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-RESEARCH ARTICLE-

FROM DATA TO DECISIONS: STRENGTHENING PROJECT RESILIENCE WITH ANALYTICS AND PROCESS MATURITY

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—Abstract—

This study examines project resilience as a performance driver in upstream oil and gas projects during the 2020–2022 global disruption. While resilience is recognized as crucial for managing uncertainty, empirical research on its enablers within the oil and gas sector remains limited. Using survey data from 170 project managers worldwide, analyzed through Partial Least Squares Structural Equation Modeling (PLS-SEM), this

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study explores how Data Analytics Capability (DACP) and Project Management Maturity (PMMM) influence Project Resilience (PRES) and, in turn, Project Success (PSUC). Findings indicate that DACP significantly enhances resilience through real-time data processing, predictive analytics, and adaptive decision-making, while PMMM contributes through structured governance and risk management, though with a weaker effect. PRES emerges as a critical predictor of project success, reinforcing its role as both a risk-mitigation mechanism and a driver of long-term performance. Multi-Group Analysis (MGA) confirms these relationships across global regions, underscoring the universal applicability of resilience strategies in high-reliability industries. These insights highlight the need for integrating data-driven capabilities with structured project governance to improve adaptability and sustain performance in volatile environments.

Keywords: Project Resilience, Data Analytics Capability, Project Management Maturity, Project Success, Oil and Gas Projects

INTRODUCTION

The upstream oil and gas industry operates within a highly complex and volatile environment, characterised by fluctuating market conditions, supply chain constraints, and stringent regulatory requirements. The COVID-19 pandemic, which unfolded between 2020 and 2022, significantly exacerbated these challenges by causing widespread disruptions to the labour market—both in terms of supply and demand—as well as to logistics operations and financial planning within the extractive industries. These disruptions exposed critical vulnerabilities, particularly in workforce availability, logistical coordination, and financial resilience. According to (Billing et al., 2021) and the (Forum, 2020), many companies were ill-prepared to cope with such unprecedented disruptions. (Vogus & Sutcliffe, 2003) also conducted a global survey which reinforced the finding that the majority of organisations lacked the resilience necessary for effective project execution under crisis conditions. In response, firms accelerated their digital transformation strategies and prioritised workforce reskilling initiatives. Areas such as project management and data analytics were identified among the top ten reskilling priorities, reflecting a strategic pivot towards enhancing organisational adaptability.

Substantial investments were subsequently directed towards these capabilities, under the assumption that such efforts would improve decision-making quality and organisational flexibility. Nonetheless, the crisis revealed that project environments were largely unprepared and lacked the necessary resilience at the time of disruption. This indicates a fundamental challenge: resilience continues to be addressed reactively rather than as an integrated element of project governance and strategic decision-making processes. The existing literature provides limited insight into whether

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resilience can be systematically cultivated through structured and proactive approaches—an area that remains underexplored and warrants further investigation. Resilience is widely discussed within the field of crisis management; however, it is frequently perceived as a reactive mechanism employed to survive adversity, rather than as a strategic capability (Bhamra et al., 2011). Within project-based industries, resilience is commonly associated with ad hoc improvisation rather than with a clearly defined or prescriptive process (Duchek, 2020; Zhang et al., 2023). In the inherently high-risk context of the oil and gas sector, High Reliability Organisations (HROs) dominate the operational landscape, wherein failure is not a viable option (Grabowski & Roberts, 2019). Given the sector's high capital intensity, extended project lead times, and stringent regulatory oversight, achieving operational stability is paramount to ensuring continuity (Lekka & Sugden, 2011; Salehi et al., 2018). Project resilience has been defined as the capacity to adapt to adversity (Vogus & Sutcliffe, 2003), to address weaknesses under dynamic conditions (McManus, 2008), and to endure disruptions while still achieving key objectives (Rahi & Bourgault, 2022). This study conceptualises project resilience as the capability of a project—considered here as a temporary organisation—to anticipate, adapt to, and effectively respond to significant changes or disturbances in the project environment. The present research treats PMMM and DACP as critical enablers of PRES, and investigates their respective development pathways. These two capabilities are selected due to their contemporary relevance in industry dialogues centred on resilience and adaptability. (Billing et al., 2021) and the (Forum, 2020) similarly identified project management and data analytics as among the most prominent organisational reskilling priorities in response to recent global disruptions. Although these reports underscore the influence of these capabilities on decision-making and agility, there remains a dearth of empirical studies that quantitatively assess whether such capabilities directly enhance project resilience and success.

Existing literature advises organisations to adopt structured project management methodologies, as these facilitate risk mitigation and informed response strategies (Alvarenga et al., 2022; Belhadi et al., 2024). The Business Process Maturity Model (BPMM), for instance, has been recognised for its role in aligning operational processes with organisational objectives (Dijkman et al., 2016; Ravesteyn et al., 2012), thereby enhancing process governance, standardisation, and knowledge management—all of which are foundational for cultivating resilience (Dubey et al., 2021; Srinivasan & Swink, 2018). Nonetheless, there remains a significant gap in research concerning the systematic embedding of resilience into the project management structure to achieve improved long-term outcomes (McManus, 2008; Stephenson et al., 2010). It is also important to acknowledge that, within the oil and gas sector, project success is often evaluated beyond the traditional criteria of scope, cost, and schedule. Additional dimensions such as safety, regulatory compliance, and long-term asset performance play an equally vital role (Irfan & Hassan, 2017; Müller & Turner, 2007; Pinto, 2014).

