Southeast Asia: A Multidisciplinary Journal
December 2022
Vol, 22, Issue 2, Pp.55-72
https://fass.ubd.edu.bn/SEA/index.html

Structural Analysis of Environmental Management of the Serasa Industrial Park

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Abstract

Modernisation is characterized by industrial development. The Serasa Industrial Park (SIP) is an industrial estate in Serasa sub-district, close to the Brunei Darussalam's only deep-water port. Given the link between industrial development and environmental degradation, as well as the general lack of environmental monitoring in Brunei, the paper questions whether environmental management (EM) is adequate to protect the area from further industrialisation. The purpose of this paper is to answer this question using SIP as a proxy because it is a well-established industrial site that should be more amenable to EM. This study involves two surveys of 20 firms and an interview with the environmental agency to gain a better understanding on the national policy and strategy. The paper found that, while the current state of EM is structurally weak, it is adequate for the SIP under current conditions. To protect the environment and increase industrialisation in the area, EM structures must be incorporated into existing regulatory frameworks.

Keywords: *Modernisation, industrial development, environmental management, degradation, Belt and Road Initiative (BRI)*

Introduction

Industrial development is a feature of modernisation. In Brunei Darussalam (in short, Brunei), this was led by the development of the oil industry in the decades after World War II. In the transition towards an independent nation-state, modernisation was guided by 5-year national development plans and powered by revenue from oil and gas. In 1970, a deep-water port was established at Muara. Several industrial parks were established in Brunei under the Brunei Industrial Development Authority (known as BINA). The Serasa Industrial Park (SIP) is located approximately one km southwest of the Muara deep-water port, longitude 5.01454°N and latitude 115.06273°E. It was developed for heavy and export-oriented industries in 1990. The 66-ha site is now a light-medium industrial state under the management of Darussalam Enterprise (DARe). Industrial activities range from the manufacture of animal feed and cement to steel fabrication and storage facilities in the form of warehouses or yards (Serasa Industrial Park, n.d.). About 30 companies operate

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in SIP. There are also several government facilities in and around the area, such as the Department of Fisheries' fish landing complex and the Serasa ferry terminal.

The Muara port was later expanded to include a container port, and the channel deepened as part of a development project. A bridge was constructed in 2015 to connect the Park to the large island of Pulau Muara Besar (PMB). Industrial development in the Muara-Serasa area has expanded with Brunei's participation in China's Belt and Road Initiative (BRI) (Huang, 2016). This has raised concerns over the potential for environmental pollution and degradation. As environmental management (EM) is relatively new in Brunei and therefore very much in its incipient stage of development, it is unclear if EM, whether by state, industrial park authority, or individual firms would be adequate for managing activities so as to avoid or mitigate environmental degradation. The main legislation, the Environment Protection and Management Order (EPMO), came into force as recently as 2016. Meanwhile, several companies in Brunei have taken the initiative to incorporate environmental management system (EMS) into their operation through ISO 14001 certification.

This paper, therefore, aims to examine the efficacy of EM based on its structure. Gaps and weaknesses would add to concerns of inadequacy, while sound structure, and confidence. The study involves conducting a survey of firms operating at SIP and an interview the environmental authority. The study was conducted as part of a Master of Arts in Environmental Studies by Research at UBD 2020-2021. The paper discusses the findings against conceptual structures of EM and EMS.

Given that access to on-going industrial development is restricted for safety and regulatory reasons, the study on the state of EM focuses on the oldest and most established industrial estate in the area, namely the Serasa Industrial Park (SIP). It is also chosen because an industrial estate is a planned development in a designated site, which means, it is expected to be managed by well-defined regulations. As a result, its EM would be more developed than that of individual companies outside the estate in the rapidly developing industrial area. The scope of the research is confined to the SIP but excludes the Serasa Ferry Terminal and the Fisheries Department's facilities.

Literature

Pollution and environmental degradation are inextricably linked. This association was stronger in the early days of industrialisation, when energy was generated on-site from raw fuel using steam boilers and, later, hydrocarbon-powered generators. Large amounts of hazardous emissions and discharges were released into the environment of industrial sites. In the long run, solid residues and land conversion for industrial purposes contributed directly to land degradation and indirectly to environmental pollution. Although there were no concerns about CO2 until the latter part of the 20th Century, CO2 was emitted from industrial sites in an amount concomitant to the scale of industry and

activity. During this period, power is however generated in power plants that are far removed from the industrial site. Electricity production has also become significantly more efficient, as have pollution control systems. Natural gas, which is considered clean energy due to its efficiency, is used to generate power in Brunei.

