

**Green Education and Sustainable Operational Practices  
in the Libyan Oil and Gas Sector:  
The Mediating Role of Environmental Awareness**

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**Abstract**

The oil and gas sector is facing growing pressure to meet the needs of operations, the environment and regulatory requirements, and stakeholder expectations. Such tensions are especially strong in nascent petroleum economies such as Libya, where the existing infrastructure, insufficient institutional capacity and underdeveloped environmental management systems create a structure which hinders sustainable performance. A mediation model between green education and sustainable operation practices is developed and theoretically justified based on the systematic literature review of the existing literature.

The synthesis was done using the results of a systematic literature review according to PRISMA 2020 guidelines, which resulted in 57 studies that were retrieved from Scopus, Web of Science, and EBSCO databases (2010-2026). Based on the Ability–Motivation–Opportunity (AMO) theory, Theory of Planned Behavior (TPB), and Institutional Theory, the paper proposes a multi-level theoretical framework and offers four testable hypotheses regarding the direct and indirect linkages between the three constructs.

The review shows that: (1) green education is not a stand-alone training activity, but rather a systemic organizational learning capability; (2) environmental awareness is the key cognitive mediation mechanism that transforms learning inputs into sustainable learning behavioral outputs; and (3) current models do not adequately consider the specificities of a developing petroleum economy. Five new research gaps that have not been previously addressed in the literature are identified, and an original Workforce Sustainability Capability Framework (WSCF) is proposed as a theoretical contribution and practical approach.

This paper contributes to the literature in three ways: (1) it conceptualizes green education as an operationally embedded construct of workforce capability with specified dimensions and mechanisms; (2) it views environmental awareness as a theoretically specified three-dimensional cognitive mediator; and (3) it proposes the first integrated conceptual model of green education, environmental awareness, and sustainable operational practices in the Libyan petroleum context which can serve as a basis for future empirical studies and practical workforce development policy.

**Keywords:** green education; environmental awareness; sustainable operational practices; oil and gas; Libya; green HRM; AMO theory; Theory of Planned Behavior; Institutional Theory; conceptual framework; systematic literature review

## 1. Introduction

### 1.1 Background and Motivation

The global oil and gas industry is undergoing an accelerated sustainability transition driven by overlapping regulatory, market and societal drivers. Petroleum companies are under pressure from both climate agreements and shifting ESG investor frameworks, as well as emerging international sustainability reporting standards and growing expectations from community stakeholders that they become good stewards of the environment, not just compliant with regulations, but proactive in resource efficiency, emissions reduction, waste minimizations and in embedding sustainability in decisions. (IOGP, 2026; World Bank, 2024) However, this 'must do' is not evenly distributed in its pressure, nor is it evenly organized in its ability to respond. In a petroleum economy, which is still the cornerstone of the economic development of a country, sustainable performance is not possible with only technological investment, but investment in human capability is also needed.

Libya is a case in point. Libya's oil industry is one of the largest proven oil reserves owners and a major OPEC producer; it, therefore, has significant environmental impact in addition to its economic importance. The sector has several structural challenges to satisfy sustainable operational practices, including aging infrastructure, limited institutional regulatory capacity, and sporadic enforcement of environmental standards, as well as high human capital gaps in environmental knowledge and sustainability skills (Ipieca, 2020). The human behavioral aspect of operational sustainability is not a sideline, but a primary focus: the choices made by operators, engineers, HSE staff and supervisors day-to-day, in the areas of energy consumption, emissions reporting, waste management, chemical handling, and leak response all contribute to the environmental performance trajectory of petroleum operations.

This paper claims that green education is one of the underused strategic mechanisms to develop environmental capability to foster the sustainable operational behavior in this context. The re-conceptualized green education in this study is not limited to formal training. It includes the systemic, workplace-based organizational learning processes that enable employees to acquire environmental knowledge, ecological literacy based on HSE principles, green operational skills and a disposition towards sustainability. It has indirect effects, however. This paper makes the theoretical argument that green education is the activation of environmental awareness, which is employees' knowledge and understanding of environmental risks, sensitivity to the operational consequences of their decisions and sense of personal and organizational responsibility—and that environmental awareness is the necessary psychological mediator between the learning investments and the change to sustainable operational practice.

Although there are many studies on green HRM, green training, and sustainable organizational behavior, the conceptual framework of the relationship between green education, environmental awareness, and sustainable organizational behavior in petroleum operating environments has not been systematically theorized and reviewed. This paper fills this gap by conducting a rigorous systematic literature review based on PRISMA 2020 guidelines and creating a theoretically grounded, contextually specified, and empirically testable original integrated conceptual framework, called the Workforce Sustainability Capability Framework (WSCF).

### 1.2 The Case for a Conceptual Contribution

Conceptual papers are a unique and appreciated type of article in the Q1 organizational and sustainability management literature that meet three criteria: They describe a documented gap in the literature; They synthesize the existing literature in a systematic way rather than selectively; They make an original contribution to the literature that provides the starting point for a new research program, rather than simply reviewing the existing literature (Gilson & Goldberg, 2015; Jaakkola, 2020). This paper fulfils all three requirements.

Firstly, the Gap documentation: The systematic literature review carried out in this paper, shows that no previous research has considered green education, environmental awareness and sustainable operational practices in a combined mediated approach and in the petroleum context of a developing economy. Second, the synthesis: PRISMA methodology 2020 is used to systematically review, code and synthesize 57 peer-reviewed studies. Third, the original contribution: the paper presents a five dimensional conceptual model that explicitly defines the constructs, mechanisms, boundary conditions, and testable propositions of the proposed relationships in a directly actionable form for researchers and practitioners, namely, the WSCF.

