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Professional Research Thesis

Titled

*The role of artificial intelligence in developing the
quality of engineering projects.*

Researcher

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Supervisor signature

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SUMMARY

Engineering projects have witnessed tremendous development in recent decades due to significant advances in various fields of science and technology, most notably artificial intelligence (AI). AI is considered one of the key factors contributing to improving the effectiveness and efficiency of engineering projects of various types, whether in construction, roads, infrastructure, civil engineering, or architecture. The integration of AI into these fields not only accelerates processes but also improves project quality, reduces costs, and provides innovative solutions to problems engineers may face.

Engineering projects are often characterized by complexity and time pressures, along with challenges related to resources, limited schedules, and high-quality requirements. In this context, AI contributes to transforming traditional engineering processes by providing tools and techniques that enable accurate analysis, predicting problems before they occur, and improving decision-making processes, which enhances the quality of final outcomes of engineering projects.

AI can effectively contribute to various aspects of an engineering project, such as project planning, scheduling, risk analysis, design improvement, developing innovative engineering solutions, as well as performance monitoring and quality control during execution phases. Therefore, this technology is gaining increasing importance in our current era, especially with the growing need to achieve the highest quality levels, reduce waste, and increase efficiency in various engineering industries.

This thesis aims to study the role of AI in improving the quality of engineering projects by highlighting its various applications during the different stages of the engineering project lifecycle, exploring its benefits in cost reduction, improving design accuracy, reducing human errors, and accelerating execution. The study will also analyze the challenges that may hinder the application of this technology in the engineering field and the strategies required to overcome these challenges to achieve the highest quality standards in engineering projects.

This study will discuss the latest innovations and technologies in the field of AI and provide practical examples illustrating how engineering projects benefit from these technologies. Through this, it will become clear how AI can be a pivotal factor in developing and improving quality in various types of engineering projects.

The study Problem.

Engineering projects are among the essential activities that play a significant role in achieving economic and social development in various societies. However, these projects face substantial challenges during their implementation stages, starting from planning to project delivery. The most notable of these challenges include achieving high-quality standards within a limited timeframe and budget, along with the necessity of complying with precise technical standards and multiple requirements that could lead to complex issues related to design, execution, and resources.

Despite the technological advancements witnessed in engineering and construction fields, engineering projects are still susceptible to numerous problems that directly impact their quality. These problems range from delays in execution, budget overruns, inaccurate risk predictions, and human errors arising from the interaction of various factors. Moreover, large and complex projects often require extensive coordination between different teams, making it more difficult to ensure overall quality.

Amid these challenges, AI emerges as a modern and promising tool capable of significantly enhancing the management of engineering projects. AI strengthens engineers' ability to make informed decisions based on accurate data analysis and helps predict problems before they occur, enabling projects to be executed with the highest levels of quality and efficiency. However, the application of AI in this field still faces several difficulties and challenges, such as the lack of expertise in its wide-scale implementation and concerns about the interaction between intelligent systems and human workers.

Based on the aforementioned points, the research problem revolves around exploring the role of AI in improving the quality of engineering projects by identifying how this technology can be used to achieve efficiency and quality across various project stages and identifying the obstacles that may impede its application in the engineering context. Consequently, the study seeks to answer how to maximize the benefits of AI to ensure quality improvement, risk reduction, and human error minimization, and what measures should be taken to effectively implement this technology in the engineering sector.

The importance of studying:

This study holds significant importance amid the accelerating technological transformations that the world is witnessing today, particularly in the fields of engineering and construction. Despite the considerable progress these fields have achieved over decades, engineering projects still face complex challenges related to achieving the highest quality levels, reducing costs, and meeting deadlines. These challenges become increasingly complex with the growing size of projects, the multiplicity of relevant specializations, and the necessity for continuous coordination between different work teams.

In this context, artificial intelligence emerges as a pivotal tool that opens new horizons in improving the effectiveness of engineering projects. It has become evident that utilizing artificial intelligence techniques can contribute substantially to addressing many quality-related issues in engineering projects by providing innovative solutions to reduce human errors, improve decision-making, and anticipate problems before they occur. The application of artificial intelligence can contribute to accelerating project completion, reducing unjustified costs, increasing design accuracy, and facilitating performance monitoring throughout the project implementation period.

The importance of this study lies in its contribution to systematically exploring the possibilities of using artificial intelligence to improve the quality of engineering projects. It will provide a scientific framework through which the impact of these technologies on the overall performance of projects can be understood, thereby improving the success level in various types of engineering projects. Additionally, the study contributes

to bridging the gap between theory and application in the field of engineering by presenting real examples and case studies that highlight how projects can benefit from these modern technologies.

