

# DETERMINATION OF EVALUATION INDICATORS FOR PRE-ABANDONED PROJECT BASED ON SUSTAINABLE GOAL DEVELOPMENT ASPIRATION

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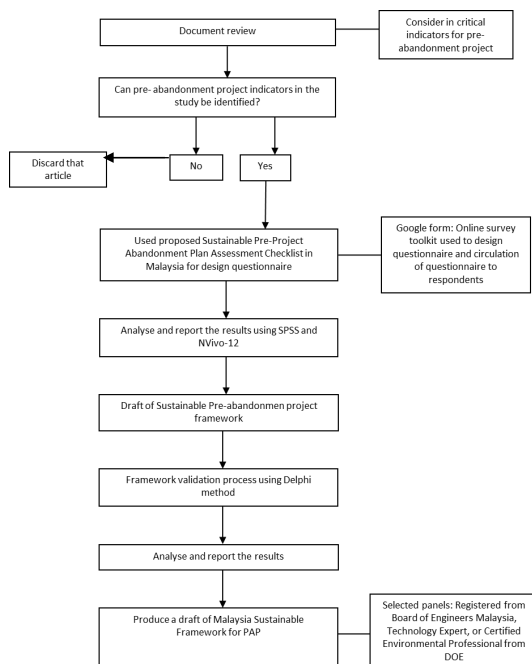
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## Graphical abstract



Flowchart of Research Methodology

## Abstract

Every project management will strive to ensure that one project can operate without any problems. Unfortunately, some projects are still abandoned due to certain reasons. If the abandonment occurs, the requirement to submit an abandonment plan is stipulated on the Environmental Impact Assessment (EIA) Guideline in Malaysia, 2016. Unfortunately, still lack of resources on pre-project abandonment guidelines which will lead to poor project abandonment report preparation and assessment. Thus, this study aims to determine crucial indicators for assessing the pre-abandoned project, proposing a framework of Malaysia Guidelines for Pre-Project Abandonment Plan (PAP), and validating the draft of the Malaysia Guidelines Framework for PAP. The collected data was compiled from various sources, including document review, survey, and Delphi Method (focus group discussion). The survey conducted proved that the most crucial indicators for the assessment of pre-abandoned project were (i) waste management, (ii) allocation of environmental budgeting, (iii) inventory of scheduled waste, (iv) slurry management, (v) method of demolished, (vi) safety and health of workers, (vii) drainage management system, (viii) site management, (ix) type of treatment plant, and (x) site housekeeping. This framework will assist both report preparer and policymakers on project abandonment report preparation and evaluation, respectively. The development of this framework was strengthened by comprising related legislations, and each indicator synchronized towards Sustainable Development Goal (SDG) 2030.

**Keywords:** Abandoned project, environmental impact assessment, sustainable development

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## 1.0 INTRODUCTION

Shared Prosperity Vision 2030 is a commitment to ensure the achievement of sustainable growth and fair and equitable distribution across income groups, ethnicities, regions and supply chains throughout the Malaysian perspective. The commitment aims to strengthen political stability, enhance the nation's prosperity, and ensure that society is united whilst celebrating ethnic and cultural diversity as the nation-state's foundation [1]. Sustainable Development Goals (SDGs) 2030 is a plan of action for people, the planet, and prosperity in a global context. Several SDGs supported this study, as shown in Table 1. The goals are very important because all countries and stakeholders will implement this plan [2].

**Table 1.** The 2030 Agenda for Sustainable Development

Sustainable Development Goals 2030 (SDGs)
SDG 6 (Clean Water and Sanitation)
SDG 13 (Climate Action)
SDG 14 (Life below water)
SDG 15 (Life on land)
SDG 3 (Good Health)
SDG 11 (Sustainable Cities & Communities)
SDG 7 (Renewable Energy)
SDG 8 (Good Jobs and Economic Growth)
SDG 9 (Innovation and Infrastructure)
SDG 15 (Life on Land)

According to Table 1, the basis of the shared prosperity being highlighted in the plan is economic growth. Indirectly, towards achieving the goals, many factors such as environmental sustainability development by the nation with effective environmental policy and efficient decision making by the policymakers can affect the effort. One of the ways to increase economic growth is through the rapidity and progress of project development. Recently, there have been many types of projects such as building works (residential, commercial, industrial), civil and heavy engineering works (roads, railways, bridges, sewers, dams, airports, jetties, cofferdams, caissons, tunnels, refineries, power stations), and construction establishments (research institutes, polytechnics and universities) that involve clients, consultants, contractors, manufactures and distributors, suppliers and sub-contractors, and end-users [3].

### 1.1 Definition And Technical Terms For The Abandoned Project

Decommissioning could also be termed “abandonment” [4,5]. It can also be seen as the reverse of the installation process [6]. Previously, several factors could contribute to the project abandonment. These factors can be classified into three major groups: (1) economic crisis, (2) social problems, and (3) environmental reasons. Unfortunately, some of the projects were abandoned for many reasons. Several studies revealed that the abandonment of a project causes a negative impact. Chaudhary [7] found that abandonment can also cause the change of land use and is being seen as a major factor contributing to the increase of eco-environmental risk, undesirable changes in the socio-cultural landscape, biodiversity

loss, and reduced capacity of the system. Existing studies also show that Anhydrite mine is abandoned because it is no longer used; improper management might cause environmental, social, economic and safety risk issues in the area [8]. Furthermore, some wind power projects abandoned potentially have adverse impacts on raptors [9]. Abandonment of petroleum industries infrastructure would affect climate change. Best management practices must be applied to reduce the negative impact on the environment. Hauck [10], who supported this view, claimed that negative carbon dioxide (CO<sub>2</sub>) emissions could be achieved by applying Carbon Dioxide Removal (CDR) technologies. Thus, a project owner needs to know related indicators involved in managing the abandoned project. Lack of indicators determination will cause pollution and problems in the future.

