

CHAPTER 4

4.1 Introduction

This chapter presents the analysis of the data that were collected through the survey which was sent to 79 large scale contracting companies in the eastern province of Saudi Arabia to examine the role of the project manager competencies in the relationship between the use of AI and project constraints. The participants in this study were all employees that are working in the project management field with good experience.

The focus of the study is on the 3 variables with their dimensions. The first variable is AI and its use in the field of project management including the previously identified dimensions of AI that are Machine Learning, Natural Language Processing, Chatbots and Visual Assistants, Predictive Analytics, Robotic Process Automation, Data Visualization Tools, and Decision Support Systems. The second variable is project manager competencies which include Technical Skills, Leadership, and Behavioral Qualities. The third variable is project constraints which include Scope, Time, Cost, Quality, Risk, Resources, Stakeholder involvement, Governance, benefits Realization, and Strategic Alignment. The assessment of these variables and their dimensions was conducted through a questionnaire that has 73 questions.

As per the planned methodology, several statistical techniques were utilized in order to analyze the collected data. These techniques include descriptive statistics, correlation test, Confirmatory Factor Analysis (CFA), Reliability Analysis, Structural Equation Modeling (SEM), mediation analysis using bootstrapping. There are other tests that are included like T-tests, ANOVA, and Multiple regression.

The chapter provides an explanation of the sampling process and response rate, includes a description of the participants, presents the results of the data analysis, tests them against the research hypotheses, and concludes with a summary of the key findings.

4.2 Response Rate and Sampling Justification

The population of the study consist of 2,890 person that are considered professionals in project management field working in 79 large scale contracting companies located in the Eastern Province of Saudi Arabia. The classification of the 79 companies is identified as per the standard of the Saudi Contractors Authority (SCA).

In order to determine the sample size, Yamane's (1967) formula for finite populations was applied using a confidence level of 95% and a margin error of 5%

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

Where:

n = Required sample size

N = Total population = 2,890

e = Margin of error = 0.05

Therefore, n = 351

The total number of participants that completed the survey was 400. However, to stay aligned with the required sample size and ensure the results remain balanced and without any bias, only the first 351 responses were selected and included in the statistical analysis.

Statistical Analysis

Reliability and validity of the Instrument

Both reliability and validity are fundamental measures used to make a trustworthy judgment about the appropriateness of a research instrument ,Reliability refers to the extent to which an instrument can produce consistent and error-free results when re-administered or used under similar conditions, whereas validity refers to the degree to which the instrument accurately measures what it is intended to measure — that is, the degree of correspondence between the theoretical construct and the actual indicators.

Among the most common methods for measuring internal consistency, Cronbach's Alpha is one of the most widely used indicators, as it expresses the degree of interrelation among items measuring the same conceptual dimension. The higher the value of Cronbach's Alpha (usually ≥ 0.70), the greater the indication that the items consistently measure the same construct.

In addition, the validity coefficient is an important statistical indicator used to estimate the accuracy of the research instrument in measuring the intended construct. This coefficient is often calculated using the Pearson Correlation Coefficient, which measures the degree of the linear relationship between the total score of the instrument and the score of each item, or between two tests assumed to measure the same conceptual dimension.

According to Phelan et al. (2005), reliability refers to the degree to which an assessment tool produces stable and consistent results, while validity refers to how well a test measures what it is intended to measure.

To ensure the validity and reliability of the data in this research, the questionnaires were designed to represent every aspect of the study objectives.

Reliability and validity for Independent Variables (Using Artificial Intelligence)

Variables	Validity coefficient (Pearson Correlation Coefficient)	Stability Coefficient (Cronbach alpha)	
ML1	0.907**	0.899	0.946
ML2	0.756**		
ML3	0.931**		
ML4	0.909**		
Machine Learning (ML)	0.679**		
NLP1	0.804**	0.882	
NLP2	0.805**		
NLP3	0.876**		
NLP4	0.963**		
Natural Language Processing (NLP)	0.884**		
CV1	0.892**	0.884	
CV2	0.759**		
CV3	0.888**		
CV4	0.902**		
Chatbots and Visual Assistants	0.760**		
PA1	0.908**	0.949	
PA2	0.961**		
PA3	0.918**		
PA4	0.944**		
Predictive Analytics	0.765**		

Variables	Validity coefficient (Pearson Correlation Coefficient)	Stability Coefficient (Cronbach alpha)	
RPA1	0.789**	0.865	
RPA2	0.727**		
RPA3	0.944**		
RPA4	0.914**		
Robotic Process Automation	0.579**		
DV1	0.971**	0.969	
DV2	0.938**		
DV3	0.968**		
DV4	0.947**		
Data Visualization Tools	0.618**		
DSS1	0.874**	0.885	
DSS2	0.939**		
DSS3	0.905**		
DSS4	0.763**		
Decision Support Systems	0.759**		

Table (4-1) Validity and stability coefficients for the study questionnaire variables.

** A function at the level of significance less than (0.01)

The table presents the validity coefficients (Pearson Correlation Coefficients) and reliability coefficients (Cronbach's Alpha) for the questionnaire items and variables. It is evident that all values fall within statistically acceptable ranges, reflecting a high level of quality in the construction of the measurement instrument.

- **Validity Coefficients (Pearson Correlation Coefficient)**

The validity coefficients for all items indicate strong and statistically significant correlations at the 0.01 level with their corresponding variables, with correlation values ranging from 0.579 to 0.971. These high values suggest that the items effectively measure the same concept associated with their respective dimension. Such findings represent an important indicator of validity, supporting the appropriateness of using these items to measure the study variables.

- **Reliability Coefficients (Cronbach's Alpha)**

Cronbach's Alpha values for the main variables were remarkably high, ranging from 0.865 to 0.969. These values exceed the widely accepted minimum threshold of 0.70, "The overall Cronbach's Alpha value for the scale reached (0.946), which is higher than the acceptable threshold of 0.70, indicating that the scale demonstrates a high level of reliability."

Reliability and validity for Mediating Variables (Project Manager's Competencies)

Variables	Validity coefficient (Pearson Correlation Coefficient)	Stability Coefficient (Cronbach alpha)	
TC1	0.801**	0.900	0.967
TC2	0.894**		
TC3	0.880**		
TC4	0.885**		
TC5	0.791**		
Technical Competencies	0.863**		
LB1	0.947**	0.969	
LB2	0.979**		
LB3	0.939**		
LB4	0.973**		
LB5	0.884**		
Leadership & Behavioral	0.963**		
SB1	0.964**	0.959	
SB2	0.951**		
SB3	0.965**		
SB4	0.906**		
SB5	0.868**		
Strategic and Business	0.926**		

Table (4-2) Validity and stability coefficients for the study questionnaire variables.

** A function at the level of significance less than (0.01)

The table presents the validity coefficients (Pearson Correlation Coefficients) and reliability coefficients (Cronbach's Alpha) for the questionnaire items and variables. It is evident that all values fall within statistically acceptable ranges, reflecting a high level of quality in the construction of the measurement instrument.

- Validity Coefficients (Pearson Correlation Coefficient)

The validity coefficients for all items indicate strong and statistically significant correlations at the 0.01 level with their corresponding variables, with correlation values ranging from 0.791 to 0.979. These high values suggest that the items effectively measure the same concept associated with their respective dimension. Such findings represent an important indicator of validity, supporting the appropriateness of using these items to measure the study variables.

- Reliability Coefficients (Cronbach's Alpha)

Cronbach's Alpha values for the main variables were remarkably high, ranging from 0.900 to 0.969. These values exceed the widely accepted minimum threshold of 0.70, "The overall Cronbach's Alpha value for the scale reached (0.967), which is higher than the acceptable threshold of 0.70, indicating that the scale demonstrates a high level of reliability."

Reliability and validity for Dependent Variables (Project Constraints)

Variables	Validity coefficient (Pearson Correlation Coefficient)	Stability Coefficient (Cronbach alpha)	
Scope1	0.891**	0.773	0.981
Scope2	0.875**		
Scope3	0.759**		
Scope	0.917**		
Schedule1	0.896**	0.865	
Schedule2	0.928**		
Schedule3	0.842**		
Schedule	0.916**		
Cost1	0.925**	0.911	
Cost2	0.950**		
Cost3	0.899**		
Cost	0.942**		
Quality1	0.942**	0.872	
Quality2	0.870**		
Quality3	0.880**		
Quality	0.888**		
Risk1	0.793**	0.723	
Risk2	0.842**		
Risk3	0.670**		
Risk	0.786**		
Resources1	0.949**	0.957	
Resources2	0.976**		
Resources3	0.954**		
Resources	0.876**		
Stakeholders1	0.887**	0.897	
Stakeholders2	0.907**		
Stakeholders3	0.949**		
Stakeholders	0.963**		
Governance1	0.906**	0.891	
Governance2	0.878**		
Governance3	0.946**		
Governance	0.925**		
Benefits1	0.863**	0.898	

Benefits2	0.935**		0.902
Benefits3	0.935**		
Benefits	0.930**		
StrategicAlignment1	0.947**		
StrategicAlignment2	0.878**		
StrategicAlignment3	0.919**		
Strategic Alignment	0.859**		

Table (4-3) Validity and stability coefficients for the study questionnaire variables.

** A function at the level of significance less than (0.01)

The table presents the validity coefficients (Pearson Correlation Coefficients) and reliability coefficients (Cronbach's Alpha) for the questionnaire items and variables. It is evident that all values fall within statistically acceptable ranges, reflecting a high level of quality in the construction of the measurement instrument.

- **Validity Coefficients (Pearson Correlation Coefficient)**

The validity coefficients for all items indicate strong and statistically significant correlations at the 0.01 level with their corresponding variables, with correlation values ranging from 0.670 to 0.976. These high values suggest that the items effectively measure the same concept associated with their respective dimension. Such findings represent an important indicator of validity, supporting the appropriateness of using these items to measure the study variables.

- **Reliability Coefficients (Cronbach's Alpha)**

Cronbach's Alpha values for the main variables were remarkably high, ranging from 0.723 to 0.957. These values exceed the widely accepted minimum threshold of 0.70, "The overall Cronbach's Alpha value for the scale reached (0.981), which is higher than the acceptable threshold of 0.70, indicating that the scale demonstrates a high level of reliability."

Respondents' Demographic Information

Table (4-4) shows the Descriptive Analysis of demographic characteristics of the Study sample regarding the respondents' Gender

Table (): Descriptive Analysis of Demographic Characteristics of the Study Sample (Gender)

Category		Freq.	Percent
Gender	Male	337	96.00
	Female	14	4.00
Total		351	100.00

Table (4-4) presents the characteristics of the study sample, revealing that:

- Regarding the Gender of the study sample, it was found that Male were slightly more represented, with a percentage of 96.00%, comprising 337 respondents, while Female represented 4.00%, comprising 14 respondents in the study sample.

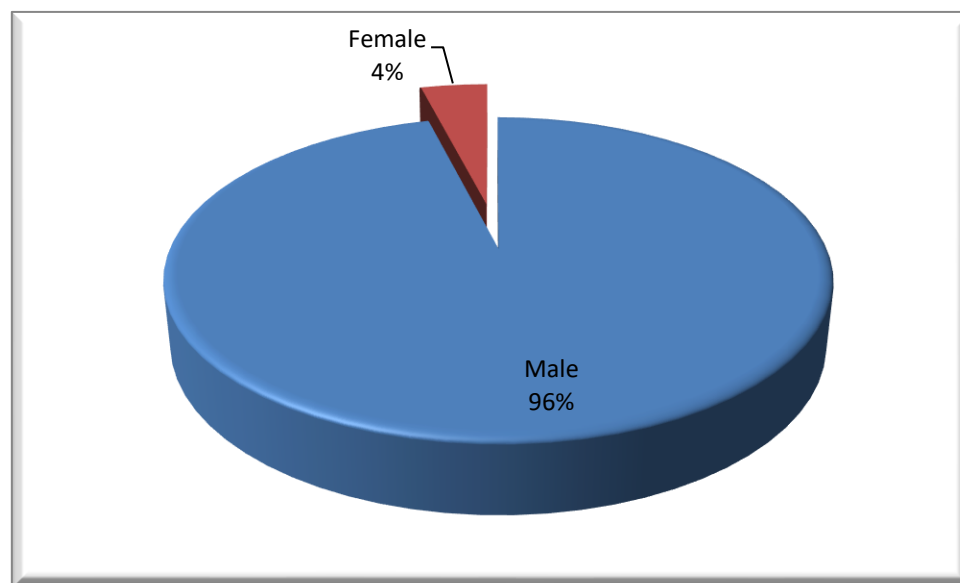


Table (4-5) shows the Descriptive Analysis of demographic characteristics of the Study sample regarding the respondents' Age group

Table (): Descriptive Analysis of Demographic Characteristics of the Study Sample (Age group)

Category		Freq.	Percent
Age group	25 – 34years	38	10.83
	35 – 44years	179	51.00
	45 – 54years	114	32.48
	55+ years	22	5.70
Total		351	100.00

Table (4-5) presents the characteristics of the study sample, revealing that:

- Regarding the Age group of the study sample, it was found that 35 – 44years were slightly more represented, with a percentage of 51.00%, comprising 179 respondents, while 55+ years represented 5.725%, comprising 22 respondents. in the study sample.

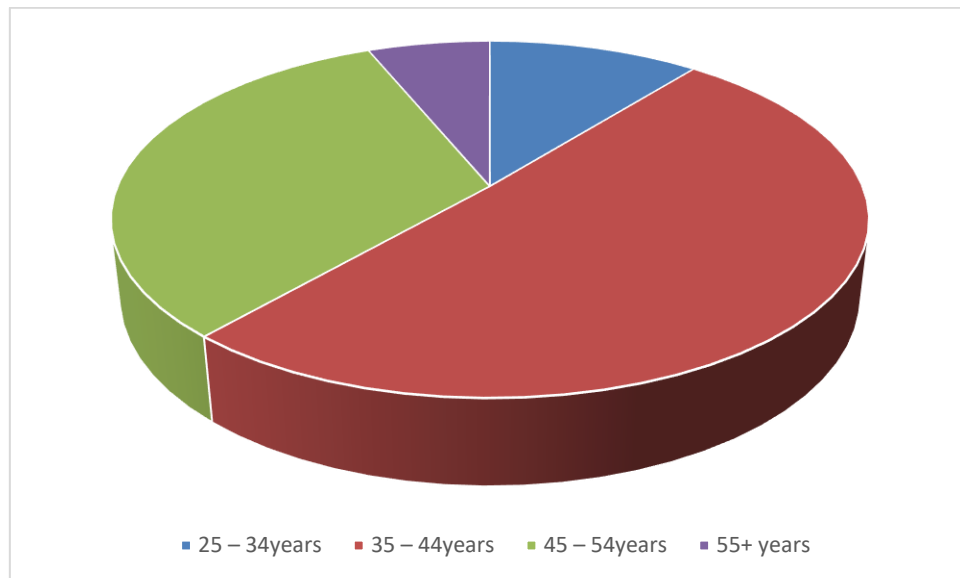


Table (4-6) shows the Descriptive Analysis of demographic characteristics of the Study sample regarding the respondents' Education.