EM emerged in response to the negative impacts of industrial and modern development. Unwanted outcomes, such as the 'Great Stink' and 'Great Smog,' served as wake-up calls, prompting the passage of legislation to regulate industries and development to reduce pollution (Cook & Werner, 2017). 'Sensitive environmental receptors' are natural areas and biomes that are more vulnerable to the effects of pollutants (US EPA, 2009, 2019). They must be protected because of their potential to affect the ecosystem and wider environment when significantly altered by industrial activity. Environmental impacts of industrial development could range from mild or negligible to major (drastic), based on assessments by government agencies, academia, and environmental watchdog groups (Krishna & Manickam, 2017).

Environmental regulations were largely 'command and control' (CAC) in nature in the 1970s. Governments were determined to reduce pollution and environmental degradation while protecting and conserving natural areas and wildlife (Harrington & Morgenstern, 2007). Economic incentives were introduced in the 1980s to encourage industries to be more environmentally friendly. This approach was found to be cost-effective but time-consuming, as it was reliant on individual companies to respond to the programme. The CAC approach, on the other hand, requires the industry to comply with the threat of penalties. It is more effective in lowering emissions. However, because field inspectors are required, the administrative costs are higher; measurements and studies are an additional expense. Furthermore, policing compliance is difficult because some businesses only follow regulations during inspection periods, particularly when regulators lack monitoring capacity.

The Earth Summit in 1992 (Meakin, 1992; UN News Centre, 2015) ushered in a new approach: forging a partnership between regulator and industry, where the former set policies and goals and the latter manages its own emissions by implementing an environmental management system (EMS). Governments similarly adopted an integrated approach to planning and management, merging line agencies to promote collaboration, efficiency, and efficacy. These are the hallmark of the sustainable development concept introduced by the World Commission on Environment and Development (1987). Since the 1990s, environmental protection has become a prominent feature of industrial regulation in the industrialised nations, with industrial leaders paving the way toward a greener future (Gunningham & Sinclair, 2017; Tracey & Anne, 2008).

Three common principles underpin environmental regulation and legislation (Wibisana, 2006): (i) the polluter should pay for the cost of environmental degradation; (ii) prevention is preferable to remediation; and (iii) precautionary measures are always prudent. The

Polluters Pay Principle places the responsibility to safeguard the environment from industrial activities on industries by requiring them to bear the cost, which had been an 'externality' in economic and business accounting. Meanwhile, the Precautionary Principle is founded on a moral obligation to protect the public and the environment from potential harm (Abdul-Baqi Alhassan, 2015). The Prevention Principle involves taking mitigation measures to avoid/prevent environmental damage before it occurs (Client Earth, 2018). Over the last century, environmental regulation and legislation have evolved to address new issues as they emerged; new approaches are always required to deal with newer issues that emerge from changing realities (McManus, 2009).

In the United States, the passage of the National Environmental Policy Act (NEPA) in 1969 was a watershed moment. It established a regulatory framework for protecting the environment from the effects of large-scale development projects. The underlying concept of NEPA was to create a "harmonious relationship" between man and the environment (UN News Centre, 2015). The Act takes a proactive approach to EM by requiring federal projects to undergo an environmental impact assessment (EIA) to identify and address potential impacts prior to project implementation. Where impacts cannot be avoided, proponents must consider alternative designs or sites. The most significant contribution of NEPA was that it required environmental consideration, or an environmental policy, in large-scale federal projects. During the Earth Summit, EIA was adopted as a tool to promote sustainable development because it allows regulators to learn about the potential impacts of the proposed development and industrial activities, allowing them to be addressed and potential impacts avoided or mitigated prior to approval (Baldwin & Robbins, 2007). It is a proactive means of EM founded on science and technical evaluation (King, 2008; Ott et al., 2012).

Another proactive method of EM is an EMS. When integrated into an industrial system, it creates a self-regulatory mechanism by analysing how the company's processes interact with the environment (known as 'environmental aspects,' identifying priority areas for intervention, establishing a management and monitoring system, and is designed for continuous improvement (World Commission on Environment and Development, 1987). It promotes and ensures adherence to environmental regulations (Waters, 1998). Adopting EMS requires the company to voluntarily recognize and accept responsibility for potential environmental damages that may occur as a result of the environmental aspects of its activities. Prior to the sustainability movement, environmental costs were treated as an externality. The costs involved represent the internalization of those costs (Ho et al., 2017; Long et al., 2012). EMS, as a system, integrates all company sections horizontally and vertically into the greening process, which includes responding to monitoring data and regulatory requirements (Long et al., 2012; National Environment Commission, 2011; Waters, 1998). It also enhances the company's image concerning its environmental and social responsibility (Bansal and Roth, 2000) and promotes innovation (in response to meeting certain targets), which could lead to new technologies and products (Singh et al.,

2015). However, the country's regulatory regime, which is related to its stage of environmental governance development, strongly influences EMS adoption.