### 1.2 Project Abandonment Categories

Abandonment of project would happen for either Environmental quality (Prescribed Activities) (Environmental Impact Assessment) Order 2015, Environmental Quality Act (EQA) 1974 or Non-Prescribed Activities. In Malaysia, the approval of the abandonment project plan for Prescribed Activities under EIA Order 2015 is under the jurisdiction of the Department of Environment (DOE) [11], while the Non-Prescribed Activities projects are under Local Authority jurisdiction. Some studies defined abandonment as a progress of a certain work facing too many problems that seem impossible to continue further, resulting in it completely stopping; therefore, it is defined as an abandoned project [12,13]. There are two types of project abandonment in Malaysia: Schedule 1 and Schedule 2, EIA Order [14] (Table 2). This table shows the Prescribed Activities In EIA Order 2015, Environmental Quality Act 1974. For the first schedule, the EIA report should be submitted to the relevant State Offices of DOE, and the second schedule report should be submitted to the DOE headquarters for review and approval. In addition, for the proposed project that traverse two or more states (such as a linear project), even though it is under the first schedule, the EIA Report submission must be made through the DOE Headquarters for review and approval. In this study, the pre-abandoned project research framework is for Prescribed Activity under EIA Order 2015 [14]. The pre-abandoned project plan needs to be assessed by policymakers before the project owner executes the abandonment activities. EIA project involves a certain scale of project and activities; thus, the project abandonment management must be managed well. Lasanta *et al.* [15], who supported the view, reported that abandonment could cause environmental, socioeconomic, and landscape implications. It can occur in European mountains, known as land abandonment. For this case, environmental implications such as the disappearance of species adapted to man-made environment reduce the biodiversity, propagating fires due to the increased plant biomass and reduction in river flows. In addition, socioeconomic impacts on cultural value and landscape implications such as uniform landscapes through the loss of farmland. Some authors actively managing an abandoned field to maintain a mosaic landscape that is very diverse, heterogeneous, and of great environmental and cultural value [16].

Recently, the novel coronavirus pandemic of 2019 (Covid-19) became a new significant cause to project abandonment due to unstable economic development. Falcon *et al.* [17] claimed that the outbreak of Covid-19 also affected the

economy. Sectors affected include agriculture, trade, tourism, textile, electronics, automobile, iron and steel mineral processing, real estate, and software. The paper industry is affected severely as paper usage has declined to a maximum extent due to the closure of various government and social institutions. Transportation or roadways later fined the government for spending rupees for repairing and social development which is related to human resources, where in the year 2019, approximately 200 million people, as estimated in the global migrant workforce, sent home US\$715 billion (£571 billion). Improper management of abundance construction wastes such as debris and residue can harm the environment. Construction waste would increase since the building constructed in mid-1960 will be demolished and reconstructed in future [18]. Thus, the assessment of pre-abandonment project indicators is very crucial.

**Table 2.** Prescribed Activities in EIA Order 2015, Environmental Quality Act 1974 [14]

First Schedule	Second Schedule
1. Agriculture	1. Agriculture
2. Aerodrome	2. Aerodrome
3. Drainage and Irrigation	3. Drainage and Irrigation
4. Fisheries	4. Fisheries
5. Forestry	5. Forestry
6. Industry	6. Industry
7. Land reclamation	7. Land reclamation
8. Mining	8. Mining
9. Petroleum	9. Petroleum
10. Ports	10. Ports
11. Power generation and transmission	11. Power generation and transmission
12. Development in Coastal and Hill Area	12. Development in Coastal and Hill Area
13. Development in slope area	13. Development in slope area
14. Waste treatment and disposal	14. Waste treatment and disposal
15. Dredging	15. Construction of a dam
16. Housing	16. Transportation
17. Industrial Estate	17. Radioactive material and radioactive waste
18. New township	
19. Quarry	
20. Road	
21. Water supply	

### 1.3 Regulatory On Project Abandonment

Most studies in the category of abandonment projects have only focused on the “cause and effect” of the actual abandonment. Debate on the best strategies for EIA project management continues. In this case, insufficient resource documents on the project's abandonment phase to be referred by the decision-making agencies will cause a negative environmental impact. Table 3 list several countries that have legislation on abandonment project, however lacks guidance on how to preparing the abandonment plan report. The abandonment report is crucial as it would have a notification on the date of project abandonment, management aspects, and mitigation measures to avoid problems related to the abandonment of the project. Both report preparer and policy makers will have adequate information for report preparation and decision-

making on the abandonment of a project. The main objective of decision-making is to make a better decision [19]. The abandon report review is a mechanism to monitor and ensure that the abandonment report complies with the legislation. The authority is responsible for policy planning, financing, project approval, quality control, monitoring, and evaluation [20]. To effectively implement the EIA and achieve the goals, a resource is required and must be given attention. The resources needed to implement the EIA should be identified at each stage of the EIA procedure [21]. The project abandon report is one of the EIA's legal requirements that need to be submitted by the owner. However, very little attention has been paid to studying the abandonment of EIA project reference documents. Therefore, indicators that need to be considered in evaluating the pre-abandonment of EIA project phases are crucial as a guide for the report preparer and evaluation by the policymakers. Sommer *et al.* [22] quoted that environmental and ecological factors are important to control environmental pollution. Recent evidence mentions that abandoned projects were not given adequate attention for long times, causing a negative effect not only on the construction industry but also on the circular economy concept as a whole. In Malaysia, an Abandonment Plan (AP) is a document prepared by a Project Proponent (PP) detailing the overall decommissioning and abandonment strategy and plan once the project abandonment has been identified [23].

**Table 3.** Summary of Project Abandonment Legislation in ASEAN and European Countries

Countries	Malaysia [11]	Singapore [139]	Philippines [140]
Legislation on abandonment	Yes	Yes	Yes
Specific guidelines on project abandonment	No	No	No
Countries	Japan [141]	Vietnam [142]	New Zealand [143]
Legislation on abandonment	Yes	Yes	Yes
Specific guidelines on project abandonment	No	No	No

### 1.4 Sustainable Project Abandonment Guidelines

This research is motivated by the fact that improper project management would impact the environment, social, economic and infrastructure management. Abandonment of a project in the operation phase had generated main pollution elements such as residue, effluent, scheduled waste and land contamination. Furthermore, activities involved in abandonment phases such as the demolition process would generate carbon footprint effects [24]. Many studies have been conducted to address these problems; therefore, this study aims to accommodate the main findings of those previous studies to help researchers identify specific areas requiring improvements and priorities. The lack of guidelines for specific indicators for the pre-abandon project has resulted in poor decision making that will influence the quality of pre-abandonment project reports. Besides, clear guidelines will assist the project owner in pre-abandonment indicators screening. This view is supported by

Panigrahi and Amirapu [25], who wrote that the absence of an approach to set the scope of the study makes the quality of the EIA report poor. Thus, it is vital to have a comprehensive guideline that consists of a framework set to be in favour of sustainable development aims. Morrision and Bailey [26] reported that a good understanding between policymakers, consultants and project developers can contribute to the effectiveness of EIA implementation.

