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Application of artificial intelligence in project management and control

Saeed Ramazani [1]

1. Industrial Engineering, University of Architecture and Art Pars, Tehran, Iran

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ABSTRACT

Artificial Intelligence (AI) holds a significantly vital role in today's world. This technology has not only transformed the ways individuals live and work but has also instigated revolutions in numerous domains. The present research aims to examine the application of artificial intelligence in project management and control. This study is characterized as applied in terms of purpose, quantitative in nature, and falls within the category of quantitative research. Additionally, this research is of a descriptive-survey type. The instrument for data collection is a researcher-developed questionnaire, and the methods of data acquisition involve both bibliographical and field-based approaches. The statistical population of the study consists of all project managers in the city of Tehran. The sample size has been estimated at 20 participants. Data analysis was conducted utilizing SPSS22 and Smart PLS3 software. The analyses encompassed both descriptive and inferential statistics. The descriptive statistics section examined central tendency measures such as median and mean related to the research variables, while the inferential statistics section evaluated path analysis, regression coefficients, t-statistics, and model fit indices. The normality of the data was assessed using the Kolmogorov-Smirnov test, with results indicating that the data were not normally distributed. Consequently, one of the reasons for employing PLS software stems from this issue. The hypotheses of the research, based on the obtained t-statistics, revealed that all hypotheses were confirmed, ultimately establishing that artificial intelligence plays a significant role in project management and control.

Introduction

In an era of rapid technological development, the integration of Artificial Intelligence (AI) across various industries is considered a significant driver. Utilizing the potential of AI, project management—a vital discipline overseeing project execution—has undergone substantial transformations. AI is recognized as one of the most advanced and important fields of technology in today's world. This computational science relies on developing computer systems and software that possess human-like reasoning and decision-making capabilities. AI can perform diverse tasks through the combination of software engineering, machine learning, natural language processing, and many similar techniques. One of the notable features of AI is its ability to analyze large and complex datasets and extract patterns from them. With machine learning technology, AI gradually enhances experience and improves efficiency (Rasch and Karkoski, 2021). Thus, modern AI systems are unique in their capacity for self-learning, enabling them to recognize patterns and make more informed predictions. As the advancement of AI technologies continues, new applications emerge that facilitate the integration of AI with other sectors of technology, such as robotics and the Internet of Things (IoT), thereby enriching and making AI-based systems more comprehensive and interactive (Brent et al., 2021). The modern project management ecosystem focuses on the continuous tracking of better performance metrics, the ongoing evolution of tasks, and the need for faster decision-making. In this dynamic environment, AI holds a promising future. Due to its unique capabilities in automating repetitive tasks, analyzing large datasets, and various other functions, AI represents a genuine opportunity for transforming contemporary project management. The combination of AI and project management is recognized as an innovative and powerful approach in the realm of project management and execution, significantly enhancing project performance and efficiency (Hefner et al., 2021). With the overwhelming and continuous advancement of technology, the business landscape is undergoing various transformations. Every day, new processes and technologies emerge that can yield different advantages and disadvantages for businesses (Parifi, 2022). One of these technologies is Artificial Intelligence. According to conducted studies, the application of AI in business has expanded considerably. Consequently, implementing AI has become essential for businesses seeking to survive in the future (Ettahadi et al., 1393).

One of the areas in which artificial intelligence is utilized is project management. A project, defined as a specific process or undertaking, is designed, planned, and executed to achieve a clearly defined objective. This process often has a specified timeline and is carried out using identified resources, including financial, human, and technical resources. Project objectives can be highly diverse, encompassing the development of new products and services, the enhancement of business processes, the implementation of a managerial change, or the development of technical infrastructures. Generally, projects can be applied in any industry and organization, facilitating increased efficiency, cost reduction, and the achievement of strategic objectives (Ghanbari et al., 2022).

The significance of employing artificial intelligence in project management derives from the technology's capability to enhance various aspects of this domain. Artificial intelligence can also assist project managers in making better decisions by providing valuable insights and automating certain tasks. For instance, the AI-driven self-regulation can occur based on parameters selected by the project manager and the project team at the outset of the project (Out et al., 2021). This program can inform the project manager of any changes that require their attention as well as potential risks, prioritize the decisions they need to make, and propose potential solutions for each.

Gartner's research indicates that there will soon be changes in the role of artificial intelligence in decision-making processes within project management. Gartner predicts that by the year 2030, 80% of the tasks currently associated with project management will be executed by artificial intelligence

capabilities harnessed through machine learning and natural language processing (Out et al., 2021). Furthermore, artificial intelligence can assist in more effectively allocating resources by processing complex project data and discovering patterns that may impact project delivery. Such systems can be beneficial in developing accurate schedules and comprehensive risk charts, predicting outcomes, optimizing resource allocation, and enhancing communication for project managers. In light of the aforementioned points, this research will examine the application of artificial intelligence in the management and control of projects.