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Despite this broader view of success, resilience continues to be interpreted predominantly as a reactive, risk mitigation mechanism, rather than as a proactive contributor to success outcomes (Duchek, 2020; Rahi & Bourgault, 2022). This study aims to address this research gap by examining whether resilience actively contributes to PSUC, as opposed to serving merely as a short-term survival tactic in times of crisis (see Figure 1).

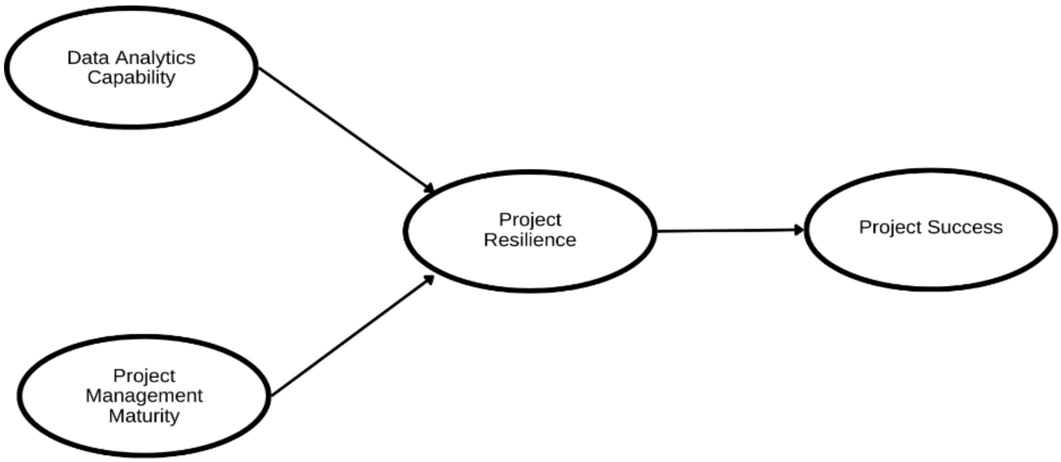

Figure 1: Conceptual Framework

The global disruption between 2020 and 2022 highlighted the critical importance of advanced data analytics, particularly within contexts requiring remote decision-making. During this period, the adoption of Internet of Things (IoT) dashboards and mobile analytics platforms accelerated across the industry, enabling real-time, interactive reporting accessible from any location. These digital tools empowered decision-makers to access and analyse diverse datasets instantaneously, thereby facilitating swift and informed responses to operational challenges even in remote work environments. For example, in addressing cement integrity concerns, project managers could concurrently evaluate real-time well data, historical cementing records, and detailed operational logs in order to identify the most suitable remedial actions. The capability to remotely access, analyse, and synthesise multifaceted data streams substantially enhanced project resilience, allowing organisations to maintain operational continuity in volatile conditions.

This study contributes to the literature in three significant ways. First, it offers empirical evidence PRES as a PSUC, thereby demonstrating that resilience serves not only as a mechanism for crisis endurance but also as a driver of sustained organisational performance. Second, drawing upon a global sample of project managers from regions including Asia Pacific, the Middle East, Africa, North America, South America, and Europe, the study investigates the extent to which regional variation affects resilience strategies, thus enriching the understanding of how resilience operates across varying

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geographical and industrial contexts. Finally, from a managerial standpoint, the study delivers actionable insights by emphasising the strategic importance of project management maturity and data analytics capability in fostering resilience-building approaches that ultimately enhance project performance in the oil and gas sector.

The remainder of this research article is organised as follows. It commences with a review of the relevant literature on project resilience, data analytics capability, project management maturity, and project success, thereby establishing the theoretical foundation of the study. This is followed by a comprehensive discussion of the research methodology, encompassing data collection procedures, measurement instruments, and analytical techniques. Subsequently, the empirical findings and their analysis are presented, exploring the interrelationships among the core constructs. The article concludes by delineating the key insights, theoretical and managerial implications, as well as acknowledging the study's limitations and proposing avenues for future research.

LITERATURE REVIEW

Multiple theoretical frameworks have been employed to explain the development of adaptive capabilities in organisations and projects in response to disruptions—commonly referred to as project resilience—and these serve as the foundational basis for this study. The Resource-Based View (RBV) posits that a firm's competitive advantage is contingent upon its possession of strategic resources that are valuable, rare, inimitable, and non-substitutable (Barney, 1991; Penrose, 1959). However, RBV does not comprehensively account for the manner in which organisations reconfigure their resource base in response to evolving environmental conditions. This limitation has prompted the emergence of Dynamic Capabilities Theory (DCT), which builds upon RBV by asserting the necessity for organisations to adapt, integrate, and reconfigure internal and external competencies in order to sustain performance amidst environmental uncertainty (Sanchez et al., 2025). Such adaptability is critical in project environments, where projects are typically characterised by constraints, risks, and external disruptions that demand timely and agile responses.

These theoretical lenses are further complemented by the Conservation of Resources (COR) Theory, which conceptualises resilience as the capacity to recover, replenish, or preserve essential resources required to function effectively across domains such as work, family, and leisure (Hobfoll et al., 2018). According to COR Theory, stress arises when key resources are threatened, depleted, or fail to yield the anticipated benefits. The theory's concept of 'resource caravans' suggests that resilience is not derived from a single capability but is instead the outcome of the synergistic interaction among multiple resource types. When considered from the perspective of project resilience, COR Theory underscores the critical role of prudent financial, technical, and human resource management in absorbing shocks, adapting to environmental volatility, and sustaining performance—especially within high-risk industrial settings. Given the growing need for operational continuity during turbulent periods, PRES has gained prominence as a key capability enabling projects to anticipate, absorb, and adapt to disruptions. Two main perspectives define resilience: the capability-based view, rooted in Resource-Based Theory (RBT) and DCT, sees it as the ability to reconfigure resources to mitigate disruptions (Penrose, 1959; Sanchez et al., 2025), while the processual view frames it as a cycle of anticipation, response, and adjustment (McManus, 2008; Vogus & Sutcliffe, 2003). Recent studies highlight two PRES dimensions—awareness and adaptive capacity—where awareness refers to early risk detection, and adaptive capacity involves resource mobilisation (Rahi & Bourgault, 2022). These align with resilience traits in organisational and high-reliability contexts, where formal governance supports consistent performance during disruptions (Zhang et al., 2023).