Table (): Descriptive Analysis of Demographic Characteristics of the Study Sample (Education)

Category		Freq.	Percent
Education	Diploma	15	4.27
	Bachelor	146	41.60
	Master	158	45.01
	PhD	32	9.12
Total		351	100.00

Table (4-6) presents the characteristics of the study sample, revealing that:

- Regarding the Education of the study sample, it was found that Master were slightly more represented, with a percentage of 45.01%, comprising 158 respondents, while Diploma represented 4.27%, comprising 15 respondents in the study sample.

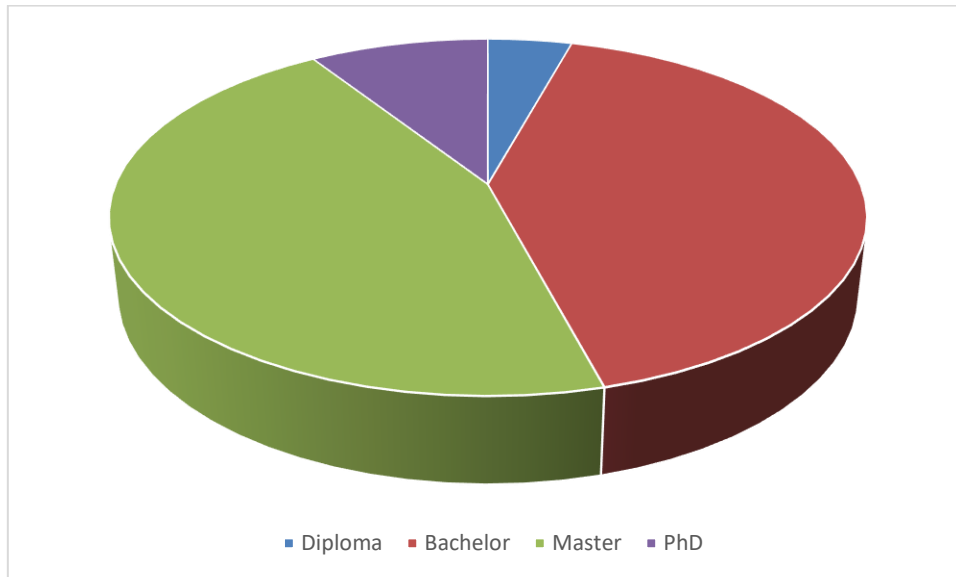


Table (4-7) shows the Descriptive Analysis of demographic characteristics of the Study sample regarding the respondents' Job title

Table (): Descriptive Analysis of Demographic Characteristics of the Study Sample (Job title)

Category		Freq.	Percent
Job title	Project Manager	127	36.18
	Site Engineer	38	10.83
	Coordinator	69	19.66
	Consultant	73	20.80
	Other	44	12.54
Total		351	100.00

Table (4-7) presents the characteristics of the study sample, revealing that:

- Regarding the Job title of the study sample, it was found that Project Manager were slightly more represented, with a percentage of 36.18%, comprising 127 respondents, while Site Engineer represented 10.83%, comprising 38 respondents in the study sample.

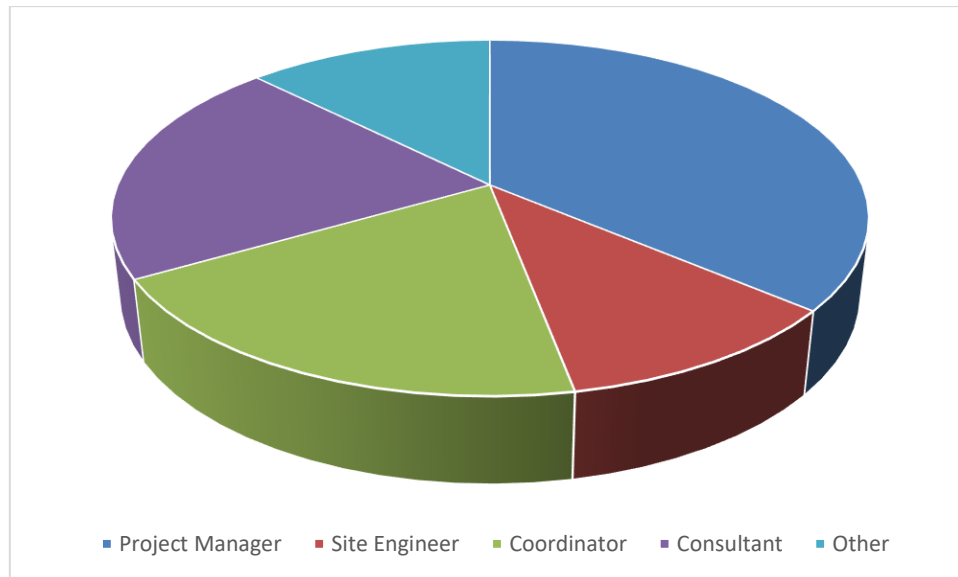


Table (4-8) shows the Descriptive Analysis of demographic characteristics of the Study sample regarding the respondents' Experience

Table (): Descriptive Analysis of Demographic Characteristics of the Study Sample (Experience)

Category		Freq.	Percent
Experience	Less than 3 years	13	3.70
	3 – 5 years	31	8.83
	6 – 10 years	77	21.94
	More than 10 years	230	65.53
Total		351	100.00

Table (4-8) presents the characteristics of the study sample, revealing that:

- Regarding the Experience of the study sample, it was found that More than 10 years were slightly more represented, with a percentage of 65.53%, comprising 230 respondents, while less than 3 years represented 3.70%, comprising 13 respondents in the study sample.

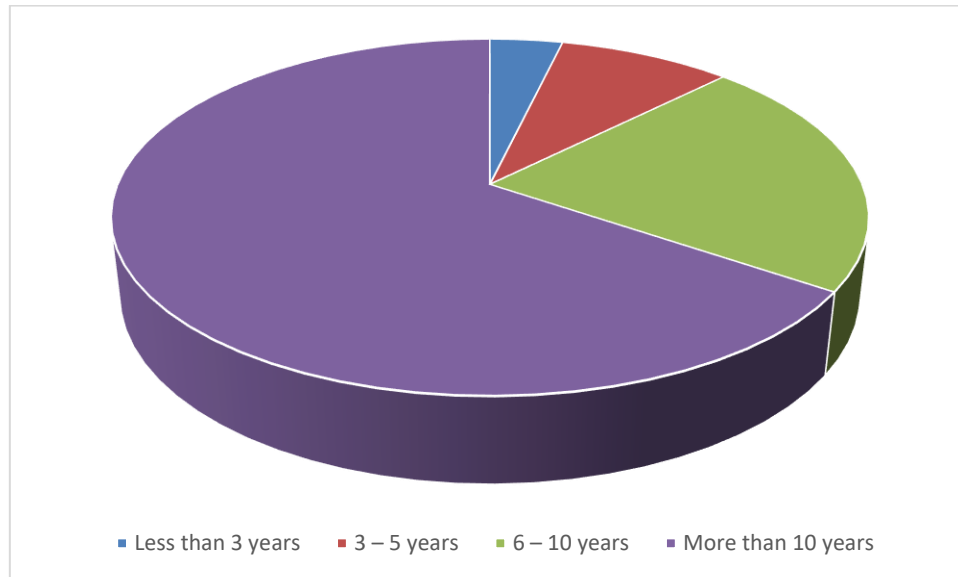


Table (4-9): Distribution of the study subjects according to Using Artificial Intelligence

Using Artificial Intelligence		Frequency	Percent	Min-Max	Mean $\pm$ SD	median	Mean score percent
Machine Learning (ML)							
Our project team uses Machine Learning (ML) models to identify patterns in past project data.	Strongly Disagree	91	22.8	1-5	2.77 $\pm$ 1.30	3.00	55.35%
	Disagree	91	22.8				
	Neutral	70	17.5				
	Agree	116	29.0				
	Strongly Agree	32	8.0				
Machine Learning (ML) tools assist us in resource	Strongly Disagree	71	17.8	1-5	3.39 $\pm$ 1.29	4.00	67.80%
	Disagree	11	2.8				
	Neutral	69	17.3				

Using Artificial Intelligence		Frequency	Percent	Min-Max	Mean ± SD	median	Mean score percent
allocation decisions.	▪ Agree	189	47.3				
	▪ Strongly Agree	60	15.0				
We use Machine Learning (ML) to predict project risks and delays.	▪ Strongly Disagree	102	25.5	1-5	2.96±1.32	3.00	59.10%
	▪ Disagree	21	5.3				
	▪ Neutral	100	25.0				
	▪ Agree	147	36.8				
	▪ Strongly Agree	30	7.5				
Machine Learning (ML) models are integrated into our project forecasting tools.	▪ Strongly Disagree	91	22.8	1-5	2.87±1.38	3.00	57.35%
	▪ Disagree	75	18.8				
	▪ Neutral	91	22.8				
	▪ Agree	82	20.5				
	▪ Strongly Agree	61	15.3				
Natural Language Processing (NLP)							
Natural Language Processing (NLP) tools are used to analyze project documents and communications.	▪ Strongly Disagree	100	25.0	1-5	2.82±1.33	3.00	56.30%
	▪ Disagree	62	15.5				
	▪ Neutral	86	21.5				
	▪ Agree	116	29.0				
	▪ Strongly Agree	36	9.0				
Natural Language Processing (NLP) helps summarize reports and technical documentation.	▪ Strongly Disagree	80	20.0	1-5	3.16±1.43	3.00	63.15%
	▪ Disagree	59	14.8				
	▪ Neutral	62	15.5				
	▪ Agree	116	29.0				
	▪ Strongly Agree	83	20.8				
We use voice-to-text or sentiment analysis features in project tools.	▪ Strongly Disagree	124	31.0	1-5	2.77±1.47	3.00	55.35%
	▪ Disagree	65	16.3				
	▪ Neutral	44	11.0				
	▪ Agree	114	28.5				
	▪ Strongly Agree	53	13.3				
Natural Language Processing (NLP) applications help us extract key information from contracts.	▪ Strongly Disagree	80	20.0	1-5	2.90±1.35	3.00	57.95%
	▪ Disagree	95	23.8				
	▪ Neutral	64	16.0				
	▪ Agree	108	27.0				
	▪ Strongly Agree	53	13.3				
Chatbots and Visual Assistants							
AI-powered assistants provide real-time support to project team members.	▪ Strongly Disagree	39	9.8	1-5	3.88±1.28	4.00	77.55%
	▪ Disagree	28	7.0				
	▪ Neutral	37	9.3				
	▪ Agree	135	33.8				
	▪ Strongly Agree	161	40.3				
	▪ Strongly Disagree	50	12.5	1-5	3.51±1.26	4.00	70.20%

Using Artificial Intelligence		Frequency	Percent	Min-Max	Mean ± SD	median	Mean score percent
Chatbots are used to answer standard project queries.	▪ Disagree	33	8.3				
	▪ Neutral	62	15.5				
	▪ Agree	173	43.3				
	▪ Strongly Agree	82	20.5				
AI assistants help guide project workflows and reminders.	▪ Strongly Disagree	63	15.8	1-5	3.24±1.40	4.00	64.80%
	▪ Disagree	82	20.5				
	▪ Neutral	32	8.0				
	▪ Agree	142	35.5				
	▪ Strongly Agree	81	20.3				
These assistants reduce the time spent on repetitive tasks.	▪ Strongly Disagree	63	15.8	1-5	3.70±1.38	4.00	74.00%
	▪ Disagree	11	2.8				
	▪ Neutral	46	11.5				
	▪ Agree	143	35.8				
	▪ Strongly Agree	137	34.3				
Predictive Analytics							
Predictive analytics tools are used to estimate project completion timelines.	▪ Strongly Disagree	39	9.8	1-5	3.62±1.16	4.00	72.40%
	▪ Disagree	21	5.3				
	▪ Neutral	78	19.5				
	▪ Agree	177	44.3				
	▪ Strongly Agree	85	21.3				
We use prediction models to evaluate cost overruns.	▪ Strongly Disagree	47	11.8	1-5	3.35±1.30	4.00	67.05%
	▪ Disagree	62	15.5				
	▪ Neutral	85	21.3				
	▪ Agree	115	28.8				
	▪ Strongly Agree	91	22.8				
Our project decisions are influenced by predictive analysis results.	▪ Strongly Disagree	47	11.8	1-5	3.30±1.39	4.00	65.90%
	▪ Disagree	97	24.3				
	▪ Neutral	54	13.5				
	▪ Agree	95	23.8				
	▪ Strongly Agree	107	26.8				
Predictive tools help us anticipate potential quality issues.	▪ Strongly Disagree	47	11.8	1-5	3.26±1.33	3.00	65.15%
	▪ Disagree	86	21.5				
	▪ Neutral	73	18.3				
	▪ Agree	105	26.3				
	▪ Strongly Agree	89	22.3				
Robotic Process Automation							
Robotic Process Automation (RPA) is used to automate administrative project tasks.	▪ Strongly Disagree	56	14.0	1-5	3.24±1.29	3.00	64.80%
	▪ Disagree	57	14.3				
	▪ Neutral	93	23.3				
	▪ Agree	123	30.8				

