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Research paper

Identifying key performance indicators for oil and gas projects in India

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Abstract

The primary goal of every project and management team is to accomplish a successful project outcome. Establishing a baseline for performance measurement is the first step in effective project control and management for achieving success. Despite wide-ranging research in this area, there is still a lack of understanding of project success or performance, especially in practice, due to the context-specific and multi-dimensional nature of the project success. Thus, the paper aims to broaden the understanding of project success and to identify the relevant performance indicators for the Oil and Gas (O&G) infrastructure projects towards success in the context of India. Qualitative research was conducted based on reflective focus group interviews with O&G project practitioners to comprehend their opinions of project performance or success. The findings indicate that the thriving areas of project performance no longer depend solely on traditional key performance indicators (KPIs) like time, cost, scope, or quality, but also on other KPIs such as safety, environment, and business & organization performance. The study is expected to enhance the current knowledge by improving comprehension of project success and identifying key performance indicators for O&G projects in India. The study's managerial implication is to guide project managers and core team members in driving the overall success of O&G projects in India, which goes beyond the conventional view of project success. The findings of the paper can offer valuable insights in general for improving project performance in infrastructure and construction management.

Keywords: *Indian O&G Projects; Key Performance Indicators (KPIs); O&G Project Performance; Project Management; Project Success.*

1. Introduction

In today's world of complex projects, rapid changes, and competition, it's crucial to reassess what constitutes project success [1, 2]. This means going beyond the traditional 'triple constraints' of time, budget, and quality. Success for complex projects, like O&G infrastructure projects may not only depend on the 'triple constraints' but also on other performance parameters i.e., success criteria. In general, infrastructure projects (IPs) are inherently complex whose delivery is disappointing concerning time, cost, and involved stakeholders' satisfaction [3]. The situation is not exceptional in India [4], [5], which "impacts the economic viability and value addition of the IPs defeating the project's overall success" [6]. O&G projects, characterized by their high uncertainty and risks, present some of the most difficult challenges in the business. These projects involve multiple stakeholders, and a large and diverse workforce at various phases of the O&G industry value chain [7]. The contributions of the O&G industry to the global economy are substantial and impact people's lives worldwide. This industry directly connects with other major sectors such as manufacturing, transportation, and petrochemicals [8]. In the context of India, the O&G sector plays a critical role in determining the country's energy security [9] and is closely tied to its economic development. Though, this sector offers significant growth potential in India, frequently suffers underperformance [10].

Effective project management is crucial for achieving project goals. However, many studies primarily focus on a few KPIs such as time, cost, and quality, rather than holistic project performance management [11]. Traditional measures of project success, often based on meeting the 'triple constraint' or "iron triangle", fall short in providing insights for performance improvement and may not meet the expectations of key stakeholders [12], [13]. It's essential to recognize that project success encompasses both immediate project objectives (efficiencies in project management) and the project's long-term goals (project effectiveness) [14]. Furthermore, project success criteria can vary widely depending on project scope, uniqueness, size, and complexity [15]. Stakeholders also interpret project success differently, adding to the complexity [16].

Given the complexity and context-specific nature of project success, it's essential to establish specific performance baselines to adequately manage and measure performance. Identifying appropriate performance areas (as the reference line) for managing the performance of projects is the first step in the effective management of projects [17]. Moreover, consensus on a universal set of project success criteria is unlikely, as suggested by Westerveld [18]. There are many studies on project success or performance in different contexts. However, most of the previous studies have focused on a limited set of performance measurements and have not taken a holistic view of project performance or management, particularly in the O&G industry [19]. Thus, the study's main objective is to identify the KPIs for O&G projects from a holistic perspective of the project success. The scope of the study is limited to the project implementation or execution phase of

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O&G infrastructure or construction projects in India from the perspective of the project management team. Towards this direction, the research conducted an empirical study based on reflective focus group interviews and qualitative analysis.

2. Literature review

Success criteria refer to the principles, standards, or performance parameters used to measure the success of a project. These criteria are influenced by various stakeholders' perceptions and the project's unique characteristics [20]. Project success is a complex concept that encompasses both the project's short-term management efficiency and the long-term attainment of desired outcomes, such as effectiveness and impact [14]. The elements of the "iron triangle": cost, time, and scope/quality [21] are still considered to be dominant in measuring project success [22 - 24]. However, further studies have established that project success is not only meeting the "iron triangle" but also meeting a project's goal and business performance in both the short and long term [25 - 27], [23], [13], [28]. The satisfaction of project stakeholders has emerged as one of the important measures of project success which mainly focuses on the satisfaction of clients/customers, users, teams, partners, and other stakeholders [29], [13], [30 - 32], [25], [26], [33], [28], [27]. It may be crucial to include sustainability as a key factor in any project alongside the iron triangle [34]. This is especially important in delivering infrastructure projects where the outcomes and methods used can significantly impact the environment and society [35].