On the other hand, the study's importance is also evident in its role in enhancing the ability of engineers and stakeholders in the sector to adapt to these modern technologies. Understanding the dimensions of artificial intelligence application will help build a more efficient and organized work environment and contribute to improving the skills of workers in the engineering field and developing their capabilities to deal with the challenges of the digital age.

In summary, this study contributes to enriching scientific and applied thought in the field of engineering and provides innovative and effective solutions to improve the quality of engineering projects, making it highly valuable in terms of practical application and scientific research simultaneously.

Objectives of the study:

- *Exploring the role of artificial intelligence in improving the quality of engineering projects.*
- *Analyzing the various applications of artificial intelligence across the stages of engineering projects.*
- *Evaluating the impact of artificial intelligence on cost reduction and efficiency improvement in engineering projects.*
- *Identifying the challenges and obstacles associated with implementing artificial intelligence in engineering projects.*
- *Presenting strategies to overcome barriers related to the application of artificial intelligence in the engineering sector.*

Study hypotheses and questions.

Hypotheses:

- *Artificial intelligence can significantly contribute to improving the quality of engineering projects by enhancing design accuracy and reducing human errors.*
- *Using artificial intelligence techniques in monitoring the performance of engineering projects contributes to increasing efficiency and reducing costs.*
- *The application of artificial intelligence improves the decision-making process in various stages of engineering projects, thereby reducing risks and achieving goals on schedule.*
- *There are challenges and obstacles related to the application of artificial intelligence in engineering projects, including lack of training and technical expertise among workers.*

Questions:

- *How can artificial intelligence contribute to improving the quality of engineering projects?*
- *What are the main applications of artificial intelligence that affect the different stages of engineering projects?*
- *What is the impact of using artificial intelligence on cost reduction and efficiency improvement in engineering projects?*
- *What challenges might face the application of artificial intelligence in the field of engineering?*

- *What are the best practices that can be followed to enhance the use of artificial intelligence in improving the quality of engineering projects?*

Study Approach.

The analytical descriptive methodology was used to determine "the role of artificial intelligence in developing the quality of engineering projects."

The limits of the study:

Spatial Boundaries: The Arab world.

Temporal Boundaries: 2003–2025.

Study plan.

Chapter One: Theoretical Framework and Scientific Concepts

Section One: Introduction to Understanding Artificial Intelligence

- 1. The Nature of Artificial Intelligence and Human Intelligence*
- 2. Methods of Artificial Intelligence*
- 3. Origins and Development of Artificial Intelligence*
- 4. Fields and Characteristics of Artificial Intelligence*

Section Two: Introduction to Understanding Engineering Project Management

- 1. The Nature and Importance of Engineering Project Management*
- 2. Engineering Project Management Strategies*
- 3. Challenges Related to Engineering Project Management*
- 4. Systems and Programs for Engineering Project Scheduling*
- 5. Methods of Human Resource Management in Engineering Projects*
- 6. Benefits of Engineering Project Management*

Section Three: Artificial Intelligence and Project Management

- 1. The Role of Artificial Intelligence in Project Planning*
- 2. The Role of Artificial Intelligence in Project Scheduling and Monitoring*
- 3. The Role of Artificial Intelligence in Project Risk Management*

Chapter Two: Potential Applications of Artificial Intelligence in Engineering Project Management

Section One: Artificial Intelligence Applications in the Planning Phase

- 1. Modeling and Simulation for Optimal Solution Selection*
- 2. Resource Forecasting and Timelines Using Machine Learning*
- 3. Data Analysis for Cost Estimation and Budget Management*

Section Two: Artificial Intelligence Applications During Implementation and Monitoring

- 1. Pattern Detection for Predicting Potential Problems*
- 2. Decision Support Systems for Risk Management*
- 3. Process Automation Using Robots and Drones*

Section Three: The Role of Information Systems in Crisis Management

- 1. The Concept of Crisis Information Systems and Their Importance*
- 2. The Role of Information Systems in Crisis Prevention and Management*

Chapter One: Theoretical Framework and Scientific Concepts

Section One: Introduction to Understanding Artificial Intelligence

Humans alone are described as having intellect, as our mental capabilities are important in every aspect of our lives, both small and large. The field of artificial intelligence is concerned with mechanizing human intelligence and studying its mental capabilities. One of the most important reasons for studying artificial intelligence is attempting to understand the processes of the human mind in a way that differs from philosophy, psychology, and anatomy, which also in their turn study the human mind. The science of artificial intelligence strives to build intelligence to the extent that it is concerned with understanding this intelligence.