Theoretical Foundations and Literature Review

Concepts and History of Artificial Intelligence

Artificial Intelligence (AI), refers to technology that possesses the capability to think. Nevertheless, this capability of thinking differs significantly from what is recognized as human thought; nonetheless, it aims to imitate it. While AI may not exist today in the form many envision, numerous activities we engage in daily, such as internet searches or browsing through social media platforms, are influenced by AI, and in fact, we utilize it in these instances (Helm et al., 2020). The usage is so subtle and habitual that we do not perceive it as an engagement with AI at that moment. The primary reason for this is our lack of understanding regarding what AI truly is and the functions it performs. Given that the future belongs to AI, it is prudent to focus on learning the possibilities it offers instead of harboring concerns, thereby enriching our knowledge in this domain. Therefore, let us commence by exploring the definition of artificial intelligence (Nikitasa et al., 2020) .

Definition of Artificial Intelligence

There is yet to be a definitive definition of artificial intelligence that all scholars can unanimously agree upon; however, most definitions can be categorized as follows :

- Thinks like a human
- Thinks logically
- Acts like a human
- Acts logically

The first two definitions pertain to the processes of thought and reasoning, whereas the latter two relate to behavior .

A Simple Definition of Artificial Intelligence

Artificial intelligence, or AI, is a branch of computer science aimed at creating intelligent machines capable of performing tasks that typically require human intelligence. Essentially, AI represents a simulation of human intelligence within computers, signifying a machine that is programmed to think like a human and replicate human behavior. This definition can be applied to any machine that functions similarly to the human mind and is capable of problem-solving and learning (Arita et al., 2020) .

Objectives of Artificial Intelligence

The foundation of AI lies in the aim to define human intelligence and its operational methods in such a manner that a machine can execute these processes smoothly and accurately perform assigned tasks. The objectives of artificial intelligence are fundamentally based on three pillars :

- Learning
- Reasoning
- Understanding; AI is a widespread branch of computer science focused on developing intelligent machines with the capacity to undertake tasks that usually require human intelligence. AI is an interdisciplinary science with multiple approaches; however, advancements in machine learning and deep learning have resulted in a paradigm shift across nearly every sector of the technology industry (Sager et al., 2023) .

History of Artificial Intelligence

The history of artificial intelligence traces back to the years of World War II, when German forces employed the Enigma machine for encoding and securely transmitting messages, while British scientist Alan Turing endeavored to break these codes. Together with his team, Turing developed

the Bombe machine, which decrypted the Enigma codes. Both the Enigma and Bombe machines serve as foundational elements of machine learning, a subset of artificial intelligence. Turing regarded a machine as intelligent if it could interact with a human without giving the latter the sensation of conversing with a machine; this premise forms the basis of artificial intelligence, i.e., creating a machine that thinks, makes decisions, and acts like a human (Kall et al., 2020) .

As technology and other necessary hardware for developing AI advanced, intelligent tools and services entered the market that utilized AI in numerous processes. Many well-known services such as search engines, satellites, etc., incorporated AI. With the advent of smartphones and subsequently smart gadgets, AI took significant strides in integrating into human lives. From that point forward, AI became more practically applicable for humans, and individuals became increasingly familiar with the term "artificial intelligence" and its applications (Fukuzawa et al., 2023) .

Concepts and Importance of Project Management

Project management is a set of principles for initiating, planning, executing, controlling, and closing the work of a team to achieve specific objectives and meet defined success criteria .

•A project is temporary, having a distinct beginning and end. Therefore, it has a defined scope and resources .

•A project is unique and thus is not an ordinary or routine task. Rather, it is a set of operations designed to achieve a single objective. Consequently, a project team typically consists of individuals who do not usually work together, sometimes coming from various organizations and even different geographical locations. Software development for a business process, the construction of a building or bridge, relief efforts after natural disasters, and selling a product in a new market are all projects that must be executed with skill to deliver results on time and within budget constraints. Therefore, project management involves the application of knowledge, skills, tools, and techniques to carry out project activities in a manner that meets project requirements .

Project Life Cycle

The project life cycle refers to the stages of project development. This cycle is significant as it illustrates how a project is conducted. In this cycle, there are five distinct phases of project progress: initiation, planning, execution, monitoring, and closure .

(1Initiation Phase in Project Management :

This phase involves developing the initial objectives and technical specifications of the project. The scope of work is defined, necessary resources are identified, and key participants within the organization or stakeholders are identified in this process .

(2Planning Phase in Project Management :

This is the stage where all details, timelines, and other plans are prepared. Work packages are broken down, individual assignments are created, and processes are defined .

(3Execution Phase in Project Management :

This is when the actual work of the project is conducted: the system is developed, or products are created and constructed, and other project-based activities are performed .

(4Monitoring and Control in Project Management :

Within the project management process, the third and fourth phases are not sequential. The project monitoring and control phase is executed concurrently with project execution to ensure that the project’s objectives and deliverables are met .

(5Closure Phase in Project Management :

This occurs when the completed project is delivered to the client, and the project is formally concluded .

Definition of Project Success

Defining a successful project can be challenging. How can one determine if a project is successful ?

