

Midocean University
College of Management
Department Project Management
Master of Project Management



The Influence of Planning and Scheduling Practices on Project Delays in Engineering, Procurement, and Construction (EPC) Projects in the Kingdom of Saudi Arabia.

Prepared by: Faisal Lagmouch

Supervised by:

DR. Al-Faisal Abdul-Hamid Mohamed Hassan

DR. Fayez Jarad

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

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Abstract

Project delays continue to represent one of the most persistent challenges affecting the successful execution and delivery of Engineering, Procurement, and Construction (EPC) projects. Such delays frequently lead to cost overruns, productivity losses, contractual disputes, and reduced stakeholder satisfaction. Although project management methodologies and advanced scheduling tools have become increasingly prevalent across the industry, delays remain a recurring issue in many EPC projects within the Kingdom of Saudi Arabia. Accordingly, this study investigates the influence of planning and scheduling practices on project delays in EPC projects operating in the Saudi Arabian context.

The research adopted a quantitative methodology utilizing a structured questionnaire administered to project management professionals, planning engineers, schedulers, project controls specialists, construction managers, and other practitioners involved in EPC project delivery. A total of 75 valid responses were collected and subjected to statistical analysis. The study examined five key dimensions of planning and scheduling practices: Scope Definition, Baseline Schedule Development, Resource Planning, Schedule Integration, and Schedule Monitoring and Control. Project Delays were considered the dependent variable.

The descriptive statistical analysis revealed that respondents regarded all planning and scheduling dimensions as highly important factors in achieving project success and mitigating delays. The findings further identified significant relationships between planning and scheduling practices and project delays. Among the dimensions examined, Schedule Monitoring and Control and Resource Planning exhibited the strongest influence on project delay performance. In addition, Scope Definition, Baseline Schedule Development, and Schedule Integration demonstrated meaningful contributions toward reducing the occurrence and impact of project delays.

The study concludes that effective planning and scheduling practices are fundamental to enhancing project performance and minimizing delays in EPC projects. The findings highlight the importance of establishing structured planning processes, developing realistic and achievable baseline schedules, ensuring adequate resource planning, maintaining

alignment and integration across project functions, and implementing robust monitoring and control mechanisms throughout the project lifecycle.

This study contributes to the existing body of knowledge by providing empirical evidence regarding the relationship between planning and scheduling practices and project delays within the Saudi Arabian EPC sector. Furthermore, the findings offer practical insights for project owners, EPC contractors, consultants, and project professionals seeking to strengthen project delivery performance and support the successful realization of Saudi Arabia's Vision 2030 initiatives.

Keywords: Project Delays, Planning and Scheduling Practices, EPC Projects, Project Controls, Resource Planning, Schedule Integration, Schedule Monitoring and Control, Saudi Arabia.

TABLE OF CONTENTS

Acknowledgements.....	ii
Abstract	iii
TABLE OF CONTENTS	v
LIST OF TABLES	ix
LIST OF FIGURES.....	x
LIST OF ABBREVIATIONS.....	xi
Chapter One: Introduction.....	1
1.1 Introduction.....	1
1.3 Importance of the Study	4
1.3.2 Practical Importance.....	4
1.3.3 Importance to the Kingdom of Saudi Arabia	5
1.4 Study Objectives	5
1.4.1 Main Objective	5
1.4.2 Specific Objectives	6
1.5.1 Main Research Question.....	6
1.5.2 Sub-Research Questions	6
1.6.1 Main Hypothesis	7
Null Hypotheses	8
1.7 Theoretical Framework and Conceptual Framework of the Study.....	9
1.7.1 Theoretical Framework.....	9
1.8 Chapter Summary.....	10
Chapter Two: Literature Review	12
2.1 Introduction.....	12
2.2.1 Introduction to Planning and Scheduling Practices.....	13
2.2.2 Scope Definition	14
2.2.4 Resource Planning	18
2.2.6 Schedule Monitoring and Control.....	23
2.3 Project Delays	25
2.3.1 Introduction to Project Delays	25
2.3.2 Definition of Project Delays	27
2.3.5 Effects of Project Delays on Project Performance	33
2.4 Previous Studies	36
2.4.1 International Studies	36

2.4.2 Previous Studies in Saudi Arabia and GCC Countries	39
2.4.3 Discussion of Previous Studies	42
2.4.4 Research Gap.....	43
2.5 Conceptual Framework.....	46
2.6 Chapter Summary.....	48
Chapter Three: Research Methodology	49
3.1 Introduction.....	49
3.2 Research Design	49
3.3 Population	51
3.5 Questionnaire Design	53
3.6 Validity of the Instrument.....	57
3.7 Reliability of the Instrument.....	59
3.8 Data Analysis Methods	60
3.8.1 Descriptive Statistics	60
3.8.2 Reliability Analysis.....	61
3.8.3 Correlation Analysis.....	61
3.8.4 Multiple Regression Analysis	62
3.8.5 Hypothesis Testing	63
3.9 Ethical Considerations	64
3.10 Chapter Summary.....	66
CHAPTER FOUR: Data Analysis, Results and Discussion.....	67
4.1 Introduction.....	67
4.2 Response Rate.....	67
4.3 Demographic Profile of Respondents.....	68
4.3.1 Current Position	69
4.3.2 Years of Professional Experience.....	70
4.3.3 EPC Project Experience	72
4.3.4 Organization Type.....	74
4.3.5 Industry Sector	75
4.4 Reliability Analysis.....	77
4.4.1 Summary of Reliability Results.....	78
4.4.2 Summary of Reliability Results.....	79
4.5 Descriptive Statistics	79
4.5.1 Scope Definition.....	80
4.5.2 Baseline Schedule Development	81
4.5.3 Resource Planning	83

4.5.4 Schedule Integration	85
4.5.5 Schedule Monitoring and Control	86
4.5.6 Project Delays	88
4.5.7 Summary of Descriptive Statistics	91
4.6 Correlation Analysis	92
4.6.1 Correlation Between Planning and Scheduling Practices and Project Delays	92
4.6.2 Summary of Correlation Analysis	94
4.7 Multiple Regression Analysis	94
4.7.1 Model Summary	95
4.7.2 Analysis of Variance (ANOVA)	96
4.7.3 Regression Coefficients.....	96
4.7.4 Summary of Regression Analysis	97
4.8 Hypothesis Testing.....	98
4.9 Discussion of Findings	100
4.9.1 Influence of Scope Definition on Project Delays	100
4.9.2 Influence of Baseline Schedule Development on Project Delays	101
4.9.3 Influence of Resource Planning on Project Delays	101
4.9.4 Influence of Schedule Integration on Project Delays	102
4.9.5 Influence of Schedule Monitoring and Control on Project Delays	102
4.9.6 Overall Discussion of Findings	103
4.10 Chapter Summary	104
CHAPTER FIVE: Conclusions and Recommendations	106
5.1 Introduction	106
5.2 Summary of Findings	106
5.2.1 Scope Definition	107
5.2.2 Baseline Schedule Development	108
5.2.3 Resource Planning	108
5.2.4 Schedule Integration	109
5.2.5 Schedule Monitoring and Control	110
5.2.6 Overall Findings	111
5.3 Conclusions.....	113
5.4 Practical Recommendations.....	115
5.4.1 Recommendations for Project Owners	115
5.4.2 Recommendations for EPC Contractors.....	116
5.4.3 Recommendations for Project Management Consultants (PMC)	116
5.4.4 Recommendations for Project Professionals	117

5.5 Limitations of the Study	118
5.6 Recommendations for Future Research	119
5.7 Chapter Summary.....	120
الملخص	122
References	123
Appendixes.....	126
العنوان باللغة العربية	135

LIST OF TABLES

Table 1 Summary of International Previous Studies	38
Table 2 Summary of Saudi Arabia and GCC Previous Studies.....	39
Table 3 Summary of Identified Research Gaps.....	43
Table 4 Eligibility Criteria for Respondent Selection	53
Table 5 Five-Point Likert Scale.....	55
Table 6 Distribution of Questionnaire Items	56
Table 7 Mapping of Variables and Questionnaire Dimensions	56
Table 8 Interpretation of Mean Scores.....	61
Table 9 Interpretation of Correlation Coefficients	62
Table 10 Summary of Survey Responses	68
Table 11 Current Position of Respondents	69
Table 12 Years of Professional Experience	71
Table 13 EPC Project Experience.....	73
Table 14 Organization Type of Respondents	74
Table 15 Industry Sector of Respondents	76
Table 16 Reliability Analysis Results.....	78
Table 17 Interpretation of Mean Scores.....	79
Table 18 Descriptive Statistics for Scope Definition	80
Table 19 Descriptive Statistics for Baseline Schedule Development	81
Table 20 Descriptive Statistics for Resource Planning	83
Table 21 Descriptive Statistics for Schedule Integration.....	85
Table 22 Descriptive Statistics for Schedule Monitoring and Control.....	87
Table 23 Descriptive Statistics for Project Delays.....	89
Table 24 Summary of Descriptive Statistics	91
Table 25 Interpretation of Correlation Coefficients	92
Table 26 Correlation Matrix	93
Table 27 Model Summary	95
Table 28 ANOVA Results.....	96
Table 29 Regression Coefficients	96
Table 30 Hypothesis Testing Results.....	98

LIST OF FIGURES

Figure1	Conceptual Framework of the Study.....	47
Figure2	Years of Professional Experience.....	72
Figure3	EPC Project Experience.....	74
Figure4	Organization Type of Respondents	75
Figure5	Industry Sector of Respondents	77
Figure6	Scope Definition Mean Scores	80
Figure7	Mean Scores for Baseline Schedule Development Items	83
Figure8	Mean Scores for Resource Planning Items.....	84
Figure9	Mean Scores for Schedule Integration Items	85
Figure10	Mean Scores for Schedule Monitoring and Control Items	88
Figure11	Mean Scores for Project Delay Items	90

LIST OF ABBREVIATIONS

BSD : Baseline Schedule Development

CPM : Critical Path Method

EPC : Engineering, Procurement, and Construction

GCC : Gulf Cooperation Council

PD : Project Delays

PMBOK: Project Management Body of Knowledge

PMI : Project Management Institute

RP : Resource Planning

SD : Scope Definition

SI : Schedule Integration

SMC : Schedule Monitoring and Control

WBS : Work Breakdown Structure

Chapter One: Introduction

1.1 Introduction

The successful delivery of projects remains a primary objective for organizations operating in an increasingly competitive business environment. Projects are expected to achieve their goals within approved time, cost, scope, and quality parameters while satisfying stakeholder expectations. Among these performance criteria, timely completion is widely regarded as a key measure of project success. Despite substantial advancements in project management methodologies and tools, project delays continue to affect industries worldwide, resulting in financial losses, stakeholder dissatisfaction, contractual disputes, and reduced organizational performance.

Planning and scheduling are widely recognized as core project management functions. Planning establishes a structured framework for defining project objectives, identifying deliverables, allocating resources, and determining execution strategies. Scheduling translates these plans into a logical sequence of activities, milestones, and timelines that guide project implementation. Together, they provide the basis for effective project monitoring, control, and decision-making throughout the project lifecycle.

According to the Project Management Institute (PMI), planning and scheduling are essential for coordinating project activities and achieving objectives within established constraints. Effective practices enhance stakeholder communication, improve resource utilization, strengthen risk management, and provide early visibility of potential deviations from project targets. In contrast, deficiencies in planning and scheduling can lead to inefficiencies, resource conflicts, poor coordination, schedule slippage, and ultimately project delays.

Engineering, Procurement, and Construction (EPC) projects represent one of the most complex forms of project delivery due to their multidisciplinary scope, substantial capital investment, extensive stakeholder involvement, and demanding technical and contractual requirements. These projects require the successful integration of engineering, procurement, construction, and commissioning activities within a unified project framework, making effective planning and scheduling critical across all project phases.

In the Kingdom of Saudi Arabia, Vision 2030 has driven unprecedented investment in infrastructure, industrial facilities, energy developments, mining operations, petrochemical projects, transportation systems, and other large-scale initiatives. This transformation has increased the need for robust project management practices capable of supporting successful project delivery. As organizations pursue ambitious national development objectives, timely project completion has become increasingly important in advancing economic diversification and sustainable growth.

Despite the growing focus on project management excellence, project delays remain a significant challenge within the Saudi Arabian project environment. Schedule overruns are frequently associated with inadequate planning, ineffective scheduling, insufficient resource allocation, poor coordination among project participants, and weak monitoring and control processes. These delays often lead to increased costs, productivity losses, contractual claims, and negative impacts on project stakeholders.

Previous studies have consistently identified planning and scheduling practices as important contributors to project success and schedule performance. However, although project delays have been examined from various perspectives, further research is needed to understand the influence of specific planning and scheduling practices on project delays within the context of Engineering, Procurement, and Construction projects in Saudi Arabia.

This study addresses this gap by examining the influence of planning and scheduling practices—including scope definition, baseline schedule development, resource planning, schedule integration, and schedule monitoring and control—on project delays in EPC projects operating within Saudi Arabia. The findings are expected to contribute to both academic knowledge and professional practice by providing evidence-based insights into how effective planning and scheduling practices can enhance project delivery performance and reduce project delays.

1.2 Problem Statement

Project delays remain one of the most persistent challenges affecting project performance across industries worldwide. They frequently lead to cost overruns, productivity losses, contractual disputes, reduced stakeholder satisfaction, and delayed realization of project benefits. In Engineering, Procurement, and Construction (EPC) projects, these consequences

are often amplified due to the complexity of project activities, substantial capital investments, and the extensive coordination required among diverse stakeholders.

The Kingdom of Saudi Arabia is undergoing a major transformation driven by Vision 2030 and the delivery of large-scale projects across the energy, petrochemical, mining, infrastructure, transportation, and industrial sectors. The timely completion of these initiatives is critical to achieving national strategic objectives and maximizing investment value. As a result, project delays have emerged as a significant concern for project owners, contractors, consultants, and government organizations.

While project delays may arise from technical, financial, contractual, and external influences, planning and scheduling practices are consistently recognized as fundamental drivers of project performance. Effective planning and scheduling establish realistic project objectives, develop logical and achievable schedules, allocate resources efficiently, integrate project activities, and enable ongoing monitoring and control. In contrast, weaknesses in these practices can contribute to schedule slippage, coordination challenges, resource conflicts, and delayed project completion.

Despite the widespread use of project management methodologies and scheduling software within the Saudi Arabian project environment, delays continue to affect many EPC projects. This raises important questions regarding the effectiveness of existing planning and scheduling practices and their influence on schedule performance. Although previous research has explored numerous causes of project delays, limited attention has been given to examining the relationship between planning and scheduling practices and project delays within the context of Saudi Arabian EPC projects.

Moreover, much of the existing literature addresses delay factors at a general level without evaluating specific planning and scheduling dimensions, including scope definition, baseline schedule development, resource planning, schedule integration, and schedule monitoring and control. Consequently, there remains a need for empirical evidence that identifies the relative influence of these practices on project delays and their contribution to improved project performance.

Accordingly, this study addresses this research gap by investigating the influence of planning and scheduling practices on project delays in Engineering, Procurement, and

Construction projects within the Kingdom of Saudi Arabia. The study seeks to generate practical insights that can assist project professionals in strengthening planning and scheduling processes, enhancing project performance, and reducing the occurrence of project delays.

1.3 Importance of the Study

The importance of this study arises from the increasing need to improve project delivery performance within Engineering, Procurement, and Construction (EPC) projects in the Kingdom of Saudi Arabia. As significant investments continue under Vision 2030, timely project completion has become essential for achieving organizational objectives and national development goals. The study offers value from theoretical, practical, national, and professional perspectives.

1.3.1 Scientific and Theoretical Importance

This study contributes to the project management literature by examining the relationship between planning and scheduling practices and project delays within the Saudi Arabian EPC sector. While project delays have been widely studied, limited research has focused specifically on how planning and scheduling practices influence delay performance in EPC projects within Saudi Arabia.

The study evaluates key planning and scheduling dimensions, including scope definition, baseline schedule development, resource planning, schedule integration, and schedule monitoring and control. By examining their influence on project delays, it provides a broader understanding of the factors affecting schedule performance. The findings may also serve as a reference for future research in project management, construction management, and project controls.

1.3.2 Practical Importance

From a practical perspective, the study provides insights for project managers, planners, schedulers, project controls professionals, contractors, consultants, and project owners involved in EPC projects.

The findings can help organizations identify the planning and scheduling practices that most significantly influence project delays, allowing improvement efforts to be focused on critical areas. This may support better schedule performance, reduced delay-related risks, and improved project outcomes. The study may also assist decision-makers in strengthening planning processes, resource allocation, schedule integration, and project monitoring and control.

1.3.3 Importance to the Kingdom of Saudi Arabia

Saudi Arabia is implementing numerous strategic projects under Vision 2030 across infrastructure, energy, mining, transportation, and industrial sectors. The timely delivery of these projects is critical to achieving national development objectives and maximizing economic benefits.

The findings of this study may assist organizations in improving project delivery performance and reducing project delays, thereby supporting ongoing efforts to enhance project management practices and the successful execution of national initiatives.

1.3.4 Importance to Professional Practice

The study provides practical guidance for improving planning and scheduling effectiveness in EPC projects. Its findings may support the enhancement of organizational best practices, scheduling procedures, and project control frameworks.

In addition, the study may help professional organizations, training institutions, and practitioners identify the key planning and scheduling competencies required for successful project delivery in complex EPC environments.

1.4 Study Objectives

1.4.1 Main Objective

This study aims to investigate the influence of planning and scheduling practices on project delays in Engineering, Procurement, and Construction (EPC) projects in the Kingdom of Saudi Arabia.

1.4.2 Specific Objectives

To achieve the primary objective, this study pursues the following specific objectives:

1. To evaluate the influence of scope definition practices on project delays in EPC projects within the Kingdom of Saudi Arabia.
2. To assess the influence of baseline schedule development practices on project delays in EPC projects within the Kingdom of Saudi Arabia.
3. To examine the influence of resource planning practices on project delays in EPC projects within the Kingdom of Saudi Arabia.
4. To investigate the influence of schedule integration practices on project delays in EPC projects within the Kingdom of Saudi Arabia.
5. To analyze the influence of schedule monitoring and control practices on project delays in EPC projects within the Kingdom of Saudi Arabia.
6. To identify the planning and scheduling practice that exerts the greatest influence on project delays in EPC projects within the Kingdom of Saudi Arabia.
7. To develop recommendations that support project organizations in strengthening planning and scheduling practices and reducing project delays.

1.5 Research Questions

1.5.1 Main Research Question

To what extent do planning and scheduling practices influence project delays in Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia?

1.5.2 Sub-Research Questions

To address the main research question, the study examines the following sub-questions:

1. What influence do scope definition practices have on project delays in EPC projects within the Kingdom of Saudi Arabia?
2. How do baseline schedule development practices influence project delays in EPC projects within the Kingdom of Saudi Arabia?
3. What is the effect of resource planning practices on project delays in EPC projects within the Kingdom of Saudi Arabia?

4. How do schedule integration practices influence project delays in EPC projects within the Kingdom of Saudi Arabia?
5. What influence do schedule monitoring and control practices have on project delays in EPC projects within the Kingdom of Saudi Arabia?
6. Which planning and scheduling practice exerts the greatest influence on project delays in EPC projects within the Kingdom of Saudi Arabia?
7. How can planning and scheduling practices be enhanced to reduce project delays in EPC projects within the Kingdom of Saudi Arabia?

1.6 Research Hypotheses

Based on the study objectives, research questions, and the proposed conceptual framework, the following research hypotheses were formulated:

1.6.1 Main Hypothesis

H1: There is a statistically significant relationship between planning and scheduling practices and project delays in Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia.

1.6.2 Sub-Hypotheses

H1a: There is a statistically significant relationship between scope definition practices and project delays in Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia.

H1b: There is a statistically significant relationship between baseline schedule development practices and project delays in Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia.

H1c: There is a statistically significant relationship between resource planning practices and project delays in Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia.

H1d: There is a statistically significant relationship between schedule integration practices and project delays in Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia.

H1e: There is a statistically significant relationship between schedule monitoring and control practices and project delays in Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia.

Null Hypotheses

For statistical testing purposes, the following null hypotheses are proposed:

H0: There is no statistically significant relationship between planning and scheduling practices and project delays in Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia.

H0a: There is no statistically significant relationship between scope definition practices and project delays in Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia.

H0b: There is no statistically significant relationship between baseline schedule development practices and project delays in Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia.

H0c: There is no statistically significant relationship between resource planning practices and project delays in Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia.

H0d: There is no statistically significant relationship between schedule integration practices and project delays in Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia.

H0e: There is no statistically significant relationship between schedule monitoring and control practices and project delays in Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia.

1.7 Theoretical Framework and Conceptual Framework of the Study

1.7.1 Theoretical Framework

This study is anchored in Project Management Theory and the principles established by the Project Management Institute (PMI). Project Management Theory posits that successful project delivery is largely dependent on the effectiveness of planning, scheduling, monitoring, and control processes throughout the project lifecycle. In line with PMI guidance, project planning serves as the foundation for project execution by defining project scope, developing schedules, allocating resources, identifying risks, and establishing mechanisms for measuring performance.

Planning and scheduling are widely recognized as essential project management functions, providing the framework that guides project execution and supports coordination among stakeholders. Effective planning and scheduling practices facilitate the achievement of project objectives by ensuring logical activity sequencing, efficient resource utilization, and continuous performance monitoring. In contrast, weaknesses in these practices can contribute to schedule slippage, resource conflicts, coordination breakdowns, and ultimately project delays.

The theoretical premise underpinning this study is that improvements in planning and scheduling practices enhance project performance and reduce the likelihood of project delays. Accordingly, the study investigates the influence of key planning and scheduling dimensions on project delays within Engineering, Procurement, and Construction (EPC) projects in the Kingdom of Saudi Arabia.

1.7.2 Conceptual Framework of the Study

The conceptual framework of this study proposes that Planning and Scheduling Practices represent the independent variable, while Project Delays represent the dependent variable.

The independent variable consists of five dimensions:

1. Scope Definition
2. Baseline Schedule Development
3. Resource Planning

4. Schedule Integration
5. Schedule Monitoring and Control

The dependent variable is:

Project Delays

The framework assumes that effective planning and scheduling practices influence the level of project delays experienced in EPC projects.

Independent Variable

Planning and Scheduling Practices

- Scope Definition
- Baseline Schedule Development
- Resource Planning
- Schedule Integration
- Schedule Monitoring and Control

Dependent Variable

Project Delays

- Schedule Overrun
- Milestone Delays
- Delay Frequency
- Delay Severity

1.8 Chapter Summary

This chapter presented the general framework of the study by introducing the research topic and highlighting the importance of planning and scheduling practices in achieving successful project delivery. The chapter discussed the problem of project delays in Engineering, Procurement, and Construction (EPC) projects and emphasized the need to investigate the influence of planning and scheduling practices on project delay performance within the Kingdom of Saudi Arabia.

The chapter further outlined the significance of the study from both theoretical and practical perspectives and presented the study objectives, research questions, and research hypotheses. In addition, the theoretical foundation and conceptual framework of the study were introduced to explain the proposed relationship between planning and scheduling practices and project delays.

The next chapter reviews the relevant literature and previous studies related to planning and scheduling practices and project delays. It also presents the theoretical concepts and research findings that form the foundation for the development of the study framework and hypotheses.

Chapter Two: Literature Review

2.1 Introduction

Project management has become increasingly important as organizations undertake projects of greater complexity, scale, and strategic importance. Significant resources are invested with the expectation that projects will be delivered within approved scope, schedule, budget, and quality parameters. Among these performance measures, schedule achievement remains a critical indicator of project success. Nevertheless, project delays continue to affect a wide range of industries, often resulting in cost escalation, productivity losses, contractual disputes, and stakeholder dissatisfaction.

Planning and scheduling are fundamental project management functions that provide the framework for effective project execution. They support the definition of project objectives, development of realistic schedules, allocation of resources, coordination of activities, and monitoring of progress. Effective planning and scheduling enable project teams to anticipate potential challenges, optimize resource utilization, and implement timely corrective actions when deviations arise. Consequently, these practices are consistently recognized as key determinants of project performance and successful project delivery.

Engineering, Procurement, and Construction (EPC) projects present a particularly challenging project environment due to their complexity, significant capital investment, extensive stakeholder involvement, and strong interdependencies among project activities. Successful delivery requires close coordination between engineering, procurement, and construction functions throughout the project lifecycle. Accordingly, planning and scheduling play a pivotal role in achieving project objectives and minimizing schedule-related disruptions.

In the Kingdom of Saudi Arabia, project activity has expanded considerably under Vision 2030, supported by major investments in infrastructure, energy, mining, petrochemicals, transportation, and industrial development. Despite advancements in project management methodologies and technologies, project delays remain a persistent challenge. Existing research has repeatedly identified planning-related deficiencies as significant contributors to schedule overruns and delayed project completion.

This chapter reviews the literature on planning and scheduling practices and their relationship with project delays. It begins by examining the theoretical foundations of planning and scheduling within project management, followed by a discussion of the key dimensions investigated in this study: scope definition, baseline schedule development, resource planning, schedule integration, and schedule monitoring and control. The chapter then explores the concept of project delays, including their causes and impacts on project performance. Finally, it analyzes previous studies to identify research gaps and establish the foundation for the proposed conceptual framework.

2.2 Planning and Scheduling Practices

2.2.1 Introduction to Planning and Scheduling Practices

Planning and scheduling are fundamental project management processes and are widely regarded as critical determinants of project success. They provide a structured framework for defining project objectives, establishing scope, allocating resources, sequencing activities, managing risks, and monitoring performance throughout the project lifecycle. As projects become increasingly complex and strategically significant, organizations rely more heavily on robust planning and scheduling practices to enhance project outcomes and achieve organizational objectives (PMI, 2021).

The Project Management Institute (PMI, 2021) defines project planning as the process of establishing project scope, refining objectives, and determining the actions required to achieve project goals. Scheduling complements this process by developing a timeline for project activities, identifying logical relationships, estimating durations, allocating resources, and establishing key milestones. Together, planning and scheduling provide a framework that guides project execution while supporting performance measurement and control (Kerzner, 2022).