In a study on the effects of EM in North America involving 1,510 respondents, Melnyk et al. (2003) distinguished EM into three: (a) no EMS; (b) informal EMS, where the company manages a range of its environmental aspects without a certified EMS; and (c) formal EMS, where the company has a certified EMS. They tested the hypothesis that EMS contributes significantly to environmental performance and found a direct relationship, such that companies with no EMS performed poorest, while those with formal EMS attained the best performance. Furthermore, EMS became more effective when more individuals within the companies from different positions and roles were involved. EMS also increased staff awareness of the company's environmental activities and goals. They found the first two variables highly significant and cited continuous improvement in staff awareness and communication as key to better environmental performance.

An industrial estate, as opposed to individual companies engaged in industrial operations, is part of a planned industrial development in which the production facilities of several companies are located in a specially designated area (Alexander, 1963; Bale, 1974). This arrangement enhances efficiency and productivity through purposed-built shared infrastructure, often in a favourable location. Eco-Industrial Parks are industrial estates designed using the concept of ecology (Mantese et al., 2018; Zhang et al., 2015; and Raafat et al., 2012). It involves organising companies to share their by-products, such as water, energy, or waste, such that they become resources for complementary companies. This arrangement closes ecological loops by allowing companies to exchange energy, materials, and waste in a mutually beneficial manner, resulting in an industrial symbiosis (Park & Park, 2014; Park et al., 2018).

EMS, however, could also be applied to the industrial estate. In 1998, a "comprehensive environmental management system" (CEMS) was implemented in the Dalian Economic and Technological Development Zone (DETDZ), China (Geng and Côté, 2003). The DETDZ's heavy reliance on coal was a source of concern. However, as a result of the CEMS, coal was gradually replaced by petroleum gas, and over a 5-year period, energy efficiency exceeded 90%, compared to 58% in 1998. Sulphur Dioxide emission was reduced by 16.7%. The water recycling program alleviated water needs, lessening water pollution and contributing to the recovery of natural habitats. The CEMS ensured compliance with regulations, minimized financial liability and costs, and facilitated the improvement of the Park's environmental performance systematically. To reduce reliance on foreign agencies, the establishment of a national ISO/EM Audit Centre in China facilitated auditing. Other industrial estates in China that have been certified with CEMS include the Tianjin Economic and Technological Development Area (TEDA), the Suzhou New District (SND) and the Yantai Economic and Technological Development Zone

(YETDZ). The local government's strong support is critical to the DETDZ's success (Geng & Côte, 2003).

All tenants must follow the park's environmental policy and common practices under the CEMS system. The park's EA and potential impacts are assessed by taking into account all tenants' activities. The park authority identifies and categorizes common, uncommon, and hazardous pollutants for different management. The tenants set environmental targets in each review cycle based on findings of studies done and or monitoring data. The park or individual tenants could organize and facilitate training for their purposes. The same is true for environmental management technologies. The Park monitors the estate's environmental aspects as a whole. Annually, the Park's CEMS will be audited and reviewed by a certified and authorized the third party.

EM in Brunei is a recent development (Department of Environment, Parks & Recreation, 2006). It can be traced back to the 5th National Development Plan (NDP, 1986-1990), which has a stated objective of simply "maintaining a clean and healthy environment". The adoption of 'sustainable development' as the guiding principle for development was also included in the 6th NDP. The 7th NDP (1996-2000), however, contained an environmental policy, entitled: "towards a better-quality environment". Its goals are to (a) maintain sustainable utilization of natural resources; (b) minimize negative environmental impacts from population growth and human activities, and (c) balance socioeconomic development goals with the need to maintain sound environmental quality. A review of the country's legislation (Tobin, 1992) discovered that there were no comprehensive environmental laws but that provisions in existing legislation could be used for a variety of environment-related regulations. Yong and Tamit (2001) identified several challenges to environmental regulation. The Environmental Protection and Management Order (EPMO), enacted in 2016, is the first and only law aimed at protecting the environment from the effects of industrial development. At the application for approval stage, companies must notify the authorities and provide an accompanying EIA. Companies are required to provide regular reports specified in the environmental management and monitoring plan following the completion of the construction or activity (EMMP).