## 2.0 METHODOLOGY

### 2.1 Data Collection

A rigorous review of all relevant studies conducted in Malaysia and other countries was done to identify relevant existing literature in accordance with the purpose of this study. The methodology flowchart is shown in Figure 1. The literature search was conducted in the main scientific databases, including Scopus, ScienceDirect, Springer, Google Scholar, EZproxy from Universiti Teknologi Malaysia (UTM), related Act, legislation and policy, using the following keywords: abandonment, decommissioning and sustainable development.

### 2.2 Determination Of Critical Indicators For The Assessment Of Pre-Abandoned Project

Identification of relevant indicators for the assessment of this research was made using secondary data to design the questionnaire of pre-abandoned project indicators for survey purposes. Literature review shows that an online questionnaire is one of the best methods to gain information from the respondents (EIA Registered Consultants). Google Forms, an online survey toolkit, was used to design the questionnaire and circulate it among the survey participants [27] and In-Depth Interviews. Likert Scale approach was used for the Questionnaire survey and the Semi-Structured Interview technique for the In-Depth Interview. The questionnaire was reviewed and refined by 67 Environment Impact Assessment (EIA) Registered Consultants. In-Depth Interview sessions conducted involved 3 representatives related to policy/legislation on a project. They are the Public Work Department (JKR), SWCorp and Department of Environment (DOE). The criteria of respondents for the interview are either registered from the Board of Engineers Malaysia (BEM) or Certified Environmental Professional from DOE. The questions on participants' demographic details sought the participants' experience on EIA study and experience on project abandonment and level of education (Table 5 and Figure 2). The questionnaire contained 28 questions about indicators on project abandonment that meet Sustainable Development Agenda 2030, which consists of Environmental, Social, Economic and Infrastructural Management assessments.

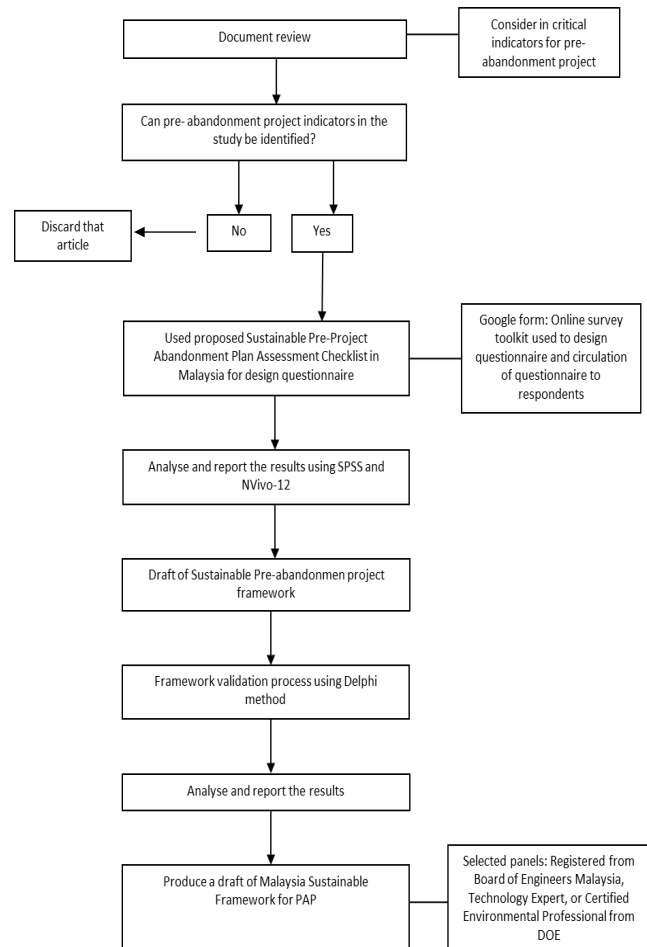


Figure 1. Flowchart of Research Methodology

### 2.3 Data Analysis

*The framework of Malaysia Guidelines for PAP-* After screening the survey responses, the selected data were analyzed using descriptive analysis. In total, 68 EIA Registered Consultants took part in this online survey. Statistical Package Social Science (SPSS) version 22 was used to archive, screen, and analyze the data collected. Descriptive Statistics analysis was the main statistical element determining the most critical indicators for the pre-project abandonment assessment. In addition, for the interview analysis, Content Analysis (NVivo-12) was used to find the critical indicators from the pre-abandonment project. Both methods were used to determine the rank of the indicators. This view is supported by Nacos *et al.* [28], stating that computer-aided software needs to be treated as an aided tool. Results from analysis on crucial indicators from the survey questionnaire and interview were tabulated in rank to indicate the most 10 crucial indicators out of 28 indicators.

*Validation of the framework and produce a draft of Malaysia Guidelines for PAP-* Finally, the analysis was validated by five (5) panels that will review and comment on the draft guidelines (validation process) using the Delphi Method. The Delphi method is an interactive process used to collect and distil the judgement of experts using a series of questionnaires interspersed with feedback. The questionnaires were designed to focus on problems, opportunities, solutions, or forecasts.

Each subsequent questionnaire is developed based on the results of the previous questionnaire [29].

### 3.0 RESULTS AND DISCUSSION

#### 3.1 Determination of Critical Indicators For Pre-Project Abandonment Assessment Checklist

The design of pre-abandoned indicators on the survey questionnaire and an in-depth interview was based on the literature in Table 4. This table indicates that comprehensive assessment for the pre-project abandonment plan is crucial as the assessment indicator will determine the sustainability of project abandonment. In addition, each indicator bonds with related legislations in Malaysia. Thus, the sustainability aspect is not only for the project's development but also for abandonment.

There are four main assessments for the pre-abandonment project from the literature review: environmental, economic, social and infrastructure management, consisting of 28 indicators. The environmental assessment consists of nine indicators, which are (i) inventory of scheduled waste generated, (ii) slurry management and treatment, (iii) Noise pollution control method, (iv) vibration measurement technique, (v) Sewage management, (vi) waste management (domestic, solid waste and wastewater), (vii) Site management, (viii) type of treatment plant & duration of residual treatment, and (ix) biomass management. In addition, economic assessment consists of seven indicators, which are (i) circular economy concept (reduce, reuse, recycle), (ii) inventory of domestic waste generated, (iii) disposal of scheduled waste cost, (iv) assumption cost of residue treatment, (v) rehabilitation cost, (vi) sustainable consumption of energy and workers, and (vii) allocation of environmental conservation budgeting. Meanwhile, social indicators consist of five indicators, which are (i) workers' safety and health, (ii) site housekeeping, (iii) vermin control, (iv) heritage project-special management, and (v) disease management control. On the other hand, infrastructure management consists of seven critical indicators, which are (i) information on stream diversion once project abandonment occurs, (ii) method of blasting, (iii) method of demolition, (iv) dilapidation survey, (v) buffer zone, (vi) drainage management system, and (vii) noise barrier. Thus, from the literature, many issues discussed on the pre-abandoned project are related to aspects of environmental management.