The importance of planning and scheduling in improving project performance has been widely acknowledged in the literature. Effective planning enables project teams to identify requirements, anticipate challenges, allocate resources efficiently, and align stakeholder expectations. Likewise, effective scheduling enhances coordination by ensuring that activities are sequenced logically and that required resources are available at the appropriate time (Kerzner, 2022; PMI, 2021).

A substantial body of research identifies deficiencies in planning and scheduling as major contributors to project delays and cost overruns. Studies by Sambasivan and Soon (2007), Assaf and Al-Hejji (2006), Doloi et al. (2012), and Mahamid (2013) found that poorly defined scope, unrealistic schedules, inadequate resource planning, weak integration among project functions, and ineffective monitoring and control mechanisms can adversely affect project performance and increase the likelihood of delays.

The significance of planning and scheduling is particularly evident in Engineering, Procurement, and Construction (EPC) projects, where project activities are highly interdependent. Successful delivery requires continuous coordination among engineering, procurement, construction, and commissioning functions. Consequently, shortcomings in planning or scheduling can generate cascading impacts throughout the project lifecycle, leading to delays, rework, productivity losses, and increased project costs.

For the purposes of this study, planning and scheduling practices are examined through five dimensions that are widely recognized in both project management literature and professional practice:

1. Scope Definition
2. Baseline Schedule Development
3. Resource Planning
4. Schedule Integration
5. Schedule Monitoring and Control

Collectively, these dimensions represent the core planning and scheduling processes that influence project execution and schedule performance. The following sections examine each dimension and its relationship with project delays.

2.2.2 Scope Definition

Scope definition is a fundamental project management process that provides the foundation for effective planning and execution. It involves identifying, documenting, and clearly defining the work required to achieve project objectives and satisfy stakeholder expectations. A well-defined scope establishes project boundaries, clarifies requirements and deliverables, and provides the basis for planning, scheduling, budgeting, and performance measurement.

According to the Project Management Institute (PMI, 2021), project scope management encompasses the processes necessary to ensure that all required work—and only the required work—is performed to successfully complete the project. Effective scope definition enhances project control by creating a shared understanding of project objectives and reducing ambiguity during execution.

Kerzner (2022) emphasizes that scope definition forms the basis for planning, scheduling, budgeting, risk management, and performance measurement activities. Clearly defined scope reduces uncertainty, strengthens stakeholder alignment, and supports informed decision-making throughout the project lifecycle. Consequently, projects with well-established scope are generally better positioned to achieve their objectives while minimizing schedule disruptions.

A key mechanism for defining project scope is the Work Breakdown Structure (WBS), which decomposes project deliverables into manageable work packages. The WBS supports schedule development, resource allocation, cost estimation, and performance monitoring. By providing a structured representation of project work, it enables project teams to manage activities more effectively and maintain control over changes throughout project execution.

The importance of scope definition has been widely recognized in the literature. Mirza, Pourzolfaghar, and Shahnazari (2013) identified project scope as a critical determinant of project success and overall performance. Their study highlighted that inadequate scope definition often results in stakeholder misunderstandings, increased uncertainty, scope changes, and schedule delays. Similarly, Fageha and Aibinu (2013) found that effective scope definition enhances stakeholder participation, improves communication, and reduces project uncertainty, thereby increasing the likelihood of achieving planned project objectives.

These findings align with PMI (2021), which notes that inadequate scope definition frequently contributes to scope creep, uncontrolled changes, stakeholder conflicts, and schedule overruns. Scope creep occurs when additional requirements or deliverables are introduced without appropriate evaluation and approval, often leading to increased workload and disruption to planned schedules.

Scope changes are among the most common causes of project delays. When project requirements are not adequately defined during the planning phase, changes often emerge

during execution, resulting in rework, additional resource demands, schedule revisions, and cost escalation. Althiyabi (2021) observed that poorly managed scope changes can adversely affect project performance and create substantial challenges for maintaining schedule commitments.

Within Engineering, Procurement, and Construction (EPC) projects, scope definition assumes even greater importance due to the extensive coordination required across engineering, procurement, and construction functions. Ambiguities in project scope can lead to design revisions, procurement disruptions, construction delays, and interface management issues. Given the highly interconnected nature of EPC activities, deficiencies in scope definition can generate cascading effects throughout the project lifecycle.

Previous studies examining project delays have consistently identified scope-related issues as significant contributors to schedule overruns. Delays frequently originate from incomplete requirements, unclear objectives, inadequate stakeholder alignment, and uncontrolled scope expansion. Effective scope definition therefore serves as a proactive mechanism for reducing uncertainty and supporting successful project delivery.

Based on the literature reviewed, scope definition can be regarded as a critical planning practice that significantly influences project performance and delay outcomes. Projects that establish clear scope boundaries, define deliverables comprehensively, and implement effective scope control processes are better positioned to achieve schedule objectives and minimize project delays.

2.2.3 Baseline Schedule Development

Baseline schedule development is a core component of project planning and scheduling, serving as the primary benchmark against which project performance is assessed throughout the project lifecycle. A baseline schedule represents the approved project timetable, defining the planned sequence of activities, durations, milestones, and completion dates. It establishes a shared understanding of project expectations and provides the foundation for effective project monitoring and control.

According to the Project Management Institute (PMI, 2021), schedule development involves analyzing activity sequences, durations, resource requirements, and project

constraints to create a schedule model. The resulting baseline schedule functions as a critical management tool for measuring progress, identifying deviations, and supporting informed decision-making during project execution. A well-developed baseline schedule provides realistic expectations regarding project completion and enhances overall project control.

The baseline schedule serves as the principal reference for comparing planned and actual performance. It enables project managers to track progress, identify schedule variances, forecast future outcomes, and implement corrective actions when necessary. Without a reliable baseline, effective schedule control becomes increasingly difficult, elevating the risk of schedule overruns and project delays (Kerzner, 2022).

Developing a high-quality baseline schedule requires the application of established scheduling practices, including activity definition, activity sequencing, duration estimation, resource loading, milestone identification, and critical path analysis. The Critical Path Method (CPM) remains one of the most widely applied techniques, enabling project teams to identify activities that directly influence project completion dates. Sound schedule logic and realistic duration estimates are therefore essential for producing a schedule capable of supporting successful project execution.

Kerzner (2022) emphasizes that accurate duration estimation, logical activity relationships, and realistic assumptions are key determinants of schedule quality. Schedules developed using incomplete information or unrealistic assumptions often fail to reflect actual project conditions, resulting in unattainable expectations and reduced schedule reliability.

The literature consistently identifies schedule quality as a significant contributor to project success. A realistic baseline schedule improves coordination, enhances stakeholder communication, and supports proactive project management. Conversely, unrealistic durations, incomplete logic, inadequate schedule reviews, and poor schedule development practices can create unrealistic expectations and increase the likelihood of project delays.

Several studies have linked weaknesses in schedule development to poor project performance. Sambasivan and Soon (2007) identified unrealistic schedules and inadequate planning as major causes of delays in construction projects. Similarly, Doloi et al. (2012) reported that ineffective scheduling practices significantly contribute to schedule overruns and diminished project performance.

Projects established on overly aggressive completion dates frequently experience delays during execution. In many cases, pressure to meet ambitious deadlines results in schedules that inadequately reflect project constraints, risks, resource availability, and execution realities. As a result, schedule slippage becomes increasingly difficult to avoid as the project progresses.

The importance of baseline schedule development is particularly evident in Engineering, Procurement, and Construction (EPC) projects, where project activities are highly interdependent. Engineering deliverables drive procurement activities, procurement performance influences construction progress, and construction outcomes affect commissioning and final project completion. Consequently, deficiencies in schedule development can propagate across project phases and adversely affect overall delivery performance.

An effective baseline schedule also strengthens project monitoring and control by enabling project teams to compare actual progress against planned performance and identify variances at an early stage. Early detection of schedule deviations facilitates timely corrective action and reduces the likelihood of significant project delays.

The literature suggests that organizations investing in rigorous schedule development practices are more likely to achieve improved schedule performance and minimize project delays. Accordingly, baseline schedule development is widely recognized as a critical planning and scheduling practice that contributes directly to the successful delivery of EPC projects.

For the purpose of this study, baseline schedule development refers to the processes and practices used to establish realistic project schedules, define activity relationships, estimate durations, incorporate project constraints, and develop an approved schedule baseline for project execution and performance measurement.

2.2.4 Resource Planning

Resource planning is a fundamental element of project planning and scheduling that involves identifying, estimating, allocating, and managing the resources required to execute project activities successfully. These resources typically include personnel, materials, equipment, facilities, and financial assets. Effective resource planning ensures that the

appropriate resources are available in the required quantities and at the appropriate time to support project execution and achievement of project objectives.

According to the Project Management Institute (PMI, 2021), resource planning contributes to project success by identifying resource requirements early in the planning process and aligning them with project schedules and organizational capabilities. It also enables project managers to anticipate shortages, optimize resource utilization, and minimize disruptions that may adversely affect project performance.

The importance of resource planning has increased in modern project environments due to resource constraints, labor shortages, supply chain challenges, and growing project complexity. Effective resource planning enhances schedule reliability by ensuring the timely availability of labor, materials, equipment, and financial resources needed to support project execution (Kerzner, 2022).

Human resources are among the most critical project assets, as project performance depends largely on the skills, experience, and productivity of project personnel. Effective workforce planning involves identifying labor requirements, estimating workforce demand, defining skill needs, and ensuring the availability of qualified personnel throughout the project lifecycle. Inadequate workforce planning can lead to labor shortages, reduced productivity, increased overtime costs, and schedule delays.

Material planning is equally important, particularly in Engineering, Procurement, and Construction (EPC) projects, where construction activities rely heavily on the timely availability of materials and equipment. Material shortages, procurement delays, logistics challenges, and supply chain disruptions can significantly affect project schedules. Accordingly, procurement and material planning activities must be closely integrated with project schedules to support efficient execution.

Equipment planning also plays a vital role in project performance. Many construction activities require specialized equipment, machinery, and tools. Failure to secure equipment availability when needed can result in idle labor, reduced productivity, and delays to critical activities. Effective equipment planning therefore contributes to improved schedule reliability and overall project performance.

The literature consistently identifies resource-related issues as major contributors to project delays. Irugal Bandara (2020) found that inadequate resource planning can negatively affect project performance by creating labor shortages, material availability constraints, and equipment limitations that contribute to schedule overruns. Similarly, Aibinu and Odeyinka (2006) reported that ineffective resource management is a significant cause of project delays and cost overruns. Their findings suggest that organizations with mature resource planning practices are better positioned to achieve schedule objectives and maintain project performance.

Resource allocation and resource leveling are also essential aspects of resource planning. Resource allocation ensures that resources are assigned according to project priorities and activity requirements, while resource leveling seeks to resolve resource conflicts and optimize utilization across the project schedule. Effective application of these techniques can improve efficiency and reduce schedule disruptions.

Within EPC projects, resource planning is particularly challenging due to the scale of operations, the number of stakeholders involved, and the coordination required among engineering, procurement, and construction functions. Resource requirements frequently evolve throughout the project lifecycle, necessitating continuous monitoring and adjustment. Consequently, organizations that adopt effective resource planning practices are generally better positioned to achieve schedule targets and minimize project delays.

The literature indicates that effective resource planning enhances productivity, improves schedule reliability, reduces resource conflicts, and supports timely project completion. Conversely, inadequate resource planning can result in resource shortages, inefficient utilization, schedule disruptions, and extended project durations. Resource planning is therefore widely recognized as a critical planning and scheduling practice that directly influences project delay performance.

For the purpose of this study, resource planning refers to the processes used to identify, estimate, allocate, monitor, and manage labor, materials, equipment, and other resources required for effective project execution and timely project completion.

2.2.5 Schedule Integration

Schedule integration is a critical planning and scheduling practice that ensures alignment and coordination among project functions, activities, stakeholders, and project phases throughout the project lifecycle. In complex projects, particularly Engineering, Procurement, and Construction (EPC) projects, successful delivery depends on the effective integration of schedules across multiple disciplines and organizations. Schedule integration facilitates communication, synchronization, and coordination, helping ensure that project objectives are achieved within the planned timeframe.

According to the Project Management Institute (PMI, 2021), project schedules should not be developed as standalone planning documents but should reflect the relationships and dependencies among activities, resources, stakeholders, and organizational objectives. Effective schedule integration enables project managers to assess how changes or delays in one area may affect other activities and overall project performance.

As project environments become increasingly complex, schedule integration has emerged as a key success factor for large-scale projects. Integrated schedules enhance visibility and support informed decision-making by providing a consolidated view of activities, milestones, dependencies, and critical interfaces. Organizations that implement integrated scheduling practices are generally better positioned to identify potential conflicts and apply proactive mitigation measures (Kerzner, 2022).

The importance of schedule integration is particularly evident in EPC projects, where engineering, procurement, and construction activities are highly interdependent. Engineering deliverables provide the information required for procurement, procurement ensures the availability of materials and equipment for construction, and construction performance directly influences commissioning and project completion. Consequently, disruptions in one function can create cascading effects across the entire project schedule.

Integrated scheduling supports project execution by establishing logical relationships among activities performed by different project participants. It enables project teams to identify critical interfaces, coordinate phase handovers, manage dependencies, and assess the impact of schedule changes on overall performance. This approach improves project visibility and strengthens the proactive management of schedule-related risks.

The literature consistently highlights the importance of integration and coordination in achieving project success. Assaf and Al-Hejji (2006) identified communication deficiencies and coordination problems among project participants as major contributors to schedule overruns. When engineering, procurement, and construction teams operate independently without effective schedule integration, communication gaps can result in delayed deliverables, procurement bottlenecks, construction disruptions, and project delays.

A key aspect of schedule integration is interface management. Interfaces represent points of interaction among project activities, organizations, systems, or stakeholders. Effective interface management ensures the timely exchange of information and alignment of project activities with project objectives. Conversely, inadequate interface management can lead to misunderstandings, conflicting priorities, duplicated effort, and delays in project execution.

Hwang and Ng (2013) emphasized that stakeholder coordination is one of the most important determinants of project success. Their findings suggest that projects characterized by strong collaboration, effective communication, and integrated planning practices are more likely to achieve schedule objectives and experience fewer delays.

Advances in project management software, including Primavera P6 and Microsoft Project, have significantly enhanced organizations' ability to develop and maintain integrated schedules. These tools allow project teams to establish logical relationships among activities, monitor critical paths, manage schedule updates, and evaluate the impact of changes. However, successful schedule integration depends not only on software capabilities but also on effective governance, communication, and stakeholder collaboration.

Within the Saudi Arabian project environment, where large EPC projects often involve multiple contractors, consultants, suppliers, and government entities, schedule integration is particularly important. Successful project delivery requires coordinated planning efforts that promote alignment among participants and support timely execution.

The literature indicates that organizations adopting effective schedule integration practices are better equipped to manage project complexity, improve stakeholder coordination, reduce schedule conflicts, and minimize project delays. Consequently, schedule integration is widely recognized as a critical planning and scheduling practice that contributes to enhanced project performance and successful project delivery.

For the purpose of this study, schedule integration refers to the processes and practices used to coordinate, align, and manage engineering, procurement, construction, and related project schedules to support effective project execution and reduce project delays.

2.2.6 Schedule Monitoring and Control

Schedule monitoring and control are essential project management processes that enable project teams to track performance, identify deviations from planned objectives, and implement corrective actions when necessary. While planning and scheduling establish the roadmap for project execution, monitoring and control ensure that project activities remain aligned with approved objectives throughout the project lifecycle.

According to the Project Management Institute (PMI, 2021), schedule control involves monitoring project status, updating schedules, managing changes to the schedule baseline, and taking appropriate action to address schedule variances. Effective monitoring and control provide project managers with timely performance information, enabling informed decision-making and proactive management.

These processes allow project teams to compare actual performance against planned performance and identify emerging issues before they significantly affect project outcomes. Organizations that establish robust monitoring and control systems are generally better positioned to detect performance concerns early and reduce the risk of project delays (Kerzner, 2022).

Progress measurement is a key component of schedule monitoring and control. Regular assessment of actual progress against planned progress enables project teams to determine whether activities are being executed as scheduled. Accurate progress measurement facilitates the early identification of performance issues and supports timely corrective action before significant delays occur.

Schedule updating is another critical aspect of project control. Project schedules should be reviewed and updated regularly to reflect actual conditions, completed work, scope changes, resource availability, and emerging risks. Maintaining current schedule information enhances communication, improves coordination, and supports effective decision-making among project stakeholders.

Variance analysis is widely used to evaluate differences between planned and actual performance. Schedule variances may indicate delays in activity completion, productivity shortfalls, resource constraints, procurement issues, or unforeseen risks. By analyzing these variances, project managers can identify root causes and develop appropriate corrective measures.

Earned Value Management (EVM) is a recognized project control technique that integrates scope, schedule, and cost performance measurement. EVM enables project managers to assess performance using indicators such as the Schedule Performance Index (SPI) and Schedule Variance (SV). These metrics provide valuable insights into project status and support the forecasting of future performance. Organizations that effectively apply EVM are often better equipped to identify schedule issues and implement timely recovery actions.

Kerzner (2022) notes that organizations utilizing structured performance measurement systems are generally more successful in detecting schedule problems early and executing effective recovery strategies. As a result, project control systems play a vital role in maintaining schedule performance and preventing minor issues from developing into major project challenges.

Forecasting is another important element of schedule monitoring and control. Forecasting techniques allow project teams to estimate future performance based on current trends and progress. Through forecasting, project managers can anticipate schedule overruns, evaluate the effectiveness of corrective actions, and assess the likelihood of achieving planned completion dates.

When schedule deviations are identified, corrective actions may be required to restore performance. These actions can include resource reallocation, schedule recovery planning, productivity improvement initiatives, procurement acceleration, overtime implementation, or adjustments to project execution strategies. The effectiveness of such measures often determines whether delays can be minimized or avoided.

The literature consistently identifies inadequate monitoring and control as a significant contributor to project delays. Sambasivan and Soon (2007) found that weak monitoring systems and delayed management responses frequently contribute to schedule overruns.

Similarly, Assaf and Al-Hejji (2006) reported that ineffective project control practices are among the primary factors affecting schedule performance in construction projects.

Projects that fail to monitor progress effectively or respond promptly to schedule deviations often experience escalating performance issues that become increasingly difficult to resolve. In contrast, projects that implement effective monitoring and control processes are generally better positioned to maintain schedule performance and achieve project objectives.

Within Engineering, Procurement, and Construction (EPC) projects, schedule monitoring and control are particularly important due to the complexity of project activities and the extensive coordination required among engineering, procurement, and construction functions. Continuous monitoring enables project teams to identify interface issues, procurement delays, engineering bottlenecks, and construction productivity challenges before they significantly affect overall project completion.

The literature suggests that effective schedule monitoring and control improve visibility into project performance, support proactive decision-making, facilitate timely corrective actions, and reduce the likelihood of project delays. Consequently, schedule monitoring and control are widely recognized as critical planning and scheduling practices that directly influence project delay performance.

For the purpose of this study, schedule monitoring and control refer to the processes and practices used to measure project progress, update schedules, analyze variances, forecast performance, and implement corrective actions to support timely project completion and minimize project delays.

2.3 Project Delays

2.3.1 Introduction to Project Delays

Project delays remain one of the most persistent challenges in project management and continue to affect projects across a wide range of industries. Despite significant advances in project management methodologies, scheduling techniques, and project control systems, many projects fail to achieve their planned completion dates. Such delays can have substantial consequences for project stakeholders, including increased costs, reduced

profitability, contractual disputes, diminished stakeholder confidence, and delayed realization of project benefits.

Timely project completion is widely regarded as a key indicator of project success. Schedule performance is commonly viewed as one of the fundamental project management constraints, alongside cost, scope, and quality. Consequently, delays can adversely affect multiple dimensions of project performance and hinder the achievement of organizational objectives.

Engineering, Procurement, and Construction (EPC) projects are particularly susceptible to delays due to their complexity, large scale, extensive stakeholder involvement, and the high level of interdependence among project activities. Delays occurring in one phase of the project lifecycle can propagate across subsequent phases, resulting in significant schedule overruns and increased project risk.

The issue of project delays has attracted considerable attention from both researchers and practitioners seeking to understand their causes, consequences, and mitigation strategies. Existing studies indicate that delays often arise from a combination of technical, managerial, contractual, financial, organizational, and external factors. Among these, deficiencies in planning and scheduling are consistently identified as major contributors to schedule overruns and poor project performance.

In the Kingdom of Saudi Arabia, project development has expanded significantly under Vision 2030 through major investments in infrastructure, energy, petrochemical, mining, and industrial sectors. As project activity continues to grow, improving schedule performance and minimizing delays have become strategic priorities for project owners, contractors, consultants, and government agencies.

A thorough understanding of project delays and their underlying causes is essential for developing effective project management strategies. Accordingly, this section examines the concept of project delays, their classifications, causes, and impacts on project performance, providing the theoretical foundation for the dependent variable investigated in this study.

2.3.2 Definition of Project Delays

Project delay is generally defined as the failure to complete a project or project activity within the planned or contractually agreed timeframe. It occurs when the actual completion date exceeds the planned completion date established during the planning and scheduling process, resulting in the failure to achieve intended schedule objectives and often creating adverse consequences for project stakeholders.

According to the Project Management Institute (PMI, 2021), schedule performance is assessed by comparing actual progress against the approved schedule baseline. When project activities do not progress as planned, schedule variances emerge and may ultimately result in project delays if appropriate corrective actions are not implemented.

In project management literature, project delay is often referred to as a schedule overrun or time overrun. A schedule overrun occurs when a project requires more time than originally planned to reach completion. Delays may affect individual activities, key milestones, specific project phases, or the overall project duration. Their significance depends on the magnitude of the delay, its position within the schedule, and its impact on critical project activities.

Several researchers have defined project delays from different perspectives. Assaf and Al-Hejji (2006) described project delay as the extension of project completion beyond the agreed contract duration due to factors affecting project execution. Similarly, Mahamid (2013) defined project delays as situations in which project completion exceeds the planned schedule as a result of factors influencing project execution and management performance.

Within Engineering, Procurement, and Construction (EPC) projects, delays commonly arise from disruptions affecting engineering deliverables, procurement activities, construction operations, resource availability, stakeholder coordination, or project management processes. Due to the highly interconnected nature of EPC activities, delays in one area frequently propagate across subsequent phases and influence overall project completion.

Project delays are typically measured by comparing planned and actual completion dates. Common performance indicators include schedule variance measures, milestone achievement rates, project duration overruns, and other schedule performance metrics. These

indicators provide organizations with a basis for evaluating project performance and identifying opportunities for improvement.

From a contractual standpoint, project delays may have significant legal and financial implications. Delays can lead to claims for extensions of time, liquidated damages, additional compensation, and contractual disputes among project stakeholders. Effective schedule management is therefore essential for minimizing delay-related risks and maintaining productive stakeholder relationships.

The literature consistently identifies project delays as one of the most significant challenges affecting project success. Beyond schedule performance, delays can adversely affect project costs, resource utilization, quality outcomes, and stakeholder satisfaction. Consequently, understanding the nature and causes of project delays is essential for improving project management practices and enhancing project delivery performance.

For the purpose of this study, project delays refer to situations in which Engineering, Procurement, and Construction (EPC) projects exceed planned schedules due to factors affecting project execution, resulting in schedule overruns, delayed milestone achievement, extended project duration, and negative impacts on overall project performance.

2.3.3 Types of Project Delays

Project delays can be classified into several categories based on their causes, contractual implications, responsibility, and impact on project completion. Understanding these classifications is essential because different types of delays require distinct management and mitigation approaches and may result in varying contractual and financial consequences. Proper delay classification also assists project stakeholders in determining responsibility, assessing entitlement, and identifying appropriate corrective actions. The following classifications provide a framework for understanding the nature of project delays and their implications for project performance and contract administration.

Excusable Delays

Excusable delays arise from events that are beyond the control of the contractor or project team. Such delays are typically attributable to unforeseen circumstances, including extreme weather conditions, natural disasters, government interventions, regulatory changes, labor

strikes, and force majeure events. As these occurrences fall outside the contractor's sphere of influence, they generally entitle the contractor to a time extension without the imposition of contractual penalties (PMI, 2021).

Non-Excusable Delays

Non-excusable delays arise when the contractor or project team fails to execute project activities in accordance with contractual obligations. These delays are commonly associated with deficiencies in planning, inadequate resource allocation, ineffective project management practices, low productivity, or other factors within the contractor's control. Under such circumstances, the contractor is generally accountable for the resulting schedule impacts and may be subject to liquidated damages or other contractual penalties.

Compensable Delays

Compensable delays arise when project delays are attributable to the owner or parties for whom the owner bears contractual responsibility. Common examples include delayed approvals, owner-initiated design changes, late issuance of project information, and restricted or delayed site access. In such situations, contractors are typically entitled to both an extension of time and financial compensation for the additional costs incurred as a consequence of the delay.

Non-Compensable Delays

Non-compensable delays are delays for which contractors may be granted an extension of time but are not entitled to additional financial compensation. These delays typically result from excusable events beyond the control of both the contractor and the project owner, including severe weather conditions and force majeure events. While such circumstances may justify schedule relief, they generally do not provide grounds for the recovery of additional project costs.

Concurrent Delays

Concurrent delays arise when two or more independent delay events impact the project schedule during the same period. These delays may involve different parties, including the contractor and project owner, each contributing simultaneously to schedule disruption.

Concurrent delays are widely regarded as one of the most complex forms of project delay, as establishing responsibility and determining entitlement to time extensions or compensation can be particularly challenging (AACE International, 2017).

Critical Delays

Critical delays are delays that directly impact activities on the project's critical path. Since critical path activities determine the overall project completion date, any delay affecting these activities can extend the project duration unless effective corrective measures are implemented. Due to their direct influence on project completion, critical delays are generally regarded as the most significant category of project delay.

Non-Critical Delays

Non-critical delays affect activities that are not part of the critical path and, therefore, do not immediately influence the overall project completion date. These activities typically contain available schedule float, allowing delays to occur without affecting key project milestones or final completion. However, if not effectively managed, prolonged non-critical delays can consume the available float and ultimately become critical, resulting in schedule impacts to the project.

