

The road to carbon trading in Malaysia: Unpacking knowledge and experience through scoping review and in-depth interviews

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CITATION

Alias A, Saarani AN, Amran A, et al. (2024). The road to carbon trading in Malaysia: Unpacking knowledge and experience through scoping review and in-depth interviews. *Journal of Infrastructure, Policy and Development*. 8(2): 3035. <https://doi.org/10.24294/jipd.v8i2.3035>

ARTICLE INFO

Received: 15 October 2023

Accepted: 7 November 2023

Available online: 27 December 2023

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Abstract: The emission trading scheme (ETS) is arguably one of the most effective approaches for encouraging industries to transition to a low-carbon economy and, as a result, assisting nations in meeting their goals under the United Nations Framework Convention on Climate Change to mitigate the challenge of climate change. ETS is gaining popularity as more governments throughout the world contemplate implementing it, particularly in developing countries. Much of the existing research has concentrated on debates concerning ETS operations in developed nations. This study is to give a discourse of the success criteria for ETS implementation that have been identified in the literature and then cross-referenced in the context of Malaysia. For this, the research used an integrated approach of scoping review of existing literature and in-depth interviews with Malaysian stakeholders. Using Narassimhan et al. (2018)'s ETS assessment framework, the scoping review identified five major attributes that lead to successful ETS implementation in a global context that are environmental effectiveness, economic efficiency, market management, stakeholder engagement, and revenue management. In-depth interviews with several groups of discovered stakeholder engagement as an essential attribute that would play a critical role in advancing ETS implementation in Malaysia. The study concludes by proposing a complete strategy based on empirical information and first-hand narratives, providing useful insights for politicians, industry players, and environmental activists. The recommendation is especially important as Malaysia strives to improve its commitment to sustainable and responsible development in light of the challenges posed by climate change.

Keywords: emission trading scheme; ETS assessment framework; scoping review; Malaysia

1. Introduction

Despite several worldwide initiatives aimed at limiting the rise in temperature to below the 1.5 °C warming threshold relative to preindustrial levels (Zhou et al., 2020), the consequences of climate change persist and intensify (Bouchard et al., 2023). The escalating emissions levels have resulted in a series of climate-related issues that exhibit continually severe and irreversible outcomes (Shehzad, 2023). These include unprecedented heat waves in the United States and Europe, unparalleled floods in Pakistan and China, severe drought in Africa, and unprecedented ice melting at the Earth's poles (Abbasi et al, 2022; Shehzad, 2023; Tassone et al., 2023; etc.). The current decade has witnessed the highest recorded global temperatures, with the year 2022 exhibiting an average worldwide temperature around 1.15 degrees Celsius higher than pre-industrial levels (Cheng et al., 2023). The implementation of an emission trading scheme (ETS) has been identified as a viable option for facilitating the transition of sectors towards a more environmentally sustainable economy by

effectively reducing carbon emissions (Han, 2020; Xiao et al., 2023). Ultimately, it will mitigate the risks attached with climate change (Sun et al., 2022).

The ETS is widely recognized as a crucial tool in the global effort to combat climate change (Li and Jia, 2017). The integration of supply and demand concepts into environmental preservation allows ETS to translate the abstract concept of carbon reduction into concrete economic terms (Han, 2020). Under ETS policy, emission limitations are allocated to industries, and the presence of a trading scheme for these permits creates a context in which the reduction of emissions is not just an ecological obligation but also a financial motivation (Li and Jia, 2017). As a result, enterprises are compelled to engage in innovation, embrace sustainable technology, and optimize operational efficiency. In addition, ETS offers a systematic framework for countries to fulfil their global climate obligations, as outlined in the Paris Agreement (Leining et al., 2020). The implementation of a greenhouse gas cap and the establishment of a market-based carbon pricing mechanism provide a measurable indicator of advancement and guarantee the attainment of emission reductions in the most economically efficient way (Han, 2020; Ranson and Stavins, 2016).

The extensive body of research suggests that emissions trading schemes have been widely implemented and used in several developed countries since the beginning of the 21st century (Boemare, 2003; Egenhofer, 2007). The primary source of carbon emissions comes from industrialized nations, mostly attributed to their advanced industrialization processes (Friedlingstein et al., 2022). According to the 2021 report from the global carbon project, the nations that contribute significantly to global greenhouse gas emissions, accounting for more than 70% collectively are the United States of America, the European Union, China, Russia, the United Kingdom, and Japan (Friedlingstein et al., 2022). The consideration of carbon emission pricing in underdeveloped nations such as Malaysia is being explored at its first stage (Fernando et al., 2023). Although Malaysia's carbon emissions account for only 0.37% of global emissions (Zainuddin and Hamzah, 2023), the country has showed its commitment by allocating sufficient funds in their annual budgets (ICDM Pulse, 2021; UNFCCC, 2022) to strengthen its efforts in alignment with other nations' endeavors to combat climate change. This includes the formulation and potential implementation of suitable strategies to mitigate carbon emissions (Yin, 2022; Nguyen et al., 2023).

The emission trading scheme bears considerable significance for Malaysia, a country experiencing fast development (Fernando et al., 2023). In the pursuit of reconciling Malaysia's economic development objectives with its environmental obligations, the implementation of an emissions trading scheme presents a market-driven approach to effectively mitigate greenhouse gas emissions (Ranson and Stavins, 2016). The implementation of a cap on overall emissions, coupled with the provision for organizations to engage in the trading of emission permits, serves as a mechanism that encourages companies to embrace cleaner technology and engage in sustainable practices (Han, 2020). The significance of this issue is particularly large in the context of Malaysia's energy intensive industries, specifically manufacturing and transportation. Malaysia's vulnerability to the detrimental consequences of climate change, such as the escalation of sea levels and the depletion of species, is attributed to its abundant biodiversity and broad coasts (Chachuli et al., 2021). The government's decision to implement the emissions trading plan in Malaysia highlights the country's

dedication to international efforts focused on mitigating carbon emissions. This decision will position Malaysia as a responsible player in the international community (Fernando et al., 2023). Moreover, Malaysia's participation in the emissions trading scheme might potentially reinforce its trade competitiveness in light of the increasing worldwide emphasis on sustainable practices. This involvement has the potential to attract investments in green technology and sustainable businesses (Raihan et al., 2022).