### 1.3 Research Objectives and Structure

The aims of this paper are as follows - and are inter-related:

1. To perform a systematic review of literature on Green Education, Environmental awareness and Sustainable operational practices in industrial and petroleum related context using PRISMA method.
2. To identify and document conceptual, empirical and contextual gaps that motivate and justify the proposed theoretical contribution.
3. To create and conceptually underpin a new integrated conceptual model, the Workforce Sustainability Capability Framework (WSCF).
4. To promote four propositions theoretically derived and a managerially implementation framework in five stages with practical implications for the petroleum organizations of Libya, and for developing petroleum economies in general.

The PRISMA guided systematic review methodology and synthesis is presented in section 2. The theoretical bases are developed in section 3. The theoretical propositions are introduced in Section 4 and the WSCF is presented. The theoretical and practical implications are discussed in Section 5. In Section 6 limitations and a future research agenda are presented.

## 2. Systematic Literature Review

### 2.1 Review Methodology

This systematic review has been carried out in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 guidelines, which aim to provide methodological transparency, reproducibility, and comprehensiveness (Page et al., 2021). The review protocol, which includes database selection, search string construction, inclusion/exclusion criteria, screening procedures, data extraction and synthesis strategy, was developed before data collection.

#### 2.1.1 Search Strategy and Database Coverage

Three major academic databases namely Scopus, Web of Science (WoS) and EBSCO Business Source Complete were searched. To ensure a temporal depth, and at the same time to capture the contemporary development of green HRM and sustainability management scholarship, the publication period 2010-2026 was searched. The main search string comprised a mix of the Boolean operators in three thematic groups:

Cluster A (Green Education/Training): "green education" OR "green training" OR "environmental training" OR "sustainability education" OR "green learning" OR "environmental learning"

Cluster B (Environmental Awareness): "environmental awareness" OR "environmental consciousness" OR "ecological awareness" OR "sustainability awareness" OR "green awareness"

Cluster C (Sustainable Operations/Context): "sustainable operational practices" OR "green behavior" OR "pro-environmental behavior" OR "oil and gas" OR "petroleum" OR "HSE" OR "industrial sustainability"

From the results of the search, 1,847 records were obtained from the database search and 214 records from grey literature search (industry reports, IOGP publications, Ipieca guidance

documents, etc.). Following automated duplicate removal, 1,623 unique records were found for screening.

### 2.1.2 Screening and Eligibility

The pool was then narrowed down to 234 full-text articles for eligibility after title and abstract screening. The following criteria were used for inclusion in the full-text review: (1) peer-reviewed journal publication or high-quality industry report; (2) English language; (3) publication period 2010–2026; (4) substantive focus on green education, environmental training, environmental awareness, sustainable operational behavior, or green HRM; (5) industrial, organizational, or petroleum operational context. Studies were excluded if they were not relevant to the core constructs, if they did not have an industrial/organizational context, or if they did not meet minimum quality criteria (based on the Mixed Methods Appraisal Tool, MMAT).

Of the 177 articles excluded based on full text, 57 studies were included in the final synthesis. The PRISMA 2020 flow diagram is shown in Figure 2.

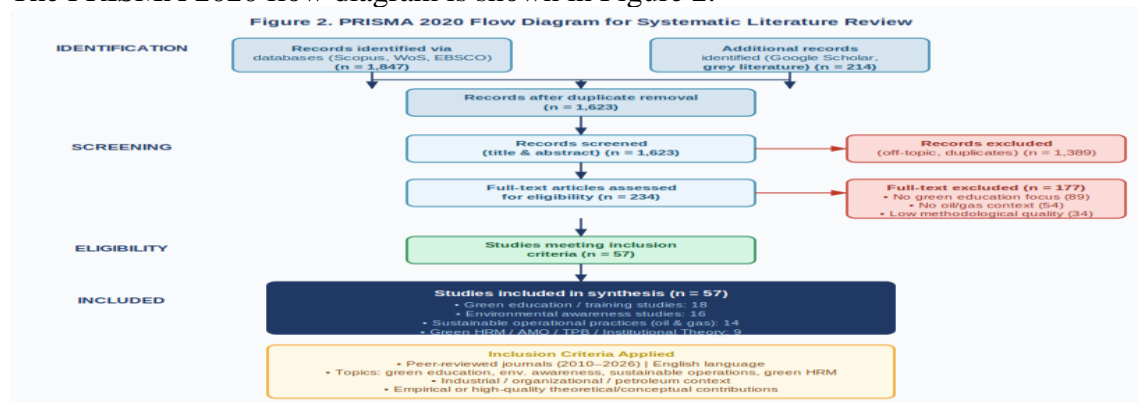


Figure 2. PRISMA 2020 flow diagram for the systematic literature review. Source: Author's development based on Page et al. (2021).

## 2.2 Synthesis of the Green Education Literature

In the formal educational discourse, green education is a structured learning process that develops environmental knowledge, values of sustainability, and capacities for action for the environment (UNESCO, 2024). However, it needs to be rethought for its industrial translation. There are 18 studies in this cluster, which all come to similar conclusions.

First, in the context of organizations, green education is implemented in several ways: formal training programs are only one of the multiple ways of delivering green education, and other methods include toolbox talks, environmental workshops, management communication, incident-learning de-briefing, and digital learning platforms (Pinzone et al., 2019). Second, its effectiveness is dependent on its operational relevance, meaning that training that is decontextualized from employees' work situations and decisions often shows less behavioral impact than training that is contextually relevant to employees' work decisions and situations (Chen et al., 2021). Third, management support and organizational learning culture are important contextual enablers: individual training effects fade away quickly if there is no supervisory reinforcement and organizational valuation of environmental learning (Anwar et al., 2020). Fourth, the difference between green training (event-driven, programmatic) and green education (systemic, continuous, culturally embedded) has practical implications: organizations that view environmental learning as a systemic, continuous and culturally embedded capability outperform those that view it as an event-driven, programmatic compliance action (Obeidat et al., 2020).

