmental management performance (Steurer, 2006).

3.4 Contingency theory

Contingency theory, a cornerstone in exploring EMCS scrutinizes the effectiveness of these systems in various organizational contexts (Chenhall, 2003). Rooted in studies on organizational design (Rötzel et al., 2019), Contingency Theory seeks to unravel the nuanced relationship between EMCS and critical factors such as environmental aspects, technology, organization size, structure, strategy, and national culture (Chenhall, 2003). At its essence, this theory posits that the design and functionality of EMCS must be contingent upon specific organizational contextual factors. This implies that the effectiveness of an EMCS is not universal but contingent upon the unique characteristics of the organization and its environment (Chenhall, 2003). For instance, the optimal design for an EMCS in a large, technologically advanced organization may differ significantly from that of a smaller, less complex organization.

While Contingency Theory provides a traditional yet effective lens for examining organizational performance (SAN et al., 2018), its significance in the realm of EMCS lies in understanding how the design and implementation of control systems should be tailored to fit the particularities of an organization's internal and external environment (Chenhall, 2003).

(Christ & Burritt, 2013) research underscores the imperative to broaden the consideration of contingency factors within the EMCS field. In today's dynamic business environment, marked by increasing stakeholder demands for environmental sustainability, this theory guides managers in customizing their EMCS to effectively address these evolving challenges. This adaptability is crucial for organizations navigating their environmental efforts, ensuring that the EMCS aligns optimally with the specific contingencies of the organizational landscape (SAN et al., 2018).

Several more theories, in addition to the ones listed above, also influence how we perceive EMCS. According to legitimacy theory, organizations must align themselves with society's norms and expectations to be considered legitimate (Amir et al., 2020). Deductive theory guides empirical inquiry by generating hypotheses based on general principles (Guenther et al., 2016). Organizations may integrate and manage environmental performance more formally with the use of EMCS frameworks (Pondeville et al., 2013), which are tailored to environmental control. Nevertheless, these theories were not well discussed or applied in the chosen papers, which led to their removal from the discussion.

Although there are several environmental management theories that provide insightful information, this study stands out for its integration of important concepts from several theoretical viewpoints. Rather than following a single theoretical framework in its entirety, our investigation uses a variety of perspectives to develop theories about the complex interactions between EMCS, its precursors, and EP. The resulting hypotheses, summarized in the Table 2 below, provide a distinctive addition to the study of environmental management dynamics by capturing the complex links produced from a combination of theoretical concepts.

Table 2: Hypothesis development

Hypothesis no.	**Developed hypothesis**
H1	Organizations with a well-defined and aligned Environmental Strategy (ES) are more likely to adopt and effectively implement Environmental Management Control Systems (EMCS).
H2	Higher levels of institutional pressure (IP) significantly influence organizations to adopt and integrate Environmental Management Control Systems (EMCS).
H3	Organizations facing higher levels of Perceived Environmental Uncertainty (PEU) are more inclined to adopt EMCS strategies.
H4	Stronger Top Management’s Commitment (TMC) positively correlates with the successful integration of Environmental Management Control Systems (EMCS).
H5	The effective adoption and utilization of Environmental Management Control Systems (EMCS) positively impact environmental performance (EP) within organizations.

The depicted diagram (Figure 1) illustrates the conceptual model encompassing the constructs studied in the meta-analysis. Within this model, four antecedents - namely ES, IP, PEU, and TMC - play a pivotal role in influencing the adoption of EMCS. The primary objective of this model is to gain insights into the various determinants impacting EMCS. Additionally, it aims to investigate how the implementation of EMCS, in turn, affects EP. Consequently, the output variable under consideration in this model is EP.

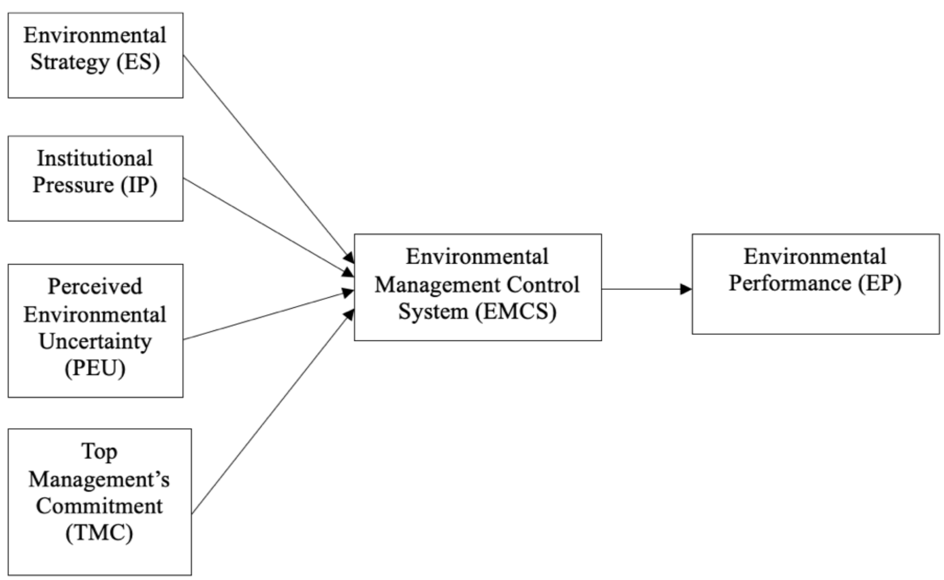

Figure 1: Conceptual model

CHAPTER 4: METHODOLOGY

4.1 Study selection

Several searches were conducted across diverse databases, including Scopus, IEEE, Springer, Taylor and Francis, Emerald, ScienceDirect, Web of Science, and ProQuest. The inclusion criteria were focused on English-language articles with no specific timeline limitations due to the limited existing research on the topic. Key search terms included "Environmental Management Control System," "Environmental Performance," "Meta-analysis EMCS", and "EMCS adoption". The comprehensive database searches yielded a total of 204 articles, and a hierarchical screening process was employed to assess their suitability for meta-analysis. Strict criteria were applied, selecting only peer-reviewed articles, resulting in the removal of 96 duplicated studies. Automation tools were then used to exclude 56 papers based on full-text availability, journal articles, and language. A manual review of the remaining 52 articles was conducted, leading to the exclusion of 16 based on title and abstract relevance, and another 5 were omitted due to divergent study aims. Further scrutiny left 31 articles, with 7 excluded for lacking numerical data, being systematic reviews, or unpublished. Conclusively, the study incorporated a total of 24 articles, each utilizing survey-based questionnaires for the purpose of data collection.