The existing ETS literature demonstrates a limited understanding of the factors that contribute to the adoption of ETS (Meng et al., 2022). The present body of research in the Malaysian context mostly focuses on a particular industry e.g., palm oil (Amran et al., 2013; Hamzah et al., 2019; Ooi et al., 2013; Zainuddin & Hamzah, 2023), and lacks comprehensive information about the current status of ETS implementation in Malaysia (Zainuddin and Hamzah, 2023). Furthermore, there exists a significant lack of comprehensive knowledge on the current situation and potential of emission trading schemes within the specific context of Malaysia (Oh and Chua, 2010; Zainuddin et al., 2017; Zainuddin and Hamzah, 2023). For example, Tengku Hamzah et al. (2019) conducted a comprehensive analysis of carbon trading initiatives within the palm oil sector in Malaysia. The study highlighted many problems, including in the areas of legislative frameworks, financial circumstances, and the availability of green resources and competencies. Nevertheless, there is scarcity of knowledge about the fundamental attributes that play a pivotal role in the implementation of an emission trading scheme in the Malaysian economy. The scarcity of literature to bracket the most relevant attributes to implement ETS in Malaysian context warrants the researchers to explore the current status of understanding of ETS implementation and possible attributes for successful ETS implementation.

In order to address this gap, the current study utilizes the ETS assessment framework proposed by Narassimhan et al. (2018) to identify the relevant attributes that contribute to the implementation of ETS. Subsequently, it cross references the relevance of these identified attributes for the implementation of ETS in the Malaysian economy using an integrated approach. By adopting an integrated approach of scoping review of literature and in-depth interviews with Malaysian stakeholders, this study aims to provide an overview and insight into the current status of an ETS development in Malaysia, with the goal of providing policy suggestions for a successful ETS implementation. Through the scoping review analysis as a methodology, the current study identifies the most important ETS attributes discussed in the literature, and then results are cross-referenced with interviews with Malaysian stakeholders to learn how these attributes are perceived to play a role in the development and potential implementation of an effective ETS in Malaysia. The findings will have managerial implications for politicians, industry players, and environmental activists for successful implementation of ETS, specifically in Malaysia.

2. Methodology

The present research utilizes a combination of scoping review and in-depth interviews as its methodological technique (Paschoalotto et al., 2023). The first phase of the research adheres to the scoping review process (Arksey and O'Malley, 2005;

Pham et al., 2014). This protocol is used to identify and select relevant articles from a pre-defined body of literature, with the aim of determining the key attributes that contribute to the successful deployment of ETS in a worldwide setting. Subsequently, in-depth interview sessions are conducted with chosen informants, encompassing pertinent stakeholders from various entities such as ministries, agencies, regulatory bodies, private companies, non-governmental organizations (NGOs), and international bodies. These stakeholders are directly engaged in the process of policy development and potential execution of an emissions trading scheme (ETS) in Malaysia (**Figure 1**).

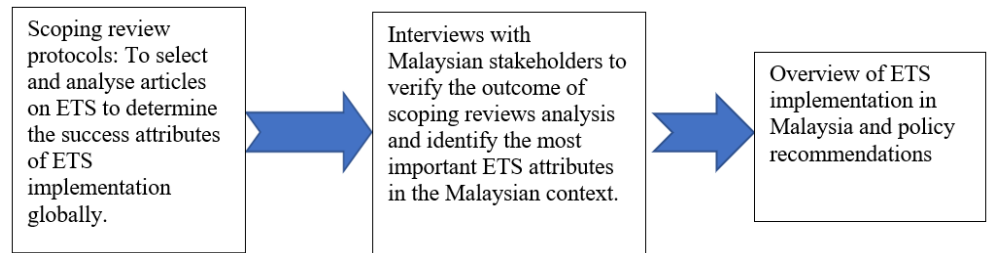


Figure 1. Mapping of methods.

3. Scoping review

The study used a scoping review technique (Arksey and O'Malley, 2005), which is known for its qualitative approach, in contrast to bibliometric or meta-analysis methodologies that primarily rely on quantitative research metrics (Paschoalotto et al., 2023). The qualitative data pertaining to the characteristics that contribute to the effective implantation of emission trading scheme (ETS) has been collected by applying 'preferred reporting items systematic reviews (PRISMA) protocol (Tricco et al., 2018). The process includes the identification of resources, the application of selection criteria, the screening of resources, and the analysis of content.

A comprehensive literature search was performed in August 2022 utilizing Scopus and Web of Science databases, using similar keywords. In order to ascertain the relevant materials, we conducted a search using the specified keywords "cape trade", "emission trading" and "implement" in two prominent databases. The combined search efforts yielded a total of 359 documents, with 55 of these being indexed in Scopus and 304 in Web of Science. The duplicated articles, totaling 10 in number ($n = 10$), have been eliminated. In addition, we eliminated a total of 210 sources from our analysis. These sources were either not research publications, not relevant to our discussion, or not written in the English language. Additionally, there were two sources that were not in English language. Consequently, the final examination included a total of 137 scholarly articles (**Figure 2**).

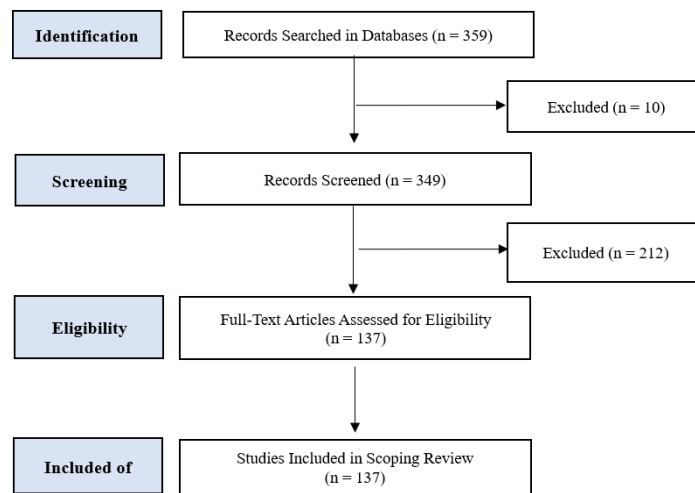


Figure 2. Literature selection process.