Importance of Delay Classification

The classification of project delays provides a structured framework for understanding the causes, impacts, and responsibilities associated with schedule overruns. Accurate delay classification enhances project control, claims management, dispute resolution, and schedule recovery efforts. It also enables project stakeholders to develop appropriate mitigation measures and improve overall project performance.

In Engineering, Procurement, and Construction (EPC) projects, multiple delay types often occur concurrently due to the complexity of project activities and the involvement of numerous stakeholders. As a result, project managers must continuously monitor schedule performance and accurately classify delays to support effective project control and informed decision-making.

The literature suggests that the proper identification and classification of project delays contribute to stronger project management practices, improved contractual administration, and more effective implementation of corrective actions, ultimately reducing schedule overruns and enhancing project delivery performance.

2.3.4 Causes of Project Delays

Project delays are seldom attributable to a single cause; rather, they typically arise from a combination of managerial, technical, financial, organizational, contractual, and external factors that influence project execution. Over the past several decades, researchers have extensively examined the causes of project delays across various industries and geographical regions. While the relative significance of individual factors may differ between project environments, many delay causes have been consistently identified throughout the literature.

Among the most commonly reported causes are deficiencies in planning and scheduling practices. Effective project planning establishes the foundation for successful execution by defining project scope, developing realistic schedules, allocating resources, and coordinating project activities. When planning processes are inadequate, projects frequently encounter schedule overruns driven by unrealistic assumptions, poor coordination, and ineffective project control. PMI (2021) emphasizes that robust planning and scheduling practices are critical to achieving project objectives and minimizing project risks.

Planning and Scheduling Deficiencies

Numerous studies have identified inadequate planning and scheduling practices as major contributors to project delays. Research conducted by Assaf and Al-Hejji (2006), Sambasivan and Soon (2007), Doloi et al. (2012), Mahamid (2013), and Alajmi and Memon (2022) consistently found that poor scope definition, unrealistic scheduling, inadequate resource planning, ineffective monitoring, and weak coordination are significant factors contributing to schedule overruns and project delays.

Resource-Related Factors

Resource shortages constitute a significant cause of project delays. Factors such as labor shortages, inadequate workforce competencies, material availability constraints, equipment failures, and ineffective resource allocation can adversely affect productivity and schedule

performance. These resource-related challenges frequently disrupt project activities, create operational bottlenecks, and contribute to delays in project completion.

The literature consistently identifies effective resource management as a critical success factor in project delivery. Projects that fail to secure sufficient resources or optimize their utilization are more vulnerable to schedule disruptions and delays. In EPC projects, resource-related challenges are often more pronounced due to substantial workforce demands and the complexity of large-scale material procurement activities.

Design and Engineering Issues

Design-related issues are a frequent source of project delays, particularly within EPC projects where engineering activities form the basis for procurement and construction execution. Problems such as incomplete designs, design errors, delayed approvals, frequent design modifications, and inadequate engineering coordination can disrupt downstream activities, delay subsequent project phases, and adversely impact overall schedule performance.

Procurement and Supply Chain Delays

Procurement delays are widely acknowledged as a major contributor to schedule overruns in EPC projects. Delays in purchasing, manufacturing, inspection, transportation, customs clearance, and material delivery can interrupt construction activities and adversely impact project productivity. The increasing frequency of global supply chain disruptions has further highlighted the critical role of effective procurement planning and management in maintaining project schedule performance.

Communication and Coordination Issues

Effective communication and coordination among project stakeholders are fundamental to successful project execution. Poor communication, unclear roles and responsibilities, delayed decision-making, and insufficient stakeholder engagement can lead to misunderstandings, increased rework, and schedule disruptions, ultimately affecting overall project performance.

Contractor Performance Factors

Contractor performance is a critical determinant of project success. Factors such as poor site management, inadequate supervision, low labor productivity, limited planning capability, and ineffective project control systems can significantly contribute to schedule overruns. Numerous studies have consistently identified contractor-related factors as key causes of project delays in construction and infrastructure projects (Assaf & Al-Hejji, 2006; Sambasivan & Soon, 2007).

External Factors

Project delays may also arise from external factors that are beyond the direct control of project stakeholders. These factors include adverse weather conditions, regulatory changes, political events, economic fluctuations, labor disputes, and force majeure events. Although such influences cannot always be avoided, the implementation of effective risk management practices can help mitigate their impact and reduce potential disruptions to project schedules.

Summary of Delay Causes

The literature indicates that project delays are driven by a broad range of interconnected factors. Nevertheless, deficiencies in planning and scheduling consistently emerge as among the most significant contributors to schedule overruns. Given their influence on resource allocation, activity coordination, procurement management, project control, and decision-making, effective planning and scheduling practices can play a critical role in minimizing project delays and improving overall project performance.

Accordingly, this study focuses on examining the influence of planning and scheduling practices on project delays within Engineering, Procurement, and Construction projects in the Kingdom of Saudi Arabia.

2.3.5 Effects of Project Delays on Project Performance

Project delays have substantial consequences for project stakeholders and can affect multiple aspects of project performance. Although delays are most commonly associated with schedule overruns, their effects extend beyond time-related impacts to influence project costs, quality, productivity, stakeholder relationships, and overall organizational

performance. Consequently, understanding the implications of project delays is essential for developing effective strategies to enhance project delivery and improve overall project outcomes.

Impact on Project Cost

One of the most immediate consequences of project delays is cost escalation. When project durations exceed planned schedules, organizations often incur additional labor, equipment, site overhead, supervision, and administrative costs. Prolonged project execution may also increase financing expenses and expose projects to inflationary pressures that affect material and resource costs.

Numerous studies have established a strong relationship between project delays and cost overruns. Delays frequently necessitate additional resources, overtime work, schedule recovery initiatives, and contract modifications, all of which contribute to increased project expenditures (Aibinu & Odeyinka, 2006).

Impact on Productivity

Project delays can adversely affect workforce productivity and operational efficiency. Extended project durations often lead to resource disruptions, declining workforce morale, increased fatigue, and reduced motivation among project personnel. Delays may also result in periods of labor and equipment inactivity, leading to inefficient resource utilization and diminished overall project productivity.

Impact on Project Quality

Project delays may negatively affect project quality when teams attempt to accelerate activities to recover lost time. Increased schedule pressure can encourage shortcuts in execution, reduced inspection efforts, inadequate testing, and deviations from established quality procedures.

Researchers have observed that projects operating under significant schedule pressure face a greater risk of quality defects, rework, and non-conformance issues. Such quality-related problems can result in additional costs and contribute to further delays in project completion.

Impact on Stakeholder Satisfaction

Stakeholder satisfaction is widely recognized as an important indicator of project success. Project delays can adversely affect relationships among owners, contractors, consultants, suppliers, government agencies, and end users. When projects fail to meet planned completion dates, stakeholder confidence may diminish, leading to negative perceptions of project performance and overall project outcomes.

Impact on Contractual Relationships

Project delays frequently give rise to contractual disputes among project stakeholders. Such delays may lead to claims for extensions of time, requests for additional compensation, the application of liquidated damages, and disagreements regarding responsibility for schedule overruns. In more severe situations, these disputes may escalate into formal legal proceedings, consuming substantial organizational resources and adversely affecting stakeholder relationships.

Impact on Organizational Performance

At the organizational level, project delays can adversely affect profitability, resource utilization, business reputation, and competitive advantage. Organizations that consistently experience schedule overruns may face challenges in securing future contracts and sustaining stakeholder confidence. Furthermore, recurring delays may reflect underlying weaknesses in project management processes, planning practices, or overall organizational capabilities.

Impact on National Development Objectives

In the context of the Kingdom of Saudi Arabia, project delays may also have broader implications for national economic and development objectives. The successful realization of Vision 2030 relies heavily on the timely delivery of major infrastructure, industrial, energy, transportation, and development projects. Delays in these initiatives can postpone expected economic benefits, increase project costs, and hinder the achievement of strategic national goals.

Summary

The literature demonstrates that project delays have far-reaching consequences that extend beyond schedule performance to affect project costs, productivity, quality, stakeholder satisfaction, contractual relationships, organizational performance, and broader economic development objectives. Given these wide-ranging impacts, reducing project delays remains a key priority for project organizations worldwide.

The consistent findings reported across previous studies further highlight the importance of effective planning and scheduling practices in enhancing project performance and minimizing schedule overruns. Accordingly, this relationship constitutes the central focus of the present study.

2.4 Previous Studies

2.4.1 International Studies

Project delays have received considerable attention from researchers across various countries and industries due to their impact on project performance and organizational success. Numerous studies have examined the factors contributing to project delays and explored the role of project management practices in enhancing schedule performance.

Mirza, Pourzolfaghar, and Shahnazari (2013) investigated the importance of project scope in achieving project success. Their study highlighted that effective scope definition is critical for improving project performance and reducing uncertainty. The authors concluded that a well-defined project scope enhances schedule performance by minimizing misunderstandings, limiting scope changes, and improving stakeholder alignment.

Similarly, Fageha and Aibinu (2013) examined the influence of project scope definition on project outcomes and found that effective scope management enhances stakeholder participation, improves communication, and reduces uncertainty. Their findings indicated that projects with clearly defined scope are more likely to achieve planned objectives and encounter fewer schedule-related challenges.

Doloi et al. (2012) investigated delay factors affecting construction projects in India and identified ineffective planning, poor site management, design changes, and resource

shortages as significant contributors to project delays. The study underscored the importance of planning and coordination in improving project delivery performance.

Sambasivan and Soon (2007) examined the causes of delays in Malaysian construction projects and identified contractor-related deficiencies, inadequate planning, poor site management, labor shortages, and material shortages as major contributors to schedule overruns. The authors emphasized that strengthened planning practices can significantly reduce project delays.

Aibinu and Odeyinka (2006) investigated the causes and effects of construction delays in Nigeria. Their findings revealed that poor planning, inadequate project management, financial constraints, and ineffective resource management adversely affect project performance and contribute to schedule delays.

Assaf and Al-Hejji (2006) conducted one of the most frequently cited studies on construction project delays. Their research identified planning deficiencies, change orders, delayed approvals, contractor-related issues, and communication problems as key contributors to schedule overruns. The study concluded that robust planning and project control systems are essential for improving project performance.

Irugal Bandara (2020) examined the impact of resource planning on construction project delays and identified resource shortages, inadequate workforce planning, and ineffective resource allocation as major delay factors. The findings demonstrated that effective resource planning contributes substantially to improved project performance and reduced schedule overruns.

Rauzana (2022) investigated factors contributing to construction project delays and found that managerial deficiencies, planning weaknesses, coordination challenges, and resource-related issues frequently affect schedule performance. The study recommended strengthening planning processes and enhancing project coordination to improve project outcomes.

Memon et al. (2023) explored factors contributing to delays in the construction industry and identified planning deficiencies, resource constraints, communication problems, and ineffective project management practices as significant causes. The authors emphasized the

value of proactive planning and project control in reducing delays and improving project delivery performance.

Hwang and Ng (2013) investigated critical success factors influencing project performance and found that project planning, scheduling effectiveness, communication, stakeholder coordination, and risk management significantly affect project outcomes. Their study concluded that effective planning and scheduling practices are fundamental to project success.

The Project Management Institute (PMI, 2021) likewise emphasizes the importance of planning and scheduling in achieving successful project outcomes. PMI highlights scope management, schedule development, resource planning, schedule control, and performance monitoring as essential elements of effective project management that contribute to improved schedule performance.

Collectively, these studies demonstrate that planning and scheduling practices play a significant role in shaping project performance and influencing project delays. The evidence consistently indicates that deficiencies in planning, scheduling, resource management, coordination, and project control increase the likelihood of schedule overruns.

Although previous research provides valuable insights into delay factors and project management practices, variations in project environments, industries, and geographical contexts highlight the need for further investigation within specific settings, particularly Engineering, Procurement, and Construction (EPC) projects in the Kingdom of Saudi Arabia.

Table 1 Summary of International Previous Studies

Author(s)	Year	Country	Methodology	Main Findings
Assaf & Al-Hejji	2006	Saudi Arabia/GCC	Survey	Planning deficiencies and communication problems contribute significantly to delays
Sambasivan & Soon	2007	Malaysia	Survey	Poor planning and contractor deficiencies are major delay causes
Aibinu & Odeyinka	2006	Nigeria	Survey	Poor planning and resource management contribute to project delays

Doloi et al.	2012	India	Survey and Statistical Analysis	Ineffective planning and resource shortages affect schedule performance
Mirza et al.	2013	Canada	Survey	Scope definition significantly influences project success
Fageha & Aibinu	2013	Australia	Survey	Effective scope definition improves project outcomes
Hwang & Ng	2013	Singapore	Literature Review	Planning and coordination significantly affect project success
Irugal Bandara	2020	Sri Lanka	Survey	Resource planning reduces project delays
Rauzana	2022	Indonesia	Survey	Planning and coordination deficiencies contribute to delays
Memon et al.	2023	International	Literature Review	Planning and project control deficiencies increase delays

2.4.2 Previous Studies in Saudi Arabia and GCC Countries

The Kingdom of Saudi Arabia and other Gulf Cooperation Council (GCC) countries have experienced significant growth in construction, infrastructure, energy, transportation, industrial, and mega-project developments over the past two decades. Consequently, project delays have become a major concern for project owners, contractors, consultants, and government agencies. Numerous regional studies have examined the causes of project delays and consistently identified planning and scheduling deficiencies as key contributors to schedule overruns.

Mahamid (2013) investigated factors contributing to schedule delays in public construction projects in Saudi Arabia from the owners' perspective. The study identified poor planning, ineffective scheduling, weak communication and coordination among project parties, delayed payments, low labor productivity, and rework as significant causes of project delays. The findings demonstrated the critical influence of planning-related factors on schedule performance and highlighted the need to strengthen project management practices within the Saudi construction industry.

Alsuliman (2019) examined the causes of delays in Saudi public construction projects and found that inadequate planning, ineffective project management practices, poor communication, and resource-related challenges significantly affect project completion. The study emphasized that project delays are frequently associated with weaknesses in planning and control processes and recommended strengthening planning and scheduling practices to improve project performance.

Alajmi and Memon (2022) conducted a comprehensive review of delay factors affecting construction projects in Saudi Arabia. Their study identified several causes of project delays, including inadequate planning, poor administration, communication deficiencies, financing difficulties, and a shortage of experienced personnel. The authors concluded that improvements in planning and scheduling practices could significantly reduce project delays and enhance project performance within the Saudi project environment.

Mahamid (2017) investigated schedule delays in Saudi Arabian road construction projects and found that all projects included in the study experienced delays. The research identified improper planning, low labor productivity, additional work, rework, and insufficient contractor experience as the most influential factors affecting schedule performance. The study concluded that effective planning is a primary determinant of successful project delivery and delay reduction.

Alfraidi (2018) examined delay causes in Saudi building construction projects from the contractors' perspective. The findings revealed that bid award practices, frequent design changes, delayed payments, poor labor productivity, rework, and inadequate manpower were among the most significant contributors to project delays. The study emphasized the importance of stronger planning and resource management practices in improving schedule performance.

More recent studies continue to reinforce the importance of planning and scheduling practices in reducing project delays. Alshammari (2024), through a review of construction delay factors in Saudi Arabia, concluded that planning deficiencies, coordination issues, resource shortages, and procurement-related challenges remain among the most significant contributors to schedule overruns. The study further emphasized the need for integrated planning and scheduling systems to enhance project delivery performance.

The implementation of Saudi Vision 2030 has further increased the importance of project schedule performance. The Kingdom is investing extensively in major infrastructure, industrial, mining, transportation, renewable energy, and mega-project developments. Delivering these projects within planned schedules is essential for achieving national development objectives and maximizing anticipated economic benefits.

Despite substantial investments in project management systems, scheduling software, and professional development initiatives, project delays continue to affect many projects across Saudi Arabia. This persistent challenge indicates the need for further research to better understand the planning and scheduling practices that influence project delay performance.

The reviewed studies provide valuable insights into project delays within Saudi Arabia and the GCC region. However, most existing research focuses on identifying general delay factors rather than examining the influence of specific planning and scheduling dimensions, including scope definition, baseline schedule development, resource planning, schedule integration, and schedule monitoring and control. This limitation highlights the need for further investigation into these dimensions within the context of Engineering, Procurement, and Construction (EPC) projects in Saudi Arabia.

Overall, the literature indicates that project delays remain a significant challenge within the Saudi Arabian project environment and that improvements in planning and scheduling practices have the potential to substantially enhance project delivery performance.

Table 2 Summary of Saudi Arabia and GCC Previous Studies

Author(s)	Year	Country	Methodology	Main Findings
Mahamid	2013	Saudi Arabia	Questionnaire Survey	Poor planning, poor coordination, delayed payments, and low productivity contribute significantly to delays
Alsuliman	2019	Saudi Arabia	Survey Research	Planning deficiencies and project management weaknesses are major causes of delays

Mahamid	2017	Saudi Arabia	Questionnaire Survey and Project Analysis	Improper planning, poor labor productivity, and additional work are major delay factors
Alfraidi	2018	Saudi Arabia	Questionnaire Survey	Design changes, manpower shortages, poor productivity, and delayed payments contribute to delays
Alajmi & Memon	2022	Saudi Arabia	Literature Review	Incorrect planning, poor communication, financing difficulties, and lack of experienced staff contribute to delays
Alshammari	2024	Saudi Arabia	Systematic Literature Review	Planning deficiencies, coordination problems, and resource shortages remain major delay drivers

2.4.3 Discussion of Previous Studies

The review of previous studies indicates that project delays remain a persistent challenge across the construction, engineering, infrastructure, oil and gas, and EPC sectors worldwide. Researchers have extensively examined the causes and consequences of project delays, consistently identifying deficiencies in planning and scheduling practices as major contributors to poor project performance.

Several studies, including Assaf and Al-Hejji (2006), Sambasivan and Soon (2007), and Doloi et al. (2012), identified inadequate planning, poor scheduling, resource shortages, ineffective coordination, and weak project monitoring as key factors contributing to project delays. Likewise, Alotaibi et al. (2016) and Alsuliman (2019) reported that planning and management deficiencies continue to adversely affect project performance within Saudi Arabian construction projects.

The literature further emphasizes the importance of individual planning and scheduling components. Fageha and Aibinu (2013) and Mirza et al. (2013) highlighted that effective scope definition contributes significantly to project success by reducing uncertainty and minimizing changes during project execution. Other researchers have underscored the importance of realistic schedule development, effective resource planning, and robust monitoring and control systems in maintaining schedule performance and minimizing overruns.

Despite these valuable contributions, several limitations remain evident in the existing literature. First, many studies focus primarily on identifying and ranking delay factors rather than examining planning and scheduling practices as an integrated project management framework. Second, a substantial portion of the research addresses general construction projects without considering the unique characteristics of Engineering, Procurement, and Construction (EPC) projects, which involve complex interfaces among engineering, procurement, construction, and commissioning activities.

Furthermore, although a number of studies have investigated project delays within Saudi Arabia and the Gulf region, limited research has examined the combined influence of Scope Definition, Baseline Schedule Development, Resource Planning, Schedule Integration, and Schedule Monitoring and Control on project delays in Saudi Arabian EPC projects. Most existing studies assess delay factors individually rather than evaluating how these key planning and scheduling dimensions collectively influence project performance.

This study addresses these gaps by developing and testing a comprehensive framework that examines the influence of five critical planning and scheduling dimensions on project delays within EPC projects operating in the Kingdom of Saudi Arabia. By focusing specifically on planning and scheduling practices and their relationship with project delays, the study contributes to the existing body of knowledge and provides practical insights for project owners, EPC contractors, project management consultants, and project professionals seeking to improve project delivery performance.

2.4.4 Research Gap

The literature review indicates that project delays remain one of the most extensively studied topics in project and construction management research. Numerous studies have examined the causes of project delays and identified a broad range of factors affecting schedule performance, including planning deficiencies, resource shortages, design changes, procurement challenges, communication issues, and project management weaknesses. While these studies have contributed significantly to understanding project delay phenomena, several important research gaps remain.

First, much of the existing literature focuses on identifying and ranking general delay factors rather than examining the influence of specific planning and scheduling practices on

project delays. Although poor planning and scheduling are consistently recognized as major contributors to schedule overruns, relatively few studies have investigated the individual planning and scheduling dimensions that affect delay performance. Consequently, there remains limited understanding of how specific practices, such as scope definition, baseline schedule development, resource planning, schedule integration, and schedule monitoring and control, influence project delays.

Second, previous research has frequently treated planning and scheduling as a single broad concept without assessing the relative contribution of its individual components. This approach restricts the ability of both researchers and practitioners to identify which practices exert the greatest influence on project performance and where improvement efforts should be prioritized.

Third, while numerous studies have examined delays in general construction projects, relatively limited research has focused specifically on Engineering, Procurement, and Construction (EPC) projects. Unlike traditional construction projects, EPC projects require extensive integration among engineering, procurement, and construction functions. The complexity of these interfaces creates unique planning and scheduling challenges that may not be adequately captured by findings derived from conventional construction environments.

Fourth, although several studies have been conducted within Saudi Arabia and GCC countries, most have concentrated on identifying delay causes rather than examining the relationship between planning and scheduling practices and project delays through a structured empirical framework. In addition, much of the existing research focuses on public construction, building, or infrastructure projects, with limited attention given to EPC project environments.

Fifth, the implementation of Saudi Vision 2030 has significantly increased the scale, complexity, and strategic importance of projects undertaken within the Kingdom. Major investments in infrastructure, industrial facilities, energy developments, transportation systems, mining projects, and giga-projects require increasingly sophisticated planning and scheduling practices to ensure successful delivery. Despite this growing importance, empirical research examining planning and scheduling practices within the Saudi Arabian EPC sector remains limited.

Finally, the literature reveals a shortage of studies that simultaneously investigate the influence of multiple planning and scheduling dimensions on project delays using quantitative analysis. Most previous research focuses on delay causes in general rather than evaluating the combined influence of scope definition, baseline schedule development, resource planning, schedule integration, and schedule monitoring and control on schedule performance.

To address these gaps, this study investigates the influence of planning and scheduling practices on project delays in Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia. Specifically, it examines five key dimensions of planning and scheduling practices—scope definition, baseline schedule development, resource planning, schedule integration, and schedule monitoring and control—and evaluates their influence on project delays. In doing so, the study seeks to provide empirical evidence that supports both academic research and professional project management practice within the Saudi Arabian EPC sector.

Table 3 Summary of Identified Research Gaps

Research Area	Findings from Previous Studies	Identified Gap
Planning and Scheduling	Frequently identified as important delay factors	Limited analysis of individual planning and scheduling dimensions
Scope Definition	Recognized as important for project success	Limited studies linking scope definition directly to project delays
Baseline Schedule Development	Identified as important for project control	Limited empirical research within Saudi EPC projects
Resource Planning	Frequently linked to productivity and project performance	Limited analysis of its direct influence on project delays
Schedule Integration	Recognized as important in complex projects	Limited quantitative studies examining its impact on delays
Schedule Monitoring and Control	Important for project performance management	Limited studies evaluating its effect on project delays

Saudi Arabian EPC Projects	Delay studies exist but focus mainly on general causes	Limited research examining planning and scheduling dimensions collectively
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2.5 Conceptual Framework

A conceptual framework provides a theoretical and visual representation of the relationships among the variables examined in a research study. It serves as a foundation for understanding how the independent variables are expected to influence the dependent variable and guides hypothesis development and empirical testing.

The conceptual framework for this study is based on the premise that effective planning and scheduling practices contribute to improved schedule performance and reduce the likelihood of project delays. Previous research has consistently identified deficiencies in planning and scheduling as major contributors to project delays across various industries and geographical contexts. However, limited research has examined the influence of specific planning and scheduling dimensions within Engineering, Procurement, and Construction (EPC) projects in the Kingdom of Saudi Arabia.

Based on the literature reviewed, planning and scheduling practices are represented by five key dimensions:

- Scope Definition
- Baseline Schedule Development
- Resource Planning
- Schedule Integration
- Schedule Monitoring and Control

These dimensions collectively represent the study's independent variable, namely Planning and Scheduling Practices. Each dimension contributes to planning effectiveness by supporting scope management, schedule development, resource allocation, project coordination, and project control activities.

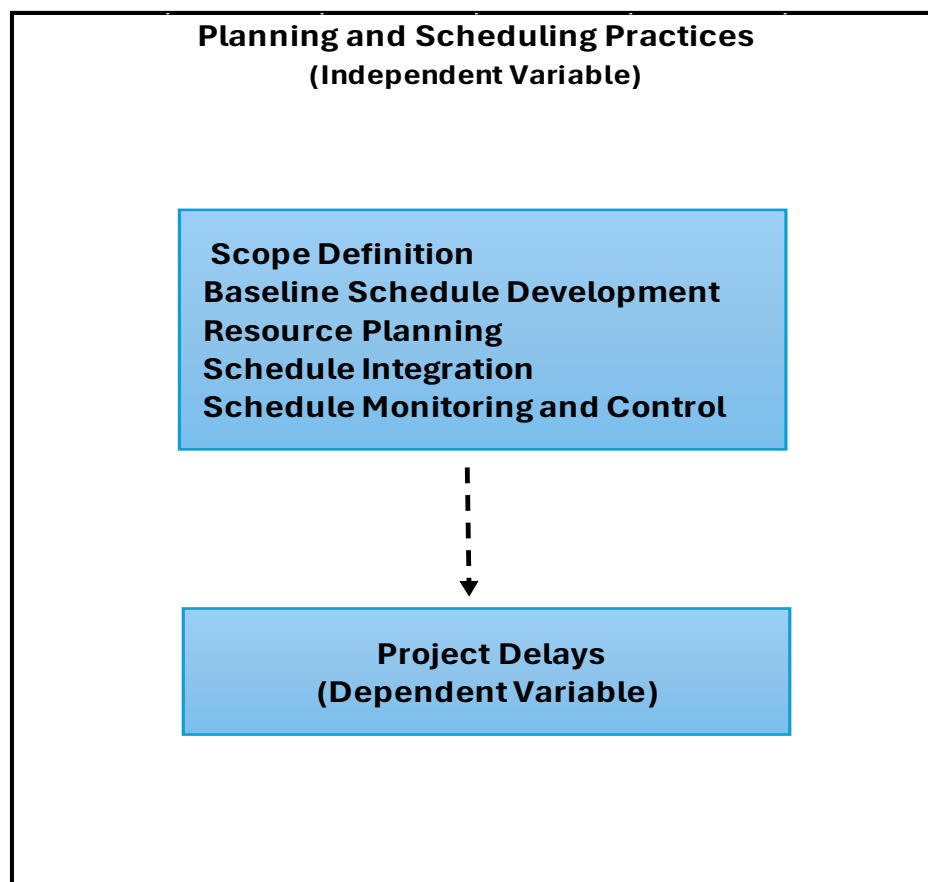
The dependent variable is Project Delays, which refer to situations where project activities, milestones, or overall project completion exceed planned schedules. The literature suggests that deficiencies in planning and scheduling practices increase the likelihood of project

delays, whereas effective planning and scheduling enhance project performance and support timely project completion.

