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عنوان البحث

**The Influence of Poor Planning and Scheduling Practices on Project Delays in Pipeline
Construction Projects in the Kingdom of Saudi Arabia**

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Introduction

Oil and gas pipeline construction projects represent some of the most complex and capital-intensive infrastructure developments in the Kingdom of Saudi Arabia (KSA). These projects play a critical role in supporting national energy production, facilitating industrial growth, and enabling the transportation of hydrocarbons to domestic processing facilities and international export terminals. The Kingdom possesses one of the largest oil and gas industries in the world, and its extensive network of pipelines forms the backbone of the national energy supply chain. As a result, the development and expansion of pipeline infrastructure remain essential for sustaining production capacity, supporting downstream industrial activities, and maintaining the reliability of energy transportation systems across the country.

Given the strategic importance of the oil and gas sector to the Saudi economy, the timely and efficient delivery of pipeline infrastructure projects is closely linked to national economic stability, energy security, and long-term development objectives. Delays in pipeline construction projects can therefore have far-reaching consequences that extend beyond individual projects. Schedule overruns may disrupt production planning, delay the commissioning of processing facilities, and increase overall project costs, ultimately affecting the efficiency of the national energy system. Furthermore, large-scale infrastructure delays can undermine investor confidence and reduce the effectiveness of major national development programs aligned with initiatives such as Saudi Vision 2030.

Pipeline construction projects differ significantly from traditional building projects due to their linear and geographically dispersed nature. Unlike vertical construction projects, pipelines extend over long distances and frequently traverse diverse terrain conditions, including desert landscapes, mountainous areas, coastal zones, and densely populated regions. This geographical dispersion introduces unique logistical challenges related to material transportation, workforce deployment, equipment mobilization, and coordination

between multiple construction spreads operating simultaneously along the pipeline route. These operational complexities require careful planning and precise scheduling to ensure that project activities are properly sequenced and coordinated across different locations.

In addition to geographical complexity, pipeline projects typically involve multiple stakeholders, including project owners, engineering consultants, EPC contractors, subcontractors, regulatory authorities, and local communities. Effective coordination among these parties is essential for maintaining project progress and avoiding disruptions to planned work sequences. In many cases, pipeline projects must also comply with environmental regulations, land access agreements, and permitting requirements, which may introduce additional constraints on project schedules if not adequately planned and managed.

Most oil and gas pipeline projects in Saudi Arabia are delivered through Engineering, Procurement, and Construction (EPC) contractual arrangements. Under this project delivery model, engineering design, procurement of materials and equipment, and field construction activities must be closely integrated throughout the project lifecycle. Delays or inefficiencies in one phase can quickly propagate to other phases, creating cascading effects that disrupt project schedules. For example, late engineering deliverables may delay procurement activities, while procurement delays may prevent construction crews from accessing required materials at the planned time. Such disruptions highlight the critical role of integrated planning and scheduling processes in ensuring the smooth execution of pipeline construction projects.

Because of these complexities, effective planning and scheduling represent fundamental project management functions that directly influence project performance. Planning involves defining the project scope, identifying project activities, establishing logical relationships between tasks, estimating durations, allocating resources, and developing a realistic project baseline schedule. Scheduling, on the other hand, provides a framework for monitoring project progress, measuring performance against the established baseline, and identifying deviations that require corrective action. In large-scale infrastructure projects such as pipelines, the accuracy and reliability of the project schedule play a crucial role in

coordinating project resources and ensuring that work progresses in a structured and efficient manner.

Despite the availability of advanced scheduling software tools, including systems such as Primavera P6, and the widespread adoption of internationally recognized project management frameworks promoted by organizations such as Project Management Institute, many large infrastructure projects continue to experience schedule delays. This suggests that the primary challenge does not necessarily lie in the absence of planning tools or formal methodologies, but rather in the effectiveness with which planning and scheduling practices are implemented and managed throughout the project lifecycle.

Extensive research within the construction management literature consistently identifies poor planning and scheduling practices as among the most significant contributors to project delays. Studies conducted across different countries and infrastructure sectors have highlighted deficiencies in scope definition, unrealistic baseline schedules, inadequate resource planning, and weak schedule monitoring as key internal causes of time overruns. These factors often originate from weaknesses in project planning processes, insufficient coordination between project stakeholders, or a lack of integration between engineering, procurement, and construction activities.