The Serasa Industrial Park Environment

The natural environment of the SIP is a tropical estuary along the northwest coast of Borneo. The location is on the western edge of Brunei Bay. The Inner Bay, which lies beneath Brunei, accounts for only one-fifth of the entire bay. West of SIP is a low, narrow, north-south oriented, forested ridge that juts into the South China Sea at Tanjong Batu's coast. The Pelumpong spit extends abruptly eastward for 8 kilometers into Brunei Bay, one kilometer south (Yong, 1996, 2010). PMB, which is located just south of the spit, was previously a recurved spit that was severed from the mainland (Yong, 1995, 2010; Sandal, 1996). Mangroves and mudflats line the western shores of the mainland. SIP was built on

reclaimed land that displaced mangroves and mudflats, leaving only a narrow band and a channel called Sungai Serasa at its southern end.

As with all estuaries, the shallow Brunei Bay is a highly productive region and an important part of the marine ecosystem. A seagrass meadow on the extensive mudflat between PMB and Pelumpong is also the endangered dugong's feeding ground, found in and around the area. Two deep submerged channels exist in the Inner Bay. The Eastern and Western Channels are connected to the catchments of Sg Temburong and Sg Brunei, respectively. The western channel flows around the western edge of PMB and in between the island and the Pelumpong spit, while the eastern channel is found east of PMB. The two-channel joined off the tip of Pelumpong and veered north-westwards into the South China Sea through a set of small islands associated with Labuan; this island is a federal territory of Malaysia. The western channel receives discharges from the urbanised district of Brunei-Muara.

Brunei Bay is a micro-meso tidal estuary with a tidal range of 1.5 to 2 m. Ebb tidal current is stronger than a flood, and tidal flushing in the area is 1-2 days (Curie, 1979). The estuary is generally partially stratified vertically, laterally across the width of the bay as well as longitudinally from the mouth of the bay to that of the main rivers. However, it is quite well-mixed in the vicinity of SIP (DHI, 2020). Sedimentation is a natural process in estuaries. This is evident from the bathymetry map of the area, where shallow areas at points to the north and south of SIP along the channel appear to be 'choke-points' or sediment traps. This suggests that sediments from discharges into this section of the channel are unlikely to be transported by currents into the coastal waters, where it could affect patches of coral reefs. Seagrass similarly occurs in small patches on the leeward side of islands and the mainland with respect to ebb and storm discharge currents. These are depositional sites within the estuarine environment, and hence, most at risk of industrial pollution.

The channel between the land, where SIP and Muara Port are found, and PMB had been dredged and deepened to 9m as part of the port's original development. To facilitate navigation, an "access channel" was also cut halfway along the Pelumpong spit. Much of the spit-up to the access channel has been developed as industrial land for the Navy, marine police, and port activities. Muara town is located adjacent to the port. As part of earlier plans to develop PMB into a 'supercontainer' port, the channel was deepened to 12.5 m in 2000. The port has also grown. The Zhejiang Hengyi Group was granted permission to build a petrochemical complex on PMB in 2011. EIA was conducted for the different phases, and therefore, detailed environmental information for the study area exits. There are ongoing developments on and around PMB, such as channel dredging and reclamation of the island's northern shores. Figure 1 depicts the land use and environment surrounding SIP.

