Safe Operational Behavior of Oil, Gas & Petroleum Industry: A Research & Review Agenda

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Human factors, processes and risk management in the oil, gas and petroleum (OGP) industry have always been the causes of appalling accidents. This paper examines the role of human factors, processes and risk management using the literature survey explicitly curated for the OGP industry. The OGP industry literature is reviewed through the management lenses of theories, contexts, characteristics, and methodology framework. The research findings are concrete in the intention of integrating human factors, processes, and risk management frameworks for the OGP industry. The integrated thematic constructs are conceptualized based on the literature evidence for OGP safety management systems. The present work concludes the research and managerial implications to fill the knowledge gaps regarding safe operational behavior covering the perimeters of OGP industry accidents.

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Introduction

Catastrophic accidents have hit the OGP industry for years. Accidents like the Piper Alpha disaster, blowout in BP Deepwater Horizon and fire in the BP Texas refinery and other destructions raised concerns about safety measures in the high-risk industry like OGP (Singh et al., 2010; Shappell & Wiegmann, 2012; Ismail et al., 2014; Nwankwo et al., 2022). OGP safety system design, engineering implementation and equipment maintenance have constantly been challenged with reliable information pertaining to performance, early warning of system failures and analysis from accident-prone events (Kariuki & Löwe, 2007; Theophilus et al., 2017). Human factors analysis and classification system (HFACS) were considered a holy grail for investing in accidents, most commonly in

the aviation industry but adopted in many other industries like mining, construction, maritime and railways, etc. (Reinach & Viale, 2006; Hale et al., 2012; Chen S-T et al., 2013).

Human errors are defined as the inconsistency, incongruity between humans' intended and omitted actions. The discrepancies can be the measured, observed, computed or conditioned against the benchmarks and theoretically correct failure items. Resilience and human error data are used to examine the failure cause analysis as a tool for resilience engineering (ISO 14224; Theophilus et al., 2018). On a broader scale OGP industry categorizes human factors as the organizational environment, job elements and individual characteristics influencing the health and safety behavior in the organization (Wiegmann & Shappell, 2017; Theophilus et al., 2018).

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Existing literature validates that it is essential to integrate process safety with human factor to avoid accidents (Theophilus et al., 2016; Energy Institute, 2016). It refers to preventing the exposure of hazardous substances that can cause accidents when not handled by humans as per the laiddown process (Theophilus et al., 2017). The Bhopal disaster was a testimony of the failure of improper maintenance and human factors leading to inadequacies which overruled the safety process systems (Varma &Varma, 2005). The OGP high-risk industry is not well protected by human factor-led errors (Bevilacqua & Ciarapica, 2018). Risk management integration with human factors achieves the desired risk-managed corporate culture, human factor contribution, risk reduction and mitigation recommendations due to human errors (Bevilacqua & Ciarapica, 2018). Risk management processes must integrate human factors with the safety process systems to avoid accident losses (Bevilacqua & Ciarapica, 2018).

There exists little evidence of human factors, human errors, process safety, and risk management research, specifically for oil, gas and petroleum industry. The integrated approach to studying all the factors in a single research makes the literature search more challenging for the OGP research fraternity. The widened gap and such compressing need to study the influences of integrated OGP accident causal factors motivated us to study the area to appreciate safe operational behavior. The literature survey was performed to assess the current state of OGP literature, and the theories, contexts, characteristics, and methodology (TCCM) method is leveraged to structure the discussion of research results. The literature survey is unique and one of its kind and didnot cover vital safety measures in the OGP industry. The objective is to study the following research questions.

1. What are the theoretical foundations of different factors responsible for safe operational behavior in OGP industry?

Theoretical Foundations

Inadequate maintenance of the OGP industry is a primary reason for accidents (Katsakiori et al., 2009). Chemical releases and piping failures contribute significantly to accidents in many parts of the global OGP companies (DeWolf, 2003). Lack of operational discipline, flaws in equipment design, malfunctions, and failure to control natural calamities lead to many accidents. Accident occurrences are non-deterministic in nature, but the study of the causal factors directs to the same type of failure factors of human factors and errors in maintenance (Knegtering & Pasman, 2013; Nwankwo et al., 2022). Many factors are associated with accident causal factors, as propounded in the Swiss cheese model, where the worker's unsafe acts are considered active (Reason, 2000). Omission of the procedural steps and incorrect action by humans are proposed as unsafe acts in HFACS (Graham, 2010). Technological and environmental factors were considered significantly in the original HFACS. Contractors and partnerships in OGP organizations contributed to fatal accidents in the higher order of fatal accident rates (FAR). The mental, psychological and physical state of worker and team influence the causality of accidents (Theophilus et al., 2017). The need for training and certification is regularly emphasied by researchers working towards safe operations in the OGP industry (Theophilus et al., 2017).