Using Artificial Intelligence		Frequency	Percent	Min-Max	Mean ± SD	median	Mean score percent
	▪ Strongly Agree	71	17.8				
Our team uses bots to generate reports automatically.	▪ Strongly Disagree	65	16.3	1-5	2.93±1.37	3.00	58.50%
	▪ Disagree	120	30.0				
	▪ Neutral	69	17.3				
	▪ Agree	72	18.0				
	▪ Strongly Agree	74	18.5				
Robotic Process Automation (RPA) minimizes errors in document processing.	▪ Strongly Disagree	45	11.3	1-5	3.50±1.38	4.00	70.00%
	▪ Disagree	62	15.5				
	▪ Neutral	72	18.0				
	▪ Agree	90	22.5				
	▪ Strongly Agree	131	32.8				
Project communication is improved through automation.	▪ Strongly Disagree	45	11.3	1-5	3.62±1.42	4.00	72.45%
	▪ Disagree	62	15.5				
	▪ Neutral	51	12.8				
	▪ Agree	83	20.8				
	▪ Strongly Agree	159	39.8				
Data Visualization Tools							
Dashboards provide real-time project insights.	▪ Strongly Disagree	25	6.3	1-5	3.93±1.19	4.00	78.65%
	▪ Disagree	39	9.8				
	▪ Neutral	28	7.0				
	▪ Agree	154	38.5				
	▪ Strongly Agree	154	38.5				
Visual analytics help us detect trends and anomalies.	▪ Strongly Disagree	25	6.3	1-5	3.73±1.16	4.00	74.50%
	▪ Disagree	39	9.8				
	▪ Neutral	70	17.5				
	▪ Agree	153	38.3				
	▪ Strongly Agree	113	28.3				
Data visualization tools enhance stakeholder communication.	▪ Strongly Disagree	25	6.3	1-5	3.89±1.14	4.00	77.80%
	▪ Disagree	39	9.8				
	▪ Neutral	17	4.3				
	▪ Agree	193	48.3				
	▪ Strongly Agree	126	31.5				
We rely on visual reports for decision-making in project meetings.	▪ Strongly Disagree	25	6.3	1-5	3.84±1.15	4.00	76.80%
	▪ Disagree	38	9.5				
	▪ Neutral	37	9.3				
	▪ Agree	176	44.0				
	▪ Strongly Agree	124	31.0				
Decision Support Systems							
Decision Support Systems (DSS)	▪ Strongly Disagree	42	10.5	1-5	3.27±1.21	4.00	65.45%
	▪ Disagree	73	18.3				

Using Artificial Intelligence		Frequency	Percent	Min-Max	Mean $\pm$ SD	median	Mean score percent
tools assist in selecting among project alternatives.	▪ Neutral	71	17.8				
	▪ Agree	162	40.5				
	▪ Strongly Agree	52	13.0				
These systems support data-driven decision-making.	▪ Strongly Disagree	42	10.5	1-5	3.73 $\pm$ 1.18	4.00	74.60%
	▪ Disagree	11	2.8				
	▪ Neutral	63	15.8				
	▪ Agree	181	45.3				
	▪ Strongly Agree	103	25.8				
Decision Support Systems (DSS) integrates multiple data sources for better insights.	▪ Strongly Disagree	42	10.5	1-5	3.63 $\pm$ 1.22	4.00	72.55%
	▪ Disagree	11	2.8				
	▪ Neutral	115	28.8				
	▪ Agree	118	29.5				
	▪ Strongly Agree	114	28.5				
Our Decision Support Systems (DSS) tools are regularly updated with new data inputs.	▪ Strongly Disagree	62	15.5	1-5	3.34 $\pm$ 1.38	4.00	66.70%
	▪ Disagree	66	16.5				
	▪ Neutral	29	7.3				
	▪ Agree	162	40.5				
	▪ Strongly Agree	81	20.3				

The table presenting the distribution of the study participants according to their use of artificial intelligence techniques shows varying levels of adoption across the different dimensions. The values of the arithmetic means and the percentage scores indicate a general trend toward moderate to high use for most of the examined applications. The data further reveal that participants tend to adopt tools that are more closely related to direct operational support—such as data visualization tools, decision support systems, visual assistants, and chatbots—more than the more complex analytical techniques such as machine learning and natural language processing.

- **Machine Learning (ML)**

The results indicate that the use of machine learning remains at moderate levels, with arithmetic means ranging between (2.77–3.39), suggesting that the adoption of this technique is still relatively limited despite its importance in risk prediction and data analysis. The Mean score percent ranged between (55.35%–67.80%).

- **Natural Language Processing (NLP)**

The table shows that the use of NLP techniques also tends toward the moderate level, with arithmetic means ranging between (2.77–3.16), and Mean score percent ranging between (55.35%–63.15%).

- **Chatbots & Visual Assistants**

This dimension emerged as one of the highest in terms of usage, with item means ranging between (3.24–3.88), and Mean score percent ranging between (64.80%–77.55%).

- **Predictive Analytics**

The results point to a moderate-to-high level of use, with arithmetic means between (3.26–3.62), and Mean score percent ranging between (65.15%–72.40%).

- **Robotic Process Automation (RPA)**

The data indicate that the use of RPA falls within the moderate level, with means ranging between (2.93–3.62), and Mean score percent ranging between (58.50%–72.45%).

- **Data Visualization Tools**

This dimension recorded the highest levels of adoption, with elevated arithmetic means between (3.73–3.93), and Mean score percent ranging between (74.50%–78.65%).

- **Decision Support Systems (DSS)**

The results reveal good levels of use, with means ranging between (3.27–3.73), and Mean score percent ranging between (65.45%–74.60%).

Table (4-10): Distribution of the study subjects according to Project Manager's Competencies

Project Manager’s Competencies		Frequency	Percent	Min- Max	Mean ± SD	median	Mean score percent
Technical Competencies							
I am proficient in using project management software tools (e.g., MS Project, Primavera).	▪ Strongly Disagree	36	9.0	1-5	3.40±1.17	4.00	68.05%
	▪ Disagree	46	11.5				
	▪ Neutral	112	28.0				
	▪ Agree	133	33.3				
	▪ Strongly Agree	73	18.3				
I have a strong understanding of project planning and scheduling techniques.	▪ Strongly Disagree	16	4.0	1-5	3.60±1.01	4.00	71.90%
	▪ Disagree	40	10.0				
	▪ Neutral	102	25.5				
	▪ Agree	174	43.5				
	▪ Strongly Agree	68	17.0				
I can effectively manage project budgets and cost estimations.	▪ Strongly Disagree	36	9.0	1-5	3.72±1.24	4.00	74.40%
	▪ Disagree	33	8.3				
	▪ Neutral	63	15.8				
	▪ Agree	143	35.8				
	▪ Strongly Agree	125	31.3				
I possess technical knowledge relevant to the nature of my projects.	▪ Strongly Disagree	16	4.0	1-5	4.04±1.00	4.00	80.70%
	▪ Disagree	24	6.0				
	▪ Neutral	26	6.5				
	▪ Agree	198	49.5				
	▪ Strongly Agree	136	34.0				
I ensure the application of standards and best practices in project execution.	▪ Strongly Disagree	16	4.0	1-5	4.18±0.94	4.00	83.55%
	▪ Disagree	0	0.0				
	▪ Neutral	52	13.0				
	▪ Agree	161	40.3				
	▪ Strongly Agree	171	42.8				
Leadership & Behavioral							
I can effectively lead cross-functional project teams.	▪ Strongly Disagree	16	4.0	1-5	4.25±0.93	4.00	84.90%
	▪ Disagree	0	0.0				
	▪ Neutral	41	10.3				
	▪ Agree	156	39.0				
	▪ Strongly Agree	187	46.8				
I communicate clearly and proactively with all stakeholders.	▪ Strongly Disagree	16	4.0	1-5	4.19±0.92	4.00	83.75%
	▪ Disagree	0	0.0				
	▪ Neutral	41	10.3				
	▪ Agree	179	44.8				
	▪ Strongly Agree	164	41.0				
	▪ Strongly Disagree	16	4.0	1-5	4.09±0.96	4.00	81.80%

Project Manager's Competencies		Frequency	Percent	Min-Max	Mean ± SD	median	Mean score percent
I resolve conflicts in a constructive and timely manner.	▪ Disagree	24	6.0				
	▪ Neutral	0	0.0				
	▪ Agree	228	57.0				
	▪ Strongly Agree	132	33.0				
I motivate team members to achieve project objectives.	▪ Strongly Disagree	16	4.0	1-5	4.18±0.86	4.00	83.55%
	▪ Disagree	0	0.0				
	▪ Neutral	24	6.0				
	▪ Agree	217	54.3				
	▪ Strongly Agree	143	35.8				
I motivate team members to achieve project objectives.	▪ Strongly Disagree	16	4.0	1-5	4.16±0.84	4.00	83.15%
	▪ Disagree	0	0.0				
	▪ Neutral	19	4.8				
	▪ Agree	235	58.8				
	▪ Strongly Agree	130	32.5				
Strategic and Business							
I align project objectives with organizational strategy.	▪ Strongly Disagree	16	4.0	1-5	4.15±0.93	4.00	82.95%
	▪ Disagree	0	0.0				
	▪ Neutral	52	13.0				
	▪ Agree	173	43.3				
	▪ Strongly Agree	159	39.8				
I understand the business impact of project decisions.	▪ Strongly Disagree	16	4.0	1-5	4.06±0.99	4.00	81.15%
	▪ Disagree	0	0.0				
	▪ Neutral	90	22.5				
	▪ Agree	133	33.3				
	▪ Strongly Agree	161	40.3				
I analyze project performance in terms of benefits realization.	▪ Strongly Disagree	16	4.0	1-5	3.93±1.10	4.00	78.50%
	▪ Disagree	41	10.3				
	▪ Neutral	39	9.8				
	▪ Agree	165	41.3				
	▪ Strongly Agree	139	34.8				
I contribute to strategic planning in my organization.	▪ Strongly Disagree	25	6.3	1-5	3.68±1.20	4.00	73.50%
	▪ Disagree	52	13.0				
	▪ Neutral	68	17.0				
	▪ Agree	138	34.5				
	▪ Strongly Agree	117	29.3				
I evaluate risks and opportunities from a strategic perspective.	▪ Strongly Disagree	16	4.0	1-5	3.95±0.94	4.00	78.95%
	▪ Disagree	17	4.3				
	▪ Neutral	39	9.8				
	▪ Agree	228	57.0				
	▪ Strongly Agree	100	25.0				

The table presenting the distribution of the study participants according to Project Manager's Competencies reflects a general trend toward high levels of competencies across the technical, leadership, and strategic domains. This is clearly demonstrated by the elevated arithmetic means and percentage scores, which were as follows:

- **Technical Competencies**

The results of this dimension indicate that participants possess a good to high level of technical skills, with mean scores ranging between (3.40–4.18) and Mean score percent ranging between (68.05%–83.55%).

- **Leadership & Behavioral Competencies**

This dimension emerges as the strongest among the competency dimensions, with mean scores ranging between (4.09–4.25), reflecting a high level of leadership proficiency and Mean score percent ranging between (81.80%–84.90%).

- **Strategic & Business Competencies**

The results of this dimension are at a good to high level, with means ranging between (3.68–4.15). These values highlight the participants' ability to understand the strategic aspects of projects and align them with organizational objectives and Mean score percent ranging between (73.50%–82.95%).

Table (4-11): Distribution of the study subjects according to Project Constraints

Project Constraints		Frequency	Percent	Min-Max	Mean $\pm$ SD	median	Mean score percent
Scope							
Project scope is clearly defined and managed throughout execution.	Strongly Disagree	25	6.3	1-5	3.94 $\pm$ 1.09	4.00	78.80%
	Disagree	17	4.3				
	Neutral	48	12.0				
	Agree	177	44.3				
	Strongly Agree	133	33.3				
Scope changes are systematically evaluated and controlled.	Strongly Disagree	16	4.0	1-5	4.11 $\pm$ 0.92	4.00	82.15%
	Disagree	9	2.3				
	Neutral	28	7.0				
	Agree	210	52.5				

Project Constraints		Frequency	Percent	Min-Max	Mean ± SD	median	Mean score percent
	▪ Strongly Agree	137	34.3				
Stakeholders have a common understanding of the project scope.	▪ Strongly Disagree	45	11.3	1-5	3.67±1.24	4.00	73.40%
	▪ Disagree	24	6.0				
	▪ Neutral	52	13.0				
	▪ Agree	176	44.0				
	▪ Strongly Agree	103	25.8				
Schedule							
Projects are usually completed within the scheduled timeline.	▪ Strongly Disagree	45	11.3	1-5	3.20±1.31	3.00	63.90%
	▪ Disagree	103	25.8				
	▪ Neutral	56	14.0				
	▪ Agree	121	30.3				
	▪ Strongly Agree	75	18.8				
Time estimates are realistic and based on historical data.	▪ Strongly Disagree	45	11.3	1-5	3.50±1.15	4.00	69.90%
	▪ Disagree	11	2.8				
	▪ Neutral	112	28.0				
	▪ Agree	165	41.3				
	▪ Strongly Agree	67	16.8				
Schedule delays are managed through proactive planning.	▪ Strongly Disagree	25	6.3	1-5	3.75±1.09	4.00	75.00%
	▪ Disagree	30	7.5				
	▪ Neutral	59	14.8				
	▪ Agree	192	48.0				
	▪ Strongly Agree	94	23.5				
Cost							
Project budgets are well estimated and managed.	▪ Strongly Disagree	25	6.3	1-5	3.67±1.11	4.00	73.40%
	▪ Disagree	31	7.8				
	▪ Neutral	92	23.0				
	▪ Agree	155	38.8				
	▪ Strongly Agree	97	24.3				
We frequently monitor actual versus planned costs.	▪ Strongly Disagree	25	6.3	1-5	4.01±1.01	4.00	80.20%
	▪ Disagree	11	2.8				
	▪ Neutral	20	5.0				
	▪ Agree	223	55.8				
	▪ Strongly Agree	121	30.3				
Projects are typically completed within the allocated budget.	▪ Strongly Disagree	25	6.3	1-5	3.59±1.24	4.00	71.75%
	▪ Disagree	76	19.0				
	▪ Neutral	44	11.0				
	▪ Agree	149	37.3				
	▪ Strongly Agree	106	26.5				
Quality							
	▪ Strongly Disagree	25	6.3	1-5	3.93±1.21	4.00	78.50%

Project Constraints		Frequency	Percent	Min-Max	Mean ± SD	median	Mean score percent
Quality standards are clearly defined at the project’s start.	▪ Disagree	28	7.0				
	▪ Neutral	74	18.5				
	▪ Agree	98	24.5				
	▪ Strongly Agree	175	43.8				
Deliverables meet required specifications and customer expectations.	▪ Strongly Disagree	9	2.3	1-5	4.04±0.86	4.00	80.85%
	▪ Disagree	0	0.0				
	▪ Neutral	87	21.8				
	▪ Agree	173	43.3				
	▪ Strongly Agree	131	32.8				
Quality reviews are regularly conducted during project execution	▪ Strongly Disagree	25	6.3	1-5	3.99±1.08	4.00	79.85%
	▪ Disagree	15	3.8				
	▪ Neutral	38	9.5				
	▪ Agree	182	45.5				
	▪ Strongly Agree	140	35.0				
Risk							
Project risks are identified and assessed early in the project.	▪ Strongly Disagree	9	2.3	1-5	3.88±0.97	4.00	77.60%
	▪ Disagree	35	8.8				
	▪ Neutral	56	14.0				
	▪ Agree	195	48.8				
	▪ Strongly Agree	105	26.3				
Risk response strategies are developed and implemented.	▪ Strongly Disagree	9	2.3	1-5	3.85±0.80	4.00	76.95%
	▪ Disagree	0	0.0				
	▪ Neutral	108	27.0				
	▪ Agree	209	52.3				
	▪ Strongly Agree	74	18.5				
Risk monitoring is an ongoing part of project control.	▪ Strongly Disagree	16	4.0	1-5	4.10±0.92	4.00	81.95%
	▪ Disagree	0	0.0				
	▪ Neutral	57	14.3				
	▪ Agree	183	45.8				
	▪ Strongly Agree	144	36.0				
Resources							
Projects are adequately staffed with the required competencies.	▪ Strongly Disagree	45	11.3	1-5	3.67±1.21	4.00	73.30%
	▪ Disagree	15	3.8				
	▪ Neutral	65	16.3				
	▪ Agree	179	44.8				
	▪ Strongly Agree	96	24.0				
Resource allocation is optimized across projects.	▪ Strongly Disagree	45	11.3	1-5	3.68±1.26	4.00	73.60%
	▪ Disagree	17	4.3				
	▪ Neutral	79	19.8				
	▪ Agree	139	34.8				