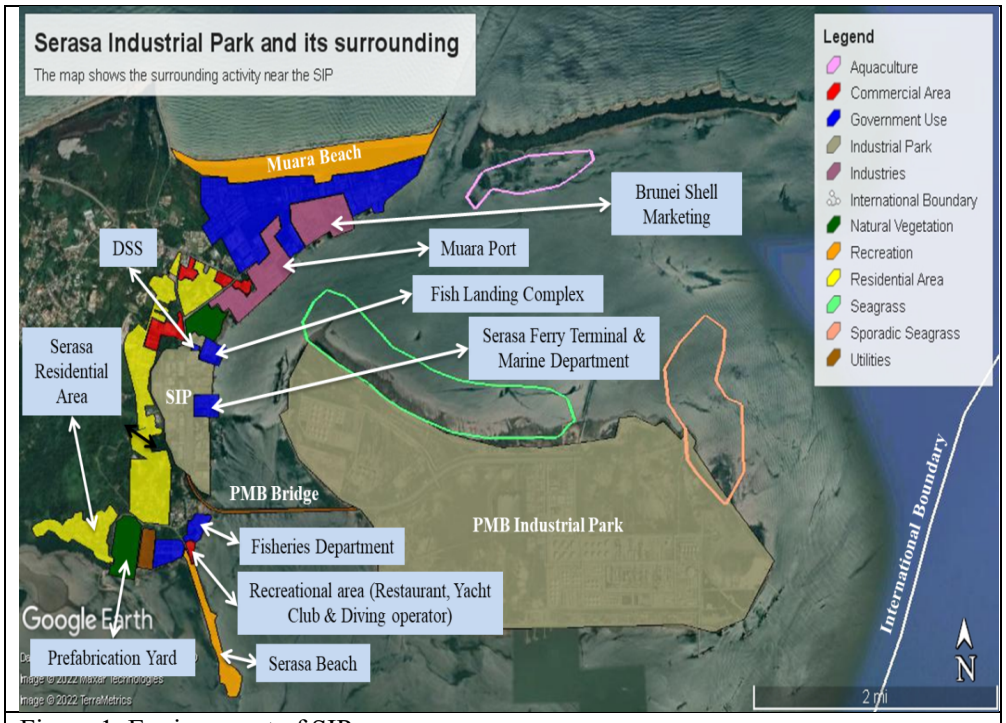

Figure 1. Environment of SIP

Methodology

The underlying concept of EM is to make environmental aspects (EA) of industrial activities environmentally friendly and to mitigate against significant ones. The key actors are the environmental authority and private companies, as well as industrial estates as wholes. The former regulates the latter and monitors environmental conditions. Companies with an EMS would regulate their own activities and monitor their processes for potential environmental degradation. Environmental receptors that are sensitive to environmental degradation are identified. Figure 2 depicts the study's conceptual framework.

There is extensive environmental data available (e.g., Yong, 1996, 2010; Sandal, 1996; Department of Environment, Parks & Recreation, 2006; DHI Water and Environment, 2020). Questionnaire surveys were used and an interview with the environmental authority was conducted to gather information on EM. The first survey questionnaire used a 5-level Likert scale to collect information about individual companies' EM practices, as well as their opinions on four common ways to strengthen EM. These are as follows: (i) mandatory EMS for all companies; (ii) different EM for different industries; (iii) a green rating scheme to recognize companies with good EM; and (iv) incentives to

promote/support EM. Questionnaire surveys were mostly conducted over the phone and through Google forms since it was conducted during the COVID-19 partial lockdown.

Based on the findings of the first survey, a second survey was conducted to obtain more information about EM capacity and practice. Two different sets of questionnaires were used, one for companies with formal EM and one for those without. The EM questionnaire (survey 2 EM) requested the following information: the formal EMS (name); the reasons for certification; dedicated personnel for EM; the company's environmental vision/goal and policy, if any; the main challenges in EM, and details of expected environmental impacts if processes were not properly managed. The questionnaire for companies without EM (Survey 2 NEM) asked about their policies and practices concerning energy, waste reduction, and emissions. They were also asked whether they: (i) consider the company to be environment-friendly; (ii) are willing to adopt partial/full EMS to improve operational efficiency; (iii) would invest in pollution abatement technologies if a study found that they are polluting the environment. They were also asked about their interaction with regulators and any improvements desired.

The interview with one officer from the environmental authority was carried out on 22 February 2021. The questions asked include:

(i) how is regulation of companies carried out?
(ii) is self-regulation through formal EMS promoted?
(iii) response to survey findings of the company for clearer guidelines?
(iv) does the authority monitor activities in industrial estates to safeguard the environment?
(v) how are environmental offenders dealt with?
(vi) what are the main concerns regarding industrial estates?
(vii) plans for enhancing EM and monitoring industrial development in Brunei.

Data and Findings

Of the 29 occupied sites in the SIP, only 20 are operational, and half did not respond to the survey. Four of the ten companies that responded said they have formal EMS, while the others said they don't but follow regulations. Among those with formal EMS, one said that the adoption of ISO 14001 should be promoted, while another said that there should be a stricter control of noise and dust pollution. Only one company indicated that its staff had undergone EM training. It should be noted that all but two of those who participated in the survey had EM-related responsibilities.