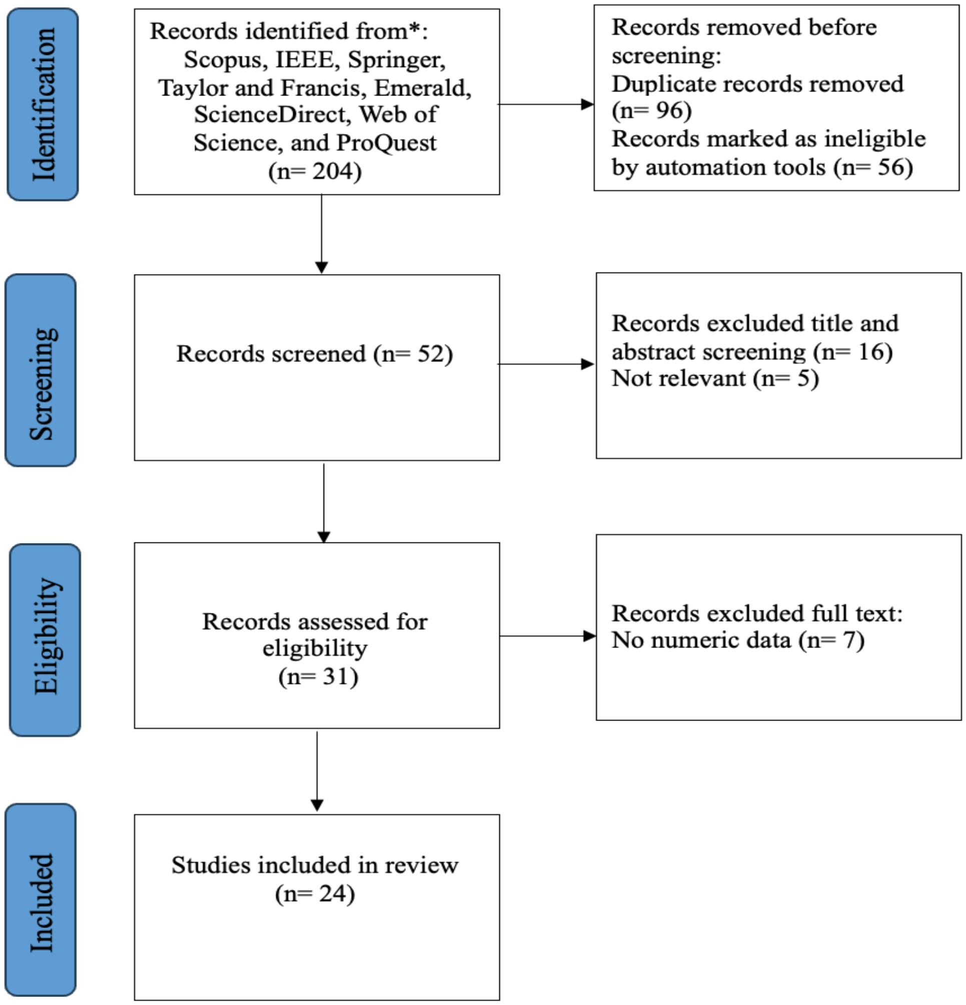

Figure 2: PRISMA Flow Diagram

4.2 Data collection and coding

The research incorporated into the meta-analysis investigated the influence of environmental management control systems on environmental performance across diverse sectors, including manufacturing, hospitality, banking, and construction (refer to the Table 3). These studies covered a spectrum of countries, spanning Australia, China, Malaysia, Thailand, and Pakistan. Among the studies, all of them utilized employed survey-based data collection methods, a majority opted for the Least Square Regression method (PLS-SEM) for their analyses. Key variables commonly examined in papers addressing antecedents of EMCS adoption included perceived usefulness, relative advantage, perceived ecological environmental uncertainty, environmental strategy, top management's commitment, institutional pressure, perceived benefits, and stakeholder pressure.

A comprehensive Excel data collection sheet was devised to systematically gather both descriptive and numerical data. Article coding commenced by capturing descriptive details, including sample size, the domain of study, the type of test employed, the geographical location of the study, and the factors affecting the adoption of EMCS and the systems' effect on environmental performance. Subsequently, data coding encompassed hypotheses aligned with our conceptual framework, intricately exploring the connections among propensity to adopt, and output of adoption. Data recorded from each article included p-values, t-values, means, standard deviations (SD), and beta coefficients for all factors.

A detailed summary was formulated of each study, outlining the characteristics to facilitate grouping and to identify patterns of consistency and variability across the studies. Subsequently, a unique code was assigned to each study to facilitate easy reference. On a second level, articles were specifically reviewed to identify those incorporating variables influencing the impact of EMCS on environmental performance. The meta-analysis employed correlation coefficients as the primary measure of effect size. Studies that did not report a beta coefficient, effect size was calculated based on formulas as it appears later in the text. Before starting the analysis, standardized beta coefficients reported in all included studies were transformed based on the methodology proposed by Peterson and Brown, as detailed later in this text.

Table 3: List of studies included in meta-analysis

No.	Studies	Year	Industry/Sector	Theory
1	Latan a et al., (2018)	2018	Financial	The natural resource-based view (NRBV)
2	Peter et al., (2021)	2021	Industrial	NRBV
3	San et al., 2019	2019	Manufacturing	Contingency theory
4	Solovidaet al. 2017	2017	Financial	NRBV
5	Lutfi et al., 2023	2023	Manufacturing	RBV
6	Ngoc et al., 2021	2021	Financial	EMCS Framework
7	Fahad et al., 2022	2022	Manufacturing	Institutional Theory
8	Rehman et al.,2021	2021	Construction	NRBV
9	Rötzel et al., 2019	2019	Financial and Environmental	Contingency theory
10	Smangele et al.,2022	2022	Food and Barrages Manufacturing	Stakeholder theory
11	Ngo et al., 2023	2023	Manufacturing	Institutional Theory
12	Zameera et al.,2012	2012	Equipment Manufacturing Industry	Environmental Economics

No.	Studies	Year	Industry/ Sector	Theory
13	Passetti et al., 2016	2016	Manufacturing	Contingency theory
14	ONG et al.,2018	2018	Manufacturing	Contingency theory
15	Susanto et al.,2019	2019	SME	Resource-Based View (NRBV)
16	Asiaei et.al., 2017	2017	Mixed Manufacturing	RBV & Institutional Theory
17	Fuadah a et al., 2021	2021	Manufacturing	NRBV
18	Eduardus, 2023	2023	Manufacturing	Stakeholder & Contingency theory
19	Abdalwali et al.,2023	2023	Manufacturing	RBV & Institutional Theory
20	Ibrahim, 2022	2022	Manufacturing	RBV and TOE
21	Kong et al.,2022	2022	Manufacturing	Institutional Theory
22	Appiah et al.,2019	2019	Manufacturing	Deductive theory
23	Amir & Khan, 2020	2020	Manufacturing	Legitimacy theory
24	Phan aet al.,2019	2019	Manufacturing	Institutional Theory

4.3 Meta-analysis procedure

Our meta-analysis method combines two main goals: 1) to provide a thorough evaluation of the association between various factors from different studies and how they affect the use of EMCS; 2) to report a generalized support for the hypotheses from different research, providing a broader perspective than findings from one study.

