

CHAPTER 3

3.1 Introduction

This chapter presents a comprehensive description of the research methodology adopted for this study, which investigates the mediating role of project manager's competencies in the relationship between the use of artificial intelligence (AI) and project constraints. The selection of methodology, sampling strategy, data collection instrument, and statistical analysis tools are all carefully aligned with the research problem, objectives, and hypotheses articulated in Chapter One.

In the first chapter, it was emphasized that the integration of AI technologies in project management processes remains inconsistent across contracting companies, especially in regions such as the Eastern Province of Saudi Arabia. Furthermore, there exists a knowledge gap regarding how the competencies of project managers influence the effectiveness of AI utilization in alleviating or addressing project constraints. Therefore, the current chapter outlines the methodological framework designed to systematically explore these interconnections and provide empirical evidence.

The chapter is structured as follows: Section 3.2 discusses the research design and rationale; Section 3.3 defines the population and explains the sampling procedures; Section 3.4 presents the development and structure of the research instrument; Section 3.5 elaborates on validity and reliability procedures; Section 3.6 outlines the data collection procedures; Section 3.7 details the statistical techniques used for data analysis and explains the purpose of each; and Section 3.8 addresses the ethical considerations relevant to this study

3.2 Research Methodology

This section provides an in-depth discussion of the philosophical foundation, methodological orientation, and the specific research strategy adopted for this study. It aims to offer a comprehensive explanation and justification for the research decisions made, ensuring that each choice is linked to the study's overall objectives, hypotheses, and conceptual framework. By outlining the underlying philosophical approach, this section highlights the theoretical

underpinnings that guide the research, reflecting the values and assumptions that influence the design and implementation of the study. Additionally, the section elaborates on the chosen methodology, detailing how it supports the research questions and aligns with the goals of the study. It also emphasizes how the selected strategy enables the research to produce meaningful, valid, and reliable results that contribute to the field of knowledge. The intention is to provide a clear rationale for the research design, ensuring transparency and coherence throughout the study.

3.2.1 Research Philosophy and Paradigm

The study is situated within the positivist paradigm, which is based on the assumption that reality is objective, observable, and measurable through empirical research. The positivist perspective asserts that knowledge is derived from observable facts and that the relationships between variables can be objectively assessed using quantitative methods. This worldview aligns well with the use of quantitative techniques to examine relationships between variables, allowing for hypothesis testing and statistical analysis.

In the context of this study, which investigates the relationship between artificial intelligence (AI), project managers' competencies, and project constraints, a positivist approach is highly suitable for several reasons. First, it facilitates hypothesis-driven inquiry, allowing the study to systematically test the proposed relationships between the key concepts. Second, the approach relies on objective, numerical data collected through a standardized instrument, ensuring that the findings are based on measurable and comparable information. Third, a positivist methodology promotes the principles of replicability and generalizability, which are essential for ensuring that the results of the study can be consistently reproduced and applied across different contexts, particularly in management research. These characteristics make the positivist approach an ideal framework for this study, ensuring that the research is rigorous, objective, and capable of producing reliable and applicable results.

3.2.2 Type of Research Design

The study adopts a non-experimental, correlational, and explanatory design to explore the relationships between key variables. The correlational aspect of the design allows the researcher to examine the associations between different variables without the need to manipulate them, making it particularly well-suited for field research conducted in real-world organizational settings. By analyzing these relationships as they naturally occur, the study provides valuable insights into how various factors, such as AI usage, project manager competencies, and project constraints, are interconnected.

In addition to its correlational nature, the explanatory orientation of the study allows it to go a step further by not only identifying these associations but also by seeking to explain the underlying causal pathways. This approach is particularly important as it helps to uncover the mechanisms through which project managers competencies may mediate the relationship between AI usage and project constraints. By evaluating these mediating effects, the study offers a deeper understanding of how competencies influence project outcomes in AI-driven project management environments, providing more than just a description of relationships but an explanation of the underlying processes at play. This combination of correlational and explanatory design ensures a comprehensive examination of the factors that shape project management effectiveness in the context of AI integration.

3.2.3 Time Frame and Unit of Analysis

This study employs a cross-sectional time horizon, meaning that data will be collected at a single point in time rather than over an extended period. This design is particularly suitable given the practical limitations related to field access and the need for timely insights that can inform immediate improvements in project management practices. By focusing on data gathered at one specific moment, the study aims to provide a snapshot of the current state of AI usage, project manager competencies, and project constraints within the studied organizations.

The unit of analysis for this research is the individual project management staff member. Since the key constructs under investigation—AI usage, project manager competencies, and project constraints—are inherently experienced and interpreted at the individual level, this focus allows

for a deeper understanding of how these factors are perceived and applied by the project managers themselves. This approach ensures that the research captures the personal insights and experiences that contribute to the overall effectiveness of project management within the organizational context. By examining the constructs at the individual level, the study seeks to provide valuable perspectives on how project managers navigate AI technologies and manage project constraints in their daily roles.

3.3 Study Population and Sampling

3.3.1 Study Population

The population for this study comprises project management professionals employed by large contracting companies, as officially classified by the Saudi Contractors Authority, located in the Eastern Province of the Kingdom of Saudi Arabia. This specific population was selected for several strategic reasons that align with the contextual justification outlined in Chapter One.