•Is it successful when it is profitable ?

- Is it successful when it is completed within budget ?
- Is it successful when it is completed on time ?
- Or is it successful when the technology we developed works ?

Interestingly, project managers continue to face significant challenges in identifying acceptable and comprehensive definitions of success. Most of us naturally refer to the classic definition of project objectives, which includes time, budget, and performance .

Methods and Techniques of Project Control

In the fast-paced and intricate world of project management, the critical key to success is the art of project control. From seasoned professionals to novices, everyone requires a profound understanding of this art to ensure that projects are executed promptly and with quality. Project control refers to the collection of information, its management, and the subsequent analysis of the gathered data; this ensures quality is maintained, time and costs are controlled, and planning is executed correctly to achieve the final objective. The principles of project control encompass project initiation, planning, monitoring and controlling, communication establishment, cost estimation, and ultimately, the preparation of a project schedule. Control is utilized to identify potential problems before they arise during project execution. Project control is a process that is periodically revisited throughout the project to examine its status, forecast potential outcomes, and enhance its performance. This process assists the project manager in identifying and resolving issues before they escalate. In the control process, it is imperative for the project manager to be informed of existing deviations using various measurement tools so that corrective measures can be implemented to realign the project with its original trajectory (Ballard & Tomlin, 2021).

Essential Stages of Project Control

Broadly, control can be divided into three fundamental sections.

These three sections include Prevention, Detection, and Action, or abbreviated as PDA.

In this section, we intend to examine the stages of project control more rigorously and with examples:

Prevention

We have all heard the adage that prevention is better than cure. Just as we must be vigilant about our physical health to avoid becoming ill, the same principle applies to project control. To achieve the final outcome, deviations must be prevented. Key activities such as meticulous planning, effective communication, continuous monitoring of risk factors, and resolving potential issues can contribute to sustaining the project's health. At this stage, efforts are made to prevent problems by identifying previous project challenges, utilizing past experiences, and applying standards and best practices. This may include providing training to the team, employing industry best practices, and establishing effective processes and policies.

Detection

Detection functions like an early warning system. During control, deviations (variances) must be identified promptly. The sooner variances can be detected and actions implemented against them, the greater the likelihood of returning the project to its original path and achieving success. The key to early detection lies in the use of project control tools and software. Leveraging metrics, progress reports, feedback sessions, and monitoring tools facilitates the identification of issues at their initial appearance. This may encompass suitable monitoring and reporting systems, ongoing reporting, and thorough information analysis.

Action

Following detection, the critically important stage of action commences. This involves implementing corrective decisions to address the problems. Actions may include modifications to the schedule, adjustments to processes, adding resources, or even reassigning the project team. The aim of this stage is to prevent issues from escalating, enhance the project, and ensure its continued success.

In summary, these three interrelated stages play a vital role in the project control process to ensure that the project progresses toward its anticipated objectives, with issues minimized to the greatest extent possible.

Internal Background

1- Keshavarz and Abedin Pour (1403) examined the application of artificial intelligence in business management in their research. The results of this study reveal that artificial intelligence has the potential to create significant advancements, including increased productivity, cost savings, and enhanced decision-making. However, the adoption of artificial intelligence comes with several challenges, including data privacy concerns, security issues, ethical considerations, and potential job displacement. With the development of information technology, the associated doubts regarding artificial intelligence are diminishing, and its application is on the rise. Artificial intelligence has demonstrated a specific application in managing complex systems and assisting individuals across various processes. The implementation of artificial intelligence systems across different sectors of an organization is integral to improving the performance of business processes and enhancing satisfaction with the services or products provided by organizations.

2- Rezaiyan et al. (1402) investigated the application of artificial intelligence in construction projects in their study. This paper endeavors to define artificial intelligence and machine learning while elucidating the various functions of this technology, applicable algorithms, and introducing useful and innovative software in civil engineering, with artificial intelligence playing a pivotal role. Additionally, fundamental parameters influencing the study of progressive failure, such as critical path identification and extraordinary load patterns, have been examined. Given the functions outlined in this research, the importance of employing artificial intelligence in theoretical studies and future practical projects is evidently significant, particularly for large-scale projects such as spatial structures and buildings with specific seismic load-bearing systems, such as alternating trusses and structures requiring high deformability, necessitating special analysis, design, and monitoring.

3- Pour Mibdi and colleagues (1402) explored the application of artificial intelligence in architectural projects and related tools in their research. The present study adopts a descriptive-analytical method. Generally, artificial intelligence possesses the potential to provide powerful tools for designers to generate innovative designs, advanced algorithms, data analysis, and informed decision-making, thereby enhancing efficiency, accuracy, and sustainability in landscape planning and management. This paradigm shift could revolutionize the realm of design, planning, management, and landscape maintenance, empowering landscape architects to create innovative and environmentally conscious designs.