Although awareness of project resilience is growing, it remains fragmented in the literature, particularly in high-risk sectors like oil and gas. For instance, in construction, resilience is strengthened through flexible structures and multidisciplinary collaboration (Yang & Cheng, 2020), while manufacturing and supply chains emphasise data-driven decisions for real-time monitoring and predictive analytics (Dubey et al., 2021). In oil and gas, resilience is typically linked to safety, operational stability, and compliance, though broader perspectives highlight the role of project management and analytics in fostering network resilience (Bento et al., 2021). This study adopts awareness and adaptive capacity as key indicators of project resilience, supported across various industries (Rahi & Bourgault, 2022; Zhang et al., 2023). DACP is emerging as a vital enabler of resilience in high-risk, project-based industries like oil and gas. DACP reflects an organisation's ability to process and use data for informed decision-making, risk anticipation, and efficiency (Dubey et al., 2021). DACP enhances awareness, flexibility, and crisis response (Kang & Stephens, 2022), with strong DACP linked to better infrastructure and decisions (Kiron et al., 2014) and big data talent being key to its optimisation (Akter et al., 2016). Yet, debate persists on whether analytics alone suffice, or if human judgement remains essential (Nguyen et al., 2020; Raffoni et al., 2018). While DACP enables trend synthesis and resource optimisation (Zhang et al., 2023), industry uptake is uneven due to integration challenges, limited expertise, and resistance to data-led decisions (Dubey et al., 2021).

From the early maturity models (Crosby, 1980; Nolan, 1979), the purpose of PMMM has evolved into more comprehensive frameworks that assess an organisation's capability to standardise and optimise project management processes (Wendler, 2012). Specific process areas, such as cost control and risk management, were initially emphasised in traditional models like PMMM (Kerzner, 2002). However, the Business Process Management Maturity (BPMM) model offers a more holistic framework for

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managing project operations in dynamic environments (Dijkman et al., 2016). As projects are temporary organisations requiring coordination across multiple disciplines, models that focus on isolated process efficiencies, such as BPMM, are deemed more appropriate (de Bruin & Rosemann, 2007). The BPMM framework identifies five stages of maturity ((OMG), 2008), ranging from ad-hoc workflows to structured, continuous improvement, at which point the organisation should be capable of handling disruptions through a systematic approach. BPMM is employed in this study as it aligns with the development of resilience, which necessitates the integration of governance structures, process adaptability, and knowledge management (Ongena & Ravesteyn, 2020; Ravesteyn et al., 2012). By definition, processes at higher maturity levels facilitate quicker recovery from disruptions (Kraus et al., 2023). However, while governance structures contribute to resilience, a rigid framework may hinder agility in fast-evolving environments (Marincean, 2024). Therefore, this study examines the balance between structured governance and the flexibility of project maturity to enhance resilience and improve project success (Sincorá et al., 2023; Pisano, 2017).

Traditionally, PSUC has been measured in terms of adherence to cost, schedule, and scope (Munns & Bjeirmi, 1996). However, recent research indicates that PSUC now encompasses factors beyond the iron triangle, such as long-term business impact (Joslin & Müller, 2016), stakeholder satisfaction, and strategic alignment (Pinto, 2014). Success criteria in high-reliability industries, such as oil and gas, also include safety performance, environmental sustainability, and compliance with regulatory frameworks (Das & Khanapuri, 2019; Irfan & Hassan, 2017). Effective execution, particularly in capital-intensive projects, relies on robust front-end planning, governance structures, and dynamic managerial capabilities (Budiman et al., 2023). While the literature underscores the expanded scope of success measures, gaps remain in understanding how resilience contributes to long-term project success, beyond immediate performance metrics (Yang & Cheng, 2020). Drawing upon the expanded PSUC dimensions established by Irfan, (Irfan et al., 2019), which include efficiency, quality, stakeholder satisfaction, and sustainability, this study seeks to address these gaps.

Hypotheses Development

(Kleindorfer & Saad, 2005) stressed that effective risk identification, assessment, and mitigation rely on collaborative information sharing, with data analytics crucial in detecting threats and disruptions. As a core organisational capability, data analytics enhances performance through value, rarity, and inimitability. Digital transformation is now vital for building resilience (Zhang et al., 2023), with DACP offering tools and processes for data processing, visualisation, and informed decision-making (Srinivasan & Swink, 2018). In supply chains, data-driven visibility boosts resilience (Jüttner & Maklan, 2011), while (Brandon-Jones et al., 2014) found analytics-based information sharing reduces disruption risk and impact. (Dubey et al., 2021) also confirmed that big

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data analytics enhances resilience and agility. Similarly, (Rezaei et al., 2022) identified a positive link between DACP and supply chain resilience. Based on these insights, this study proposes the following hypothesis:

H1: *DACP has a significant positive impact on PRES.*

PMM functions as a dynamic capability, enabling projects to adjust, integrate, and reallocate resources in response to disruptions (Amit & Zott, 2015). It enhances process efficiency, risk management, and stakeholder engagement, thereby strengthening organisational resilience (vom Brocke et al., 2016). High PMM levels are linked to greater resistance to variation, as mature organisations are better equipped to manage complexity and uncertainty (Alvarenga et al., 2022; Belhadi et al., 2024). In oil and gas, operations remained stable during 2020–2022 due to robust engineering management systems (Ruzhnikov & Prasetyo, 2024). Proactive risk mitigation and stakeholder engagement—key PMM elements—further bolster resilience in uncertain contexts (Shafi, 2024). While some argue PMM may reduce agility in dynamic settings (Marincean, 2024), a balanced governance-flexibility mix ensures effective project response and adaptability (Sincorá et al., 2023; Amit & Zott, 2015). Based on this strong empirical support, this study proposes:

H2: *PMMM has a significant positive impact on PRES.*

HROs rely on project resilience for success, particularly when teams are able to identify changes, plan responses, manage risks, and adapt accordingly. Resilient teams are capable of quickly recovering from stress, regenerating swiftly to maintain high performance and capitalising on emerging opportunities (Vogus & Sutcliffe, 2003). The positive impact of resilience has been studied in large-scale construction projects (Yang & Cheng, 2020) and supply chain management, where resilience strategies have been shown to enhance performance and reduce disruptions (Badkoubeh & Ghannadpour, 2024; Kang & Stephens, 2022). Although resilience proves beneficial, it is a challenging concept to implement effectively. However, an overemphasis on survival mechanisms can undermine long-term growth (Amit & Zott, 2015). In the context of megaprojects, resilience strategies have at times led to inefficiencies that delayed completion (Liu et al., 2024). Additionally, overly rigid resilience plans may hinder an organisation's ability to adapt and respond promptly as conditions evolve (Sikder & Harvey, 2023). The way in which a project team learns to balance resilience with efficiency is crucial, ensuring that projects not only withstand disruptions but also pursue broader strategic objectives. With this in mind, this study proposes:

H3: *PRES has a significant positive impact on PSUC.*

The relationship between DACP, PMMM, and PSUC is mediated by PRES in HROs, particularly in the oil and gas sector. While DACP and PMMM enhance performance,

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their effects are often indirect, with resilience enabling projects to navigate uncertainty and achieve success. Mediation analysis shows that capabilities like data analytics and maturity improve outcomes primarily through resilience, which mitigates disruptions. Resilience has been empirically validated as a key mediator—e.g., in supply chains (Kang & Stephens, 2022), large construction projects (Yang & Cheng, 2020), and megaprojects (Wang & Zhao, 2024). Dubey et al., (2021) found data analytics yield competitive advantage via resilience, while (Sincorá et al., 2023) reported PMMM influences success through resilience. The lower effect size supports (de Bruin & Rosemann, 2007) model in regulated industries, where maturity may hinder agility, aligning with (Dijkman et al., 2016) call for a holistic process view. Based on this evidence, this study suggests:

H4: *PRES works as a mediator between DACP and PSUC.*
H5: *PRES mediates the relationship between PMMM and PSUC.*

RESEARCH METHODOLOGY

This study employs a survey-based methodology, using a 5-point Likert scale to assess DACP, PMMM, PRES, and PSUC. The questionnaire items are adapted from established sources to ensure validity and reliability, with modifications made to ensure alignment with the oil and gas industry context. Three industry professionals reviewed the instrument, leading to refinements in wording and enhancing its relevance to the industry. A pre-test involving 10 experienced project managers confirmed the instrument's effectiveness in measuring resilience and project success within oil and gas projects. The sources of constructs and items are presented in Table 1.

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Table 1: Source of Measurements and Items

Construct	Dimension	Subdimension	Indicators/ Items
Project Resilience (PRES) (Rahi & Bourgault, 2022)	Awareness (AWRN)	Use of skills (SKLE)	I continuously use my expertise to identify project risks (RES1) I continuously use my expertise to assess project risks (RES2) The team members work in collaboration with other team members to remain alert to disruptive events (RES3)
		Alertness of performance deviations (APLD)	Project management methods and artefacts (project plan, issue log, dispute logs, incident investigations) are employed to capture all project requirement and avoid possible disruption events (RES4) Risk management methods (risk register, risk classification matrix, monte Carlo, etc.) are used to avoid possible disruption events (RES5) Project financial KPIs (cost, revenue, profitability) and schedule KPIs are continuously monitored to detect any deviation throughout the project (RES6)
		Sensitivity to organizational changes (SOCH)	Internal organizational changes (new PM process, update in methods, etc.) that may impact the project are clearly communicated to avoid possible disruptive events (RES7) When needed, resources within the organization are accessible to help identify project weaknesses (RES8) When needed, resources within the organization are accessible to help assess the project weaknesses (RES9)
		Efficiency of external resources (EXRS)	New partnership with external parties that have field-specific knowledge are continuously developed (RES10) Existing partnerships with external parties are continuously strengthened (RES11) Access to external resources through partnerships help to identify and assess project weaknesses (RES12)
	Adaptive Capacity (ADPT)	Accessibility and mobilization of resources (MOBR)	When needed, resources can be mobilized from different departments in the company and third-party companies to face disruptive events (RES13) Information systems are available to log disruptive events (RES14) Involved parties (departments and third parties) can access and provide feedback on possible solutions to face disruptive events through digital tools such as websites, emails or industry-specific software (RES15)
		Responsiveness of team members	I tend to adopt creative solutions to face disruptive events (RES16) I am encouraged to think outside the box to find solutions to face disruptive events (RES17)