## 2.3 Synthesis of the Environmental Awareness Literature

Within the cluster of 16 studies on environmental awareness, there is considerable conceptual differences in the way the construct is defined, operationalized and measured. This paper

combines the three dimensions of the 3-D structure namely, the cognitive dimension (the knowledge of environmental risk, regulatory requirements and operational consequences of day to day decisions, Anwar et al., 2020; Burlea-Schiopoiu & Timpa, 2025), the affective dimension (the emotional sensitivity to environmental damage and felt concern for ecological consequences, Anwar et al., 2020; Burlea-Schiopoiu & Timpa, 2025) and the normative dimension (perceived personal and organizational responsibility for environmental protection and felt obligation to act sustainably, Anwar et al., 2020; Burlea-Schiopoiu & Timpa, 2025). Several studies support the mediation logic of environmental awareness, which is its mediation role as a cognitive mechanism that takes learning inputs and gives behavior outputs. The results of Burlea-Schiopoiu and Timpa (2025) reveal that, in the context of the oil and gas industry, the most significant direct effects on ethical environmental conduct are exerted by employees' environmental consciousness, rather than by HRM practices. Perceived green HRM practices were found to have a partial mediating effect on environmental awareness and green behavior as reported by Chen et al. (2021). These results align with the literature in the behavioral sciences which shows that attitude and normative cognition are proximal determinants of behavioral intentions (Ajzen, 1991), and with the AMO theory which focuses upon the importance of motivation, in this case awareness, as a complement of ability in inducing behavioral change (Appelbaum et al., 2000).

## 2.4 Synthesis of the Sustainable Operational Practices Literature

The 14 studies that fall under the sustainable operational practices cluster collectively indicate that sustainable operational behaviors in oil & gas is a multi-dimensional construct, and includes energy conservation, waste management, emissions control, water stewardship, HSE compliance, reporting of environmental risks and participation in operational improvement initiatives (IOGP, 2026; Ipieca, 2024). One of the common themes in this literature is technical-behavioral complementarity: technical systems and monitoring platforms provide environmental benefits only when they are used by personnel who understand their environmental purpose and are motivated to use them effectively.

Research in a similar setting such as Iraqi oil and gas (Abdulameer & Ibrahim, 2025), Qatari petroleum (Obeidat et al., 2020) and North African industrial fields (Abu Shada et al., 2019) have all revealed that better operational behaviors is more likely to be achieved if employees are knowledgeable and aware. This discovery underscores the human capability development as a sustainable operations strategy in institutionally constrained petroleum economies.

## 2.5 Identified Research Gaps

The systematic synthesis reveals five previously undocumented gaps that motivate and justify the present conceptual contribution, as also visualized in Figure 3 (Research Gap Matrix):

**Figure 5. Research Gap Matrix: Prior Studies vs. Present Contribution**

Study / Domain	Green Education	Env. Awareness	Sustainable Oper. Pract.	Mediation Tested	Libya Context
Chen et al. (2021)	□	□	□	—	□
Obeidat et al. (2020)	□	—	□	□	□
Pinzone et al. (2019)	□	□	□	□	□
Burlea-Schiopoiu & Timpa (2025)	—	□	□	□	□
Anwar et al. (2020)	□	□	—	—	□
Abdulameer & Ibrahim (2025)	□	—	□	□	□
<b>Present Study (Conceptual Contribution)</b>	□	□	□	□	□

Fully addressed    
  Partially addressed    
  Not addressed    
 Present study = first to address all five dimensions

Figure 3. Research gap matrix comparing prior studies with the present contribution across five key dimensions. Source: Author's development.

**Construct reconceptualization:** No prior study has operationalized green education as a multidimensional systemic organizational learning capability with specified dimensions applicable to petroleum operations. Existing studies treat green education as equivalent to green training, losing the systemic and cultural dimensions of the construct.

**Mediation mechanism:** The mediating role of environment awareness, as a three-dimensional theoretical construct of cognition, between green education and sustainable operational practices has not been tested in a petroleum context. Studies on mediation do so using other mediators (e.g., green motivation, organizational commitment) and in non-petroleum contexts.

**Theoretical integration:** There is no previous framework that integrates AMO theory, TPB and Institutional Theory in a unified multi-level architecture explaining the green education effects in industrial contexts. Existing studies draw on single theories, losing explanatory coverage of the individual, behavioral, and institutional levels simultaneously.

**Developing petroleum economy context:** The Libyan petroleum sector has received no prior attention in the green education or environmental awareness literatures. More broadly, developing petroleum economies with institutional constraints, legacy infrastructure, and human capital development challenges are substantially underrepresented, limiting the generalizability of existing models.

**Integrated managerial framework:** No prior study has advanced a practically operational, stage-based managerial framework for implementing green education as a strategic organizational capability with specified awareness outcomes, operational outcomes, and performance indicators linked to each implementation stage.

### 3. Theoretical Foundations

#### 3.1 Multi-Level Theoretical Architecture

The proposed conceptual framework is derived from a three-level theoretical architecture that explains the phenomenon from three complementary analytical levels: the individual capability and motivational level (AMO theory), the cognitive-behavioral mechanism level (Theory of Planned Behavior), and the organizational-institutional legitimacy level (Institutional Theory). This multi-level integration is not only a conceptual innovation but also a theoretical necessity because the phenomenon to be explained (the translation of the investment in organizational learning into individual sustainable operational behavior in an institutionally structured context) cannot be explained by any one theoretical perspective.