Seven critical success criteria were found by Osei-Kyei et al. [36] through a survey which includes "effective risk management, meeting output specifications, reliable and quality service operations, adherence to time, satisfying the need for public facility/service, long-term relationship-partnership, and profitability". Omer [7] evaluated O&G projects using various performance indicators, such as quality, time, cost, health and safety, environment, scope, customer satisfaction, resource efficiency, productivity effectiveness, profitability, achievement of project goals, sustainability, and reliability. Although the construction industry typically assesses project success based on measurable metrics such as cost, schedule, performance, and safety, studies have revealed that intangible factors that are more difficult to quantify can also influence the perception of project success [37]. Similarly, Matoug et al. [38] found that the traditional iron triangle model is no longer applicable to O&G project success in Libya. Instead, they identified other key performance indicators like health and safety, resource utilization, profitability, stakeholder satisfaction, sustainability, maintainability, and reliability. In a recent study by Ingle and Mahesh [39] on Indian construction projects, ten key performance areas were identified, including "customer relations, safety, schedule, cost, quality, productivity, finance, communication and collaboration, environment, and stakeholder satisfaction". The field of project management is increasingly focused on achieving broad business benefits and creating multipurpose value dimensions, as noted by Atkinson [23], Shenhar et al. [28], and Martinsuo and Killen [40]. While evaluating project performance and success, many of these studies did not differentiate between "indicators and criteria" [7]. The performance indicators or success criteria from the literature are summarized in Table 1.

Table 1: Project Performance Indicators or Success Criteria from Literature

Performance/ Success Criteria	References	Definition / Meaning / Details
Time	Al-Tmeemy et al. [41]; Agarwal and Rathod 2006 [22]; Atkinson [23]; Turner and Cochrane [21]	Project completion within/below the scheduled plan
Cost	Al-Tmeemy et al. [41]; Agarwal and Rathod 2006 [22]; Atkinson [23]; Turner and Cochrane [21]	Project completion on/below budget plan
Scope	Bryde, 2008; Agarwal and Rathod [22]; Atkinson [23]	Project completion with scope /clarity/change management/compliance-related
Quality	Al-Tmeemy et al. [41]; Agarwal and Rathod, 2006 [22]; Atkinson [23]; Turner and Cochrane [21]	Meeting specifications and standards of product and project processes
Client/customer satisfaction	Müller and Turner [25]; Papke-Shields et al. [26]; Milosevic and Patankul [32]; Thomas and Fernández [26]; Shenhar et al. [27]; Lim and Mohammad [30]	Satisfaction of process/ product service/use by client or customer
Business and organizational benefits	Martinsuo and Killen [41]; Müller and Turner [24]; Papke-Shields et al. [25]; Milosevic and Patankul [32]; Thomas and Fernández [27]; Shenhar et al. [28]	Project goal/contribution or increase in profits or market share/organizational competency or project learnings/new market or technology
Sustainability	Silvius and Schipper [42]; Kivilä et. al [43]; Ebbesen and Hope [34]	Social/environmental/economic aspects
Safety	Hughes et al. [37]; Matoug et al. [38]; Ingle and Mahesh [39]; Omer [7]	Compliance or level of safety/no of accidents
Resource utilization/productivity	Matoug et al. [38]; Omer [7]; Ingle and Mahesh [39]	Efficient utilization of resources to avoid waste/increase productivity
Product maintainability/reliability	Matoug et al. [38]	Product quality/sustainability

There is a change in the project success definition (see Figure 1) in the literature from sole focus on the iron triangle to sustainability and impacts of the project [42], [43].

However, project success is not a one-size-fits-all concept; instead, it is multidimensional, shaped by each project's unique characteristics (size/complexity, etc.) and the diverse viewpoints of individuals and stakeholders involved. Additionally, the industry and context in which a project operates can also influence how success is perceived and measured [44].



Fig. 1: Change in Definition of Project Success or Performance.