Project Constraints		Frequency	Percent	Min-Max	Mean ± SD	median	Mean score percent
	▪ Strongly Agree	120	30.0				
We have access to the necessary tools, equipment, and infrastructure.	▪ Strongly Disagree	45	11.3	1-5	3.54±1.24	4.00	70.85%
	▪ Disagree	26	6.5				
	▪ Neutral	92	23.0				
	▪ Agree	141	35.3				
	▪ Strongly Agree	96	24.0				
	Stakeholders						
Stakeholder needs and expectations are clearly identified.	▪ Strongly Disagree	25	6.3	1-5	3.77±1.07	4.00	75.30%
	▪ Disagree	17	4.3				
	▪ Neutral	85	21.3				
	▪ Agree	173	43.3				
	▪ Strongly Agree	100	25.0				
Stakeholders are engaged throughout the project lifecycle.	▪ Strongly Disagree	25	6.3	1-5	3.80±1.20	4.00	76.05%
	▪ Disagree	55	13.8				
	▪ Neutral	18	4.5				
	▪ Agree	178	44.5				
	▪ Strongly Agree	124	31.0				
Feedback from stakeholders is used to improve performance.	▪ Strongly Disagree	25	6.3	1-5	3.96±1.02	4.00	79.20%
	▪ Disagree	0	0.0				
	▪ Neutral	67	16.8				
	▪ Agree	182	45.5				
	▪ Strongly Agree	126	31.5				
Governance							
Projects are guided by a defined governance framework.	▪ Strongly Disagree	25	6.3	1-5	3.78±1.09	4.00	75.60%
	▪ Disagree	15	3.8				
	▪ Neutral	96	24.0				
	▪ Agree	151	37.8				
	▪ Strongly Agree	113	28.3				
Roles and responsibilities are clear across all levels.	▪ Strongly Disagree	25	6.3	1-5	3.65±1.12	4.00	73.05%
	▪ Disagree	46	11.5				
	▪ Neutral	54	13.5				
	▪ Agree	193	48.3				
	▪ Strongly Agree	82	20.5				
Decisions are taken based on structured escalation procedures.	▪ Strongly Disagree	25	6.3	1-5	3.94±0.97	4.00	78.70%
	▪ Disagree	0	0.0				
	▪ Neutral	51	12.8				
	▪ Agree	224	56.0				
	▪ Strongly Agree	100	25.0				
Benefits							
	▪ Strongly Disagree	25	6.3	1-5	3.99±1.01	4.00	79.70%

Project Constraints		Frequency	Percent	Min-Max	Mean ± SD	median	Mean score percent
Project outcomes align with expected organizational benefits.	▪ Disagree	15	3.8				
	▪ Neutral	13	3.3				
	▪ Agree	235	58.8				
	▪ Strongly Agree	112	28.0				
Benefits realization is tracked beyond project closure.	▪ Strongly Disagree	25	6.3	1-5	3.71±1.13	4.00	74.15%
	▪ Disagree	43	10.8				
	▪ Neutral	52	13.0				
	▪ Agree	184	46.0				
	▪ Strongly Agree	96	24.0				
Project success is evaluated in terms of both output and outcomes.	▪ Strongly Disagree	25	6.3	1-5	3.91±1.02	4.00	78.25%
	▪ Disagree	11	2.8				
	▪ Neutral	44	11.0				
	▪ Agree	214	53.5				
	▪ Strongly Agree	106	26.5				
Strategic Alignment							
Projects contribute to the strategic goals of the organization.	▪ Strongly Disagree	16	4.0	1-5	3.94±0.99	4.00	78.75%
	▪ Disagree	35	8.8				
	▪ Neutral	9	2.3				
	▪ Agree	238	59.5				
	▪ Strongly Agree	102	25.5				
Project selection is aligned with strategic priorities.	▪ Strongly Disagree	25	6.3	1-5	3.85±1.08	4.00	76.90%
	▪ Disagree	15	3.8				
	▪ Neutral	72	18.0				
	▪ Agree	173	43.3				
	▪ Strongly Agree	115	28.8				
Performance indicators reflect strategic objectives	▪ Strongly Disagree	16	4.0	1-5	3.72±0.97	4.00	74.35%
	▪ Disagree	20	5.0				
	▪ Neutral	105	26.3				
	▪ Agree	179	44.8				
	▪ Strongly Agree	80	20.0				

The table presenting the distribution of study participants according to Project Constraints illustrates a comprehensive overview of how various constraints are perceived and managed within the projects under investigation. Overall, the results indicate a generally high level of awareness and adherence to project management practices across multiple constraint dimensions, as reflected by the elevated mean scores and percentage agreement levels.

- **Scope Constraints**

The results show that the scope is clearly defined and managed, with mean scores ranging between 3.67 and 4.11 and Mean score percent ranging between (73.40%-82.15%). This indicates that participants recognize the importance of well-defined project boundaries and systematic control of scope changes, reflecting a strong alignment among stakeholders regarding project objectives.

- **Schedule Constraints**

Schedule management appears to be moderately robust, with mean scores between 3.20 and 3.75 and Mean score percent ranging between 63.90% to 75.00%. While projects are generally completed within planned timelines, some variability suggests opportunities for improving time estimation accuracy and proactive scheduling measures.

- **Cost Constraints**

The management of project budgets and costs shows a good level of control, with means ranging from 3.59 to 4.01 and Mean score percent ranging between 71.75% and 80.20%. The results suggest that participants actively monitor actual versus planned costs and aim to complete projects within allocated budgets, highlighting effective financial oversight.

- **Quality Constraints**

Quality standards are consistently applied, with mean scores between 3.93 and 4.04 and Mean score percent ranging between 78.50% to 80.85%. This demonstrates that participants prioritize delivering outputs that meet required specifications and customer expectations, supported by regular quality reviews during project execution.

- **Risk Constraints**

Project risk management reflects a proactive approach, with means from 3.85 to 4.10 and Mean score percent ranging between 76.95% and 81.95%. Participants identify and assess risks early, develop mitigation strategies, and continuously monitor risks, indicating a mature risk management practice.

- **Resource Constraints**

Resource allocation and availability are managed at a moderate to good level, with mean scores ranging from 3.54 to 3.68 and Mean score percent ranging between 70.85% to 73.60%. The results suggest that projects are generally staffed appropriately, with adequate tools and infrastructure, though there may be room for optimization.

- **Stakeholder Constraints**

Stakeholder engagement and feedback utilization are strong, with means between 3.77 and 3.96 and Mean score percent ranging between 75.30% to 79.20%. This highlights the recognition of stakeholders' critical role in project success and the use of their input to enhance performance.

- **Governance Constraints**

Project governance is effectively established, with mean scores ranging from 3.65 to 3.94 and Mean score percent ranging between 73.05% to 78.70%. Participants indicate that roles, responsibilities, and decision-making procedures are clearly defined and structured, supporting accountability and control.

- **Benefits**

Projects demonstrate high alignment with organizational benefits, with mean scores between 3.71 and 3.99 and Mean score percent ranging between 74.15% to 79.70%. Participants emphasize tracking outcomes beyond project closure and ensuring that project objectives support broader organizational priorities, reflecting strategic project management maturity.

- **Strategic Alignment**

Projects demonstrate high alignment with organizational strategic Alignment, with mean scores between 3.72 and 3.94 and agreement percentages from 74.35% to 78.75%. Participants emphasize tracking outcomes beyond project closure and ensuring that project objectives support broader organizational priorities, reflecting strategic project management maturity.

Descriptive Statistics of Variables

Table (4-12) Descriptive Statistics of Independent Variables (Using Artificial Intelligence)

Variables	Mean±SD	Skewness	Kurtosis	Mean score percent
Machine Learning (ML)	11.98±4.70	-0.448	-0.763	59.90%
Natural Language Processing (NLP)	11.64±4.96	-0.163	-0.967	58.19%
Chatbots and Visual Assistants	14.33±4.51	-0.936	0.173	71.64%
Predictive Analytics	13.53±4.75	-0.495	-0.561	67.63%
Robotic Process Automation	13.29±4.77	-0.530	-0.629	66.44%
Data Visualization Tools	15.39±4.39	-1.185	0.791	76.94%
Decision Support Systems	13.97±4.46	-0.950	0.218	69.83%
Using Artificial Intelligence	94.11±24.64	-0.356	-0.642	67.22%

Table (4-12) shows Descriptive Statistics of Independent Variables (Using Artificial Intelligence) the following Machine Learning (ML) 11.98±4.70 Mean score percent 59.90%, Natural Language Processing (NLP) 11.64±4.96 Mean score percent 58.19%, Chatbots and Visual Assistants 14.33±4.51 Mean score percent 71.64%, Predictive Analytics 13.53±4.75 Mean score percent 67.63%, Robotic Process Automation 13.29±4.77 Mean score percent 66.44%, Data Visualization Tools 15.39±4.39 Mean score percent 76.94%, Decision Support Systems 13.97±4.46 Mean score percent 69.83%, Using Artificial Intelligence 94.11±24.64 Mean score percent 67.22%.

Table (4-13) Descriptive Statistics of Mediating Variables (Project Manager's Competencies)

Variables	Mean±SD	Skewness	Kurtosis	Mean score percent
Technical Competencies	18.93±4.45	-1.012	1.711	75.72%
Leadership & Behavioral	20.86±4.21	-2.072	5.656	83.43%
Strategic and Business	19.75±4.70	-1.215	1.693	79.01%
Project Manager's Competencies	59.54±12.17	-1.873	4.891	79.39%

Table (4-13) shows Descriptive Statistics of Mediating Variables (Project Manager's Competencies) the following Technical Competencies 18.93±4.45 Mean score percent 75.72%, Leadership & Behavioral 20.86±4.21 Mean score percent 83.43%, Strategic and Business 19.75±4.70 Mean score percent 79.01%, Project Manager's Competencies 59.54±12.17 Mean score percent 79.39%.

Table (4-14) Descriptive Statistics of Dependent Variables (Project Constraints)

Variables	Mean±SD	Skewnes s	Kurtosis	Mean score percent
Scope	11.72±2.79	-1.508	2.747	78.12%
Schedule	10.44±3.14	-0.675	-0.087	69.60%
Cost	11.27±3.05	-1.095	1.183	75.12%
Quality	11.96±2.86	-1.091	1.201	79.73%
Risk	11.83±2.09	-0.095	-0.460	78.83%
Resources	10.89±3.49	-1.035	0.378	72.58%
Stakeholders	11.53±3.00	-1.213	1.636	76.85%
Governance	11.37±2.91	-1.304	1.985	75.78%
Benefits	11.61±2.87	-1.569	2.622	77.37%
Strategic Alignment	11.50±2.74	-1.240	1.898	76.67%
Project Constraints	114.10±25.94	-1.227	2.042	76.07%

Table (4-14) shows Descriptive Statistics of Dependent Variables (Project Constraints) the following Scope 11.72±2.79Mean score percent 78.12%, Schedule 10.44±3.14Mean score percent 69.60%, Cost 11.27±3.05Mean score percent 75.12%, Quality 11.96±2.86Mean score percent 79.73%, Risk 11.83±2.09Mean score percent 78.83%, Resources 10.89±3.49Mean score percent 72.58%, Stakeholders 11.53±3.00Mean score percent 76.85%, Governance 11.37±2.91Mean score percent 75.78%, Benefits 11.61±2.87Mean score percent 77.37%, Strategic Alignment 11.50±2.74Mean score percent 76.67%, Project Constraints 114.10±25.94Mean score percent 76.07%.

Correlation Matrix between Variables (Pearson Correlation)

The Pearson Correlation Coefficient is an important statistical tool for measuring the linear relationship between two continuous variables, with values ranging from -1 to +1, indicating the direction and strength of the relationship. A value close to +1 indicates a strong positive relationship, a value close to -1 indicates a strong negative relationship, while values near 0 reflect the absence of a clear linear relationship.

this coefficient is widely used in social and administrative research to understand the degree of association between variables before conducting advanced analyses. Its use requires that the variables be continuous, the relationship approximately linear, the data roughly normally distributed, and extreme values avoided.