Process safety mechanism struggles in all process industries and look for the appropriate and robust approach to maintain the operational systems' integrity (Naicker, 2014). The objective is simple: minimize the incidents leading to accidents due to hazards, chemicals, fires, toxic explosions or even structural damages to the factories (Knegtering & Pasman, 2009). Prevention of fire, explosions, and chemical releases while operating, handling and storing the substances in upstream production and refineries is the primary focus of the OGP industry (Goh & Lai, 2015). The process safety benchmarks are based on the industry, and indicators are used to measure the effectiveness of the process and ascertain whether it is adequately followed (Theophilus et al., 2018). Standard operating procedures (SOPs) are vital in reducing the hazards to provide a safe and healthy work environment (Acheampong, 2022). Sound hearing protection aids and personal protective equipment must be provided to workers to practice safe operational behavior. Heavy load management, excessive heat, welding failures in pressure lines, oil / gas transport, worker communications and working conditions cause concerns both upstream and downstream of the OGP industry (Jagoda & Wojcik, 2019). Issues in monitoring the process chain include leakage control systems, oxygen levels, and ventilation. The workers from various backgrounds, resource scheduling, mobility and ad-hoc rosters explain the robust process requirements (Waqar et al., 2024). Failure to adhere to the pro-

Failure to adhere to the process guidelines in OGP may lead to severe accidents.

cess guidelines in OGP may lead to severe accidents. The legislation and law were weak before the 1990s. Multiple reforms, like Process Safety Management of Highly Hazardous Chemicals, were implemented (Theophilus et al., 2018). Country-specific process regulations like Control of Major Accident Hazards (COMAH) were enforced to control the safety process systems in the United Kingdom (O'Mahony et al., 2014).

Health and Safety Engineering and human reliability assessment methods have evolved over the last 60-70 years. Interestingly, the maturity of the risk management methods and tools is sighted to have a direct relationship with the site where human factors are deployed and experienced (Calixto et al., 2013; Bevilacqua and Ciarapica, 2018). The initial phase established the focus on operational human error and probabilities. By the end of the year 2000, the cognitive processes were assessed under the purview of the Human Performance Factor and risk management activities. The nuclear power research supported the area of human factors, human error and associated risk significantly (Swain & Guttmann, 1983; Bevilacqua & Ciarapica, 2018).

Methodology

The research follows the robust literature review method based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The objective is to scout and target the relevant papers to analyze the human, process, and risk management literature related to operational management to avoid OGP industry accidents. The outcome of the literature survey is captured in specific tables that are used to articulate the discussion, research, and managerial agenda with evidence.

Literature Review

Moher et al.'s (2009) research was apt to compile the state of the OGP body of knowledge of OGP industry literature on accident cause and risk management due to human and process factors. January 2024 to March 2024 and August 2024 to September 2024 time periods were used to filter the paper from various established databases. Web of Science, Google Scholar, and Science Direct were significant databases that pinpointed the documents that were desired for the intended review. The OGP literature was surveyed using the combination of keywords like reliability engineering, system safety process, safety science, environmental protection, target operating model, risk research, operations management, risk management, risk mitigation, governance, human causal factors, HFACS, integrated process safety management system, hazard and operability, HAZOP with the keywords like oil, gas, energy, petroleum, oil and gas, OGP, Chemical and safe operational behavior. The string concatenation is described in Fig. 1.

Research Paper Selection Criteria

The research followed the robust method of PRISMA to select and screen the relevant papers, as depicted in Fig. 2. The researchers initially discussed the

Fig. 1 Search Strings

Search string 1:

("reliability engineering" OR "system safety process" OR "safety science" OR "environmental protection" OR "target operating model" OR "risk research" OR "operations management" OR "risk management" OR "risk mitigation" OR "governance" OR "human causal factors" OR "HFACS" OR "integrated process safety management system" OR "hazard and operability" OR "HAZOP")

Search string 2:

<Search string 1> AND ("oil" OR "gas" OR "energy" OR "petroleum" OR "oil & gas" OR "oil and gas" OR "chemical" OR "safe operational behaviour"

inclusion criteria and suitability of the research papers and followed them rigorously to maintain the quality assessment of the intended research. The references of the screened paper were also used to identify the research papers following the bibliographic trail search method. As discussed below, multistage assessment, inclusion and exclusion filtration were performed to exercise the literature survey.

Inclusion: The research only focused on the papers found in journals. The process initially scouted and reviewed the documents using the paper's title, abstracts, keywords and conclusion. The papers were identified if it is directly related to the human factors, process and risk management of safe operational behavior in the OGP industry.

Exclusion: The documents sourced from chapters, books, thesis, white papers, books and non-English papers were not considered in the literature screening exercise. The duplicate paper was removed, and only OGP industry, Chemical and petroleum accidents / risk management documents were screened to achieve the research's central theme.

Quality Management

Reputed databases were used to screen the papers to meet the theoretical foundations and OGP body of knowledge related to human factors, processes, and risk management causing accidents. It ensured that the strong quality assessment guidelines aligned with the survey and met the desired objective.