As previously mentioned, the contracting sector in Saudi Arabia is undergoing a profound transformation under the framework of Vision 2030. The Eastern Province, in particular, has become a focal point for large-scale megaprojects, infrastructure development, and industrial expansion. Despite this significance, many companies still face significant challenges in project delivery, especially in terms of time, cost, scope, and risk management. While the integration of AI into project management is still in its developmental stages, the effectiveness with which project managers adopt and utilize these tools remains a critical factor in determining the success or failure of projects.

Therefore, focusing on this population provides both practical value and theoretical insight. On a practical level, the findings can contribute to real-world improvements in organizational practices and project management strategies. Theoretically, the study fills a gap in the literature by expanding the empirical research on AI utilization and managerial competencies into a regional context that has not been extensively studied, thereby offering a unique perspective on AI's role in the Saudi contracting sector.

3.3.2 Sampling Frame and Criteria

According to Monsha'at, a division of the Saudi Ministry of Commerce, companies in Saudi Arabia are classified into four categories based on the number of full-time employees. These categories are as follows: Micro companies, which have between 1 and 5 employees; Small companies, which employ 6 to 49 individuals; Medium companies, with 50 to 249 employees; and Large companies, which employ 250 or more individuals (Monsha'at, n.d.).

For this study, the sampling frame includes all large contracting companies in the Eastern Province of Saudi Arabia that meet the following criteria:

- They are registered with the Saudi Contractors Authority (SCA),
- They have dedicated project management departments or units,
- They employ qualified personnel in decision-making or operational roles relevant to project delivery.

Participants will be selected from these organizations based on their involvement in managing, coordinating, or supporting project operations. This may include project managers, project engineers, planning and scheduling personnel, and other professionals in similar roles.

Based on these criteria, a total of 79 companies form the population for this study, as shown in Table (3.1) (Muqawil, n.d.).

SN	Company Name	Website	Contact Number	Email Address
1	Alkifah Contracting	www.alkifah.com	0138459564	abdullah.busodah@alkifah.com
2	Eastern Projects Contracting Company	www.epcc.com.sa	013586 6023	info@epcc.com.sa
3	Bin Delamah Contracting Co.	www.bindelamah.com	0136680668	mail@bindelamah.com
4	Nesma Trading Co.	www.nesma.com	0138298200	marketingnt@nesma.com
5	Almuzain Gulf Saudi Contracting	www.almuzain.com	0133404200	info@almuzain.com
6	Rowad Aljazeera Co.	www.rjazeeraco.com	966555059999	naif@rjazeeraco.com
7	Faisal Electro-Mechanical Company	www.femco.com.sa	920023595	FEMCO@FEMCO.COM.SA
8	Thabat	www.thabat.sa	0138260345	majed.zahrani@thabat.sa
9	Nesma & Partners	www.nesmapartners.com	0138519000	bd@nesmapartners.com
10	Al Osais Contracting Co.	www.osais.com	0138196159	Sec.yousef@osais.com
11	Babtain Contracting Company	albabtain-contracting.com	0138584218	naif@abc.sa.com
12	Alyamama	www.yc..com.sa	0138266444	info@yc.com.sa
13	Ansab	ansab.com.sa	966599000677	n.hashem@ansab.com.sa
14	MOFARREH ALHARBI & PARTNERS	www.harbico.com	0138500011	ghazi@harbico.com
15	Building Construction Company	www.bcc-sa.com	0138612223	info@bcc-sa.com
16	Rawabi Specialized Contracting	www.rsccl.com.sa	966551079009	info@rsccl.com.sa
17	Ahmad N. Albinali Holding Company	www.albinali.com/	0138595555	nalbinali@albinali.com
18	Makana	www.makana.com.sa	0133617100	ofiah@makana.com.sa
19	Al-Bushaier Trading & Contracting Co.	www.albushaier.com	0135891999	info@albushaier.com
20	Al-Essa for Contracting	www.saadalessa.com	0544634612	info@saadalessa.com
21	Mohammad Al-Barghash Al-Mansouri & Sons	www.MBTC.COM.SA	0138693345	HRD@MBTC.COM.SA
22	Alotaishan Holding	www.al-otaishan.com.sa/	0138116048	info@al-otaishan.com.sa
23	Siyar Al-Watan Trading & Contracting Company	www.daco-ksa.com	0136639569	info@daco-ksa.com
24	Abdul Rahman Saad Al-Rashid & Sons	www.artar.com.sa	0114646111	Hr@artar.com.sa
25	TCC	www.tcc.sa/	0138302009	Info.tcc@al-tamimi.com
26	Sedres	www.sedres.com	966532024948	m.deeb@sedres.com
27	Alojaimi Holding	www.alojaimi.com	0138221800	faisal.alojaimi@alojaimi.com

