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A scale to assess organizational resilience for the oil and gas industry: testing and future perspectives

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Abstract

Purpose – As part of the scale development process, this paper aims to test a scale to measure organizational resilience for the oil and gas industry. The objective is to provide stakeholders with a set of indicators to evaluate their organizations and prepare them to cope with the negative consequences of disruptions (e.g. Covid-19, shortage of resources, etc.).

Design/methodology/approach – The paper conducts exploratory and confirmatory factor analysis to test the suitability, dimensionality and reliability of specific indicators and their items under examination. Therefore, the goal is not to validate hypotheses by testing an organizational resilience scale in the oil and gas industry.

Findings – The study tests and proposes a scale to effectively measure organizational resilience within the oil and gas industry. A comprehensive set of ten indicators and 40 items are identified through this process. The findings of this research provide stakeholders in this sector with a rigorous set of indicators to evaluate the strengths and weaknesses of their organizations and better prepare them to handle disruptions.

Originality/value – This paper fills the gap in existing research by testing and proposing a scale to measure organizational resilience specifically for the oil and gas industry. It highlights the importance of organizational resilience for survival in a sector that is especially susceptible to disruptions.

Keywords Resilience, Organizational studies, Oil and gas industry, Scale development, Indicators

Paper type Research paper

1. Introduction

As a result of socio-ecological research, the term "resilience" came to describe the ability of an ecosystem to bounce back after a disturbance and return to its previous condition (Holling, 1973). A system is resilient if it can change its modus operandi without losing its capacity to operate in the face of internal and external faults. This means that building resilience needs a change in the basic operations of the system (Brown *et al.*, 2017). New techniques and improved safety procedures are required, particularly in the oil and gas (O&G) industry, which has a high risk of accidents, because of the quick changes in technology and the enormous costs they entail. These accidents and hazards can be, among others, societal, technological, biological, and environmental hazards (e.g. Covid-19, War in Ukraine, shortage of resources, etc.) that can hinder economic development (Blay, 2017).

Human participant: This study describes research on human. Therefore, an approval from the Institutional Review Board of Abu Dhabi University with file number: COE– 22-10-00031.

Data availability statement: The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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Nevertheless, the O&G business should pay close attention to resilience because of internal and external hazards. Oil production is complicated and fraught with danger on the operational level (Rehak *et al.*, 2019). Accordingly, it is vital to keep safety in mind while looking at organizational resilience, which is a significant capability in the O&G sector.

Focusing on enhancing organizational resilience doesn't replace all current safety measures, but it is an approach that helps diagnose the current organizational settings in order to detect the organization's strengths and weaknesses. The goal is to build on the strengths and improve the weaknesses to help cope when faced with disruptions (Stephenson, 2010). Resilience is the innate capacity of a system to modify its function before, during, or after significant disasters or changes so that it can continue the activities necessary under both predicted and unforeseen scenarios. To put it another way, resilience is the capacity of an organization to foresee, identify, adapt to, and learn from disruptions that may hurt what human people value (Brown *et al.*, 2017).

It is difficult to quantify a system's resilience in a direct manner. Sensing, monitoring, predicting, and learning are the four pillars of resilience engineering. Resilience may be built on four pillars: management commitment, flexibility, education, and awareness (Sharifi, 2016). Flexible, controllable, early detection, reduction of failure, limited effects, and administrative control system were the six concepts that Sharifi and Yamagata (2016) presented as contributing to the resilience of an organization. The ability to self-organize, have many backup sources, and be fault-tolerant are all some elements of organizational resilience.

Organizational variables hold immense significance as they can act as an effective mechanism for anticipating and preparing for potential disruptions. It is, therefore, imperative to establish relevant metrics that measure the organizational, technological, and human aspects independently to ensure more precise assessment of overall resilience, which, in turn, leads to improved planning and decision-making.

In light of these challenges, this paper aims to measure organizational resilience as its primary objective. Building upon the previous work of (Rahi, 2019), the authors conducted a quantitative analysis to examine the suitability of proposed indicators in measuring resilience within the O&G industry. It is worth noting that the scale development process is rigorous and can span over several years. While it is crucial to propose scales, it is equally vital to test them and ascertain that they measure the intended concepts and dimensions (Hair *et al.*, 2010; Hinkin, 1998).

So, as the O&G industry faces unprecedented challenges, including the transition towards renewable energy sources and the impact of social and economic fluctuations, understanding and enhancing organizational resilience have become paramount (Bento *et al.*, 2021). This study aims to address the pressing need for a comprehensive assessment of organizational resilience in the O&G sector. By testing and validating key indicators and measures of organizational resilience, this research seeks to provide stakeholders with valuable insights to effectively prepare for and respond to disruptive events. Through a systematic quantitative analysis that follows a concise scale development process of organizational resilience dimensions and indicators, this study aims to contribute to the industry's ability to navigate uncertainties and ensure sustainable operations in the face of evolving challenges.

This paper is organized into five main sections. In the first section, a literature review is conducted to understand in depth the concepts of resilience and organizational resilience, and the indicators used to assess the latter. In the second section, the methodology is outlined and the steps to test the indicators are explained. In the third and the fourth sections, the results are presented and their theoretical and practical utility are delineated. Finally, recommendations and future research are explained in the conclusion's section of this document.

2. Literature review

2.1 Disruptive events in the oil and gas industry

The term "disruptive event" refers to hazards that go beyond the scope of normal business (Stephenson, 2010). The O&G industries face many of these hazards that could have disastrous repercussions.

Murray *et al.* (2022) have provided an extensive list of 302 hazards that pose threats to the built environment including the O&G sector. These hazards fall into eight categories: technological, societal, meteorological and hydrological, extraterrestrial, geohazards, environmental, chemical, and biological. Technological risks in the O&G industry include equipment malfunctions like blowouts or pipeline leaks that could result in catastrophic incidents. Societal hazards could include political unrest, terrorism, or crimes that compromise safety and security operations (Mama and Onuoha, 2020). Meteorological and hydrological hazards such as hurricanes, floods, and tsunamis can have lasting repercussions for O&G operations. Geohazards like earthquakes and landslides pose similar threats and could result in infrastructure damage or production disruptions (Oosterhaven and Bouwmeester, 2016). Environmental hazards like pollution and climate change pose regulatory difficulties and reputational risks for businesses in the O&G sector, while chemical hazards include spills or leaks that pose environmental and health hazards, and biological threats like the spread of infectious diseases pose a risk to worker safety as well as operations (Yusuf *et al.*, 2014).

In addition to the extensive list of hazards identified by Murray *et al.* (2022), it is crucial to consider the evolving landscape of the O&G industry. As companies explore new and challenging geographical areas and expand towards renewable energy sources, they face additional risks beyond traditional hazards (Jin and Jorion, 2006). As companies venture into new geographical areas and transition towards renewable energy sources, they encounter additional complexities that necessitate adapting to new technologies and regulatory frameworks. The shift towards renewable energy not only introduces new risks but also requires organizations to navigate social and economic fluctuations that can impact the industry's resilience by potentially leading to a loss of valuable knowledge and expertise.

Moreover, the industry's susceptibility to oil price shocks underscores the importance of understanding and managing these risk factors to maintain stability and profitability. Furthermore, the increasing reliance on digital technologies in the O&G industry brings about new challenges, including cybersecurity threats (Stergiopoulos *et al.*, 2020). Additionally, social and economic fluctuations can lead to a loss of valuable experimental knowledge and expertise, impacting the industry's daily operations (Hoque *et al.*, 2020).

Therefore, now more than ever, the industry must concentrate on resilience. To remain competitive, companies will have to strike, as an example, a balance between responding to changing stakeholder demands for reduced carbon emissions while also keeping an eye on legislative changes (Ruiz-Martin *et al.*, 2018). New technology and customer preferences need a focus on resilience management, particularly in light of similar changes (Oosterhaven and Bouwmeester, 2016).

In 2030, energy consumption will be at a level that has not been seen before (Janić, 2019). Increased demand for renewable energy sources from governments and consumers, the effect of current geopolitical issues on the future price of commodities, an excess of oil and a lack of storage options, and global supply networks are being restructured as a result (Ruiz-Martin *et al.*, 2018). According to IRM's poll, up to 80% of organizations don't have a strategy in place in case of a pandemic (Ruiz-Martin *et al.*, 2018). However, the good news is that the pandemic's unpredictability and uncertainty has brought to light the need for stronger emergency preparedness planning to enhance organizational strategic, operational, and fiscal resilience (Hillmann and Guenther, 2021). By offering feedback on financial, supply networks, digital, political, and emerging risks, risk managers will play a larger role in helping to clarify the

assessment and choices on big new investments (Blay, 2017). In addition, risk management will have to progress as well. It could involve the development of new critical risk indicators and improved methods for monitoring external risk variables, which can change much faster and drastically than expected.