2.1. Challenges and performance of O&G projects

The O&G industry is one of the most critical and complex sectors globally. It holds immense global significance, economic importance, and environmental sensitivity, which subjects it to various pressures from stakeholders, thus increasing its complexity [45]. As a vital industry, it plays a substantial role in the overall development of a nation [8]. However, it faces persistent challenges such as cost overruns and schedule delays, significantly impacting project efficiency [46]. The O&G sector generally can be broadly divided into three key segments, namely upstream, which focuses on exploration and production activities [47] for the generation of oil and gas; midstream, which encompasses the transportation, storage, and marketing of raw products; while the downstream sector involves refining, gas processing, petrochemicals, and the distribution of by-products [48].

These projects exhibit unique characteristics, including high-technology involvement, the production of made-to-order products, challenges posed by remote locations, communication and logistical complexities, the involvement of multiple subprojects, and consequently, integration challenges [49, 50]. Environmental and social impacts are also significant factors to consider [49]. Despite the three segmentations, it's important to note that construction projects within the O&G industry often span the entire spectrum of its operations. Construction projects in the O&G industry (mainly in down and mid-stream) include building refineries, petrochemical plants, gas treatment facilities, retail outlets, and pipelines whereas other O&G projects for example involve retail outlet automation and refinery maintenance. Globally, the oil demand is expected to focus more on transport and refined products rather than generation, as reported by the International Energy Agency (IEA) [51].

In addition, the IEA [52] predicts a higher increase in demand for oil in India at 57%, in comparison to China (42%) and the Middle East (26%) from 2013 to 2025, while a decreased demand is expected in OECD (Organization for Economic Co-operation and Development) countries. The O&G sector as one of the critical energy sectors [9] is deeply linked with the economic development in India. The sector exhibits substantial growth potential in India [10]. Historically, the Government of India and select government enterprises primarily regulated the industry. However, with liberalization and privatization, both domestic and foreign private entities have entered the market, creating a highly competitive environment [9]. According to an industrial study by PMI [10], the increasing energy demand in India due to speedy economic development, urbanization and industrial expansion will be met to a significant extent by the O&G sector. The situation makes it imperative for Indian O&G sector companies to adopt the best project management practices or measures to enhance performance.

3. Research methodology

The purpose of this study was to determine the key performance indicators necessary for efficiently managing the success of O&G projects in India. Qualitative research methodology was adopted, focusing on the views and experiences of organizational members (viz., project team members) instead of numerical data. The investigation was carried out based on reflective focus group discussions and qualitative analysis.

3.1. Research design and data collection

A qualitative study was conducted to ensure that the viewpoints of project managers and team members were not influenced by any predetermined theories. This study aimed to explore their perceptions of project realities, as they are the responsible ones during project implementation [53]. It is important to consider them as knowledgeable agents and listen to their views without bias or assumptions [54]. In qualitative studies, interviews can occur with either an individual/s or in a group setting, known as a focus group, where the individuals are interviewed together which encourages flexibility and exploration through open-ended discussion. During the focus group interview, the interactions between participants are emphasized, rather than between the interviewees and interviewer (i.e., the researcher/s), who mediate/s to facilitate the group discussion, in this case. Thus, the researcher/s can guide the group discussion by taking a less active role and reducing researcher bias compared to individual interviews [55]. Researchers use focus groups to collect data by analyzing group interactions on particular topic/s relevant to both the group and the researcher [56], [57].

Two focus groups were formed consisting of project professionals experienced in downstream O&G infrastructure and construction projects such as refinery, LPG plant, retail outlet/automation, petro-storage, pipeline and refinery maintenance projects in India. One group consisted of six middle/higher level practitioners with ten or more years of experience, while the other group had ten practitioners with more than five years (but less than ten) of experience, for the possible variation. Further, focus group interviews were not being conducted as saturation and repetition were observed in collected data with two focus groups of a total of sixteen participants [58]. The participants (engaged in projects as mentioned above) with various designations such as Dy. General manager (procurement), Sr. manager (refinery/petro-storage/LPG plant, construction), manager (retail-outlet), manager (petroleum), Sr. engineer (pipeline), project manager (refinery/maintenance), and Chief general manager (O&G) were selected using convenience and purposive sampling. This resulted in a representative sample with diverse expertise and experience.

The questions during the focus group interviews were designed to be indirect and broad in their approach [59], as the aim was to gain a better understanding of the actual situation, instead of relying only on common assumptions (of time and cost performance or triangle approach performance of project) regarding the focus areas of desired project success or performance and or performance or success to achieve for the project. Additionally, this approach helped to establish a stronger foundation of theoretical insights and mitigate biases [60].