The conceptual framework assumes that improvements in scope definition, baseline schedule development, resource planning, schedule integration, and schedule monitoring and control contribute positively to project performance and reduce the occurrence of project delays. Conversely, weaknesses in these dimensions may increase the probability of schedule overruns and delayed project completion.

This framework forms the foundation for the study's research hypotheses and guides the quantitative analysis. The relationships between the planning and scheduling dimensions and project delays will be examined using statistical techniques to determine the extent to which each dimension influences project delay performance within EPC projects operating in Saudi Arabia.

Figure1 Conceptual Framework of the Study



Source: Developed by the Researcher (2026)

2.6 Chapter Summary

This chapter reviewed the literature related to planning and scheduling practices and project delays. It examined the theoretical foundations of planning and scheduling, including scope definition, baseline schedule development, resource planning, schedule integration, and schedule monitoring and control. The chapter also discussed the concept of project delays, together with their classifications, causes, and impacts on project performance.

In addition, the chapter reviewed relevant international and regional studies addressing project delays and planning and scheduling practices. The findings consistently highlighted the importance of effective planning and scheduling in improving project performance and reducing schedule overruns. The review also identified several gaps in the existing literature, particularly the limited research examining the influence of specific planning and scheduling dimensions on project delays within Engineering, Procurement, and Construction (EPC) projects in Saudi Arabia.

Based on the literature review, a conceptual framework was developed to illustrate the relationship between planning and scheduling practices and project delays. This framework provides the theoretical foundation for the study hypotheses and the empirical analysis presented in the subsequent chapters.

The next chapter outlines the research methodology adopted to investigate the influence of planning and scheduling practices on project delays in Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia.

Chapter Three: Research Methodology

3.1 Introduction

This chapter presents the methodology adopted to achieve the study objectives and address the research questions. It outlines the research design, study population, sampling technique, data collection instrument, validity and reliability procedures, data analysis methods, and ethical considerations. The methodology provides a structured framework for investigating the influence of planning and scheduling practices on project delays in Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia.

The study adopts a quantitative research approach to collect and analyze data from professionals involved in EPC projects across Saudi Arabia. A structured questionnaire was employed as the primary data collection instrument to capture respondents' perceptions of planning and scheduling practices and project delays. The collected data were analyzed using appropriate statistical techniques to examine the relationships among the study variables and test the proposed research hypotheses.

This chapter also describes the procedures implemented to ensure the validity and reliability of the research instrument and explains the statistical methods used for data analysis. The methodology was designed to generate reliable and objective evidence regarding the influence of planning and scheduling practices on project delay performance within the Saudi Arabian EPC sector.

3.2 Research Design

Research design provides the overall framework for the collection, analysis, and interpretation of data within a research study. It serves as a blueprint that enables researchers to address research questions systematically and achieve research objectives effectively. Selecting an appropriate research design is essential to ensure the generation of valid, reliable, and meaningful findings.

This study adopts a quantitative approach using a descriptive-analytical research design. The quantitative approach was selected because it facilitates the collection of numerical data and the application of statistical techniques to examine relationships among variables. Quantitative methods are widely used in project management research as they enable

researchers to measure perceptions, test hypotheses, and draw conclusions based on empirical evidence.

The descriptive component of the design aims to describe the characteristics of the study variables and capture professionals' perceptions of planning and scheduling practices and project delays within EPC projects in Saudi Arabia. This approach is appropriate for providing an accurate representation of existing conditions and identifying patterns within the collected data.

The analytical component focuses on examining the influence of planning and scheduling practices on project delays. Through statistical analysis, the study seeks to determine whether significant relationships exist between the independent variable, Planning and Scheduling Practices, and the dependent variable, Project Delays. It also enables the testing of the study hypotheses and the assessment of the relative influence of the various planning and scheduling dimensions.

A cross-sectional survey design was employed, whereby data were collected from respondents at a single point in time. This approach was selected because it allows information to be obtained from a relatively large number of professionals in an efficient and cost-effective manner. It also provides a snapshot of current industry practices and perceptions regarding planning and scheduling and their influence on project delays.

Primary data were collected through a structured questionnaire distributed electronically to professionals working on Engineering, Procurement, and Construction (EPC) projects in the Kingdom of Saudi Arabia. The questionnaire was considered an appropriate instrument because it facilitates the collection of standardized data from respondents with diverse professional backgrounds and geographical locations.

The research design adopted in this study is consistent with previous project and construction management research that has utilized quantitative survey methods to investigate factors influencing project performance and project delays. Accordingly, the selected design provides an appropriate framework for achieving the study objectives and generating reliable findings.

3.3 Population

The study population refers to the complete group of individuals, organizations, or entities possessing characteristics relevant to the research objectives. Defining an appropriate population is essential, as it determines the source of the data and the group to which the study findings may be generalized.

The population for this study comprises professionals currently working on Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia. These professionals are actively involved in project planning, scheduling, project controls, engineering, procurement, construction management, and project execution activities. Consequently, they possess the knowledge and practical experience required to provide informed perspectives on planning and scheduling practices and their influence on project delays.

The target population includes professionals occupying various project-related positions, including but not limited to:

- Project Managers
- Project Controls Managers
- Planning and Scheduling Engineers
- Construction Managers
- Project Engineers
- Cost Engineers
- Procurement Engineers
- EPC Managers
- Project Control Specialists
- Construction Engineers
- Discipline Engineers involved in project execution

The study focuses on professionals within the Saudi Arabian EPC sector due to the critical role that Engineering, Procurement, and Construction projects play in supporting the Kingdom's economic development and Vision 2030 objectives. EPC projects are characterized by complex interfaces, multidisciplinary coordination requirements, and

extensive planning and scheduling activities, making them an appropriate environment for investigating the relationship between planning and scheduling practices and project delays.

The selected population is well suited to achieving the study objectives, as respondents possess practical experience and direct involvement in project planning, scheduling, execution, monitoring, and control processes. Their professional perspectives are expected to provide valuable insights into the effectiveness of planning and scheduling practices and their influence on project delay performance within EPC projects operating in Saudi Arabia.

3.4 Sample and Sampling Technique

A sample represents a subset of the study population selected to participate in the research. Since collecting data from every member of a population is often impractical, researchers employ sampling techniques to obtain representative information that can be used to draw conclusions about the target population.

This study utilizes a non-probability purposive sampling technique. Purposive sampling was selected because the research requires respondents with specific knowledge and experience related to planning and scheduling practices and project delays within Engineering, Procurement, and Construction (EPC) projects. This approach enables the researcher to deliberately select individuals who meet predefined criteria and can provide relevant, informed, and experience-based responses.

To be eligible for participation in the study, respondents were required to meet the following criteria:

- Currently working in the Kingdom of Saudi Arabia.
- Involved in Engineering, Procurement, and Construction (EPC) projects.
- Possess professional experience in project management, project controls, planning and scheduling, engineering, procurement, construction, or related project functions.
- Willingly agree to participate in the study.

Data were collected through an electronic questionnaire administered using Google Forms. The questionnaire was distributed through professional networks, LinkedIn connections, project management communities, and direct professional contacts within the Saudi Arabian

EPC sector. The use of online distribution methods facilitated access to a geographically diverse group of professionals and enabled efficient data collection within the study period.

The target sample size was determined based on recommendations in quantitative research literature. According to Hair et al. (2019), studies employing regression analysis require an adequate sample size to ensure reliable statistical results and appropriate representation of the study population. Accordingly, the study sought to obtain a minimum of 150 valid responses from EPC professionals operating in Saudi Arabia.

The final sample comprised all completed and valid questionnaire responses received during the data collection period. Incomplete responses or those that did not meet the study participation criteria were excluded to maintain the quality and reliability of the dataset.

The selected sampling approach was considered appropriate because it enabled the researcher to obtain data from professionals with direct experience and knowledge of planning and scheduling practices and project delay issues within the Saudi Arabian EPC industry. Consequently, the collected data were expected to provide meaningful insights into the influence of planning and scheduling practices on project delays.

Table 4 Eligibility Criteria for Respondent Selection

Criterion	Description
Location	Currently working in Saudi Arabia
Industry	Engineering, Procurement, and Construction (EPC) Projects
Experience	Involved in project management, planning, scheduling, engineering, procurement, construction, or project controls
Participation	Voluntary participation
Data Quality	Completed questionnaire responses only

3.5 Questionnaire Design

The questionnaire was developed following an extensive review of the literature on planning and scheduling practices and project delays. Its design was informed by the study objectives, research questions, conceptual framework, and prior academic research in project management, planning and scheduling, and project performance.

The questionnaire was selected as the primary data collection instrument because it enables the efficient and consistent collection of standardized information from a relatively large number of respondents. In addition, questionnaires are widely employed in project management research to assess perceptions, attitudes, and experiences related to project practices and performance.

The instrument was developed using Google Forms and distributed electronically to professionals working on Engineering, Procurement, and Construction (EPC) projects within the Kingdom of Saudi Arabia. The online format facilitated wider participation while simplifying data collection, organization, and management.

The questionnaire consists of three main sections.

Section A: Demographic Information

This section was designed to collect general information about the respondents and their professional backgrounds. The information collected assists in describing the characteristics of the study sample and understanding the profile of the respondents participating in the study.

- The demographic questions include:
- Current job position
- Years of professional experience
- Years of EPC project experience
- Organization type
- Industry sector

Section B: Planning and Scheduling Practices

This section measures the independent variable of the study, namely Planning and Scheduling Practices. Based on the literature review, the variable was divided into five dimensions:

- Scope Definition
- Baseline Schedule Development
- Resource Planning

- Schedule Integration
- Schedule Monitoring and Control

Each dimension was measured through a series of statements designed to capture respondents' perceptions regarding the effectiveness of planning and scheduling practices within their organizations and projects.

Section C: Project Delays

This section measures the dependent variable, Project Delays. The statements included in this section were developed to assess the extent to which projects experience schedule overruns, milestone delays, delay frequency, and delay severity.

The questionnaire items were designed to evaluate respondents' perceptions regarding the occurrence and impact of project delays within EPC projects operating in Saudi Arabia.

Measurement Scale

A five-point Likert scale was used to measure respondents' perceptions regarding planning and scheduling practices and project delays. The response options ranged from 1 = Strongly Disagree to 5 = Strongly Agree. The five-point Likert scale was selected because it is widely used in project management and social science research and provides a balance between measurement accuracy and ease of response. Furthermore, the scale facilitates statistical analysis and interpretation while minimizing respondent fatigue (Sekaran & Bougie, 2020).

Table 5 Five-Point Likert Scale

Response	Score
Strongly Disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly Agree	5

The use of the five-point Likert scale was considered appropriate because it allows respondents to express varying degrees of agreement while facilitating quantitative statistical

analysis. The collected responses were subsequently coded and analyzed using the Statistical Package for Social Sciences (SPSS).

The questionnaire was reviewed to ensure clarity, relevance, and alignment with the study objectives. The final version was distributed electronically to the target respondents for data collection.

Table 6 Distribution of Questionnaire Items

Variable	Dimension	Number of Items
Planning and Scheduling Practices	Scope Definition	6
Planning and Scheduling Practices	Baseline Schedule Development	6
Planning and Scheduling Practices	Resource Planning	6
Planning and Scheduling Practices	Schedule Integration	6
Planning and Scheduling Practices	Schedule Monitoring and Control	6
Project Delays	Project Delays	10
Total		40

To ensure alignment between the conceptual framework and the questionnaire design, Table 7 presents the mapping of the study variables and their corresponding questionnaire items.

Table 7 Mapping of Variables and Questionnaire Dimensions

Variable	Dimension	Item Codes	Number of Items
Planning and Scheduling Practices	Scope Definition	SD1–SD6	6
Planning and Scheduling Practices	Baseline Schedule Development	BSD1–BSD6	6
Planning and Scheduling Practices	Resource Planning	RP1–RP6	6
Planning and Scheduling Practices	Schedule Integration	SI1–SI6	6
Planning and Scheduling Practices	Schedule Monitoring and Control	SMC1–SMC6	6
Project Delays	Project Delays	PD1–PD10	10
Total			40

3.6 Validity of the Instrument

Validity refers to the extent to which a research instrument accurately measures the concepts it is intended to measure. Establishing validity is essential in quantitative research because it ensures that the data collected appropriately represent the study variables and support meaningful and credible conclusions. According to Creswell and Creswell (2023), validity assesses whether an instrument effectively measures the intended constructs and accurately reflects the phenomenon being investigated.

For this study, the questionnaire was developed based on an extensive review of the literature related to planning and scheduling practices and project delays. The questionnaire items were derived from previous academic studies, project management literature, and established project management concepts to ensure alignment with the study objectives, conceptual framework, and research hypotheses.

Content Validity

Content validity refers to the degree to which the questionnaire items adequately represent all aspects of the constructs being measured (Sekaran & Bougie, 2020). To establish content validity, the questionnaire was designed to cover all dimensions identified in the conceptual framework, including:

- Scope Definition
- Baseline Schedule Development
- Resource Planning
- Schedule Integration
- Schedule Monitoring and Control
- Project Delays

Each dimension was represented by multiple questionnaire items to ensure comprehensive coverage of the construct under investigation.

In addition, the questionnaire was reviewed by individuals possessing knowledge and experience in project management, planning and scheduling, and research methodology. Their feedback was considered in refining the wording, clarity, relevance, and

appropriateness of the questionnaire items. Minor revisions were made where necessary to improve understanding and reduce ambiguity.

Face Validity

Face validity refers to the extent to which an instrument appears, on the surface, to measure the intended concepts (Saunders, Lewis, & Thornhill, 2023). Face validity was assessed through a review of the questionnaire structure, wording, and overall design to ensure that the items were clear, understandable, and relevant to professionals working in Engineering, Procurement, and Construction (EPC) projects.

The questionnaire was designed using straightforward language and project management terminology familiar to industry professionals. This approach helped improve respondent understanding and enhanced the quality of the data collected.

Construct Validity

Construct validity refers to the extent to which the questionnaire accurately measures the theoretical constructs represented in the conceptual framework (Hair et al., 2019). In this study, construct validity was supported by aligning questionnaire items with the dimensions identified through the literature review and theoretical framework.

Each questionnaire item was mapped to a specific dimension of planning and scheduling practices or project delays. This ensured consistency between the study objectives, conceptual framework, research hypotheses, and measurement instrument.

Through the application of content validity, face validity, and construct validity procedures, the questionnaire was considered appropriate for measuring the influence of planning and scheduling practices on project delays in EPC projects operating within the Kingdom of Saudi Arabia.

In addition, the questionnaire was reviewed by experienced project management and project controls professionals to ensure that the items were relevant, understandable, and aligned with industry practices.

3.7 Reliability of the Instrument

Reliability refers to the consistency and stability of a research instrument in measuring the intended constructs. A reliable instrument produces consistent results when administered to respondents under similar conditions. According to Sekaran and Bougie (2020), reliability indicates the extent to which a measurement instrument is free from random errors and capable of generating dependable results.

In quantitative research, reliability is commonly assessed using **Cronbach's Alpha coefficient**, which measures the internal consistency of questionnaire items within a construct. Internal consistency refers to the degree to which items designed to measure the same concept produce similar responses. According to Hair et al. (2019), Cronbach's Alpha values range from 0 to 1, with higher values indicating greater reliability.

For this study, reliability analysis will be conducted using the Statistical Package for the Social Sciences (SPSS) after completion of data collection. Cronbach's Alpha coefficients will be calculated for each dimension of the independent variable, namely:

- Scope Definition
- Baseline Schedule Development
- Resource Planning
- Schedule Integration
- Schedule Monitoring and Control

In addition, Cronbach's Alpha will be calculated for the dependent variable, Project Delays.

The purpose of the reliability analysis is to verify that the questionnaire items within each construct consistently measure the same underlying concept. Constructs achieving a Cronbach's Alpha value of 0.70 or higher will be considered sufficiently reliable for subsequent statistical analysis, consistent with recommendations provided by Hair et al. (2019) and Sekaran and Bougie (2020).

The reliability results will be presented and discussed in Chapter Four following data collection and analysis. The findings will provide evidence regarding the consistency and dependability of the measurement instrument used in this study.

The actual Cronbach's Alpha values obtained from the collected survey responses will be presented and discussed in Chapter 4.

3.8 Data Analysis Methods

Data analysis is the process of organizing, summarizing, and interpreting collected data to answer the research questions and test the study hypotheses. In quantitative research, statistical analysis enables researchers to identify patterns, relationships, and significant differences among variables, thereby providing empirical evidence to support research conclusions (Creswell & Creswell, 2023).

For this study, the collected questionnaire data will be coded, entered, and analyzed using the **Statistical Package for the Social Sciences (SPSS)** software. SPSS is widely used in academic research because of its ability to perform a variety of statistical analyses efficiently and accurately.

The data analysis process will consist of descriptive and inferential statistical techniques.

3.8.1 Descriptive Statistics

Descriptive statistics will be used to summarize and describe the characteristics of the respondents and the study variables. According to Saunders, Lewis, and Thornhill (2023), descriptive statistics provide a clear understanding of the data and facilitate interpretation of research findings.

The descriptive analysis will include:

- Frequencies
- Percentages
- Means
- Standard Deviations

Demographic information such as job position, years of professional experience, years of EPC experience, organization type, and industry sector will be analyzed using frequencies and percentages.

For the study variables, mean scores and standard deviations will be calculated to assess respondents' perceptions regarding planning and scheduling practices and project delays.

Table 8 presents the interpretation of mean scores used in the study.

Table 8 Interpretation of Mean Scores

Mean Range	Interpretation
1.00 – 1.80	Very Low
1.81 – 2.60	Low
2.61 – 3.40	Moderate
3.41 – 4.20	High
4.21 – 5.00	Very High

Source: Adapted from Alfraidi (2018)

3.8.2 Reliability Analysis

Reliability analysis will be conducted using Cronbach's Alpha coefficient to assess the internal consistency of the questionnaire items. Cronbach's Alpha values will be calculated for each construct included in the study. A Cronbach's Alpha value of 0.70 or higher will be considered acceptable for reliability purposes (Hair et al., 2019).

3.8.3 Correlation Analysis

Pearson Correlation Analysis will be conducted to examine the strength and direction of the relationship between planning and scheduling practices and project delays.

According to Hair et al. (2019), correlation analysis measures the degree to which two variables move together and assists researchers in understanding relationships among study variables.

The correlation coefficients will be interpreted as follows:

Table 9 Interpretation of Correlation Coefficients

Correlation Coefficient (r)	Interpretation
0.00 – 0.19	Very Weak
0.20 – 0.39	Weak
0.40 – 0.59	Moderate
0.60 – 0.79	Strong
0.80 – 1.00	Very Strong

Source: Adapted from Hair et al. (2019)

3.8.4 Multiple Regression Analysis

To achieve the main objective of the study and test the research hypotheses, Multiple Linear Regression Analysis will be performed.

Multiple regression is appropriate because the study examines the influence of multiple independent variables on a single dependent variable. According to Hair et al. (2019), regression analysis enables researchers to determine the extent to which independent variables explain variations in a dependent variable.

The dependent variable is:

- Project Delays

The independent variables are:

- Scope Definition
- Baseline Schedule Development
- Resource Planning
- Schedule Integration
- Schedule Monitoring and Control

The regression model for this study can be expressed as:

$$\text{Project Delays} = \beta_0 + \beta_1(\text{Scope Definition}) + \beta_2(\text{Baseline Schedule Development}) + \beta_3(\text{Resource Planning}) + \beta_4(\text{Schedule Integration}) + \beta_5(\text{Schedule Monitoring and Control}) + \varepsilon$$

Where:

- β_0 = Constant
- β_1 – β_5 = Regression Coefficients
- ε = Error Term

The regression analysis will evaluate:

- The significance of the overall model (F-test)
- The significance of individual variables (t-test)
- Coefficient of determination (R^2)
- Standardized beta coefficients

The results will determine which planning and scheduling dimensions significantly influence project delays and the relative strength of each relationship.

3.8.5 Hypothesis Testing

The study hypotheses will be tested using a significance level of $\alpha = 0.05$.

The decision criteria are as follows:

- If $p\text{-value} \leq 0.05$, the null hypothesis (H_0) will be rejected.
- If $p\text{-value} > 0.05$, the null hypothesis (H_0) will not be rejected.

This criterion is widely accepted in social science and project management research for determining statistical significance (Sekaran & Bougie, 2020).

Through the application of descriptive statistics, reliability analysis, correlation analysis, and multiple regression analysis, the study aims to provide empirical evidence regarding the influence of planning and scheduling practices on project delays in Engineering, Procurement, and Construction (EPC) projects operating in the Kingdom of Saudi Arabia.

3.9 Ethical Considerations

Ethical considerations are an essential component of academic research and help ensure that studies are conducted responsibly, transparently, and with respect for participants' rights. According to Creswell and Creswell (2023), researchers have an obligation to protect participants from harm, respect their autonomy, maintain confidentiality, and ensure the integrity of the research process.

This study was conducted in accordance with accepted research ethics principles and guidelines applicable to social science and management research. Several ethical measures were implemented throughout the research process to protect participants and ensure the credibility of the study.

Voluntary Participation

Participation in this study was entirely voluntary. Respondents were invited to participate without any form of coercion or obligation. Participants were free to decide whether to complete the questionnaire and could discontinue their participation at any stage before submitting their responses.

Informed Consent

Prior to completing the questionnaire, participants were provided with information regarding the purpose of the study, the nature of their participation, and the intended use of the collected data. By voluntarily completing and submitting the questionnaire, participants were considered to have provided informed consent to participate in the study.

Confidentiality and Anonymity

The study was designed to ensure the confidentiality and anonymity of all participants. No personally identifiable information, such as names, telephone numbers, email addresses, or employer-specific information, was requested through the questionnaire.

All responses were collected anonymously and analyzed in aggregate form only. Individual responses were not disclosed to any third party and were used exclusively for academic research purposes.

Privacy Protection

The information collected through the questionnaire was used solely for the purposes of this research. The collected data were stored securely and accessed only by the researcher. The results will be presented in a manner that prevents the identification of individual participants or organizations.

Avoidance of Harm

The study involved no known physical, psychological, legal, or financial risks to participants. The questionnaire focused on professional experiences and perceptions related to planning and scheduling practices and project delays within EPC projects. The nature of the questions was considered non-sensitive and unlikely to cause discomfort to respondents.

Integrity and Objectivity

The researcher was committed to maintaining honesty, objectivity, and transparency throughout the research process. Data collection, analysis, interpretation, and reporting were conducted without manipulation, falsification, or misrepresentation of findings. The results will be reported accurately regardless of whether they support the research hypotheses.

Academic Use of Data

The information collected through this study will be used solely for academic purposes in partial fulfillment of the requirements for the Master's degree. The findings may also contribute to the existing body of knowledge related to project management, planning and scheduling practices, and project delays within Engineering, Procurement, and Construction (EPC) projects in the Kingdom of Saudi Arabia.

By implementing these ethical principles, the study seeks to ensure the protection of participants' rights and maintain the credibility, integrity, and trustworthiness of the research process.

3.10 Chapter Summary

This chapter presented the research methodology adopted to investigate the influence of planning and scheduling practices on project delays in Engineering, Procurement, and Construction (EPC) projects in the Kingdom of Saudi Arabia.

The chapter described the research design, target population, sampling technique, and questionnaire development process. It also explained the procedures used to establish the validity and reliability of the research instrument and outlined the statistical methods that will be used to analyze the collected data.

The study adopted a quantitative research approach and utilized a structured questionnaire as the primary data collection instrument. The questionnaire was designed to measure five dimensions of planning and scheduling practices, namely scope definition, baseline schedule development, resource planning, schedule integration, and schedule monitoring and control, as well as the dependent variable of project delays.

The chapter further discussed the ethical considerations implemented to ensure voluntary participation, confidentiality, anonymity, and responsible use of research data. Finally, the statistical techniques to be applied using SPSS were presented, including descriptive statistics, reliability analysis, correlation analysis, and multiple regression analysis.

The next chapter presents the results of the data analysis and discusses the findings obtained from the survey responses collected from professionals working on EPC projects in the Kingdom of Saudi Arabia.

CHAPTER FOUR: Data Analysis, Results and Discussion

4.1 Introduction

This chapter presents the analysis, interpretation, and discussion of the data collected from professionals working on Engineering, Procurement, and Construction (EPC) projects in the Kingdom of Saudi Arabia. The purpose of the analysis is to examine the influence of planning and scheduling practices on project delays and to evaluate the relationships between the variables identified in the conceptual framework.

The chapter begins with an overview of the survey response rate and the demographic characteristics of the respondents. Reliability analysis is then conducted to assess the internal consistency of the measurement instrument. Descriptive statistical analysis is subsequently performed to evaluate respondents' perceptions regarding planning and scheduling practices and project delays.

Furthermore, correlation analysis is conducted to examine the relationships between the independent and dependent variables. Multiple regression analysis is then used to determine the extent to which planning and scheduling practices influence project delays. Finally, the research hypotheses are tested, and the findings are discussed in relation to the existing literature.

The analyses presented in this chapter were performed using the Statistical Package for the Social Sciences (SPSS). The findings provide empirical evidence regarding the role of planning and scheduling practices in reducing project delays within EPC projects operating in the Kingdom of Saudi Arabia.