The native database filters were applied to gather the relevant papers. The keywords discussed in Fig. 1 were inputted with various combinations. The output of the filtration process provided 273 papers, and 64 papers were added by different sources, such as bibliographic trail search and direct search engine results. 51 papers were adjudged duplications after the first round of preliminary examination of the paper. 129

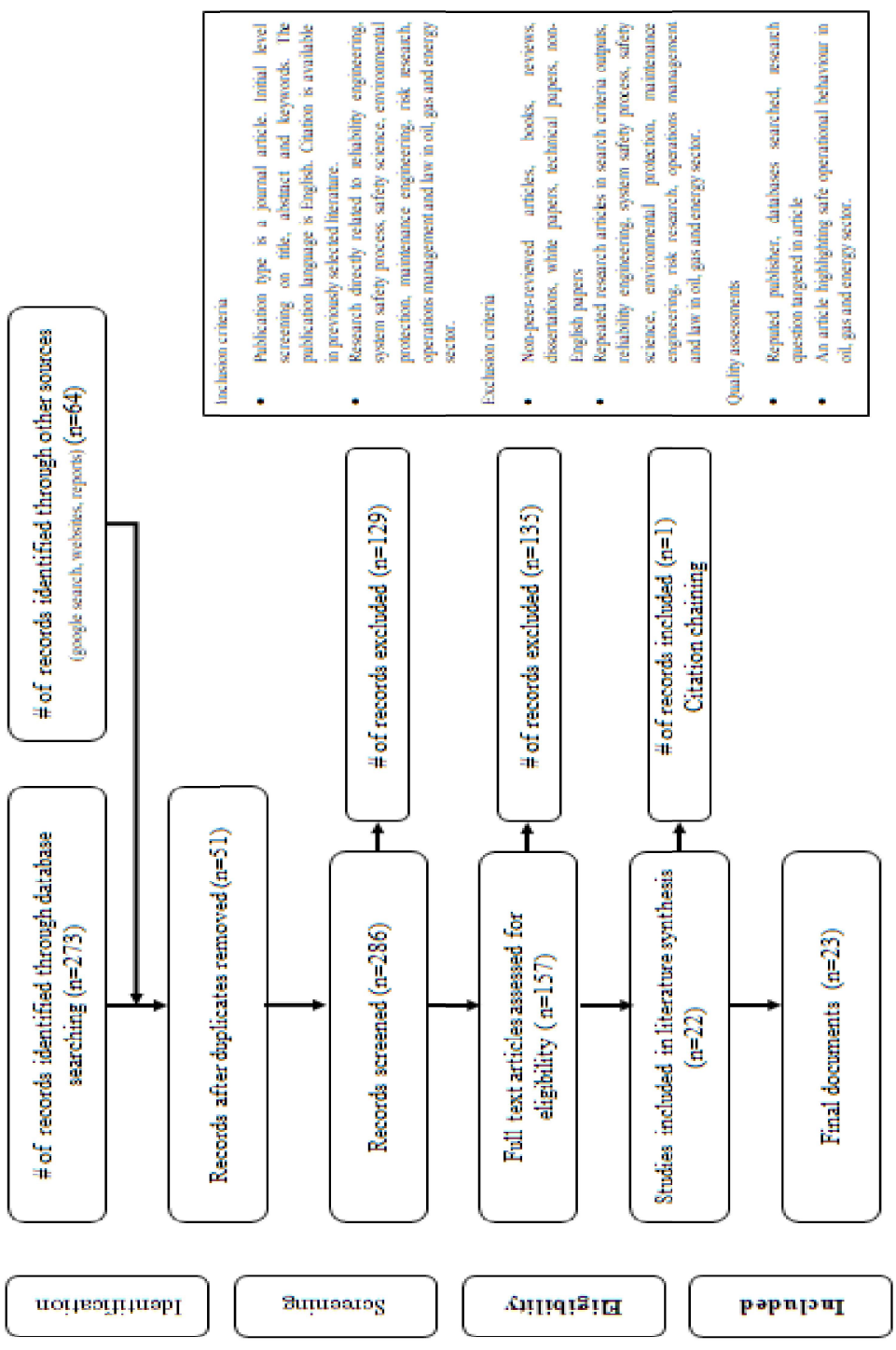

Fig. 2 Moher et al. (2009) Work-powered Literature Survey

and 135 papers were removed, putting the screening, inclusion and exclusion criteria in action. The entire filtration of PRISMA resulted in 22 papers in scope, and one paper was added because of the cross-citation availability of the paper. It resulted in the final 23 papers that became the scope of the literature survey.