4- Rouhani and Mohammad Abadi (1401) investigated the application of artificial intelligence in oil and gas supply chain projects in their research. The analytical results demonstrated the necessity of implementing artificial intelligence in the oil and gas industry. Furthermore, various recommendations were provided for technology managers, policymakers, specialists, and leaders in the oil and gas sector to ensure the successful implementation of artificial intelligence. Ultimately, based on the analysis and examination, suggestions and potential directions for the application of artificial intelligence in the development of oil processes were presented.

5- Poladi and colleagues (1401) examined the application of artificial intelligence in laboratory projects within their research. The advantages of utilizing artificial intelligence in relation to COVID-19 have been discussed in areas such as rapid identification and treatment, facilitating swift diagnosis, monitoring treatment stages, epidemiology, tracking contaminated regions, forecasting pandemic status, management of pharmaceutical systems, reducing the workload of healthcare personnel, anticipating and monitoring the spread of COVID-19, tracking infected individuals, and individualized vaccine planning and design. Additionally, a high potential for the application of artificial intelligence in clinical and research laboratories has been estimated. Another promising aspect of artificial intelligence pertains to predicting mutations that may occur in viruses in the future, which could lead to new symptoms and complications of diseases.

Foreign Background

1. Shushtari et al. (2024) examined the applications of artificial intelligence in project management in their research. The existing literature on the techniques of artificial intelligence employed for

resource allocation, risk prediction, scheduling, cost estimation, and communication was reviewed. Subsequently, the methodology for implementing artificial intelligence in project management, including data collection, model selection, and training, was addressed. The challenges and potential limitations were then discussed, followed by numerical results indicating the effectiveness of artificial intelligence in improving project outcomes. Finally, the paper concludes by outlining future pathways for artificial intelligence in project management and its potential impact in this domain.

2. Taboda et al. (2023) focused on the activation of project management through artificial intelligence in their research. The results indicate that the number of influential publications in the field of artificial intelligence-based project management has significantly increased over the past decade. The findings suggest that artificial intelligence, primarily machine learning, can be notably beneficial in managing construction and information technology projects. This is particularly encouraging for enhancing planning, measuring, and managing uncertainties by providing promising predictive and decision-making capabilities.

3. Shafie Abadi et al. (2023) explored the use of artificial intelligence for predicting organizational agility in their research. Data for this study were collected from 44 respondents in the public and private industrial sectors of Australia. The findings of this research, along with previous studies, identify the practices and characteristics that contribute to organizational agility for success. This paper contributes to the ongoing discourse of these principles, practices, characteristics, and features that assist organizations with limited resources in overcoming certain barriers to building a framework and culture of **agility for** strategizing in a changing world.

4. Bento et al. (2022) conducted a systematic literature review to examine artificial intelligence in project management. The objective of this paper was to recognize the potentials and limitations of artificial intelligence in the specific domain of project management through a systematic review of the literature. This approach enabled the analysis and correlation of selected articles, leading to the identification of certain patterns and trends. In conclusion, an increasing interest within the academic community in this field was observed, although areas for further exploration remain.

5. Al-Khateeb (2021) investigated the impacts of artificial intelligence on decision-making in project management. The aim of this article was to examine the influence of artificial intelligence on decision-making in project management. After conducting secondary research that involved reviewing numerous academic articles and gathering information from various regions, as well as preliminary research including interviews with 13 IT managers and project managers, it was concluded that the application of artificial intelligence enhances data quality and integrity, leading to improved speed and effectiveness in decision-making within both single and multiple project environments.

Methodology

This research is applied in terms of purpose, quantitative from the methodological standpoint, and cross-sectional concerning time. The study falls under the category of survey research, as evidenced by the type of data collection instrument employed, which is a questionnaire. Survey research entails the administration of questionnaires to a sample of respondents selected from a population, comprising a systematic and standardized method for collecting information about individuals, families, or larger groups. The results obtained from the questionnaires were initially expressed in verbal terms, subsequently converted into numerical data, and ultimately imported into software for analysis. The choice of this method is attributed to the manner of analysis, categorizing it within the scope of quantitative research. Generally, in natural and social sciences, quantitative research represents systematic empirical investigations of observable phenomena conducted through statistical, mathematical methods, or related theories and hypotheses. The statistical population for the study comprises all project-oriented companies and organizations in Tehran province. The

sample size will consist of 20 project managers from project-oriented companies and organizations in Tehran province. The sampling method employed was stratified random sampling. The data collection tool in the field section was a researcher-designed standard questionnaire. The researcher-developed questionnaire serves as a tool for collecting and measuring the perspectives of the statistical sample regarding the studied phenomenon, crafted by the researcher themselves. Given that standardized questionnaires were utilized in the present research, both the validity and reliability of the data collection instrument have been confirmed. However, to ensure the aforementioned aspects, the content validity underwent a review based on both convergent and divergent validity. The results of this review are observable below.

Divergent validity

To examine the correlation, the Fornell-Larcker method and the correlation matrix have been utilized. This matrix quantifies the relationship between a construct and its indicators in comparison to the relationship of that construct with other constructs.