**Table 4.** The Proposed Sustainable Pre-Project Abandonment Plan Assessment Checklist in Malaysia

Environmental indicators	References
Inventory of scheduled waste generated and handling	Scheduled Waste Regulation 2005, Environmental Quality Act 1974 [14]. U.S. Environmental Protection Agency (USEPA) [30], Balde <i>et al.</i> [31], Lydall <i>et al.</i> [32], United Nation Environment Management Group (UNEMG) [33], Martos <i>et al.</i> [24], Soler <i>et al.</i> [34], Al-Khatib <i>et al.</i> [35], Loiseau <i>et al.</i> [36], Scheduled Waste Regulation 2005 [14], Haccuria <i>et al.</i> [37], Copper <i>et al.</i> [38], Holt <i>et al.</i> [39], Galvez Martos and Schoenberger [40],

	Guereca <i>et al.</i> [41], Hens <i>et al.</i> [42], Holt <i>et al.</i> [43], Sethurajan <i>et al.</i> [44], Hula <i>et al.</i> [45], Hsu <i>et al.</i> [46], Guimaraes <i>et al.</i> [47], Ribeiro <i>et al.</i> [48], Kaya [49], Dodbiba <i>et al.</i> [50], Khaliq <i>et al.</i> [51], Gollakota <i>et al.</i> [52], Chauhan <i>et al.</i> [53], Islam and Huda [54], Ahmed and Panwar [55], Agency for statistics of Bosnia and Herzegovina [56], Zhou and Xu [57], United States Environmental Protection Agency (USEPA) [58], Balde <i>et al.</i> [59]
Slurry management and treatment	Standard Specifications for Building Works, Public Work Department (Material generate from construction/ excavation work) [60], Li <i>et al.</i> [61]; Wu <i>et al.</i> [62]; Wu <i>et al.</i> [63], Yuan [64]; Ding <i>et al.</i> [65]; Zheng <i>et al.</i> [66]; Lu <i>et al.</i> [67]
Noise pollution control method	Guidelines for Environment Noise Limit and Control 2017 [68], Sharma [69], Occupational, Safety and Health (Noise Exposure) Regulations [70], Nemerow [71], Department of Safety and Health (DOSH) [72]
Vibration measurement technique	The Planning Guidelines for Vibration Limits and Control in the Environment 2007 [73], Jantunen <i>et al.</i> [74], Environmental Essential for Siting of Industries in Malaysia [75]
Sewage management	Sewage Regulation 2015, Environmental Quality Act 1974 [14], Sewage Regulation [14], Solid Waste Transfer Station and Landfill Regulations [14], and Industrial Effluents Regulations [14], Regulation 7, Environmental Quality Regulations [14], Environmental Guidelines in Malaysia (EGIM) [23]
Domestic or solid waste	Solid Waste and Public Cleansing Management (Scheme for Construction Solid Waste) 2018 [76]; Department of Solid Waste Management [77]; Ministry of Environment Japan [78]; Ilvonen [79], Kaza <i>et al.</i> [80], Luttenberger [81], United Nations Environment Programme (UNEP) [82]; Bernado <i>et al.</i> [83]; Yuan <i>et al.</i> [84]; Eurostat [85]; Huang <i>et al.</i> [86]; Jin <i>et al.</i> [87]; Peng and Liu [88]; Chang <i>et al.</i> [89]; Agamuthu and Dennis [90]; United Nations (UN) [91], European Commission [92], Li <i>et al.</i> [93]; EIA Guidelines For Petrochemical Industries [94]; Ajayi and Oyedele [96]; Chinda [97]; Menegaki and Damigos [98];
Wastewater	Department of Environment Malaysia [95]; Industrial Effluent Regulation, 2015, Environmental Quality Act 1974 [14];
Site management (LD-P2M2)	Guidelines on Land Disturbing Pollution Prevention and Mitigating Measures, 2017 [99];
Type of treatment plant and duration of residual treatment	Industrial Effluent Regulation, 2015, Environment Quality Act 1974 [14]; DOE [100]; Tian <i>et al.</i> [101] Cechinel <i>et al.</i> [102]; Wei <i>et al.</i> [103], Sponza and Oztekin [104], Jabatan Perkhidmatan Veterinar Malaysia [105], Siddique <i>et al.</i> [106]
Biomass management	Solid Waste and Public Cleansing Management (Scheme for Construction Solid Waste) 2018 [76] Hens <i>et al.</i> [41]
<b>Economic Indicators</b>	<b>References</b>



Circular economy concept (Reduce, reuse, recycle)	Cluster 3, National Cleanliness Policy 2019 [107], Solid Waste and Public Cleansing Management (Scheme for Construction Solid Waste) 2018 [76]; Boon and Sunikka [108]; Lawania et al. [109]; Jin et al. [87]; Yang et al. [110]; Wong et al. [111], Wahi et al. [112]
Inventory of domestic waste generated	Regulation 7(3), Solid Waste and Public Cleansing Management (Scheme for Construction Solid Waste) 2018 [76]
Disposal of Scheduled waste cost	Guided Self-Regulation (GSR), Department of Environment Malaysia [113]; Brookes and Locatelli, [114]
Assumption cost of residue treatment	Morozova et al. [115]
Rehabilitation cost	Oliveira et al. [116]; National Hydraulic Research Institute of Malaysia (NAHRIM) [117], Li et al. [118], Jantunen et al. [73]
Sustainable consumption of energy and workers	Part X1, Demolition, Factories and Machinery (Building Operations and Works of Engineering Construction (Safety) Regulations 1986) [119] University Technology Malaysia (UTM)-Low Carbon Asia Research Centre [120]
Allocation of environmental conservation budgeting	Guided Self-Regulation (GSR), Department of Environment Malaysia [113]
<b>Social indicators</b>	<b>References</b>
Safety & health of workers	Department of Occupational Safety and Health Act 1994 [121]
Site housekeeping	Solid Waste and Public Waste Management Act 2007 [76]
Vermin control	Destruction of Disease-Bearing Insects Act 1975 (Act 154) & Prevention and Control of Infectious Diseases Act 1988 (Act 342) [122]
Heritage project Special Management	National Heritage Act, 2005[123]; Boon & Sunikka [108]
Disease Management control	Prevention and Control of Infectious Diseases Act 1988 (Act 342) [122]
<b>Infrastructure management indicators</b>	<b>References</b>
Information on stream diversion once project abandonment occurs	Chapter 5.0 Erosion and Sediment Control Facilities, Diversion channel, Guideline for Erosion and Sediment Control In Malaysia, 2010 [124] Charlesworth et al. [125], Lashford et al. [126]
Method of blasting	Sub Chapter 6.6.1, Pre blast consideration, Malaysian Standard (MS) 2318: 2012 [127] Nelson L. Nemerow [128]
Method of demolition	Chapter 6, Methods of demolition, Malaysian Standard (MS) 2318: 2012 [12]; Chan [129], Jaramillo et al. [130], Slavina et al. [131], Oleinik et al. [132], Lautaru et al. [133]
Dilapidation survey	Sub Chapter 4.1.4, Dilapidation Survey, Malaysian Standard, (MS) 2318: 2012 [127] Harris [134], Schwartz et al. [135]
Buffer zone	Chapter 5.2, Erosion Control Facilities, Guideline for Erosion and Sediment Control In Malaysia, 2010 [124]; Environmental Essential For Siting of Industries in Malaysia [75]