2.2 The concept of organizational resilience

Organizational resilience, according to (Hillmann and Guenther, 2021), is an organization's capability to withstand or respond to adversity. Following a number of worldwide occurrences, this notion has been thoroughly investigated in recent years. Businesses were forced to reevaluate their business procedures in light of these events so that they could better control the effects of occurrences that may possibly interrupt their operations. It is surprising how little attention is paid to the practical application of organizational resilience (Ruiz-Martin *et al.*, 2018). Theories are still being developed and assessment methods are being proposed in academic research, but there is little actual data to support these approaches (Hillmann and Guenther, 2021).

According to Stephenson (2010), for communities to prepare for, react to, and recover from catastrophes and crises, they depend on the services and employment offered by organizations. There is a direct correlation between organizational resilience and community resilience; if organizations cannot adapt to crises, neither can the communities they serve. More resilient organizations may also gain a competitive advantage (Ruiz-Martin *et al.*, 2018). It's hard to prioritize resilience and dedicate resources that might be put to more immediate use, despite the business and performance benefits of being more robust (McManus, 2008). The business case for resilience must outweigh the strategic plan for new equipment or new employees for organizations to invest in their resilience (Rahi and Bourgault, 2022). Additionally, there is a relationship between being aggressive and being resilient, in addition to the link between the two. Resilient organizations depend on strong leadership, knowledge of and comprehension of their operational environment, the management of vulnerabilities, and the capacity to respond quickly to fast change to be resilient. Competitive organizations with leaders that can harness their strengths to adapt ahead of their competition and react to quick changes in their market or industrial sector have these same traits. It is difficult for organizations to prioritize resilience and integrate resilience to disaster or crisis to function successfully and profitably during the business (Brown *et al.*, 2017).

Many organizational leaders agree to strengthen their resilience in theory; however, they lack time to address the issue. Organizations are constantly looking for something else to focus on, either because they're doing so well, they're working so hard to stay up, or because they're already hurting and don't have any more money (Brown *et al.*, 2017). Furthermore, securing board approval for expenditures with no demonstrable return or value is challenging. This is particularly true when competing with more conventional initiatives for the same funding (Ruiz-Martin *et al.*, 2018). Organizations are gradually incorporating social and cultural considerations into their decision-making, although this is unlikely to rise dramatically shortly. Investing in organizational competitiveness and strengthening community resilience are two critical steps toward enhancing community resilience (Sharifi, 2016). Investing in resilience requires organization to have a mechanism to track its progress and show how its measurements have changed over time (Stephenson *et al.*, 2010). Resilience may be measured and benchmarked so that organizations can analyze their present resilience management practices and evaluate their effectiveness. Organizations may use this knowledge to devise new methods for addressing weaknesses in resilience and enhancing their resilience.

According to Blay (2017), a more comprehensive strategy for dealing with interruptions in which the operational capability of organizations is identified and developed and difficulties

created by crises are resolved; resilience is necessary, and crises and entire organizational restoration are not oversimplified. Organizations become increasingly subject to disruptions induced by uncertainty due to reducing their susceptibility and shock avoidance. Recovery is the process of adapting to the same or a new set of goals to guarantee the effective completion of organization endeavors after or during an interruption (Mama and Onuoha, 2020). The authors define the response as one's response to interruptions. It entails following defined procedures and using skills to respond to the disturbance. An organization's resilience is its ability to withstand unexpected events. However, little study has been done to discover how organizations might be prepared for interruptions, and nothing has been done to use capabilities to react to disturbances. Recovering rather than reducing vulnerability is advantageous because it gives a more comprehensive view of the organization's resources for dealing with interruption. Specifically, ecological and economic recovery lessens the risk of future threats. It is necessary to develop a conceptualization of organizational resilience to understand how recovery from disruption is accomplished properly.

McManus (2008) claims that resilience is a product of a firm's ability to identify and manage core vulnerabilities and adaptation abilities to an ever-changing and linked world. As a result, organizational resilience has often been defined as a person's ability to manage, adapt, and recover from calamities (Duchek, 2020). When a system can take in new information (often in abrupt shocks) while still functioning, we say it has organizational resilience. Scientific fields have developed the idea of resilience throughout time. There has been much talk about the importance of resilience in the context of climate change and vulnerability (McManus, 2008). A company's level of resilience may shift over time and rely on the specifics of a crisis and its effects on the organization. The infrastructure, economy, and society all depend on the work of organizations (Duchek, 2020). In the aftermath of a natural disaster, the capacity of organizations to react and recover is critical to the length of time that critical services are unavailable. As a result, building more resilient communities begins with strengthening the organization's resilience (Hatton *et al.*, 2018). Organizational resilience planning supports the capacity to strengthen the resilience of self-organizing systems in a situation where they are not at the mercy of random occurrences.

An organization's resilience crisis-coping ability may be increased by using strategic planning in combination with organizational learning. Resilience must not just be a theoretical idea for organizations; it must also become an operational construct with observable and quantifiable results. Although organizational resilience is frequently seen as a crisis management problem, organizations usually do not understand the relationship between developing robust day-to-day activities and having a resistant crisis response/recovery. Resilience is an essential component of any organization's success (Duchek, 2020). An organization's ability to build resilience will enhance the ability to recognize and respond to risks (and opportunities) in any given circumstance. In addition, an organization's ability to identify and prioritize its most critical vulnerabilities will improve due to increased resilience.

As a result of its higher resilience, an organization may be less vulnerable to disasters in the short term, but in the long term, it may have a radically different organizational resilience structure than it had before the crisis. These findings demonstrate how complex systems like organizations are self-organizing and have various equilibrium states. It is common for organizations that concentrate primarily on their post-disaster recovery to strive to return to their pre-disaster status (McManus *et al.*, 2008). On the other hand, recovery seldom tackles the underlying causes of the disaster, which increases the likelihood of another catastrophe. Vulnerability is often seen as the inverse of resilience in many philosophical frameworks, and this is no exception (Barasa *et al.*, 2018).

For the O&G industry, Bento *et al.* (2021) identified a variety of studies, through a rigorous systematic literature review, focusing on organizational resilience as a system property, with a majority linking resilience to safety in organizations (Martorell *et al.*, 2008). Most articles

approached resilience at the system level, emphasizing interactions among agents for promoting adaptive processes. While resilience was often presented as an abstract construct in analytical frameworks, there was a lack of explicit implementation in organizational practices (Bento and Garotti, 2019). Bento *et al.* (2021) highlighted the need for further research on resilience beyond safety concerns, emphasizing the importance of understanding emergent changes in social interactions and promoting resilience at the system level through innovative practices.

Additionally, there is a clear need to assess organizational resilience for the O&G industry. For instance, Bayesian network models can be adopted to quantitatively assess the resilience of engineering systems (Hossain *et al.*, 2019). Therefore, additional studies are needed to explore specific methods and tools for assessing resilience in the O&G industry (Ai Lin Teo and Yean Yng Ling, 2006; Brown *et al.*, 2017; Chen *et al.*, 2021). This gap highlights the importance of our study, which aims to test and validate specific indicators and their respective items for assessing resilience in this critical sector.

2.3 Indicators to assess organizational resilience

The indicators, according to Rahi (2019), assess "awareness" and "adaptive capability" as two dimensions of organizational resilience. In the context of business, awareness refers to a company's ability to assess and adapt to current and future changes in its environment in order to avoid or minimize disruption (Stephenson *et al.*, 2010). What you know about your company's operations and what you know about your organization's responsibilities to your stakeholders are all elements of awareness (McManus *et al.*, 2008). Companies need to be aware of their environment and develop preventative and protective actions to better handle disruptions and reduce risks, in order to gain this insight. Having a thorough awareness of the organization's components and comparing them to the resources available to perform operational activities is essential. The company's financial and economic status, as well as the latest market developments and consumer and rival behavior, must be constantly monitored. There should be an ongoing examination of the company's structural properties, culture, and goals (McManus *et al.*, 2008). Keep an eye out for hazards and keep your organization running smoothly by constantly developing your procedures, practices and skills, strategies and processes.