Table 1: Company Types & EM, Survey 1

Industrial Category	EMS	No EMS	Total
Manufacturing (M)	1	2	3
Fabrication (F)	1	1	2
Construction & Engineering (CE)		2	2

Supply Base (S)	2	1	3
Total	4	6	10

In response to an open-ended question about the environmental impacts of each company, 6 out of 10 said water pollution, while 4/10 said air pollution, water conservation, or hazardous waste 4. One person mentioned noise pollution, while another mentioned waste oil. Questionnaires answered by health safety and environment (HSE) personnel listed 3-4 environmental issues, while non-HSE respondents gave two or less. This could simply be due to a lack of knowledge on the part of non-HSE personnel. There is no clear distinction between businesses that have formal EMS and those that do not. Manufacturing, fabrication, and workshop activities are generally expected to have higher environmental impacts, resulting in some level of air, water, or noise pollution. Apart from the occasional noise and potentially polluted discharge associated with storm runoff, supply bases with materials exposed to the elements are not expected to have significant interaction with the environment. Because of the low level of activity, there are also low levels of transportation emissions. Construction and engineering companies operate at work sites. Their bases at SIP comprise largely of offices, warehouses, and yards. According to information obtained through direct communication with a few of the companies, manufacturing operations at SIP appear to be mostly late-stage processes such as mixing and packaging. Although it was originally intended as a heavy and export-oriented industrial site, SIP is now a light industrial estate with low emission levels.

The average scores for the four questions on ways to improve EM on a scale of 2 (strongly agree) to -2 (strongly disagree), where neutral is zero, were just slightly higher (1.1) or lower (0.8) than "agree" (1). Those who have formal EMS agree that EMS should be mandatory for companies in industrial estates, and they support an incentive scheme for EM. In contrast, many companies that did not use EMS were uninterested in the concept. However, both categories were "neutral" to "agree" on having specialized EM procedures for different types of industries or having a rating scheme to recognize companies with good EM practices. There are no companies that disagree with any of the suggestions. This could be due to the cultural trait of employees and businesses in Brunei in general of not voicing opinions that are contrary to what is perceived to be correct or presented by authorities or their representatives. However, the responses may not be representative of the company but rather reflect the respondent's personal views. They may also be based on a lack of EM/EMS knowledge, as 8 of the ten respondents were non-EM personnel. Nevertheless, companies with formal EMS indicated a greater degree of agreement. Although only slightly, those who did not receive more mute responses.

In the second survey, only 8 of the ten companies from the first survey responded. It was found that only two have ISO 14001:2015 certification, while one has an in-house EMS, i.e., informal, which it established to comply with the site’s Environmental Management and Monitoring Plan (EMMP). The fourth does not have any certified EMS or an informal EMS, even though it indicated that it has in the first survey. This was clarified by the

'document controller' in the second survey, who also relayed that a clear environmental guideline would be desirable.

The three companies with EMS all have environmental policies and dedicated teams, as is required in theory and practice. However, they are HSE rather than strictly EM, which has different functions and expertise, although there is an overlap. The two with formal EMS acquired the ISO 14001 certification to align with international requirements. In response to the question on the severity of environmental impacts that could occur without EM, the companies with certified EMS indicated 3 and 4, respectively, while the one with an informal EMS rated it 5, i.e., maximum severity. However, the high scores might reflect its industry (oil and gas), rather than the actual facilities at SIP, which are storage facilities (Abdul-Baqi Alhassan, 2015; Wibisana, 2006).

In terms of EM challenges, one of the companies with certified EMS has not encountered any since 2004. Quarterly dust and noise monitoring reports are submitted to the authority. They see their relationship with the regulator as a 'partnership,' and they are happy with it. The other company, on the other hand, struggled with compliance due to a lack of resources, particularly knowledgeable personnel, to deal with regulatory requirements and EM. A contractor is currently in charge of monitoring potable and drilling water. The 'hazardous substances' (brines) they handle are not actually hazardous in EM, but they may be in HSE. The brines are stored in SIP warehouses before being disposed of by a contractor. Due to the limited number of approved specialist services available in Brunei, the main challenge for the company with informal is managing waste management costs. Waste and CO2 emissions are the primary environmental parameters monitored. Their records, however, are not sent to the authorities unless requested. The majority of the hazardous wastes handled are waste oil and drilling fluids, which are stored in the company's warehouse.

The findings from the second survey for non-EMS group, only 3 out of the 6 in Survey 1 responded. However, the responses revealed that the three companies practiced EM informally because they have processes to minimise waste/wastage as well as energy use; recycling is practiced by one. All three stated that they are aware of where their gaseous, liquid or solid wastes end up and that they are pleased with how their discharges are managed. Although one of the three does not consider the company to be "environmentally friendly," the fact that it is "constantly trying to improve" is consistent with the EMS concept. As a result, all three could be considered to have informal EMS. Furthermore, all three are willing to implement more formal EMS and are willing to spend to improve their environmental performance. One light manufacturing company conducts an environmental risk assessment to manage its environmental aspects.