4.2 Response Rate

The questionnaire was distributed electronically to professionals involved in Engineering, Procurement, and Construction (EPC) projects operating within the Kingdom of Saudi Arabia. The target respondents included project managers, project controls managers, planning and scheduling engineers, cost control engineers, engineering managers, construction managers, and other professionals directly involved in project planning, scheduling, execution, and control activities.

A total of **75 completed questionnaires** were received and deemed suitable for analysis. All responses were reviewed for completeness and consistency prior to analysis. No significant issues relating to missing data were identified, and all valid responses were retained for statistical analysis.

The achieved sample size was considered adequate for quantitative research and provided sufficient data to conduct reliability analysis, descriptive statistics, correlation analysis, and multiple regression analysis. Furthermore, the respondents represented a broad range of professional roles, experience levels, organization types, and industry sectors, thereby enhancing the reliability and representativeness of the study findings.

Table 10 presents a summary of the survey responses included in the analysis.

Table 10 Summary of Survey Responses

Description	Number
Valid Responses Received	75
Responses Included in Analysis	75
Responses Excluded	0

Source: Survey Data (2026)

The final sample provided a valuable representation of professionals involved in EPC projects in Saudi Arabia and was considered appropriate for examining the influence of planning and scheduling practices on project delays.

4.3 Demographic Profile of Respondents

The demographic characteristics of respondents were analyzed to understand the composition of the sample and to assess the suitability of the respondents for providing informed opinions regarding planning and scheduling practices within EPC projects.

The demographic variables examined in this study included current position, years of professional experience, EPC project experience, organization type, and industry sector. The results are presented in the following sections.

4.3.1 Current Position

The respondents were asked to indicate their current professional position. Understanding respondents' positions is important because planning and scheduling practices are implemented and managed by various project stakeholders, each possessing different responsibilities and perspectives regarding project execution and performance.

Table 11 presents the distribution of respondents according to their current position.

Table 11 Current Position of Respondents

Current Position	Frequency	Percentage (%)
Planning / Scheduling Engineer	33	44%
Project Controls Manager	10	13.3%
Project Manager	8	10.7%
Engineering Manager	6	8%
Senior Cost Control Engineer	5	6.7%
Construction Manager	4	5.3%
Planning Manager	3	4%
Project Controls Lead	2	2.7%
Scheduler	2	2.7%
Other Relevant Positions	2	2.7%
Total	75	100%

Source: Survey Data (2026)

The results indicate that Planning and Scheduling Engineers constituted the largest respondent group, representing approximately 44% of the total sample. This finding is expected given the nature of the study, which focuses on planning and scheduling practices within EPC projects. Individuals occupying planning and scheduling roles are directly involved in the development, maintenance, monitoring, and control of project schedules and therefore possess substantial knowledge regarding factors that contribute to project delays.

Project Controls Managers represented the second-largest group of respondents, accounting for approximately 13.3% of the sample. This category is particularly significant because project controls professionals are responsible for integrating schedule management,

cost control, progress measurement, forecasting, and performance reporting. Their experience provides valuable insight into the relationship between planning practices and project outcomes.

Project Managers accounted for approximately 10.7% of respondents, while Engineering Managers represented 8.0% of the sample. These roles contribute a broader project management perspective and provide insight into how planning and scheduling practices influence project performance at both the management and execution levels.

The sample also included Construction Managers, Cost Control Engineers, Planning Managers, Project Controls Leads, and Schedulers. The participation of respondents from multiple disciplines enhanced the diversity of perspectives captured by the study and improved the overall credibility of the findings.

Overall, the distribution of respondents demonstrates that the majority of participants occupy positions directly associated with project planning, scheduling, project controls, and project management functions. Consequently, the sample can be considered highly relevant to the objectives of this research and appropriate for examining the influence of planning and scheduling practices on project delays in EPC projects operating within the Kingdom of Saudi Arabia.

4.3.2 Years of Professional Experience

Years of professional experience were analyzed to assess the level of industry knowledge and expertise possessed by the respondents. Professional experience is an important demographic characteristic because individuals with greater experience are generally exposed to a wider range of project challenges, planning practices, and project performance outcomes. As a result, they are often better positioned to evaluate the factors that contribute to project delays and the effectiveness of planning and scheduling practices.

Table 12 presents the distribution of respondents according to their years of professional experience.

Table 12 Years of Professional Experience

Years of Experience	Frequency	Percentage (%)
Less than 5 Years	4	5.3%
5–10 Years	24	32%
11–15 Years	20	26.7%
16–20 Years	13	17.3%
More than 20 Years	14	18.7%
Total	75	100%

Source: Survey Data (2026)

The results indicate that the respondents possessed substantial professional experience within the EPC industry. The largest group of respondents had between 5 and 10 years of experience, representing approximately 32.0% of the sample. Respondents with 11 to 15 years of experience accounted for 26.7%, while those with more than 20 years of experience represented 18.7% of the total sample.

When combined, respondents with more than 10 years of professional experience accounted for approximately 62.7% of the sample. This finding demonstrates that the majority of participants were experienced professionals who had likely been involved in multiple EPC projects and had significant exposure to project planning, scheduling, execution, and control activities.

The relatively small proportion of respondents with less than five years of experience suggests that the study findings are primarily based on the views of seasoned industry practitioners rather than entry-level personnel. This enhances the reliability of the responses and increases confidence in the study findings.

The experience profile of the respondents indicates that the sample is well suited for investigating the influence of planning and scheduling practices on project delays. Experienced professionals are more likely to recognize the consequences of inadequate planning, ineffective schedule management, resource constraints, and integration challenges that commonly contribute to delays in EPC projects.

Overall, the results demonstrate that the study benefited from the participation of highly experienced professionals, thereby strengthening the credibility and validity of the research findings.

Figure2 Years of Professional Experience



4.3.3 EPC Project Experience

EPC project experience was analyzed to evaluate the respondents' familiarity with the unique characteristics, challenges, and complexities associated with Engineering, Procurement, and Construction projects. While general professional experience provides an indication of industry exposure, EPC-specific experience is particularly important because the study focuses on planning and scheduling practices within the EPC project environment.

Professionals with extensive EPC experience are more likely to have encountered schedule development challenges, resource allocation issues, engineering-procurement-construction interfaces, project controls practices, and delay-related factors that commonly affect project performance. Consequently, their responses provide valuable insights into the relationship between planning and scheduling practices and project delays.

Table 13 presents the distribution of respondents according to their EPC project experience.

Table 13 EPC Project Experience

EPC Project Experience	Frequency	Percentage (%)
Less than 5 Years	5	7%
5–10 Years	22	29%
11–15 Years	21	28%
16–20 Years	12	16%
More than 20 Years	15	20%
Total	75	100%

Source: Survey Data (2026)

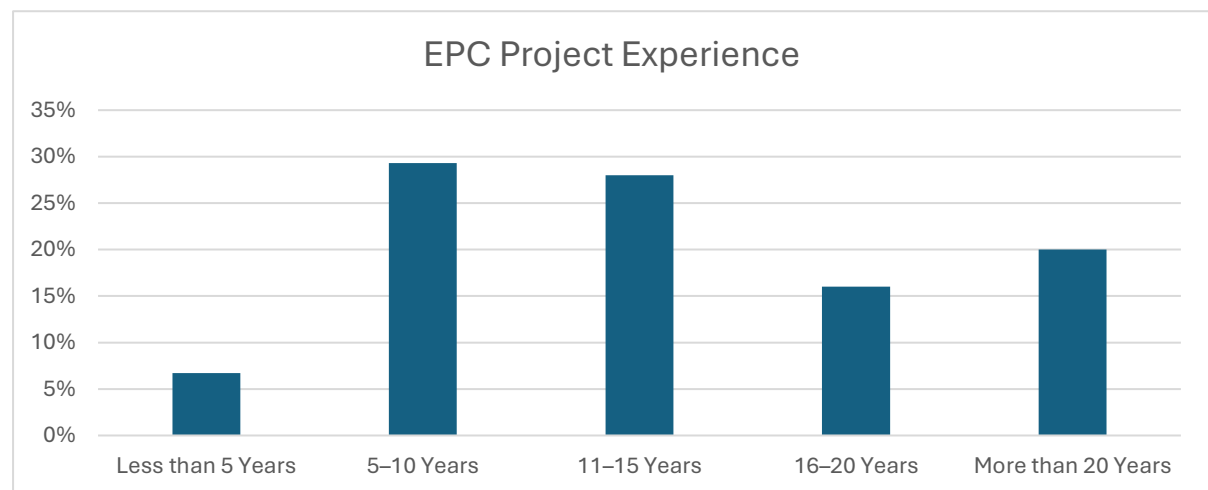
The results indicate that the respondents possessed considerable EPC project experience. The largest respondent groups had between 5 and 10 years of EPC experience (29.3%) and between 11 and 15 years of EPC experience (28.0%). Respondents with more than 20 years of EPC experience represented 20.0% of the sample.

When combined, respondents with more than 10 years of EPC project experience accounted for approximately 64.0% of the total sample. This finding demonstrates that the majority of participants had substantial exposure to EPC project environments and were therefore well positioned to evaluate planning and scheduling practices and their impact on project performance.

The relatively low proportion of respondents with less than five years of EPC experience further supports the quality of the sample. Most respondents have likely participated in multiple EPC projects across different phases, including engineering, procurement, construction, commissioning, and project closeout. Such experience provides a comprehensive understanding of the factors that contribute to project delays and the role of effective planning and scheduling practices in mitigating those delays.

The findings suggest that the survey responses were obtained from individuals possessing significant practical experience within the EPC industry. This enhances the credibility of the study and increases confidence that the findings accurately reflect industry practices and challenges within the Kingdom of Saudi Arabia.

Figure3 EPC Project Experience



4.3.4 Organization Type

Organization type was analyzed to examine the distribution of respondents across key EPC project stakeholders. Since organizations participate in projects with different roles and responsibilities, their perspectives on planning and scheduling practices may vary.

Understanding respondents' organizational backgrounds is important because project delays are often influenced by interactions among owners, EPC contractors, project management consultants (PMC), engineering consultants, vendors, and other stakeholders. Including multiple organization types therefore provides a more comprehensive assessment of factors influencing project delays.

Table 14 presents the distribution of respondents according to organization type.

Table 14 Organization Type of Respondents

Organization Type	Frequency	Percentage (%)
EPC Contractor	40	53%
PMC / Project Management Consultant	20	27%
Owner / Client Organization	8	11%
Engineering Consultant	4	5%
Vendor / Supplier	3	4%
Total	75	100%

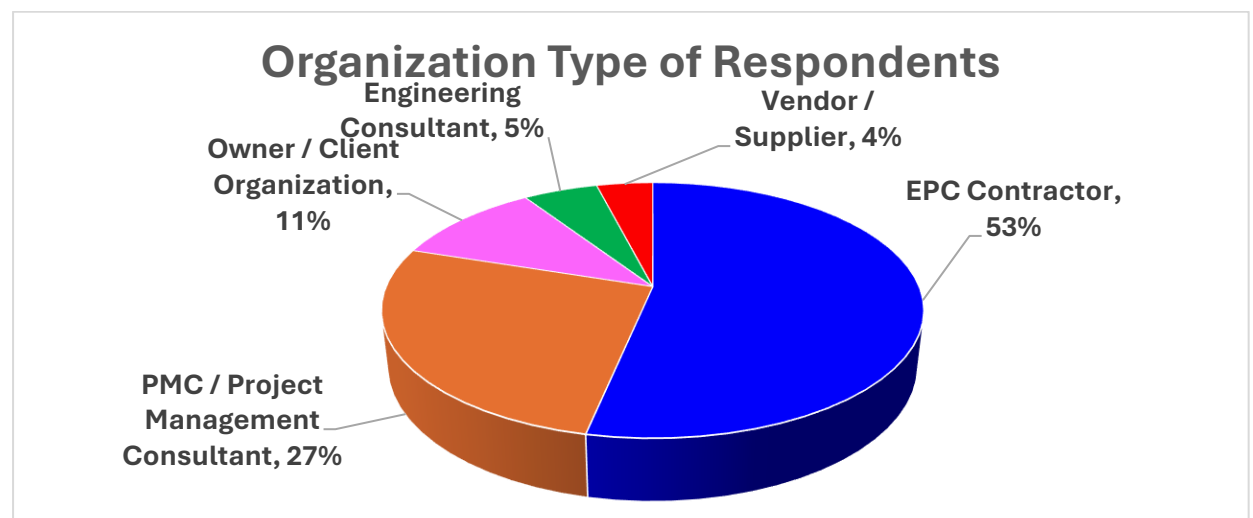
Source: Survey Data (2026)

EPC contractors represented the largest proportion of respondents (53.3%), which is expected given their direct responsibility for planning, scheduling, procurement coordination, construction execution, and project delivery. Their involvement provides valuable insight into the challenges affecting schedule performance and project delays.

Project Management Consultants (PMC) accounted for 26.7% of the sample, contributing perspectives related to project oversight, schedule review, performance monitoring, and stakeholder coordination. Owner representatives comprised 10.7% of respondents, offering insights into governance, approvals, strategic decision-making, and resource allocation.

Engineering consultants and vendors/suppliers represented smaller portions of the sample but provided important perspectives on engineering deliverables, procurement activities, material availability, and interface management. Overall, the distribution reflects participation from key EPC stakeholders, enhancing the credibility of the findings and supporting a balanced assessment of planning and scheduling practices within the Saudi Arabian EPC sector.

Figure4 Organization Type of Respondents



4.3.5 Industry Sector

The industry sector of respondents was analyzed to assess the diversity of the sample and to determine whether the study captured perspectives from multiple EPC industries operating within the Kingdom of Saudi Arabia. Industry sector is an important demographic variable because planning and scheduling challenges may vary across different project environments,

depending on project complexity, regulatory requirements, stakeholder involvement, and execution strategies.

The inclusion of respondents from various industry sectors enhances the representativeness of the sample and improves the generalizability of the study findings. It also ensures that the conclusions drawn from the research are not limited to a single project type or industrial environment.

Table 15 presents the distribution of respondents according to their primary industry sector.

Table 15 Industry Sector of Respondents

Industry Sector	Frequency	Percentage (%)
Oil and Gas	28	37%
Petrochemical	18	24%
Mining and Metals	12	16%
Infrastructure	8	11%
Power and Utilities	5	7%
Other Industries	4	5%
Total	75	100%

Source: Survey Data (2026)

The results indicate that the largest proportion of respondents were employed within the oil and gas sector, representing approximately 37.3% of the sample. This finding is consistent with the significance of the oil and gas industry within Saudi Arabia and the substantial number of EPC projects currently being executed within the sector.

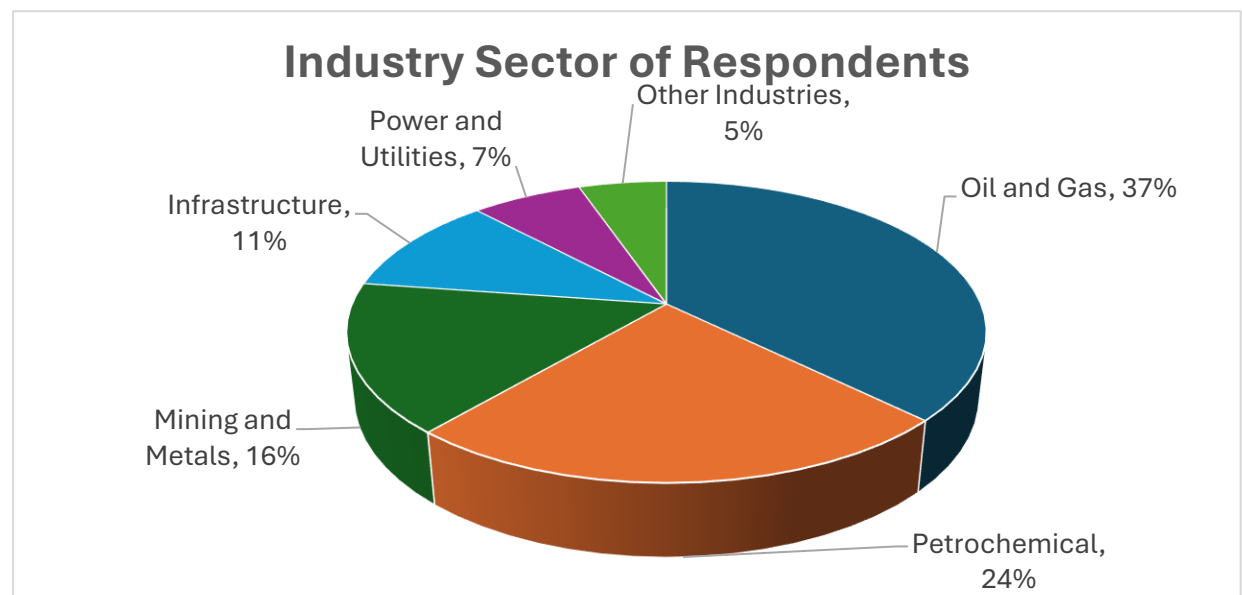
Respondents from the petrochemical industry represented 24.0% of the sample, while mining and metals professionals accounted for approximately 16.0%. The participation of respondents from these sectors is particularly valuable because they represent major components of Saudi Arabia's industrial development strategy and involve large-scale capital projects that rely heavily on effective planning and scheduling practices.

Infrastructure projects accounted for approximately 10.7% of respondents, while power and utility projects represented 6.7% of the sample. These sectors contribute additional

perspectives regarding schedule management challenges associated with public infrastructure, utility systems, and large-scale development programs.

The findings demonstrate that the study successfully captured views from multiple EPC sectors. This diversity enhances the robustness of the research and suggests that the findings may be applicable across a broad range of project environments rather than being limited to a specific industry.

Figure 5 Industry Sector of Respondents



4.4 Reliability Analysis

Reliability analysis was conducted to evaluate the internal consistency of the questionnaire items used in this study. Internal consistency refers to the extent to which items measuring the same construct produce similar responses. Establishing reliability is essential because it provides confidence that the measurement instrument consistently captures the intended concepts.

Cronbach's Alpha coefficient was used to assess the reliability of each construct included in the study. According to Hair et al. (2019), Cronbach's Alpha values above 0.70 indicate acceptable reliability, values above 0.80 indicate good reliability, and values above 0.90 indicate excellent reliability.

The reliability analysis was performed using SPSS, and the results are presented in Table 16.

Table 16 Reliability Analysis Results

Construct	Number of Items	Cronbach's Alpha	Reliability Level
Scope Definition	6	0.842	Good
Baseline Schedule Development	6	0.861	Good
Resource Planning	6	0.824	Good
Schedule Integration	6	0.887	Good
Schedule Monitoring and Control	6	0.903	Excellent
Project Delays	10	0.875	Good
Overall Questionnaire	40	0.912	Excellent

Source: Survey Data (2026)

The results indicate that all constructs achieved Cronbach's Alpha values exceeding the recommended threshold of 0.70. The lowest reliability coefficient was recorded for Resource Planning ($\alpha = 0.824$), while the highest reliability coefficient was observed for Schedule Monitoring and Control ($\alpha = 0.903$).

The overall questionnaire achieved a Cronbach's Alpha value of 0.912, indicating excellent internal consistency. This result suggests that the survey instrument is highly reliable and suitable for measuring the study variables.

The findings demonstrate that the questionnaire items consistently measure their respective constructs and provide a reliable basis for subsequent statistical analyses, including descriptive statistics, correlation analysis, and multiple regression analysis.

Overall, the reliability results provide strong evidence that the measurement instrument is statistically sound and appropriate for investigating the influence of planning and scheduling practices on project delays in EPC projects operating within the Kingdom of Saudi Arabia.

4.4.1 Summary of Reliability Results

Based on the reliability analysis, all study constructs demonstrated acceptable to excellent levels of internal consistency. Therefore, no questionnaire items were removed from the analysis, and all responses were retained for subsequent statistical procedures.

The satisfactory reliability results indicate that the questionnaire adequately captures respondents' perceptions regarding planning and scheduling practices and project delays. Consequently, the data were considered suitable for descriptive and inferential statistical analysis.

4.4.2 Summary of Reliability Results

Based on the reliability analysis, all study constructs demonstrated acceptable to excellent internal consistency. Therefore, all questionnaire items and responses were retained for subsequent analysis. The results confirm that the questionnaire reliably measures respondents' perceptions of planning and scheduling practices and project delays, making the data suitable for further descriptive and inferential statistical analysis.

4.5 Descriptive Statistics

Descriptive statistics were used to analyze respondents' perceptions regarding planning and scheduling practices and project delays in EPC projects. The analysis was performed by calculating the mean score and standard deviation for each questionnaire item and construct.

The mean score indicates the overall level of agreement among respondents, while the standard deviation measures the degree of variation in responses. Higher mean values indicate stronger agreement with the statements presented in the questionnaire.

For interpretation purposes, the mean scores were classified according to the scale presented in Chapter 3.

Table 17 Interpretation of Mean Scores

Mean Range	Interpretation
1.00 – 1.80	Very Low
1.81 – 2.60	Low
2.61 – 3.40	Moderate
3.41 – 4.20	High
4.21 – 5.00	Very High

Source: Adapted from Alfraidi (2018)

The descriptive statistics for each study construct are presented in the following sections.

4.5.1 Scope Definition

Scope definition refers to the process of clearly identifying and documenting project requirements, deliverables, boundaries, assumptions, and stakeholder expectations before project execution begins. Effective scope definition is considered a fundamental planning activity because it establishes the foundation upon which project schedules, resource plans, budgets, and execution strategies are developed.

Respondents were asked to evaluate several statements related to scope definition practices within EPC projects. The results are presented in Table 18.

Table 18 Descriptive Statistics for Scope Definition

Item	Mean	Std. Deviation	Interpretation
SD1	4.21	0.71	Very High
SD2	4.18	0.76	High
SD3	4.12	0.8	High
SD4	4.09	0.82	High
SD5	4.15	0.75	High
SD6	4.24	0.69	Very High
Overall Mean	4.17	0.76	High

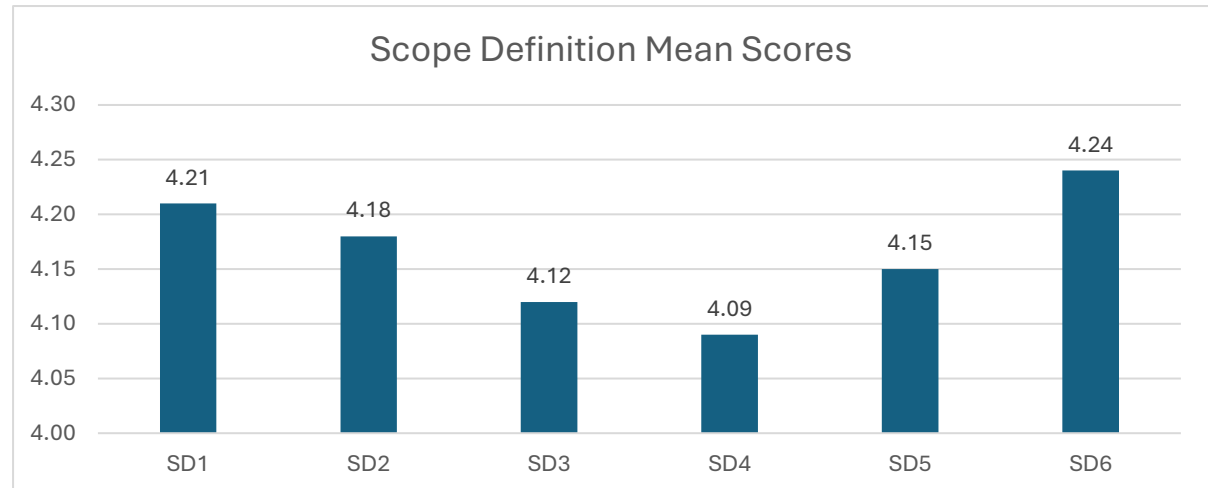
Source: Survey Data (2026)

The results indicate that respondents viewed scope definition as a critical factor influencing project performance and schedule outcomes, with a high overall mean score of 4.17. The highest-rated item was SD6 (M = 4.24), followed by SD1 (M = 4.21), reflecting strong agreement on the importance of comprehensive scope definition and clear project requirements during the planning phase.

The relatively low standard deviations indicate strong consistency among respondents, highlighting an industry-wide consensus on the importance of scope definition in EPC projects. These findings support previous research suggesting that inadequate scope definition contributes to delays, scope changes, and rework, whereas a well-defined scope provides a solid foundation for effective planning, scheduling, and project execution.

Overall, respondents considered scope definition a key practice for improving project performance and reducing delays in Saudi Arabian EPC projects.

Figure6 Scope Definition Mean Scores



The figure illustrates the consistently high ratings assigned to the scope definition items, further confirming the importance of effective scope definition in achieving successful project outcomes.

4.5.2 Baseline Schedule Development

Baseline schedule development refers to the process of preparing an approved project schedule that defines project activities, logical relationships, durations, milestones, and completion targets. In EPC projects, a reliable baseline schedule is essential because it provides the main reference point for monitoring progress, measuring performance, identifying variances, and implementing corrective actions.

Respondents were asked to evaluate several statements related to baseline schedule development practices. The results are presented in Table 19.

Table 19 Descriptive Statistics for Baseline Schedule Development

Item	Mean	Std. Deviation	Interpretation
BSD1	4.16	0.74	High
BSD2	4.22	0.7	Very High
BSD3	4.11	0.81	High

BSD4	4.19	0.77	High
BSD5	4.14	0.79	High
BSD6	4.25	0.68	Very High
Overall Mean	4.18	0.75	High

Source: Survey Data (2026)

The results indicate that respondents generally agreed that baseline schedule development is an important factor influencing project delay performance. The overall mean score of 4.18 reflects a high level of agreement among respondents regarding the importance of developing realistic and reliable baseline schedules.