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		(RSPV)	I have the expertise to deal with disruptive events (RES18)
		Effectiveness of communications and relationships (COMM)	Clear explanations of issues and possible solutions are provided to all stakeholders through transparent communications (RES19) Stakeholders including the client, are encouraged to take ownership of issues and possible solutions (RES20) Stakeholders are involved through continuous follow-ups (regular meetings, status calls, etc.) to ensure proper management of disruptive events (RES21)
		Adapted and responsible decision-making (DCMK)	Project sponsors or senior managers plot a course of action to face disruptive events (RES22) Project sponsors or senior managers ensure actions are implemented in the right way and at the right time to effectively face disruptive events (RES23) Project sponsors or senior managers adapt their strategies to face disruptive events based on the project's importance to the organization (RES24)
Data Analytics Capability (DACP) (Akter et al., 2016; Dubey et al., 2021)			We use advanced tools and analytical techniques (simulation, optimization, regression, etc.) to take decisions (DAC1) We use information extracted from various sources of data to take decisions (DAC2) We use data visualization techniques (dashboard, etc.) to assist users or decision makers in understanding complex information (DAC3) We have connected dashboard applications or information with the manager's communication devices (DAC4) In our organization there are personnel capable of teaching others about data analytics (DAC5)
Project Management Maturity (PMMM) (Dijkman et al., 2016; Sincorá et al., 2023)	Managed (MNGD)		At the beginning of the project, we make agreements about which methods and methodology we will use (PMM1) If we make agreements about work methods, they will be documented such that they can be executed in the same way at another time (PMM2) We use planning and management procedures to control our individual projects (PMM3)
	Standardized (STDD)		Procedures are standardized for the project (PMM4) Work procedures and objectives are well documented in our project (PMM5) Processes are defined such that they will be in the same way by different work groups (PMM6)
	Predictable (PDCT)		Processes and tasks are managed in such a way that they meet agreed-upon performance and quality goals (PMM7)

			If processes do not perform according to predefined standards, they are corrected to meet the quantitative goals (PMM8)
	Innovating (INVT)		Our project understands its critical business issues and areas of concern by using feedback from performance measurements (PMM9) Our project sets quantitative improvement goals to constantly reorganize processes when perceived necessary (PMM10) We constantly pilot new ideas and new technologies to improve our processes (PMM11)
Project Success (PSUC) (Irfan et al., 2019)	Project Efficiency (PEFF)		Project scope is finished on time (PS1) Project scope finished within approved budget (PS2) Project complies with environmental regulations (PS3) Project meets safety standards (PS4)
	Organizational Benefits (ORBF)		The organization learns to improve its project management practices from this project (PS5) Project shows compliance to defined procedures (PS6) The project helps the organization in gaining knowledge about the customer, in the technical domain as well as non-technical domain (commercial, legal, supply chain, etc.) (PS7)
	Project Impact (IMPC)		Projects have impact on the customer that are visible (early production, reduced emissions, record-breaking performance, novel implementation) (PS8) Projects have impact on the performing organization that are visible (additional revenue, profit, competitive advantage from patents, technology, competency) (PS9) Organization ensures that the customer is satisfied with the project (PS10)
	Future Potential (FUTR)		The project enables other potential similar project work in the future (PS11) The project enables expansion of work (larger scope, diversification) in the future (PS12) The project brings improvement and learning in organizational capability (new market, new competency acquired, etc.) (PS13)
	Stakeholders Satisfaction (SSAT)		The customer is satisfied with the project results (PS14) During the course of the project, I experienced professional growth, my skills were enhanced due to project demands (PS15) The project has good reputation in the eyes of the project sponsor within the organization (PS16)

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Data were collected over four months (1 August–21 December 2024) using purposive and convenience sampling to ensure participant eligibility. Respondents were recruited via project management communities, industry networks, and direct outreach, with snowball sampling used to expand the pool while maintaining relevance. The survey targeted professionals with a minimum of five years' experience in well construction projects during the 2020–2022 global disruption, aligning with prior studies (Bredillet et al., 2015; Ramazani & Jergeas, 2015). A pilot test with 30 respondents assessed instrument clarity. Additionally, TR leaders pursued three aims: (1) to analyse outcome statistics; (2) to survey participants; and (3) to conduct stakeholder interviews. The sample exceeded G*Power's minimum threshold (Faul et al., 2009), ensuring sufficient statistical power for SEM (Kono & Sato, 2023).

The final dataset comprises participants from various roles, experience levels, and organisations, operating in different geographical areas. The largest group was represented by project managers, constituting 60.59%, followed by functional managers at 17.65%, portfolio and programme managers at 11.18%, and operational leadership roles at 10.58%. Participants had varying levels of experience: 55.29% had between 5 and 10 years of experience, 35.88% had 10 to 15 years, and 8.82% had over 15 years. In terms of organisational affiliation, 80.59% were employed by service providers, 15.88% by oil and gas operators, and 3.53% by rig contractors. The respondents were geographically distributed across Africa (7.65%), Asia and Australia (16.47%), Europe (14.12%), the Middle East (33.53%), North America (7.65%), and South America (20.58%), representing a diverse range of industry sectors and global regions.

To assess the proposed model involving multiple latent constructs, this study employed a variance-based SEM approach, specifically PLS-SEM (Kono & Sato, 2023). PLS-SEM was chosen for predictive research using complex models, non-normal data, and small to intermediate sample sizes (Kono & Sato, 2023). The measurement model was tested for construct reliability and validity, then the structural model was tested to test hypotheses. Path significance was determined using bootstrapping with 10,000 resamples, which enhances the stability of standard errors and the accuracy of confidence intervals. The model's explanatory and predictive power was evaluated using R^2 and Q^2 values, ensuring that the variance in dependent constructs was adequately explained. Despite its advantages, such as robustness to non-normality and suitability for exploratory research, PLS-SEM has limitations—namely, its tendency to overestimate path coefficients and the absence of traditional goodness-of-fit indices, limiting its use for strict confirmatory factor analysis (Kono & Sato, 2023). Nonetheless, given the study's focus on theory development and prediction, PLS-SEM was deemed appropriate for analysing complex interrelationships and guiding interpretation of the findings.