The findings from each study were synthesized as effect sizes throughout the meta-analysis, where effect sizes serve as statistical measures offering quantifiable information for each investigated association. Effect sizes were calculated using averages, regression coefficients, and correlations. Correlations or regression coefficients (β) taken from the included studies were used in the analysis phase. The formula suggested by (Peterson & Brown, 2005) was used to determine the effect size of the regression coefficient r: The formula is expressed as follows: $r=\beta+0.05\lambda$, where β represents the regression coefficient, r denotes the effect size, and λ is an indicator variable. Specifically, λ is set to zero when β is negative and one when β is non-negative.

The analysis that followed employed the Stata software, and all the collected data were uploaded into StataSE version18. Results were illustrated using both fixed effect models and random effect models. A heterogeneity test was conducted to validate the reliability of the meta-analysis model. Q and I^2 statistics were employed to identify the presence of heterogeneity and determine the suitability of applying a random-effects statistical framework. The I^2 statistic, representing the percentage of total effect size variability attributable to genuine heterogeneity, quantified the actual degree of heterogeneity.

CHAPTER 5: RESULT

The analysis in this section explores how antecedents, including Perceived Environmental Uncertainty (PEU), Top Management's Commitment (TMC), Environmental Strategy (ES), and Institutional Pressure (IP), influence the adoption of Environmental Management and Control System (EMCS). Furthermore, it investigates the impact of EMCS on environmental performance (EP) within organizations. The assessment of this research was grounded in 47 effect sizes, which emerged from a systematic review of the literature. Each correlation effect, indicating the relationship between two variables, underwent both descriptive and meta-analytical scrutiny, as summarized in Table 4. The studies incorporated in this analysis collectively contributed to a total of 9,444 sample sizes, ranging from 54 to 373. Each construct received support from several research studies, ranging from 5 to 24. Notably, 24 studies specifically focused on exploring the impact of EMCS on EP, while the remaining studies addressed the effect of one or more of the three antecedents on EMCS adoption, each with its distinct range of focus. Furthermore, two antecedents- environmental strategy and top management's commitment, have been examined in seven distinct studies. These two variables stand out due to the considerable sample sizes they encompassed, involving 1,096 and 1,480 participants, respectively.

Conversely, the analysis revealed comparatively less research attention devoted to institutional pressure. This composite factor, comprising coercive, normative, and mimetic pressure, was explored in just two studies, totaling four research investigations. Importantly, these studies featured smaller sample sizes, with a combined sample of 918 individuals.

To determine the appropriate model for our analysis, we drew guidance from (Fu et al., 2022) meta-analysis, specifically focusing on evaluating heterogeneity. Fu’s approach recommends applying the Fixed-effect model when the I^2 statistic falls below 50%, signifying relatively low heterogeneity. Conversely, when the I^2 statistic surpasses the 50% threshold, it suggests greater heterogeneity, and accordingly, the Random-effect model is advised. Following this methodology, we have opted for the Random-effect model for all factors exhibiting an I^2 value exceeding 50%.

In our analysis, we assessed the 95% level (CI) for each effect size, assessing the impact strength of various factors on both EMCS and its influence on EP. Evidently both EMCS and TMC exhibited a robust effect, as evidenced by a narrow CI. In contrast, the factors ES and IP were found to exert a moderate impact. On the other hand, the PEU showed a wide 95% CI, indicating a low effect relationship.

To assess heterogeneity among the various hypotheses, we employed the Q and I^2 statistics. The Q estimates for all the constructs were found to be statistically significant with $p\text{-value} < 0.005$. This signifies that there is variability in the results for each factor across the various studies included in our analysis. These findings underscore the substantial diversity in the outcomes observed among the different studies related to each factor. Given the relatively limited number of studies related to each factor, the Q statistic may be less reliable in detecting heterogeneity. Various methods exist for quantifying heterogeneity, offering insights into result inconsistency. I^2, a key metric, provides an alternative approach to evaluate the extent of heterogeneity, aiding in better understanding of the degree of variability among the studies. I^2 ranges from 0% to 100%, with higher values indicating greater heterogeneity. In this meta-analysis, the elevated I^2

values suggest that a substantial portion of the variability seen among studies is due to factors other than random chance.

Moreover, the high significance of Q estimates emphasizes challenges in synthesizing diverse outcomes, urging careful interpretation. The observed heterogeneity complicates generalization, underscoring the need to explore sources of diversity among studies (Trong Ho et al., 2022).

The Fail-Safe N, also known as Rosenthal's Fail-Safe Number, is a metric in meta-analysis that gauges result reliability and the potential influence of publication bias on findings (Acar et al., 2017). A reliable meta-analysis typically requires a Fail-Safe N that is more than two times the total number of included studies. A high Fail-Safe N signifies enhanced result reliability and decreased susceptibility to bias (Fragkos et al., 2014). We find that each hypothesis has considerably resilient Fail-Safe N values in our investigation, and that each ratio of Fail-Safe N to K is more than 2. This indicates that our findings are robust and less likely to be swayed by publication bias (Higgins et al., 2003).

In our analysis, all hypotheses received strong support, as indicated by p-values below 0.005. However, p-values alone cannot ascertain the extent of an effect; they only signify its significance (Goulet-Pelletier & Cousineau, 2018). We use effect size statistics, which (Schmidt & Bohannon, 1988) categorizes into three levels: strong ($r \geq 0.5$), medium ($0.3 \leq r < 0.5$), and low ($0.10 \leq r < 0.3$) in order to assess the strength and accuracy of these effects. Importantly, focusing on the core objective of our study, the relationship between EMCS and environmental performance stood out prominently. Notably, among the five relationships examined, two (H1: ES →EMCS and H5: EMCS → EP) demonstrated high effect size strength, indicating a robust association. In contrast, the other three factors (H2, H3, and H4) exhibited low effect size strength, suggesting a less pronounced relationship with environmental performance. An overview of each correlation link between the components and their impact is given in Table 4. Additionally, Table 5 below provides a concise summary of antecedents for EMCS, outlining key factors, corresponding studies, and total sample size.