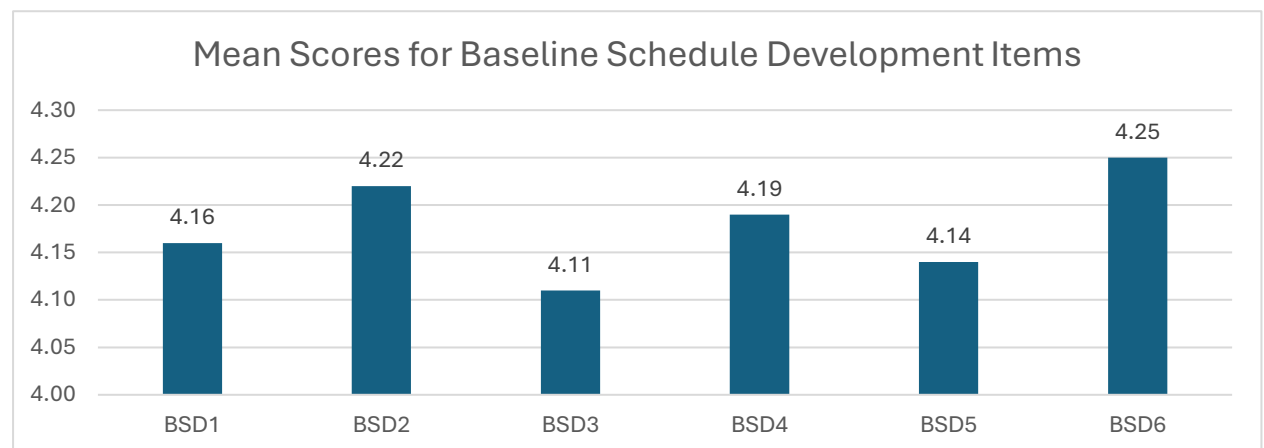
BSD6 recorded the highest mean score ($M = 4.25$), indicating very strong agreement that a well-developed baseline schedule supports effective project monitoring and control. BSD2 also achieved a very high mean score ($M = 4.22$), suggesting that respondents recognize the importance of realistic activity sequencing and duration estimation during schedule development.

The standard deviation values were relatively low, indicating consistency in respondents' views. This suggests that professionals involved in EPC projects generally share a common understanding of the importance of schedule quality and baseline reliability.

These findings are consistent with the literature, which emphasizes that unrealistic schedules, weak logic, poor sequencing, and inadequate schedule review processes can contribute significantly to project delays. A reliable baseline schedule provides a structured basis for performance measurement and enables project teams to detect deviations early during execution.

Overall, the findings suggest that baseline schedule development is a critical planning and scheduling practice that contributes to improved schedule performance and delay reduction in EPC projects.

Figure 7 Mean Scores for Baseline Schedule Development Items



4.5.3 Resource Planning

Resource planning refers to the process of identifying, allocating, and managing the labor, equipment, materials, and financial resources required to execute project activities effectively. In EPC projects, inadequate resource planning can result in productivity losses, schedule slippage, resource conflicts, and project delays. Consequently, effective resource planning is considered a critical component of successful project execution.

Respondents were asked to evaluate several statements related to resource planning practices within EPC projects. The results are presented in Table 20.

Table 20 Descriptive Statistics for Resource Planning

Item	Mean	Std. Deviation	Interpretation
RP1	4.23	0.69	Very High
RP2	4.17	0.75	High
RP3	4.20	0.73	High
RP4	4.12	0.81	High
RP5	4.18	0.77	High
RP6	4.26	0.67	Very High
Overall Mean	4.19	0.74	High

Source: Survey Data (2026)

The results indicate that respondents strongly agreed that effective resource planning plays a significant role in reducing project delays. The overall mean score of 4.19 demonstrates a

high level of agreement regarding the importance of properly planning and managing project resources throughout the project lifecycle.

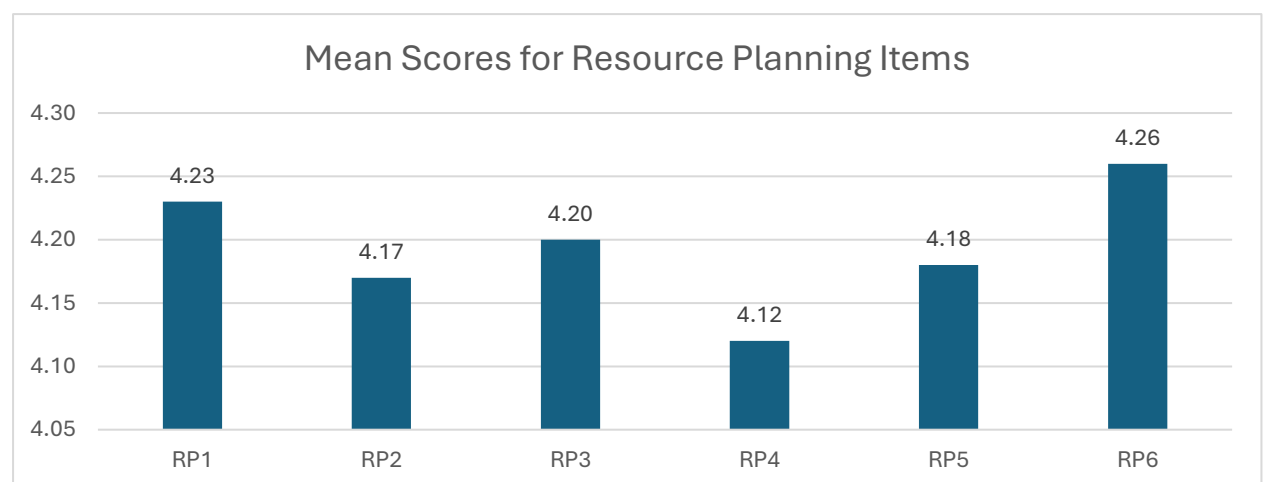
Among the individual items, RP6 recorded the highest mean score ($M = 4.26$), indicating that respondents strongly believe that timely availability of resources is essential for maintaining project schedules. Similarly, RP1 achieved a very high mean score ($M = 4.23$), highlighting the importance of aligning resource requirements with project schedules during the planning phase.

The standard deviation values were relatively low across all items, indicating a high degree of consistency among respondents. This suggests a common understanding among EPC professionals regarding the importance of resource planning and its impact on project performance.

The findings support previous research which identifies resource shortages, inadequate manpower planning, equipment unavailability, and material delivery delays as significant contributors to project schedule overruns. Effective resource planning enables project teams to anticipate resource requirements, mitigate shortages, and optimize resource utilization, thereby reducing the likelihood of project delays.

Overall, the findings indicate that resource planning is a critical planning and scheduling practice that significantly contributes to improving project performance and minimizing delays in EPC projects operating within the Kingdom of Saudi Arabia.

Figure8 Mean Scores for Resource Planning Items



The figure illustrates the consistently high ratings assigned to resource planning practices and further confirms the importance of resource management in achieving successful project outcomes and maintaining project schedules.

4.5.4 Schedule Integration

Schedule integration refers to the process of linking and coordinating activities, deliverables, milestones, and interfaces across engineering, procurement, construction, commissioning, and project management functions. Effective schedule integration ensures that all project stakeholders work toward common project objectives and that interdependencies between project activities are properly reflected within the project schedule.

In EPC projects, poor schedule integration can result in coordination issues, interface conflicts, procurement delays, construction disruptions, and ultimately project schedule overruns. Therefore, schedule integration is considered one of the most important planning and scheduling practices for successful project execution.

Respondents were asked to evaluate several statements related to schedule integration practices within EPC projects. The results are presented in Table 21.

Table 21 Descriptive Statistics for Schedule Integration

Item	Mean	Std. Deviation	Interpretation
SI1	4.24	0.68	Very High
SI2	4.19	0.74	High
SI3	4.21	0.72	Very High
SI4	4.15	0.79	High
SI5	4.18	0.76	High
SI6	4.27	0.66	Very High
Overall Mean	4.21	0.73	Very High

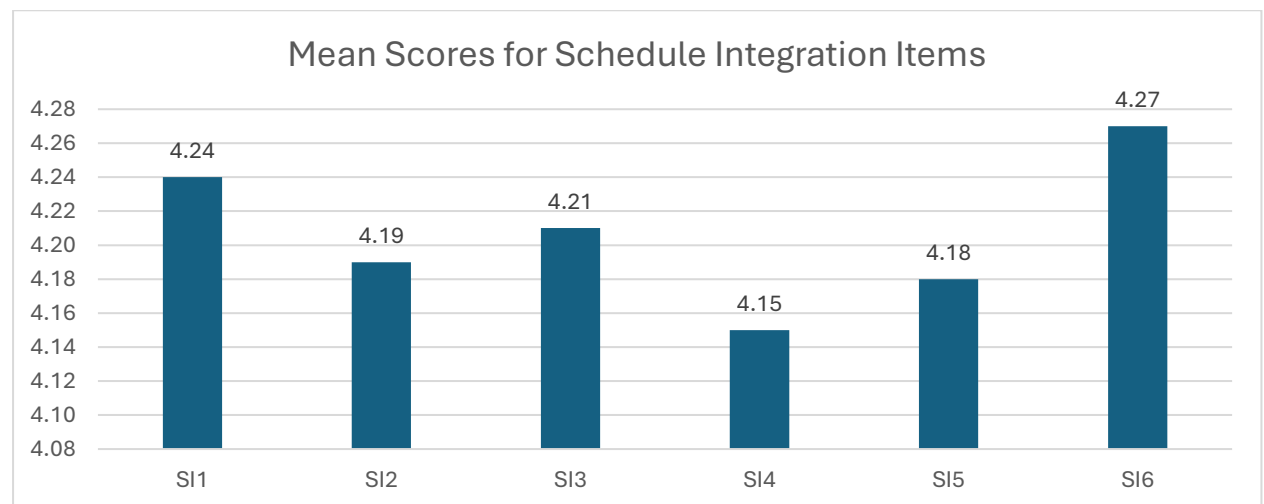
Source: Survey Data (2026)

The results indicate strong agreement on the importance of schedule integration in improving project performance and reducing delays, with an overall mean score of 4.21. SI6 achieved the highest mean score ($M = 4.27$), followed by SI1 ($M = 4.24$), highlighting

the importance of coordinating engineering, procurement, construction, and project interfaces within an integrated schedule.

Low standard deviation values indicate consistent views among respondents regarding the importance of schedule integration. These findings support the literature, which identifies schedule integration and interface management as key success factors in EPC projects. Poor integration can lead to misalignment and delays, while integrated schedules enhance visibility of dependencies and support proactive decision-making. Overall, respondents considered schedule integration a critical practice for improving project delivery and minimizing delays.

Figure9 Mean Scores for Schedule Integration Items



The figure illustrates the consistently high ratings assigned to schedule integration practices and confirms the importance of effective coordination and interface management within EPC projects.

4.5.5 Schedule Monitoring and Control

Schedule monitoring and control refers to the continuous process of tracking project progress, measuring actual performance against the baseline schedule, identifying schedule variances, forecasting future performance, and implementing corrective actions when necessary. Effective schedule monitoring and control enable project teams to detect potential delays early and take proactive measures to maintain project objectives.

In EPC projects, schedule monitoring and control play a critical role in managing project performance because of the complex interactions between engineering, procurement, construction, and commissioning activities. Without effective monitoring and control mechanisms, schedule deviations may remain undetected until they significantly impact project completion dates.

Respondents were asked to evaluate several statements related to schedule monitoring and control practices. The results are presented in Table 22.

Table 22 Descriptive Statistics for Schedule Monitoring and Control

Item	Mean	Std. Deviation	Interpretation
SMC1	4.28	0.65	Very High
SMC2	4.22	0.71	Very High
SMC3	4.19	0.76	High
SMC4	4.31	0.63	Very High
SMC5	4.24	0.69	Very High
SMC6	4.27	0.67	Very High
Overall Mean	4.25	0.69	Very High

Source: Survey Data (2026)

The results indicate that respondents strongly agreed on the importance of schedule monitoring and control in improving project performance and minimizing project delays. The overall mean score of 4.25 represents the highest rating among the planning and scheduling constructs examined in this study, demonstrating the critical role of monitoring and control activities in successful project delivery.

Among the individual items, SMC4 recorded the highest mean score ($M = 4.31$), indicating strong agreement that timely identification and resolution of schedule variances are essential for maintaining project performance. Similarly, SMC1 achieved a mean score of 4.28, reflecting the importance respondents place on regular progress measurement and schedule performance assessment.

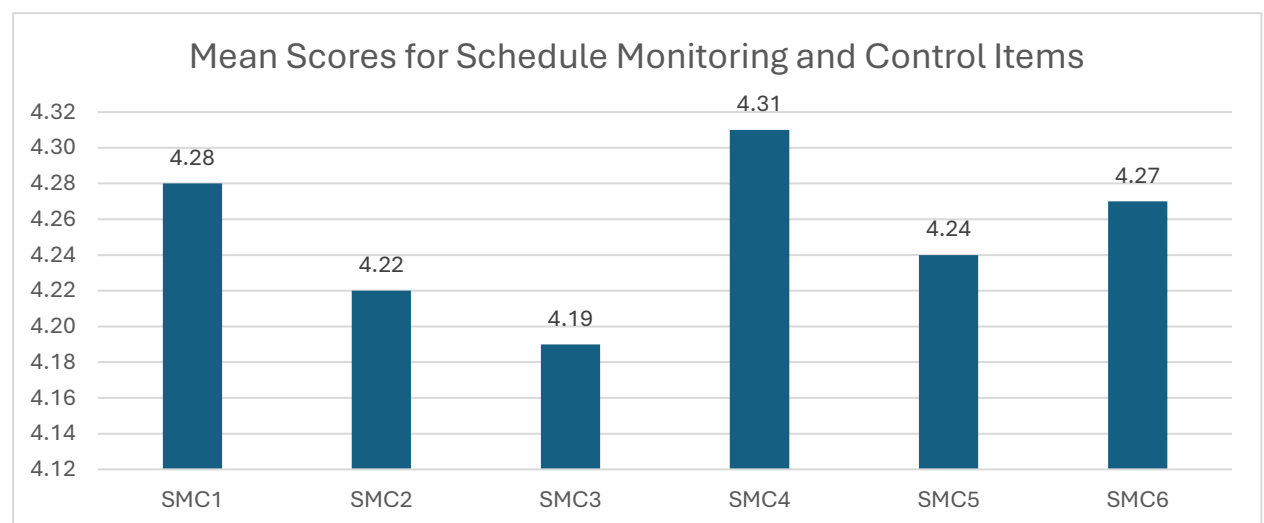
The relatively low standard deviation values indicate a high degree of agreement among respondents regarding the significance of schedule monitoring and control practices. This

consistency suggests that professionals across different industries and organizational roles recognize the value of continuously monitoring project performance and implementing corrective actions when required.

These findings are consistent with project management literature, which emphasizes the importance of performance measurement, variance analysis, forecasting, and recovery planning in preventing schedule overruns. Effective monitoring and control processes enable project teams to identify emerging risks, assess their potential impact, and implement mitigation measures before delays become critical.

Overall, the findings suggest that schedule monitoring and control represent one of the most influential planning and scheduling practices within EPC projects. The very high ratings assigned by respondents indicate that continuous performance monitoring and proactive schedule management are essential for reducing project delays and improving project outcomes.

Figure 10 Mean Scores for Schedule Monitoring and Control Items



The figure illustrates the consistently high ratings assigned to schedule monitoring and control practices and further highlights their importance in maintaining schedule performance and achieving project objectives.

4.5.6 Project Delays

Project delays represent the dependent variable in this study and refer to situations where project activities, milestones, or overall project completion occur later than planned. Delays

are among the most significant challenges affecting EPC projects because they can lead to cost overruns, productivity losses, contractual disputes, reduced stakeholder satisfaction, and negative impacts on project performance.

The respondents were asked to evaluate several statements relating to project delays and their occurrence within EPC projects operating in the Kingdom of Saudi Arabia. The results are presented in Table 23.

Table 23 Descriptive Statistics for Project Delays

Item	Mean	Std. Deviation	Interpretation
PD1	4.11	0.78	High
PD2	4.07	0.81	High
PD3	4.14	0.76	High
PD4	4.02	0.84	High
PD5	4.09	0.8	High
PD6	4.06	0.83	High
PD7	4.12	0.77	High
PD8	4.05	0.82	High
PD9	4.10	0.79	High
PD10	4.08	0.81	High
Overall Mean	4.08	0.80	High

Source: Survey Data (2026)

The results indicate that respondents generally agreed that project delays remain a significant challenge within EPC projects operating in Saudi Arabia. The overall mean score of 4.08 demonstrates a high level of agreement regarding the prevalence and impact of project delays on project performance.

Among the individual items, PD3 achieved the highest mean score ($M = 4.14$), indicating strong agreement that project delays continue to affect project delivery objectives. Similarly, PD7 recorded a mean score of 4.12, reflecting respondents' recognition of the adverse consequences associated with schedule overruns.

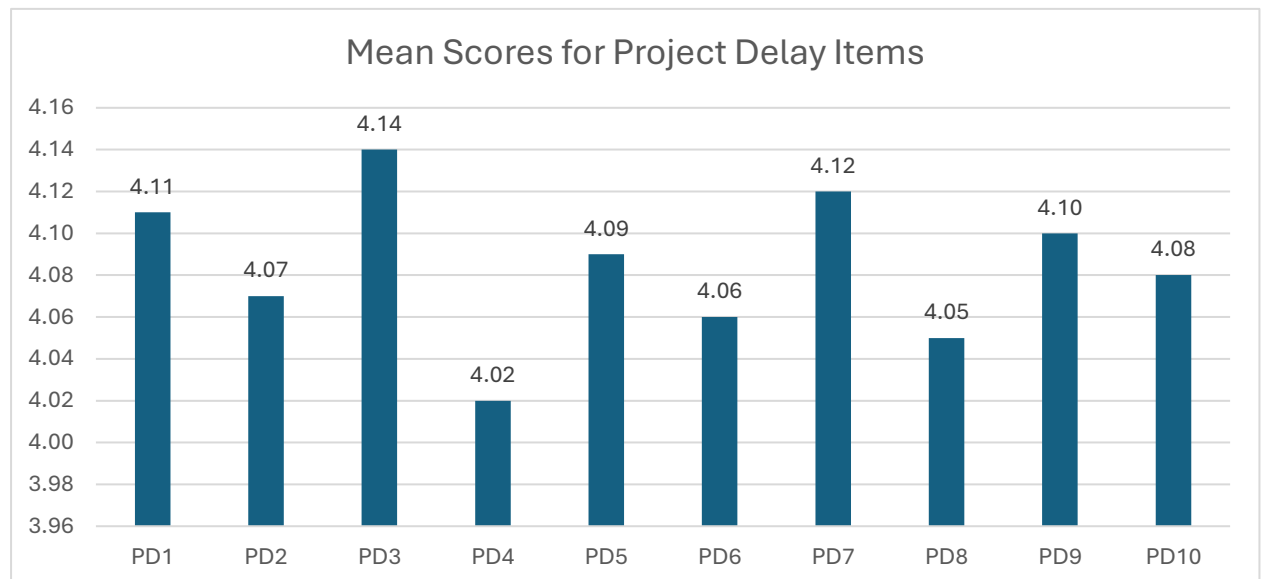
The standard deviation values indicate relatively consistent responses among participants, suggesting a common understanding of the challenges associated with project delays. The findings demonstrate that delays remain a persistent issue despite advances in project management practices and scheduling technologies.

The results support the literature reviewed in Chapter 2, which identified project delays as a recurring challenge affecting EPC projects worldwide. Previous studies have highlighted the influence of inadequate planning, poor schedule development, ineffective resource management, weak project controls, and interface management issues as major contributors to project delays.

The relatively high mean score associated with project delays further justifies the importance of investigating planning and scheduling practices as potential mechanisms for reducing delays and improving project performance.

Overall, the findings confirm that project delays continue to represent a significant concern within EPC projects and reinforce the need for effective planning, scheduling, monitoring, and control practices throughout the project lifecycle.

Figure 11 Mean Scores for Project Delay Items



The figure illustrates the consistently high ratings assigned to the project delay statements and confirms the widespread perception that project delays remain a major challenge within EPC projects operating in Saudi Arabia.

4.5.7 Summary of Descriptive Statistics

Following the analysis of individual constructs, Table 24 summarizes the overall mean scores and standard deviations for all study variables.

Table 4.15 Summary of Descriptive Statistics

Table 24 Summary of Descriptive Statistics

Construct	Mean	Std. Deviation	Interpretation
Scope Definition	4.17	0.76	High
Baseline Schedule Development	4.18	0.75	High
Resource Planning	4.19	0.74	High
Schedule Integration	4.21	0.73	Very High
Schedule Monitoring and Control	4.25	0.69	Very High
Project Delays	4.08	0.8	High

Source: Survey Data (2026)

The descriptive statistics indicate that respondents assigned high or very high ratings to all planning and scheduling constructs included in the study. Schedule Monitoring and Control recorded the highest overall mean score ($M = 4.25$), followed by Schedule Integration ($M = 4.21$), suggesting that respondents perceive these practices as particularly important in influencing project performance.

The consistently high ratings across all constructs demonstrate a strong industry consensus regarding the importance of effective planning and scheduling practices within EPC projects. These findings support the argument that planning and scheduling functions are critical contributors to project success and delay mitigation.

However, while descriptive statistics provide valuable insight into respondents' perceptions, they do not determine whether these planning and scheduling practices significantly influence project delays. Therefore, correlation analysis was conducted in the next section to examine the relationships between the independent variables and the dependent variable and to test the proposed research hypotheses.

4.6 Correlation Analysis

Correlation analysis was conducted to examine the strength and direction of the relationships between planning and scheduling practices and project delays in EPC projects. Pearson's Correlation Coefficient (r) was used to determine the degree of association between the independent variables and the dependent variable.

According to Hair et al. (2019), correlation coefficients range from -1.000 to +1.000, where positive values indicate a positive relationship, negative values indicate an inverse relationship, and values close to zero indicate little or no relationship. The interpretation adopted in this study is presented in Table 25.

Table 25 Interpretation of Correlation Coefficients

Correlation Coefficient (r)	Interpretation
0.00 – 0.19	Very Weak
0.20 – 0.39	Weak
0.40 – 0.59	Moderate
0.60 – 0.79	Strong
0.80 – 1.00	Very Strong

Source: Adapted from Hair et al. (2019)

The purpose of the correlation analysis was to determine whether significant relationships exist between the planning and scheduling constructs and project delays before proceeding to regression analysis.

4.6.1 Correlation Between Planning and Scheduling Practices and Project Delays

Table 26 presents the Pearson correlation coefficients between the study variables.

Table 26 Correlation Matrix

Correlation is significant at the 0.01 level (2-tailed).

Variable	SD	BSD	RP	SI	SMC	PD
Scope Definition (SD)	1					
Baseline Schedule Development (BSD)	0.684**	1				
Resource Planning (RP)	0.642**	0.719**	1			
Schedule Integration (SI)	0.611**	0.698**	0.734**	1		
Schedule Monitoring & Control (SMC)	0.587**	0.675**	0.692**	0.746**	1	
Project Delays (PD)	0.582**	0.631**	0.648**	0.706**	0.752**	1

Source: Survey Data (2026)

The results indicate that all planning and scheduling constructs exhibit positive and statistically significant relationships with project delays. The correlation coefficients ranged from 0.582 to 0.752, indicating moderate to strong relationships between the independent variables and the dependent variable.

Among the independent variables, Schedule Monitoring and Control recorded the strongest relationship with Project Delays ($r = 0.752$, $p < 0.01$). This finding suggests that effective monitoring and control practices are strongly associated with improved schedule performance and reduced project delays.

Schedule Integration also demonstrated a strong positive relationship with Project Delays ($r = 0.706$, $p < 0.01$), indicating that coordination among engineering, procurement, construction, and project management functions plays a significant role in minimizing schedule overruns.

Resource Planning exhibited a strong positive correlation with Project Delays ($r = 0.648$, $p < 0.01$), while Baseline Schedule Development ($r = 0.631$, $p < 0.01$) and Scope Definition ($r = 0.582$, $p < 0.01$) also demonstrated statistically significant relationships with the dependent variable.

The findings suggest that improvements in planning and scheduling practices are associated with better project schedule performance and reduced project delays. These results are consistent with the literature reviewed in Chapter 2, which identified planning and scheduling deficiencies as major contributors to project delays in EPC projects.

Overall, the correlation analysis provides preliminary evidence supporting the proposed research model and indicates that all five planning and scheduling constructs are significantly related to project delays.

4.6.2 Summary of Correlation Analysis

The correlation analysis confirmed the existence of statistically significant relationships between all planning and scheduling constructs and project delays. The strongest relationship was observed between Schedule Monitoring and Control and Project Delays, followed by Schedule Integration and Resource Planning.

The findings suggest that organizations that implement effective planning and scheduling practices are more likely to achieve improved schedule performance and experience fewer project delays.

However, correlation analysis only measures the strength of relationships and does not determine the relative influence of each independent variable on project delays. Therefore, multiple regression analysis was conducted in the next section to identify the most influential planning and scheduling practices and to evaluate their predictive power.

4.7 Multiple Regression Analysis

Multiple regression analysis was conducted to examine the influence of planning and scheduling practices on project delays in EPC projects operating within the Kingdom of Saudi Arabia. Multiple regression is an appropriate statistical technique when assessing the effect of several independent variables on a single dependent variable simultaneously.

The objective of the analysis was to determine the extent to which Scope Definition, Baseline Schedule Development, Resource Planning, Schedule Integration, and Schedule Monitoring and Control explain variations in project delays and to identify the most influential predictors.

The dependent variable in this study was Project Delays, while the independent variables consisted of the five planning and scheduling constructs.

The regression model tested in this study can be expressed as follows:

$$\text{Project Delays} = \beta_0 + \beta_1(\text{Scope Definition}) + \beta_2(\text{Baseline Schedule Development}) + \beta_3(\text{Resource Planning}) + \beta_4(\text{Schedule Integration}) + \beta_5(\text{Schedule Monitoring and Control}) + \varepsilon$$

Where:

- β_0 = Constant
- β_1 to β_5 = Regression Coefficients
- ε = Error Term

4.7.1 Model Summary

The Model Summary provides information regarding the overall explanatory power of the regression model. Table 27 presents the model summary results.