Drainage management system	Subchapter 4.3.4, Drainage Control/Runoff Management, Guideline for Erosion and Sediment Control In Malaysia, 2010 [124] Warwick et al. [136]
Type of noise barrier	Annexe E, Guidance on noise control, Guidelines for Environment Noise Limit and Control 2019 [68]

### 3.2 Survey Participant's Profile

Two questions were formulated to seek participants' demographics data, including experience on the EIA project and project abandonment experience, to better understand and analyze the respondents' responses. More than 50% of the respondents have experience in EIA project study for 15 years and above, followed by 38.8% (6–10 years), 9% (11–15 years), and 1.5% (0–5 years), respectively. However, most of the respondents have less experience in project abandonment study which shows that 52.2% (none), 41.8% (1–5 times), 4.5% (6–10 times), 4.5% (6–10 times) and 1.5% (more than 15 times) respectively (Table 5). Nevertheless, due to the lack of abandonment guidelines in major environmental assessments, assessment on the actual implementation at any documentation stated by reports and Environmental Quality Report (EQR) are not adequate to analyse. However, their feedback is very much valuable to be counted due to their position as appointed EIA Consultants endorsed by DOE as mentioned in Section 34A(2C), Environmental Quality Act 1974. The act stipulates that any person intending to carry out any prescribed activities must appoint a Qualified Person to conduct an EIA and submit a report to the Director General of Environment. A Qualified Person is an individual who has met the DOE's technical and experience criteria; hence he is eligible to be registered as an EIA Consultant. As mentioned in Chapter 6, Post Submission Stage of EIA Report, Subchapter 6.5, (i) Abandonment Plan [11] mention that an abandonment plan shall be prepared if the project proponent intends to abandon a project and EIA Consultant shall prepare the report. Therefore, the respondents are qualified to holistically share their perspectives on the proposed abandonment project's impact on the environment.

**Table 5.** Respondents Demographics Analysis Results

Question	Distribution	(%)
Experience in EIA project	0–5 years	1.5
	6–10 years	38.8
	11–15 years	9.0
	15 years and above	50.7
Experience in project abandonment	1–5 times	41.8
	6–10 times	4.5
	more than 15 times	1.5
	none	52.2

Figure 2 shows that 49.3% of the respondents are Degree holders, followed by 43.3% with Master and 7.5% with PhD. From this, the majority of respondents have higher levels of education. It was expected that these EIA Registered Consultants would have more knowledge on project

abandonment and related legislation by having a high level of education, although less experience in project abandonment.

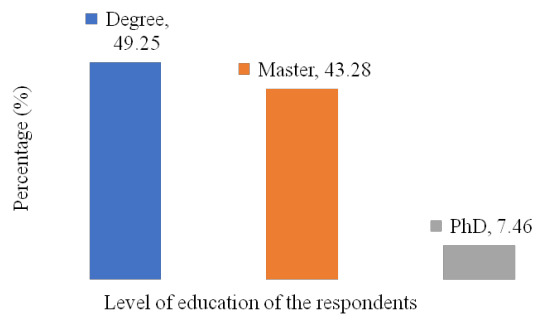


Figure 2. Level of Education of the Respondents

### 3.3 Critical Indicators For The Assessment Of A Pre-Abandoned Project

The design of pre-abandoned project indicators on the survey questionnaire and in-depth interview was based on the literature in Table 6. This table indicates that comprehensive assessment for the pre-project abandonment plan is crucial as the assessment indicator will determine the sustainability of project abandonment. Thus, the sustainability aspect is not only for the project's development but also for the abandonment of the project phase. There are four main assessments for the pre-abandonment project from the literature review: (i) environmental assessment, (ii) economic assessment, (iii) social assessment, and (iv) infrastructure management assessment that consists of 28 indicators.

The environmental assessment consists of nine types of critical indicators, which are (i) inventory of scheduled waste generated, (ii) slurry management and treatment, (iii) noise pollution control method, (iv) vibration measurement technique, (v) sewage management, (vi) waste management (domestic, solid waste and wastewater), (vii) site management, (viii) type of treatment plant and duration of residual treatment, and (ix) biomass management.

Meanwhile, social indicators consist of five critical indicators, which are (i) workers' safety and health, (ii) site housekeeping, (iii) vermin control, (iv) heritage project-special management, and (v) disease management control. On the other hand, economic assessment consists of seven critical indicators, which are (i) circular economy concept (reduce, reuse, recycle), (ii) inventory of domestic waste generated, (iii) disposal of scheduled waste cost, (iv) assumption cost of residue treatment, (v) rehabilitation cost, (vi) sustainable consumption of energy and workers, and (vii) allocation of environmental conservation budgeting. In addition, infrastructure management assessment consists of seven critical indicators, which are (i) information on stream diversion once project abandonment occurs, (ii) method of blasting, (iii) method of demolition, (iv) dilapidation survey, (v) buffer zone, (vi) drainage management system, and (vii) type of noise barrier. Thus, from the literature, many issues discussed on the pre-abandoned project are related to aspects of environmental management. This relationship is expected that major project abandonment problems are related to environmental problems.

The questionnaire survey results and in-depth interviews to determine significant indicators for the assessment of pre-abandoned projects were divided into four main assessments: environmental, social, economic and infrastructure management with their indicators, respectively, as shown in Table 6. From this table, respondents significantly favored waste management (domestic/solid waste and wastewater) as the first rank, allocation of environmental budgeting in rank 2, inventory of scheduled waste in rank 3, slurry management in rank 4, method of demolished in rank 5, safety and health of workers in rank 6, drainage management system in rank 7, site management in rank 8, type of treatment plant in rank 9, and site housekeeping in rank 10. Furthermore, the result was synchronized with their respective legislation (Malaysia legislation). In this regard, the legislation's emphasis is very important so that all parties involved, whether policymakers or project owners, have clear jurisdiction related to the management of the indicators. In addition, it will facilitate the evaluation of the report by relevant parties such as government agencies and project owners to understand the related indicators in the preparation of the pre-abandoned project report. In this case, the Department of Environment Malaysia is the approver for the report.