4. Content analysis

The present study conducted a keyword comparative analysis to examine the features associated with the adoption of ETS similar to Zakaria et al. (2012). The analysis focused on the abstracts of specific papers, with the aim of identifying these attributes. The present research relies on the ETS assessment framework proposed by Narassimhan et al. (2018), which offers a comprehensive framework for evaluating the efficacy of ETS attributes. The framework has five distinct features, including environmental effectiveness, economic efficiency, market management, stakeholder engagement, and revenue management. The distinct characteristics of each criterion are shown in the second column of **Table 1**. Higher scores of characteristics are indicative of the efficiency of ETS attributes (Narassimhan et al., 2018), identified through the keyword analysis.

Table 1. ETS assessment framework.

Overall assessment of ETS criteria	ETS attributes	Effectiveness indicators	*Keywords representing ETS attributes
Environmental effectiveness (EE)	Coverage of key emitting sectors	The higher the coverage of sectors indicates a more effective ETS.	Emission; Environment; Sustainable; Sector; Cap
	Emission caps to covered emissions	Cap set less than the covered BAU emission levels and decreases over time indicates a more effective ETS.	
	Stringency of cap	The presence of pre-determined of annual tightening of emission caps indicates a more effective ETS.	
Economic efficiency (EcE)	Abatement cost	Low to medium permit prices with the EIT included indicates a more effective ETS.	Abatement; Cost; MRV; Compliance; Administration
	Cost of compliance (MRV cost etc.)	Low marginal MRV costs to firm with government assistance indicates a more effective ETS.	
	Cost of administration	Relatively low marginal cost to administer ETS indicates a more effective ETS.	

Table 1. (Continued).

Overall assessment of ETS criteria	ETS attributes	Effectiveness indicators	*Keywords representing ETS attributes
Market management (MM)	Method of current allocations	The presence of full auction or partial free allocations, benchmarked with emissions inventory data indicates a more effective ETS.	Allocation; Price; Liquidity; Accounting; System; Linkage
	Improved allocation practices over time	Increase in auctioning indicates a more effective ETS.	
	Percentage of auctioning	Full auctioning indicates a more effective ETS.	
	Trajectory of price stability	Stable pricing indicates a more effective ETS.	
	Price signal commitment	The presence of cap commitment and higher price floor and price ceiling indicates a more effective ETS. The presence of an allowance reserve with price-based trigger and clear guidelines for intervention indicates a more effective ETS. The presence of banking/borrowing with well-defined limits to avoid hoarding of allowances by firms indicates a more effective ETS.	
	System flexibility	A system with no allowance reserve and no reserve auctions indicates a more effective ETS. The presence of an allowance reserve with rigid intervention time frames or time delay and absence of both price and emissions containment indicate a more effective ETS.	
	Current linkage	Bilateral linkage with similar compliance rules indicates a more effective ETS.	
Stakeholder engagement (SE)	Number of meetings per period or comments received	Stakeholder engagements with regulated firms through the establishments of emissions accounting process indicates a more effective ETS.	Capacity; Awareness; Stakeholder; Engagement; Training; Information
	Outcomes	The presence of an overall agreement with the stakeholders on the outcome indicates a more effective ETS.	
Revenue management (RM)	Revenue raised	Significant revenue generated to spend on additional environmental goal indicates a more effective ETS.	Revenue; EITE; Benefit; Collection; Distribution; Earmarking; Equity;
	EITE earmarking	Revenue used to reduce the burden of EITE sectors without free allowances indicates a more effective ETS.	
	Green earmarking	Bigger share of revenue used for green earmarking indicates a more effective ETS.	
	Earmarking for distributional equity	Bigger share of revenue allocated to assist low-income communities indicates a more effective ETS.	

Note: Keywords are interpreted by the authors following Zakaria et al. (2012). Source: Narassimhan et al. (2018).

5. In-depth interviews

In order to investigate the factors influencing ETS in the Malaysian setting, a total of 29 individuals were interviewed between December 2022 and February 2023. The participants were chosen via purposive selection from seven distinct types of stakeholders in Malaysia in order to provide a diverse range of perspectives (Creswell, 2014). The collaborative effort included 11 governmental ministries tasked with policy formulation, pertinent regulatory bodies, participants from the financial market, technical specialists, experts in climate change, and representatives from the business sector, non-governmental organizations, and international organizations (Appendix 1).

The respondents were posed with a series of open-ended questions in order to gather their viewpoints on the ETS in Malaysia (Appendix 2). These questions focused on many aspects, including the present status of the ETS, the degree of awareness, the existing capacity development efforts, the future need for capacity building, and the attributes that define a successful ETS (Carey et al., 1996). The primary objective of the interviews was to ascertain the key attributes necessary for the successful deployment of ETS within the specific setting of Malaysia. The interviews were meticulously documented during the process of recording and subsequent transcription. A cumulative duration of 2138 min of interviews were conducted. In order to uphold the reliability and accuracy of the data, as well as maintain consistency in the analysis and mitigate any biases, three impartial assessors conducted a thorough evaluation of the methodological procedures used in the scoping reviews and interview analyses (Arksey and O'Malley, 2005).

6. Findings

The findings of the research indicate that among the 137 articles examined, 42.5% possess a worldwide scope, whilst 57.5% concentrate on specific nations. The majority of studies pertaining to ETS have been carried out in China, accounting for 27.4% of the overall research publications. This is followed by the United States, contributing 19.2%, and the European Union, contributing 16.4%. A limited number of studies were identified, including two conducted in Germany, two in Sweden, two in Italy, and one each in the United Kingdom, Denmark, Switzerland, Turkey, Spain, Estonia, Iran, Canada, Argentina, Kazakhstan, and India. A total of 62 publications were published between 2020 and 2022, representing the most current scholarly contributions. Among these articles, 38.7% were dedicated to examining global contexts, while the remaining 61.3% focused on specific nations. The findings also indicate that within the category of emerging nations, only Argentina, Columbia, Chile, Indonesia, South Africa, Ukraine, and Uruguay have successfully enacted a carbon tax policy. Conversely, Bulgaria, Croatia, Kazakhstan, and Malta have chosen to establish an emissions trading system (ETS) as a means of addressing carbon emissions. Mexico is the only developing country among the countries that have established a hybrid system (Table 2).