The purpose of the Pearson coefficient is to determine whether a significant relationship exists between variables and to estimate the amount of shared variance through the squared value of r (r^2). However, the coefficient indicates correlation only, not causation, and is therefore often used alongside additional analyses such as regression or structural equation modeling. It is considered an essential preliminary step in understanding relationships between variables and making methodological decisions in research

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

Variables		Machine Learning (ML)	Natural Language Processing (NLP)	Chatbots and Visual Assistants	Predictive Analytics	Robotic Process Automation	Data Visualization Tools	Decision Support Systems	Using Artificial Intelligence	Technical Competencies	Leadership & Behavioral	Strategic and Business	Project Manager's Competencies
Machine Learning (ML)	r	1											
	p												
Natural Language Processing (NLP)	r	0.774**	1										
	p	0.000											
Chatbots and Visual Assistants	r	0.444**	0.657**	1									
	p	0.000	0.000										
Predictive Analytics	r	0.410**	0.646**	0.703**	1								
	p	0.000	0.000	0.000									
Robotic Process Automation	r	0.293**	0.492**	0.445**	0.672**	1							
	p	0.000	0.000	0.000	0.000								
Data Visualization Tools	r	0.250**	0.489**	0.432**	0.283**	0.217**	1						
	p	0.000	0.000	0.000	0.000	0.000							
Decision Support Systems	r	0.547**	0.724**	0.444**	0.422**	0.475**	0.669**	1					
	p	0.000	0.000	0.000	0.000	0.000	0.000						
Using Artificial Intelligence	r	0.707**	0.907**	0.779**	0.787**	0.684**	0.621**	0.805**	1				
	p	0.000	0.000	0.000	0.000	0.000	0.000	0.000					
Technical Competencies	r	0.314**	0.323**	-0.021	-0.179**	-0.085	0.367**	0.508**	0.228**	1			
	p	0.000	0.000	0.682	0.000	0.090	0.000	0.000	0.000				
Leadership & Behavioral	r	0.351**	0.360**	0.102*	-0.059	-0.157**	0.492**	0.448**	0.285**	0.742**	1		
	p	0.000	0.000	0.041	0.236	0.002	0.000	0.000	0.000	0.000			
Strategic and Business	r	0.504**	0.509**	0.220**	0.068	0.038	0.457**	0.648**	0.458**	0.627**	0.868**	1	
	p	0.000	0.000	0.000	0.172	0.449	0.000	0.000	0.000	0.000	0.000		
Project Manager's Competencies	r	0.431**	0.440**	0.113*	-0.059	-0.071	0.481**	0.591**	0.359**	0.865**	0.953**	0.916**	1
	p	0.000	0.000	0.024	0.235	0.159	0.000	0.000	0.000	0.000	0.000	0.000	
Scope	r	0.229**	0.411**	0.323**	-0.074	-0.076	0.624**	0.515**	0.361**	0.659**	0.609**	0.631**	0.696**
	p	0.000	0.000	0.000	0.139	0.131	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Schedule	r	0.297**	0.435**	0.193**	-0.072	-0.026	0.500**	0.405**	0.323**	0.472**	0.377**	0.456**	0.479**
	p	0.000	0.000	0.000	0.153	0.601	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cost	r	0.265**	0.431**	0.170**	-0.087	-0.116*	0.464**	0.463**	0.295**	0.648**	0.478**	0.521**	0.604**

Variables		Machine Learning (ML)	Natural Language Processing (NLP)	Chatbots and Visual Assistants	Predictive Analytics	Robotic Process Automation	Data Visualization Tools	Decision Support Systems	Using Artificial Intelligence	Technical Competencies	Leadership & Behavioral	Strategic and Business	Project Manager's Competencies
Quality	p	0.000	0.000	0.001	0.081	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	r	0.263**	0.563**	0.509**	0.208**	0.245**	0.665**	0.682**	0.586**	0.622**	0.587**	0.657**	0.685**
	p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Risk	r	0.377**	0.583**	0.273**	0.250**	0.069	0.596**	0.616**	0.518**	0.465**	0.522**	0.638**	0.597**
	p	0.000	0.000	0.000	0.000	0.166	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Resources	r	0.275**	0.465**	0.152**	-0.107*	0.028	0.369**	0.505**	0.316**	0.761**	0.417**	0.427**	0.588**
	p	0.000	0.000	0.002	0.032	0.583	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Stakeholders	r	0.392**	0.682**	0.429**	0.163**	0.247**	0.645**	0.670**	0.606**	0.654**	0.566**	0.597**	0.666**
	p	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Governance	r	0.175**	0.459**	0.277**	-0.001	0.039	0.618**	0.557**	0.395**	0.678**	0.644**	0.652**	0.723**
	p	0.000	0.000	0.000	0.985	0.438	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Benefits	r	0.252**	0.483**	0.408**	0.045	0.016	0.606**	0.498**	0.430**	0.532**	0.490**	0.513**	0.563**
	p	0.000	0.000	0.000	0.366	0.752	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Strategic Alignment	r	0.438**	0.531**	0.115*	-0.106*	-0.071	0.453**	0.438**	0.337**	0.661**	0.608**	0.545**	0.663**
	p	0.000	0.000	0.021	0.033	0.156	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Project Constraints	r	0.327**	0.559**	0.315**	0.014	0.039	0.612**	0.593**	0.459**	0.693**	0.586**	0.622**	0.697**
	p	0.000	0.000	0.000	0.774	0.442	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table (4-15) Correlation Matrix between Variables Independent Variables (Using Artificial Intelligence) ,Mediating Variables (Project Manager's Competencies) and Dependent Variables (Project Constraints)

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

* Correlation is significant at the 0.05 level (2-tailed).

* Pearson correlation test

Variables		Scope	Schedule	Cost	Quality	Risk	Resources	Stakeholders	Governance	Benefits	Strategic Alignment	Project Constraints
Scope	r	1										
	p											
Schedule	r	0.815**	1									
	p	0.000										
Cost	r	0.871**	0.914**	1								
	p	0.000	0.000									
Quality	r	0.889**	0.706**	0.749**	1							
	p	0.000	0.000	0.000								
Risk	r	0.689**	0.688**	0.730**	0.729**	1						
	p	0.000	0.000	0.000	0.000							
Resources	r	0.717**	0.742**	0.772**	0.730**	0.590**	1					
	p	0.000	0.000	0.000	0.000	0.000						
Stakeholders	r	0.815**	0.813**	0.795**	0.892**	0.727**	0.857**	1				
	p	0.000	0.000	0.000	0.000	0.000	0.000					
Governance	r	0.915**	0.797**	0.832**	0.891**	0.637**	0.746**	0.869**	1			
	p	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
Benefits	r	0.868**	0.865**	0.849**	0.831**	0.590**	0.710**	0.856**	0.878**	1		
	p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
Strategic Alignment	r	0.664**	0.744**	0.716**	0.651**	0.582**	0.791**	0.828**	0.753**	0.760**	1	
	p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
Project Constraints	r	0.922**	0.907**	0.922**	0.900**	0.766**	0.866**	0.947**	0.932**	0.921**	0.841**	1
	p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

Table (4-16) Correlation Matrix between Variables Independent Variables (Using Artificial Intelligence), Mediating Variables (Project Manager's Competencies) and Dependent Variables (Project Constraints)

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

* Correlation is significant at the 0.05 level (2-tailed).

* Pearson correlation test

The table presents the correlation coefficients between the independent variables related to the use of Artificial Intelligence (AI) technologies, the mediating variable (Project Manager's Competencies), and the dependent variable (Project Constraints), providing a comprehensive view of the statistical relationships among these variables. The results reveal several key points:

- **Relationship between AI usage and Project Manager's Competencies**

The correlations indicate significant positive relationships between most AI technologies and project managers' competencies. For instance, Machine Learning ($r = 0.431, p < 0.01$), Natural Language Processing ($r = 0.440, p < 0.01$), Data Visualization Tools ($r = 0.481, p < 0.01$), and Decision Support Systems ($r = 0.591, p < 0.01$) show moderate to strong correlations with project managers' competencies. Meanwhile, Chatbots and Visual Assistants show a weak correlation ($r = 0.113, p < 0.05$), whereas Predictive Analytics ($r = -0.059, p > 0.05$) and Robotic Process Automation ($r = -0.071, p > 0.05$) do not exhibit statistically significant correlations, suggesting that some advanced technologies are not yet fully leveraged to enhance managerial competencies.

- **Relationship between AI usage and Project Constraints**

The results indicate that most AI tools and technologies are positively and moderately to strongly correlated with project constraints, with correlation coefficients ranging from ($r = 0.315$ to $0.612, p < 0.01$), except for Predictive Analytics ($r = 0.014, p > 0.05$) and Robotic Process Automation ($r = 0.039, p > 0.05$), which show no significant correlation. These findings reflect the role of AI in improving control over certain project constraints, such as quality and resources, while highlighting that some technologies have yet to be fully exploited to impact these constraints.

- **Relationship between Project Manager's Competencies and Project Constraints**

The table shows that project managers' competencies serve as a crucial mediating variable, with all three competency dimensions (technical, leadership & behavioral, and strategic & business) displaying strong and significant correlations with project constraints, ranging between ($r = 0.586$ – $0.693, p < 0.01$). This indicates that high

managerial competencies enhance the ability to manage various constraints effectively and achieve project objectives.

• Implications of the Results

Based on the above, it can be concluded that the relationship between AI usage and project constraints is not always direct; project managers' competencies play a central mediating role that strengthens the effect of AI technologies on managing constraints efficiently. This also implies that investing in training and enhancing managerial capabilities can maximize the practical benefits of AI adoption in project management.

H2: There is a positive impact of using Artificial Intelligence on Project Manager's Competencies.

To test the main study Hypothesis H2, the researcher used simple linear regression analysis of the effect of using Artificial Intelligence on Project Manager's Competencies.

Model	df	Sum of Squares	Mean Square	(R)	(R2)	B	B1	F test		T test	
								F	Sig	T	Sig
Regression	1	7612.60	7612.60	0.359	0.129	42.86	0.18	58.849	0.000*	7.671	0.000*
Residual	398	51484.76	129.36								
Total	399	59097.36									
a. Dependent Variable: Project Manager's Competencies											
b. Predictors: (Constant), using Artificial Intelligence											

Table (4-17) Test of using Artificial Intelligence effect on Project Manager's Competencies

*A function at the level of significance less than (0.05).

The table presents the results of a simple linear regression analysis examining the effect of using Artificial Intelligence (AI) on Project Manager's Competencies. The model shows a significant positive relationship between the independent variable (AI usage) and the dependent variable (Project Manager's Competencies).

Model Fit and Explained Variance:

The coefficient of determination ($R^2 = 0.129$) indicates that approximately 12.9% of the variance in project managers' competencies can be explained by the level of AI usage. Although this represents a modest proportion, it is statistically significant, suggesting that AI adoption contributes meaningfully to enhancing managerial

competencies. The multiple correlation coefficient ($R = 0.359$) reflects a moderate linear association between the variables.

Regression Coefficients:

The regression coefficient ($B = 0.18$, $t = 7.671$, $p < 0.01$) is positive and highly significant, indicating that increased use of AI tools is associated with higher levels of project managers' competencies. In practical terms, this suggests that for every unit increase in AI usage, there is a corresponding increase in the competency score of project managers, highlighting the positive role of AI in supporting managerial effectiveness.

Statistical Significance:

The F-test for the regression model ($F = 58.849$, $p < 0.01$) confirms that the model as a whole is statistically significant, meaning that AI usage significantly predicts variations in project managers' competencies.

Implications:

These results underscore the importance of integrating AI technologies in project management practices. By leveraging AI tools, organizations can enhance the technical, leadership, and strategic competencies of their project managers, ultimately leading to more effective project planning, decision-making, and execution. However, given that R^2 is 0.129, it also indicates that other factors beyond AI usage contribute to managerial competencies, suggesting the need for complementary strategies such as training, experience, and organizational support.

Summary:

In conclusion, the regression analysis confirms a significant positive effect of AI usage on project managers' competencies, validating the role of AI as a supportive factor in developing managerial skills while acknowledging that additional variables influence competency levels.

To test the main study Hypothesis H2, the researcher used Multiple linear regression analysis of the effect of using Artificial Intelligence on Project Manager's Competencies

Coefficient ^a										
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	F	Sig.	R square	R square change
		B	Std. Error	Beta						
1	(Constant)	46.157	1.508		30.613	0.000*	90.855	0.000*	18.59%	
	Machine Learning (ML)	1.117	0.117	0.431	9.532	0.000*				18.5%
2	(Constant)	44.958	1.517		29.632	0.000*	54.019	0.000*	21.39%	
	Machine Learning (ML)	0.587	0.182	0.226	3.222	0.001*				18.5%
	Natural Language Processing (NLP)	0.649	0.172	0.265	3.765	0.000*				2.81%
3	(Constant)	51.134	1.922		26.611	0.000*	46.549	0.000*	26.07%	
	Machine Learning (ML)	0.466	0.178	0.180	2.609	0.009*				18.5%
	Natural Language Processing (NLP)	1.205	0.201	0.491	5.998	0.000*				2.81%
	Chatbots and Visual Assistants	-0.781	0.156	-0.290	-5.006	0.000*				4.68%
4	(Constant)	55.682	1.798		30.976	0.000*	65.771	0.000*	39.98%	
	Machine Learning (ML)	0.252	0.163	0.097	1.548	0.122				18.5%
	Natural Language Processing (NLP)	1.824	0.192	0.743	9.478	0.000*				2.81%
	Chatbots and Visual Assistants	-0.060	0.160	-0.022	-0.374	0.708				4.68%
	Predictive Analytics	-1.444	0.151	-0.564	-9.566	0.000*				13.9%
5	(Constant)	57.466	1.902		30.209	0.000*	54.907	0.000*	41.06%	
	Machine Learning (ML)	0.217	0.162	0.084	1.343	0.180				18.5%
	Natural Language Processing (NLP)	1.902	0.193	0.775	9.848	0.000*				2.81%
	Chatbots and Visual Assistants	-0.104	0.159	-0.039	-0.653	0.514				4.68%
	Predictive Analytics	-1.207	0.174	-0.471	-6.955	0.000*				13.9%
	Robotic Process Automation	-0.364	0.135	-0.143	-2.697	0.007*				1.09%
6	(Constant)	45.888	2.158		21.265	0.000*	68.615	0.000*	51.16%	
	Machine Learning (ML)	0.546	0.152	0.211	3.596	0.000*				18.5%
	Natural Language Processing (NLP)	1.223	0.191	0.498	6.387	0.000*				2.81%
	Chatbots and Visual Assistants	-0.388	0.149	-0.144	-2.608	0.009*				4.68%
	Predictive Analytics	-0.975	0.160	-0.381	-6.082	0.000*				13.9%
	Robotic Process Automation	-0.361	0.123	-0.141	-2.930	0.004*				1.09%
	Data Visualization Tools	1.067	0.118	0.385	9.014	0.000*				10.1%
7	(Constant)	44.551	1.991		22.376	0.000*	79.876	0.000*	58.79%	
	Machine Learning (ML)	0.384	0.141	0.148	2.727	0.007*				18.5%

	Natural Language Processing (NLP)	0.668	0.188	0.272	3.560	0.000*				2.81
	Chatbots and Visual Assistants	-0.225	0.138	-0.083	-1.631	0.104				4.68
	Predictive Analytics	-0.791	0.149	-0.309	-5.308	0.000*				13.9
	Robotic Process Automation	-0.712	0.121	-0.279	-5.910	0.000*				1.09
	Data Visualization Tools	0.424	0.132	0.153	3.198	0.001*				10.1
	Decision Support Systems	1.395	0.164	0.511	8.516	0.000*				7.62

Table (4-18) Test of using Artificial Intelligence effect on Project Manager's Competencies

a. Dependent Variable: Project Manager's Competencies

*A function at the level of significance less than (0.05).

The table presents the results of a series of Multiple linear regression models aimed at examining the impact of different dimensions of Artificial Intelligence (AI) usage on project managers' competencies. Independent variables were introduced progressively to evaluate the contribution of each technology individually, while considering changes in the explanatory power of the model (R^2) at each step.