With regards to the relationship with the regulator, 5 of the eight respondents see the regulator as the authoritative figure to heed (command and control type). The three with EMS regards the regulator as an authority partner. The two manufacturing companies

without EMS prefers the regulator to conduct regular inspection to reduce environmental risks and provide clear guidelines. In general, companies with formal EMS are more concerned with controlling emissions and getting approval from the authority, while the non-EMS group is more concerned with managing waste and energy. Companies with EMS are more aware of their specific environmental aspects because the EM processes elucidate them. However, the effort taken by the three that responded to Survey 2 non-EMS suggests that they have informal EMS.

An interview with an officer from the environmental authority provided clarity on EM by the regulator (ER). The responses are summarised in Table 2 below.

Table 2: Environmental Regulation

Question	Answer
1. How are companies regulated?	They will notify ER if required under EPMO 2016 and report as required under EMMP.
2. Role of ER in EIA.	EIA required under EPMO for projects under Schedule 1. The company to notify ER and submit EIA for review and approval.
3. Issues with EIA.	Overlapping jurisdiction, partly due to lack of clarity of ER's role, as it was established without legislation and therefore has no statutory power.
4. Role in Environment Regulation.	ER is the authority for EMPO 2016 (though not clearly identified) and Hazardous Waste Order 2013. It also enforces compliance with EMMP. ER is, however, short of manpower; 2 officers are handling up to 100 notifications.
5. View regarding the adoption of EMS, e.g., ISO 14001.	Companies with EMS have a more disciplined approach to EM. However, ER does not 'force' companies that cannot afford it due to the cost of certification. ER does not provide any incentives to encourage companies to have formal EMS.
6. Response to survey findings calling for clear guidelines.	ER is surprised because existing requirements are straightforward.
7. What is basic environmental compliance?	Compliance with EPMO 2016 and ER's Pollution Control Guidelines.
8. Language of law is hard for many. Any plans to produce simple guides?	No. ER will liaise with other authorities to relay information, with no direct communication with companies.
9. Does ER regulate activities in industrial estates?	No. ER will liaise with other authorities.
10. How does ER deal with environmental offenders?	ER will halt operations in cases of major incidents (accidents). Police deal with minor offenses.

Clearly that the ER is not actively involved in EM, it does not communicate directly with companies on environmental matters, except for major incidents. Its primary regulatory tool is the EPMO 2016, which requires the company to notify DEPR of its proposal and submit an EIA along with an EMMP. It is also the responsibility of the company to report environmental incidents. The ER does not believe it is necessary to respond to survey feedback requesting clearer guidelines and regulations because it believes the current ones

are adequate. In response to questions on (i) the main concerns with regards to industrial estates and (ii) any plans to enhance the regulation of industries in Brunei, ER said that cumulative air and water pollution are the main concern in response to the first. There are no plans to strengthen environmental regulation until its statutory authority is established.

Discussion

The study confirms that EM management by companies operating at SIP is quite minimal, with only two out of ten having formally certified EMS and three out of ten having informal EM. The other five have no EM policy or practice. It is very likely that the ten people who did not respond to the survey also do not have EM. Except for one, all got very limited EM technical capacity. However, given the nature of the SIP occupants, it is understandable that many do not see the need for EM policies, practices, or systems, given that the majority are essentially storage facilities or late/end-stage production. Steel and stone fabrication do not produce many emissions. Electricity consumption or emission from transportation is also low due to the relatively low level of activity. The main environmental concerns appear to be isolated dust and noise. Hazardous wastes (oils, drill cuttings, and brines) are currently stored in facilities and handled by specialists. Based on a recent survey associated with the EIA for the Hengyi Petrochemical Complex Phase 2 development, the natural environment appears to be in good condition. Structurally, the two with certified EMS have the proper structure for EM but are somewhat 'thin' because of inadequate resources and justifiably, need. The three with informal EMS require intervention to build capability in order to establish a more robust structure for EM that includes mechanisms for aspects and impact analysis, target setting, mitigation systems, training, systematic management and monitoring, review and analysis, and continuous improvement.