Table 2. Countries with carbon pricing schemes (created by authors).

Country	Year introduced	Power	Industry	Transport	Building
Carbon taxes	-	-	-	-	-
-Argentina	2018	Yes	Yes	Yes	-
-Columbia	2017	Yes	Yes	Yes	Yes
-Chile	2017	Yes	Yes	-	-
-Indonesia	2022	Yes	-	-	-
-Singapore	2019	Yes	Yes	-	-
-South Africa	2019	Yes	Yes	Yes	Yes
-Ukraine	2011	Yes	Yes	-	Yes
-Uruguay	2022	-	Yes	Yes	-

Table 2. (Continued).

Country	Year introduced	Power	Industry	Transport	Building
ETSs	-	-	-	-	-
-EU	2005	Yes	Yes	-	-
-Austria	2005	Yes	Yes	-	-
-Belgium	2005	Yes	Yes	-	-
-Bulgaria	2005	Yes	Yes	-	-
-Croatia	2005	Yes	Yes	-	-
-Cyprus	2005	Yes	Yes	-	-
-China	2013, 2014, 2016, 2021	Yes	-	-	-
-Czech Republic	2005	Yes	Yes	-	-
-Germany	2005, 2021	Yes	Yes	Yes	Yes
-Greece	2005	Yes	Yes	-	-
-Hungary	2005	Yes	Yes	-	-
-Italy	2005	Yes	Yes	-	-
-Kazakhstan	2013	Yes	Yes	-	Yes
-Korea	2015	Yes	Yes	Yes	Yes
-Lithuania	2005	Yes	Yes	-	-
-Malta	2005	Yes	Yes	-	-
-New Zealand	2008	Yes	Yes	Yes	-
-Romania	2005	Yes	Yes	-	-
-Slovakia	2005	Yes	Yes	-	-
-US	2009, 2012, 2018, 2021	Yes	Yes	Yes	Yes
Hybrid	-	-	-	-	-
-Canada	2019	Yes	Yes	Yes	Yes
-Denmark	1992, 2005	Yes	Yes	Yes	Yes
-Estonia	2000, 2005	Yes	Yes	-	-
-Finland	1990, 2005	Yes	Yes	Yes	Yes
-France	2005, 2014	Yes	Yes	Yes	Yes
-Iceland	2005, 2010	Yes	Yes	Yes	Yes
-Ireland	2005, 2010	Yes	Yes	Yes	Yes
-Mexico	2014, 2020	-	-	-	-
-Japan	2010, 2011, 2012	Yes	Yes	Yes	Yes
-Latvia	2004, 2005	Yes	Yes	-	-
-Liechtenstein	2005, 2008	Yes	Yes	Yes	Yes
-Luxemburg	2005, 2021	Yes	Yes	Yes	Yes
-Netherlands	2005, 2021	Yes	Yes	-	-
-Norway	1991, 2005	Yes	Yes	Yes	Yes
-Poland	1990, 2005	Yes	Yes	Yes	Yes
-Portugal	2015, 2005	Yes	Yes	Yes	Yes
-Slovenia	1996, 2005	Yes	Yes	Yes	Yes
-Spain	2005, 2014	Yes	Yes	Yes	Yes
-Sweden	1991, 2005	Yes	Yes	Yes	Yes
-UK	2013, 2021	Yes	Yes	Yes	Yes
-Switzerland	2008	Yes	Yes	-	Yes

7. Scoping review

7.1. Attributes of effective ETS

According to the comparative keyword analysis, the total number of times the literature cited the ETS attributes was 1278. “Environmental effectiveness” has 725 references out of 1278. Specifically, the term “emission” was used 413 times among the “environmental effectiveness” criteria, followed by “cap” (200), “environment” (86), and “sustainable” (26) times. With 302 occurrences, “market mechanism” was the second most mentioned attribute. The term “system” was referenced 143 times, followed by “pricing” (115), “allocation” (26), “accounting” (19), and “linking” (8). “Economic efficiency” was referenced 155 times as the third feature. The “cost” was

cited 117 times among the “economic efficiency”, followed by “abatement” (26), “compliance” (6), “administration” (4), and “monitoring, reporting, and verification” (MRV) 2 times. “Revenue management” was recognized as the fourth attribute, with 63 references. For “revenue management”, the term “benefit” was used 30 times, followed by “revenue” (17), “earmarking” (8), “distribution” (5), and “equity” 1 time. Finally, with 33 references, “stakeholder participation” was identified as an ETS attribute. “Stakeholder engagement” was stated (10), “awareness” (6), “stakeholder” (6), “information” (6) and “engagement” 5 times. However, no article included the phrase “training” (Table 3).

Table 3. Scoping review results (created by authors).

Overall assessment	ETS attributes	Scoping review analysis (keywords mentioned in articles)	No of times they keywords are mentioned in the articles/total mentions	No of sentences the keywords mentioned in the context of ETS criteria/total no of mentions	*Ranking	
Environmental effectiveness (EE)	Coverage of key emitting sectors	Emission	413	601/1, 303 (39.2%)	1	
	Emission caps to covered emissions	Environment	86			
		Sustainable Sector	26			
Stringency of cap	Cap	98	200	Total: 725/1,282 (56.7%)		
Economic efficiency	Abatement cost	Abatement	26	345 (22.3%)	2	
	Cost of compliance (MRV cost etc.)	Cost	117			
		MRV	2			
Cost of administration	Administration	6	4	Total: 155 (12.1%)		
Market mechanism	Method of current allocations	Allocation	26	298 (20.2%)	3	
	Improved allocation practices over time		115			
	Percentage of auctioning		Price			0
	Trajectory of price stability		Liquidity			10
			Accounting System			143
	Price signal commitment		Linkage			8
System flexibility						
Current linkage						
Stakeholder engagement	Number of meetings per period or comments received	Capacity	10	45 (3.5%)	5	
		Awareness	6			
		Stakeholder	6			
		Engagement	5			
		Training	0			
	Outcomes	Information	6			
		Meeting	4			
		Consultation	0			
		Message	0			
		Briefing	0			Total: 37 (2.6%)
Revenue management	Revenue raised	Revenue	17	120 (10.9%)	4	
	EITE earmarking	EITE	2			
		Benefit	30			
	Green earmarking	Collection	5			
		Distribution	8			
	Earmarking for distributional equity	Earmarking	1			6