DATA ANALYSIS AND RESULTS

Measurement Model

The evaluation of the measurement model adhered to the PLS-SEM guidelines, focusing on indicator reliability, convergent validity, and discriminant validity, in accordance with established recommendations (Henseler et al., 2009; Kono & Sato, 2023). Reliability was assessed using both Cronbach's alpha and composite reliability (ρc), with the latter preferred due to its consideration of varying indicator loadings. Nonetheless, Cronbach's alpha was reported for completeness. Indicator reliability was examined through outer loadings, with items exhibiting loadings below 0.6 removed to improve construct validity (Henseler et al., 2009). Specifically, item DAC2 was excluded due to its low loading, which led to an improvement in the Average Variance Extracted (AVE), surpassing the recommended 0.5 threshold (Fornell & Larcker, 1981). Initially, several constructs demonstrated AVE values below 0.5, indicating insufficient convergent validity. Following the removal of DAC2, AVE values improved across constructs; however, Project Efficiency (PEFF) and SSAT remained marginally below the threshold, with AVE values of 0.482 and 0.492, respectively.

Table 2: First-Order Reliability and Convergent Validity

Construct	Alpha	CR	AVE
ALPD	0.664	0.815	0.596
COMM	0.584	0.780	0.543
DACP	0.715	0.824	0.540
DCMK	0.828	0.897	0.745
EXRS	0.808	0.887	0.723
FUTR	0.706	0.837	0.631
IMPC	0.552	0.769	0.527
INVT	0.711	0.838	0.633
MNGD	0.713	0.838	0.633
MOBR	0.523	0.750	0.506
ORBF	0.578	0.779	0.544
PDCT	0.448	0.783	0.644
PEFF	0.639	0.781	0.482
RSPV	0.612	0.787	0.554
SKLE	0.590	0.779	0.540
SOCH	0.668	0.818	0.599
SSAT	0.501	0.742	0.492
STDD	0.507	0.756	0.513

Although PEFF and SSAT recorded AVE values slightly below the 0.5 threshold, they were retained due to their strong theoretical underpinnings. (Cheung et al., 2024) demonstrated that an AVE marginally below 0.5 does not necessarily invalidate convergent validity. In their study, a construct with an AVE of 0.4819 was retained, as the deviation from the 0.5 threshold was not statistically significant ($p < 0.05$). This

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aligns with the rationale in the present study to retain PEFF (0.482) and SSAT (0.492), as their AVE values remain within an acceptable margin to uphold the theoretical integrity of the measurement model. PEFF encompasses essential dimensions such as timeliness, adherence to budget, and compliance with safety and environmental regulations. SSAT, meanwhile, captures aspects of project manager development and internal organisational reputation—both of which are critical to key stakeholders (Irfan et al., 2019). The removal of indicators such as PS3 (safety), PS4 (environment), PS14 (customer satisfaction), or PS15 (project manager development) would eliminate elements that reflect broader dimensions of project success beyond traditional metrics (Müller & Turner, 2007). Given their conceptual relevance and only marginal deviation from the AVE threshold, both PEFF and SSAT were retained to preserve measurement rigour (Cheung et al., 2024). Table 2 presents the evaluation of the first-order measurement model.

The second-order model assessment (Table 3) examined PMMM and PSUC as higher-order constructs, while also validating the dimensions of PRES, namely Awareness (AWRN) and Adaptability (ADPT). While all constructs demonstrated satisfactory composite reliability ($\rho c > 0.70$), AWRN's AVE was slightly below the 0.50 benchmark at 0.490, indicating limited convergent validity. However, as PRES consists of only two dimensions, the exclusion of AWRN would undermine the conceptual framework of the construct. Consequently, the study proceeded with the formative higher-order model evaluation. It is not uncommon for several to be statistically non-significant in formative models with numerous indicators. Nevertheless, provided there is strong theoretical justification for their inclusion, such indicators should be retained. This approach was followed to ensure conceptual comprehensiveness and validity. The HTMT values indicated discriminant validity, as all values remained below the conservative threshold, confirming that the constructs were empirically distinct. Based on these findings, the study progresses to the evaluation of the formative higher-order model to further assess construct validity.

Table 3: Second-Order Reliability and Convergent Validity

Construct	Alpha	CR	AVE
ADPT	0.700	0.815	0.524
AWRN	0.652	0.793	**0.490**
DACP	0.715	0.824	0.540
PMMM	0.752	0.844	0.575
PSUC	0.742	0.830	0.500

Validating Higher-Order Construct (PRES)

The third-order measurement model was evaluated by assessing multicollinearity (VIF), model fit, explanatory power (R^2), and predictive relevance (Q^2_predict). As shown in

Table 4, all VIF values were below 5.0, confirming no collinearity and that each indicator uniquely contributed to its construct. Model fit analysis in Table 5 revealed an SRMR value of 0.077 for the saturated model, which is within the acceptable threshold of 0.08 (Henseler, 2018). Although the estimated model SRMR was slightly higher at 0.103, it remains acceptable for PLS-SEM models, which prioritise predictive accuracy over absolute fit. (Cheung et al., 2024) emphasise that SRMR should not be seen as a strict cut-off, and model fit must be assessed in context. Given that PLS-SEM focuses on predictive accuracy, the SRMR value slightly above 0.08 is within an acceptable range, supporting their argument that fit indices should be evaluated holistically. Additional indices, including d_ULS (0.736) and d_G (0.208), further validated the model's specification, allowing for the transition to structural model analysis.