The literature survey on integrating human factors, processes and risk management to practice safe operation behavior does not exist or is scarce. The filtered 23 papers were considered the foundation and body of knowledge of safe operation behavior in the OGP industry. A rigorous literature analysis constituted Tables 1-7, which depicted the current state of research in the OGP industry about safe operational behavior in response to the research questions framed in the introduction earlier. The sources of paper with frequency and associated journals are presented in Table 1. Reliability Engineering & System and Safety and Safety Science are the apparent journals with many papers, while other journals have a discrete presence with single paper entries in the whole frequency list. The paper's objectives and key findings are discussed crisply in Table 2 to understand the research avenues of 23 papers. Table 3 presents the OGP industry penetration, enumerating the dominance of oil / gas with oil refineries / chemical plants / downstream, petroleum as subfields and chemical as an industry. Table 4 is the repository of the applied methods of all 23 papers. The astonishing results indicate the balanced approach of conceptual, qualitative and quantitative papers, including case studies. Literature survey-type papers are scarce; hence, the research work carried out becomes more unique. Table 5 validates the theoretical nitty-gritty of all the documents and concludes the rich amalgamation of functional and extended theories to support the intended work by the researchers. Table 6 is unique and can be proposed as the thematic base of future work presenting the thematic presence of literature in the OGP industry targeting safe operational behavior. Traces are available to understand the theoretical underpinnings, relationships and dependencies that can contribute to other research initiatives. The region-wise literature context is available for Malaysia, Vietnam, Norwegian, Thailand, and Nigeria, as shown in Table 7.

Discussion

Paul et al., (2017) and Paul, (2020) are extensively used in reviewing the literature using the theories, characteristics of the related papers, and applied methods of the research with the contextual discussions. TCCM framework is used to align the structure of the discussion of the reviewed literature. The debate structure helps quantitively appreciate the richness of the literature in the OGP domain. The themes allow the bogger horizon where human, process and risk factors can be integrated together to observe the larger gamut of safe OGP operations behavior.

Theory

HFACS framework was clearly distinguished as the foundational theory for human-led accident causation in OGP lit-

Table 1 Bibliographic Sources of OGP Safe Operational Behavior Literature

Bibliographic Source	Articles Considered for Review	Total %
Reliability Engineering & System Safety	3	13.04
Safety Science	2	8.70
International Journal of Occupational Safety and Ergonomics	1	4.35
Process safety progress	1	4.35
PLoS One	1	4.35
Ain Shams Engineering Journal	1	4.35
International Journal of Energy Sector Management	1	4.35
Materials Today: Proceedings	1	4.35
Process Safety and Environmental Protection	1	4.35
Organization Studies	1	4.35
Journal of Quality in Maintenance Engineering	1	4.35
Environmental Development	1	4.35
Journal of Risk Research	1	4.35
Journal of Marine Science and Engineering	1	4.35
Journal of Services and Operations Management	1	4.35
Natural Gas Industry	1	4.35
Journal of Safety Research	1	4.35
Journal of Engineering Research and Reports	1	4.35
Applied Sciences	1	4.35
Journal of world energy law and business	1	4.35

Source: Author's own compilation.

erature. It is essential to mention that there is no standardization in using the standard integrated theory of human, process and risk management theory to explain the underpinnings of the OGP industry. The theoretical approach was discrete in most papers, with different theories covering vast aspects. Commonly used theories are reasons theory of accident causation, systemic analysis or signal detection theory (SDT), combining graph theory, safety factors, human factor risk management (HFRM), risk management for OGP, hazard identification and risk assessment with controls (HIRAC), accident theories, normal accidents, prospect theory, high-reliability organization, environmental and petroleum laws, safety citizenship behavior, safety barrier management, institutional theory, intelligent safe operation and maintenance technology, asset integrity management, the hazard and operability (HAZOP) and guiding principles on business and human rights. The theoretical explanations justify the conceptual definitions of human-led risk management activities in OGP industries. Most theories are the calibrated versions of the HFACS when human aspects are discussed to establish accident causation in the OGP industry. Fundamental risk management theories were applied in multiple contexts, including safety, maintenance, reliability, environmental covers, hazards, and human rights. Safe operational behavior is not a niche topic in OGP, but the lack of an integrated model, thematic