Although a significant body of research has examined construction delays in general infrastructure projects, relatively limited empirical research has focused specifically on oil and gas pipeline construction projects in the Saudi Arabian context. Pipeline projects possess distinctive operational characteristics that differentiate them from other forms of construction, including long linear work fronts, complex logistics, and simultaneous multi-location execution. These characteristics may amplify the consequences of planning deficiencies and create unique scheduling challenges that are not fully captured in studies focused on other types of construction projects.

Therefore, there is a clear need for sector-specific research that examines how planning and scheduling practices influence schedule performance in pipeline construction projects within Saudi Arabia. Understanding the relationship between planning deficiencies and project delays is essential for improving project management practices and enhancing the reliability of infrastructure project delivery in the oil and gas sector.

This study aims to address this research gap by empirically examining the influence of poor planning and scheduling practices on schedule delays in oil and gas pipeline construction projects in the Kingdom of Saudi Arabia. Through quantitative analysis of data collected from industry professionals involved in pipeline projects, the research seeks to identify the most critical planning deficiencies affecting project schedules and evaluate their impact on overall schedule performance. By providing empirical evidence and practical insights, the study intends to contribute to the improvement of planning practices and support more efficient delivery of pipeline infrastructure projects within the Kingdom.

Study Problem

Pipeline construction projects in Saudi Arabia are typically executed under complex EPC contractual structures involving multiple stakeholders, including owners, engineering consultants, EPC contractors, and subcontractors. These projects involve long construction corridors, multiple work fronts, and strict completion deadlines.

Despite the use of modern planning tools and sophisticated project control systems, many pipeline projects continue to experience significant schedule delays. Industry reports and project case studies suggest that these delays are often associated with weaknesses in planning and scheduling practices rather than purely external factors.

Common planning-related issues reported in infrastructure projects include inadequate scope definition, unrealistic baseline schedules, ineffective resource planning, poor schedule monitoring, and insufficient integration between engineering, procurement, and construction activities. When these planning processes are poorly implemented, project teams may face inaccurate forecasts, inefficient resource utilization, and delayed decision-making, ultimately leading to time overruns.

Therefore, there is a need for systematic research to identify which planning and scheduling weaknesses most significantly influence schedule delays in pipeline construction projects in Saudi Arabia and to determine the extent to which these practices affect overall project schedule performance.

Importance of the Study

The importance of this study stems from its academic, practical, economic, and strategic contributions to the oil and gas infrastructure sector in Saudi Arabia.

From an academic perspective, this research contributes to the existing body of knowledge in construction project management by providing empirical evidence on the relationship between planning and scheduling practices and schedule performance. While previous studies have investigated general causes of construction delays, relatively few studies have examined the specific role of planning deficiencies in pipeline construction projects in Saudi Arabia. This study addresses that research gap and provides quantitative analysis that can support future research in infrastructure project management.

From a practical perspective, the study is highly relevant for project managers, planning engineers, project control professionals, and EPC contractors involved in pipeline construction. Planning and scheduling processes directly influence project execution efficiency. Identifying the most significant planning deficiencies can help organizations improve schedule development practices, enhance resource planning, and strengthen coordination between engineering, procurement, and construction phases.

Economically, schedule delays in pipeline projects can generate significant financial consequences, including cost overruns, increased labor and equipment expenses, contractual penalties, and delayed operational revenues. By identifying planning weaknesses that contribute to these delays, the study can support the development of more reliable scheduling practices and improve cost predictability in large infrastructure projects.

Strategically, improving planning and scheduling practices contributes to the overall efficiency of infrastructure development programs in Saudi Arabia. Efficient project delivery strengthens the national energy sector and supports long-term economic development by ensuring the timely completion of critical infrastructure projects.

Research Objectives

Main Objective

To evaluate the influence of poor planning and scheduling practices on schedule performance in oil and gas pipeline construction projects in Saudi Arabia.

Specific Objectives

1. Identify planning and scheduling practices commonly used in pipeline construction projects.
2. Determine common deficiencies in schedule development and control processes.
3. Analyze the statistical relationship between planning weaknesses and schedule delays.
4. Rank the most critical planning-related factors affecting schedule performance.
5. Provide recommendations to improve planning effectiveness in pipeline projects.