Table 4: Results of meta-analysis

Hypothesis	Path	K	∑n	r (Effect size)	p - value	95% level	I^2	Df.	Q's p-value	Strength of r	Fail-Safe N	Decision
H1	ES-->EMCS	7	1096	0.54	0.000	0.392,0.710	90.70%	6	0.00	High	62.49	Supported
H2	IP-->EMCS	6	1288	0.27	0.000	0.157,0.374	76.10%	5	0.00	Low	24.27	Supported
H3	PEU-->EMCS	5	963	0.21	0.000	-0.113,0.550	90.50%	4	0.00	Low	11.13	Supported
H4	TMC-->EMCS	7	1480	0.26	0.000	0.143,0.387	83.80%	6	0.00	Low	29.06	Supported
H5	EMCS-->EP	24	4617	0.59	0.000	0.445,0.624	93.30%	23	0.00	High	197.5	Supported

K= number of studies used in meta-analysis, ∑n = sample size, 95% level = 95% Confidence interval

Table 5: Antecedents included in analysis

Factor Name	**No. of studies**	**Study**	**Total number of sample size (∑n)**
Environmental strategy (ES)	7	(Latan et al., 2018), (Solovida & Latan, 2017),(SAN et al., 2018),(Fuadah et al., 2021),(Kong, Javed, Sultan, Hanif, et al., 2022),(Kong, Javed, Sultan, Muhammad Shehzad, et al., 2022),(Petera et al., 2021)	1096
Institutional pressure (IP)	6	(Lutfi, Alqudah, Alrawad, Alshira'h, Alshirah, Almaiah, Alsyouf, & Hassan, 2023),(Kong, Javed, Sultan, Muhammad Shehzad, et al., 2022), (Ngo, 2023), (Yusheeng et al.,2023), (Pondeville et al., 2013), (SAN et al., 2018)	1288
Perceived environmental uncertainty (PEU)	5	(Latan et al., 2018), (Lutfi, Alqudah, Alrawad, Alshira'h, Alshirah, Almaiah, Alsyouf, & Hassan, 2023),(Kong, Javed, Sultan, Muhammad Shehzad, et al., 2022), (SAN et al., 2018), (Yusheng et al.,2021),	963
Top Management's commitment (TMC)	7	(Latan et al., 2018), (Hamza et al.,2022), (Lutfi, Alqudah, Alrawad, Alshira'h, Alshirah, Almaiah, Alsyouf, & Hassan, 2023), (Yu et al., 2020), (Yusheng et al., 2021), (Amir et al., 2020),(Appiah et al., 2020)	1480

CHAPTER 6: DISCUSSION

Through the analysis of data from several quantitative studies, the primary objective of this research was to thoroughly investigate the factors impacting the influence of the Environmental Management Control System (EMCS) on environmental performance (EP). To enhance our comprehension of the elements propelling EMCS adoption in various organizational contexts, this study examined the connections between EMCS and its antecedents, which include Environmental Strategy (ES), Institutional Pressure (IP), Perceived Environmental Uncertainty (PEU), and Top Management's Commitment (TMC).

Strategically, organizations keen on enhancing their environmental performance must recognize the pivotal role of aligning environmental strategies (ES) with the adoption of EMCS. The positive correlation observed (H1) underscores the significance of well-defined environmental strategies in steering organizations toward effective EMCS implementation ($r = 0.54$, p value = 0.000). The plot illustrating the impact of ES on EMCS adoption is displayed in Figure 3. This revelation prompts a strategic rethink, encouraging organizations to embed environmental considerations within their overarching strategies, fostering a holistic approach to sustainability (Bouten, 2015).