28	Al-Tamimi	www.al-tamimi.sa	0138500000	asawi2006@yahoo.com
29	Saudi Mace	www.saudimace.com	0128948887	gro@saudimace.com
30	JAL International	www.jalint.com.sa	0138128888	jal@jalint.com.sa
31	Aljalhami Contracting & Trading Company	www.JALHAMI.COM	0137660140	CONTRACT@JALHAMI.COM
32	Mohammad Rashid Al-Khathlan	www.mrk.com.sa	0138112200	admin@mrk.com.sa
33	Fields modern solutions company Trading and Contracting	www.fmsco.com.sa/	966570997443	Info@fmsco.com.sa
34	Almajal Alarabi Holding	www.mag-sa.com	0112051666	y.saad@mag-sa.com
35	Alfalak	www.AlFalak.com	0138591990	yasser_alshafei@AlFalak.com
36	Projects Pioneer Contracting Co.	www.pppo-ksa.com	0138372532	hr@ppco-ksa.com
37	NASSACO	www.nassaco.com	0136680775	fattah@nassaco.com
38	Twail Holding	www.twaik.com	0112634444	info@twaik.com
39	Al-Shalawi International Company for Trading & Contracting	www.alshalawi.com	0138645917	ahmadhr@alshalawi.com
40	Almdeed Contracting	www.almdeed.com	0135758119	hossam_madi@almdeed.com
41	Alhoty Stanger	www.alhotystanger.com	138084317	morsy.abuzaid@alhotystanger.com
42	Hadi Haider Company for Trading & Contracting	www.hadihaider.com	0136680001	info@hadihaider.com
43	Manar Alomran	www.manar.com.sa	966504518066	a.akram@manar.com.sa
44	Saqco Arabia	www.saqco.com	0138986491	sahlalshmmmary@saqco.com
45	Abaja Contracting	www.abaja.net	0136671282 ext 108	hr@abaja.net
46	Jana Marine Services Co.	www.jana-ms.com	0138401818	nader.aldossari@jana-ms.com
47	Saudi Arabian Baytur	www.baytur.com.sa	0138930179	murat.giray@baytur.com.sa
48	Arabian Fal	www.arabianfal.com/	0136680111	ibrahim33@arabianfal.com
49	Al-Fahhad Zegwaard Co.	www.afzco.com	0138115944	jerai@afzco.com
50	Alhajdyah Contracting Company	www.HAJDYAH.COM.SA	0138810592	HAJDYAH@HAJDYAH.COM.SA
51	Hamood H. Al-Ha,,ad Group Holding	www.alhammad.com	0138500000	info@alhammad.com
52	National Contracting Co. (Rezayat)	www.rezayat.com/unit/ncc/	0136636000	nccho@ncc.com.sa
53	Saudi Tunneling Co.	www.tunnels.sa	0138810066	info-stcc@tunnels.sa

54	Reda'a Developing Co.	www.alredaa.net	0138266626	redacontract@alredaa.net
55	Mastoura Contracting Co.	www.mastoura.com.sa	0136672280	mastoura@mastoura.com.sa
56	Globe Group	http://www.globeksa.com/	013852222	aaldossary@globeksa.com
57	Civil Works Company	www.cwc.com.sa	0138572205	mahmoud.saad@cwc.com.sa
58	Al Kuhaimi Metal Industries	www.kmr.com.sa	0138472444	mohd.alajou@kmr.com.sa
59	Zamil Industrial	www.zamilindustrial.com/	0138108111	Abdullahshehri@zamilindustrial.com
60	Afac United Company	www.afac.com.sa	01338901123	ibrahim@afac.com.sa
61	Salem Saleh Al-Hareth General Contracting Company	www.salemalhareth.com	0138901009	ali@salemalhareth.com
62	Zaid Alhussain & Brothers Group	www.zaidg.com	0138590066	mr_elzen@zaidg.com
63	Global Suhaimi	www.globalsuhaimi.net	0138571953	f.alghamdi@globalsuhaimi.net
64	Fountain Gulf General Contracting Est.	www.FGC-SA.COM	920002636	INFO@FGC-SA.COM
65	Exact Technical Solutions	www.exactts.com	0138641856	Mousa.aljaroudi@exactts.com
66	Enjaz Al-Sharq	www.enjazalsharq.com	0128901086	musfer@enzazalsharq.com
67	Naizak	www.naizak.com	0138989577	alhajrsm@naizak.com
68	Group Amana	www.groupamana.com	012422 2266	sadiq.almatrood@groupamana.com
69	Afras	www.afras.com.sa	013833 6056	majed@afras.com.sa
70	NABIL A. ABU NHAYA & PARTNER Co.	www.np-concrete.com	0138948253	alkhourif@np-concrete.com
71	Mesmack Co. for Construction & Development	www.mesmack.com	0138969388	abdullah@mesmack.com
72	Abdulla B. Al-Khalifa & Sons	www.akgroup.com.sa/	0138273269	aktsd@akgroup.com.sa
73	SRACO	www.sracocom.sa	0138433441	sabry@sraco.com.sa
74	REDA Hazard Control	www.redafire.com	920001679	yasser.kernazi@redafire.com
75	Faisal S. Alnaimi	www.fsn.com.sa	0138577054	mohd@fsn.com.sa
76	Abid Ali Alhabashi Contracting Co.	www.alhabashigroup.com	0138448591	info@alhabashigroup.com
77	Gulf Architects Contracting	www.gac-cont.com/	0138187314	eljebaly@gac-cont.com
78	RAPCO EPC	www.http://rapcogroups.com/	0136681617	hadi.turki@rapcogroups.com
79	Tareg Al-Jaafari Cont. Co.	www.tareg.com.sa	0138344468	saud.aldossary@tareg.com.sa

Table (3.1)

3.3.3 Sampling Technique

A probability sampling technique will be used for this study, with stratified random sampling being the preferred method, if feasible. This approach ensures that different segments of the population, such as company size within the "large" category, project type, and geographic location within the Eastern Province, are adequately represented.