4. Analysis and findings

The transcribed materials or data obtained from the two focus group interactions were analyzed using an open coding grounded approach with strict adherence to the raw data and iterations with relevant literature [61]. This approach i.e., the 'Gioia method' was adopted due to its capacity to analyze the lived experiences of interview participants [62] as well as due to its suitability for presenting findings, rooted in empirical evidence [61].

According to the general guideline [61] the analytical process was structured in two steps. In step 1, first-order (informant-centered) concepts were formulated, encapsulating the participants' perceptions of the project's performance or success to achieve. In step 2, visible patterns, similarities and divergences among the first-order concepts were identified, leading to their categorization into second-order themes based on existing literature. These iterative steps continued in a few cycles supported by extant theoretical frameworks (i.e., literature). These second-order themes were subsequently aggregated into overarching or collective dimensions (i.e., project performance indicators). Once these foundational elements first-order concepts, second-order themes, and aggregate dimensions—were outlined, they served as the framework for constructing the data structure. (Refer to Figure 2). This visual representation explains the path from the raw data or narratives of participants to key findings, supporting the methodological rigor of the qualitative inquiry [61].

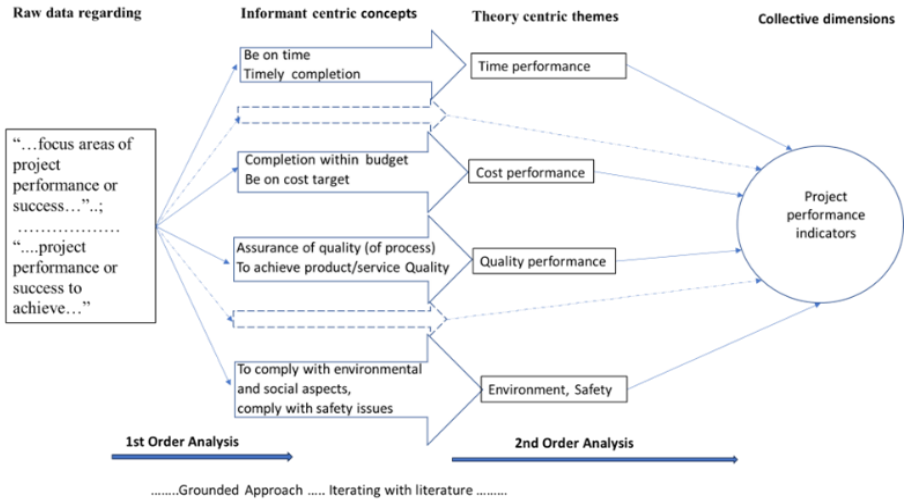


Fig. 2: "Data Structure" [61] - Focus Group Analysis (Examples).

The project KPIs towards the success of O&G projects in India have been identified from focus group interviews and analysis. Empirical evidence revealed a comprehensive perspective on project performance, encompassing time, cost, scope, quality, safety, environmental impact, and business and organizational benefits. Some illustrative quotes on the perceptions of the project participants (during focus group interviews) regarding project performance or success (criteria) and or challenges areas against success are given below.

"Meeting the quality, safety, and environmental standards is crucial for the success of …. any project, especially in the case of O&G projects with strict energy sector policies and regulations" (Project manager, refinery maintenance).

"Business and organizational performance and benefits…learnings from projects are essential for project's success…. not only for current projects but also for future projects…." (Chief general manager, O&G).

"Quality dissatisfaction is a common problem in O&G projects, in addition to time and cost overruns….it is essential to control [quality, time and cost] for [project] success" (Manager, retail outlet).

"Scope changes, quality issues/dissatisfaction and environmental pollution or impact caused by construction activities are common challenges [against project performance of scope, quality, environment-safety] faced during the execution of O&G projects" (Sr. engineer, pipeline).

"… it is crucial to implement strict control measures to ensure compliance with schedule, budget, safety, environmental, and workmanship standards [quality] […] important for [project] performance" (Sr. manager, refinery/petro-storage construction).

During focus group interactions, project managers and team members identified the KPIs, associated with the focus areas concerning project performance or success. This is demonstrated by some examples in Table 2 for scope, environment-safety and business-organizational benefits.