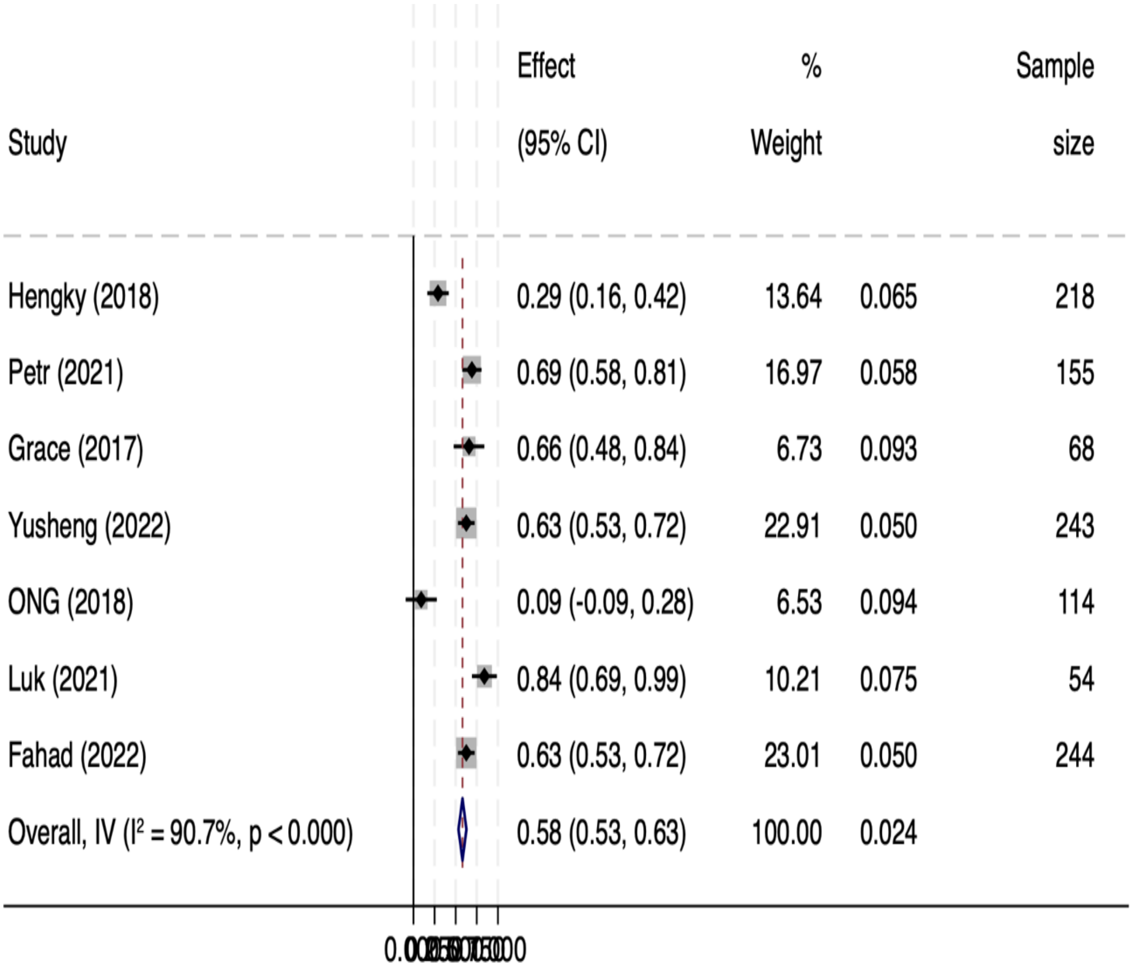

Figure 3: Relationship between ES and EMCS

The findings also shed light on the adaptive nature of organizational control mechanisms in the face of external pressures. Notably, the positive correlation between Institutional Pressure (IP) and EMCS adoption (H2) (r = 0.27, p- value = 0.000) emphasizes the role of external influences in shaping organizational environmental practices (Figure 4). Policymakers can leverage this insight to design regulatory frameworks and incentives that encourage the integration of robust EMCS (Colwell & Joshi, 2013) , aligning organizational practices with broader environmental goals.

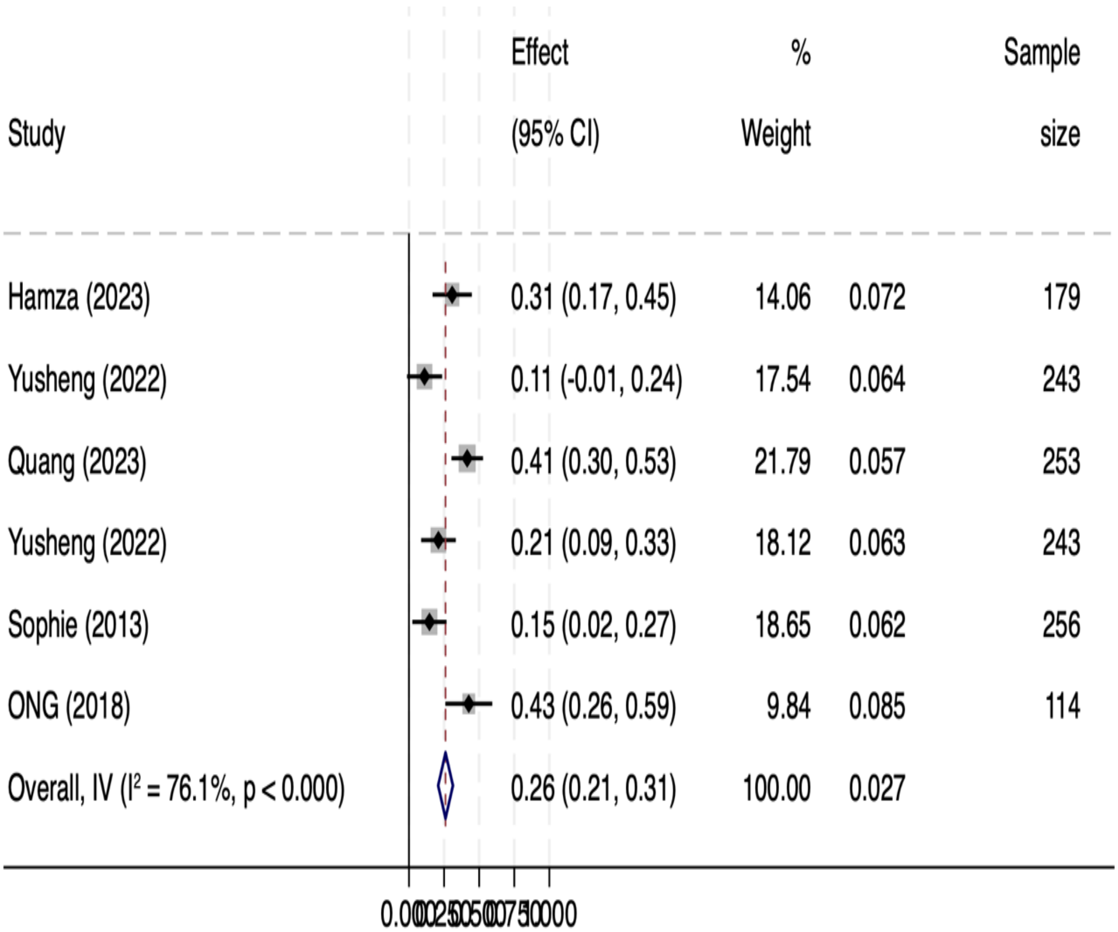

Figure 4: Relationship between IP and EMCS

Top Management's Commitment (TMC) emerges as a critical factor influencing EMCS adoption (H4) (r = 0.26, p- value = 0.000). Figure 5 shows the plot indicating the effect of TMC on the adoption of EMCS. For organizational leaders, this implies that fostering a culture of commitment toward environmental stewardship is integral to the successful implementation of EMCS. A top-down approach, where leadership prioritizes and actively supports environmental initiatives (De Brentani & Kleinschmidt, 2004), can serve as a catalyst for broader organizational buy-in and adherence to environmental control measures.