In the event of access limitations to certain companies, a simple random sampling method will be employed among organizations that agree to participate. This ensures the validity of the sample while minimizing selection bias.

3.3.4 Sample Size Determination

To determine the required sample size, the following Yamane (1967) formula for finite populations will be applied:

$$n = \frac{N}{1 + N (e)^2}$$

Where:

- n = Sample size
- N = Total population (estimated number of eligible employees)
- e = Margin of error (commonly set at 0.05 for 95% confidence)

Once the estimated total population (N) is confirmed through the Saudi Contractors Authority database or through cooperation from the companies, the sample size will be precisely calculated using the Yamane formula. This approach ensures that the study achieves sufficient statistical power to test its hypotheses effectively. Particularly for structural equation modeling (SEM), which requires larger sample sizes to provide reliable and robust estimates, this calculated sample size will ensure that the findings are statistically significant and generalizable within the targeted population.

3.3.5 Sample Size Justification for SEM

Since one of the primary analytical techniques in this study is Path Analysis using Structural Equation Modeling (SEM), the sample size needs to fulfill the minimum requirements for model complexity. Hair et al. (2017) suggest that for models with moderate complexity—comprising 3 to 5 latent variables, each with several indicators—a sample size of 200 to 300 respondents is typically considered sufficient, provided that the data quality is high. Therefore, this study aims to meet or exceed this threshold to ensure the reliability and robustness of the SEM analysis.

3.4 Instrumentation: Questionnaire Design and Development

3.4.1 Overview of Instrument Design

Designing a questionnaire is a critical component of the research process, as it directly influences the reliability and accuracy of the data collected. Brace (2004) emphasizes that an effective questionnaire should be carefully aligned with the research objectives and designed to minimize errors while ensuring the collection of accurate and valid responses. Achieving this requires meticulous planning of question types, sequence, and phrasing to ensure clarity and maintain respondent engagement. Additionally, the design must consider the perspectives and needs of all stakeholders involved, including the respondents, interviewers, and data analysts. In essence, a well-constructed questionnaire serves as a structured conversation, facilitating the collection of meaningful, unbiased data that contributes to meeting the research objectives.

The main data collection tool for this study is a structured questionnaire, which has been meticulously designed to gather comprehensive, valid, and reliable data that accurately reflects the research variables. The questionnaire is directly aligned with the conceptual model introduced in Chapter One and the theoretical framework discussed in Chapter Two. It translates the three primary constructs, AI Usage, Project Manager's Competencies, and Project Constraints, into measurable dimensions and indicators, ensuring that each concept is operationalized in a way that allows for effective data analysis.

A 5-point Likert scale is used for all items related to the constructs, with response options ranging from (1) Strongly Disagree to (5) Strongly Agree. This scale is commonly employed in research for measuring attitudes, perceptions, and self-reported behaviors, ensuring consistency and reliability in the assessment of the variables.

3.4.2 Questionnaire Structure

Based on the 5 research hypotheses that are:

H1: There is a significant relationship between the use of AI, Project Constraints, and Project Managers' Competencies.

H2: There is a positive impact of using AI on Project Managers' Competencies.

H3: There is a positive impact of using AI on Project Constraints.

H4: There is a positive impact of Project Managers' Competencies on Project Constraints.

H5: The significant impact of using artificial intelligence on project constraints increases when mediated by project managers' competencies.

The questionnaire is structured into four distinct sections, each organized in a logical sequence to ensure clarity and coherence in data collection. These sections are as follows:

Section A: Demographic and Organizational Information

This section gathers key background information to facilitate segmentation and enable comparative analysis. The variables covered include:

- Gender
- Age group
- Educational qualification
- Years of experience in project management
- Position or role

This data allows for descriptive profiling, comparison of groups using statistical tests (such as t-tests and ANOVA), and provides the context necessary to interpret the findings effectively.

Section B: Artificial Intelligence Usage

This section aims to evaluate the degree to which AI tools are adopted and integrated into project management activities. It includes 7 dimensions, each assessed through 3 to 5 items:

- Machine Learning (ML)
- Natural Language Processing (NLP)
- Chatbots and Visual Assistants
- Predictive Analytics
- Robotic Process Automation (RPA)
- Data Visualization Tools
- Decision Support Systems (DSS)

Each item in this section captures either the actual use or the perceived usefulness of AI tools within the project management context.

Section C: Project Manager's Competencies

This section focuses on the mediating variable of the study, which is based on internationally recognized competency frameworks (e.g., IPMA, PMI). The construct is operationalized into three key competency clusters:

Technical Competencies – e.g., planning, budgeting, software usage

Leadership and Behavioral Competencies – e.g., communication, team management

Strategic and Business Competencies – e.g., understanding of organizational strategy, business acumen

Each cluster includes specific indicators designed to assess perceived proficiency and effectiveness within the context of project management roles. These indicators provide a comprehensive measure of the competencies required to effectively navigate the complexities of AI integration and project constraints.

Section D: Project Constraints

This section evaluates the dependent variable by examining how effectively projects meet the established constraints. The 10 dimensions, derived from both classical and contemporary project management theories, encompass key factors that influence project performance. These dimensions include scope, time, cost, quality, risk, resources, stakeholder engagement, governance, benefits realization, and strategic alignment. Each dimension is designed to assess the critical aspects of project constraints, providing a comprehensive overview of how well projects adhere to their predefined boundaries and objectives.