This implies that, when it comes to the first outcome dimension, the literature is more interested on specific ETS attributes such as environmental effectiveness, market management, and economic efficiency than stakeholder involvement. Furthermore, for the second outcome dimension, data revealed that environmental effectiveness was stated 100% of the time, followed by economic efficiency 55.5% of the time, market management 32.2% of the time, and revenue management 9.5% of the time. Similar to the first outcome dimension, stakeholder involvement got the least amount of attention from publications, with just 6 (4.5%) addressing this ETS feature. Based on these results, it is expected that in-depth interviews will reveal similar ranking of ETS attributes in the Malaysian context (**Table 4**).

Table 4. Ranking of ETS attributes (created by authors).

No.	ETS criteria (Based on the keywords representing the 5 criteria)	No. of Times the keywords representing criteria is mentioned (% of total)	No. of sentences the keywords were mentioned in the context of ETS criteria	No. of articles mentioning the criteria as part of objectives (% of total)	*Ranking of intensity (avg of % of the mentions over total)
1.	Environmental effectiveness (emission, environment, sustainable, sector, cap)	725/1276 (56.8%)	332/750 (44.3%)	137 (100%)	1 (67%)
2.	Economic efficiency (allocation, price, liquidity, accounting, system, linkage)	155 (12.1%)	81 (10.8%)	76 (55.5%)	2 (26.1%)
2.	Market management (abatement, Cost, MRV, compliance, administration)	302 (23.7%)	150 (20%)	44 (32.2%)	3 (25.3%)
4.	Revenue management (revenue, EITE, benefit, collection, distribution, earmarking, equity)	61 (4.8%)	10 (1.4%)	33 (9.5%)	4 (5.2%)
5.	Stakeholder engagement (capacity, awareness, stakeholder, engagement, training, information, meeting, consultation, message, briefing)	33 (2.6%)	5 (0.7%)	6 (4.5%)	5 (2.6%)

7.2. Outcome of in-depth interviews

Interviews with stakeholders revealed a distinct ordering of criteria to produce a successful ETS in the Malaysian context, contrary to the conclusions of the scoping review research. The research discovered that the participants mentioned any of the five ETS features in a total of 535 phrases (**Table 5**). Stakeholder engagement topped the list with 301/535 sentences, accounting for 55% of the total sentences. This was followed by 16.2% for environmental effectiveness, 9.1% for economic efficiency, 8.9% for market mechanism, and 8.8% for revenue management. The respondents also shared their thoughts on the most essential aspects of ETS that needed to be addressed. According to the findings, 100% of the 29 participants thought stakeholder involvement, 69% economic efficiency, 66% environmental effectiveness, 57% revenue management, and 52% market mechanism were the most significant aspects to address in the Malaysian context (**Table 5**).

Table 5. Interview results (created by authors).

No.	ETS attribute (Based on the keywords representing the 5 ETS criteria)	No. of sentences the keywords were mentioned in the context of ETS criteria	No. of informants mentioning the ETS criteria as most important to address (% of total)	*Ranking
1.	Stakeholder engagement (capacity, awareness, stakeholder, engagement, training, information, meeting, consultation, message, briefing)	301/548 (55%)	29 (100%) (1)	1 (all informants emphasized on the critical importance of stakeholder's engagement)
2.	Environmental effectiveness (emission, environment, sustainable, sector, cap)	89 (16.2%)	19 (66%) (3)	(2–5 interchangeably) Due to the lack of information on the details of ETS mechanism and direction, informants are not able to concretely describe the importance of each criterion in relation to one another and thus the author are not able to concretely rank the order of importance of these criteria.
3.	Economic efficiency (allocation, price, liquidity, accounting, system, linkage)	50 (9.1%)	20 (69%) (2)	
4.	Market mechanism (abatement, cost, MRV, compliance, administration)	49 (8.9%)	15 (52%) (5)	
5.	Revenue management (revenue, EITE, benefit, collection, distribution, earmarking, equity)	48 (8.8%)	17 (57%) (4)	

The findings from the interviews indicate that stakeholder engagement is considered the most crucial attribute for the effectiveness of the ETS in Malaysia. This assertion is further supported by the analysis of the interview data, which reveals that a significant number of participants identified stakeholder engagement as the foremost priority that requires immediate attention in the current stage of the ETS implementation. However, the majority of interviewees (**Table 6**) did not discuss other attributes related to emissions trading systems, specifically those concerning market mechanisms and revenue management. Their lack of discussion of these attributes may be due to a lack of available knowledge on the subject (**Table 6**).

In addition to determining the relative relevance of ETS attributes, the study also identified certain essential success attributes (**Table 6**) that were consistently underlined by all informants. The results once again confirmed and underscored the need of including stakeholders in the process. The results of the interviews also demonstrate a notable absence of specific information and understanding regarding the specifics of the remaining four ETS attributes within the Malaysian context (**Table 6**). This lack of knowledge has impeded the stakeholders' capacity to furnish detailed information on these criteria, consequently preventing them from effectively ranking these criteria in relation to one another. A limited number of stakeholders were able to briefly outline or provide opinions on all features of the ETS.

Table 6. Outcome of interview sessions.

Participant	Stakeholder engagement	Environmental effectiveness	Economic efficiency	Market mechanism	Revenue management
P1	√	Na	Na	Na	Na
P2	√	√	√	Na	√
P3	√	√	√	√	√
P4	√	√	√	Na	Na
P5	√	√	√	Na	Na
P6	√	Na	Na	Na	Na

Table 6. (Continued).