Table 6. The most significant indicators for Pre-Project Abandonment in Malaysia

Indicators	Rank	Legislations
Waste management (domestic/solid waste and wastewater)	1	Solid Waste and Public Cleansing Management (Scheme for Construction Solid Waste) 2018 [76]
Allocation of environmental conservation budgeting	2	Guided Self-Regulation (GSR) – Department of Environment Malaysia (EMAINS-Environmental Mainstreaming Tools) [113]
Inventory of Scheduled Waste	3	Scheduled Waste Regulation [14]
Slurry management	4	Standard Specifications for Building Works, The Malaysian Public Works Department (JKR) [60] (Material generate from construction/excavation work)
Method of demolition	5	Chapter 6, Methods of demolition, Malaysian Standard (MS) 2318: 2012 [127]
Safety and health of workers	6	DOSH requirement (Regulations Under Occupational Safety and Health Act 1994 (Act 514) [121]
Drainage management system	7	Guideline for Erosion and Sediment Control, Department of Irrigation and Drainage [124]
Site management	8	Guidelines on Land Disturbing Pollution Prevention and Mitigating Measures (LDP2M2) [99]
Type of treatment plant & residual of treatment	9	Industrial Effluent Regulations, Environmental Quality Act 1974 [14]
Site housekeeping	10	Guidelines on Land Disturbing Pollution Prevention and Mitigating Measures (LDP2M2) [99]

### 3.4 The Framework Of Malaysia Guidelines For Pre-Project Abandonment Plan

Lack of knowledge on the management of pre-abandonment project indicators will cause environmental problems such as the residual impact that cause climate change effects. This viewpoint is supported by Wang *et al.* [137], who claimed that the issue of abandoned construction projects tremendously affects the industry in terms of economy, and needs a more serious outlook on this issue to have a better understanding of the problem so that the government could take necessary steps to overcome the issue. The formation of the framework in this study includes the improvement of the existing framework for the pre-abandoned project as well as new assessment aspects that are accompanied by comprehensive indicators that are supported by related legislation and SDG 2030 elements.

From existing literature, the project abandonment framework in Malaysia only caters for environmental assessment for the pre-abandon project, as shown in Figure 3 [4]. This shows that the owner or occupiers who intend to abandon their project need to develop a pre-project abandonment plan that only consists of environmental assessment. Contrary to the finding of this study, the pre-project abandonment assessment must also cover other important aspects of assessment to control pollution problems before the execution of the abandonment project and ensure sustainable project abandonment management.

Thus, the existing framework was improvised by inserting a new comprehensive assessment that not only catered to the environment but also consisted of social, economic and infrastructure management (Figure 4). This figure indicates that this framework is specifically for the project owner, Department of Environment officers and related agencies such as local authorities for decision-making purposes and project owner for the pre-abandoned project report preparation. Therefore, these reports need to be submitted by the owner or occupier six months before the project execution. The approval process will take about three weeks from the date submitted by the project owner. In this regard, the approval of this pre-project abandonment report is also influenced by all related agencies' consensus. According to Chanchitpricha and Bond [138], standard guidelines and procedures provide principles that must be adhered to and, at the same time, influence the practice of impact assessment.

In addition, with this new framework, the assessments would also consist of new comprehensive indicators equipped with related legislation and complemented by related Sustainable Development Goal (SDG) 2030 for the preparation of PAP (refer to Table 7). This table indicates the dependence of this assessment and their respective indicators for pre-project abandonment plan on legal or respective legislations and emphasis the importance of supporting the SDGs 2030 agenda by inserting the related goals to this table. Furthermore, legislation is one of the important aspects in ensuring environmental sustainability by all parties. Incorporating legal elements into this framework can be seen as a means of tackling environmental pollution, as project owners will be bound by compliance with such legislation. This framework can be an initial bulwark in controlling environmental pollution management economic, social and infrastructure management before the actual project abandonment is executed. This research divides waste management into domestic/solid waste

and wastewater. For this first rank of indicators, the related legislation for the management of solid waste generated from construction area in Malaysia is Solid Waste and Public Cleansing Management (Licensing) (Undertaking of Provision of Collection Services for Construction Solid Waste) Regulation [76], Solid Waste and Public Cleansing Management (Scheme for Construction Solid Waste)[76], and Solid Waste and Public Cleansing Management (Scheme for Commercial, Industrial, Institutional Solid Waste) [76]. However, only seven states have adopted this act, namely Johor, Melaka, Negeri Sembilan, Federal Territory of Kuala Lumpur (WPKL) and the Federal Territory of Putrajaya, Kedah, Perlis, and Pahang. States that do not adopt the act will have to use the Local Government Act 1976. Furthermore, through this indicator, wastewater management must comply with Environmental Quality Act 1974 requirements. In addition, this indicator will support SDG 6 (Clean Water and Sanitation), SDG 13 (Climate Action), SDG 14 (Life below water), and SDG 15 (Life on land). The management of water on land or below water, sanitation and air is important because the residue and the discharge from project management activities may create problems to the surrounding area.

The second and third rank for pre-project abandonment assessment is environmental conservation budgeting and inventory of scheduled waste. The assessment of economic aspects in terms of environmental conservation budgeting indicator has been mentioned on Guided Self Regulation (GSR) [113] through the Environmental Mainstreaming Directive in Malaysia. This indicator is one of the Environmental Mainstreaming Tools (EMT) in the GSR. The inventory of the scheduled waste is believed to enhance economic growth with the circular economy concept implementations: recycle, reduce and reuse approach. Both indicators must be highlighted on the pre-project abandonment report to comply with the environmental regulatory requirements and other environmental-related efforts. Well-manage of Scheduled waste not only protect the environment but also supports SDG 7 (Renewable Energy) and SDG 8 (Good Jobs and Economic Growth) and increase the compliance of Schedule Waste Regulations [14] by the owner of the project.