Table 1. Examination of Divergent Validity

Effective Planning Enhancement	Increase in Risk Forecasting	Increase in Screening	Enhancement of quality	Project Management	
				0.762	Project Management
			0.759	0.743	Enhancement of Quality
		0.829	0.740	0.721	Increase in Screening
	0.745	0.681	0.688	0.670	Augmentation of Risk Forecasting
0.767	0.758	0.735	0.703	0.692	Improvement of Efficient Planning

As indicated in the above table, the values of the main diagonal of the matrix exceed the correlation values among them, which are arranged in the lower and left cells of the main diagonal. In this regard, one can assert that in the present research, the variables under investigation exhibit a higher level of interaction with each other; in other words, the measurement model demonstrates correlation.

Convergent Validity

The second criterion for assessing the model is convergent validity, which examines the correlation of each variable with its corresponding questions. The Average Variance Extracted (AVE) indicates the level of correlation of a variable with its own questions. The greater this correlation, the better the fit. According to the table below, the confirmed values should be equal to or greater than 0.5, and the convergent validity of the research variables is also confirmed.

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Table 2. Examination of Convergent Validity

AVE	Research Variables
0.782	Project Management
0.734	Quality Improvement

0.806	Increased Screening
0.811	Enhanced Risk Forecasting
0.793	Improved Efficient Planning

Reliability

In the present study, reliability has been assessed based on Cronbach's alpha using SPSS software. Generally, there is consensus among statisticians that Cronbach's alpha should be above 0.7.
In the table below, the values of alpha and their corresponding verbal criteria are presented.

Table 3. Cronbach's Alpha Coefficient

Significance Level	Kolmogorov-Smirnov	Variable
0.05	0.041	Artificial Intelligence
0.05	0.043	Cost Savings
0.05	0.023	Time Savings
0.05	0.046	Quality Improvement
0.05	0.036	Increased Screening
0.05	0.029	Enhanced Risk Prediction
0.05	0.032	Improved Efficient Planning

Data Analysis

To examine and analyze the information, two distinct sections will be employed. The first section pertains to the demographic and descriptive information of the statistical sample, while the second section encompasses inferential statistics, which are related to the main research. In fact, this section utilizes SPSS software to investigate the stated issues. Initially, the demographic details of the sample individuals, including age, gender, etc., were determined. Subsequently, descriptive statistics related to the research variables were addressed, followed by an examination of inferential statistics.

For the above analysis, PLS and SPSS 22 software were utilized. To this end, the data and information, categorized by dependent and independent variables in SPSS, were entered into the PLS software environment, and a model was designed in this software according to the items of each variable.

Analysis of Descriptive Statistics and Demographic Information of Sample Individuals

Age analysis was conducted using SPSS software.

Table 4. Age

Age		
Percentage	Frequency	Age Range
0.15	3	Under 30 years
0.3	6	Between 31 and 40 years
0.35	7	Between 41 and 50 years
0.2	4	Over 51 years
100.00%	20	Total

Examination of the Gender of Sample Individuals

Table 5. Gender

Gender		
Range	Frequency	Percentage
Male	17	0.85
Female	3	0.15
Total Count	20	100.00%

The results presented in the table above indicate that the number of men in the statistical sample is 17, while the number of women in this sample is 3.

Examination of the educational level of the individuals in the sample.

Table 6. Education

Education		
Undergraduate and below	Frequency	Percentage
Postgraduate	5	0.25
Doctorate	11	0.55
Total	4	0.20
Undergraduate and below	20	100.00%

The results presented in the above table indicate the validity of all data related to the educational background of the sampled individuals.

The aforementioned table pertains to the educational levels of the sampled individuals, and these figures demonstrate that the highest number of participants fall within the master's degree category, while the least number of participants are those with doctoral level education.

Information regarding the organizational levels of the sampled individuals.

Table 7. Organizational Hierarchy

Range	Frequency	Percentage
Senior Manager	9	0.45
Middle Manager	7	0.35
Supervisor	4	0.20
Total Sum	20	100.00%

The above table indicates the confirmation of the validity of all data pertaining to the organizational category of the sampled individuals, representing a total of 20 samples.

The initial output of the model, along with the factor loadings and path coefficients.