Participants will be asked to evaluate their perception of how effectively these constraints are managed in their respective projects. Their responses will provide valuable insights into the effectiveness of project management practices and the extent to which various constraints impact project success. This assessment will allow for a deeper understanding of the areas where project managers may face challenges and where improvements could be made to better meet project objectives.

3.4.3 Questionnaire Structure

The items in Sections B (AI Usage), C (Project Manager's Competencies), and D (Project Constraints) were meticulously adapted from established and validated instruments used in prior peer-reviewed studies and professional standards. The adaptation process included a thorough review of relevant measurement items from similar studies, followed by adjustments to ensure they were appropriate for the unique context of large contracting companies operating in the Eastern Province of Saudi Arabia. This ensured that the items accurately reflect the specific conditions and challenges faced by these organizations while maintaining the conceptual integrity of the original instruments.

Linguistic and contextual modifications were implemented to ensure that the terminology accurately aligns with local industry practices while maintaining the original conceptual meaning. For example, AI-related terms were revised to reflect the specific tools and technologies currently utilized within Saudi project management environments, ensuring that the language resonates with the local context without altering the underlying concepts.

Before full deployment, the questionnaire will undergo several testing phases:

- **Face validity testing:** To evaluate the clarity, wording, and overall comprehension of the questions.
- **Content validity review:** Conducted by a panel of academic and industry experts to ensure that the instrument adequately covers all relevant constructs.
- **Pilot testing:** A trial run with 20–30 project management professionals to assess the timing, consistency, and initial reliability of the questionnaire.

3.4.4 Language and Format

The questionnaire will be initially developed in English, as it is the primary language used in most corporate project environments in Saudi Arabia. If necessary, an Arabic version will be created to ensure that the conceptual meaning remains consistent across both versions. The survey will be administered electronically, utilizing secure online platforms to facilitate easy access, tracking, and efficient data management.

3.5 Validity and Reliability Testing

Ensuring the validity and reliability of the research instrument is essential for maintaining the credibility and accuracy of any quantitative study. In this research, a range of robust procedures will be employed to verify that the questionnaire effectively measures the intended constructs. These procedures will also ensure that the instrument consistently produces reliable results across different participants and contexts.

3.5.1 Content Validity

Content validity refers to the degree to which the items in an instrument effectively represent the full scope of each construct being measured. To ensure this, the initial version of the questionnaire will be reviewed by a panel of experts with backgrounds in project management, artificial intelligence, and academic research methodology. These experts will evaluate the relevance, clarity, comprehensiveness, and phrasing of each question. Based on their feedback, revisions will be made, including rewording, adding, or removing items to better align with theoretical frameworks and real-world applications. This step is especially important for the AI-related dimensions, as they are rapidly evolving and must be carefully calibrated to reflect the most current industry practices and technologies.

3.5.2 Face Validity

Face validity involves determining whether the questionnaire items seem to measure the intended constructs, based on the respondents' perspectives. To assess this, a pilot group of 10–15 project management professionals will be asked to review the questionnaire. Their task will be to evaluate the clarity, cultural relevance, and logical flow of the questions. The feedback gathered will help identify and resolve any ambiguity or potential biases, ensuring the tool is user-friendly and accessible. While face validity is not a formal statistical test, it is an important step in improving the questionnaire's effectiveness, encouraging greater participation, and enhancing the accuracy of the responses.

3.5.3 Construct Validity – Confirmatory Factor Analysis (CFA)

To assess construct validity, the study will utilize Confirmatory Factor Analysis (CFA) with AMOS software or R (lavaan package). This approach allows for the statistical confirmation that each item (indicator) is significantly associated with its intended latent construct (e.g., Machine Learning items load on AI usage). The measurement model will be evaluated using several fit indices to ensure it aligns with acceptable standards, including:

- CFI (Comparative Fit Index) ≥ 0.90
- RMSEA (Root Mean Square Error of Approximation) ≤ 0.08

- Chi-square/df ratio ≤ 3.0

CFA will also assess convergent validity, which ensures that items measuring the same construct are highly correlated, and discriminant validity, which confirms that the constructs are distinct from one another. This process strengthens the theoretical integrity and robustness of the measurement model.

3.5.4 Reliability – Internal Consistency

To assess the reliability of each construct, Cronbach's Alpha will be calculated using SPSS. Constructs with alpha values greater than or equal to 0.70 will be deemed acceptable, as this threshold indicates sufficient internal consistency. If any construct demonstrates weak reliability, problematic items will be identified and revised or removed based on item-total correlations and alpha-if-item-deleted metrics. This reliability testing will be conducted for all AI sub-dimensions, competency clusters, and each project constraint dimension to ensure that the measures consistently reflect the intended constructs across respondents.

3.5.5 Pilot Testing

A pilot test will be conducted prior to the main data collection, involving 20–30 respondents from the target population who are not part of the final sample. The objectives of this pilot test are to assess the response time and usability of the electronic questionnaire, ensure that data is correctly captured and exported, calculate preliminary Cronbach's Alpha values for each dimension, and identify any logistical or technical issues that may arise during the data collection process. The feedback and preliminary results obtained from the pilot will be used to make any necessary adjustments to the questionnaire and data collection procedures before the full implementation of the study.