P7	√	√	√	Na	Na
P8	√	Na	Na	Na	Na
P9	√	√	√	Na	Na
P10	√	√	√	Na	Na
P11	√	√	√	Na	Na
P12	√	√	√	Na	Na
P13	√	√	√	Na	Na
P14	√	√	√	Na	Na
P15	√	√	√	Na	Na
P16	√	√	√	Na	Na
P17	√	√	√	√	√
P18	√	√	√	Na	Na
P19	√	√	√	√	√
P20	√	Na	Na	Na	√
P21	√	√	√	Na	Na
P22	√	√	√	Na	Na
P23	√	Na	Na	Na	Na
P24	√	Na	Na	Na	Na
P25	√	Na	Na	√	√
P26	√	Na	Na	Na	Na
P27	√	√	√	√	√
P28	√	√	√	√	√
P29	√	√	√	√	√

Source: Author’s own interpretation and tabulation based on the responses provided by the informants (2023). Na: Denotes informants’ inability to clearly describe the details of the ETS criteria as a result of insufficient information/unclear direction at the national level.

8. Discussion

The primary goal of this research was to identify key attributes that contribute to the deployment of an emissions trading scheme by conducting a scoping review of the existing literature and to provide a contextual framework for the selected attributes within the Malaysian economy by conducting in-depth interviews with relevant stakeholders (Paschoalotto et al., 2023). The scoping review discovered many important attributes for the successful implementation of emissions trading schemes in several economies (Zhu et al. (2016). These factors include environmental efficacy, economic efficiency, the use of market mechanisms and revenue management, as well as active engagement of stakeholders. Nevertheless, after conducting interviews with various stakeholders, it became evident that the attributes of ETS in the Malaysian context diverge from the conclusions of the scoping study research.

Based on the interviews conducted with the stakeholders, it was determined that prompt attention should be given to stakeholder engagement as the foremost critical attribute (**Table 6**). The research done by Stevens (2022) in Mexico yielded similar findings. Numerous endeavors like stakeholder’s active participation and stakeholders’ approach, have been undertaken by different organizations to raise awareness and

improve preparedness regarding ETS (Stevens, 2022). Notably, these efforts have been more prevalent in large corporate entities rather than the public sector. However, there is a noticeable lack of a unified, conclusive message and guidance from the government regarding the specific expectations from individual stakeholders, particularly the main industry players (**Table 6**).

Ensuring relevant parties, particularly the enterprises directly impacted in the specified sectors (e.g., energy sector), possess a comprehensive understanding of their duties and accountabilities will enable them to proactively strategize and make appropriate preparations in anticipation of the adoption of an emissions trading scheme (Liu and Abu Hatab, 2022). Therefore, it is imperative for the government to prioritize early, frequent, and extensive discussions with all pertinent stakeholders. Stakeholder engagement will streamline and expedite the establishment of an efficient and successful ETS. The significance of a uniform and transparent policy that may provide a clear direction and prevent any possible uncertainty among stakeholders, particularly industry participants, was identified via interviews with stakeholders (P6, P7 and P24). Therefore, it is crucial to guarantee the development and dissemination of a precise and specific message and policy orientation to all relevant parties from the beginning.

There is variation in the frequency of references among the ETS attributes, suggesting that these attributes can be ordered based on their respective frequency of discussion in interviews (**Table 5**).

The interdependence and mutual significance of these factors require simultaneous consideration (Narassimhan et al., 2018). In the analysis of the environmental effectiveness, it is essential to consider various attributes, including the coverage of carbon emitting sectors like transportation. It is crucial to examine environmental effectiveness in conjunction with its implications for economic efficiency, such as the costs associated with abatement, measurement, reporting, and verification (MRV), as well as administration costs (Liu et al., 2022). The environmental efficacy and economic efficiency of an emissions trading scheme are closely linked to market processes, including the manner of allocation and the trajectory of price stability. The present study examines the interconnections among revenue management strategies used by ETS, with a specific focus on the utilization of revenue. Wiese et al. (2020) have discovered that revenue utilization has a key role in green earmarking. Therefore, the research has discovered that it is not feasible and seems to be unattainable to individually handle each attribute in isolation. Prompt action is required in implementing activities that will enhance the stakeholder engagement process, raise stakeholders' awareness, and adequately prepare for the implementation of an ETS in Malaysia.

The limited understanding of the ETS attributes among the majority of stakeholders, as shown by the results of the interview sessions, may be attributed to the current stage of ETS development in Malaysia in comparison to other nations like China (Zainuddin and Hamzah, 2023). Although the Malaysian government is actively working to establish its future course of action on ETS implementation, none of the interviewed stakeholders could give any clear data on most of the ETS attributes with a high degree of confidence. Other international players like China and the European Union (EU) have been engaged in the implementation of emissions trading schemes for several years: China initiated its ETS roadmap in 2013, whereas the EU began

implementing ETS in 2005. Both regions are currently focused on ongoing enhancements and refinements to their respective ETS operations (Leining et al., 2020; Zhu et al., 2016).

In addition, it is crucial to prioritize the process of generating ideas and expanding upon the many factors and engagement with international stakeholders (China, EU) may be utilized to foster the implementation of ETS in Malaysia (**Figure 3**). Based on the results of in-depth interviews with stakeholders, the current study offers a set of prioritized actions that would lead to the effective implementation of ETS in Malaysia. To begin, the government must concentrate on the first attribute, “stakeholder engagement”. Conducting extensive engagements with industry leaders, environmental experts, and those affected is critical for understanding various perspectives and concerns about ETS. The government’s action will raise stakeholders’ understanding and readiness for ETS implementation. In the second step, the focus must be placed on the parameters of the ETS attributes. The stakeholders will gain clarity on the possible mechanism, system, and operation of the ETS by establishing the coverage of major emitting sectors, emission and stringency of cap, cost of compliance, MRV and administration method of allocation, and green earmarking. Third, it is suggested that relevant studies that provide details on ETS criteria on environmental effectiveness, economic efficiency, market management, and revenue management be prioritized for developing concrete recommendations on the potential implementation of an ETS mechanism. Finally, based on the outcomes of second and fourth phases, a climate change act may be drafted to provide clear regulatory frameworks and standards, ensuring legal structures and rules are in place to ensure effective operation. This legislation will establish a strong monitoring, reporting, and verification mechanism for the success of ETS.