Table 4: Variance Inflation Factor (VIF)

Construct	VIF
ADPT	1.589
AWRN	1.589

Table 5: Model Fit

Metric	Saturated Model	Estimated Model
SRMR	0.077	0.103
d_ULS	0.718	1.261
d_G	0.216	0.245

Further validation of the third-order model was obtained through explanatory power (R^2) and predictive relevance (Q^2_predict). The R^2 values for PRES (0.329) and PSUC (0.250) in Table 6 indicate moderate explanatory power, suggesting that the model accounts for a reasonable proportion of the variance in these constructs.

Table 6: Explanatory Power (*R^2*)

Construct	R^2
PRES	0.329
PSUC	0.250

Moreover, predictive relevance was assessed using PLSpredict analysis (Table 7), which confirmed that PRES (Q^2_predict = 0.161) and PSUC (Q^2_predict = 0.150) have positive values exceeding the Q^2_predict > 0 threshold. While PSUC shows slightly weaker predictive power than PRES, the model still outperforms a naïve mean-based prediction. As the model meets the necessary criteria, the study proceeds with bootstrapping for hypothesis testing and structural model evaluation.

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Table 7: Predictive Relevance (Q^2)

Construct	Q^2
PRES	0.161
PSUC	0.150

Structural Model

The structural model was assessed by testing the direct effects of DACP and PMMM on PRES and evaluating how PRES influences PSUC. As shown in Table 8, all hypothesised relationships were statistically significant ($p < 0.001$), supporting the study's theoretical framework. The results reveal that DACP positively affects PRES ($\beta = 0.343$, $t = 4.086$, $p = 0.000$), indicating that stronger data analytics capabilities help teams access information, make informed decisions, and adapt more effectively to disruptions. Likewise, PMMM significantly impacts PRES ($\beta = 0.295$, $t = 3.064$, $p = 0.002$), although with a slightly lower effect size, highlighting that structured project management practices improve resilience by establishing governance, standardising processes, and fostering adaptive capabilities to manage complex projects in uncertain environments.

Table 8: Direct Relationships

Hypotheses	B	T	P
H1: DACP PRES	0.343	4.086	0.000
H2: PMMM PRES	0.295	3.064	0.002
H3: PRES PSUC	0.500	6.479	0.000

Additionally, PRES is found to have a strong direct influence on PSUC ($\beta = 0.500$, $t = 6.479$, $p = 0.000$), emphasising resilience as a key determinant of project success. This finding aligns with the concept that resilient teams thrive in uncertainty by effectively managing risks and adapting. A strong path coefficient suggests that resilience is not merely a defensive mechanism, but a capability that supports project continuity, learning, and long-term competitiveness. These results further reinforce the idea that resilience is a critical characteristic driving effective project execution, particularly in the ultra-high reliability upstream oil and gas sector, where it is underpinned by data analytics capability and project management maturity.

Mediation Analysis

Table 9 first confirms that both indirect effects (PRES as a mediator between DACP, PMMM, and PSUC) were statistically significant. In summary, the findings demonstrate that while DACP indirectly influences PSUC through PRES ($\beta = 0.172$, $t = 3.716$, $p = 0.000$), this confirms that data analytics capability genuinely enhances resilience, with its full impact on project success being realised through resilienceenabled adaptability. Additionally, the analysis reveals that PMMM indirectly affects PSUC through PRES ($\beta = 0.147$, $t = 2.368$, $p = 0.018$), suggesting that structured project management practices contribute to achieving project success by enhancing resilience. Resilience plays a crucial role in bridging the gap between managerial competencies and long-term project performance, as evidenced by the relationship between these two concepts. This highlights the importance of systematically developing resilience to translate strategic capabilities into tangible, measurable success.

Table 9: Mediation Analysis

Hypotheses	B	T	P
H4: DACP → PRES → PSUC	0.172	3.716	0.000
H5: PMMM → PRES → PSUC	0.147	2.368	0.018

In Project Resilience, Analysing Regional Variations: Insights from Multi-Group Analysis (MGA)

Project management research has increasingly focused on geographical factors, as these elements significantly influence both project success rates and operational durability. Factors such as regulatory frameworks, risk culture, industry focus, and technological adoption play crucial roles in shaping resilience strategies and overall project performance (Müller & Turner, 2007). Geographical differences pose unique challenges to project success, including economic fluctuations, workforce shortages, and infrastructure limitations (Zwikael & Ahn, 2011). This study employs Multi-Group Analysis (PLS-MGA) to compare projects in the Middle East & Africa (MENA) with those in the Americas, Asia & Australia, and Europe, aiming to identify how resilience mechanisms align with success factors across regions.

The MENA/Non-MENA classification of regions was based on both statistical evaluation and practical considerations. The Middle East serves as a key location for large Lump Sum Turnkey (LSTK) projects, which are among the highest-risk integration projects due to their fixed-cost systems, multiple stakeholders, and geopolitical uncertainties. MENA respondents represented 41% of the total sample (70 out of 170), making a separate analysis both relevant and statistically robust. Further subdividing the regions would reduce sample sizes, decreasing statistical power and potentially compromising the reliability of the results. Analysis of the MGA results (Table 10) revealed no statistically significant differences between the MENA and Non-MENA groups, suggesting that the structural relationships among constructs are consistent across regions. The most notable variation was observed in the link between DACP and PRES, followed by DACP and PSUC. These findings imply potential regional differences in how data analytics capability and resilience contribute to project success. However, despite some numerical discrepancies, there is no substantial evidence to indicate that regional factors significantly moderate these relationships.