Table 2. Objective(s) and finding(s) of previously published works

Author(s)	Objective(s)	Finding(s)
Nwankwo et al., (2022)	Target is to study accidents human causal factors (HFACS-OGI framework led human factors analysis	Contractor work environment is the major reason Drilling workover was the second most obvious cause
Theophilus et al., (2017)	Improvement in HFACS investigation tool Classification system for HFACS-OGI	Categorising accidents is vital using HFACS National/international industry regulatory failures lead to accidents
Selvik and Bellamy, (2020)	Human error classification and assessment Distinction between error and human error	Classify and collect human errors ISO 14224 could provide human error led knowledge base
Theophilus et al., (2018)	Integrated process safety management system (IPSMS) for learning system and control Process safety system (PSM) integration with HFACS	PLAN, DO, CHECK, and ACT framework for IPSMSMeasure and analyse PSM
Mignan et al., (2022)	Energy-related Severe Accident Database(ENSAD) Graph based OG accident records	Central measures on human errors as catalysts Rank and fundamental matrix of accidents likelihood chains-of-events
Waqar et al., (2024)	Primary safety factors for accidents Critical safety factors related to training, supervision and procedures.	Safety construction in Malaysia OG industry Significant safety elements contributing to accidents
Bevilacqua et al., (2018)	Human Factor Risk Management (HFRM) Refinery Risk Management System based on historical data	Association Rules (AR) led conceptual model Risk index, performance shaping factors (PSFs) and corrective actions
Van Thuyet et al., (2019)	Identify risk factors and responses Risk responses for Vietnam OGP industry	Bureaucratic systems and long approval process Multiple criteria decision-making approach for decision making
Iqbal et al., (2021)	Analysis of disaster casesRisk assessment of hazards are workplace and environment	Hazards identification and control measures Hazards impacts on employees
Andersen and Mostue, (2012)	Study of the changes by Integrated Operations (IO) Challenge for traditional risk analysis	Exploratory approach for risk analysis for OG line of businesseshuman factors organizational aspects and technological issues are considered for risk analysis
Moura et al., (2017)	Complex communication between technologies, organisations and human factors, Efforts needed to control and measure hazards	Data mining technique on the accident dataset Common patterns disclosing major accidents causes
Zio and Aven, (2013)	Review of last decade risk assessment approaches for chemical industry Quantitative Risk Assessment (QRA) role in process safety and design	Risk assessment tool for plant installations and process design Limitations of QRA in chemical industry settings

Table 2. Continued

Author(s)	Objective(s)	Finding(s)
Leveson et al., (2009)	High reliability organizations (HRO) and normal accident theory (NAT) deals with hazards Culture and organization structure explicate accidents.	Outline approaches and identify limitations, ambiguity w.r.t reliability and safety Debate on NAT and HRO, We believe that the debate between NAT and HRO
Dey et al., (2004)	Study the leak and burst of OGP pipelines hazards Tangible/in-tangible loss of maintenance breakdown	Develop risk-based maintenance model OG pipeline management using Multiple-criteria decision-making and weight method
Ambituun et al., (2014)	Study then issues of accidents and disasters impacting environment Critically examine the environmental and petroleum laws	Enforcement of oil governance law and regulations OpEx variance could improve operations
Didla et al., (2009)	Examine the human, legal, environmental and financial impacts of accidents risks Understanding the safety behaviour under compliances and regulations	Examined motivators and consequences of Safety citizenship behaviour Positive safety culture impacts Safety citizenship behaviour
Hosseinnia Davatgar et al., (2021)	Study flammable hydrocarbons led accidents and risks Safety barriers assessments to control the accident frequency	Directive results through accidental risk assessment methodology Frequency modification technical operationaland organizational factors
Muazu et al., (2021)	Understand the health, safety and the environment for refineries OpEx and regulatory framework for enterprise risk management (ERM)	Findings presents firm characteristics and regulatory framework positively influences OpEx and ERM Variance in OpEx improve operational performance
Zhang and Wang, (2023)	Examine maintenance and intelligent safe operation of OGPConceptualize OG interactive cyber-physical intelligent system	Investigate maintenance technology and intelligent safe operation Realization of safe OGP production systems
Dahl and Kongsvik, (2018)	Study OG safety behaviour with safety climate Safety compliance and participation with mindful safety practices	Findings highlight mindful safety practices are contextual Safety leadership factor is the most important climate factor
Tang, (2021)	Study the influences of asset integrity with process safety Petronas mandatory control framework	Alignment with reiterative plan-do-check-act model Control of on-shore/ off-shore processes
Penelas and Pires, (2021)	Examine Hazard and Operability (HAZOP) Evaluation of environmental, health and economic impact	Identify potential hazards and HAZOP efficacy Equipment malfunction and process impact study
Lindsay et al., (2013)	Understand the guiding principles on OG business and human rights Respect human rights and OG responsibility	Identify potential humanrights impacts and due diligence Responsibility consequences and legal risks and third-party relevance

Table 3 Industry-wise literature Context of OGP Safe Operational Behavior

Industry	Stream	Author(s)
Oil & Gas	Oil Refineries and Chemical plants	Nwankwo et al., (2022); Theophilus et al., (2017); Selvik and Bellamy, (2020); Theophilus et al., (2018); Bevilacqua et al., (2018); Van Thuyet et al., (2019); Iqbal et al., (2021); Moura et al., (2017); Didla et al., (2009) ; Hosseinnia Davatgar et al., (2021); Muazu et al., (2021); Zhang and Wang, (2023); Dahl and Kongsvik, (2018); Tang, (2021); Penelas and Pires, (2021); Lindsay et al., (2013); Leveson et al., (2009)
	Downstream Petroleum	Waqar et al., (2024); Andersen and Mostue, (2012); Ambituun et al., (2014)
Chemical		Mignan et al., (2022); Zio and Aven, (2013); Dey et al., (2004)

Source: Author's own compilation.