3.6 Data Collection Procedures

The data collection phase is a crucial stage in ensuring the integrity, completeness, and ethical soundness of the study. This section outlines the process of administering the questionnaire,

coordinating access to participants, and implementing procedural safeguards throughout the data collection process. It details the steps involved in ensuring that data is gathered systematically and ethically, while also addressing how participants' rights will be protected and how the collection process will be managed efficiently. This ensures that the data collected is accurate, reliable, and aligned with the study's objectives.

3.6.1 Preparation Phase

Before initiating the full data collection process, several key preparations will be made to ensure the study is well-organized and ethically sound. These include finalizing the questionnaire based on feedback from experts and the results of pilot testing. The questionnaire will then be converted into an electronic format using a secure and user-friendly platform such as Google Forms, Qualtrics, or SurveyMonkey to facilitate ease of access for participants. A formal cover letter will be developed, clearly outlining the purpose of the study, its duration, the confidentiality measures in place to protect participants' data, and a statement of informed consent to ensure participants are fully aware of their rights and involvement in the study. Additionally, formal approvals will be obtained from the academic institution, and where necessary, from company representatives or relevant ethical boards, ensuring that all procedural requirements are met prior to data collection.

3.6.2 Targeting and Access

As outlined in Section 3.3, the target respondents for this study are project management professionals working within large classified contracting companies in the Eastern Province of Saudi Arabia. To facilitate access to this population, the following steps will be undertaken:

- An initial outreach will be made to the corporate offices of the selected companies, requesting permission to distribute the survey to the relevant project management staff.
- Coordination will be established with internal project management offices (PMOs), human resources (HR) departments, or department heads to assist in the distribution and collection of the surveys.

- In cases where centralized distribution channels are not available, direct contact will be made with potential respondents through professional networks, industry-specific groups, and online project management communities to ensure broad participation.

3.6.3 Distribution Process

The survey will be distributed via a secure online link, and the following procedures will be implemented to ensure a smooth and ethical data collection process:

- An invitation message will be sent via email or other official communication channels. This message will include the following details:
 - The purpose of the study
 - The estimated time required to complete the survey (approximately 10–15 minutes)
 - Assurances of confidentiality and data privacy
 - A statement confirming voluntary participation
 - Contact details for the researcher in case participants have any questions or need further clarification
- Respondents will be able to access the survey at their convenience through desktop or mobile devices, providing flexibility in completing the questionnaire.
- The system will be set up to ensure that each participant can submit only one response, utilizing measures such as IP address restrictions or login credentials, depending on the platform used. This will help maintain the integrity of the data and avoid duplicate submissions.

3.6.4 Data Monitoring and Follow-up

During the data collection window, which is expected to last between 4 and 6 weeks, the researcher will actively manage and monitor the process to ensure smooth and efficient data gathering. The specific actions include:

- Monitoring response rates on a daily basis to track progress and identify potential issues early.
- Sending reminder messages after one week and again after two weeks to encourage participation and increase response rates.
- Identifying and resolving any technical or access-related issues that may arise, ensuring all participants can complete the survey without difficulty.
- Logging any irregularities or incidents that occur during the data collection process for transparency and to maintain a clear record of the data collection activities.

3.6.5 Data Cleaning and Preparation

Once the data collection period concludes, the raw data will undergo several steps to ensure its quality and readiness for analysis. These steps include:

- **Initial Screening:** The data will be screened for completeness to identify and remove any incomplete or duplicate responses, ensuring that only valid entries are included in the analysis.
- **Coding and Labeling:** Variables will be coded and labeled within SPSS to standardize the data, making it easier to analyze.
- **Handling Missing Values:** Any missing data will be addressed using standard procedures such as listwise deletion or imputation, depending on the extent and pattern of missingness, to maintain the integrity of the dataset.
- **Preliminary Frequency Checks:** Frequency checks will be conducted to identify outliers or errors that may need to be corrected before further analysis.

Only after these procedures will the dataset be considered ready for full statistical analysis, as detailed in the following section

3.7 Data Analysis Techniques

This section provides an overview of the statistical methods that will be utilized to analyze the data obtained from the structured questionnaire. The selection of each method is carefully aligned with the research objectives and hypotheses presented in Chapter One. The chosen techniques are grounded in established best practices in quantitative data analysis, as recommended by leading scholars in the field. These methods will allow for a comprehensive examination of the relationships between variables, helping to address the study's research questions and test the proposed hypotheses effectively.

3.7.1 Descriptive Statistics

Purpose:

The purpose of this analysis is to summarize and describe the basic characteristics of the sample and the collected data. This step will provide a clear understanding of the demographic and professional profile of the respondents, as well as offer an initial overview of the key study variables.

Methods:

For categorical variables (e.g., gender, education level, years of experience), frequencies and percentages will be used to provide an overview of the distribution within the sample. For continuous variables (e.g., AI usage scores, competency ratings, project constraints), means and standard deviations will be calculated to summarize the central tendency and variability of the data. This descriptive analysis will set the foundation for subsequent inferential statistical techniques.

Justification:

Descriptive statistics offer essential insights into the respondents' profiles and the distribution of key variables. By summarizing the data in terms of central tendency, variability, and frequency, these statistics facilitate a clearer interpretation of the findings. This foundational understanding is critical as it enables meaningful comparisons and lays the groundwork for further analysis in subsequent stages of the study.