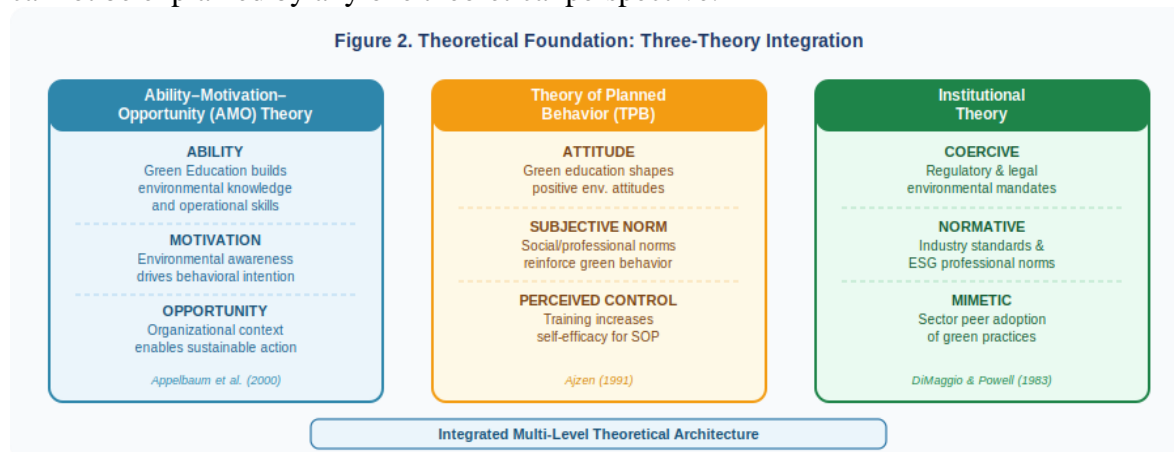


Figure 4. Integrated three-theory architecture: AMO Theory, Theory of Planned Behavior, and Institutional Theory as multilevel explanatory framework. Source: Author's development.

#### 3.2 Ability-Motivation-Opportunity Theory

AMO theory (Appelbaum et al., 2000) provides the foundational individual-level mechanism of the proposed framework. The theory posits that employee performance behaviors are jointly determined by three factors: Ability (the competencies required to perform a

behavior), Motivation (the volitional drive to engage in the behavior), and Opportunity (the structural conditions that enable behavioral expression). The application of AMO theory in the context of green education – sustainable operational practices relationship implies that green education is the key mechanism of the organization to develop employee environmental Ability (environmental knowledge, HSE ecological literacy, green operational skills) and to build employee environmental Motivation (environmental awareness, values, and norms). Organisational Sustainability Culture, Management Support and Structure of the operational environment in which sustainable behaviour can be expressed or not, provide the Opportunity dimension.

The AMO architecture explains why green education programs that focus exclusively on knowledge transfer (Ability) without simultaneously building motivational awareness (Motivation) or creating supportive operational conditions (Opportunity) consistently yield weaker behavioral outcomes. This insight underlies the tripartite design requirements of effective green education systems advanced in this paper.

### **3.3 Theory of Planned Behavior**

The cognitive-behavioral mechanism specification of the framework is provided by the theory of planned behavior (TPB) (Ajzen, 1991). TPB assumes that the three antecedents to behavioral intention — attitude toward the behavior (evaluative orientation), subjective norm (perceived social expectation), and perceived behavioral control (self-efficacy and controllability) — are the proximal determinants of behavioral intention, and thus behavior. Green education influences the employees' attitudinal orientation towards environmental responsibility, the normative expectation that they are expected to act in a sustainable way and their professional value, as well as their perceived behavioral control through the acquisition of competencies and operational knowledge to perform sustainable actions.

In this framework, environmental awareness is the internalized result of these three TPB antecedents regarding environmental operational behaviors: an aware employee has positive attitudes toward the environment, internalized sustainability norms and feels competent enough to act more sustainably. This specification uses environmentally related awareness as the mediating cognitive construct between the learning inputs from green education and the behavioral outputs of sustainable operational practices, and it is a theoretically precise formulation, which moves beyond the generic 'awareness' constructs used in previous green HRM studies.

### **3.4 Institutional Theory**

The macro-level organizational and sector-level dynamics in which the individual-level dynamics of green education and awareness operate is provided by Institutional Theory (DiMaggio & Powell, 1983). There are three isomorphic mechanisms that are active in the petroleum industry context. Coercive isomorphism is brought about by regulations at the national and international levels, as well as by contractual obligations imposed by partners and organizations from other countries that require petroleum organizations to invest in environmental management systems and environmental education of employees. Normative isomorphism can be achieved by the mechanisms of professional associations (IOGP, Ipieca), professional certification bodies of HSE, and industry benchmarking practices that set up normative expectations of environmental workforce competencies. Mimetic isomorphism stems from a tendency for organizations to mimic sustainability practices already adopted by sector peers that are thought to be successful or prestigious.

Institutional theory is especially relevant in the Libyan context, as institutional pressures exist, albeit through international partnerships, NOC obligations and the reintegration of Libyan petroleum into global markets, and the enforcement of these pressures and their normative penetration are uneven. This institutional variability is an important boundary condition for the

framework: the effectiveness of green education is moderated by the strength and coherence of the institutional context in which it is implemented.

#### 4. The Workforce Sustainability Capability Framework (WSCF)

##### 4.1 Framework Overview

The Workforce Sustainability Capability Framework (WSCF) is the main theoretical contribution of this paper. It synthesizes the construct reconceptualization's, mediating mechanism specification, theoretical foundations and contextual boundary conditions discovered in the systematic review in a testable conceptual model. The WSCF extends beyond previous models of green HRM and green education in four ways: (1) it moves beyond conceptualization of green education as a one-off training event to a multidimensional systemic organizational learning capability; (2) it moves beyond the conceptualization of environmental awareness as a unidirectional attitudinal variable to a three-dimensional cognitive mediating variable; (3) it combines three complementary lenses in a multi-level architecture; and (4) it takes into account the contextual boundary conditions for developing petroleum economies.