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Table 10: Multi-Group Analysis

Relationships	Difference (MENA – non-MENA)	P
DACP → PRES	0.216	0.220
DACP → PSUC	0.148	0.142
PMMM → PRES	-0.005	0.978
PMMM → PSUC	0.026	0.879
PRES → PSUC	0.101	0.455

DISCUSSION

The findings establish DACP as a crucial driver of PRES, emphasising the vital role of analytics in maintaining operational continuity during disruptions. This supports (Srinivasan & Swink, 2018) definition of DAC as an integrated set of tools, techniques, and processes that enable organisations to collect, organise, and visualise data for informed decision-making. In well construction projects, where subsurface uncertainties, operational challenges, and external disruptions require constant adaptation, data analytics plays a pivotal role in facilitating coordination among engineering, operations, and project management teams, particularly in remote work environments. By aggregating, analysing, and displaying project data (e.g., material consumption, formation characteristics, cost trends) in real-time through simple interactive dashboards, teams have been able to scrutinise information and adopt proactive approaches. This study aligns with Dubey's (2019) research on the impact of data analytics on organisational resilience and supports (Kiron et al., 2014) assertion that technology infrastructure and talent capability are essential. Furthermore, (La Porte & Rochlin, 1994) study of high-reliability organisations is validated, confirming that real-time analytics and visualisation tools strengthen decision-making, enabling teams to foresee issues, adapt strategies, and maintain high performance levels in complex project environments.

PMMM is among the factors that moderately affect PRES, though its influence is less significant than that of DACP. This finding supports (Sincorá et al., 2023) argument that while structured processes enhance resilience, data-driven adaptability plays a more critical role. The Business Process Maturity (BPM) framework was used for assessing overall project management maturity, rather than focusing on specific processes like procurement or communication. This approach aligns with (de Bruin & Rosemann, 2007) assertion that maturity assessment should encompass the entire organisation, not just individual functions. In the upstream oil and gas sector, customer tender requirements often make project maturity a prerequisite, particularly concerning managerial expertise and governance standards. (Dijkman et al., 2016) argument that mature organisations inherently build resilience through structured governance is also supported, which is why the "Initial" maturity stage was excluded from this study. However, the lower effect size suggests that the role of maturity levels in promoting

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resilience is not entirely conclusive. In an industry with deeply embedded governance frameworks, the increase in adherence to the HPCL is marginal.

The relationship between PRES and PSUC was found to be the strongest, reinforcing the notion of resilience not just as a survival mechanism but as a crucial factor in achieving successful project outcomes. This supports (Bhamra et al., 2011) perspective that resilience enables teams to anticipate, recover from, and adapt to change. Additionally, the results contribute to (Rahi & Bourgault, 2022) two-dimensional model, highlighting the importance of situational awareness and adaptive capacity, which aligns with (McManus, 2008) view of operational flexibility as a key aspect of resilience. The study further underscores the importance of Change Management as a means of fostering resilience and strengthens the concept of HROs, which continually adapt while maintaining safety and efficiency. Lastly, consistent with (Boin & Van Eeten, 2013) findings on the flexibility of oil and gas projects in modifying budgets, schedules, and scope to meet revised objectives, the study challenges the traditional project success criteria proposed by (Munns & Bjeirmi, 1996). It supports (Vogus & Sutcliffe, 2003) assertion that resilience enables organisations to sustain performance even amid adverse events.

MGA results confirm that geographical differences do not significantly influence the correlations between PRES, PSUC, and their predictors. The mechanisms for resilience building, supported by DACP and PMMM, are applicable across project-based industries in both MENA and Non-MENA regions. This aligns with (Rahi & Bourgault, 2022), who highlighted the importance of adaptive capability to resilience, even under regional constraints. Findings on PMMM's internal environment in both Brazil (Berssaneti & Carvalho, 2015) and Pakistan (Irfan et al., 2019) support the relationship between project maturity, resilience, and project success across diverse sectors and settings. Despite differences in regional regulatory frameworks, industry practices, and risk culture, resilience remains central to project success. Minor variations in path coefficients were observed, but none were statistically significant, affirming that resilience is a universally recognised capability in project-based industries. Furthermore, mediation analysis confirmed that PRES consistently mediates the relationship between its predictors and project success across both regional groups, reinforcing the role of resilience as a key enabler of project performance globally.

CONCLUSION

This research explored how DACP and PMMM contribute to PRES and, in turn, PSUC in the upstream oil and gas sector. It fills a key gap by redefining resilience as a proactive strategic enabler rather than a reactive survival mechanism. The study confirms that DACP significantly enhances resilience through predictive analytics, scenario planning, and data-driven decision-making, while PMMM plays a foundational role rather than a differentiator. The resilience mechanisms are universally applicable across regions, as shown in the MGA. The study reinforces resilience as a strategic resource within RBT, DCT, and CRT. Combining structured governance and adaptive capability allows projects to not only withstand but sustain long-term performance. The results highlight the importance of real-time decision-making, data utilisation, and structured project management in increasing resilience, essential for organisations to grow, protect against uncertainties, and develop appropriate technology and managerial frameworks. However, the study has limitations. It does not account for economic or regulatory variations between countries that may affect resilience strategies. Leadership style, digital transformation, and organisational agility are other potential enablers, though DACP and PMMM remain crucial in the modern business environment. Future research should explore resilience across different disruptions and expand the model to include variables such as project size and industry segment to gain deeper insights.

DISCLOSURE STATEMENT

The author(s) have no potential conflict of interest to report.

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