TIMELINE	PROPOSED ACTION	AIM
2023 → 2024 → 2025	Stakeholder engagements (Relaying a clear and concrete message and policy direction to stakeholders)	To enhance awareness and readiness of stakeholders for ETS implementation.
	↓	
2023 → 2024 → 2025	Determining the parameters for consideration for the four ETS attributes (determining the coverage of key emitting sectors, emission and stringency of cap, cost of compliance, MRV and administration method of allocation, green earmarking etc.)	To achieve clarity on the potential mechanism, system and operation of the ETS
	↓	
2023 → 2024 → 2025	Completion of the relevant studies (attaining the recommendations on the details of ETS criteria on environmental effectiveness, economic efficiency, market management and revenue management)	To achieve a concrete recommendation on the potential implementation of a suitable mechanism, system and operations of ETS in Malaysia
	↓	
2024 → 2025	Completion of Climate Change Act (providing the necessary legal Framework for the implementation of Compliance-based ETS – to also consider and incorporate the ETS criteria recommendations by the relevant studies)	To provide the needed legal and regulatory framework for ETS implementation within the overall national aim and planning in addressing climate change

Figure 3. Proposed actions (Author’s own tabulation).

9. Conclusions

The establishment and implementation of ETS exhibits variations across different countries. The disparity in motivation and rate of development between developing countries and industrialized nations may be attributed to factors such as the economic development status and level of emissions. The research revealed that, given the current level of ETS development in Malaysia, the likelihood of effective adoption of the system would be contingent upon many factors. Firstly, it is important to analyze

the experiences of other nations, as well as the ongoing efforts that are being implemented. Malaysia is now in the first phase of developing an ETS, which limits its ability to fully utilize the many aspects of ETS as mentioned in academic literature. However, Malaysia has the opportunity to capitalize on the government's strong promises in order to promote the future implementation of a local emissions trading scheme. This is shown by the recent introduction of the world's first shariah-compliant carbon trading platform (Afroz et al., 2019). The aforementioned pledges will serve as significant motivating elements for the execution of the proposed actions (**Figure 3**). However, their effectiveness is contingent upon the successful realization of specific suggestions derived from ongoing research endeavors. In conclusion, although the deployment of an ETS in Malaysia may pose several challenges. Malaysia can lead the road to a more sustainable and environmentally responsible future by emphasizing the activities described in this discourse. The effective implementation of an ETS would not only cut greenhouse gas emissions but will also contribute to Malaysia's worldwide commitment to tackle climate change while supporting economic development and innovation. Malaysia must use this opportunity and stay committed to environmental sustainability.

10. Policy implications

The current study has substantial practical implications for policymakers and businesses operating in the Malaysian environment. The findings of current study provide policymakers with valuable insights for implementation of ETS. Conducting in-depth interviews may enhance our understanding of the local environment and enable us to develop policies that are both practical and take into account the unique issues encountered in Malaysia. Regarding business things, the study findings provide significant insights for sectors aiming to adjust to a low-carbon economy. Companies can utilize this knowledge to develop strategies and make preparations for upcoming regulatory changes, enhance their operations to minimize their carbon emissions, and potentially explore options to engage in ETS programs. This will promote sustainable practices while potentially generating extra sources of income. Likewise, investors may benefit from the findings by making informed investment decisions in environmentally friendly enterprises.

Secondly, the study exposes the need for Malaysia to promptly redirect its focus towards implementing crucial measures to assure the readiness of all stakeholders for the prospective implementation of an ETS. The Malaysian economy needs a different set of prioritized attributes in terms of ETS implementation. The current study underscored the significance of robust stakeholder engagement. The government must identify ETS qualities via stakeholder interviews (as done in this research), and then convey them to the private sector in terms of what it expects from private sector stakeholders and enterprises. Furthermore, the government should explicitly explain the government's priority of establishing certain ETS attributes required for future ETS implementation success. The research also discovered that given Malaysia's current stage of ETS debate, planning, and development, there is a noticeable deficiency in understanding about the other four attributes of ETS. Consequently, it is imperative to provide equal emphasis to these attributes and ensure their simultaneous

and coherent planning. Presently, given the results obtained from the interviews, which unveiled a substantial scarcity of information regarding these characteristics, it is critical to give precedence to the identification of factors that must be considered in order to guarantee effective implementation of ETS. The results of this exercise will have a substantial impact on increasing awareness and establishing a solid foundation for improving capacity development efforts among all stakeholders.

The current study also highlights the importance of establishing a comprehensive and transparent regulatory framework. With a global movement for increased environmental awareness and sustainability, there is an associated expectation of nations, including Malaysia, to adhere to more stringent emissions standards. The implementation of a clear ETS framework would not only create a fair business environment, but also demonstrate Malaysia's commitment to global efforts in mitigating climate change. Moreover, this framework would facilitate Malaysia's transition towards a low-carbon economy, aligning it with international sustainability objectives and potentially positioning the country as a leader within the ASEAN region. Introduction of the ETS is likely to stimulate sustainable investments, offering long-term economic advantages to businesses (Hussain and Lee, 2022). Therefore, it is crucial for both the private sector and governmental entities to engage in ongoing dialogue to ensure that the ETS is implemented in a manner that effectively balances environmental objectives with economic realities.