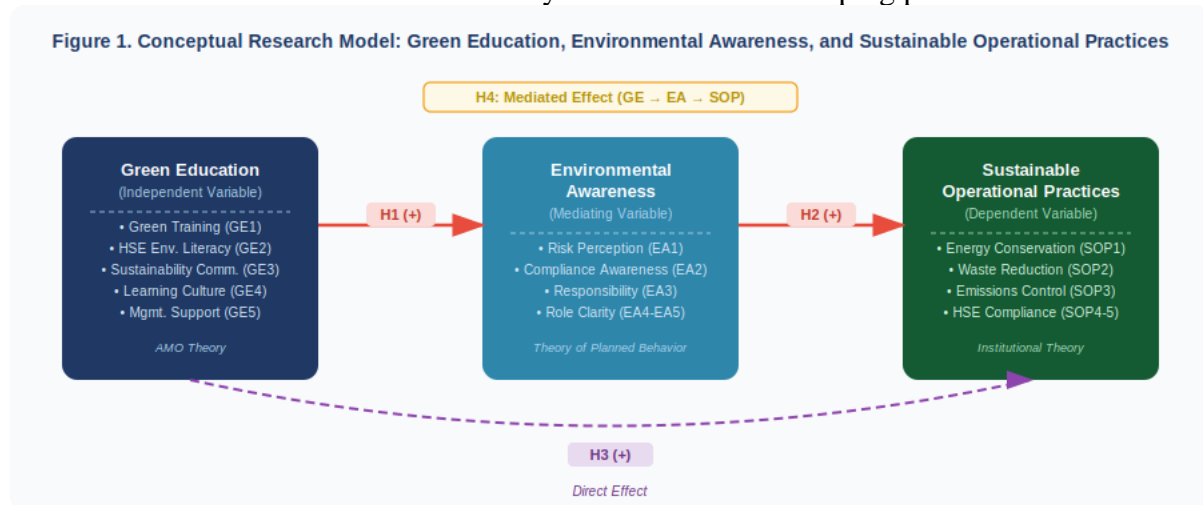


Figure 1. Workforce Sustainability Capability Framework (WSCF): integrated conceptual model of the relationships among Green Education, Environmental Awareness, and Sustainable Operational Practices. Source: Author's development.

##### 4.2 Construct Specifications

Construct	Definition	Dimensions	Theoretical Grounding
Green Education (GE)	A systemic, workplace-embedded organizational learning capability that builds environmental knowledge, HSE ecological literacy, green operational competencies, and sustainability-oriented attitudes across multiple delivery channels.	(1) Formal environmental training; (2) HSE ecological literacy; (3) Sustainability communication; (4) Organizational learning culture; (5) Management support	AMO: Ability + Motivation development; Institutional Theory: normative & coercive pressures
Environmental Awareness (EA)	A three-dimensional cognitive construct encompassing cognitive	(1) Risk perception & cognitive knowledge; (2) Affective	TPB: Attitude + Subjective norm + Perceived

Construct	Definition	Dimensions	Theoretical Grounding
	knowledge of environmental risks and operational consequences; affective sensitivity to environmental impacts; and normative perception of personal/organizational responsibility for environmental protection.	environmental concern; (3) Normative responsibility attribution; (4) Compliance awareness; (5) Role-specific environmental clarity	behavioral control; AMO: Motivation
Sustainable Operational Practices (SOP)	The aggregate of routine work behaviors and process-level actions through which employees minimize environmental impact, enhance resource efficiency, strengthen HSE compliance, and contribute to the long-term environmental resilience of petroleum operations.	(1) Energy conservation; (2) Waste segregation & minimization; (3) Emissions control & monitoring; (4) Water stewardship; (5) HSE compliance & risk reporting	AMO: Opportunity + Ability expression; TPB: Behavioral intention → Behavior

Table 1. WSCF construct specifications, dimensions, and theoretical grounding.

### 4.3 Theoretical Propositions

The WSCF yields four propositions that are theoretically derived and directly testable by quantitative survey research by using PLS-SEM methodology. Each proposition is based on the theoretical architecture and systematic review synthesis mentioned above.

(P1) Green education is positively correlated with environmental awareness among the personnel in petroleum operating environment.

Green education can give employees the knowledge about the environment (cognitive dimension), the activation of ecological concern (affective dimension), and the framing of ecological responsibility (normative dimension) which are the three aspects of environmental awareness. The cognitive structures that make up environmental awareness are developed by continuous multi-channel learning exposure (formal training, HSE briefings, management communication and incident-learning). This relationship is based on the viewpoint of AMO theory that green education is the key mechanism for developing the motivation (Appelbaum et al., 2000), the argument of TPB that attitude formation processes involve the processing of information (Ajzen, 1991), and the empirical support from petroleum and industrial HRM contexts (Chen et al., 2021; Pinzone et al., 2019).

(P2): Environmental awareness is positively related to sustainable operational practices.

Employees who have built up substance and three-dimensional environmental awareness are more likely to see environmental impacts of operating decisions, feel personally responsible for reducing environmental risks, and take pro-active initiatives for resource conservation, emissions management, waste minimization and reporting. Environmental awareness is the link between general environmental knowledge and operationally situated behavioral motivation, which gives the psychological impetus and directionality for sustainable practice. This proposition is based on TPB's attitude-to-behavior pathways (Ajzen, 1991) and

is supported by empirical studies in the field of oil and gas and industrial sustainability (Burlea-Schiopoiu & Timpa, 2025; Anwar et al., 2020).

P3: Green education has a positive relationship to sustainable operational practices as a direct relationship.

In addition to the mediated effects that come from environmental awareness, green education can have direct impacts on sustainable operational practices, through skill-acquisition and behavioral rehearsal aspects of organizational learning. Some procedural knowledge and operational skills (waste segregation rules, energy monitoring routines, emissions reporting systems, chemical handling practices) can result in practice change without the attitudinal mediation pathway, particularly if the training is operationally specific and procedure oriented. (P4): The impact of green education on sustainable operational practices is mediated by environmental awareness, thus the impact of green education on sustainable operational practices is mainly indirect.