When it comes to increasing awareness, though, removing communication barriers between an organization's various divisions is vital (Barasa *et al.*, 2018). Inefficient working habits and outcomes are the result of these roadblocks, which are often linked to the cognitive processes of individuals, different cultures, and previous work experiences. Workers must have access to training and development resources to do their jobs effectively. As a result, a work environment that encourages information exchange and excellent connections with management enable the company's workers and management to motivate and promote organizational reforms that seek to accomplish strategic goals. This will also encourage staff to think outside the box and creatively apply their expertise to remain competitive. An organization needs to enhance its employees' knowledge and abilities, enable cross-departmental sharing of information and expertise, and keep its employees up to date, warned, and alerted to cope with unforeseen events in order to be prepared for them (Stephenson *et al.*, 2010). Expanding a firm's external networks on a regular basis is another requirement for enhancing its exposure. The people who do business with the corporation form these networks.

Another way of putting it is that agreements with external organizations that permit the deployment and sharing of resources in the event of disruptive events are vital for raising organizational awareness. Keeping abreast of changes in legislation, rules, and the involvement of other public and private parties is also crucial to maintaining these agreements and keeping lines of communication open. The association between adaptive ability and resilience is not new, on the other hand, in the field of organizational research. As a

result, the more adaptable a system is, the more robust it is. In the face of disruptive occurrences, an organization's adaptive ability is vital for maintaining its missions, operations, and so on (Brown *et al.*, 2017). Because it enables quick and meaningful reactions to disturbances, it provides long-term sustainability of an organization.

As a result, an organization's ability to adapt is critical to its existence. Organizations that fail to adapt to unexpected events will eventually collapse and cease to exist if they cannot cope with the repercussions of their inability to handle these occurrences. Nevertheless, adaptive capacity is a company's ability to adapt to a disruptive event by reorganizing its structure, operations, culture, and so forth. The ability of an organization to respond effectively to disruptive events depends on its ability to make timely decisions and mobilize the necessary resources. It is important to note that disruptions, their causes, repercussions, and options to overcome them, all play a role in developing an individual's adaptive ability. According to Hillmann and Guenther (2021), disruptive events may arise due to an organization's internal or external changes. An economic crisis, increased spending, trouble attracting new consumers, competition and fears of terrorism may lead to changes in the company's finances. Figure 1 presents the indicators under examination in this exploratory analysis to assess the two dimensions of organizational resilience; awareness and adaptive capacity.

2.4 Literature gap

While studies have explored resilience in various organizational contexts, there is a notable scarcity of research specifically focusing on organizational resilience within the O&G sector. The literature predominantly emphasizes safety aspects, which are crucial but do not comprehensively cover the unique challenges and dynamics of the O&G industry (Bento *et al.*, 2021).

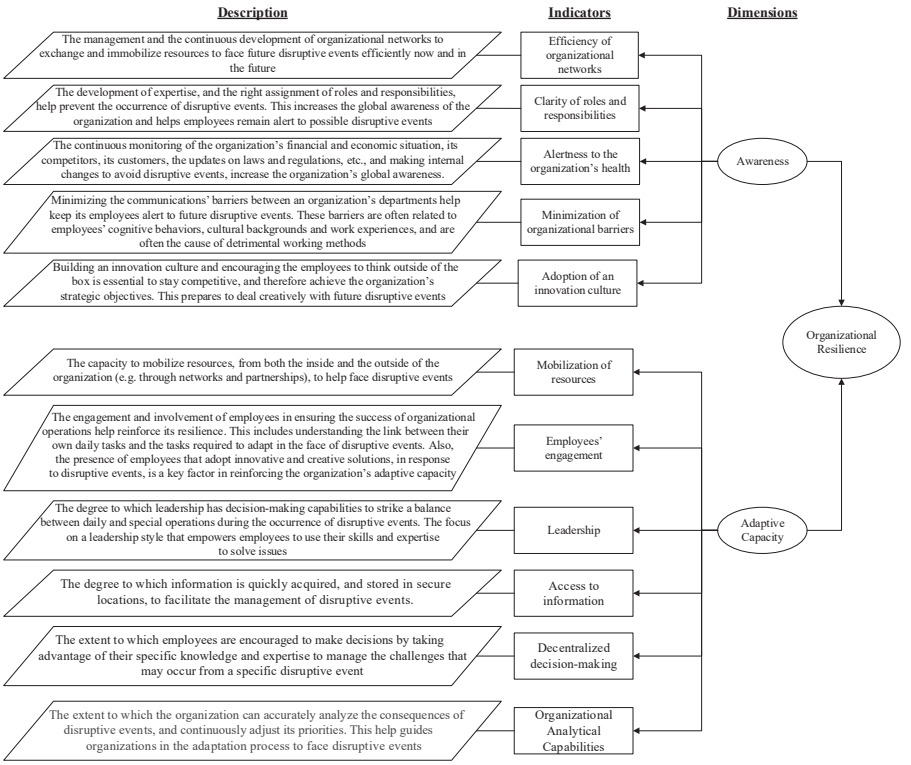
Moreover, existing studies have primarily concentrated on general conceptualizations of organizational resilience across different industries (Chen *et al.*, 2021; Duchek, 2020). While these conceptualizations provide valuable insights into resilience as a broad construct, they may not capture the industry-specific nuances and challenges faced by O&G companies.

Additionally, the literature highlights the importance of strategic factors in enhancing organizational resilience, particularly in small and medium enterprises during economic crises. However, there is a gap in terms of operationalizing and measuring these strategic factors within the context of the O&G industry (Verreynne *et al.*, 2023).

Given the unique operational, environmental, and geopolitical challenges faced by O&G companies, a dedicated organizational resilience scale tailored to this sector is imperative to effectively assess, enhance, and benchmark resilience capabilities within O&G organizations. This scale has to align with the strategic needs of O&G organizations and provide a structured framework for assessing and strengthening resilience capabilities in this sector.

3. Methodology and research objectives

The need for the O&G industry to embrace resilience necessitates the urge to develop ways to assess the two dimensions of organizational resilience; awareness and adaptive capacity (Hatton *et al.*, 2018). Therefore, based on (Rahi, 2019), there are 11 indicators that the authors are going to rely on to scale the organizational resilience in the O&G industry. These leading indicators ("*indicators that measure observable processes, methods, structures, etc., that contribute to a system's continuous functioning*" (Lee *et al.*, 2013, p. 30)) were developed after a rigorous literature review on the measurements used in empirical studies to assess organizational resilience. Therefore, Rahi's work is grounded in its robust empirical foundation and comprehensive conceptualization of the organizational resilience concept. It synthesized insights from a rigorous analysis of 33 empirical studies spanning diverse



Source(s): Authors' own creation
Adapted from (Rahi, 2019, pp. 93 and 95)

Figure 1.
Indicators to assess organizational resilience

industries, thereby ensuring its applicability across sectors. The definition of organizational resilience presented in Rahi's work, along with the 11 corresponding indicators, offers a holistic and theoretically substantiated approach to evaluation. While alternative frameworks exist, Rahi's conceptualization is favored due to its empirical grounding and extensive cross-industry validation, augmenting its credibility and generalizability. It is important to note that Rahi's indicators are not industry-specific, necessitating an empirical investigation of their suitability, dimensionality, reliability, and potential adaptations within the O&G industry, which is the overarching objective of this study.

These indicators lack evidence-based findings to demonstrate their effectiveness in the O&G industry. Therefore, the purpose of this study is to test and validate the indicators in the particular context to ensure construct validity (Hair *et al.*, 2010). This validation is necessary to entrench that the developed indicators can be used in the O&G industry to evaluate organizational resilience. In particular, the study will seek to achieve the following objectives:

1. Review of previous literature/research in resilience generally and more specifically related to O&G;
2. Investigating and analysis of the 11 indicators;
3. Providing insights/recommendations on best practices.