General Observations:

The results indicate that most AI technologies positively contribute to enhancing project managers' competencies, with variations in the magnitude of the effect across different technologies. The unstandardized coefficient (B) represents the direct effect, while the standardized coefficient (Beta) shows the relative impact of each technology compared to the other variables.

Detailed Observations by Technology:

Machine Learning (ML):

Demonstrates a consistent positive effect on project managers' competencies across all models, with Beta ranging from 0.084 to 0.431 and highly significant p-values ($p < 0.01$). This indicates that using ML enhances both the technical and strategic competencies of managers.

Natural Language Processing (NLP):

Shows a strong positive effect, particularly in models including multiple AI dimensions. Beta ranges from 0.265 to 0.775, with high t-values ($p < 0.01$), indicating a critical role for NLP technologies in improving managers' analytical, communication, and knowledge management skills.

Chatbots & Visual Assistants:

Exhibits negative effects in some models, with Beta ranging from -0.039 to -0.290, and statistically significant in certain cases. This suggests that these tools may not directly enhance core managerial competencies and are likely more supportive of routine operational tasks.

Predictive Analytics:

Shows a negative effect in advanced models, with Beta ranging from -0.309 to -0.564 ($p < 0.01$), which may indicate that reliance on predictive analytics alone reduces the need for some traditional managerial skills or highlights differences in expertise required to interpret results effectively.

Robotic Process Automation (RPA):

Demonstrates a moderate negative effect, with Beta between -0.141 and -0.279, statistically significant in most models, suggesting that heavy automation may reduce the performance of some traditional tasks but still serves as a supporting tool for other competencies.

Data Visualization Tools:

It shows a notable positive impact, with Beta ranging from 0.153 to 0.385, highly significant, reflecting the strong role of these tools in supporting decision-making and enhancing managers' analytical capabilities.

Decision Support Systems (DSS):

Shows a strong positive effect in the final model (Beta = 0.511, $p < 0.01$), indicating that integrating DSS into daily work directly strengthens strategic decision-making ability and overall managerial competencies.

Model Explanatory Power (R^2):

R^2 increases from 18.59% to 58.79% as all variables are included, demonstrating that combining multiple AI tools substantially improves the model's ability to explain variance in project managers' competencies, highlighting the importance of using an integrated set of technologies for a comprehensive positive effect.

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

To test the main study Hypothesis H3, the researcher used simple linear regression analysis of the effect of using Artificial Intelligence on Project Constraints.

Model	df	Sum of Squares	Mean Square	(R)	(R2)	B	B1	F test		T test	
								F	Sig	T	Sig
Regression	1	56615.75	56615.75	0.459	0.211	68.61	0.48	106.330	0.000*	10.312	0.000*
Residual	398	211915.45	532.45								
Total	399	268531.20									
a. Dependent Variable: Project Constraints											
b. Predictors: (Constant), using Artificial Intelligence											

Table (4-19) Test of using Artificial Intelligence effect on Project Constraints

*A function at the level of significance less than (0.05).

The table presents the results of a regression analysis examining the effect of using Artificial Intelligence (AI) on project constraints, with project constraints as the dependent variable and AI usage as the independent variable.

Model Overview:

The regression model demonstrates a statistically significant positive relationship between the use of AI and project constraints, as indicated by the F-test value of 106.330 ($p < 0.001$). The model's correlation coefficient ($R = 0.459$) suggests a moderate relationship, while the coefficient of determination ($R^2 = 0.211$) indicates that approximately 21.1% of the variance in project constraints can be explained by AI utilization.

Interpretation of Coefficients:

- The unstandardized regression coefficient ($B = 68.61$) and standardized coefficient ($B1 = 0.48$) indicate that increased use of AI is associated with a significant improvement in managing project constraints. Specifically, higher levels of AI adoption contribute to better handling of scope, schedule, cost, quality, risk, resources, and stakeholder-related constraints.

- The t-test value ($t = 10.312$, $p < 0.001$) confirms that the effect of AI on project constraints is statistically significant, supporting the hypothesis that AI can serve as a critical tool for mitigating project limitations and enhancing overall project performance.

To test the main study Hypothesis H3, the researcher used Multiple linear regression analysis of the effect of using Artificial Intelligence on Project Constraints

Coefficient ^a									
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	F	Sig.	R square
		B	Std. Error	Beta					
1	(Constant)	92.444	3.366		27.465	0.000*	47.728	0.000*	10.71%
	Machine Learning (ML)	1.807	0.262	0.327	6.909	0.000*			
2	(Constant)	85.071	2.962		28.720	0.000*	102.539	0.000*	34.06%
	Machine Learning (ML)	-1.455	0.355	-0.263	-4.092	0.000*			
	Natural Language Processing (NLP)	3.992	0.337	0.763	11.858	0.000*			
3	(Constant)	90.766	3.842		23.622	0.000*	70.881	0.000*	34.94%
	Machine Learning (ML)	-1.566	0.357	-0.284	-4.389	0.000*			
	Natural Language Processing (NLP)	4.504	0.402	0.861	11.212	0.000*			
	Chatbots and Visual Assistants	-0.721	0.312	-0.125	-2.308	0.021*			
4	(Constant)	104.022	3.091		33.653	0.000*	154.071	0.000*	60.94%
	Machine Learning (ML)	-2.190	0.279	-0.396	-7.836	0.000*			
	Natural Language Processing (NLP)	6.309	0.331	1.206	19.063	0.000*			
	Chatbots and Visual Assistants	1.383	0.275	0.241	5.034	0.000*			
	Predictive Analytics	-4.209	0.260	-0.771	-16.216	0.000*			
5	(Constant)	105.409	3.295		31.990	0.000*	123.694	0.000*	61.09%
	Machine Learning (ML)	-2.217	0.280	-0.401	-7.911	0.000*			
	Natural Language Processing (NLP)	6.369	0.334	1.218	19.042	0.000*			
	Chatbots and Visual Assistants	1.349	0.276	0.235	4.886	0.000*			
	Predictive Analytics	-4.025	0.301	-0.737	-13.387	0.000*			
	Robotic Process Automation	-0.283	0.234	-0.052	-1.210	0.227			
6	(Constant)	83.217	3.650		22.799	0.000*	147.490	0.000*	69.25%
	Machine Learning (ML)	-1.586	0.257	-0.287	-6.174	0.000*			
	Natural Language Processing (NLP)	5.068	0.324	0.969	15.650	0.000*			

	Chatbots and Visual Assistants	0.805	0.251	0.140	3.202	0.001*				0.3
	Predictive Analytics	-3.580	0.271	-0.656	-13.203	0.000*				26.
	Robotic Process Automation	-0.276	0.208	-0.051	-1.327	0.185				0.1
	Data Visualization Tools	2.044	0.200	0.346	10.213	0.000*				8.1
7	(Constant)	82.147	3.601		22.809	0.000*	132.697	0.000*	70.32%	
	Machine Learning (ML)	-1.716	0.255	-0.311	-6.727	0.000*				10.
	Natural Language Processing (NLP)	4.624	0.340	0.884	13.617	0.000*				23.
	Chatbots and Visual Assistants	0.935	0.250	0.163	3.746	0.000*				0.3
	Predictive Analytics	-3.432	0.270	-0.629	-12.734	0.000*				26.
	Robotic Process Automation	-0.558	0.218	-0.102	-2.558	0.011*				0.1
	Data Visualization Tools	1.530	0.240	0.259	6.383	0.000*				8.1
	Decision Support Systems	1.116	0.296	0.192	3.769	0.000*				1.0

Table (4-20) Test of using Artificial Intelligence effect on Project Constraints

a. Dependent Variable: : Project Constraints

*A function at the level of significance less than (0.05).

The table presents the results of regression analysis examining the effect of using artificial intelligence (AI) technologies on project constraints. Each AI technology was tested individually and then integrated progressively in sequential models to clarify their relative contributions.

Overview of the Model:

The results indicate that all regression models were statistically significant ($p < 0.001$), with varying explanatory power (R^2) ranging from 10.71% in the first model to 70.32% in the final model when all AI technologies were combined. This indicates that the integration of different AI technologies explains a substantial portion of the variance in project constraints, highlighting the important role of AI in enhancing project management.

Analysis of Each Technology's Effect:

Machine Learning (ML):

Shows a negative effect in most models when combined with other technologies, which is statistically significant. This suggests that relying on ML alone or within a set may reduce certain constraints if it is not integrated with supporting technologies.

Natural Language Processing (NLP):

Exhibits a strong positive effect across all models with the highest standardized coefficient (Beta), indicating that adopting NLP significantly improves the management of project constraints, particularly in communication, requirement understanding, and stakeholder management.

Chatbots and Visual Assistants:

Shows a relatively positive effect in the later models with statistical significance ($p < 0.05$), suggesting that these tools enhance the team's ability to interact with information and stakeholders, though they are not the most influential factor.

Predictive Analytics:

Exhibits a large negative effect in most models, which is statistically significant. This indicates that applying predictive analytics without comprehensive support from other technologies may reveal constraints or challenges that remain unresolved, though it remains an important tool for strategic decision-making when integrated.

Robotic Process Automation (RPA):

Shows a limited negative effect in some models with statistical significance in certain cases, suggesting that process automation alone may not reduce all constraints but contributes to operational efficiency when combined with other technologies.

Data Visualization Tools:

Demonstrates a clear positive and statistically significant effect, reflecting their importance in simplifying complex information and enabling project managers to make faster and more accurate decisions.

Decision Support Systems:

Show a relatively positive effect in the final model, indicating that integrating these systems with other technologies enhances the ability to make strategic decisions and reduce project constraints.

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

To test the main study Hypothesis H4, the researcher used simple linear regression analysis of the effect of Project Manager's Competencies on Project Constraints.

Model	df	Sum of Squares	Mean Square	(R)	(R2)	B	B1	F test		T test	
								F	Sig	T	Sig
Regression	1	130445.85	130445.85	0.697	0.486	25.64	1.49	375.981	0.000*	19.390	0.000*
Residual	398	138085.35	345.95								
Total	399	268531.20									
a. Dependent Variable: Project Constraints											
b. Predictors: (Constant), Project Manager’s Competencies											

Table (4-21) Test of Project Manager's Competencies effect on Project Constraints

*A function at the level of significance less than (0.05).

The table presents the results of a regression analysis examining the effect of Project Manager's Competencies on Project Constraints. The findings reveal a strong and statistically significant relationship between these two variables.

Model Fit and Variance Explained:

The regression model shows a high coefficient of determination ($R^2 = 0.486$), indicating that approximately 48.6% of the variance in project constraints can be explained by project managers' competencies. This demonstrates the substantial impact that managerial skills have on mitigating or managing project-related constraints.

Strength and Significance of the Relationship:

The correlation coefficient ($R = 0.697$) indicates a strong positive relationship, suggesting that higher levels of competencies in project managers are associated with better control and reduction of project constraints.

The F-test ($F = 375.981$, $p < 0.001$) confirms the overall statistical significance of the regression model, indicating that the model reliably predicts project constraints.

The t-test for the regression coefficient ($t = 19.390$, $p < 0.001$) demonstrates that the effect of project managers' competencies on project constraints is highly significant.

To test the main study Hypothesis H4, the researcher used Multiple linear regression analysis of the effect of Project Manager's Competencies on Project Constraints

Coefficient ^a										
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	F	Sig.	R square	R square change
		B	Std. Error	Beta						
1	(Constant)	37.654	4.092		9.202	0.000*	368.272	0.000*	48.06%	
	Technical Competencies	4.038	0.210	0.693	19.190	0.000*				48.06%
2	(Constant)	30.143	4.756		6.338	0.000*	192.417	0.000*	49.22%	
	Technical Competencies	3.344	0.311	0.574	10.770	0.000*				48.06%
	Leadership & Behavioral	0.990	0.328	0.161	3.014	0.003*				1.16%
3	(Constant)	31.174	4.466		6.981	0.000*	163.888	0.000*	55.39%	
	Technical Competencies	3.457	0.292	0.593	11.846	0.000*				48.06%
	Leadership & Behavioral	-1.782	0.485	-0.289	-3.673	0.000*				1.16%
	Strategic and Business	2.767	0.374	0.501	7.399	0.000*				6.17%

Table (4-22) Test of Project Manager's Competencies effect on Project Constraints

a. Dependent Variable: Project Constraints

*A function at the level of significance less than (0.05).

The table presents the results of regression analysis examining the effect of Project Manager's Competencies (technical, leadership & behavioral, and strategic & business) on Project Constraints. The results indicate that each competency dimension has a distinct impact on project constraints, with varying strength across different models.

Model 1 – Technical Competencies only:

Technical competencies of project managers show a strong positive effect on project constraints, with a standardized coefficient (Beta = 0.693) and statistically significant ($t = 19.190$, $p < 0.001$).

This model explains approximately 48.06% of the variance in project constraints, highlighting the critical role of technical skills in managing constraints related to scope, cost, schedule, and quality.

Model 2 – Adding Leadership & Behavioral Competencies:

When leadership & behavioral competencies are added, the effect of technical competencies remains strong ($\text{Beta} = 0.574$), while leadership & behavioral competencies contribute an additional positive effect ($\text{Beta} = 0.161$, $p = 0.003$).

The explained variance slightly increases to 49.22%, indicating that leadership & behavioral skills contribute positively, but to a lesser extent compared to technical competencies.