The P4 is the WSCF's core theory and is the synthesis of P1–P3. The mediated pathway is an expression of the theoretical assertion that the most significant impact of green education on sustainable operations is not simply the transfer of procedural knowledge but the establishment of the cognitive motivational state – environmental awareness – which fundamentally shifts employees' interpretive frameworks for operational decision-making. Empirical evidence to support this proposition (and specifically the full or partial mediation inference) would provide strong support for the WSCF's theoretical model and for the superiority of the model over direct-effects models.

Code	Proposition	Path	Theoretical Basis
P1	Green Education → Environmental Awareness	GE → EA (+)	AMO (Motivation); TPB (Attitude formation)
P2	Environmental Awareness → Sustainable Operational Practices	EA → SOP (+)	TPB (Attitude → Behavior); AMO (Motivation → Behavior)
P3	Green Education → Sustainable Operational Practices (direct)	GE → SOP (+)	AMO (Ability → Behavior); Skill acquisition theory
P4	GE → EA → SOP (mediated; primary pathway)	GE → EA → SOP (+)	AMO + TPB + Institutional Theory (integrated)

Table 2. WSCF theoretical propositions, pathways, and theoretical grounding.

#### 4.4 Boundary Conditions and Contextual Moderators

In the WSCF, the context boundary conditions of proposed relationships are explicitly addressed. There are two types of moderating factors that are hypothesized to affect the strength of the P1–P4 pathways.

Organizational-level moderators are: (1) Sustainability culture strength — strong, coherent and behaviorally reinforced sustainability cultures magnify the impact of green education on awareness and practice; (2) Management environmental leadership quality — supervisor modelling of sustainable behaviors and environmental communication fosters learning transfer; and (3) Operational context hazard salience — more immediately and operationally salient contexts result in stronger awareness-behaviors relationships.

Institutional level moderators include: (1) Regulatory enforcement intensity — stronger and more consistently enforced environmental regulations amplify the coercive institutional pressure that motivates organizational green education investment; (2) Industry normative maturity — sectors with well-developed professional norms around environmental performance sustain higher baseline levels of environmental awareness; and (3) Institutional stability — the degree of institutional stability and regulatory continuity moderates the extent to which institutional pressures are coherently translated into organizational learning investment, as is particularly relevant in the Libyan context.

#### 4.5 Proposed Measurement Framework

A structured measurement framework is suggested to support the empirical validation of the WSCF. All constructs are operationalized as reflective latent variables and measured with five indicators on a five-point Likert scale that were adapted from existing scales from the literature on green training, environmental awareness, and sustainable behavior and were tailored to the context of the petroleum industry.

Construct	Code	Measurement Item
Green Education	GE1	My organization provides structured environmental education or training relevant to oil and gas operations.
	GE2	Employees receive systematic guidance on how their daily operational activities can reduce environmental impact.
	GE3	Environmental sustainability topics are regularly incorporated into HSE meetings, toolbox talks, and operational briefings.
	GE4	Management actively encourages employees to learn and apply sustainable operational practices.
	GE5	Training programs explicitly address how energy use, emissions, waste, and water management affect sustainability performance.
Environmental Awareness	EA1	I have a clear understanding of the environmental risks associated with oil and gas operations.
	EA2	I am aware that small operational decisions can have measurable effects on emissions, waste generation, and resource consumption.
	EA3	I understand my personal responsibility for supporting environmental protection in my workplace.
	EA4	I can reliably identify operational situations that may generate environmental risk.

Construct	Code	Measurement Item
	EA5	I believe that environmental protection is an integral component of operational excellence.
Sustainable Operational Practices	SOP1	I actively seek to reduce unnecessary energy consumption in my work activities.
	SOP2	I consistently follow established procedures for waste handling, chemical management, and environmental reporting.
	SOP3	I report leaks, spills, abnormal emissions, and other environmental risks promptly upon observation.
	SOP4	I actively support operational improvements that reduce emissions, waste, and resource consumption.
	SOP5	My work practices systematically contribute to safer and more environmentally responsible operations.

Table 3. Proposed measurement items for empirical validation of the WSCF.

For PLS-SEM validation, the following measurement quality thresholds are recommended: outer loadings  $\geq 0.708$ ; Cronbach's alpha and composite reliability  $\geq 0.70$  (and  $\leq 0.95$  to avoid indicator redundancy); AVE  $\geq 0.50$ ; HTMT  $< 0.85$  for conceptually distinct constructs (Henseler et al., 2015); and VIF  $< 3.3$  for common method bias assessment (Kock, 2015). Mediation testing should employ bootstrapping with 5,000 subsamples and bias-corrected 95% confidence intervals following Hair et al. (2022).