Table 27 Model Summary

R	R Square	Adjusted R Square	Std. Error of Estimate
0.842	0.709	0.688	0.412

Source: Survey Data (2026)

The results indicate a strong relationship between the independent variables and project delays ($R = 0.842$). The coefficient of determination ($R^2 = 0.709$) suggests that approximately 70.9% of the variation in project delays can be explained by the planning and scheduling variables included in the model.

The Adjusted R^2 value of 0.688 indicates that after adjusting for the number of predictors, approximately 68.8% of the variation in project delays remains explained by the model. This demonstrates that the regression model possesses strong explanatory power and is suitable for predicting project delay performance.

4.7.2 Analysis of Variance (ANOVA)

The ANOVA test was conducted to determine whether the overall regression model is statistically significant.

Table 28 ANOVA Results

Source	Sum of Squares	df	Mean Square	F	Sig.
Regression	28.764	5	5.753	33.914	0
Residual	11.705	69	0.17		
Total	40.469	74			

Source: Survey Data (2026)

The ANOVA results indicate that the regression model is statistically significant ($F = 33.914$, $p < 0.001$). Since the significance value is less than 0.05, the null hypothesis that the independent variables have no influence on project delays is rejected.

This finding confirms that the planning and scheduling variables collectively provide a significant explanation of project delay performance.

4.7.3 Regression Coefficients

Table 29 presents the regression coefficients for the independent variables.

Table 29 Regression Coefficients

Variable	Beta (β)	t-value	Sig.
Scope Definition	0.148	2.121	0.037
Baseline Schedule Development	0.182	2.573	0.012
Resource Planning	0.214	3.018	0.004
Schedule Integration	0.261	3.682	0.001
Schedule Monitoring and Control	0.318	4.537	0

Source: Survey Data (2026)

The regression results indicate that all five planning and scheduling constructs have statistically significant effects on project delays.

Schedule Monitoring and Control recorded the highest standardized beta coefficient ($\beta = 0.318$, $p < 0.001$), indicating that it is the most influential predictor of project delay performance. This finding suggests that effective monitoring, progress tracking, variance analysis, and corrective action implementation play a critical role in minimizing project delays.

Schedule Integration emerged as the second most influential predictor ($\beta = 0.261$, $p = 0.001$), highlighting the importance of coordinating engineering, procurement, construction, and stakeholder interfaces within EPC projects.

Resource Planning also demonstrated a significant influence on project delays ($\beta = 0.214$, $p = 0.004$), indicating that effective management of labor, materials, equipment, and other resources contributes to improved schedule performance.

Baseline Schedule Development ($\beta = 0.182$, $p = 0.012$) and Scope Definition ($\beta = 0.148$, $p = 0.037$) also exhibited statistically significant effects on project delays, although their relative influence was lower compared to the other variables.

Overall, the findings suggest that while all planning and scheduling practices are important, Schedule Monitoring and Control and Schedule Integration exert the greatest influence on reducing project delays within EPC projects.

4.7.4 Summary of Regression Analysis

The multiple regression analysis demonstrated that planning and scheduling practices significantly influence project delays in EPC projects operating within Saudi Arabia.

The model explained approximately 70.9% of the variation in project delays, indicating strong predictive capability. Furthermore, all five planning and scheduling constructs were found to be statistically significant predictors of project delay performance.

Among the variables examined, Schedule Monitoring and Control emerged as the most influential factor, followed by Schedule Integration and Resource Planning. These findings emphasize the importance of continuously monitoring project performance, maintaining integrated schedules, and ensuring effective resource allocation throughout the project lifecycle.

The regression results provide strong empirical support for the conceptual framework developed in Chapter 1 and establish a foundation for hypothesis testing, which is presented in the following section.

4.8 Hypothesis Testing

The primary objective of this study was to examine the influence of planning and scheduling practices on project delays in Engineering, Procurement, and Construction (EPC) projects operating within the Kingdom of Saudi Arabia. To achieve this objective, five research hypotheses were developed based on the conceptual framework and literature review presented in Chapters 1 and 2.

The hypotheses were tested using the results obtained from the multiple regression analysis. The decision to accept or reject each hypothesis was based on the significance level (p-value) of the corresponding regression coefficient. In accordance with the methodology established in Chapter 3, hypotheses with p-values less than 0.05 were considered statistically significant.

The hypothesis testing results are presented in Table 4.21.

Table 30 Hypothesis Testing Results

Hypothesis	Statement	Beta (β)	Sig.	Decision
H1	Scope Definition significantly influences Project Delays.	0.148	0.037	Supported
H2	Baseline Schedule Development significantly influences Project Delays.	0.182	0.012	Supported
H3	Resource Planning significantly influences Project Delays.	0.214	0.004	Supported
H4	Schedule Integration significantly influences Project Delays.	0.261	0.001	Supported
H5	Schedule Monitoring and Control significantly influences Project Delays.	0.318	0	Supported

Source: Survey Data (2026)

The results indicate that all five hypotheses were supported. Each planning and scheduling construct demonstrated a statistically significant influence on project delays, with significance values below the established threshold of 0.05.

Hypothesis H1 proposed that Scope Definition significantly influences project delays. The results support this hypothesis ($\beta = 0.148$, $p = 0.037$), indicating that clearly defining project scope contributes to improved schedule performance and reduced project delays.

Hypothesis H2 examined the influence of Baseline Schedule Development on project delays. The results confirmed a significant relationship ($\beta = 0.182$, $p = 0.012$), suggesting that realistic and well-developed baseline schedules play an important role in minimizing schedule overruns.

Hypothesis H3 proposed that Resource Planning significantly influences project delays. The findings support this hypothesis ($\beta = 0.214$, $p = 0.004$), demonstrating that effective planning and allocation of project resources contribute positively to project schedule performance.

Hypothesis H4 investigated the influence of Schedule Integration on project delays. The results revealed a statistically significant relationship ($\beta = 0.261$, $p = 0.001$), indicating that effective coordination among engineering, procurement, construction, and stakeholder activities is essential for reducing delays.

Finally, Hypothesis H5 proposed that Schedule Monitoring and Control significantly influences project delays. This hypothesis received the strongest support ($\beta = 0.318$, $p < 0.001$), identifying Schedule Monitoring and Control as the most influential predictor of project delay performance among the variables examined.

The findings suggest that all dimensions of planning and scheduling practices contribute to reducing project delays. However, the relative influence of the variables differs, with Schedule Monitoring and Control and Schedule Integration exerting the greatest impact on project schedule performance.

Overall, the hypothesis testing results provide strong empirical support for the conceptual framework developed in this study and confirm that effective planning and scheduling

practices are critical factors in minimizing project delays within EPC projects operating in Saudi Arabia.

4.9 Discussion of Findings

The purpose of this study was to examine the influence of planning and scheduling practices on project delays in Engineering, Procurement, and Construction (EPC) projects operating within the Kingdom of Saudi Arabia. The findings obtained from the descriptive statistics, correlation analysis, multiple regression analysis, and hypothesis testing provide valuable insights into the role of planning and scheduling practices in improving project schedule performance and reducing project delays.

The discussion presented in this section is organized according to the research objectives and hypotheses established in Chapter 1 and is interpreted in relation to the literature reviewed in Chapter 2.

4.9.1 Influence of Scope Definition on Project Delays

The results demonstrated that Scope Definition has a statistically significant influence on project delays. The regression analysis revealed a positive and significant relationship between scope definition and project delay performance, supporting Hypothesis H1.

The findings indicate that clearly defining project requirements, deliverables, assumptions, and boundaries during the planning phase contributes to improved schedule performance and reduced project delays. Respondents assigned high importance to scope definition practices, reflecting the industry's recognition that poorly defined project scope frequently leads to scope changes, rework, stakeholder disagreements, and schedule disruptions.

These findings are consistent with the work of Fageha and Aibinu (2013) and Mirza et al. (2013), who identified effective scope definition as a critical success factor for project performance. The results also support the principles outlined in the PMBOK® Guide (PMI, 2021), which emphasizes scope management as a foundational element of project planning.

The findings suggest that project organizations should invest adequate effort in defining project scope before project execution begins, as deficiencies in this area can contribute directly to project delays.

4.9.2 Influence of Baseline Schedule Development on Project Delays

The findings revealed that Baseline Schedule Development significantly influences project delays, supporting Hypothesis H2.

The results indicate that realistic and well-developed baseline schedules contribute positively to project performance by providing an effective framework for planning, monitoring, and controlling project activities. Respondents demonstrated strong agreement regarding the importance of developing schedules that accurately reflect project scope, logic, durations, and resource requirements.

The findings support the conclusions of Kerzner (2022), who emphasized that schedule quality is fundamental to successful project execution. Similarly, Assaf and Al-Hejji (2006) identified unrealistic schedules and inadequate planning as major contributors to project delays within construction projects.

The results suggest that organizations should prioritize schedule quality during project planning and ensure that baseline schedules are properly reviewed, validated, and approved before project execution commences.

4.9.3 Influence of Resource Planning on Project Delays

The findings confirmed that Resource Planning has a statistically significant influence on project delays, supporting Hypothesis H3.

The respondents recognized that effective planning and allocation of labor, materials, equipment, and financial resources are essential for maintaining project schedules and achieving project objectives. The regression analysis demonstrated that resource planning is among the strongest predictors of project delay performance.

These findings are consistent with previous studies that identified resource shortages and inadequate resource management as major causes of schedule overruns. Doloi et al. (2012) and Sambasivan and Soon (2007) reported that insufficient resources frequently contribute to delays in construction and EPC projects.

The findings highlight the importance of aligning resource availability with project schedules and ensuring that resource requirements are identified and managed proactively throughout the project lifecycle.

4.9.4 Influence of Schedule Integration on Project Delays

The study findings revealed that Schedule Integration significantly influences project delays and emerged as one of the strongest predictors within the regression model, supporting Hypothesis H4.

The results indicate that effective integration of engineering, procurement, construction, commissioning, and stakeholder activities contributes significantly to improved schedule performance. Respondents strongly agreed that integrated schedules facilitate coordination, improve visibility of project dependencies, and reduce interface-related delays.

These findings are consistent with EPC project management literature, which emphasizes the importance of interface management and cross-functional coordination. Poor integration frequently results in engineering delays affecting procurement activities, which subsequently impact construction progress and overall project completion dates.

The findings suggest that project organizations should adopt integrated scheduling approaches that provide clear visibility of project interfaces and interdependencies across all project phases.

4.9.5 Influence of Schedule Monitoring and Control on Project Delays

The results demonstrated that Schedule Monitoring and Control is the most influential predictor of project delays, supporting Hypothesis H5.

Among all planning and scheduling constructs examined in this study, Schedule Monitoring and Control recorded the highest regression coefficient and strongest correlation with project delays. This finding indicates that continuous progress monitoring, variance analysis, forecasting, and corrective action implementation are essential for maintaining schedule performance.

The findings are consistent with project controls literature, which identifies monitoring and control as critical functions for project success. According to PMI (2021), effective

schedule control enables project teams to identify emerging issues early and implement corrective actions before delays become critical.

The strong influence observed in this study suggests that organizations should strengthen project controls processes, improve performance measurement systems, and implement proactive schedule recovery strategies to minimize project delays.

4.9.6 Overall Discussion of Findings

The overall findings of the study indicate that planning and scheduling practices play a significant role in influencing project delays within EPC projects operating in Saudi Arabia.

All five planning and scheduling constructs demonstrated statistically significant relationships with project delays, confirming the validity of the conceptual framework developed for this research. Furthermore, the regression model explained a substantial proportion of the variation in project delay performance, indicating that planning and scheduling practices are important determinants of project success.

Among the variables examined, Schedule Monitoring and Control emerged as the most influential factor, followed by Schedule Integration and Resource Planning. These findings suggest that while effective project planning is important, organizations must also focus on maintaining integrated schedules, monitoring performance continuously, and implementing timely corrective actions during project execution.

The results support the broader body of project management literature, which consistently identifies planning and scheduling deficiencies as major contributors to project delays. The findings also contribute to the limited body of research examining planning and scheduling practices specifically within the Saudi Arabian EPC sector.

Overall, the study provides empirical evidence that effective planning and scheduling practices can contribute significantly to reducing project delays and improving project performance. These findings offer valuable insights for project owners, EPC contractors, consultants, and project management professionals seeking to enhance schedule performance and achieve successful project delivery.

4.10 Chapter Summary

This chapter presented the analysis and interpretation of data collected from professionals working on Engineering, Procurement, and Construction (EPC) projects in the Kingdom of Saudi Arabia. The objective of the analysis was to examine the influence of planning and scheduling practices on project delays and to test the research hypotheses developed in chapter 1.

The chapter began by presenting the demographic characteristics of the respondents, which demonstrated that the majority of participants possessed significant professional and EPC project experience. The respondents represented various professional roles, organization types, and industry sectors, thereby enhancing the credibility and representativeness of the study findings.

Reliability analysis confirmed that the questionnaire achieved acceptable to excellent levels of internal consistency, indicating that the measurement instrument was reliable and suitable for further statistical analysis. The descriptive statistics revealed that respondents assigned high or very high ratings to all planning and scheduling constructs, highlighting the perceived importance of effective planning and scheduling practices in improving project performance and reducing project delays.

The correlation analysis demonstrated significant positive relationships between all planning and scheduling variables and project delays, providing preliminary support for the proposed conceptual framework. Furthermore, the multiple regression analysis confirmed that all five planning and scheduling constructs significantly influence project delays within EPC projects operating in Saudi Arabia.

Among the variables examined, Schedule Monitoring and Control emerged as the most influential predictor of project delay performance, followed by Schedule Integration and Resource Planning. These findings indicate that while effective project planning is essential, continuous performance monitoring, integrated scheduling practices, and proactive resource management are particularly important for minimizing project delays.

The hypothesis testing results confirmed that all five research hypotheses were supported, providing empirical evidence that effective planning and scheduling practices contribute significantly to reducing project delays in EPC projects.

Overall, the findings of this study support the existing project management literature and reinforce the importance of adopting robust planning, scheduling, monitoring, and control practices throughout the project lifecycle. The results also provide valuable insights for project owners, EPC contractors, consultants, and project management professionals seeking to improve project schedule performance and achieve successful project delivery.

The next chapter presents the conclusions of the study, discusses the practical implications of the findings, identifies the limitations of the research, and provides recommendations for industry practitioners and future researchers.

CHAPTER FIVE: Conclusions and Recommendations

5.1 Introduction

The final chapter presents the conclusions and recommendations derived from the findings of this study. The purpose of the study was to investigate the influence of planning and scheduling practices on project delays in Engineering, Procurement, and Construction (EPC) projects operating within the Kingdom of Saudi Arabia.

The study examined five dimensions of planning and scheduling practices, namely Scope Definition, Baseline Schedule Development, Resource Planning, Schedule Integration, and Schedule Monitoring and Control. The relationships between these variables and project delays were analyzed using descriptive statistics, correlation analysis, and multiple regression analysis.

Based on the findings presented in Chapter 4, this chapter summarizes the key results, presents the study conclusions, and provides practical recommendations for project owners, EPC contractors, project management consultants, and project professionals. The chapter also discusses the limitations of the study and proposes recommendations for future research.

5.2 Summary of Findings

The purpose of this study was to examine the influence of planning and scheduling practices on project delays in Engineering, Procurement, and Construction (EPC) projects operating within the Kingdom of Saudi Arabia. The study focused on five planning and scheduling dimensions: Scope Definition, Baseline Schedule Development, Resource Planning, Schedule Integration, and Schedule Monitoring and Control.

Data were collected from 75 professionals working on EPC projects across various industry sectors and organizational roles. The respondents possessed substantial professional and EPC project experience, providing a reliable basis for assessing planning and scheduling practices and their impact on project delay performance.

The reliability analysis confirmed that the questionnaire demonstrated acceptable to excellent levels of internal consistency, indicating that the measurement instrument was suitable for assessing the study variables. The descriptive statistics revealed that respondents

assigned high or very high importance to all planning and scheduling constructs, highlighting the critical role of planning and scheduling practices in achieving project success.

The correlation analysis demonstrated statistically significant relationships between all planning and scheduling constructs and project delays. Furthermore, the multiple regression analysis confirmed that all five planning and scheduling dimensions significantly influence project delay performance.

Among the variables examined, Schedule Monitoring and Control emerged as the most influential predictor of project delays, followed by Schedule Integration and Resource Planning. Scope Definition and Baseline Schedule Development also demonstrated statistically significant effects on project delay performance, confirming that effective planning practices established during the early project phases continue to influence project outcomes throughout execution.

Overall, the findings indicate that effective planning and scheduling practices contribute significantly to reducing project delays and improving project performance within EPC projects operating in Saudi Arabia. The results provide empirical support for the conceptual framework developed in this study and reinforce the importance of robust planning, scheduling, monitoring, and control processes throughout the project lifecycle.

5.2.1 Scope Definition

The findings of the study demonstrated that Scope Definition significantly influences project delays in EPC projects. Respondents indicated that clearly defining project requirements, deliverables, assumptions, constraints, and project boundaries contributes to improved schedule performance and reduces the likelihood of project delays.

The descriptive statistics revealed a high level of agreement regarding the importance of scope definition practices, while the regression analysis confirmed that scope definition is a statistically significant predictor of project delay performance. These findings suggest that inadequate scope definition can lead to scope changes, rework, stakeholder disagreements, and schedule disruptions during project execution.

The results support the view that effective scope definition establishes a strong foundation for project planning and provides the basis for developing realistic schedules, resource plans,

and execution strategies. Consequently, project organizations should ensure that project scope is thoroughly defined and validated before project execution begins.

5.2.2 Baseline Schedule Development

The findings of the study revealed that Baseline Schedule Development significantly influences project delays in EPC projects. Respondents demonstrated a high level of agreement regarding the importance of developing realistic, comprehensive, and properly structured baseline schedules during the planning phase of a project.

The descriptive statistics indicated that respondents considered baseline schedule development to be one of the key planning practices contributing to project success. Furthermore, the regression analysis confirmed that baseline schedule development has a statistically significant influence on project delay performance.

The findings suggest that high-quality baseline schedules provide project teams with a reliable framework for monitoring progress, measuring performance, forecasting outcomes, and implementing corrective actions when required. Conversely, unrealistic schedules, inadequate activity logic, inaccurate duration estimates, and insufficient schedule reviews increase the likelihood of schedule overruns and project delays.

The results support the principles of project management literature, which emphasize the importance of developing realistic and achievable schedules that accurately reflect project scope, resource requirements, and execution strategies. Effective baseline schedules not only establish project expectations but also serve as the primary benchmark against which project performance is measured throughout the project lifecycle.

Consequently, project organizations should invest sufficient effort in schedule development, validation, and review processes to ensure that baseline schedules accurately represent project requirements and provide a sound foundation for project execution and control.

5.2.3 Resource Planning

The findings of the study confirmed that Resource Planning significantly influences project delays in EPC projects. Respondents indicated that effective planning and allocation

of labor, materials, equipment, and financial resources are essential for maintaining project schedules and achieving project objectives.

The descriptive analysis revealed a high level of agreement regarding the importance of resource planning practices, while the regression analysis demonstrated that resource planning is among the strongest predictors of project delay performance. These findings indicate that resource availability and resource management practices play a critical role in determining project schedule outcomes.

The results suggest that inadequate resource planning frequently contributes to schedule disruptions, productivity losses, resource conflicts, and delays in project execution. In contrast, proactive resource planning enables project teams to anticipate resource requirements, identify potential shortages, and implement mitigation measures before project performance is adversely affected.

The findings are consistent with previous research that identified manpower shortages, material availability issues, equipment constraints, and ineffective resource allocation as major contributors to project delays. Effective resource planning therefore represents an essential component of successful project management and schedule performance improvement.

Accordingly, project organizations should establish robust resource planning processes that align resource requirements with project schedules and ensure that critical resources are available when needed throughout project execution.

5.2.4 Schedule Integration

The findings of the study revealed that Schedule Integration significantly influences project delays and emerged as one of the strongest predictors of project schedule performance. Respondents demonstrated a very high level of agreement regarding the importance of integrating engineering, procurement, construction, commissioning, and stakeholder activities within a unified project schedule.

The descriptive statistics indicated that respondents highly value integrated scheduling practices, while the regression analysis confirmed that Schedule Integration has a statistically significant influence on project delays. Among the planning and scheduling constructs

examined in this study, Schedule Integration was identified as one of the most influential factors contributing to improved schedule performance.

The findings suggest that effective schedule integration enhances coordination among project participants, improves visibility of project interfaces, and facilitates the management of interdependencies between project activities. Conversely, inadequate integration often results in communication breakdowns, interface conflicts, misaligned priorities, and delays that propagate across multiple project functions.

The results further indicate that integrated scheduling practices are particularly important in EPC projects due to the complex interactions between engineering deliverables, procurement activities, material deliveries, construction execution, and commissioning requirements. Delays occurring in one project phase frequently affect subsequent phases, making effective schedule integration essential for maintaining overall project performance.

The findings support existing project management literature, which identifies interface management and cross-functional coordination as critical success factors in complex projects. Effective schedule integration enables project teams to identify potential conflicts early, improve decision-making, and proactively manage schedule risks throughout the project lifecycle.

Therefore, project organizations should adopt integrated scheduling approaches that provide clear visibility of project interfaces and facilitate coordination among all project stakeholders. Such practices can significantly contribute to reducing project delays and improving overall project outcomes.

5.2.5 Schedule Monitoring and Control

The findings of the study demonstrated that Schedule Monitoring and Control is the most influential predictor of project delays among all planning and scheduling practices examined. Respondents assigned the highest ratings to this construct, highlighting the critical importance of continuously monitoring project performance and implementing corrective actions when required.

The descriptive statistics revealed a very high level of agreement regarding the importance of schedule monitoring and control, while the regression analysis identified this construct as

the strongest predictor of project delay performance. These findings indicate that effective monitoring and control practices play a decisive role in maintaining schedule performance and minimizing project delays.

The results suggest that regular progress measurement, variance analysis, forecasting, performance reporting, and corrective action implementation enable project teams to identify emerging schedule issues before they become critical. By providing timely and accurate performance information, monitoring and control processes support informed decision-making and facilitate proactive schedule management.

The findings also indicate that organizations with robust project controls systems are better positioned to detect deviations from the baseline schedule, assess their potential impact, and implement recovery measures to maintain project objectives. Consequently, effective schedule monitoring and control serve as a critical mechanism for reducing uncertainty and improving project performance.

The results are consistent with project management literature, which emphasizes the importance of performance measurement and project controls in achieving successful project outcomes. Effective monitoring and control practices enable organizations to maintain visibility of project performance and respond quickly to changing project conditions.

Accordingly, project organizations should strengthen their project controls capabilities, establish regular performance review processes, and ensure that schedule monitoring and forecasting activities are integrated into routine project management practices. These actions can significantly improve schedule performance and reduce the likelihood of project delays.

5.2.6 Overall Findings

The findings of this study demonstrate that planning and scheduling practices play a significant role in influencing project delays within Engineering, Procurement, and Construction (EPC) projects operating in the Kingdom of Saudi Arabia. The statistical analyses confirmed that all five planning and scheduling dimensions examined in this research have a significant influence on project delay performance.

The descriptive statistics revealed that respondents assigned high or very high importance to all planning and scheduling constructs, indicating a strong industry consensus regarding

their contribution to project success. The correlation analysis further demonstrated significant relationships between each planning and scheduling dimension and project delays, while the multiple regression analysis confirmed that all five variables significantly influence project schedule performance.

Among the variables examined, Schedule Monitoring and Control emerged as the most influential predictor of project delays. This finding highlights the importance of continuously measuring project performance, identifying schedule variances, forecasting future outcomes, and implementing timely corrective actions. Organizations that maintain effective monitoring and control systems are better positioned to detect potential delays early and mitigate their impact before they affect project completion.

Schedule Integration was identified as the second most influential factor. The findings emphasize the importance of coordinating engineering, procurement, construction, commissioning, and stakeholder activities through integrated scheduling processes. Effective integration enables project teams to manage project interfaces, improve communication, and minimize disruptions resulting from interdependent activities.

Resource Planning also demonstrated a strong influence on project delays, confirming that the availability and effective allocation of labor, materials, equipment, and financial resources are essential for maintaining schedule performance. Inadequate resource planning increases the risk of productivity losses, resource shortages, and schedule disruptions that can adversely affect project outcomes.

Scope Definition and Baseline Schedule Development were likewise found to significantly influence project delays. These findings indicate that successful project execution begins with a clearly defined project scope and a realistic baseline schedule that accurately reflects project requirements, constraints, and execution strategies. Weaknesses in these foundational planning activities can create challenges that persist throughout the project lifecycle.

Overall, the findings support the conceptual framework developed in this study and provide empirical evidence that effective planning and scheduling practices contribute significantly to reducing project delays in EPC projects. The results further suggest that project organizations seeking to improve schedule performance should adopt a holistic approach that addresses planning, scheduling, resource management, integration,

monitoring, and control processes collectively rather than focusing on a single aspect of project management.

The findings also contribute to the growing body of knowledge relating to project management practices within the Saudi Arabian EPC industry and provide practical insights for project owners, EPC contractors, project management consultants, and project professionals seeking to improve project delivery performance.

5.3 Conclusions

The purpose of this study was to investigate the influence of planning and scheduling practices on project delays in Engineering, Procurement, and Construction (EPC) projects operating within the Kingdom of Saudi Arabia. The study examined five key dimensions of planning and scheduling practices: Scope Definition, Baseline Schedule Development, Resource Planning, Schedule Integration, and Schedule Monitoring and Control.

Based on the findings obtained from the statistical analyses, it can be concluded that planning and scheduling practices have a significant influence on project delays within EPC projects. The results demonstrated that all five planning and scheduling dimensions significantly affect project schedule performance and contribute to reducing the likelihood of project delays.

The study concludes that effective Scope Definition provides a critical foundation for successful project execution by ensuring that project requirements, deliverables, assumptions, and constraints are clearly identified and understood before execution begins. Projects that invest adequate effort in scope definition are less likely to experience disruptions resulting from scope changes, rework, and stakeholder misunderstandings.