Therefore, in this paper we will try to answer the following research question:

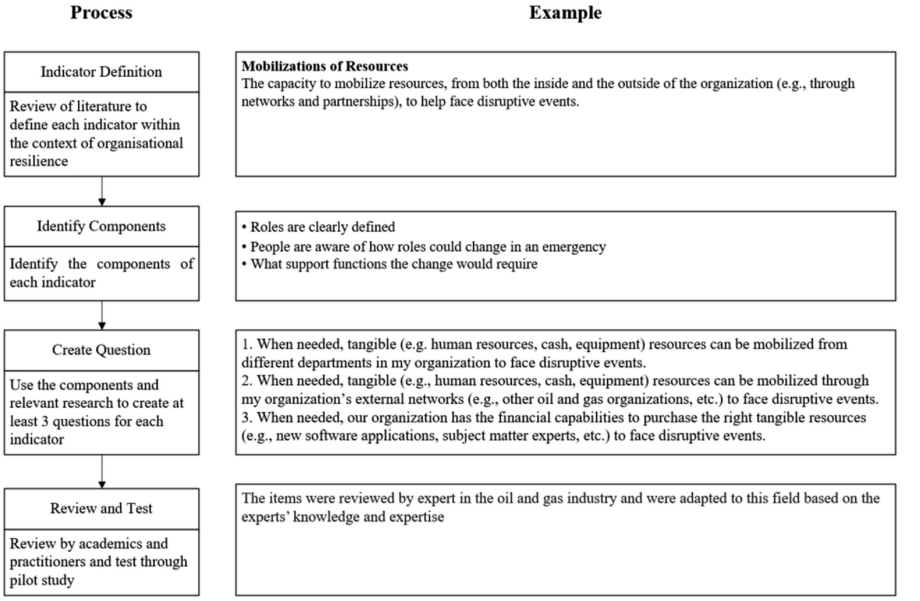
RQ1. Based on the proposed indicators of Rahi (2019), what organizational resilience's indicators can be used to assess the awareness and the adaptive capacity dimensions of organizations for the O&G industry?

To answer this question, suggestions for the scale development from Hair *et al.* (2010) and Hinkin (1998) were adopted. These suggestions have been widely used in many studies to test and validate indicators. The latter refers to the work of Holt *et al.* (2007), Slavec and Drnovsek (2012), and Swanson and Holton (2005), including disquisitions directed at introducing indicators to assess organizational resilience, as seen in the research of McManus (2008) and Stephenson (2010).

In the work of (Rahi, 2019) only the indicators were instigated from the literature without their respective items to assess them. Therefore, in this section the process proposed by (Stephenson, 2010) was used to develop the items for the indicators. Figure 2 explains the process and gives an example on how to use it. Table 1 present the list of all the indicators and their respective items after following the process suggested by (Stephenson, 2010).

It is important to mention that this study covers various organizational departments within the O&G sector, including Services (e.g., Tubular Running Services, Controlled Pressure Drilling Services, Integrity and Corrosion Engineering Services, Airloop and H2S Safety Services, Plant and Pipeline Maintenance), Supporting (e.g., Human Resources, Marketing, Supply Chain, Marketing and Business Development, Outsourced Services and Projects), and Sales (e.g., Safety Supplies, Petroleum Supplies, Industrial Process Supplies). By examining resilience across these departments, a comprehensive understanding of how different facets of the O&G industry can enhance their ability to withstand, adapt to, and recover from disruptions.

Once the items developed, the questionnaire was designed and the size of the sample was calculated based on the factor loadings and residuals in factor analysis (two factors for organizational resilience; awareness and adaptive capacity), pairwise correlations between the indicators of awareness and adaptive capacity (10 for both; awareness and adaptive



Source(s): Authors' own creation
Adapted from (Stephenson, 2010)

Figure 2.
Process to developing items to measure the Indicators of Organizational Resilience

Indicators	Items	Codes
Awareness		
Efficiency of organizational networks (EON)	1. Partnerships with external parties (e.g. other oil and gas organizations, fuel companies, etc.) that have field-specific knowledge are continuously developed at my organization	EON1
	2. Current partnerships with external parties (e.g. other oil and gas organizations, fuel companies, etc.) are continuously reinforced at my organization	EON2
	3. Access to external resources (e.g. oil and gas experts, technologies, etc.) through partnerships is possible to help identify our organization's weaknesses	EON3
	4. Access to external resources (e.g. oil and gas experts, technologies, etc.) through partnerships is possible to help assess our organization's weaknesses	EON4
Clarity of roles and responsibilities (CRR)	1. I have a clear picture of my role (the position that I should assume) in my organization	CRR1
	2. I have a clear picture of my responsibilities (duties that I am expected to complete based on my role) in my organization	CRR2
	3. I am continuously offered training to develop new expertise and knowledge in my organization	CRR3
	4. I continuously use my expertise to identify possible disruptive events	CRR4
	5. I continuously use my expertise to assess possible disruptive events	CRR5
	6. Information is stored in secured locations in my organization	CRR6
Alertness to the organization's health (AOH)	1. The financial and economical situations of my organization are continuously monitored to avoid possible disruptive events	AOH1
	2. The competitors (e.g. other oil and gas organizations) are continuously monitored to remain competitive and avoid possible disruptive events	AOH2
	3. Internal laws and regulations (changes inside the organization) are continuously monitored to avoid possible disruptive events	AOH3
	4. External laws and regulations (changes outside the organization (e.g. new regulations on Covid-19)) are continuously monitored to avoid possible disruptive events	AOH4
	5. The situation of our customers is continuously monitored to keep them engaged in order to avoid possible disruptive events	AOH5
	6. Organizational changes are continuously implemented based on internal new events (e.g. changes in internal law and regulations, changes on financial key performance indicators) to avoid possible disruptive events	AOH6
	7. Organizational changes are continuously implemented based on external new events (e.g. competition, employees' situations) to avoid possible disruptive events	AOH7
Minimization of organizational barriers (MOB)	1. In my organization, orientation is continuously provided to employees about the organization's goals, and the means to achieve them (policies, procedures, programs, authority relations, etc.)	MOB1
	2. Employees are encouraged to participate in the development of the best practices to achieve the goals of my organization	MOB2
	3. Interpersonal relations are continuously improved in my organization to increase the collaboration spirit between employees	MOB3
	4. Our management team uses direct and simple language in communication to keep employees informed on the organization's goals	MOB4

(*continued*)

Table 1. The indicators to assess organizational resilience and their respective items

Indicators	Items	Codes
Adoption of an Innovation Culture (AIC)	1. In my organization employees are actively encouraged to innovate through their work	AIC1
	2. Employees in my organization are rewarded for thinking outside of the box	AIC2
	3. A clear innovation process exists in my organization	AIC3
	4. A clear innovation process is used in my organization to help employees share their creative ideas	AIC4
Adaptive Capacity		
Mobilization of resources (MOR)	1. When needed, tangible (e.g. human resources, cash, equipment) resources can be mobilized from different departments in my organization to face disruptive events	MOR1
	2. When needed, tangible (e.g. human resources, cash, equipment) resources can be mobilized through my organization's external networks (e.g. other oil and gas organizations, etc.) to face disruptive events	MOR2
	3. When needed, our organization has the financial capabilities to purchase the right tangible resources (e.g. new software applications, subject matter experts, etc.) to face disruptive events	MOR3
Employees' engagement (EENG)	1. The link between my daily tasks and the tasks required to face the disruptive events is clear	EENG1
	2. When faced with disruptive events, I give my best to solve issues	EENG2
	3. I feel responsible and accountable to help my organization face disruptive events	EENG3
Leadership (LDRSP)	1. Senior managers plot a course of action to face disruptive events	LDRSP1
	2. Senior managers ensure actions are implemented in the right way and at the right time to effectively face disruptive events	LDRSP2
	3. Senior managers adapt their strategies to face disruptive events based on the organization's priorities	LDRSP3
Access to information (ATI)	1. Information systems are available to provide quick access to information to help dealing with disruptive events	ATI1
	2. Various organizational departments can provide feedback on possible solutions to face disruptive events through information systems	ATI2
	3. External partners can provide feedback on possible solutions to face disruptive events	ATI3
Decentralized decision-making (DDM)	1. In my organization, people with the right qualifications can take decisions, based on their seniority level, to face disruptive event	DDM1
	2. When faced with disruptive events, an individual with the right authority to act is always accessible	DDM2
	3. When faced with disruptive events, my organization can take tough decisions quickly	DDM3
Organizational Analytical Capabilities (OAC)	1. When faced with disruptive events, our organization has the right expertise to quickly analyze the situation	OAC1
	2. Organizational priorities are effectively adjusted to face the negative consequences of disruptive events	OAC2
	3. In our organization, information systems are used to help in the analysis of the negative consequences of disruptive events	OAC3

Table 1. **Source(s):** Authors' own creation

capacity), and the minimum ratio (five respondents by item) for scientific studies (Hair *et al.*, 2010; Hinkin, 1998). Therefore, the number of observations required for this analysis is 300 respondents.

www.surveyhero.com was used to create and distribute the survey questions. The survey was launched with total confidentiality among employees in the O&G industry. Potential

respondents were encouraged to participate in the survey questionnaire through social media sites such as LinkedIn, and face-to-face discussions. In total, 263 respondents started the survey, 26 of them didn't complete it, and therefore, they were removed from the analysis. So, only 237 respondents were considered in this exploratory study. Table 2 presents the demographic profiles of the participants. The scenario was clearly outlined in the survey where respondents need to answer the questionnaires by considering a disruptive event (e.g. Covid-19) and its implications on their organization at a specific point in time.