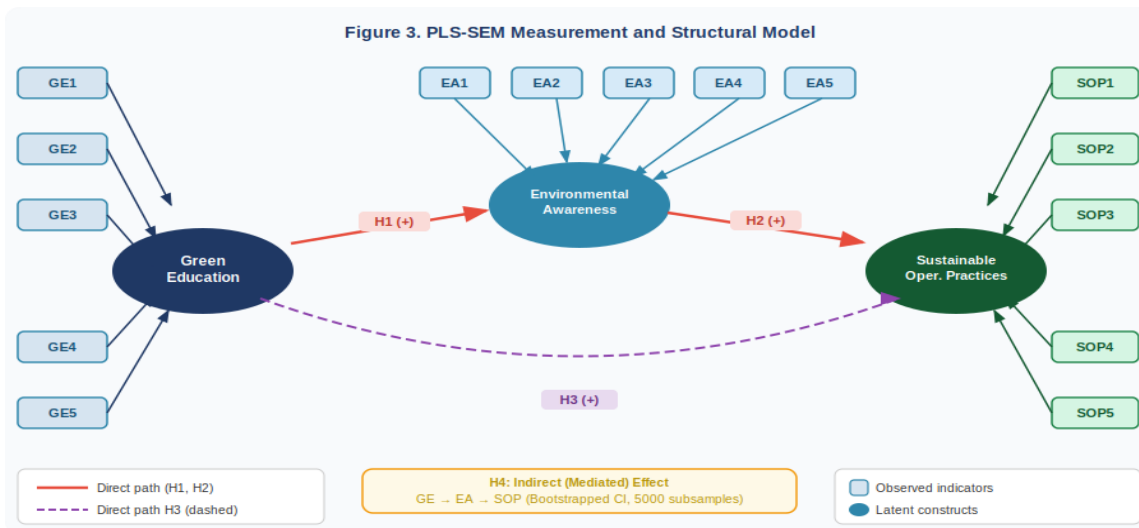


Figure 5. PLS-SEM measurement and structural model for empirical validation of the WSCF. Ellipses represent latent constructs; rectangles represent observed indicators; arrows represent hypothesized structural paths. Source: Author's development.

## 5. Discussion

### 5.1 Theoretical Contributions

This paper makes three distinct theoretical contributions to the green HRM, industrial sustainability, and engineering management literatures.

The first is the reconceptualization of green education as a systemic organizational learning capability. Existing studies have tended to equate green education with green training, a

programmatic, event-based and periodic instructional intervention. The WSCF represents a different conceptualization: green education as a capability that is continuous, multi-channel, organizationally embedded, and that influences employees' environmental knowledge structures, affective orientations and normative commitments throughout the entire organizational fabric of life. The implications of this reconceptualization are direct on the theorization, measurement, and management of green education effects and are the reason that training oriented research studies show lower behavioral effects than would be expected if the complete systemic learning system would be functioning.

The second is a theoretical description of environmental awareness as a tri-dimensional cognitive mediating construct. Previous studies have either conceptualized environmental awareness as a general attitudinal variable or merged it with environmental knowledge, environmental concern or green behavioral intention variable. The WSCF's three-dimensional specification – cognitive, affective and normative – offers a theoretically precise and empirically distinct operationalization that allows for more accurate measurement and more informative mediation testing. The WSCF takes the theoretical explanatory power of the green education–sustainable behavior relationship one step further by stating the mechanism instead of just claiming that they are mediated.

The third contribution is the multi-level theoretical integration. The explanatory coverage of the WSCF's triangulation of AMO theory, TPB, and Institutional Theory exceeds that of any single theory. AMO theory sheds light on how green education influences individual capability and motivation; TPB provides a cognitive-behavioral mechanism to understand how awareness leads to behavioral intentions and practices; and Institutional Theory provides a lens into the legitimacy pressures that give rise to and maintain conditions for investing in green education. This combination is not redundant, however; each theory has a different analytical level and their combination yields a more complete and richer explanatory architecture.

### **5.2 Implications for Research**

The WSCF is a testable model that is fully specified, has defined constructs and measurement items, and proposes a specific analytical approach and boundary conditions for context. Based on the four propositions, direct hypotheses are created, which can be tested using quantitative survey research and PLS-SEM in Libyan and other developing petroleum economy contexts. In addition to direct proposition testing, the WSCF proposes several promising research extensions: longitudinal designs to test the temporal dynamics of the green education → awareness → practice pathway; multi-group analyses to examine differences across organizational levels, departmental functions and institutional contexts; mixed-methods designs that integrate survey data with objective HSE performance metrics; and comparative studies across petroleum developing economies to establish contextual generalizability.

The WSCF also proposes a research agenda for the future that will be based on the boundary conditions hypothesized in Section 4.4. An empirical analysis of the moderating effects of sustainability culture strength, management environmental leadership, regulatory enforcement intensity, and institutional stability would significantly help to further develop the theoretical underpinning of the model and its application in different petroleum operating conditions.

### **5.3 Implications for Practice**

Perhaps the most important practical consequence of the WSCF is a re-thinking of green education as a strategic capability for the organization rather than a compliance training requirement for managers in the petroleum industry and the HSE function. The implications of this reframing are substantive and operational: it means that more effective sustainable operational performance is not a matter of offering more training, but of more complete, continuous and operationally embedded learning systems.

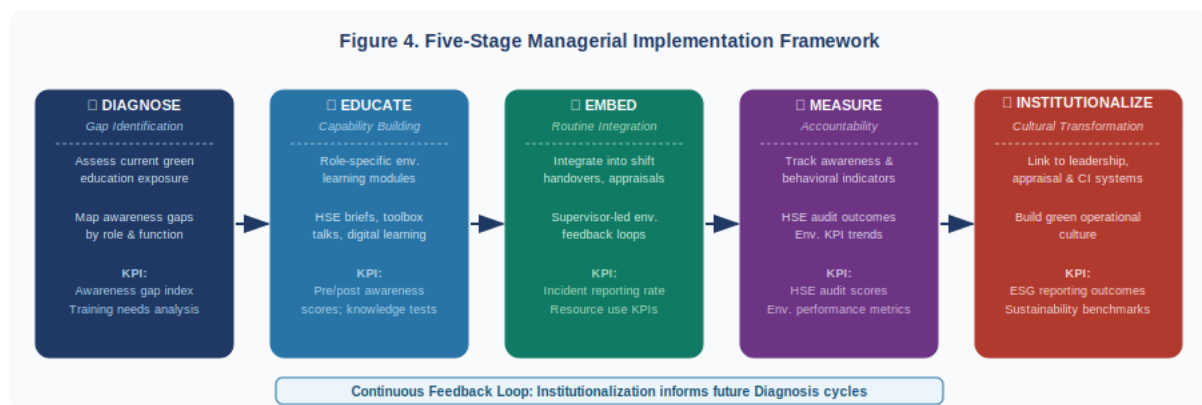


Figure 6. Five-stage managerial implementation framework for WSCF-guided green education in petroleum organizations. Source: Author's development.