In the fourth rank, the slurry management indicator is highlighted by the Malaysian Public Works Department (JKR) [60], which is to be well managed. The pre-project abandonment environment assessments of this indicator are generated once the project is executed. Therefore, well-managed indicators would support SDG 6 (Clean Water and Sanitation) which is to avoid water and sanitation pollution from the improper management of slurry, SDG 13 (Climate Action) that is related to the exhaust emissions effect on the air by the transport activities such as transportation of slurry to a disposal area or treatment facilities, SDG 14 (Life Below Water) that will avoid below water pollution that harms species such as aquatic life, and SDG 15 (Life on Land) which is to avoid land contamination.

Assessment of infrastructure management through a demolished indicator method (rank number 5) is important due to the types of technology used to abandon project purposes, as mentioned in Environmental Essential for Siting of Industries in Malaysia [75]. This indicator would support SDG 9 (Innovation and Infrastructure) with the best technologies for pollution reduction strategies and SDG 15 (Life on Land) to protect life on land for better living.



Safety and health of workers indicator are on rank number 6, which to be complied by the project owner on the management of workers as stipulated in DOSH requirements on Regulations Under Occupational Safety and Health Act 1994 (Act 514) [121]. This indicator's compliance not only reduces the accident level at a workplace or avoids disease but also supports SDG 3 (Good Health) and SDG 11 (Sustainable Cities & Communities).

For indicator rank number 7, which is drainage management system under infrastructure management assessment, the compliance on Guideline for Erosion and Sediment Control, based on the requirement by Department of Irrigation and Drainage [124], is very important to avoid failure of drainage systems such as volume of water flow and velocity of water which influence the flood mitigation management by the respective department. This indicator will support SDG 9 (Innovation and Infrastructure) for a sustainable drainage

management approach and SDG 15 (Life on Land) to protect the ecosystem and chain of life on land.

The site management indicator—selected to be in rank number 8 by the respondents—is mentioned in the Guidelines on Land Disturbing Pollution Prevention and Mitigating Measures (LDP2M2) [99]. This guideline mentions that the site management includes the best management practice for erosion control, such as installing silt curtains, holding the fence, and related site management by the project owner. On the other hand, the types of treatment plant and residual of treatment, which ranked number 9, are important due to residue contamination that will affect the surrounding environment. From the literature, the final discharge effluent limitation from industries is under the jurisdiction of DOE Malaysia, as stipulated in the Industrial Effluent Regulations [14]. Both indicators will support SDG 6 (Clean Water and Sanitation), SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land).

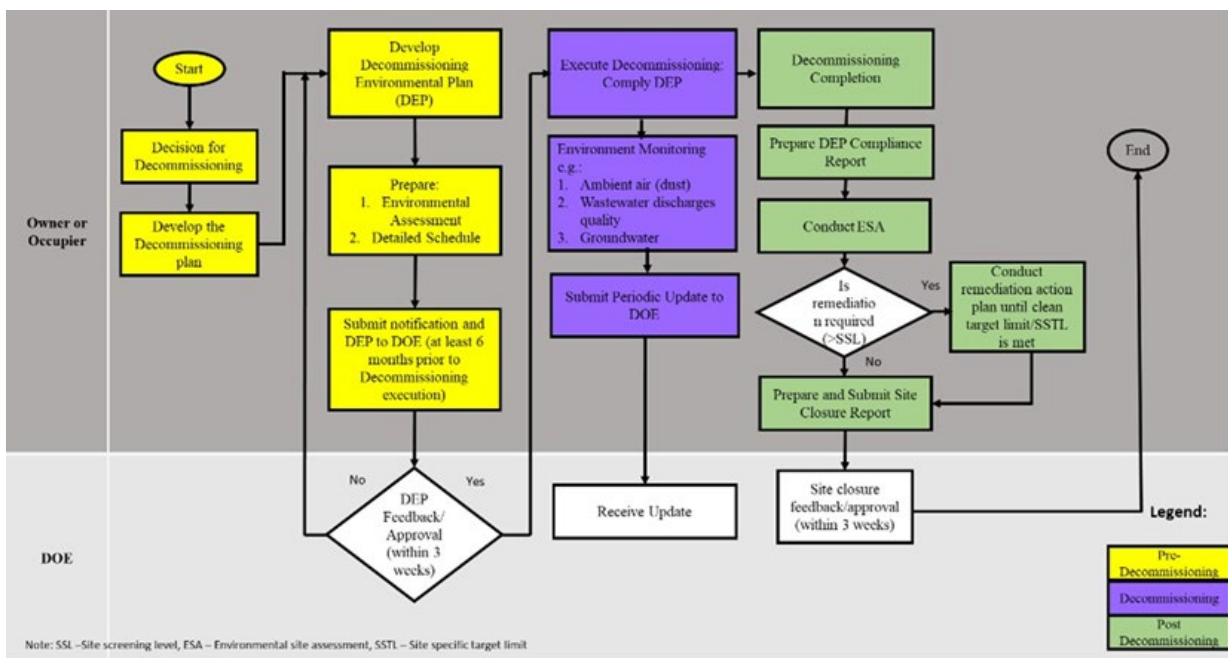


Figure 3. The existing approval process flow for downstream facilities (Environmental Guidelines for Decommissioning of Oil & Gas Facilities In Malaysia, 2019)

Finally, the tenth-ranked indicator is site housekeeping, which is under social assessment. The site housekeeping will avoid the improper management of domestic waste produced by the workers and waste generated from the execution of the abandonment of project activities. These indicators are stipulated in the Solid Waste and Public Waste Management Act 2007 [76]. Good management of the indicators will support SDG 3 (Good Health) and SDG 11 (Sustainable Cities & Communities). For example, Kuala Lumpur has Prescribed Activities under EIA Order 2015, such as the Mass Rapid Transit transportation

project, so the site's management is important due to Kuala Lumpur as the heart of Malaysia city. Improper domestic management will affect not only health but also negatively impact tourism industry achievement. Indirectly, this will also affect the economic growth in Malaysia.

Thus, all the indicators will benefit related stakeholders such as policymakers and project owners in terms of assessment and report preparation and mitigation measures before the execution of the abandonment of the project.