11. Limitations and future research

Like other scientific studies, this particular study is not immune to some limitations. The in-depth interviews may face some limitations inherent to qualitative research, since they are inherently subjective and contingent upon contextual factors (Creswell, 2014). Interviews provide useful and comprehensive viewpoints, but their validity might be altered by the specific persons or circumstances involved (Creswell, 2014). The unique nature of this fact raises questions about the generalizability of the findings to a wider scope (Creswell, 2014). The generalizability of conclusions derived from a restricted sample of ETS stakeholders in Malaysia is constrained and cannot be extrapolated to include the whole population of ETS economies. It highlights the need of exercising caution when applying the findings to a broader context. Hence, it is recommended that future research endeavors broaden the extent and inclusiveness of this study to incorporate a wide range of stakeholders. This approach will enable the acquisition of diverse perspectives regarding the anticipated impact of ETS on these stakeholders, as well as solicit their valuable input on potential initiatives that can be adopted to effectively prepare them for the forthcoming challenges. Expanding the pool of informants to include a broader range of stakeholders will provide a more extensive and diversified collection of perspectives about the ongoing activities implemented by different agencies.

Second, a notable constraint arises from the intrinsic characteristics of scoping reviews, as highlighted by Yuriev et al. (2020). Academic literature reviews are intended to give a thorough synthesis of current academic works, which may include a wide spectrum of research and publications. Nonetheless, the broad span of the topic matter may occasionally impede completeness (Yuriev et al., 2020). Although the

review gives an overview of general themes of attributes, it does not go into great detail on the technical intricacies or methodological rigor of any given research. As a result, although a generalized overview is useful, it lacks the particular observations necessary to produce accurate and implementable suggestions that is the hallmark of empirical studies. Thus, future research may use empirical methodologies in a longitudinal design to determine the important variables that drive ETS performance.

Author contributions: Conceptualization, AA (Amran Alias) and AA (Azlan Amran); methodology, AA (Amran Alias) and ANS; formal analysis, AA (Amran Alias) and MAA; investigation, AA (Amran Alias) and MAA; resources, AA (Amran Alias) and MAA; data curation, AA (Amran Alias) and MAA; writing—original draft preparation AA (Amran Alias) and MAA; writing—review and editing, MAA and MG; supervision, AA (Azlan Amran); project administration, AA (Azlan Amran). All authors have read and agreed to the published version of the manuscript.

Acknowledgments: This research is being supported by a grant provided by the Malaysian Public Services Department to Universiti Sains Malaysia—Grant No.: 304/PPAMC/6501317.

Conflict of interest: The authors declare no conflict of interest.

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Appendix

Table A1. Participants' profile.

Participants	Designation	Experience in years	Organization	ETS areas
P1	Deputy under secretary	23	Ministry of finance (fiscal and economics division)	Formulation of policies related to financial and capital market management
P2	Divisional head	19	Ministry of finance (Tax Division)	Formulation of policies related to tax
P3	Principal assistant secretary	14	Natural resources, environment and climate change (NRECC) ministry (energy division)	Formulation of policies related to energy
P4	Unit head	18	Natural resources, environment and climate change (NRECC) ministry (forestry division)	Formulation of policies related to forestry
P5	Divisional head	19	Natural resources, environment and climate change (NRECC) ministry (REDD plus unit)	Formulation of policies related to forestry (REDD Plus)
P6	Deputy under secretary	19	Natural resources, environment and climate change (NRECC) ministry (climate change division)	Formulation of policies related to climate change
P7	Deputy secretary general	23	Ministry of international trade and industry	Formulation of policies related to trade and industry development specially manufacturing industry
P8	Deputy under secretary	23	Ministry of transport (strategic policy division and land and rail division)	Formulation of policies related to transportation (land and rail)
P9	Under secretary	23	Ministry of transport (aviation)	Formulation of policies related to transportation (aviation)
P10	Deputy under secretary	23	Ministry of agriculture	Formulation of policies related to agriculture (fishery sector)
P11	Director	25	Economic planning unit (EPU)	Formulation of policies related to national economic development
P12	Director	18	Malaysian productivity center	National focal point for productivity and competitiveness
P13	Senior deputy director	16	Energy commission	Regulating energy sector to ensure sustainable energy provision
P14	General manager	15	Securities commission	Regulating capital market
P15	Deputy director	23	Bank negara Malaysia	Regulating monetary and finance
P16	CEO	21	Sustainable energy development authority (SEDA)	Regulating and managing renewable energy
P17	Deputy director general	25	Malaysian maritime enforcement agency	Enforcement agency for maritime sector
P18	Director	25	Malaysian industrial development authority (MIDA)	Investment promotion
P19	Divisional head	26	Forest research institute of Malaysia (FRIM)	Expert and reference on climate change
P20	Senior lecturer	19	UTP/energy institute	Expert and reference on energy research
P21	Senior vice president	21	Bursa Malaysia	Trading market platform
P22	Unit head	18	Pras Arana Corp	Business industry (public transport)
P23	Managing director	18	Tenaga national berhad (TNB)	Business industry (energy)

Table A1. (Continued).

Participants	Designation	Experience in years	Organization	ETS areas
P24	Unit head	22	Petronas national berhad (Petronas)	Business industry (oil and gas)
P25	CEO	19	Vienna advantage Sdn Bhd.	Business industry (SME)
P26	CEO	18	Biodiversity Malaysia Sdn Bhd./PERKON Corp	Business industry (SME)
P27	Senior vice president	17	Khazanah nasional Bhd	National investment arm
P28	Unit head	19	WWF (NGO)	NGO
P29	Divisional head	18	United nations	International organization

Table A2. Interview questions.

Leading questions for the in-depth interviews with the stakeholders on emission trading (ETS) implementation in Malaysia	
1.	What are the roles of your organization in the planning and development of ETS in Malaysia?
2.	How do you see the level of awareness and readiness especially among the stakeholders and industries (relevant to you) in terms of ETS implementation in Malaysia?
3.	How do you see the existing state of ETS implementation in Malaysia? Please describe the current situation on ETS planning and implementation in Malaysia state.
4.	What is the level of capacity and capacity building needs in terms of ETS implementation in Malaysia?
5.	What needs to be done to enhance the capacity of all stakeholders?
6.	Do you think ETS is important to achieve Malaysia's Nationally Determined Contribution (NDC) under the United Nations Framework Convention on Climate Change (UNFCCC) and Malaysia's net zero emission target by as early as 2050?
7.	Is ETS going to be successfully implemented in Malaysia?
8.	What are the factors for a successful and effective implementation of ETS in Malaysia?