The WSCF is used to create a five-stage roadmap for the managerial implementation of the WSCF as shown in Figure 6. The framework brings the conceptual model insights to a step-by-step process of organizational change, starting with a gap assessment, capability building, embedding in operational routines, measurement and accountability, and institutional anchoring. For each stage, specific managerial actions, expected environmental awareness results, and operational performance indicators are identified that can be used to monitor and evaluate.

Stage	Managerial Action	Awareness Outcome	Operational Outcome	Performance Indicator
1. Diagnose	Conduct WSCF-guided assessment of current green education exposure and environmental awareness gaps by role and function.	Identify cognitive, affective, and normative awareness deficits.	Establish baseline environmental performance and learning investment levels.	Awareness gap index; training needs analysis; HSE baseline metrics
2. Educate	Design and deliver role-specific, scenario-based environmental learning modules across multiple channels (formal, toolbox, digital, HSE briefing).	Improve risk perception, environmental concern, and responsibility attribution.	Increase compliance rates with sustainable operational procedures.	Pre/post awareness assessment scores; knowledge tests; attendance and engagement rates
3. Embed	Integrate environmental learning into daily operational routines: shift	Normalize environmental responsibility as a core	Reduce emissions tolerance, under-reporting, and	Environmental incident reporting rates; energy and waste KPIs;

Stage	Managerial Action	Awareness Outcome	Operational Outcome	Performance Indicator
	handovers, maintenance planning, incident investigations, supervisory feedback conversations.	professional value.	resource waste behaviors.	supervisory observation scores
4. Measure	Implement systematic tracking of environmental awareness levels, sustainable behavior indicators, and operational sustainability performance metrics.	Reinforce accountability and identify persistent awareness gaps for targeted intervention.	Drive measurable, documented improvements in operational sustainability performance.	HSE audit outcomes; environmental KPI trends; awareness survey periodic results
5. Institutionalize	Anchor green education in organizational performance appraisal, leadership development, continuous improvement systems, and sustainability reporting.	Build durable green operational culture embedded in organizational identity.	Achieve long-term, self-sustaining environmental performance transformation.	ESG reporting outcomes; sustainability benchmarking scores; organizational learning maturity index

Table 4. Five-stage WSCF managerial implementation framework.

The WSCF provides an achievable route to better environmental performance for Libyan petroleum organisations, without the need for significant capital investment in new technology. Libyan oil and gas companies can effectively enhance their environmental performance trajectories within their current operational and resource constraints by investing in the design quality, delivery continuity and operational specificity of green education and creating organizational conditions that support, measure and reward environmental awareness and sustainable behavior. This is a strategic argument of relevance for a sector in institutional and infrastructural recovery, where human capability development represents a more accessible and more rapidly deployable sustainability lever than technological modernization.

## 6. Conclusion, Limitations, and Future Research

### 6.1 Conclusion

This paper has created the original integrated conceptual model, the Workforce Sustainability Capability Framework (WSCF) which theorizes and specifies the relationships between green education, environmental awareness, and sustainable operational practices for the Libyan oil

and gas sector. The paper builds on a systematic review of 57 studies guided by the PRISMA framework and a triangulated theoretical architecture composed of the AMO theory, the Theory of Planned Behavior and Institutional Theory, and proposes three novel theoretical contributions: the re-conceptualization of green education as a systemic organizational learning capability; the specification of environmental awareness as a three-dimensional cognitive mediating construct; and the development of a multi-level explanatory framework that integrates individual, behavioral, and institutional levels of analysis.

The WSCF addresses five known research gaps and proposes four theory-driven, empirical testable statements about the direct and indirect relationships between the constructs. The conceptual contribution is translated into practical research and managerial tools through a proposed measurement framework, the PLS-SEM analytical model, and a proposed roadmap for managerial implementation in five stages. The framework is developed to be empirically tested in petroleum organizations in Libya and then revised and expanded to other petroleum economy development environments.

The findings in this paper have implications beyond the petroleum sector because the most important role of green education in achieving sustainable operational performance is through the cognitive mediating role of environmental awareness. The specification of the awareness-mediated pathway provided by the WSCF provides a theoretically accurate and actionable basis for investment in organizational learning in any high-risk industrial setting where the knowledge to behavior gap is the biggest obstacle to sustainable performance.

## **6.2 Limitations**

The WSCF's propositions are conceptual and have not been confirmed by empirical evidence, as it is a systematic literature review. The lack of empirical validation is not a methodological weakness, but an acknowledged limitation: conceptual papers that advance original theoretical frameworks are a recognized and valued contribution type in the Q1 organizational and sustainability management literatures and this paper meets the criteria of gap documentation, systematic synthesis, and original theoretical contribution (Gilson & Goldberg, 2015; Jaakkola, 2020).

Other limitations are: (1) Systematic literature search may not have identified all relevant literature in non-English languages or contributions found in unpublished grey literature. (2) The WSCF is developed based on gaps identified in the literature, which is constantly evolving and may need updating as new empirical evidence is collected. (3) The proposed boundary conditions are theoretical and need empirical investigation to determine the moderating effects of each and their relative importance.

## **6.3 Future Research Agenda**

The WSCF sets forth a rich and targeted research agenda. The next steps are to test the four propositions by quantitative survey research with PLS-SEM in Libyan oil and gas organizations; to investigate the three-dimensional structure of the environmental awareness construct using confirmatory factor analysis; and to examine the boundary conditions theorized in Section 4.4 starting with sustainability culture strength and management environmental leadership as moderators.

Longer-term extensions involve: longitudinal designs that follow the development of environmental awareness and sustainable operational practices over time as a result of green education interventions; comparative multi-country studies between different developing petroleum economies (e.g., Algeria, Iraq, Nigeria, Angola); mixed-methods designs that incorporate survey data and objective data on HSE performance with observational behavioral data; and computational modeling of the complex dynamic interactions among green education, awareness, institutional pressure and sustainable operational performance in organizational systems.

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