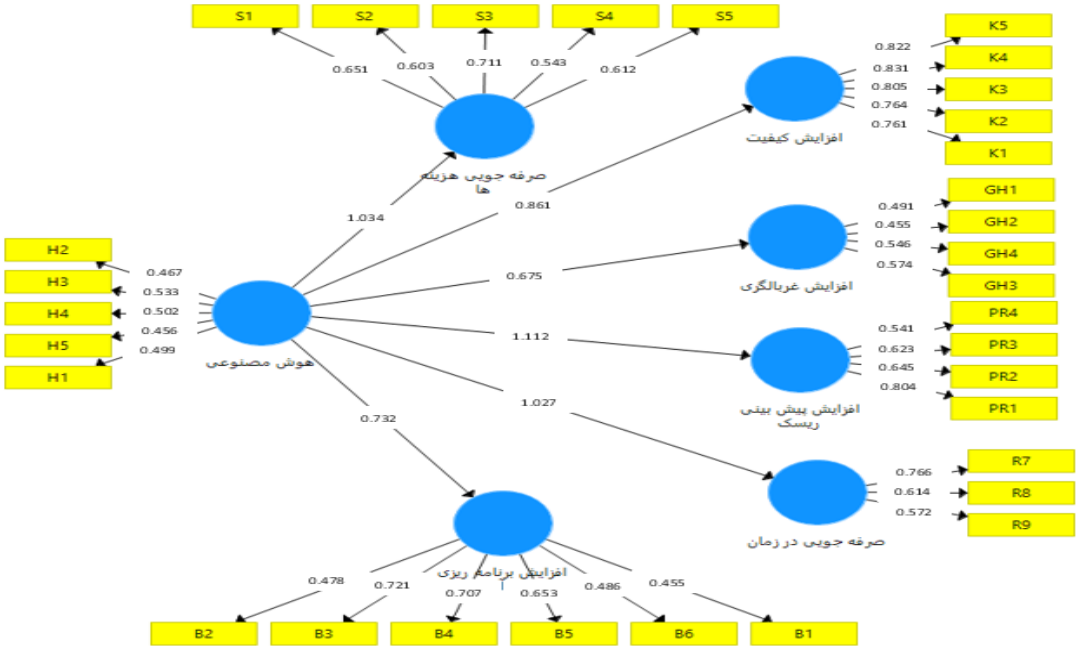

Figure 1. Path Analysis

In the aforementioned model, the numbers indicated on the arrows correspond to the regression coefficients. These coefficients illustrate the extent of the impact of the respective variable on another variable. According to the relationships and resulting figures, artificial intelligence demonstrates the greatest influence on the enhancement of risk prediction. Subsequently, this variable exhibits the most substantial effect on cost savings, and ultimately on time savings.

In the above images, the factor loadings have been specified. These factor loadings serve to determine whether the item in question has effectively assessed the variable under consideration. This is identified by the magnitude of the factor loading, which must exceed 0.4. In the factor loadings of all five variables examined, the magnitude of their factor loadings was greater than 0.4. Consequently, all items are validated, and none will be excluded from the study's process.

Second Output of the Model

For the structural model fitting of the research, the first criterion for assessing the significance of the coefficients (t-value) is fundamental; it serves as a measure of the relationship between constructs within the model. If the value of these numbers exceeds 1.96, it signifies the validity of the relationship between the constructs, ultimately confirming the research hypotheses at a 95% confidence level. However, it is important to note that this criterion determines the accuracy of the relationships but does not measure the intensity of the relationships between the constructs. The results for the primary hypotheses of the research are presented in the following