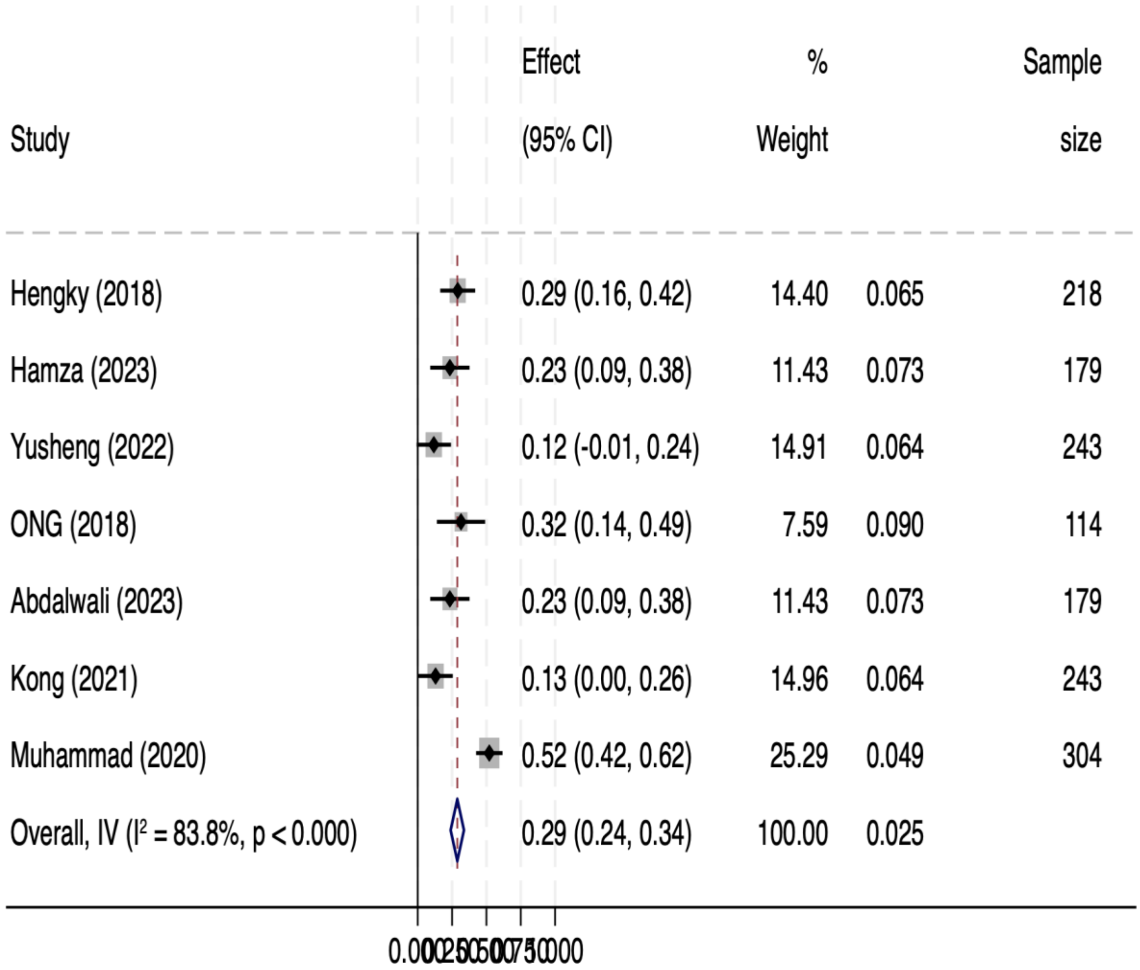

Figure 5: Relationship between TMC and EMCS

The study highlights the relationship between PEU and the implementation of EMCS (H3) by finding a substantial correlation (r = 0.21, p-value = 0.000) (Figure 6). Organizations must not only respond to changes in the dynamic and unpredictable world of environmental landscapes, but also plan forward proactively. This proactive approach is like designing EMCS with predictive analysis in mind. Organizations may strategically adjust their EMCS to anticipate and handle impending issues by embracing predictive analysis, which enables them to anticipate prospective changes in environmental circumstances. In the ever-changing environmental scene, the flexibility of EMCS combined with predictive insights guarantees the continued relevance and effectiveness of environmental management measures (Folami & Powers, 2009).