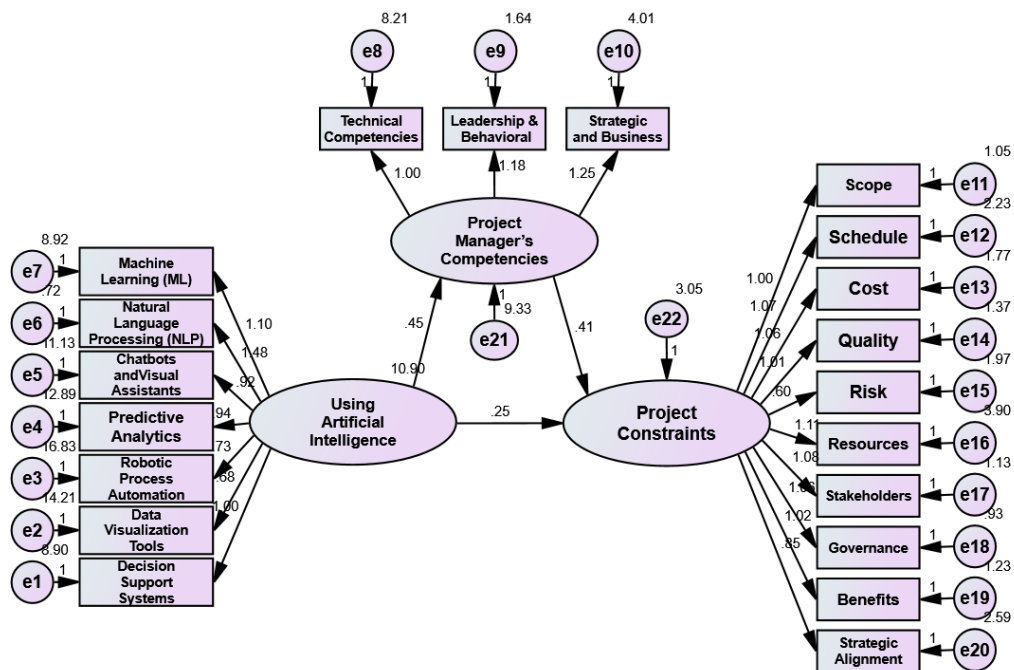
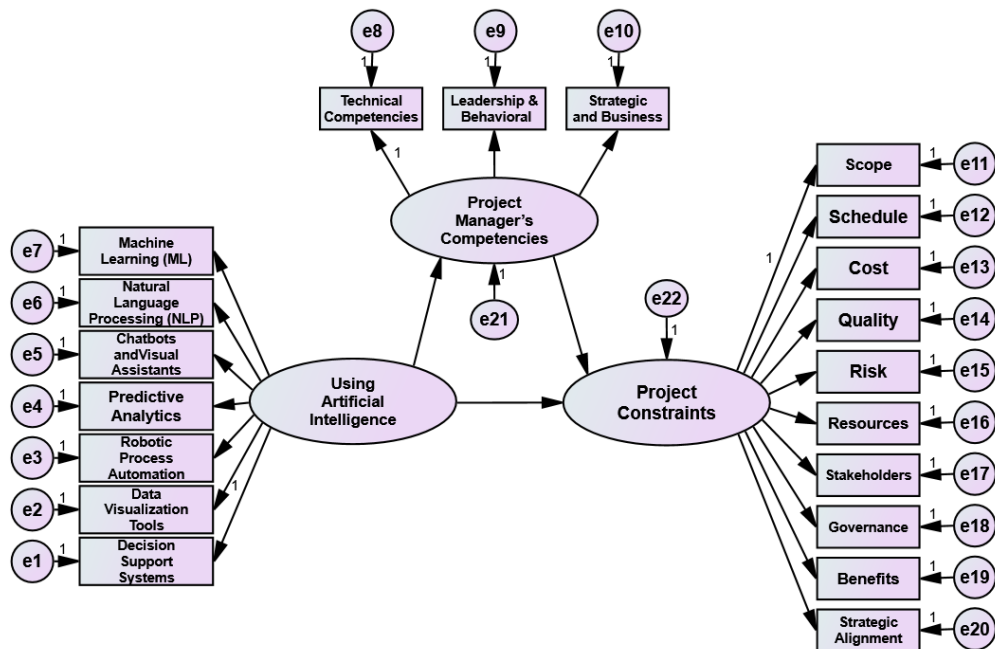
Model 3 – Adding Strategic & Business Competencies:

With the inclusion of strategic & business competencies, this dimension also shows a strong positive effect ($\text{Beta} = 0.501$, $p < 0.001$), whereas the effect of leadership & behavioral competencies becomes negative ($\text{Beta} = -0.289$, $p < 0.001$), possibly due to interaction effects or adjustment when controlling for other dimensions.

This model explains 55.39% of the variance in project constraints, suggesting that combining all three competency dimensions provides a more comprehensive prediction of project constraints.

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

Initial model values:



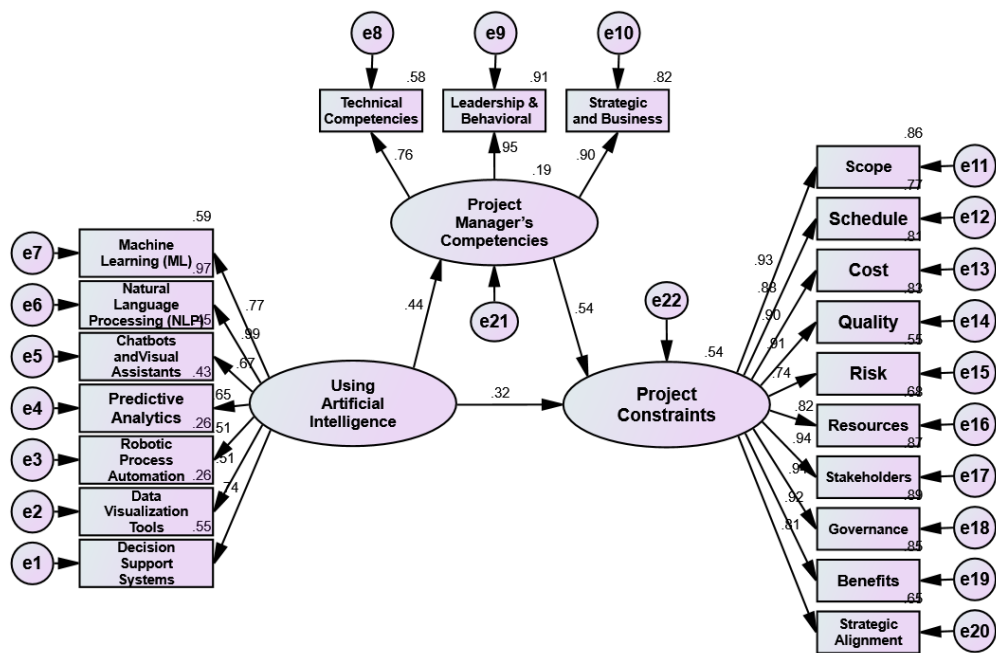


Figure (4-1): Structural Equation Model – Initial Model

Variables			Estimate	S.E.	C.R.	P
Project.Manager'sCompetencies	<---	UsingArtificial.Intelligence	.454	.056	8.049	***
Project.Constraints	<---	Project.Manager'sCompetencies	.410	.036	11.240	***
Project.Constraints	<---	UsingArtificial.Intelligence	.251	.034	7.380	***
DecisionSupportSystems	<---	UsingArtificial.Intelligence	1.000			
DataVisualizationTools	<---	UsingArtificial.Intelligence	.680	.066	10.339	***
RoboticProcessAutomation	<---	UsingArtificial.Intelligence	.731	.071	10.242	***
PredictiveAnalytics	<---	UsingArtificial.Intelligence	.940	.070	13.432	***
ChatbotsandVisualAssistants	<---	UsingArtificial.Intelligence	.917	.066	13.830	***
NaturalLanguageProcessingNLP	<---	UsingArtificial.Intelligence	1.478	.072	20.449	***
MachineLearningML	<---	UsingArtificial.Intelligence	1.095	.068	16.097	***
TechnicalCompetencies	<---	Project.Manager'sCompetencies	1.000			
LeadershipBehavioral	<---	Project.Manager'sCompetencies	1.177	.057	20.602	***
StrategicandBusiness	<---	Project.Manager'sCompetencies	1.249	.063	19.823	***
Scope	<---	Project.Constraints	1.000			
Schedule	<---	Project.Constraints	1.067	.036	29.409	***
Cost	<---	Project.Constraints	1.060	.034	31.470	***
Quality	<---	Project.Constraints	1.006	.031	32.865	***
Risk	<---	Project.Constraints	.598	.030	19.961	***
Resources	<---	Project.Constraints	1.111	.045	24.903	***
Stakeholders	<---	Project.Constraints	1.083	.030	35.919	***
Governance	<---	Project.Constraints	1.058	.028	37.140	***
Benefits	<---	Project.Constraints	1.021	.030	34.122	***
StrategicAlignment	<---	Project.Constraints	.853	.036	23.808	***
CMIN (6990.453)			NFI(0.516)			
CMIN/DF(41.859)			AGFI(0.337)			
GFI(0.473)			CFI(0.521)			
RMSEA(0.320)						

Table (4-23): Results of the Initial Structural Equation Model with Standardized Path Coefficients

The table reflects the results of the initial Structural Equation Model (SEM) with standardized path coefficients, providing a detailed view of the relationships between the use of Artificial Intelligence (AI), Project Manager's Competencies, and Project Constraints. The scientific academic commentary can be presented as follows:

The initial SEM indicates a significant positive effect of using AI on Project Manager's Competencies ($\beta = 0.454$, $p < 0.001$), suggesting that higher adoption of AI technologies contributes notably to enhancing the technical, leadership, and strategic competencies of project managers.

The model also shows a significant positive effect of Project Manager's Competencies on Project Constraints ($\beta = 0.410$, $p < 0.001$), highlighting the pivotal role of managerial capabilities in handling challenges related to project scope, schedule, cost, quality, risks, resources, stakeholders, governance, benefits, and strategic alignment.

The direct effect of using AI on Project Constraints is also positive and significant ($\beta = 0.251$, $p < 0.001$), indicating that AI has a direct impact on improving project constraint management, in addition to its indirect effect mediated through project managers' competencies, emphasizing the mediating role of competencies in the relationship between AI adoption and project constraints management.

Regarding AI components, all technologies, including Machine Learning (ML), Natural Language Processing (NLP), Chatbots and Visual Assistants, Predictive Analytics, Robotic Process Automation, Data Visualization Tools, and Decision Support Systems, show strong significant associations with the AI usage variable, reflecting wide adoption of these tools.

For Project Manager's Competencies, all dimensions (Technical, Leadership & Behavioral, and Strategic & Business) show significant path coefficients, indicating the model's consistency in representing the relationship between competencies and project management.

For Project Constraints, all core dimensions (Scope, Schedule, Cost, Quality, Risk, Resources, Stakeholders, Governance, Benefits, and Strategic Alignment) have significant path coefficients, suggesting the model comprehensively represents all aspects of project constraints.

However, model fit indices indicate that the initial model requires improvement:

CMIN/DF = 41.859 (very high),

NFI = 0.516, AGFI = 0.337, GFI = 0.473, CFI = 0.521, RMSEA = 0.320,

These values suggest relatively poor overall fit, indicating a need to refine the model, such as improving relationships between variables or introducing additional factors to enhance accuracy and statistical adequacy.

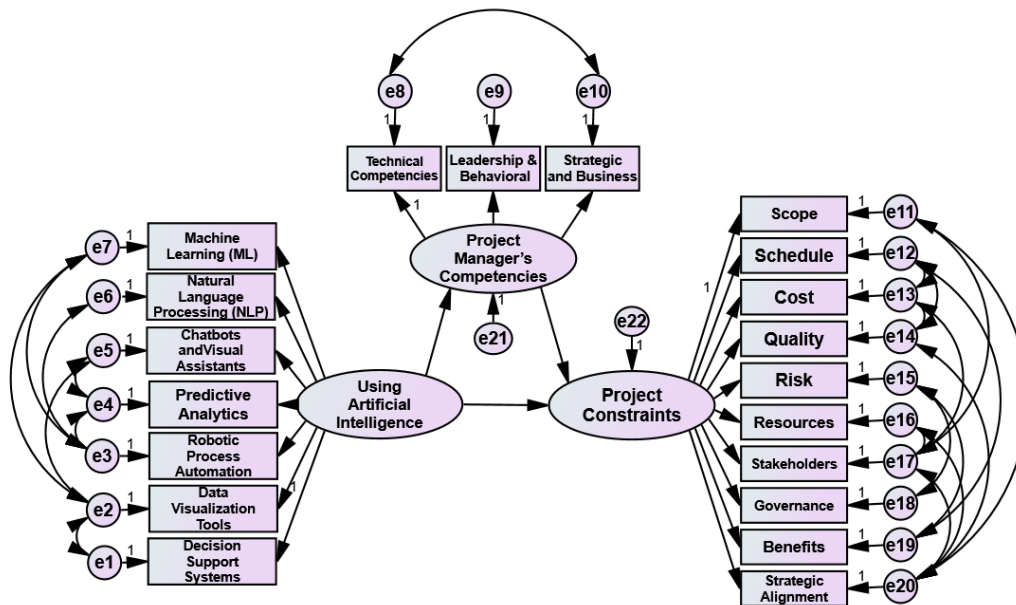
Conclusion: The model confirms the positive importance of AI adoption in enhancing Project Manager's Competencies, which in turn positively affects the management of Project Constraints, while emphasizing the necessity to improve model fit to achieve more reliable results.

Independent Variable	Dependent Variable	Effect	Effect Percentage
Using Artificial Intelligence	Project Constraints	Direct Effect	32.00%
		Indirect Effect	23.70%
		Total Effect	55.70%

Table (4-24): Percentages of Direct, Indirect, and Total Effects in the Model of the Study

Table (4-24) illustrates the percentages of direct, indirect, and total effects in the study model. It is evident that **the use of artificial intelligence** has a **direct effect of 32.00%** on **project constraints**, indicating a tangible and independent influence of AI in enhancing the management of project-related constraints. Moreover, there is an **indirect effect of 23.70%**, suggesting that part of the impact of AI is transmitted through the **mediating variable—Project Managers' Competencies**, which strengthens the influence of AI on project constraints. Consequently, the **total effect reaches 55.70%**, reflecting the overall strength of the relationship between the use of artificial intelligence and the reduction or better management of project constraints. This underscores the pivotal role of artificial intelligence as a strategic tool in modern project management.