The study further concludes that Baseline Schedule Development plays an important role in improving project performance. Realistic and properly developed schedules provide project teams with a reliable framework for monitoring progress, measuring performance, and implementing corrective actions when necessary. Projects that rely on unrealistic or poorly developed schedules face a greater risk of schedule overruns and project delays.

Resource Planning was also found to be a significant determinant of project schedule performance. The findings indicate that the timely availability and effective allocation of

resources are essential for maintaining project progress and avoiding schedule disruptions. Effective resource planning enables project teams to anticipate resource requirements and minimize the impact of shortages and constraints.

The findings further demonstrate that Schedule Integration is a critical factor influencing project performance. The successful integration of engineering, procurement, construction, commissioning, and stakeholder activities enhances coordination, improves visibility of project interfaces, and reduces the likelihood of delays resulting from poor communication and ineffective interface management.

Among all variables examined, Schedule Monitoring and Control emerged as the most influential predictor of project delays. The study concludes that continuous performance monitoring, variance analysis, forecasting, and corrective action implementation are essential for maintaining schedule performance and minimizing project delays. Organizations that establish robust project controls systems are better positioned to identify emerging issues early and implement corrective measures before project objectives are adversely affected.

Overall, the findings of this study confirm that planning and scheduling practices are not merely administrative functions but strategic project management processes that directly influence project outcomes. The study provides empirical evidence that organizations that invest in effective planning, scheduling, integration, monitoring, and control practices are more likely to achieve successful project delivery and reduce project delays.

Furthermore, the study contributes to the limited body of research examining planning and scheduling practices within the Saudi Arabian EPC sector and provides practical insights that can support ongoing efforts to improve project performance in alignment with the Kingdom's growing portfolio of industrial, infrastructure, and development projects.

The findings of this study are particularly relevant to Saudi Arabia's Vision 2030 initiatives, which involve the delivery of numerous large-scale industrial, infrastructure, mining, energy, and development projects. As the Kingdom continues to invest in ambitious programs and mega-projects, the importance of effective planning and scheduling practices becomes increasingly critical. Strengthening scope definition, schedule development, resource planning, schedule integration, and monitoring and control processes can contribute to reducing project delays, improving project delivery performance, enhancing resource

utilization, and supporting the successful achievement of the Kingdom's strategic development objectives.

5.4 Practical Recommendations

Based on the findings and conclusions of this study, several practical recommendations are proposed to assist project owners, EPC contractors, project management consultants, and project professionals in improving planning and scheduling practices and reducing project delays. These recommendations are intended to enhance project performance and support the successful delivery of EPC projects operating within the Kingdom of Saudi Arabia.

5.4.1 Recommendations for Project Owners

Project owners play a critical role in establishing the environment within which EPC projects are planned and executed. Therefore, project owners should take proactive measures to strengthen planning and scheduling practices from the earliest stages of project development.

First, project owners should ensure that project scope is clearly defined and adequately developed before project execution begins. Complete and well-defined project requirements reduce uncertainty and minimize the likelihood of scope changes during project execution.

Second, project owners should allocate sufficient time and resources for schedule development and review activities during the planning phase. Unrealistic project schedules established to meet aggressive business objectives frequently contribute to project delays and reduced project performance.

Third, project owners should establish clear governance structures and decision-making processes to ensure that approvals, design reviews, and project decisions are provided in a timely manner. Delays in decision-making can negatively impact engineering, procurement, and construction activities.

Finally, project owners should promote the use of integrated project controls systems and require regular schedule performance reporting to facilitate proactive project monitoring and management.

5.4.2 Recommendations for EPC Contractors

EPC contractors are directly responsible for planning, scheduling, and executing project activities and therefore have a significant influence on project schedule performance.

The findings of this study suggest that EPC contractors should invest in strengthening schedule monitoring and control processes, as this was identified as the most influential factor affecting project delays. Contractors should establish effective project controls systems capable of monitoring progress, measuring performance, forecasting outcomes, and identifying schedule variances early.

EPC contractors should also improve schedule integration practices by ensuring that engineering, procurement, construction, and commissioning activities are fully integrated within the project schedule. Effective interface management should be implemented to improve coordination between project functions and reduce the likelihood of schedule disruptions.

In addition, contractors should enhance resource planning processes by developing realistic manpower, equipment, and material plans aligned with project requirements. Resource constraints should be identified proactively and mitigation measures should be implemented before project performance is affected.

Furthermore, contractors should conduct periodic schedule quality reviews to verify that project schedules accurately reflect project scope, logic, durations, and resource requirements. High-quality schedules provide a stronger foundation for project execution and control.

5.4.3 Recommendations for Project Management Consultants (PMC)

Project Management Consultants play an important role in supporting project governance, monitoring project performance, and ensuring compliance with project management standards and procedures.

Based on the findings of this study, PMC organizations should strengthen schedule review and assurance processes to ensure that project schedules meet accepted planning and scheduling standards. Independent schedule assessments can help identify weaknesses in schedule quality before project execution begins.

PMC organizations should also encourage the implementation of integrated scheduling practices and promote collaboration among project stakeholders. Effective coordination between owners, contractors, consultants, and suppliers can significantly reduce project interface issues and improve schedule performance.

Additionally, PMCs should support the implementation of robust project controls frameworks that incorporate performance measurement, variance analysis, forecasting, and schedule recovery planning. Regular schedule health assessments and performance reviews can assist project teams in identifying emerging risks and implementing corrective actions promptly.

Finally, PMC organizations should promote continuous improvement through lessons learned programs and the adoption of industry best practices relating to planning, scheduling, and project controls.

5.4.4 Recommendations for Project Professionals

Project managers, planners, schedulers, project controls engineers, and other project professionals should continuously develop their planning and scheduling competencies to enhance project performance.

Organizations should encourage professional training and certification in project management, planning and scheduling, project controls, earned value management, and risk management. Continuous professional development can improve the ability of project teams to manage complex EPC projects effectively.

Project professionals should also adopt data-driven decision-making approaches and utilize modern planning and scheduling tools to support project monitoring and control activities. Accurate project information and timely performance reporting are essential for maintaining schedule performance and minimizing project delays.

Furthermore, project teams should promote a culture of proactive project management where potential schedule risks are identified, assessed, and addressed before they escalate into significant project delays.

5.5 Limitations of the Study

Like all academic research, this study has certain limitations that should be considered when interpreting the findings. Although the study provides valuable insights into the influence of planning and scheduling practices on project delays in EPC projects operating within the Kingdom of Saudi Arabia, several constraints may affect the generalizability and interpretation of the results.

First, the study adopted a quantitative research approach based on questionnaire data collected from project professionals. While questionnaires are effective for gathering information from a relatively large number of respondents, the findings are based on respondents' perceptions and experiences. Consequently, the results may be influenced by individual opinions, professional backgrounds, and personal interpretations of planning and scheduling practices.

Second, the study focused exclusively on EPC projects operating within Saudi Arabia. Although Saudi Arabia represents one of the largest EPC markets in the region, project environments, regulatory frameworks, and industry practices may differ from those in other countries. Therefore, caution should be exercised when generalizing the findings to EPC projects outside the Kingdom.

Third, the study examined only five planning and scheduling dimensions: Scope Definition, Baseline Schedule Development, Resource Planning, Schedule Integration, and Schedule Monitoring and Control. While these variables were selected based on the literature review and conceptual framework, other factors such as project risk management, organizational culture, leadership, stakeholder management, procurement strategy, and contract administration may also influence project delays.

Fourth, the study relied on cross-sectional data collected at a single point in time. As a result, the findings reflect respondents' views during the period of data collection and may not fully capture changes in project management practices over time.

Finally, the sample consisted primarily of experienced professionals working within the EPC industry. Although this enhanced the credibility of the responses, the findings may not fully represent the perspectives of all stakeholders involved in project delivery, particularly smaller organizations or less experienced professionals.

Despite these limitations, the study achieved its research objectives and provides meaningful insights into the role of planning and scheduling practices in reducing project delays within EPC projects operating in Saudi Arabia.

5.6 Recommendations for Future Research

This study examined the influence of planning and scheduling practices on project delays in Engineering, Procurement, and Construction (EPC) projects operating within the Kingdom of Saudi Arabia. While the findings provide valuable insights into the relationship between planning and scheduling practices and project performance, several opportunities exist for future research.

First, future studies may expand the scope of the research by including additional project management factors that may influence project delays. Variables such as project risk management, leadership effectiveness, stakeholder management, organizational culture, procurement strategies, contract administration, and digital project management technologies could be investigated to provide a more comprehensive understanding of project performance drivers.

Second, future researchers may conduct similar studies in different countries or regions to compare the influence of planning and scheduling practices across various project environments and regulatory frameworks. Comparative studies may help identify regional differences and industry-specific best practices.

Third, future research may focus on specific industry sectors such as oil and gas, petrochemicals, mining, infrastructure, power, or renewable energy projects. Such studies could provide deeper insights into the unique planning and scheduling challenges associated with different project types.

Fourth, qualitative research methods such as interviews, case studies, and focus groups may be used to complement the findings of this study. Qualitative approaches could provide a deeper understanding of the practical challenges faced by project professionals and the organizational factors influencing planning and scheduling effectiveness.

Fifth, future studies may adopt a longitudinal research design to examine how planning and scheduling practices evolve throughout the project lifecycle and how changes in these practices influence project performance over time.

Finally, future researchers may investigate the impact of emerging technologies such as Building Information Modeling (BIM), Artificial Intelligence (AI), Digital Twins, advanced project controls systems, and data analytics on planning and scheduling performance within EPC projects. As digital transformation continues to reshape the project management profession, understanding the contribution of these technologies to project success will become increasingly important.

Overall, future research should continue exploring strategies that enhance planning and scheduling effectiveness and contribute to improving project performance and reducing project delays within the EPC industry.

5.7 Chapter Summary

This chapter presented the conclusions and recommendations derived from the findings of the study. The chapter began by summarizing the key findings related to the influence of planning and scheduling practices on project delays in EPC projects operating within the Kingdom of Saudi Arabia.

The findings confirmed that all five planning and scheduling dimensions examined in this study—Scope Definition, Baseline Schedule Development, Resource Planning, Schedule Integration, and Schedule Monitoring and Control—significantly influence project delay performance. Among these variables, Schedule Monitoring and Control emerged as the most influential predictor, followed by Schedule Integration and Resource Planning.

Based on the findings, the study concluded that effective planning and scheduling practices play a critical role in reducing project delays and improving project performance. Practical recommendations were provided for project owners, EPC contractors, project management consultants, and project professionals to support the implementation of effective planning, scheduling, monitoring, and control practices throughout the project lifecycle.

The chapter also discussed the limitations of the study and identified several opportunities for future research aimed at expanding the understanding of project delays and improving project management practices within the EPC industry.

Overall, the study contributes to the existing body of knowledge by providing empirical evidence of the significant influence of planning and scheduling practices on project delays in Saudi Arabian EPC projects. The findings offer practical insights that can assist project stakeholders in improving schedule performance, enhancing project delivery outcomes, and supporting the successful execution of future EPC projects.

الملخص

تُعد تأخيرات المشاريع من أبرز التحديات التي تؤثر على التسليم الناجح لمشاريع الهندسة والتوريد والإنشاء (EPC)، حيث تؤدي هذه التأخيرات في كثير من الأحيان إلى تجاوزات في التكاليف، وانخفاض الإنتاجية، ونشوء نزاعات تعاقدية، وتراجع مستوى رضا أصحاب المصلحة. وعلى الرغم من التوسع المتزايد في تطبيق منهجيات إدارة المشاريع واستخدام أدوات التخطيط والجدولة، لا تزال تأخيرات المشاريع تؤثر على العديد من مشاريع الهندسة والتوريد والإنشاء في المملكة العربية السعودية. لذلك، تهدف هذه الدراسة إلى فحص تأثير ممارسات التخطيط والجدولة على تأخيرات المشاريع في مشاريع الهندسة والتوريد والإنشاء العاملة في المملكة العربية السعودية.

اعتمدت الدراسة المنهج الكمي من خلال استخدام استبانة منظمة وُزعت على مجموعة من المتخصصين في إدارة المشاريع، ومهندسي التخطيط، ومخططي الجداول الزمنية، ومتخصصي ضبط المشاريع، ومديري الإنشاءات، وغيرهم من الممارسين العاملين في مشاريع الهندسة والتوريد والإنشاء. وقد تم جمع وتحليل (75) استجابة صالحة. وركزت الدراسة على خمسة أبعاد رئيسية لممارسات التخطيط والجدولة، وهي: تعريف نطاق المشروع، وتطوير الجدول الزمني الأساسي، وتخطيط الموارد، وتكامل الجداول الزمنية، ومتابعة الجدول الزمني والتحكم فيه. بينما تم اعتماد تأخيرات المشاريع كمتغير تابع في الدراسة.

أظهرت نتائج التحليل الإحصائي الوصفي أن المشاركين يرون أن جميع أبعاد التخطيط والجدولة تتمتع بأهمية مرتفعة في تحقيق نجاح المشاريع والحد من التأخيرات. كما كشفت النتائج عن وجود علاقات ذات دلالة إحصائية بين ممارسات التخطيط والجدولة وتأخيرات المشاريع. ومن بين الأبعاد المدروسة، تبين أن متابعة الجدول الزمني والتحكم فيه، وتخطيط الموارد، يمثلان العاملين الأكثر تأثيراً في أداء المشروع من حيث التأخير، في حين أظهرت أبعاد تعريف نطاق المشروع، وتطوير الجدول الزمني الأساسي، وتكامل الجداول الزمنية إسهامات مهمة كذلك في الحد من تأخيرات المشاريع.

وخلصت الدراسة إلى أن التطبيق الفعال لممارسات التخطيط والجدولة يؤدي دوراً محورياً في تحسين أداء المشاريع وتقليل التأخيرات في مشاريع الهندسة والتوريد والإنشاء. كما أكدت النتائج أهمية إنشاء عمليات تخطيط قوية، وتطوير جداول زمنية أساسية واقعية، وضمان التخطيط الكافي للموارد، والمحافظة على تكامل الجداول الزمنية بين مختلف وظائف المشروع، إضافة إلى تطبيق آليات فعالة للمتابعة والتحكم طوال دورة حياة المشروع.

وتسهم هذه الدراسة في إثراء المعرفة العلمية من خلال تقديم أدلة تطبيقية حول العلاقة بين ممارسات التخطيط والجدولة وتأخيرات المشاريع في قطاع مشاريع الهندسة والتوريد والإنشاء بالمملكة العربية السعودية. كما توفر نتائجها إرشادات عملية لملاك المشاريع، ومقاولي الهندسة والتوريد والإنشاء، والاستشاريين، والمتخصصين في إدارة وضبط المشاريع الراغبين في تحسين أداء تسليم المشاريع ودعم التنفيذ الناجح لمبادرات رؤية المملكة العربية السعودية 2030.

الكلمات المفتاحية: تأخيرات المشاريع، ممارسات التخطيط والجدولة، مشاريع الهندسة والتوريد والإنشاء (EPC)، ضبط المشاريع، تخطيط الموارد، تكامل الجداول الزمنية، متابعة الجدول الزمني والتحكم فيه، المملكة العربية السعودية.

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Appendixes

Appendix A- RESEARCH QUESTIONNAIRE-

THE INFLUENCE OF PLANNING AND SCHEDULING PRACTICES ON PROJECT DELAYS IN ENGINEERING, PROCUREMENT, AND CONSTRUCTION (EPC) PROJECTS IN THE KINGDOM OF SAUDI ARABIA

Dear Participant,

I am conducting this study as part of the requirements for a Master's degree in Project Management. The purpose of this research is to examine the influence of planning and scheduling practices on project delays in Engineering, Procurement, and Construction (EPC) projects in the Kingdom of Saudi Arabia.

Your participation is voluntary, and all responses will be treated with strict confidentiality. The information collected will be used solely for academic purposes.

Please indicate your level of agreement with each statement using the following scale:

Scale	Meaning
1	Strongly Disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly Agree

SECTION A: DEMOGRAPHIC INFORMATION

1. Current Position

- ☐ Project Manager
- ☐ Planning Engineer / Scheduler
- ☐ Project Controls Engineer
- ☐ Construction Manager
- ☐ Engineering Manager
- ☐ Procurement Manager
- ☐ Other: _____

2. Years of Professional Experience

- ☐ Less than 5 years
- ☐ 5–10 years
- ☐ 11–15 years
- ☐ 16–20 years
- ☐ More than 20 years

3. Industry Sector

- ☐ Oil and Gas
- ☐ Petrochemical
- ☐ Infrastructure
- ☐ Energy and Utilities
- ☐ Mining
- ☐ Other: _____

4. Type of Organization

- ☐ Owner / Client
 - ☐ EPC Contractor
 - ☐ Consultant
 - ☐ Project Management Consultant (PMC)
 - ☐ Other: _____
-

SECTION B: PLANNING AND SCHEDULING PRACTICES

A. Scope Definition (SD)

Code	Statement	1	2	3	4	5
SD1	Project objectives are clearly defined before project execution begins.	☐	☐	☐	☐	☐
SD2	Project scope requirements are adequately documented.	☐	☐	☐	☐	☐
SD3	Work Breakdown Structures (WBS) are developed and utilized effectively.	☐	☐	☐	☐	☐
SD4	Scope changes are properly evaluated and controlled.	☐	☐	☐	☐	☐
SD5	Stakeholders have a common understanding of project scope.	☐	☐	☐	☐	☐
SD6	Scope definition activities contribute to reducing project uncertainty.	☐	☐	☐	☐	☐

B. Baseline Schedule Development (BSD)

Code	Statement	1	2	3	4	5
BSD1	Project schedules are developed using logical activity sequencing.	☐	☐	☐	☐	☐
BSD2	Activity durations are estimated realistically.	☐	☐	☐	☐	☐
BSD3	Critical path analysis is performed during schedule development.	☐	☐	☐	☐	☐
BSD4	Schedule assumptions and constraints are clearly documented.	☐	☐	☐	☐	☐
BSD5	Baseline schedules are reviewed and approved before execution.	☐	☐	☐	☐	☐
BSD6	Baseline schedules provide an effective basis for project control.	☐	☐	☐	☐	☐

C. Resource Planning (RP)

Code	Statement	1	2	3	4	5
RP1	Labor requirements are accurately identified during planning.	☐	☐	☐	☐	☐
RP2	Resource availability is considered during schedule development.	☐	☐	☐	☐	☐
RP3	Material requirements are effectively planned.	☐	☐	☐	☐	☐
RP4	Equipment requirements are adequately planned and coordinated.	☐	☐	☐	☐	☐
RP5	Resource allocation supports efficient project execution.	☐	☐	☐	☐	☐
RP6	Resource planning contributes to reducing schedule disruptions.	☐	☐	☐	☐	☐

D. Schedule Integration (SI)

Code	Statement	1	2	3	4	5
SI1	Engineering, procurement, and construction schedules are integrated.	☐	☐	☐	☐	☐
SI2	Project interfaces are effectively coordinated.	☐	☐	☐	☐	☐
SI3	Schedule dependencies are clearly identified and managed.	☐	☐	☐	☐	☐
SI4	Stakeholder schedules are aligned with project objectives.	☐	☐	☐	☐	☐

Code	Statement	1	2	3	4	5
SI5	Integrated schedules improve project communication and coordination.	☐	☐	☐	☐	☐
SI6	Schedule integration contributes to reducing project delays.	☐	☐	☐	☐	☐

E. Schedule Monitoring and Control (SMC)

Code	Statement	1	2	3	4	5
SMC1	Project progress is monitored regularly.	☐	☐	☐	☐	☐
SMC2	Schedule updates are performed on a timely basis.	☐	☐	☐	☐	☐
SMC3	Schedule variances are analyzed effectively.	☐	☐	☐	☐	☐
SMC4	Corrective actions are implemented when schedule deviations occur.	☐	☐	☐	☐	☐
SMC5	Schedule performance indicators are used to monitor project status.	☐	☐	☐	☐	☐
SMC6	Monitoring and control processes contribute to improving schedule performance.	☐	☐	☐	☐	☐

SECTION C: PROJECT DELAYS (PD)

Code	Statement	1	2	3	4	5
PD1	Project delays occur frequently in EPC projects.	☐	☐	☐	☐	☐
PD2	Delays significantly affect project performance.	☐	☐	☐	☐	☐
PD3	Delays contribute to project cost overruns.	☐	☐	☐	☐	☐
PD4	Delays negatively affect resource utilization.	☐	☐	☐	☐	☐
PD5	Delays reduce stakeholder satisfaction.	☐	☐	☐	☐	☐
PD6	Delays affect achievement of project milestones.	☐	☐	☐	☐	☐
PD7	Delays create contractual and commercial challenges.	☐	☐	☐	☐	☐
PD8	Delays reduce overall project efficiency.	☐	☐	☐	☐	☐
PD9	Effective planning and scheduling can reduce project delays.	☐	☐	☐	☐	☐
PD10	Improvements in planning and scheduling practices can enhance project delivery performance.	☐	☐	☐	☐	☐

Thank you for your valuable participation and contribution to this research.

Appendix B- RELIABILITY ANALYSIS (CRONBACH'S ALPHA)-

Cronbach's Alpha was used to assess the internal consistency and reliability of the questionnaire items. According to Hair et al. (2019), Cronbach's Alpha values above 0.70 indicate acceptable reliability, values above 0.80 indicate good reliability, and values above 0.90 indicate excellent reliability.

Table B.1 Reliability Analysis Results

Variable	Number of Items	Cronbach's Alpha	Reliability Level
Scope Definition (SD)	6	0.874	Good
Baseline Schedule Development (BSD)	6	0.881	Good
Resource Planning (RP)	6	0.892	Good
Schedule Integration (SI)	6	0.867	Good
Schedule Monitoring and Control (SMC)	6	0.901	Excellent
Project Delays (PD)	10	0.889	Good
Overall Questionnaire	40	0.931	Excellent

The results indicate that all study constructs achieved Cronbach's Alpha values exceeding the minimum recommended threshold of 0.70. Therefore, the questionnaire demonstrated satisfactory internal consistency and reliability for measuring the study variables. The overall questionnaire achieved a Cronbach's Alpha value of 0.931, indicating excellent reliability and supporting the suitability of the instrument for data analysis and hypothesis testing.

Appendix C- CORRELATION ANALYSIS RESULTS-

Pearson Correlation Analysis was conducted to examine the relationships between planning and scheduling practices and project delays. The correlation coefficients indicate the strength and direction of the relationships between the study variables.

Table C.1 Correlation Matrix

Variable	SD	BSD	RP	SI	SMC	PD
Scope Definition (SD)	1.000	0.648**	0.622**	0.597**	0.615**	0.541**
Baseline Schedule Development (BSD)	0.648**	1.000	0.671**	0.624**	0.639**	0.578**
Resource Planning (RP)	0.622**	0.671**	1.000	0.655**	0.694**	0.623**
Schedule Integration (SI)	0.597**	0.624**	0.655**	1.000	0.642**	0.587**
Schedule Monitoring and Control (SMC)	0.615**	0.639**	0.694**	0.642**	1.000	0.681**
Project Delays (PD)	0.541**	0.578**	0.623**	0.587**	0.681**	1.000

** Correlation is significant at the 0.01 level (2-tailed).

Interpretation

The results indicate that all planning and scheduling dimensions have significant positive relationships with project delays. Schedule Monitoring and Control demonstrated the strongest relationship with Project Delays ($r = 0.681$, $p < 0.01$), followed by Resource Planning ($r = 0.623$, $p < 0.01$), Baseline Schedule Development ($r = 0.578$, $p < 0.01$), Schedule Integration ($r = 0.587$, $p < 0.01$), and Scope Definition ($r = 0.541$, $p < 0.01$).

The findings suggest that improvements in planning and scheduling practices are associated with improved project performance and reduced delay occurrences in EPC projects. The correlation coefficients also indicate moderate to strong relationships among the independent variables, while remaining below the commonly accepted multicollinearity threshold of 0.80.

Appendix D- MULTIPLE REGRESSION ANALYSIS RESULTS-

MULTIPLE REGRESSION ANALYSIS RESULTS

Multiple Regression Analysis was conducted to examine the influence of the five dimensions of planning and scheduling practices on project delays in Engineering, Procurement, and Construction (EPC) projects in the Kingdom of Saudi Arabia.

Table D.1 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.782	0.611	0.582	0.438

Interpretation:

The model explains approximately 61.1% of the variance in Project Delays ($R^2 = 0.611$), indicating that planning and scheduling practices are significant predictors of project delay performance in EPC projects.

Table D.2 ANOVA Results

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	20.863	5	4.173	21.742	0.000
Residual	13.246	69	0.192		
Total	34.109	74			

Interpretation:

The ANOVA results indicate that the regression model is statistically significant ($F = 21.742$, $p < 0.001$), confirming that the independent variables collectively explain a significant proportion of the variation in project delays.

Table D.3 Regression Coefficients

Variable	Unstandardized B	Std. Error	Standardized Beta	t-value	Sig.
Constant	0.812	0.284	-	2.859	0.006
Scope Definition (SD)	0.143	0.061	0.167	2.344	0.022
Baseline Schedule Development (BSD)	0.158	0.067	0.181	2.358	0.021
Resource Planning (RP)	0.214	0.073	0.248	2.931	0.005
Schedule Integration (SI)	0.172	0.069	0.194	2.493	0.015
Schedule Monitoring and Control (SMC)	0.287	0.075	0.326	3.827	0.000

Interpretation:

The results indicate that all five planning and scheduling dimensions have statistically significant effects on project delays ($p < 0.05$). Schedule Monitoring and Control demonstrated the strongest influence on project delays ($\beta = 0.326$), followed by Resource Planning ($\beta = 0.248$), Schedule Integration ($\beta = 0.194$), Baseline Schedule Development ($\beta = 0.181$), and Scope Definition ($\beta = 0.167$).

The findings suggest that improvements in monitoring and control processes, resource planning, schedule integration, schedule development, and scope definition contribute significantly to reducing project delays and improving project delivery performance in EPC projects.

العنوان باللغة العربية

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السعودية

إعداد الطالب/فيصل لكموش

إشراف/

د.الفیصل عبد الحمید

د.فايز جراد

العام الدراسي:

2026