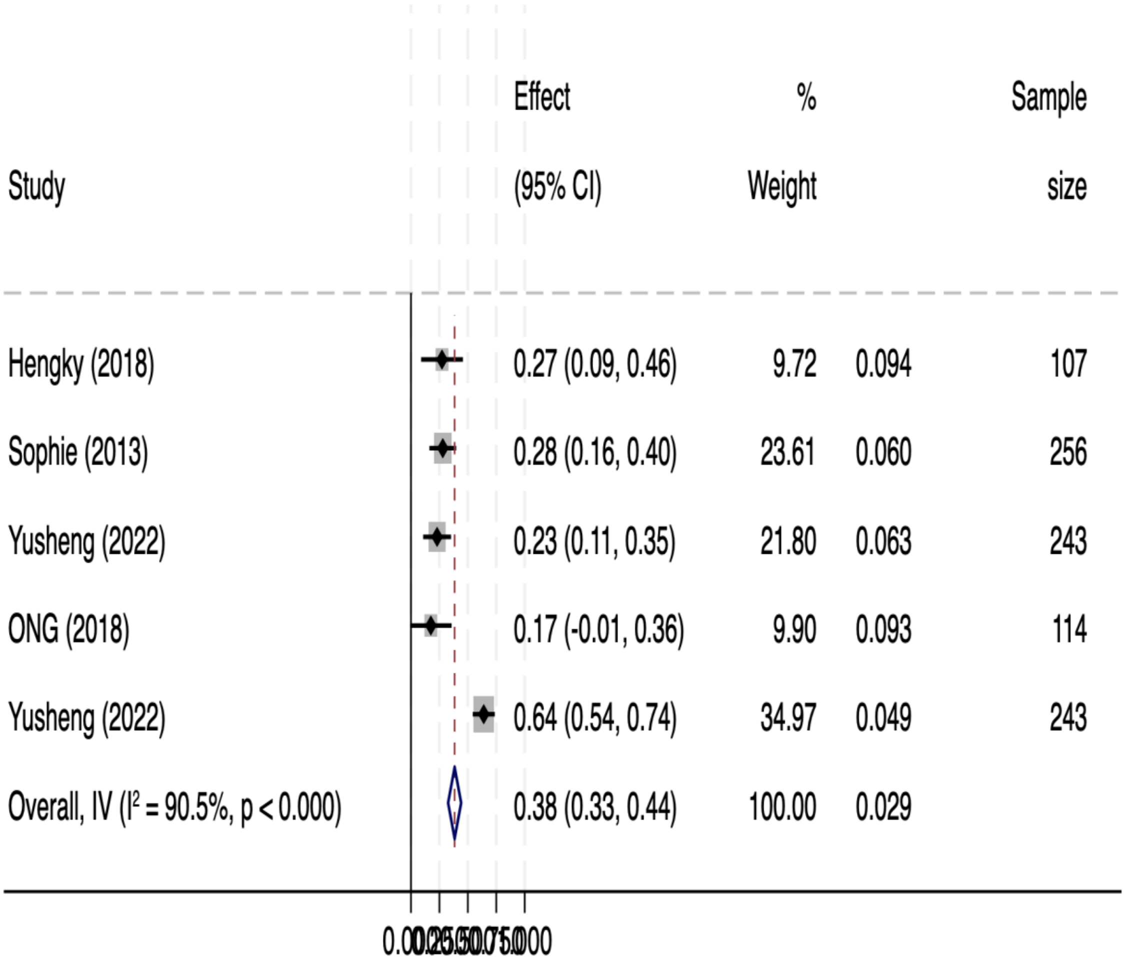

Figure 6: Relationshio between PEU and EMCS

From a market perspective, the study's affirmation of the positive impact of EMCS on environmental performance (H5) (r = 0.59, p- value = 0.000) highlights a potential avenue for organizations to differentiate themselves (Figure 7). The environmentally conscious consumer base is growing, and organizations can leverage their commitment to EMCS as a market differentiator (Arjaliès & Mundy, 2013). This pivotal alignment with environmental stewardship not only contributes to sustainability but also taps into a notable surge in the popularity of green stocks and socially responsible investments (Dutta et al., 2021)- favorites among customers for their ethical appeal and perceived lower risk (Sadorsky, 2014). This not only contributes to environmental sustainability but also aligns with broader societal expectations, potentially enhancing brand reputation and customer loyalty (Pondeville et al., 2013).

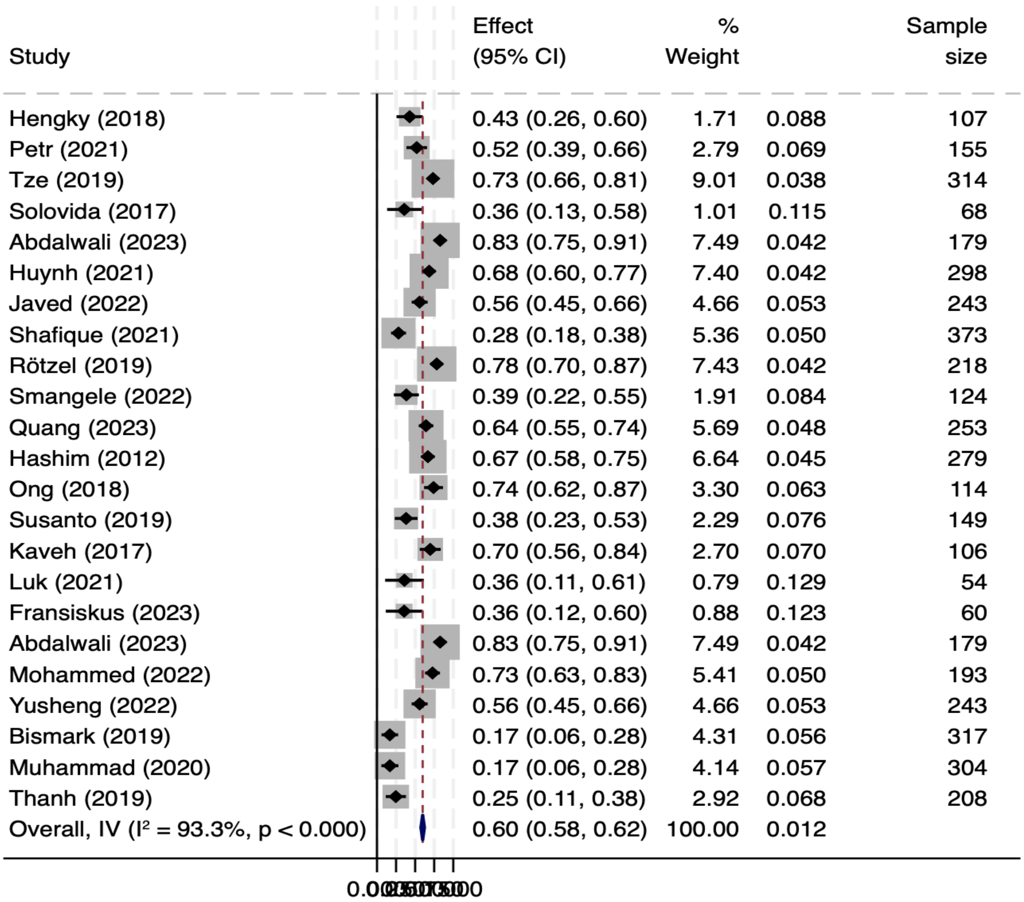

Figure 7: Relationship between EMCS and EP

Furthermore, though the study can be explained by Resource-Based View (RBV), it finds its most natural alignment with Cybernetic Control Theory. This framework is more concerned with the functionality of systems than with how they are composed. With the help of Cybernetics concepts, EMCS may become more flexible and efficient. Maintaining equilibrium and reacting proactively to changes requires the capacity to interpret data, simulate environmental dynamics, and adopt control mechanisms. Assuring a comprehensive and robust environmental management plan, this transdisciplinary approach allows EMCS to tackle the complex and interrelated difficulties found in the environmental sector (Heylighen & Joslyn, 2003). Within this theoretical framework, a thorough comprehension emerges, shedding light on both the antecedents (ES, IP, TMC, PEU) and the outcomes (EP) of EMCS.

Cybernetic Control Theory underscores the importance of Goal Setting and Performance Standards in maintaining organizational equilibrium (DeYoung, 2015). In our study, the positive correlation between ES and EMCS (H1) aligns with the cybernetic notion that organizations set goals (in this case, environmental goals) and utilize feedback to ensure alignment with these objectives. This strategic alignment becomes a driving force behind the adoption and implementation of EMCS.

Moreover, this theory emphasizes the importance of Feedback Loops, a concept highly relevant to organizations aiming for optimal environmental performance (Cummings & Cooper, 1998). In our findings, we observed that organizations with a clearly articulated Environmental Strategy (ES) exhibited a strong correlation with the adoption of EMCS (H1). This resonates with the feedback loop principle, where continuous monitoring and adjustment of organizational activities, guided by the environmental strategy, contribute significantly (Edwards, 1992) to the effective implementation of EMCS.

Regulation and Adaptation are crucial facets of cybernetic control (Schuh & Kramer, 2016), and our findings echo this sentiment. Organizations facing higher levels of Perceived Environmental Uncertainty (PEU) were more inclined to adopt EMCS (H3). This suggests that, in the face of environmental uncertainties, organizations adapt their control mechanisms, and the adoption of EMCS becomes a regulatory response to maintain environmental sustainability.

The concept of Dynamic Equilibrium is central to Cybernetic Control Theory, emphasizing the continuous balancing act between internal and external forces (Adkins & Premeaux, 2019). Our study reveals that stronger Top Management's Commitment (TMC) positively correlates with the successful integration of EMCS (H4). This alignment supports the notion that, through top management commitment, organizations seek to maintain a dynamic equilibrium, where environmental considerations are balanced with operational objectives (Klein, 1989).