The second reason for studying this science is that artificial intelligence programs are useful in several areas of our lives that have become digital! Although no one can predict the details of the future, it is clear that computers with human-like intelligence will have a huge and obvious impact on our daily lives and in the creation of civilization.

***Artificial intelligence is considered an important puzzle:** How is it possible for this small brain, whether biological or electronic, to understand, perceive, predict, and interact with a world larger and more complex than the brain itself? How can we take a path concerned with creating such a small brain with all its complex characteristics? This is a difficult question, but unlike searching for a means of transportation faster than the speed of light, the researcher in the science of artificial intelligence and its student finds that this science is based on solid and*

possible foundations; all they have to do is look in the mirror to find a living example of an intelligent system.

First: The Nature of Artificial Intelligence and Human Intelligence

1. Definition of Artificial Intelligence

Intelligence is a term that usually encompasses many mental abilities related to analytical capacity, planning, problem solving, and speed of mental simulation. It also includes the ability for abstract thinking, gathering and coordinating ideas, language acquisition, and speed of learning.

Although the common concept of intelligence among people includes all these aspects, and people may strongly associate it with memory strength, psychology studies intelligence as a behavioral characteristic independent of creativity, character, wisdom, and even memory retention.

Artificial Intelligence: *It is one of the sciences branching from computer science, and it is the science concerned with making computers perform tasks similar – approximately – to human intelligence processes, including: learning, deduction, and decision-making.*

There are other definitions in books and references related to the science of artificial intelligence, most notably from the dictionary of the Arab Encyclopedia for Computers and the Internet:

Artificial Intelligence: *Abbreviated as AI. A term referring to one of the most recent computer sciences, belonging to the modern generation of*

computer science generations. It aims to have the computer simulate intelligence processes that occur within the human mind, so that the computer has the ability to solve problems and make decisions in a logical and orderly manner, using the same thinking method as the human mind.

These processes include:

- *Learning: Acquiring information and rules that use this information.*
- *Reasoning: Using previous rules to reach approximate or fixed conclusions.*
- *Automatic or self-correction.*

So Artificial Intelligence: Is a branch of computer science concerned with mechanizing intelligent behavior in humans. In it we need:

- ***Data system:*** *Used to represent information and knowledge.*
- ***Algorithms:*** *Needed to map how this information is used.*
- ***Programming language:*** *Used to represent both information and algorithms.*

The science of Artificial Intelligence: Is one of the modern computer sciences that searches for advanced methods to program computers to perform actions and reach conclusions that resemble, albeit within narrow limits, those methods attributed to human intelligence. It is therefore a science that first researches the definition of human intelligence and determining its dimensions, and then simulating some of its properties. Here it must be clarified that this science does not aim to compare or liken the human mind, created by God in His power and greatness, to a machine made by creation, but rather this new science aims to understand the complex mental processes performed by the human mind during its

practice of (thinking) and then translate these mental processes into equivalent computational operations that increase the computer's ability to solve complex problems.

2. Human Intelligence:

God Almighty said in His precise verses: "And among His Signs, He shows you the lightning, by way of fear and hope, and He sends down water from the sky and with it gives life to the earth after its death. Verily in that are Signs for those who understand."

And He, Glory be to Him, said: "Behold! In the creation of the heavens and the earth, and the alternation of night and day, there are indeed Signs for people of understanding." The Almighty God has spoken the truth.

This noble statement demonstrates the importance of mental processes, first in distinguishing humans from other creatures, and second in distinguishing one person from another. Although intelligence is one of the most important processes or activities performed by the human mind, it is difficult to define precisely: Is it the ability to deduce? Or is it the ability to acquire and apply knowledge? Or is it the ability to comprehend, conceptualize, and influence things in the physical world? Without delving into deep philosophical matters, intelligence can be defined by all of the above and more. In its broad scope, it may include all mental processes from brilliance and innovation to control of movement, senses, and emotions. However, in the scope of studying artificial intelligence for computers, it can be defined in terms of human ability to visualize things, analyze their properties, and draw conclusions from them. It thus represents the human ability to develop a mental model of a domain of life,

identify its elements, extract the relationships between them, and then develop responses appropriate to the events and situations in this domain.