Table 4 Commonly Applied Methods for OGP Safe Operational Behavior

Method	Sub-stream	Author(s)
Quantitative	Quantitative Statistical Analysis $\chi 2$ test	Nwankwo et al. (2022)
	Spearman's Correlation with Chi-square and Fisher's Exact Test	Theophilus et al., (2017)
	Markov analysis and catastrophe dynamics	Mignan et al., (2022)
	Quantitative- Exploratory factor (EFA) and structural analysis equation modelling (SEM)	Waqar et al., (2024)
	Survey Method	Muazu et al., (2021); Dahl and Kongsvik, (2018)
Qualitative	Case Study	Bevilacqua et al., (2018); Tang, (2021); Penelas and Pires, (2021)
	Interview Method	Iqbal et al., (2021); Andersen and Mostue, (2012); Didla et al., (2009); Lindsay et al., (2013)
	Debate	Leveson et al., (2009)
Conceptual Model	Human reliability assessment (HRA) methods and root cause analysis;	Selvik and Bellamy (2020);
	Human Factors Analysis and Classification System (HFACS) into Process Safety Management Systems	Theophilus et al., (2018)
	Data Mining	Moura et al., (2017)
	Framework	Zhang and Wang, (2023)
	Dynamic Risk Assessment Methodology (DRA)	Zio and Aven, (2013)
	Accidental Risk Assessment Methodology	Hosseinnia Davatgar et al., (2021)
	Analytic Hierarchy Process (AHP)- Multiple-Criteria Decision-Making and Weight Method	Dey et al., (2004)
Mixed Method	Qualitative and Statistical Analysis	Van Thuyet et al., (2019)
Literature Review	Review	Ambituun et al., (2014)

Source: Author's own compilation.

Table 5. Commonly Applied Theories of OGP Safe Operational Behavior

Theory	Author(s)
(HFACS-OGI) Framework.	Nwankwo et al., (2022); Theophilus et al., (2018)
Reasons Theory of Accident Causation	Theophilus et al., (2017)
Systemic Analysis or Signal Detection Theory (SDT)	Selvik and Bellamy (2020).
Combining Graph Theory	Mignan et al., (2022)
Safety Factors	Waqar et al., (2024)
Human Factor Risk Management (HFRM)	Bevilacqua et al., (2018)
Risk Management For OG	Van Thuyet et al., (2019); Andersen and Mostue, (2012); Dey et al., (2004)
Hazard Identification and Risk Assessment with Controls (HIRAC)	Iqbal et al., (2021)
Accident Theories, Normal Accidents	Moura et al., (2017); Dahl and Kongsvik, (2018)
Prospect Theory	Zio and Aven, (2013)
High Reliability Organization	Leveson et al., (2009)
Environmental And Petroleum Laws	Ambituun et al., (2014)
Safety Citizenship Behavior	Didla et al., (2009)
Safety Barrier Management	Hosseinnia Davatgar et al., (2021)
Institutional Theory	Muazu et al., (2021)
Intelligent Safe Operation and Maintenance Technology	Zhang and Wang, (2023)
Asset Integrity Management	Tang, (2021)
The Hazard and Operability (HAZOP)	Penelas and Pires, (2021)
Guiding Principles on Business and Human Rights	Lindsay et al., (2013)

Source: Author's own compilation.

Table 6 Human Factors, Process Factors, Risk Management and Safe Operational Behavior Themes & Sub-themes of the OGP Industry

Theme (T)	Subtheme (ST)	Author(s)
Human Factor (T1)		Nwankwo et al. (2022); Theophilus et al., (2017); Selvik and Bellamy, (2020)
Process Factor (T2)		Theophilus et al., (2018); Mignan et al., (2022); Waqar et al., (2024)
Risk Management (T3)		Bevilacqua et al., (2018); Van Thuyet et al., (2019); Iqbal et al., (2021); Andersen and Mostue, (2012)
	Risk Governance (T3ST1)	Moura et al., (2017); Zio and Aven, (2013
	Risk Reliability (T3ST1)	Leveson et al., (2009); Dey et al., (2004); Ambituun et al., (2014)
Safe Operational Behaviour (T4)		Didla et al., (2009) ; Hosseinnia Davatgar et al., (2021); Muazu et al., (2021) Zhang and Wang, (2023); Dahl and Kongsvik, (2018); Tang,(2021);Penelas and Pires, (2021); Lindsay et al., (2013)

Source: Author's own compilation.

Table 7. Region Specific Literature

country/region	author(s)
Malaysia	Waqar et al., (2024); Tang, (2021)
Vietnam	Van Thuyet et al., (2019)
Norwegian OGP	Andersen and Mostue, (2012); Dahl and Kongsvik, (2018)
Thailand	Dey et al., (2004)
Nigeria	Ambituun et al., (2014); Muazu et al., (2021)

Source: Author's own compilation.

relationship, and concrete managerial / research implications under management lenses was a surprising element of the theoretical review of the literature.