Prior to analysis, the data underwent several pre-processing steps. Missing values were imputed using the Expectation-Maximization (EM) algorithm. Additionally, the distribution of each item was assessed for normality using skewness and kurtosis statistics to ensure appropriate data quality for further analysis (Hair *et al.*, 2010).

Exploratory Factor Analysis was conducted to identify the data's underlying structure and ensure items grouped into factors corresponding to the proposed indicators. Sample adequacy was assessed using the Kaiser-Meyer-Olkin measure and Bartlett's test of sphericity. Maximum likelihood was used to extract factors and an oblique rotation (Promax) was employed to allow for correlations between factors, reflecting the theoretical interrelatedness of the indicators of organizational resilience.

Demographic profiles		
Gender		
Male	164	69%
Female	73	31%
Total	*237*	
Organizational Departments		
Services department (Tubular Running Services, Controlled Pressure Drilling Services, Integrity and Corrosion Engineering Services Airloop and H2S Safety Services, Plant and Pipeline Maintenance, etc.)	85	36%
Supporting department (Human Resources, Marketing, Supply chain, Marketing and Business Development, Outsourced Services and Projects, etc.)	92	39%
Sales department (Safety supplies, Petroleum supplies, Industrial process, supplies, etc.)	59	25%
Total	*237*	
Size of the Organization		
Less than 2,000 staff	0	0%
Between 2,001 and 10,000 staff	185	78%
Between 10,001 and 20,000 staff	38	16%
More than 20,000 staff	14	6%
Total	*237*	
Employment Category		
Junior Level	43	18%
Senior Level	64	27%
Intermediate Level	90	38%
Management Level	40	17%
Total	*237*	
Age		
Between 18 and 30 years old	97	41%
Between 31 and 40 years old	95	40%
Between 41 and 50 years old	38	16%
51 years old and older	7	3%
Total	*237*	

Source(s): Authors' own creation

Table 2. Demographic profiles of the participants

Table 3 presents all the information on the methodology used in this study based on Hair *et al.* (2010) and Hinkin (1998).

4. Results

4.1 Exploratory Factor Analysis

4.1.1 Suitability analysis. As discussed in the methodology section, two tests were conducted to validate whether the data is suitable for factor analysis. A KMO test result of 0.926 and a Bartlett's test of sphericity result of less than 0.001 were registered. This implies that the data is suitable for factor analysis (Hair *et al.*, 2010).

4.1.2 Dimensionality analysis. After validating that the data is suitable for factor analysis, many iterations of the EFA was conducted on the items level for each dimension (awareness and adaptive capacity) separately (First-order analysis on item level), and on the dimension level to verify if the dimensions load onto the main concept (Second-order analysis on the dimension level). The number of factors was reconsidered, and items were dropped because of the following reasons:

1. The item didn't load with a value higher than 0.4, on any factor thus tainting the convergent validity;
2. The item loaded on many factors at the same time with values higher than 0.4, thus tainting the discriminant validity;
3. Less than three items loaded on one particular factor, thus breaking the rule of at least 3 items are needed to load on one factor (Hinkin, 1998)
4. The items loading on a specific factor are not logically related after reviewing the literature.

For the ***first-order analysis***, and after two rounds of EFA for the awareness and the adaptive capacity dimensions separately, the following actions were taken:

1. For the awareness dimension
   a. MOB2 and MOB4 were removed because they loaded on two factors
   b. After reviewing the literature and re-evaluating the items and the indicators, it was decided to merge MOB1 with the AOH indicator and MOB3 with the AIC indicator
   c. As a result, this dimension has 4 indicators instead of 5
2. For the adaptive capacity dimension
   a. LDRSP1 was removed because it loaded on two factors
   b. After getting the EFA results, reviewing the literature, and re-evaluating the items and the indicators, it was decided to merge the indicators DDM and ATI into a new indicator named "*Integrated Decision Support Systems*" (IDSS). This integration fosters a more cohesive and efficient response to disruptions, and underlines the interconnectedness of information availability and decision-making authority, promoting a comprehensive approach to resilience.
   c. LDRSP3 was merged with the new indicator IDSS.
   d. LDRSP2 was merged with the indicator EENG.
   e. As a result, this dimension has 4 indicators instead of 5.

The results for the first-order analysis are presented in Table 4 for the two dimensions of organizational resilience separately.

Exploratory factor analysis (EFA) Analyses completed	Tests conducted	Reasons behind the tests	Rules of thumb for exploratory research
Suitability	Kaiser-Meyer-Olkin (KMO) Test	To validate if the data is suitable for factor analysis	Values > 0.5
	Bartlett Sphericity test	To measure if all items should have similar average intercorrelations	Value < 0.05
Dimensionality	1. Method: Exploratory Factor Analysis (EFA) 2. Factor Extraction: Principal Axis Factoring (PAF) 3. Number of Factors: Parallel Analysis (PA) 4. 4. Rotation: Oblique Rotation (Promax)	1. EFA provide evidence of construct validity and unidimensionality of the scale by identifying underlying latent constructs (dimensions) 2. PAF mixes common, specific, and random error variances 3. PA offers an objective criterion by comparing the eigenvalues of the actual data to those of randomly generated data 4. oblique rotation (Promax) allows for potential correlations between factors, aligning with the theoretical expectation that awareness and adaptive capacity are related dimensions of organizational resilience	1. Eigenvalues >1 2. Factor loadings >0.4 3. Percentage of the total item variance ≥ 60%
Reliability	Inter-Item correlations (IIC)	To measure if all items should have similar average intercorrelations	Item-to-total correlations >0.4 Inter-item correlations >0.3
	Internal consistency reliability (Cronbach's alpha)	Cronbach's alpha to ensure the accuracy and precision of a measuring scale and strong item covariance	Cronbach alpha ≥ 0.7

Confirmatory factor analysis (CFA) Measure	Rules of thumb for CFA
CFA Standardized Loadings	≥0.4
Fit indexes	– Comparative Fit Index (CFI): ≥0.95 can tolerate 0.90 in exploratory analysis – Tucker-Lewis Index (TLI): ≥0.90 – Bentler-Bonett Non-Normed Fit Index (NNFI): ≥0.90 – Incremental Fit Index (IFI): ≥0.90 can tolerate 0.85 in exploratory analysis – Goodness of Fit Index (GFI): ≥0.90 can tolerate 0.85 in exploratory analysis – Root Mean Square Error of Approximation (RMSEA): ≤0.08 can tolerate 0.09 in exploratory analysis

Convergent and discriminant validity Measure	Rules of thumb for convergent and discriminant validities through CFA
Convergent Validity	AVE ≥0.5
Discriminant Validity	HTMT (Heterotrait-Monotrait ratio) < 0.90: Discriminant validity is established HTMT (Heterotrait-Monotrait ratio) > 0.90: Discriminant validity is not established

Source(s): Authors' own creation
Adapted from Hair *et al.* (2010) and Hinkin (1998)

Table 3.
The methodology used in this study and its respective elements

Indicators	Items	Awareness Factor loadings	KMO	Adaptive capacity Factor loadings	KMO
EON	EON1	0.781	0.93		
	EON2	0.746	0.949		
	EON3	0.900	0.925		
	EON4	0.623	0.949		
CRR	CRR1	0.789	0.948		
	CRR2	0.794	0.952		
	CRR3	0.755	0.957		
	CRR4	0.757	0.936		
	CRR5	0.682	0.961		
	CRR6	0.715	0.958		
AOH	AOH1	0.541	0.966		
	AOH2	0.646	0.969		
	AOH3	0.518	0.963		
	AOH4	0.552	0.956		
	AOH5	0.598	0.975		
	AOH6	0.786	0.948		
	AOH7	0.779	0.934		
	MOB1	0.550	0.967		
AIC	MOB3	0.580	0.964		
	AIC1	0.736	0.947		
	AIC2	0.722	0.933		
	AIC3	0.909	0.912		
	AIC4	0.885	0.909		
MOR	MOR1			0.843	0.889
	MOR2			0.765	0.888
	MOR3			0.452	0.923
EENG	EENG1			0.660	0.922
	EENG2			0.809	0.871
	EENG3			0.957	0.916
	LDRSP2			0.611	0.873
IDSS	LDRSP3			0.561	0.912
	ATI1			0.748	0.916
	ATI2			0.725	0.94
	ATI3			0.535	0.963
	DDM1			0.983	0.938
	DDM2			0.841	0.885
	DDM3			0.685	0.948
OAC	OAC1			0.565	0.578
	OAC2			0.99	0.52
	OAC3			0.743	0.528

Source(s): Authors' own creation

Table 4. First-Order Analysis - results for the dimensionality and suitability analyses for the awareness and the adaptive capacity dimensions separately

As a result of the first-order analysis, a second-order analysis was conducted to validate if the indicators load into their respective dimensions. All indicators loaded into their appropriate dimension except the indicator "Organizational Analytical Capabilities" (AOC) who didn't load with values higher than 0.4 on any of the two dimensions of organizational resilience. Therefore, and after reviewing the literature on organizational resilience, it was decided to remove this indicator and redo the EFA.