To understand the details of this definition, let us imagine that two people went together to watch a football match. One of them was well-versed in the rules of the game, its tactics, the names of the players, and the importance of the match result for various competitions, while the other person was far removed from football and its rules. After the match ended, we asked each of them to comment on what they saw. We would find that the first person is able to provide an "intelligent" analysis of the match, the teams' tactics, and the mistakes made, while we would find that the second person's commentary is mostly primitive, perhaps not exceeding a simple description of 22 players competing in sports clothes over one ball without purpose or meaning... From this, we can conclude that the reason the first person provided an intelligent analysis is the existence of what can be called a model of the game and its rules in his mind, which enabled him to recall and analyze the situations and events of the match he watched. Meanwhile, the absence of this model in the second person led to the simplicity of his commentary on the match. If we left the second person enough time to watch numerous matches, it is possible that he would develop a model in his mind about this game and would be able to provide an objective analysis about it later. The first person is also capable of developing the model he created and changing its elements whenever something new emerges. Thus, humans are capable of creating the mental models we are talking about through practice and thinking, and then developing them if necessary.

One of the most important benefits of this mental model that humans unconsciously create is that it helps them to limit the facts related to the

subject in the field of research and simplify the complex steps that characterize the true picture. If the field of research, for example, is the health condition of a patient's heart, then the mental model that the specialist doctor creates about the patient focuses on important relationships such as the patient's blood pressure and the percentage of sugar and cholesterol in the blood, and excludes unimportant relationships such as the patient's favorite food, the size of his garment, the color of his car, and so forth.

3. The Difference Between Artificial Intelligence and Human Intelligence:

Artificial Intelligence: *Artificial intelligence in computers can be defined as the ability to represent computational models of a domain of life and identify the fundamental relationships between its elements, and then develop responses appropriate to the events and situations of this domain. Artificial intelligence is therefore primarily associated with representing a computational model of a field, and then retrieving and developing it. Secondly, it is associated with comparing it with situations and events in the research field to arrive at useful conclusions.*

It is clear that the difference between the definitions of artificial and human intelligence mentioned above is, first, the ability to create the model. Humans are capable of inventing and creating this model, whereas the computational model is a representation of a model previously created in the human mind. Second, the difference lies in the types of conclusions that can be drawn from the model. Humans are capable of using different types of mental operations such as innovation, creativity, and various forms of

reasoning, whereas computational operations are limited to specific conclusions according to recognized axioms and laws.

Conclusion.

At the conclusion of this study, it is clearly evident that engineering project management faces significant challenges that require the use of modern and innovative techniques to achieve success. The results derived from this study demonstrate the importance of integration between modern technologies, especially artificial intelligence techniques, in the context of project management to improve process performance and reduce risks.

The current gap between traditional methods and digital transformation emerges as a source of challenges, but it also appears that this gap can be reduced and improved through the application of well-structured and integrated strategies. The integration between artificial intelligence technologies and project management processes is considered a key factor in effectively achieving project objectives.

Providing the necessary tools and techniques to enhance effectiveness and reduce risks represents fundamental aspects of the results of this study. These tools can contribute to improving planning, monitoring progress, and making strategic decisions more accurately.

In conclusion, this research shows that leveraging artificial intelligence techniques in the field of engineering project management represents a critical development. By adopting the proposed solutions, organizations can enhance their ability to adapt to rapid changes in the business environment and achieve sustainable successes in their engineering projects.

Results:

- *Artificial intelligence applications contribute to improving engineering project management and reducing associated risks.*
- *Machine learning techniques help in predicting potential problems in engineering projects and taking appropriate preventive measures.*
- *Computer vision techniques allow better monitoring of workflow on-site and early detection of deviations.*
- *Decision support systems based on artificial intelligence contribute to making sound administrative decisions during project implementation.*

Recommendations:

- *Recommendation to adopt artificial intelligence techniques in engineering project management processes to improve risk prediction and accurately determine timelines.*
- *It is advised to develop and enhance data analysis tools and machine learning techniques to enable project management to effectively understand and analyze complex and massive information.*
- *Recommendation to provide training courses and skill development for teams working in project management to improve their understanding of artificial intelligence technology and use it effectively.*
- *Encouragement to enhance interaction and collaboration between various departments and working teams by adopting effective integration systems based on artificial intelligence techniques.*
- *It is recommended to develop a comprehensive framework that includes standards and principles for integrating artificial intelligence techniques in engineering project management.*
- *It is advised to follow the latest developments in the field of artificial intelligence techniques and project management technology to stay constantly informed of best practices and innovations.*
- *Recommendation to integrate artificial intelligence techniques into strategic monitoring and evaluation systems to enhance the ability of institutions to make sustainable and intelligent decisions.*

The reviewer:

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