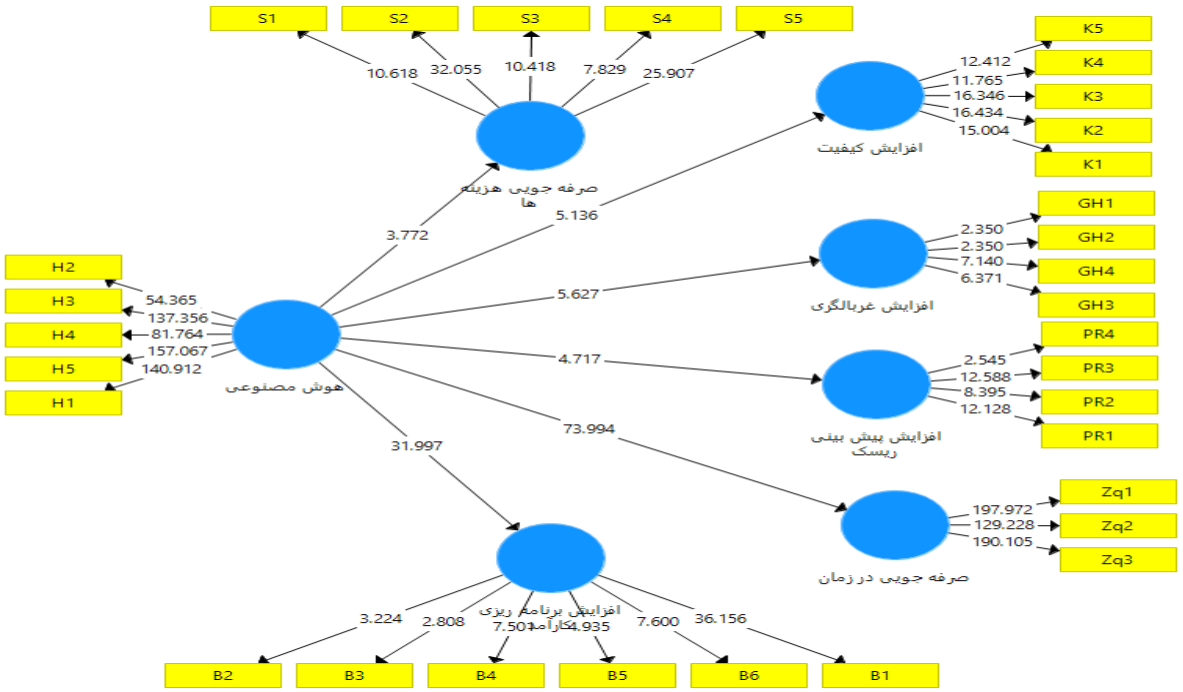

Figure 4-3 T-statistic

As observed in the above figure, the t-statistics for the relationship between artificial intelligence and increased efficient planning is 31.997, for artificial intelligence and time savings is 73.994, for artificial intelligence and improved risk prediction is 4.717, for artificial intelligence and enhanced screening is 5.627, for artificial intelligence and increased quality is 5.136, and for the relationship between artificial intelligence and cost savings is 3.772. All these values exceed 1.96, thus affirming the validity of these relationships and confirming the associated hypotheses.

Examination of Model Fit Indices

In structural equation modeling analysis, it is essential to consider construct validity in confirmatory factor analysis. This is because confirmatory factor analysis determines whether the selected items for measuring the research variables possess the necessary accuracy. The results of these analyses are presented in the following tables.

Table 8. Examination of Factor Loadings and t-Statistic

t-statistic	Baramali	speech	variable
140.912	0.499	Hq1	Artificial Intelligence
54.365	0.467	Hq2	
137.356	0.533	Hq3	
81.760	0.502	Hq4	
157.067	0.486	Hq5	
15.004	0.761	Kq1	Enhancement of Quality
16.434	0.764	Kq2	
16.346	0.805	Kq3	
11.765	0.831	Kq4	
12.412	0.822	Kq5	
10.618	0.651	Sq1	cost-saving
32.055	0.603	Sq2	
10.418	0.711	Sq3	
7.829	0.543	Sq4	
25.907	0.612	Sq5	

2.350	0.491	Ghq1	Increase in Screening
2.350	0.455	Ghq2	
6.371	0.574	Ghq3	
7.140	0.546	Ghq4	
12.128	0.804	Prq1	Increase in Risk Prediction
8.395	0.645	Prq2	
12.588	0.623	Prq3	
2.545	0.541	Prq4	
36.156	0.455	Bq1	Effective Planning Enhancement
3.224	0.478	Bq2	
2.808	0.721	Bq3	
7.503	0.707	Bq4	
4.935	0.653	Bq5	
7.600	0.486	Bq6	
197.970	0.766	Zq1	Time management
129.220	0.614	Zq2	
190.	0.572	Zq3	

Factor loadings are estimated by calculating the correlation coefficients between the indicators of a construct and the construct itself. If this value is equal to or greater than 0.4, it indicates that the measurement model possesses an acceptable level of reliability. As illustrated in the above figure, all factor loadings, which represent the relationships between latent and manifest variables, exceed 0.4, indicating a suitable and desirable correlation between the items and constructs of the model. Consequently, all items exhibit factor loadings above 0.4 and t-statistics greater than 1.96.

R-Squared Criterion

This criterion is utilized to assess both the measurement and structural sections of structural equation modeling, indicating the impact of exogenous variables on endogenous variables. Positive values of this index signify suitable and acceptable quality for the model. The table below presents the values corresponding to the variables.

Table 9. Examination of the R Square Criterion

time efficiency	Effective Planning Enhancement	Increase in Risk Prediction	increased screening	enhancement of quality	Cost savings	component
0.825	0.804	0.882	0.634	0.812	0.861	Criterion R S
strong	strong	strong	Average	strong	strong	intensity

The above values indicate a strong fit of the model.

Analysis $\boldsymbol{Q^2}$

Another criterion that has been introduced for examining the structural model is Q^2 its predictive validity. This criterion reflects the model's ability to predict the dependent (endogenous) variables.

Models that possess an acceptable fit for the structural component must have the capability to forecast the indicators associated with the endogenous constructs of the model. This implies that if the relationships between the constructs are accurately defined within the model, the constructs can influence each other, thereby allowing for the correct validation of hypotheses. Regarding the intensity of the model's predictive power concerning the endogenous constructs, three values have been established: 0.02, 0.15, and 0.35, which respectively denote small, medium, and large predictive power concerning the indicators of those constructs. The results of the criterion analysisQ^2 are presented in the table below.