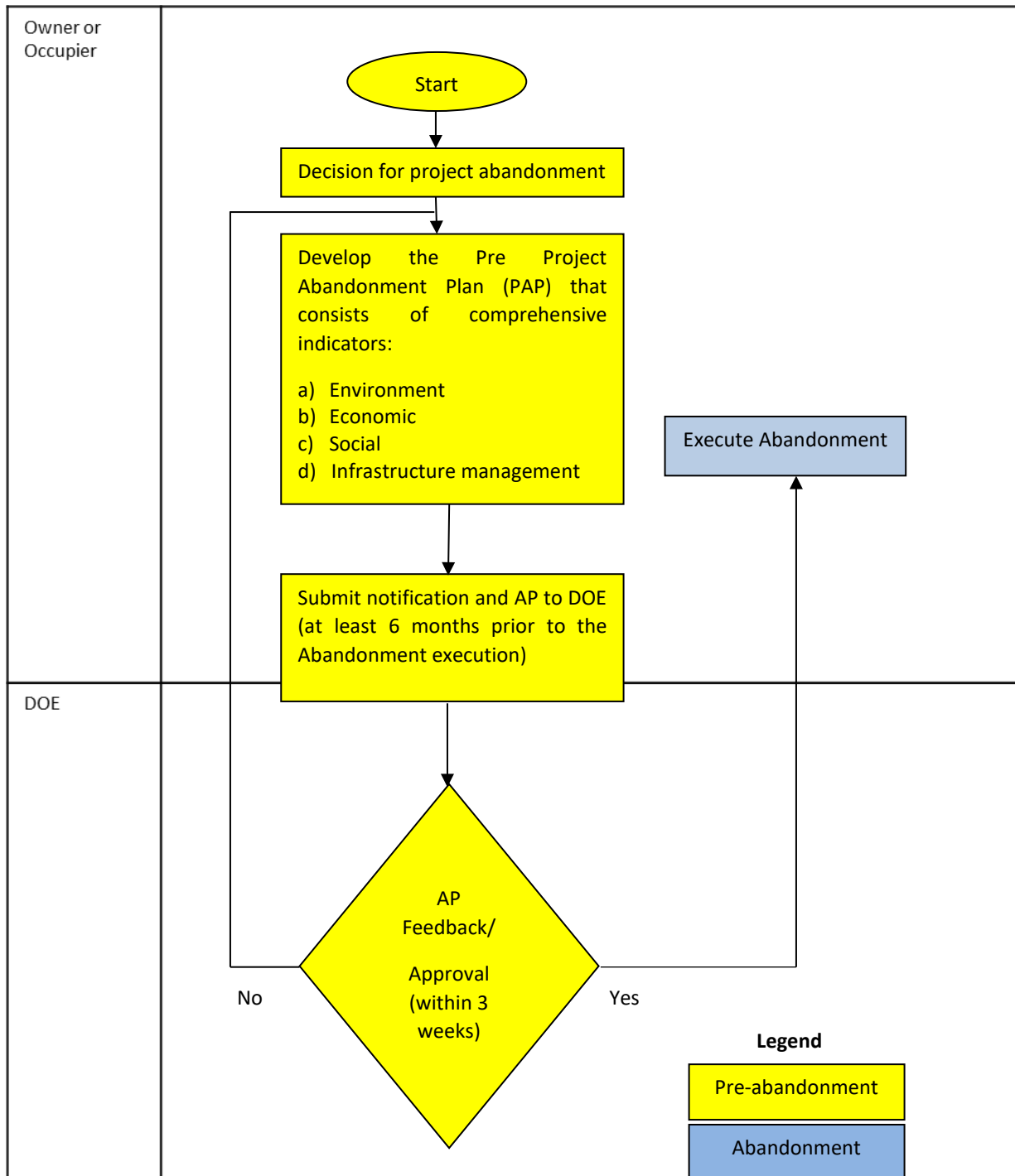


Figure 4. The improved version of the existing project abandonment framework for the Pre-Abandonment Project Plan

**Table 7.** Comprehensive Pre-Project Abandonment Plan indicators, related legislations and SDG 2030

Assessment	Indicator	Rank	SDG	Legislations
Environmental	Waste management (domestic/solid waste and wastewater)	1	SDG 6 (Clean Water and Sanitation) SDG 13 (Climate Action) SDG 14 (Life below water) SDG 15 (Life on land)	As stipulated in Solid Waste and Public Cleansing Management (Licensing)(Undertaking of Provision of Collection Services for Construction Solid Waste) Regulation [76], Solid Waste and Public Cleansing Management (Scheme for Construction Solid Waste) [76], and Solid Waste and Public Cleansing Management (Scheme for Commercial, Industrial, Institutional Solid Waste) [76].
Economic	Allocation of environmental conservation budgeting	2	SDG 7 (Renewable Energy) SDG 8 (Good Jobs and Economic Growth)	Guided Self Regulation (GSR) – Department of Environment Malaysia (EMAINS-Environmental Mainstreaming Tools)[113]
Economic	Inventory of Scheduled Waste	3		Scheduled Waste Regulation, Environmental Quality Act 1974 [14]
Environmental	Slurry management	4	SDG 6 (Clean Water and Sanitation) SDG 13 (Climate Action) SDG 14 (Life below water) SDG 15 (Life on land)	Standard Specifications for Building Works, Malaysia Public Works Department, Jabatan Kerja Raya [60] (Material generate from construction/excavation work)
Infrastructure management	Method of demolition	5	SDG 9 (Innovation and Infrastructure) SDG 15 (Life on Land)	Chapter 6, Methods of demolition, Malaysian Standard (MS) 2318: 2012 [127]
Social	Safety and health of workers	6	SDG 3(Good Health) SDG 11 Sustainable Cities & Communities)	DOSH requirement (Regulations Under Occupational Safety and Health Act 1994 (Act 514)[121]
Infrastructure management	Drainage management system	7	SDG 9 (Innovation and Infrastructure) SDG 15 (Life on Land)	Subchapter 4.3.4, Drainage Control/Runoff Management, Guideline for Erosion and Sediment Control In Malaysia, 2010 [124] Warwick <i>et al.</i> [136]
Environment	Site management	8	SDG 6 (Clean Water and Sanitation)	Guidelines on Land Disturbing Pollution Prevention and Mitigating Measures, 2017 [99];
Environment	Types of treatment plant & residual of treatment	9	SDG 13 (Climate Action) SDG 14 (Life below water) SDG 15 (Life on land)	Industrial Effluent Regulation, 2015, Environmental Quality Act 1974 [14]
Social	Site housekeeping	10	SDG 3(Good Health) SDG 11 Sustainable Cities & Communities)	Solid Waste and Public Waste Management Act 2007 [76]

## 4.0 CONCLUSION

The conducted survey proved that 28 indicators for the assessment of the pre-abandoned project are crucial and the developed framework was strengthened by comprising related legislation and each indicator synchronized towards SDG 2030. Next, the identified framework that consists of comprehensive indicators will further validate using the Delphi method based on the survey conducted among experienced and expert panels. In the future, this framework is planned to be integrated into the development of the Malaysia Guideline for Pe-Project

Abandonment Plan draft, which could be used by owners of a project as guide and decision-makers to prepare or make decision regarding pre-abandonment project.

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