Taking an Open System Perspective, the Cybernetic Control Theory views organizations as systems interacting with their environment (O'Grady et al., 2016). The positive impact of EMCS on EP (H5) reinforces this perspective. Organizations with robust EMCS not only focus on internal processes but also consider external inputs, leading to enhanced environmental performance and adaptability.

Information Processing is a critical component in cybernetic control, and our study emphasizes its significance (Flamholtz, 1996). The positive relationship between EMCS and EP (H5) suggests that information processed through feedback mechanisms informs decisions, contributing to the effective alignment of EMCS with environmental performance goals.

Considering control mechanisms, our study reveals that organizations employ EMCS as a pivotal control mechanism in response to various pressures. The positive correlation observed between institutional pressure (IP) and EMCS adoption (H2) aligns with the cybernetic idea that control mechanisms, such as institutional pressures, significantly influence the adoption of EMCS. This underscores the role of control mechanisms as drivers in shaping organizations' strategic responses to external pressures(Ngo, 2023). Particularly, institutional pressures act as catalysts, prompting organizations to embrace EMCS as an effective tool for environmental governance (Daddi et al., 2016). This dynamic interaction highlights how control mechanisms, driven by institutional pressures, become instrumental in shaping organizations' decisions and actions related to environmental management, thereby reinforcing the link between EMCS adoption and institutional pressures (Guenther et al., 2016).

Finally, the Cybernetic Control Theory underscores the importance of Learning and Adaptation (Downs, 2016). Our study's positive findings across all hypotheses suggest that organizations learn from past experiences, identify areas for improvement, and adapt their strategies and processes accordingly. This adaptive capacity is crucial for the successful adoption and utilization of EMCS, influencing overall environmental performance.

An intriguing revelation stemming from our study is the alignment of our results with the Cybernetic Control Theory. This theory aptly explains the relationships among the identified antecedents and the ultimate outcome, environmental performance. The Cybernetic Control Theory, with its emphasis on feedback loops, goal setting, regulation, adaptation, an open system perspective, information processing, control mechanisms, and learning and adaptation, offers a holistic and integrated understanding of the dynamics involved. Thus, we propose the adoption of the Cybernetic Control Theory as a new theoretical framework that comprehensively captures the intricacies of EMCS and its influences.

6.1 Implication

The findings of this study extend beyond theoretical considerations, offering practical guidance for organizations, policymakers, and scholars invested in Environmental Management Control Systems (EMCS) and their impact on Environmental Performance (EP). Organizations seeking to enhance their environmental performance can adopt strategic measures derived from our research, acknowledging the influence of environmental strategy, institutional pressure , perceived environmental uncertainty , and top management commitment on EMCS.

Implementing training programs that familiarize executives and staff with the fundamentals of cybernetic control theory and foster a culture of environmental stewardship is crucial. This not only contributes to overall organizational success but also optimizes the effective deployment of EMCS. Specifically, the positive correlation observed between ES and EMCS, the relationship between IP and EMCS adoption, the correlation between PEU and the implementation of EMCS, and the influence of TMC on EMCS adoption underscore the importance of aligning these factors with organizational strategies.

In the specific context of Qatar, where environmental sustainability is a top priority, organizations could actively collaborate with local entities like the Gulf Organization for Research and Development (GORD). GORD, a leading institution in sustainable development, actively promotes green initiatives and environmental standards in the region (Anonymous, 2011). o address concerns about greenwashing (Delmas & Burbano, 2011), organizations should emphasize a genuine commitment to sustainability practices and transparent reporting. Integrating the principles of Cybernetic Control Theory into GORD’s sustainability initiatives can significantly enhance the effectiveness of EMCS. This collaborative effort can establish feedback loops for continuous strategy assessment, establish performance standards aligned with Qatar’s environmental objectives, and adapt control mechanisms to navigate the unique challenges presented by the region’s arid climate. Embracing Cybernetic Control Theory within local sustainability efforts ensures a tailored and comprehensive approach to environmental management in Qatar, mitigating accusations of greenwashing and contributing not only to organizational success but also to the broader environmental goals of the nation.

Through strategic partnerships with influential entities, integration of Cybernetic Control Theory into EMCS, and targeted training initiatives, organizations can proactively navigate the dynamic environmental landscape. This approach not only aligns with societal expectations but also lays the groundwork for sustained success in environmental performance.

6.2 Conclusion

In this article, our primary focus has been to explore the complex interrelationships among factors influencing the EMCS and, consequently, to understand its impact on environmental performance. A comprehensive literature review revealed a noteworthy gap - existing theoretical frameworks did not encompass all the constructs under consideration. Consequently, this study charted its course without strictly adhering to any single theory. Despite the absence of a singular theoretical framework, the hypotheses formulated based on an exhaustive review of relevant constructs found unanimous support in our results, derived from the meta-analysis of 24 selected studies. Our meticulous coding process extracted crucial details from each study, including sample size, sector type, grounded theory, correlation coefficient, and path coefficient. Every relationship scrutinized in this meta-analysis demonstrated consistent empirical support. Among the antecedents, environmental strategy emerged as a standout driver of EMCS, showcasing a robust positive relationship ($r = 0.54$, p-value = 0.000). Notably, the antecedent with the lowest coefficient was Perceived Environmental Uncertainty (PEU) at $r = 0.21$. Turning our attention to the consequences, our analysis revealed a significant positive impact of EMCS on EP ($r = 0.59$, p-value = 0.000). These findings provide compelling empirical evidence, affirming the pivotal role of EMCS in fostering environmental performance across diverse context.

6.3 Limitations and Future Recommendation

One of the study's shortcomings is the relatively small number of publications included in the meta-analysis, which could potentially impact the generalizability of the conclusions. The diversity of industries and nations covered in the selected research might introduce variability, influencing the overall results. However, the comprehensive understanding of variables influencing EMCS adoption may be limited when certain factors, such as perceived benefits, are excluded due to limited empirical evidence.

In future research, addressing the limitation of a small publication pool is crucial. Expanding the range of included studies and investigating the impact of perceived benefits on EMCS adoption and its influence on Environmental Performance (EP) will enhance overall comprehension. Furthermore, incorporating diverse moderators and mediators, such as industry variations, age demographics, and personnel experience levels, will provide deeper insights into the nuanced dynamics of EMCS across diverse organizational settings.

CHAPTER 7: REFERENCE

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