4.1.3 Reliability analysis. A Cronbach's value of 0.961 was scored on the awareness dimension and a value of 0.948 was scored for the adaptive capacity dimension. This indicates that the factors' reliability has been reached because the value is higher than the rule of thumb of 0.6 (Hair *et al.*, 2010). In addition, the average interitem correlation for the

awareness dimension scored 0.523, and 0.567 for the adaptive capacity dimension. This means that the data is reliable as it is higher than the rule of thumb of 0.3. The interitem item to rest correlation for each dimension scored higher than 0.4 on all items. It is also to mention the percentage of the total item variance scored a value less than 60%. This means that additional qualitative analysis is needed to determine additional dimensions of organizational resilience for the O&G industry. The final results for dimensionality, suitability, and reliability analyses for the second-order analysis are presented in Table 5.

4.2 Confirmatory factor analysis (CFA)

Based on the results of the EFA, many repetitions of CFA were conducted to get a good model fit. On the awareness dimension, the model derived from the EFA has a good fit. The Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) are respectively 0.926 and 0.917, which suggests that the model fits the data reasonably well. The Bentler-Bonett Non-normed Fit Index (NNFI) and Bollen's Incremental Fit Index (IFI) are also both above 0.9, which further supports the model's good fit. The Goodness of Fit Index (GFI) is equal to 0.95, which indicates that the model fits the data well. The Root Mean Square Error of Approximation (RMSEA) is at 0.076, which is considered a good fit. Table 6 presents the data of the CFA for the awareness dimension. In addition, all variables have a CFA standardized loading higher than 0.4 which means that each observed item has a relatively strong association with its corresponding indicator for the awareness dimension. It is important to mention that even though it is theoretically impossible to have estimates greater than 1 for CFA, the estimates for EON1 and AIC2 attempt to capture as much of the correlation as possible between the item and its respective latent indicator, leading to estimated factor loadings that exceeded one. However, their magnitude typically does not differ greatly from 1, which in statistical analysis can be considered acceptable (Hair *et al.*, 2010).

For the adaptive capacity dimension, after several CFA repetitions, after reviewing the literature and the indicators, and carefully analyzing the misfit plots, it was decided to drop the indicator "*Organizational Analytical Capabilities*" because its items caused the estimated covariance matrix of the variables in the model to be negative definite. After removing this indicator, the model for the adaptive capacity dimension has a good fit. The Comparative Fit Index (CFI) was found to be 0.927, indicating a good fit. The Tucker-Lewis Index (TLI) and Bentler-Bonett Non-normed Fit Index (NNFI) also provided evidence of a good fit with values of 0.908. The Bollen's Incremental Fit Index (IFI) indicated a similar fit to the CFI with a value of 0.927. Moreover, the Goodness of Fit Index (GFI) demonstrated an excellent fit of the model with a value of 0.977. Finally, the Root Mean Square Error of Approximation (RMSEA) was estimated to be 0.078, which indicates a good fit of the model to the data. These results suggest that our proposed model provides an adequate representation of the relationships among the variables included in our study. Table 7 presents the data of the CFA for the adaptive capacity dimension. In addition, all variables have a CFA standardized loading higher than 0.4 which means that each observed item has a relatively strong association with its corresponding indicator for the adaptive capacity dimension.

Additionally, convergent validity is achieved because Average Variance Extracted (AVE) loaded greater than the rule of thumb of 50% on all factors for the awareness dimension (65.4% for EON; 66% for CRR; 59.2% for AOH; 66.2% for AIC), and for the adaptive capacity dimension (64.2% for IDSS, 71.2% for EENG, and 51% for MOR).

As for the discriminant validity, based on the HTMT results, it can be concluded that the discriminant validity of the awareness dimension (EON, CRR, AOH, and AIC), and the adaptive capacity dimension (IDSS, EENG, MOR) has been established, as all HTMT values are below the 0.90 threshold. Table 8 presents the discriminant validity values using HTMT for the awareness and the adaptive capacity dimensions.

	Items	Dimensionality: Awareness	Dimensionality: Adaptive capacity	Suitability: Kaiser-Meyer-Olkin test	Reliability: Item-rest correlation	Total values
EON	EON1	0.709		0.923	0.664	
	EON2	0.681		0.93	0.628	
	EON3	0.671		0.917	0.614	
	EON4	0.653		0.957	0.663	
CRR	CRR1	0.786		0.947	0.698	
	CRR2	0.695		0.938	0.697	
	CRR3	0.745		0.939	0.672	
	CRR4	0.769		0.938	0.696	
	CRR5	0.764		0.949	0.698	
	CRR6	0.738		0.958	0.624	
AOH	AOH1	0.803		0.96	0.701	
	AOH2	0.725		0.956	0.665	
	AOH3	0.792		0.953	0.686	
	AOH4	0.728		0.949	0.733	
	AOH5	0.831		0.952	0.659	
	AOH6	0.751		0.941	0.631	
	AOH7	0.754		0.934	0.637	
	MOB1	0.788		0.955	0.643	
AIC	AIC1	0.936		0.956	0.71	
	AIC2	0.928		0.936	0.639	
	AIC3	0.914		0.925	0.599	
	AIC4	0.906		0.917	0.639	
	MOB3	0.943		0.966	0.672	
MOR	MOR1		0.911	0.902	0.646	
	MOR2		0.9	0.899	0.543	
	MOR3		0.896	0.935	0.602	
EENG	EENG1		0.929	0.92	0.63	
	EENG2		0.867	0.883	0.581	
	EENG3		0.923	0.928	0.624	
	LDRSP2		0.884	0.89	0.647	
IDSS	ATI1		0.879	0.898	0.581	
	ATI2		0.781	0.935	0.583	
	ATI3		0.839	0.95	0.52	
	DDM1		0.819	0.924	0.574	
	DDM2		0.753	0.857	0.525	
	DDM3		0.823	0.933	0.64	
	LDRSP3		0.789	0.9	0.688	
	Overall - Kaiser-Meyer-Olkin test					*0.929*
	Bartlett's test					*<0.001*
	Proportion var	*43%*	*11.80%*			*54.8%*
	Cronbach's α	*0.961*	*0.948*			*0.964*
	Average Interitem Correlation	*0.523*	*0.567*			*0.424*

Source(s): Authors' own creation

Table 5. Second-order Analysis - Results for the dimensionality, suitability, and reliability analyses

5. Discussion

5.1 Theoretical contribution

Organizational resilience refers to an organization's ability to cope with unexpected disruptions and recover from them while maintaining its core operations and continuing to fulfill its mission (Chen *et al.*, 2021). The O&G industry is particularly vulnerable to disruptive events, such as natural disasters, cyber-attacks, and economic downturns, which can have