Context

The industry-wise context was clear, and the literature shortlist targeted the OGP industry. The subclassification of the OGP industry was also considered to depict the human factors, process and risk management of oil refineries, chemical plants, and downstream petroleum and chemical industries. 70% of the papers covered the various aspects of the OGP industry, with human aspects being the primary focus of safe operational behavior. A region-specific unique review reflects good work of OGP industry-led accidents, risk, and process management in operating model failures. Malaysia, Nigeria, and Norway Oil, Gas & Petroleum have two research studies, each covering region-specific challenges and future agendas for lawmakers to understand industry prospects. Vietnam and Thailand also presented the OGP accident causal criteria based on industry frameworks. The context validates the country-specific challenges of the supply chain, law enforcement, poor health safety environment, compliances and dated processes that look for reforms for safe operational behavior.

Characteristics

Safe operational behavior arose as a central theme while reviewing, stressing the themes of human factors, process management, risk management, and risk governance and reliability (Table 6). The human factor emphasizes the development and design of the product and environment, ensuring performance and safety. Safety leadership and design strategies can play a significant role in avoiding accidents caused by human error. The complex structures in the work environment can be relaxed, and the remote-controlled and distributed organization designs can be appreciated to understand the hazards in efficient fashions. The process factors influencing the OGP industry are multifaceted and governed by upstream, midstream, and downstream processes that control the market dynamics, production,

Safety leadership and design strategies can play a significant role in avoiding accidents caused by human error.

and pricing impacts. The geological, technological and exploration concerns define the challenges of the upstream factors. Transportation, storage, and infrastructure development are the core process management areas of research for midstream factors, which is evident from the central theme exploration of the literature review. The downstream factors of refining, product demand, efficiency, safety, and economic conditions hit the safe operational behavior of the OGP industry. The practice is risky because of the complex processes, remote exploration refineries, hazardous materials, and human factors in the OGP industry. The literature mentions that risk management is crucial for financial stability, environmental protection and operation safety mechanisms. Geopolitical, technological, regulatory, environmental, economic and operational risks are the significant risks highlighted in literature in day-to-day activities of OGP equipment handling, spills and hazardous accidents. Federal regulatory adherence, price fluctuations, exchange rates, and technological advancements pose a severe risk if they are not handled with effective risk strategies. The scenario planning of the risk assessment, mitigation, transfer, acceptance, monitoring and review of the OGP industry is the continuous research area of the OGP industry. The review highlights the OGP complexities, remote locations, environmental sensitivity and regulatory compliance as the central characteristics of risk governance and reliability.

Methodology

The OGP industry is mature, and it was evident that almost all research methodologies would exist in the literature review. Quantitative / qualitative / conceptual models share an excellent proportion to mark their presence in the domain. Table 4 represents the spread of applicable methodologies in the OGP industry. Quantitative statistical analysis ÷2 test, Spearman's correlation with Chi-square and Fisher's exact test, Markov analysis and catastrophe dynamics, exploratory factor analysis (EFA) and structural equation modelling (SEM), survey method were used to analyze the OGP human, process and risk related research for quantitative safe operational behavior. 40 % of papers used case studies, interviews and debate as the qualitative methods to analyze the OGP maturity in safe operations. Human reliability assessment (HRA) methods and root cause analysis, human factors analysis and classification system (HFACS) into process safety management systems, data mining framework, dynamic risk assessment methodology (DRA), accidental risk assessment methodology, analytic hierarchy process (AHP)-multiple-criteria decision-making and weight method were the conceptual models applied in 34% of the research to propose and deploy various OGP safety frameworks and approaches. The literature survey is scarce in the existing review, with only one mixed-method research paper. The current research becomes more significant as a literature review is required to explain and integrate the larger per-

spective of the OGP industry with management lenses.