Research Questions

1. What planning and scheduling practices are commonly implemented in pipeline construction projects in Saudi Arabia?
2. What are the major deficiencies in current planning processes?
3. Is there a statistically significant relationship between poor planning practices and schedule delays?
4. Which planning deficiencies have the strongest impact on schedule performance?
5. How do planning and scheduling weaknesses influence overall project schedule performance?

Research Hypotheses

H0: Poor planning and scheduling practices have no significant effect on schedule performance in pipeline construction projects in Saudi Arabia.

H1: Poor planning and scheduling practices significantly affect schedule performance in pipeline construction projects in Saudi Arabia.

Sub-Hypotheses:

H1a: Inadequate scope definition increases schedule delays.

H1b: Unrealistic baseline scheduling increases schedule delays.

H1c: Poor resource planning increases schedule delays.

H1d: Weak schedule monitoring and control increases schedule delays.

H1e: Lack of integration between engineering, procurement, and construction schedules increases delays.

Previous Studies

Previous research in construction management consistently identifies planning and scheduling deficiencies as major contributors to project delays. Assaf and Al-Hejji (2006) conducted one of the most comprehensive studies on construction delays in Saudi Arabia and found that improper planning and ineffective scheduling practices were among the leading causes of project delays in large infrastructure projects.

Similarly, Al-Kharashi and Skitmore (2009) analyzed delays in public sector construction projects in Saudi Arabia and concluded that deficiencies in project planning, weak project management practices, and ineffective schedule control mechanisms significantly contributed to project delays.

International studies have also confirmed the importance of planning in project schedule performance. Sambasivan and Soon (2007) identified inadequate planning and poor site management as major delay factors in construction projects in Malaysia. Their research demonstrated that weak planning processes often result in inefficient resource allocation and unrealistic project schedules.

Doloi et al. (2012) conducted a quantitative analysis of delay factors in construction projects and found that poor planning, weak coordination between project participants, and ineffective monitoring systems significantly affect schedule performance. Their findings highlighted the importance of integrated planning processes across different project phases.

Although these studies provide valuable insights into delay causes in construction projects, relatively limited research has focused specifically on oil and gas pipeline projects. Pipeline construction presents unique challenges due to its linear nature, long construction corridors, complex logistics, and simultaneous execution of multiple work fronts.

Consequently, the lack of sector-specific empirical research highlights the need for studies that examine planning and scheduling practices within pipeline construction projects in Saudi Arabia. The present study seeks to address this gap by providing quantitative evidence on how planning deficiencies influence schedule performance in pipeline projects.

Theoretical Framework of the Study

This study is grounded in three complementary theoretical perspectives: project management theory, construction delay theory, and organizational performance theory. These theoretical foundations provide a conceptual basis for explaining the relationship between planning and scheduling practices and schedule performance in oil and gas pipeline construction projects in the Kingdom of Saudi Arabia (KSA). Together, these perspectives support the assumption that deficiencies in planning and scheduling processes can significantly influence the likelihood and severity of project delays.

Project management theory emphasizes the central role of effective planning and scheduling in achieving project objectives. According to widely recognized project management standards promoted by the Project Management Institute, schedule management involves a structured set of processes that include defining project activities, sequencing tasks, estimating activity durations, developing realistic baseline schedules, and monitoring schedule performance throughout the project lifecycle. These processes collectively form the foundation of effective project execution and coordination. When these planning activities are performed inadequately—such as through incomplete scope definition, unrealistic duration estimates, or weak schedule integration—the reliability of the project schedule is reduced, increasing the risk of schedule overruns.

Construction delay theory further reinforces the importance of planning and scheduling by identifying them as key internal factors affecting project performance. In construction management literature, delay causes are often categorized into external and internal factors. External factors may include regulatory changes, weather conditions, or unforeseen site issues, while internal factors typically involve management-related issues such as inadequate planning, poor coordination, and ineffective monitoring systems. Research consistently

demonstrates that internal management deficiencies, particularly those related to planning and scheduling, are among the most controllable contributors to project delays. Within the context of pipeline construction projects, where multiple activities must be coordinated across long geographical corridors and multiple work fronts, the absence of effective planning can significantly disrupt workflow continuity and delay project completion.