3.7.2 Reliability Analysis – Cronbach's Alpha

Purpose:

The purpose of this analysis is to evaluate the internal consistency of each construct in the questionnaire to ensure that the items within each construct are reliably measuring the same underlying concept.

Methods:

Cronbach's Alpha coefficients will be calculated for each subscale, such as Machine Learning (ML), Natural Language Processing (NLP), Technical Competencies, and Project Schedule, among others. An acceptable threshold for Cronbach's Alpha is considered to be ≥ 0.70 , which indicates satisfactory internal consistency. Values below this threshold may prompt further investigation and revision of the respective items in the subscale.

Justification:

This ensures that the items within each construct are consistently measuring the same underlying concept, which is essential for maintaining the reliability and validity of the inferential statistics used in the study.

3.7.3 Confirmatory Factor Analysis (CFA)

Purpose:

To validate the dimensional structure of the measurement model and confirm construct validity.

Methods:

- It will be conducted using AMOS or R (lavaan) software.
- The model fit will be assessed using fit indices such as:
 - Chi-square/df ratio
 - RMSEA (≤ 0.08)
 - CFI (≥ 0.90)

- TLI (≥ 0.90)
- Convergent validity will be evaluated, for example, using Average Variance Extracted (AVE), and discriminant validity will be assessed to ensure constructs are distinct from one another.

Justification:

Confirmatory Factor Analysis (CFA) verifies whether the observed variables accurately represent their corresponding latent constructs, which is a crucial step before proceeding with structural modeling.

3.7.4 Correlation Analysis

Purpose:

To examine the strength and direction of linear relationships between the three main constructs.

Methods:

- Pearson's correlation coefficient (r)

Justification:

It provides initial insight into the associations among AI usage, project manager competencies, and project constraints, which guides the interpretation of SEM outcomes.

3.7.5 Structural Equation Modeling (SEM)

Purpose:

To test the proposed causal relationships among the variables and evaluate the model.

Methods:

- Full SEM using AMOS or R (lavaan)
- Assessment of direct, indirect, and total effects
- Examination of model fit indices

Justification:

SEM allows for the simultaneous testing of multiple dependent relationships, making it ideal for models involving mediators like project manager competencies.

3.7.6 Structural Equation Modeling (SEM)**Purpose:**

To determine whether project manager competencies mediate the relationship between AI usage and project constraints.

Methods:

- **Bootstrapping method** (recommended for mediation in SEM)
- **Sobel test** as a secondary method
- Evaluation of **indirect effect significance** using confidence intervals

Justification:

This test directly addresses Hypothesis H5 in the study and provides insights into how and why AI affects project outcomes through managerial capabilities.

3.7.7 Variance Analysis (T-Testing / ANOVA)**Purpose:**

To assess whether perceptions of AI usage, competencies, or constraints vary significantly across demographic groups.

Methods:

- Independent samples t-tests for binary comparisons (e.g., gender)
- One-way ANOVA for multi-group variables (e.g., years of experience, education level)

Justification:

Identifies possible demographic moderators or contextual influences that affect how different professionals engage with the constructs under study.

3.7.8 Multiple Regression Analysis

Purpose:

To assess the predictive power of specific AI dimensions and competency factors on project constraints.

Methods:

- Hierarchical or stepwise regression models
- Assessment of standardized beta coefficients, R^2 values, and significance levels

Justification:

Complements SEM by showing which variables most strongly predict project constraints and helps validate theoretical assumptions with empirical data.

3.8 Ethical Considerations

This study adheres to the ethical standards set forth for academic research involving human participants. Upholding ethical responsibility is not just a regulatory necessity, but also an essential aspect of maintaining research integrity and fostering trust among participants. The following sections detail the primary ethical principles and procedures that will be followed throughout the study's design, data collection, analysis, and dissemination stages. These measures ensure that the study is conducted with the highest regard for the rights, privacy, and well-being of the participants.

3.8.1 Informed Consent

An informed consent statement that explains:

- The purpose of the study
- That responses will be kept anonymous and confidential
- That data will be used solely for academic purposes

3.8.2 Anonymity and Confidentiality

To protect participants' identities:

- No names, email addresses, or other personally identifiable information will be collected.
- All responses will be aggregated and analyzed at the group level.
- Data will be stored securely on a password-protected device accessible only to the researcher.
- In reporting findings, no data will be attributed to specific individuals or companies.

3.8.3 Voluntary Participation

Participation in the study will be strictly voluntary. No form of coercion, reward, or penalty will be associated with responding or choosing not to respond. Participants may opt out at any stage of the survey without consequence.

3.8.4 Institutional and Organizational Approval

Formal approval for conducting this study will be sought from:

- The academic research committee or ethics board at Midocean University
- Relevant stakeholders at the participating contracting companies, where applicable

Written permissions will be documented and archived for accountability.

3.8.5 Data Usage and Retention

The collected data will be:

- Used solely for this PhD research
- Stored securely for a limited retention period (e.g., 3–5 years)

- Deleted or anonymized permanently upon the expiration of the retention period, unless further use is approved

3.8.6 Transparency and Researcher Integrity

The researcher pledges to:

- Present findings honestly and transparently
- Avoid data manipulation or misrepresentation
- Disclose any potential conflicts of interest, though none are anticipated

These ethical safeguards are designed to protect participant rights and enhance the credibility and academic rigor of the research.