Research Implications

Literature reviews for safe operational behavior in the OGP industry are scarce. The research is unique and one of a kind. Human, process and risk-led individual research is available, but the integration and thematic outcome with subthemes in Table 6 are the novel relationship findings of the literature review. The thematic outcome can become the foundation of the conceptual model to research the safety and environmental parameters of human processes and risk impacts in an integrated way. The individual parameters-led research paper is insufficient to see the broader perspective of the safety framework, including human, process and risk constraints. The causal relationships can be established with the paper's findings to illustrate the perception of humans while executing the process and adhering to the risk management activities of the OGP industry. Safety climate, safe systems, work pressure, training / competence, and leadership commitment are some of the research findings' high visibility areas that need immediate attention. Catastrophic accident analysis finds the requirement to study the human, process and risk using the causal databases attributed to accidents. The role of contractors is highlighted as one of the leading causes of accidents as they lack process training and risk management adherence because of their role uncertainty and multiple transitions. Formulating process and risk guidelines with site tours and proper mobilization and knowledge transfer can lead to safe operational behavior. The contract owner should adhere to the risk assessment outcomes and safety plans while adhering to the international and national safety process norms of the OGP industry. Budgeting, frequent design changes, organization structures, approval process, inadequate tendering approach, autocratic systems and contractual incompetence were discussed in multiple forms across all human, process, and risk-impacted OGP research. Proper risk identification, assessment, mitigation, acceptance, and transfer mechanisms must be practiced for human and process-level activities to ensure safe operational behavior in the OGP. The ill-equipped communication, machine malfunctions and non-adherence to safety protocols are the noteworthy theoretical safety implications that cause accidents. Safety protocols, education, and workplace HSE culture are the underscored analysis factors contributing to the likelihood of OGP accidents. The possibility can be further broken based on knowledge, rules, design, and skill dimensions to study the combined causes of human factor-led processes and risk management failure. The need for an OGP safe operational behavior database is imperative to conducting timely disaster recovery drills and reliability assessments based on data collection and root cause analysis.

Practical Implications

The managerial implications of the research present a distinct contribution to the OGP body of knowledge as the

paper presents the crucial viewpoints of safe operations in the OGP industry. The manager's role becomes more pertinent when integrating the OGP factors of humans, processes, and risks that are envisaged for a safe OGP industry. Managers can introduce an OGP industry-led operating model toolkit to address specific human, process, and risk-related factors contributing to safe operational behavior. The transformation in safe operational behavior cannot be rolled out overnight and requires incremental effort. Managers can be the torch bearers to propose the tolerant system, which allows the likelihood of human errors and process failures. However, managers' business continuity plans and HSE practices are crucial in workplace safety, supervision and awareness of the process to ensure safe operational behavior for the OGP industry. The thematic evolution from the literature review emphasizes the significance of communication between contractors, full-time employees, and managers in bridging the gap between process and risk management activities. Managers can support safety stakeholders (safety professionals, policymakers, and project managers) to identify gaps in the current systems. The practitioner's view can help develop the instructional courses, safety process guidelines, and procedures to avoid accidents and engage the laborer with responsibility in the OGP sector, which is full of perils. Whatever the best research outcomes and studies can be conducted, executing the research recommendation is most important. The practitioners only cultivate a culture of safety and training requirements to enhance current safety protocols and better upkeep the OGP industry's equipment. The literature review confirms the engagement of various job profiles, organizational factors, and personnel in conducting the continuous improvement cycle in the safe operational behavior of the OGP industry. Hence, the paper's managerial finding highlights the executive sponsorship role and focuses on human factors, process management systems, risk management, governance, and reliability-awareness systems. The standards, compliance, and regulations of the OGP industry are looking for more investments from research and managerial competency to match the field-level inadequacies and provide robust solutions to resolve ground OGP problems. The dependence on digital technologies and advancements comes with its problems. Managers can highlight the challenges entry-level, low-skilled OGP laborers and contractors face when exposed to sophisticated equipment powered by advanced technologies to execute OGP operations. The managers can better practice and accelerate the research references to promote intelligent and safe OGP industry operations and maintenance.

Managers can introduce an OGP industry-led operating model toolkit to address specific human, process, and risk-related factors contributing to safe operational behavior.

Conclusion, Limitations & Future Agenda

Research confirmed that the current literature review is one of the unique

works, not just as per the method in the OGP industry but also the domain integration of safe operation behavior. The underpinning of integrating the human, process and risk management factors with management research lenses is the unique and first-of-its-kind work in the OGP domain. TCCM framework supported the unique way of weaving the research threads of applied methods, theories, contexts, platforms, regions and characteristics. The thematic outcome of the literature review is one of the novel contributions to the OGP body of knowledge. The literature synthesis can support the model formation of further research avenues in quantative and qualitative research arenas. The research is a safe and forward-looking repository of multiple knowledge milestones that will help us understand the depth of OGP safe operational behavior research with management tools and accelerators. The reference points of the literature review provide well-thought-out levers to transform the safety paradigms and understand the current state of the safety paradigms of the OGP industry.

The literature review is developed with some limitations and scope of study. While most management research methodologies were present in the survey outcomes, the literature review is not available at the maturity level of others. Most of the papers researched either the human or process or risk management elements of the OGP industry, but the integrated approach was missing from the review. It is imperative to see the use of case-driven research for safe operational behavior. The scope of integrating the human process and risk management factors is novel. Therefore, the qualitative method will be appropriate to test the thematic outcomes of the paper. Induced and deduced codes of qualitative research can become the foundation of the research model to apply the quantitative methods and examine further applicability of the constructs using statistical methods. Additional case study methods can be leveraged to validate the model in natural industry settings before industrializing the envisaged research model for greater adoption. The research fills the identified void of the literature review in the OGP industry to foresee safe operations and responsible behavior from intended stakeholders.

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