Table 10: Examination of the Q2 Index

Q^2	Variables
0.631	Cost savings
0.632	Time savings
0.612	Quality enhancement
0.578	Increased screening
0.641	Enhanced risk forecasting
0.537	Improved efficient planning

Path coefficients and t-statistic of the research hypotheses

Table 11 Path Coefficients and P Values

	Original Sample (O)	**Sample Mean (M)**	**Standard Deviation (STDEV)**	**T Statistics (|O/STDEV|)**	**P Values**
Artificial Intelligence -> Enhanced Efficient Planning	0.690	0.695	0.023	31.997	**0.000**
Artificial Intelligence -> Improved Screening	0.242	0.256	0.045	5.627	**0.000**
Artificial Intelligence -> Increased Risk Prediction	0.225	0.237	0.048	4.717	**0.000**
Artificial Intelligence -> Improved Quality	0.232	0.242	0.046	5.136	**0.000**
Artificial Intelligence -> Cost Savings	-0.147	-0.157	0.049	3.772	**0.003**
Artificial Intelligence -> Time Savings	0.285	0.293	0.042	73.994	**0.000**

The t-statistic value for all paths indicated in the above table is greater than 1.96, which signifies the statistical significance of these paths. The t-statistic value for all relationships among the examined variables exceeds 1.96; consequently, based on the p-values obtained, all hypotheses of the research are confirmed.

Examination of Research Hypotheses

In this study, artificial intelligence is regarded as the independent variable, while cost savings, quality enhancement, increased screening, improved risk forecasting, and enhanced efficient planning serve as the dependent variables. Below is the output presented by the software.

Investigation of the Main Hypothesis :

Artificial intelligence has applications in project management and control .

Considering the confirmation of all subsidiary hypotheses, which constitute the variables under investigation in project management and control as part of the main hypothesis, this hypothesis is validated, and it can be asserted that artificial intelligence possesses applications in project management and control.

Examination of the Subsidiary Hypotheses :

•Artificial intelligence leads to cost savings in project management and control. Given the t-statistic value of 3.772 obtained, this hypothesis is confirmed, as the t-statistic value exceeds 1.96 .

•Artificial intelligence leads to time savings in project management and control. Given the t-statistic value of 73.994 obtained, this hypothesis is confirmed, as the t-statistic value exceeds 1.96 .

•Artificial intelligence leads to improvements and enhancements in quality in project management and control. Given the t-statistic value of 5.136 obtained, this hypothesis is confirmed, as the t-statistic value exceeds 1.96 .

•Artificial intelligence leads to improvements and enhancements in the accuracy of screening in project management and control. Given the t-statistic value of 5.627 obtained, this hypothesis is confirmed, as the t-statistic value exceeds 1.96 .

•Artificial intelligence leads to improvements and enhancements in risk forecasting in project management and control. Given the t-statistic value of 4.717 obtained, this hypothesis is confirmed, as the t-statistic value exceeds 1.96 .

•Artificial intelligence leads to improvements and enhancements in efficient planning in project management and control. Given the t-statistic value of 31.997 obtained, this hypothesis is confirmed, as the t-statistic value exceeds 1.96

- Summary of Research Hypotheses
- Conclusions and Recommendations
- In the fast-paced world of project development, maintaining responsibilities, planning, and budgets can pose a genuine challenge. Project management becomes increasingly complex with each iteration. Today, we require project management tools that are more dynamic and agile. Fortunately, the integration of artificial intelligence with project management is fundamentally transforming the field. This empowers project managers to streamline operations, make informed decisions, and achieve success. Unfortunately, statistics indicate that only 35% of projects are delivered successfully today. One of the reasons for this disheartening ratio is the low maturity level of existing technologies in project management. However, this issue will soon change. Researchers, startups, and innovative organizations are beginning to harness artificial intelligence (AI), machine learning, and other technologies in project management, and by 2030, this domain will undergo significant changes. In the near future, technologies will enhance project prioritization and selection, monitor project progress, accelerate reporting, and ultimately likely facilitate testing and quality control activities. Project managers will be supported by intelligent virtual assistants, allowing them to focus more on coaching and stakeholder management rather than daily and sometimes manual tasks. This will, of course, only be

realized if organizations commence today on collecting and refining project data and preparing their human resources, dedicating all necessary resources to steering this essential and significant transformation. In this study, the hypotheses and descriptive statistics related to the research variables were examined using Smart PLS software and SPSS. Subsequently, demographic information about the sample individuals was discussed. Inferential statistics of the research variables were then analyzed using Smart PLS software. The research model was implemented in the software and various fit indices were subsequently examined. In the next step, path analysis and regression coefficients, as well as the t-statistic, were evaluated. The results of the research confirmed the hypotheses and demonstrated the application of artificial intelligence in project management and control.

- Considering the confirmation of the main hypothesis of the research, which states that artificial intelligence is applicable in project management and control, the following recommendations can be made in this regard:
- Utilization of predictive algorithms: Employing scheduling and cost predictive algorithms can provide accurate forecasts of completion times and project costs by analyzing historical data.
- Performance: Developing predictive models to assist project managers in making better decisions and reducing risks.
- Automation of management tasks: Implementing AI systems to automate repetitive and time-consuming tasks such as reporting, scheduling meetings, and resource management.
- Big data analysis: Utilizing big data analytics to collect and analyze data related to project performance, resources, and time.
- Development of AI-based systems for the automatic identification and assessment of project risks.
- Creation of AI-driven collaboration platforms allowing teams to communicate effectively and share project information seamlessly.
- Conducting training sessions for teams on the use of tools and techniques related to artificial intelligence in project management.

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