Organizational performance theory also contributes to the conceptual foundation of this study by highlighting the relationship between management capability and project outcomes. According to this perspective, the quality of planning and scheduling practices reflects the maturity of an organization's project management systems and its ability to manage complex projects effectively. Organizations with well-established planning procedures, experienced project controls teams, and effective schedule monitoring mechanisms tend to demonstrate higher levels of project performance and schedule reliability. Conversely, organizations with weak planning processes may experience frequent disruptions, inefficient resource allocation, and difficulties in coordinating project activities.

In large infrastructure projects such as oil and gas pipelines, these theoretical perspectives become particularly relevant due to the scale and complexity of project operations. Pipeline construction requires continuous coordination between engineering design activities, procurement of specialized materials, and field construction execution. Any misalignment between these project phases can result in significant schedule disruptions. Effective planning therefore acts as a coordinating mechanism that integrates these project functions and ensures that work progresses according to the established schedule.

Based on these theoretical foundations, the present study adopts a cause-and-effect conceptual model in which poor planning and scheduling practices represent the independent variables influencing schedule performance and delay severity as the dependent variable. The study assumes that deficiencies in planning processes—such as inadequate scope definition, unrealistic baseline scheduling, weak resource planning, and insufficient schedule monitoring—can lead to increased schedule uncertainty and higher probabilities of project delays.

The theoretical framework therefore provides the conceptual structure for examining how planning-related factors affect schedule outcomes in pipeline construction projects in Saudi Arabia. By empirically testing these relationships through quantitative analysis, the study aims to validate the theoretical assumption that improvements in planning and scheduling practices can enhance project schedule performance and reduce the likelihood of delays.

Research Methodology

This study adopts a quantitative research approach to examine the influence of planning and scheduling practices on schedule performance in pipeline construction projects in Saudi Arabia.

The research design is descriptive and correlational, as it seeks to describe existing planning practices and analyze the statistical relationship between planning deficiencies and project schedule delays.

The target population consists of professionals involved in oil and gas pipeline construction projects, including project managers, planning engineers, schedulers, construction managers, and project controls specialists working for EPC contractors or client organizations.

A purposive sampling technique will be used to select respondents who possess relevant experience in pipeline construction projects. The study aims to collect responses from approximately 100 to 150 professionals, which is considered an adequate sample size for statistical analysis.

Data will be collected through a structured questionnaire developed based on previous research studies and established project management principles. Responses will be measured using a five-point Likert scale ranging from strongly disagree to strongly agree.

The collected data will be analyzed using statistical software such as SPSS. Descriptive statistics will summarize respondent characteristics and identify the most common planning deficiencies. Reliability will be tested using Cronbach's Alpha to ensure internal consistency of measurement items. Pearson correlation analysis will examine the relationship between planning practices and schedule delays, while multiple regression analysis will determine the predictive effect of planning deficiencies on schedule performance.

Research Instruments

The primary research instrument for this study is a structured questionnaire designed to measure planning and scheduling practices and their impact on schedule performance.

The questionnaire consists of three main sections.

The first section collects demographic information such as respondents' job position, years of experience, and involvement in pipeline projects.

The second section evaluates planning and scheduling practices, including scope definition, baseline schedule development, activity sequencing, resource planning, schedule integration between engineering, procurement, and construction, and schedule monitoring and control.

The third section measures schedule performance and the perceived severity of project delays.

All responses will be measured using a five-point Likert scale to enable statistical analysis and ranking of planning factors.

Scope and Limitations of the Study

This study focuses on the influence of planning and scheduling practices on schedule performance in oil and gas pipeline construction projects in Saudi Arabia. The scope is limited to internal project management factors related to planning processes, including scope definition, baseline schedule development, resource planning, schedule integration, and monitoring practices.

The research is geographically limited to pipeline projects executed in Saudi Arabia. Consequently, the findings may not be fully generalizable to projects in other countries with different regulatory or economic conditions.

The study relies primarily on perception-based survey data collected from industry professionals rather than direct access to confidential project records. Additionally, the research adopts a cross-sectional design, meaning that data will be collected at a single point in time.

Despite these limitations, the focused scope enables the study to provide meaningful insights into improving planning practices and reducing schedule delays in pipeline construction projects.

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