3.9 Questionnaire

Section A: Demographic Information

1- **Gender**

☐ Male ☐ Female

2- **Age Group**

☐ Under 25 ☐ 25–34 ☐ 35–44 ☐ 45–54 ☐ 55+

3- **Educational Qualification**

☐ Diploma ☐ Bachelor ☐ Master ☐ PhD ☐ Other: _____

4- **Job Title**

☐ Project Manager ☐ Site Engineer ☐ Coordinator ☐ Consultant ☐ Other: _____

5- **Years of Experience in Project Management**

☐ Less than 3 years ☐ 3–5 years ☐ 6–10 years ☐ More than 10 years

Scale Used (Sections B, C, D):

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

Section B: Artificial Intelligence Usage in Project Management

Machine Learning (ML)

1- Our project team uses machine learning models to identify patterns in past project data.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

2- ML tools assist us in resource allocation decisions.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

3- We use ML to predict project risks and delays.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

4- ML models are integrated into our project forecasting tools.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Natural Language Processing (NLP)

5- NLP tools are used to analyze project documents and communications.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

6- NLP helps summarize reports and technical documentation.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

7- We use voice-to-text or sentiment analysis features in project tools.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

8- NLP applications help us extract key information from contracts.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Chatbots and Visual Assistants

9- AI-powered assistants provide real-time support to project team members.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

10- Chatbots are used to answer standard project queries.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

11- AI assistants help guide project workflows and reminders.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

12- These assistants reduce the time spent on repetitive tasks.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Predictive Analytics

13- Predictive analytics tools are used to estimate project completion timelines.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

14- We use prediction models to evaluate cost overruns.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

15- Our project decisions are influenced by predictive analysis results.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

16- Predictive tools help us anticipate potential quality issues.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Robotic Process Automation (RPA)

17- RPA is used to automate administrative project tasks.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

18- Our team uses bots to generate reports automatically.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

19- RPA minimizes errors in document processing.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

20- Project communication is improved through automation.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Data Visualization Tools

21- Dashboards provide real-time project insights.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

22- Visual analytics help us detect trends and anomalies.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

23- Data visualization tools enhance stakeholder communication.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

24- We rely on visual reports for decision-making in project meetings

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Decision Support Systems (DSS)

25- DSS tools assist in selecting among project alternatives.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

26- These systems support data-driven decision-making.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

27- DSS integrates multiple data sources for better insights.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

28- Our DSS tools are regularly updated with new data inputs.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Section C: Project Manager's Competencies

Technical Competencies

29- I am proficient in using project management software tools (e.g., MS Project, Primavera).

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

30- I have a strong understanding of project planning and scheduling techniques.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

31- I can effectively manage project budgets and cost estimations.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

32- I possess technical knowledge relevant to the nature of my projects.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

33- I ensure the application of standards and best practices in project execution.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Leadership and Behavioral Competencies

34- I can effectively lead cross-functional project teams.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

35- I communicate clearly and proactively with all stakeholders.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

36- I resolve conflicts in a constructive and timely manner.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

37- I motivate team members to achieve project objectives.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

38- I demonstrate resilience and adaptability in dynamic project environments.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Strategic and Business Competencies

39- I align project objectives with organizational strategy.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

40- I understand the business impact of project decisions.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

41- I analyze project performance in terms of benefits realization.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

42- I contribute to strategic planning in my organization.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

43- I evaluate risks and opportunities from a strategic perspective.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Section D: Project Constraints

Scope

44- Project scope is clearly defined and managed throughout execution.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

45- Scope changes are systematically evaluated and controlled.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

46- Stakeholders have a common understanding of the project scope.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Schedule

47- Projects are usually completed within the scheduled timeline.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

48- Time estimates are realistic and based on historical data.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

49- Schedule delays are managed through proactive planning.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Cost

50- Project budgets are well estimated and managed.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

51- We frequently monitor actual versus planned costs.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

52- Projects are typically completed within the allocated budget.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Quality

53- Quality standards are clearly defined at the project's start.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

54- Deliverables meet required specifications and customer expectations.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

55- Quality reviews are regularly conducted during project execution

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Risk

56- Project risks are identified and assessed early in the project.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

57- Risk response strategies are developed and implemented.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

58- Risk monitoring is an ongoing part of project control.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Resources

59- Projects are adequately staffed with the required competencies.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

60- Resource allocation is optimized across projects.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

61- We have access to the necessary tools, equipment, and infrastructure.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Stakeholders

62- Stakeholder needs and expectations are clearly identified.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

63- Stakeholders are engaged throughout the project lifecycle.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

64- Feedback from stakeholders is used to improve performance.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Governance

65- Projects are guided by a defined governance framework.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

66- Roles and responsibilities are clear across all levels.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

67- Decisions are taken based on structured escalation procedures.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Benefits

68- Project outcomes align with expected organizational benefits.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

69- Benefits realization is tracked beyond project closure.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

70- Project success is evaluated in terms of both output and outcomes.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Strategic Alignment

71- Projects contribute to the strategic goals of the organization.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

72- Project selection is aligned with strategic priorities.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

73- Performance indicators reflect strategic objectives

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

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