CFA standardized loadings Indicator	Item	Symbol	Estimate	Std. Error	z-value	*p*
EON	EON1	λ41	1.052	0.069	15.254	<0.001
	EON2	λ42	0.972	0.068	14.395	<0.001
	EON3	λ43	0.966	0.066	14.717	<0.001
	EON4	λ44	0.891	0.065	13.632	<0.001
Cronbach's α			0.88			
AVE			*65.4%*			
CRR	CRR1	λ11	0.959	0.06	15.871	<0.001
	CRR2	λ12	0.861	0.058	14.759	<0.001
	CRR3	λ13	0.922	0.065	14.287	<0.001
	CRR4	λ14	0.884	0.057	15.652	<0.001
	CRR5	λ15	0.985	0.065	15.251	<0.001
	CRR6	λ16	0.884	0.064	13.903	<0.001
Cronbach's α			*0.92*			
AVE			*66%*			
AOH	AOH1	λ21	0.891	0.061	14.67	<0.001
	AOH2	λ22	0.842	0.062	13.483	<0.001
	AOH3	λ23	0.878	0.062	14.178	<0.001
	AOH4	λ24	0.858	0.058	14.69	<0.001
	AOH5	λ25	0.797	0.056	14.192	<0.001
	AOH6	λ26	0.848	0.064	13.228	<0.001
	AOH7	λ27	0.853	0.065	13.177	<0.001
	MOB1	λ28	0.859	0.065	13.169	<0.001
Cronbach's α			*0.92*			
AVE			*59.2%*			
AIC	MOB3	λ31	0.952	0.067	14.162	<0.001
	AIC1	λ32	0.97	0.06	16.076	<0.001
	AIC2	λ33	1.036	0.071	14.594	<0.001
	AIC3	λ34	0.977	0.066	14.732	<0.001
	AIC4	λ35	0.962	0.065	14.795	<0.001
Cronbach's α			*0.90*			
AVE			*66.2%*			

Fit indices Index	Value
Comparative Fit Index (CFI)	0.926
Tucker-Lewis Index (TLI)	0.917
Bentler-Bonett Non-normed Fit Index (NNFI)	0.917
Bollen's Incremental Fit Index (IFI)	0.927
Goodness of fit index (GFI)	0.950
Root mean square error of approximation (RMSEA)	0.076

Source(s): Authors' own creation

Table 6.
CFA results for the awareness dimension

severe consequences for both the industry and society as a whole (Mama and Onuoha, 2020). Therefore, understanding the factors that contribute to organizational resilience is critical for the industry's success and sustainability.

The awareness dimension of organizational resilience is particularly important for identifying and assessing potential risks and vulnerabilities (Hillmann and Guenther, 2021). In the context of the O&G industry, awareness involves continuous monitoring of operational risks, environmental conditions, and market fluctuations. The industry's complex and hazardous nature necessitates a high level of vigilance and proactive risk assessment to prevent and mitigate disruptions. The findings of the study suggest that the O&G industry

CFA standardized loadings						
Indicator	Item	Symbol	Estimate	Std. Error	z-value	*p*
IDSS	DDM1	λ11	0.972	0.063	15.412	<0.001
	DDM2	λ12	0.79	0.06	13.1	<0.001
	DDM3	λ13	0.947	0.061	15.473	<0.001
	ATI1	λ14	0.918	0.058	15.953	<0.001
	ATI2	λ15	0.936	0.065	14.325	<0.001
	ATI3	λ16	0.872	0.063	13.762	<0.001
Cronbach's α			*0.915*			
AVE			*64.7%*			
EENG	EENG1	λ21	0.855	0.063	13.658	<0.001
	EENG2	λ22	0.94	0.057	16.568	<0.001
	EENG3	λ23	0.989	0.057	17.362	<0.001
	LDRSP2	λ24	0.896	0.057	15.688	<0.001
Cronbach's α			*0.905*			
AVE			*71.2%*			
MOR	MOR1	λ31	1.004	0.067	15.086	<0.001
	MOR2	λ32	0.758	0.065	11.671	<0.001
	MOR3	λ33	0.791	0.064	12.42	<0.001
Cronbach's α			*0.807*			
AVE			*60.3%*			

Fit indices	
Index	Value
Comparative Fit Index (CFI)	0.927
Tucker-Lewis Index (TLI)	0.908
Bentler-Bonett Non-normed Fit Index (NNFI)	0.908
Bollen's Incremental Fit Index (IFI)	0.927
Goodness of fit index (GFI)	0.977
Root mean square error of approximation (RMSEA)	0.078

Source(s): Authors' own creation

Table 7.
CFA results for the adaptive capacity dimension

	Awareness					Adaptive capacity		
	EON	CRR	AOH	AIC		IDSS	EENG	MOR
EON	1.000				IDSS	1.000		
CRR	0.746	1.000			EENG	0.863	1.000	
AOH	0.788	0.867	1.000		MOR	0.767	0.772	1.000
AIC	0.662	0.665	0.780	1.000				

Source(s): Authors' own creation

Table 8.
Discriminant Validity using HTMT for the awareness and the adaptive capacity dimensions

put a strong emphasis on building and maintaining partnerships with external parties to gain access to relevant expertise and resources. This is consistent with previous studies that have highlighted the importance of developing and maintaining effective partnerships to enhance organizational resilience (Lee *et al.*, 2013).

The clarity of roles and responsibilities is also crucial for maintaining a cohesive and efficient workforce, which is essential for organizational resilience (Stephenson *et al.*, 2010). The findings of the study indicate that the O&G industry emphasizes a high priority on ensuring that employees understand their roles and responsibilities and possess the skills and knowledge required to perform them effectively. This is consistent with previous

research demonstrating a positive correlation between employee training and organizational resilience (Hatton *et al.*, 2018).

The industry's strong level of alertness to the organization's health in the O&G sector is also consistent with previous studies that have emphasized the importance of continuously monitoring internal and external environments to identify potential risks and vulnerabilities (Barasa *et al.*, 2018). Organizations that are more alert to their internal and external environments are better equipped to adapt to changing conditions and respond to disruptive events effectively (Lee *et al.*, 2013).

Moreover, the findings of the study indicate that the adoption of innovation culture is essential for enhancing organizational resilience in the O&G sector. This is consistent with previous research that has highlighted the importance of fostering a culture of open communication and employee engagement in order to improve organizational resilience (Duchek, 2020).

Alternatively, the results of the study on organizational resilience in the O&G industry have revealed key insights into the adaptive capacity dimension of resilience. The adaptive capacity dimension is composed of three indicators: Mobilization of resources, employees' engagement, and integrated decision support systems.

The results show that employees feel a strong connection between their daily tasks and the tasks required to face disruptive events. They also reported a high level of engagement and a sense of responsibility and accountability to help the O&G organization face disruptive events. This suggests that employees are actively involved in the resilience-building process and are willing to put in extra effort during times of disruption. This is consistent with previous studies on organizational resilience such as the work of Brown *et al.* (2017).

The study also found that access to information is crucial for O&G organizational resilience. Information systems were found to be available to provide quick access to information, and various organizational departments were able to provide feedback on possible solutions to face disruptive events. External partners were also able to provide feedback on possible solutions, indicating the importance of having a strong network of external partners. The importance of information systems and the access to information is also discussed in the literature and the results of this study align with previous studies on this particular indicator (Hatton *et al.*, 2018; Stephenson *et al.*, 2010). In addition, the results suggest that people with the right qualifications are able to take decisions based on their seniority level, and that an individual with the right authority to act is always accessible during disruptive events. O&G organizations were also found to be able to take tough decisions quickly and mobilize resources from different departments to face disruptive events. Additionally, organizations were found to have the financial capabilities to purchase the necessary resources to face disruptive events (Chen *et al.*, 2021; Duchek, 2020).