Modified model values:



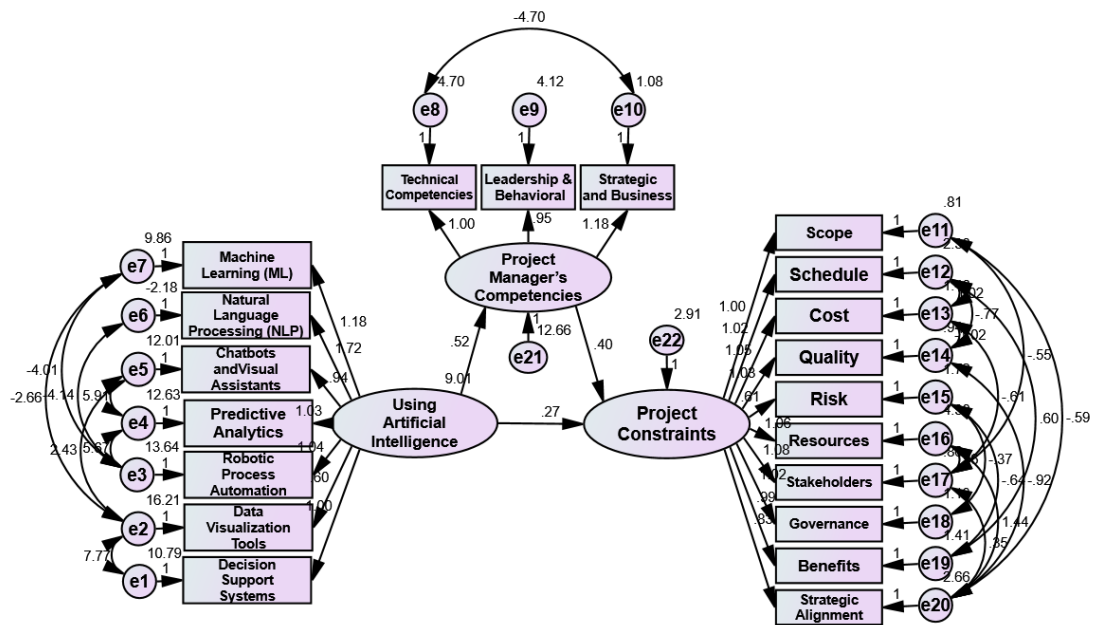
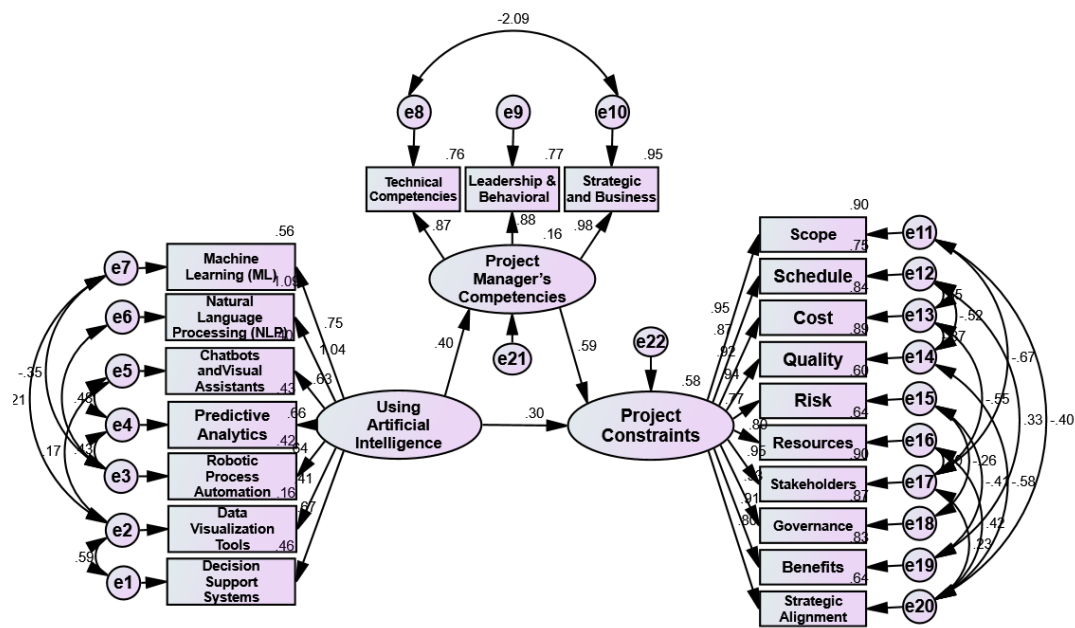


Figure (4-2): Structural Equation Model Modified model

Variables			Estimate	S.E.	C.R.	P
Project.Manager'sCompetencies	<---	UsingArtificial.Intelligence	.519	.062	8.431	***
Project.Constraints	<---	Project.Manager'sCompetencies	.399	.030	13.341	***
Project.Constraints	<---	UsingArtificial.Intelligence	.267	.031	8.500	***
DecisionSupportSystems	<---	UsingArtificial.Intelligence	1.000			
DataVisualizationTools	<---	UsingArtificial.Intelligence	.595	.051	11.669	***
RoboticProcessAutomation	<---	UsingArtificial.Intelligence	1.037	.097	10.712	***
PredictiveAnalytics	<---	UsingArtificial.Intelligence	1.029	.077	13.296	***
ChatbotsandVisualAssistants	<---	UsingArtificial.Intelligence	.943	.073	12.944	***
NaturalLanguageProcessingNLP	<---	UsingArtificial.Intelligence	1.722	.095	18.085	***
MachineLearningML	<---	UsingArtificial.Intelligence	1.182	.079	14.995	***
TechnicalCompetencies	<---	Project.Manager'sCompetencies	1.000			
LeadershipBehavioral	<---	Project.Manager'sCompetencies	.948	.046	20.712	***
StrategicandBusiness	<---	Project.Manager'sCompetencies	1.179	.062	19.081	***
Scope	<---	Project.Constraints	1.000			
Schedule	<---	Project.Constraints	1.021	.034	29.814	***
Cost	<---	Project.Constraints	1.048	.029	35.656	***
Quality	<---	Project.Constraints	1.031	.026	40.266	***
Risk	<---	Project.Constraints	.610	.027	22.719	***
Resources	<---	Project.Constraints	1.059	.044	24.148	***
Stakeholders	<---	Project.Constraints	1.081	.033	32.668	***
Governance	<---	Project.Constraints	1.025	.027	38.340	***
Benefits	<---	Project.Constraints	.994	.028	35.254	***
StrategicAlignment	<---	Project.Constraints	.828	.039	21.113	***
CMIN (5244.923)			NFI(0.637)			
CMIN/DF(35.924)			AGFI(0.408)			
GFI(0.589)			CFI(0.642)			
RMSEA(0.296)						

Table (4-25): Results of the Modified Structural Equation Model with Standardized Path Coefficients

The table presents the results of the modified Structural Equation Model (SEM) with standardized path coefficients, showing the refined relationships between Using Artificial Intelligence (AI), Project Manager's Competencies, and Project Constraints. The scientific academic commentary can be formulated as follows:

The modified SEM demonstrates that Using AI has a significant positive effect on Project Manager's Competencies ($\beta = 0.519$, $p < 0.001$), suggesting that the adoption of AI tools and technologies strongly enhances managers' technical, leadership, and strategic capabilities. This effect is slightly stronger than in the initial model, reflecting improved explanatory power after model refinement.

The path from Project Manager's Competencies to Project Constraints remains significant and positive ($\beta = 0.399$, $p < 0.001$), highlighting the critical role of managerial competencies in mitigating and managing project constraints, including scope, schedule, cost, quality, risks, resources, stakeholders, governance, benefits, and strategic alignment.

The direct effect of AI on Project Constraints is also positive and significant ($\beta = 0.267$, $p < 0.001$), which, along with the indirect effect mediated through Project Manager's Competencies, confirms that AI adoption improves project outcomes both directly and indirectly.

Individual AI components, including Machine Learning (ML), Natural Language Processing (NLP), Chatbots and Visual Assistants, Predictive Analytics, Robotic Process Automation, Data Visualization Tools, and Decision Support Systems, continue to show strong, statistically significant associations with the overall AI construct, confirming their collective importance in project management applications.

For Project Manager's Competencies, all three dimensions (Technical, Leadership & Behavioral, Strategic & Business) remain significant, confirming the robustness of the model in capturing the impact of AI on different managerial skill sets.

Similarly, Project Constraints dimensions show strong significance, confirming the model's effectiveness in representing all critical aspects of project performance limitations.

Regarding model fit indices, the modification improved the overall fit compared to the initial SEM, although it still indicates moderate fit:

CMIN/DF = 35.924 (still high),

NFI = 0.637, AGFI = 0.408, GFI = 0.589, CFI = 0.642, RMSEA = 0.296,

These indices suggest that while the model better captures the relationships among variables, further refinements—such as including additional mediators, latent variables, or adjusting paths—may be necessary to achieve a fully satisfactory fit.

Conclusion: The modified SEM confirms the positive and significant influence of AI adoption on Project Manager's Competencies, which in turn significantly enhances Project Constraints management. The model highlights both direct and indirect pathways through which AI improves project outcomes,

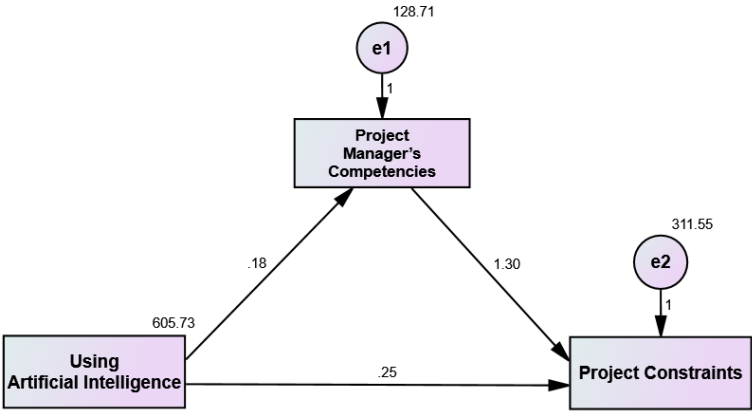
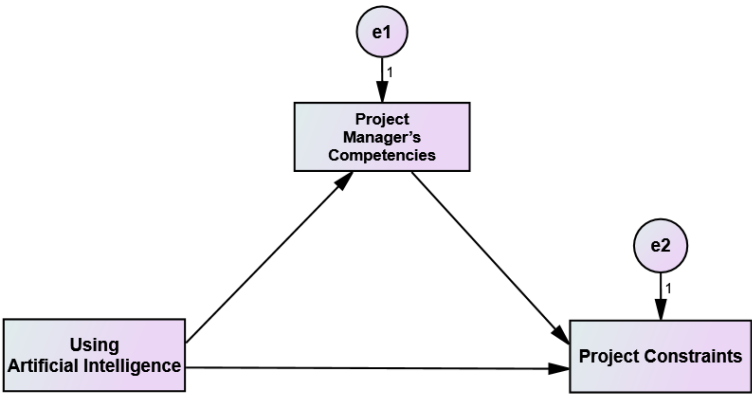
providing valuable insight for organizations seeking to integrate AI into project management practices, while also indicating room for further model optimization.

Independent Variable	Dependent Variable	Effect	Effect Percentage
Using Artificial Intelligence	Project Constraints	Direct Effect	30.40%
		Indirect Effect	23.60%
		Total Effect	54.00%

Table (4-26): Percentages of Direct, Indirect, and Total Effects in the Model of the Study

Table (4-26) presents the percentages of direct, indirect, and total effects in the study model. It is evident that **the use of artificial intelligence** has a **direct effect of 30.40%** on **project constraints**, indicating that AI significantly contributes to improving the management of project constraints through its direct influence on planning, execution, and monitoring processes. Moreover, there is an **indirect effect of 23.60%**, suggesting that part of AI’s influence operates through **Project Managers’ Competencies** as a mediating variable that enhances and reinforces this impact. Consequently, the **total effect reaches 54.00%**, reflecting the overall strength of the relationship between the use of artificial intelligence and its ability to reduce or effectively manage project constraints. This emphasizes the importance of integrating AI technologies into modern project management practices to achieve more efficient and sustainable performance.

Path Analysis Model



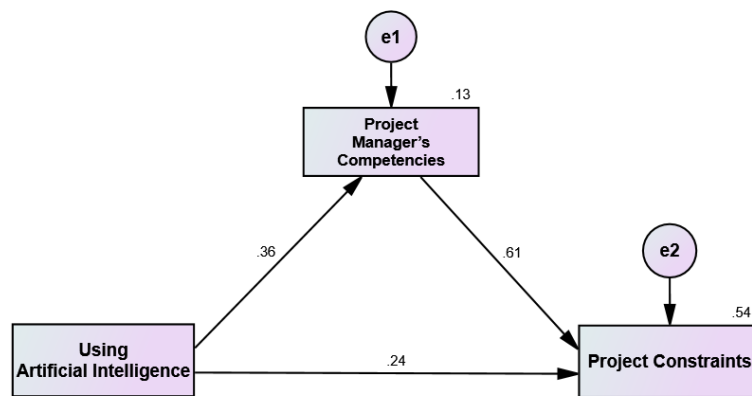


Figure (4-3): Path Analysis Model

Variables			Estimate	S.E.	C.R.	P
ProjectManagersCompetencies	<---	UsingArtificialIntelligence	.177	.023	7.681	***
ProjectConstraints	<---	ProjectManagersCompetencies	1.302	.078	16.718	***
ProjectConstraints	<---	UsingArtificialIntelligence	.253	.038	6.566	***
CMIN (0.000)			CFI(1.000)			
GFI(1.000)			RMSEA(0.547)			
NFI(1.000)						

Table (4-27): Standardized Path Estimates Showing the Effects of Using Artificial Intelligence on Project Managers' Competencies and Project Constraints

The table presents the standardized path estimates for the relationships among the use of artificial intelligence, project managers' competencies, and project constraints, showing statistically significant and positive direct effects at the $p < 0.001$ level. The results indicate that the use of artificial intelligence has a direct positive impact on project managers' competencies (Estimate = 0.177, C.R = 7.681, $p < 0.001$), suggesting that adopting AI technologies enhances managers' technical, leadership, and strategic capabilities.

The table also shows a strong effect of project managers' competencies on project constraints (Estimate = 1.302, C.R = 16.718, $p < 0.001$), indicating that higher levels of managerial competence lead to improved management of project constraints such as scope, schedule, cost, quality, risk, and resources.

In addition, the results reveal a direct effect of using artificial intelligence on project constraints (Estimate = 0.253, C.R = 6.566, $p < 0.001$), demonstrating that AI contributes directly to improving the management of these constraints, alongside its indirect influence through enhancing managers' competencies.

The model fit indices show relatively strong performance, with CFI, NFI, and GFI = 1.000, whereas RMSEA = 0.547, indicating that although the model displays excellent fit on several indices, the RMSEA value suggests some deviation from an ideal model.

Independent Variable	Dependent Variable	Effect	Effect Percentage
Using Artificial Intelligence	Project Constraints	Direct Effect	24.00%
		Indirect Effect	21.90%
		Total Effect	45.90%

Table (4-28): Percentages of Direct, Indirect, and Total Effects in the Model of the Study

The results presented in Table (4-28) indicate that **the use of artificial intelligence** has both direct and indirect significant effects on **project constraints**. The **direct effect**, which reached **24.00%**, reflects the positive and immediate impact of AI technologies on improving the management of project constraints. Additionally, the findings reveal an **indirect effect** of **21.90%** through **project managers' competencies**, emphasizing the mediating role of managerial and technical competencies in enhancing the effectiveness of AI on overall project performance. Consequently, the **total effect** amounted to **45.90%**, demonstrating the strong integrative relationship between artificial intelligence and project managers' competencies in mitigating project constraints and improving project outcomes.