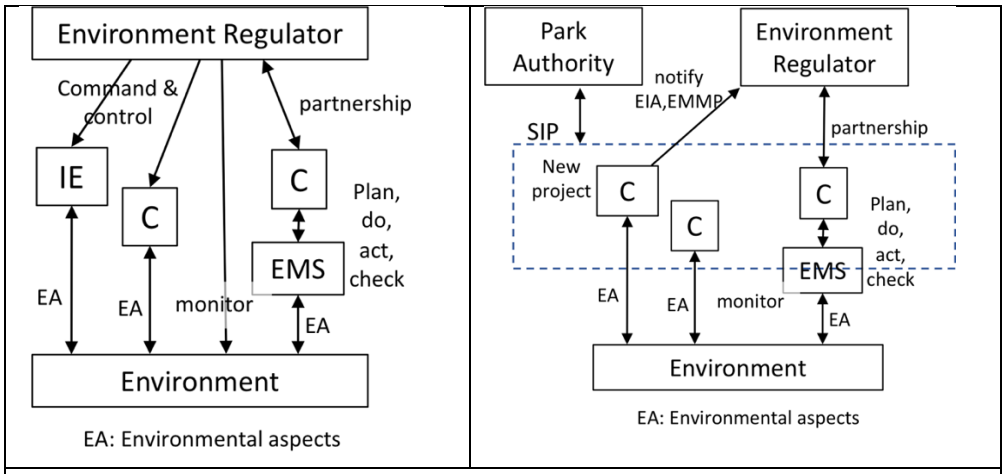

Figure 2. Environmental Regulation Structure: Theoretical (L) vs. SIP (R).

EM by ER, however, is alarmingly passive. Figure 2 compares the theoretical environmental regulation structure (left) with one constructed from the interview (right). In theory, the ER regulates companies' environmental aspects through legislation and guidelines concerning discharge and damage to the natural and social environment, as well as protected wildlife. This has traditionally been accomplished through command and control. Post-Earth Summit practice allows companies to manage their own environmental aspects through a system that continually improves their environmental performance. In contrast, because it is passive, the EM structure by ER in the SIP (Figure 3(b)) cannot be considered command and control. Companies intending to carry out a project must notify the ER if the project is listed under Schedule 1 of the EPMO 2016. The company must consult with and submit to the ER, EIA, and EMMP for the project, if necessary. After approval and implementation, the company must submit regular monitoring reports to the ER for a period of time. The ER does not independently monitor the environment. Companies that do not have new projects are not required to notify the ER or conduct an EIA. The same can be said for the industrial estate. On environmental issues, the estate authority will consult with the ER. Only in the event of a major incident will the ER shut down industrial operations.

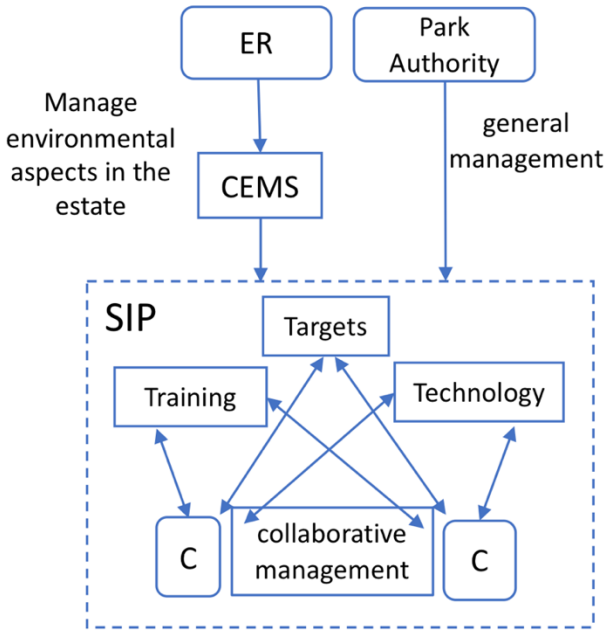

Figure 3. Incorporating CEMS into SIP

Structurally, EM deviates drastically from theoretical structures. Companies with EMS are considered favourably. However, there are no policies or incentives to promote EMS or provide EM capacity building for interested companies. Communication with companies is limited and largely restricted to guidelines, which appear to be sufficiently clear to some. The implication of this finding is that EM by the ER is inadequate to deal with industrial development on a much larger scale and intensity. EM could, however be improved by incorporating a CEMS structures, like that in the Dalian Economic and Technological Development Zone (Geng & Côte, 2003).

Conclusion

The SIP is one of the oldest industrial estates, originally intended to serve the export and heavy industries. However, it has evolved into a light industrial site with largely insignificant environmental impacts. The study carried out in 2020-2021 found only 2 of 20 companies have formally certified EMS, and 3 have informal EM practices. The authority's EM is structurally weak and passive. Although this can be explained in part by the ER's lack of statutory powers and capacity, it exposes the environment to increased industrial activity with few safeguards, with the exception of EM initiatives and EMS implemented by individual companies. The massive Hengyi petrochemical plant is located across the channel. Its second phase of development includes significant environmental modification, including the removal of seagrass meadows along its northern shores. The problem is easily remedied by restructuring the regulatory process to resemble the theoretical EM system. More research involving more stakeholders and field investigations is required to improve understanding of environmental management (EM).

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