5.2 Practical contribution

From a practical perspective, the indicators and their respective items (Table 9) can be used by stakeholders in the O&G industry to evaluate the resilience of their organizations. The plan-do-check-act process can be used in this matter (Srivannaboon, 2009). In the planning phase, stakeholders' objectives would be to improve the resilience of their organization when dealing with disruptive events. In the do phase, the survey in Appendix can be distributed among employees to collect data on the resilience of their organization, mainly on its awareness and adaptive capacity levels. In the check phase and once the data is collected, stakeholders can analyze the data using any statistical analysis software. The information can be represented in a web diagram in order to identify the strengths and weaknesses of the organization with regard to its resilience. During the act phase, stakeholders can build strategies and implement them in order to improve the resilience of their organization. The results of this study will not allow organizations to 100% deal with

Indicators	Items
Awareness	
Efficiency of organizational networks	1. Partnerships with external parties (e.g. other oil and gas organizations, fuel companies, etc.) that have field-specific knowledge are continuously developed at my organization 2. Current partnerships with external parties (e.g. other oil and gas organizations, fuel companies, etc.) are continuously reinforced at my organization 3. Access to external resources (e.g. oil and gas experts, technologies, etc.) through partnerships is possible to help identify our organization's weaknesses 4. Access to external resources (e.g. oil and gas experts, technologies, etc.) through partnerships is possible to help assess our organization's weaknesses
Clarity of roles and responsibilities	1. I have a clear picture of my role (the position that I should assume) in my organization 2. I have a clear picture of my responsibilities (duties that I am expected to complete based on my role) in my organization 3. I am continuously offered training to develop new expertise and knowledge in my organization 4. I continuously use my expertise to identify possible disruptive events 5. I continuously use my expertise to assess possible disruptive events 6. Information is stored in secured locations in my organization
Alertness to the organization's health	1. The financial and economical situations of my organization are continuously monitored to avoid possible disruptive events 2. The competitors (e.g. other oil and gas organizations) are continuously monitored to remain competitive and avoid possible disruptive events 3. Internal laws and regulations (changes inside the organization) are continuously monitored to avoid possible disruptive events 4. External laws and regulations (changes outside the organization (e.g. new regulations on Covid-19)) are continuously monitored to avoid possible disruptive events 5. The situation of our customers is continuously monitored to keep them engaged in order to avoid possible disruptive events 6. Organizational changes are continuously implemented based on internal new events (e.g. changes in internal law and regulations, changes on financial key performance indicators) to avoid possible disruptive events 7. Organizational changes are continuously implemented based on external new events (e.g. competition, employees' situations) to avoid possible disruptive events 8. In my organization, orientation is continuously provided to employees about the organization's goals, and the means to achieve them (policies, procedures, programs, authority relations, etc.)
Adoption of an Innovation Culture	1. In my organization employees are actively encouraged to innovate through their work 2. Employees in my organization are rewarded for thinking outside of the box 3. A clear innovation process exists in my organization 4. A clear innovation process is used in my organization to help employees share their creative ideas 5. Interpersonal relations are continuously improved in my organization to increase the collaboration spirit between employees

Table 9.
The final set of indicators to assess organizational resilience and their respective items in the oil and gas industry

(*continued*)

Indicators	Items
Adaptive Capacity	
Mobilization of resources	1. When needed, tangible (e.g. human resources, cash, equipment) resources can be mobilized from different departments in my organization to face disruptive events 2. When needed, tangible (e.g. human resources, cash, equipment) resources can be mobilized through my organization's external networks (e.g. other oil and gas organizations, etc.) to face disruptive events 3. When needed, our organization has the financial capabilities to purchase the right tangible resources (e.g. new software applications, subject matter experts, etc.) to face disruptive events
Employees' engagement	1. The link between my daily tasks and the tasks required to face the disruptive events is clear 2. When faced with disruptive events, I give my best to solve issues 3. I feel responsible and accountable to help my organization face disruptive events 4. Senior managers ensure actions are implemented in the right way and at the right time to effectively face disruptive events
Integrated Decision Support Systems	1. Information systems are available to provide quick access to information to help dealing with disruptive events 2. Various organizational departments can provide feedback on possible solutions to face disruptive events through information systems 3. External partners can provide feedback on possible solutions to face disruptive events 4. In my organization, people with the right qualifications can take decisions, based on their seniority level, to face disruptive event 5. When faced with disruptive events, an individual with the right authority to act is always accessible 6. When faced with disruptive events, my organization can take tough decisions quickly

Source(s): Authors' own creation

Table 9.

any disruptive events because disruptive events can have different contexts and characteristics that can jeopardize the possibility of dealing with their negative consequences. However, the indicators of organizational resilience proposed in this study, can give stakeholders in the O&G industry suggestions on the strengths and weaknesses of their organizations so that they can effectively and efficiently be prepared and increase the chances of successfully dealing with disruptions.

In addition, the proposed and tested indicators ca helps organizations align their purpose and strategy with innovative practices, resilience-building efforts, and technology adoption, ultimately driving performance and transformation. In fact, the proposed indicators present a comprehensive framework to evaluate organizational resilience in the O&G industry, aligning with the principles of sustainability and social responsibility (Verreynne *et al.*, 2023). These indicators encompass various facets of organizational awareness, such as fostering partnerships, promoting clear roles and responsibilities, continuous monitoring of financial and regulatory landscapes, minimizing organizational barriers, and cultivating an innovation culture. Collectively, these aspects can facilitate knowledge sharing, efficient resource allocation, risk mitigation, agility, and the adoption of sustainable technologies and business models. Furthermore, the adaptive capacity indicators, including mobilization of resources, strong leadership committed to sustainability, robust information systems, and decentralized decision-making, are crucial for implementing sustainable initiatives, responding to environmental and social challenges, and aligning operations with global sustainability objectives (Miceli *et al.*, 2021). By incorporating these indicators, O&G companies can

enhance their resilience, mitigate risks, and capitalize on opportunities associated with the global sustainability agenda, leading to improved environmental endeavors, social responsibility, and long-term value creation for stakeholders. Ultimately, this contributes to the achievement of the Sustainable Development Goals (SDGs), promoting a sustainable future for the industry and society as a whole (Fonseca, 2022).

5.3 Research limitation and suggestions for future studies

Though the results of this study provide insightful information about evaluating organizational resilience in the O&G sector, it is important to recognize some limitations that should be considered while interpreting and extrapolating the findings.

First of all, it is important to continue investigating additional dimensions of organizational resilience by conducting comprehensive qualitative and quantitative research in a range of sectors, including infrastructure, information technology, construction, pharmaceuticals, etc. In fact, iterative research and validations are necessary to continue the development of a scale to assess organizational resilience. Scale development is a process that takes substantial time and research effort.

This study focuses on the O&G sector. Thus, the applicability of the findings to other sectors may be restricted at this point and requires additional studies.

Furthermore, despite the fact of using robust statistical analysis and measurement to validate the reliability of the data collected from the surveys, this type of data can introduce the potential for bias and subjectivity in the measurement of organizational resilience, as individuals' perceptions and interpretations may vary.

These limitations emphasize the need of additional scientific studies to test and improve the suggested scale, evaluate its application in a variety of industries, and use more objective measuring techniques to look at long-term improvements in organizational resilience.

Future research should prioritize longitudinal studies to track organizational resilience over time, providing insights into the long-term effectiveness and stability of the proposed indicators. This approach will help understand how resilience evolves in response to various disruptions and whether the current scale can consistently measure resilience over extended periods in the O&G industry.

Additionally, it is crucial to test the resilience scale across different cultural and geographic contexts, as organizational resilience may manifest differently in various settings. Understanding these differences will enhance the scale's applicability and robustness globally.

Furthermore, future studies should consider the impact of technological advancements on organizational resilience. Investigating how digital transformation, big data analytics, and artificial intelligence contribute to resilience can provide valuable insights. Integrating these technological factors into the resilience scale will ensure it remains relevant in the rapidly evolving technological landscape.

6. Conclusion

The main findings and contributions of our study highlight the importance of both the awareness and adaptive capacity dimensions in enhancing organizational resilience within the O&G industry. Our proposed and tested scale provides a comprehensive measure that captures critical aspects of resilience. The awareness dimension, which includes leading indicators such as the efficiency of organizational networks, clarity of roles and responsibilities, alertness to organizational health, and adoption of an innovation culture, aligns with established theoretical frameworks and emphasizes the industry's need for continuous monitoring and external collaboration. The adaptive capacity dimension, consisting of leading indicators like resource mobilization, employee engagement, and

decision support systems, underscores the necessity for O&G organizations to adapt swiftly and efficiently during disruptive events.

Our study fills a significant literature gap by focusing specifically on measuring organizational resilience within the O&G sector, an area previously underexplored. Existing research has primarily emphasized safety aspects and general conceptualizations of resilience, which do not fully capture the unique challenges faced by O&G companies. Additionally, while strategic factors have been highlighted in enhancing resilience, especially in small and medium enterprises, there has been a lack of operationalizing and measuring these factors within the O&G context. Our proposed scale addresses these gaps by offering a tailored framework that aligns with the strategic needs of O&G organizations and provides structured strategies for assessing and strengthening resilience capabilities.

This scale offers significant practical implications, allowing stakeholders to assess and improve resilience through structured strategies and data-driven decision-making processes. By addressing these critical areas, our study provides valuable insights and tools for enhancing the resilience of organizations in the oil and gas sector. Consequently, this research not only fills a critical gap in the literature but also offers actionable insights for practitioners and policymakers to foster resilient organizations capable of thriving in an increasingly volatile environment.

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Appendix

The supplementary material for this article can be found online.

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