Table 2: Perceptions of Project Participants (During Focus Group Interviews) About Project Performance Focus Areas (Examples)

Empirical evidence	Empirical findings
Focus areas concerning project performance or success	Identified project performance indicators (success criteria)
• To comply with the scope, • Scope/change issues management	Scope
• To comply with environmental management/impact, • social aspects (affected/opposition/compensation etc. regarding people in the surrounding environment), • Safety issues	Environment -safety
• To close the gap between business and project • To achieve the project goal • To achieve business goals, corporate rating • Time to market, profit/market share • Management of project portfolio, • Project learnings	Business - organizational benefits

Thus, the empirical results based on focus group interviews of project professionals, identified the project KPIs under the performance parameters i.e., time, cost, quality, scope, environment & safety and business-organization benefits towards the overall success of O&G projects in India. While client/customer satisfaction is a recognized performance indicator in the literature, it did not emerge as a focal point during the focus group discussions. It became apparent later when Dy. general manager (procurement) shared "…. client/customer satisfaction automatically would be in place when a project performs well in other performance areas like time, cost, quality, scope, business and safety ...". Another observation was related to the concept of sustainability. While it featured in the literature, the term "environment-safety" took precedence during the focus group discussions.

Following the focus group interviews, analysis, and results, a confirmability check [63] was conducted through extensive discussions with some highly experienced senior-level management personnel from the Indian O&G industry, along with prominent academicians associated with the O&G sector. This assessment aimed to validate the research findings and incorporate any additional insights (especially further probing on 'sustainability' and 'client satisfaction' performance indicators or any new ones) Preliminary findings were also shared with the participants for member check [63] in informal discussions and interactions on multiple occasions to confirm the accuracy of the results, thereby establishing internal validity. The study adhered to rigorous qualitative research standards, including analysis protocols, as well as evidence-based data, to ensure external validity. Reliability was maintained through the consistent use of standardized protocols for interview schedules for focus groups, data collection, and analysis [63].

5. Discussion and conclusion

Apart from global significance, the O&G sector specifically in the Indian context is vital for energy security and economic development, with considerable growth potential. The success of O&G projects is challenging because of their high complexity and associated risks, involving multiple stakeholders and a diverse workforce. This is evident from the ongoing underperformance of O&G infrastructure projects, in particular in the Indian context. Project success not only goes beyond traditional metrics like time, cost, and quality but also may vary due to project differences, industry and diverse stakeholder interpretations. To address these challenges, there's a need for the establishment of specific performance benchmarks. Thus, the objective of this study was to identify the key performance indicators (KPIs) of O&G projects in the context of India. In that direction, an empirical study was conducted through a qualitative analysis based on the focus group interviews with experienced O&G project practitioners, mainly for the mid and downstream sectors in India. The findings of the study reveal that not only the traditional iron triangle (quality, scope, time, and cost) but, also other performance parameters of the project during its execution such as safety, environment, business benefits, and organizational learnings are important for the successful implementation of the project. While client/customer satisfaction is a recognized performance indicator in the literature, it did not emerge as a focal point during the focus group discussions. This absence does not necessarily diminish its importance; rather, it became apparent later that when a project excels in other performance parameters/indicators, client/customer satisfaction naturally follows. Another noteworthy observation was related to the concept of sustainability. While it featured in the literature, the term "environment-safety" took precedence during the focus group discussions. This preference likely stemmed from the project team's direct involvement with environmental and safety aspects, making these concerns more immediate and tangible within the project's internal environment during execution, as opposed to the broader and more encompassing term "sustainability," which also includes economic and social aspects. However, the O&G project team or professional must consider a specific focus on the sustainability and client satisfaction performance parameters during the execution phase to evaluate their project's success following emerging as well as global trends. Accordingly, specific strategies and approaches are to be devised by them.

The study is expected to contribute to the existing body of knowledge by developing a full view of project performance or success in general and particularly, identifying the project KPIs from the perspective of O&G projects in India with broader aspects of the project performance based on empirical evidence. The main implication of the study for the project management team/managers is understanding the importance of the holistic approach to project performance or success which would guide them to shift their focus from only the iron triangle to a compressive view of project performance. Accordingly, the project team can formulate the appropriate strategies for achieving better performance during project execution, which may result in higher success of projects. The findings of this study have practical implications for other infrastructure and construction projects in settings similar to O&G projects in India.

The study's focus was limited to the project management team's perceptions of O&G project performance indicators during the execution phase in the Indian context. The study's limitation is also related to the data collection from Indian O&G professionals, experienced in down- and mid-stream projects. However, the professionals involved in the O&G projects were from various locations across India and had diverse roles in the down/mid-stream processes. Although the sample was relatively small, it was analyzed in-depth. The effectiveness of the KPIs identified in this study can be verified or extended through a quantitative study as well as by implementing actual case studies of O&G projects for the future scope of the study.

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