Kufa Journal of Engineering
Vol. 17, No. 3, July 2026, P.P. 260-274
Article history: Received 26 June 2025, last revised 5 September 2025,
accepted 5 September 2025

REASONS HINDERING THE USE OF ARTIFICIAL INTELLIGENCE IN CONSTRUCTION PROJECTS IN IRAQ

Laith S. M. Al-Asadi[1], Alyaa H. Mohsin [2], Abdulrahman Adnan Ibrahim [3], Hussein A.M.S Al-Juboori[4], and Kabanov V.N[5]

[1] Civil Engineering Department-Mustansiriayah University, Baghdad, Iraq, Email:laiths66@uomustansiriyah.edu.iq.

[2] Civil Engineering Department/ Mustansiriayah University, Baghdad, Iraq, Email:dr.alyaah@uomustansiriyah.edu.iq.

[3] Civil Engineering Department/Engineering College, Tikrit University, Tikrit, Iraq, Email:Dr.abdulrahmanadnan@tu.edu.iq.

[4] Moscow State University of Civil Engineering (National Research University), Moscow 129337, Russia, Email:Hussainjuboori87@gmail.com.

[5] Moscow State University of Civil Engineering (National Research University), Moscow 129337, Russia, Email:kabanovvn@yandex.ru.

https://doi.org/10.30572/2018/KJE/170315

ABSTRACT

The use of artificial intelligence has entered into many fields, especially difficult and complex ones. It has also entered into the field of construction projects in countries around the world in several matters, but this has not been done in construction projects in Iraq. These projects are in dire need of this use because of the problems and difficulties that they have been suffering from during the various stages of the construction project life, for several reasons. The benefits of using artificial intelligence in construction projects have been demonstrated through previous research. The problems that construction projects in Iraq suffer from in the various stages of the project have been explained. Although artificial intelligence will be useful in solving these problems, there are reasons that hinder its use. To find out these reasons, it has been organizing a questionnaire for a number of experts in this field to explain these reasons. Seven reasons have been identified with experts that hinder the use of artificial intelligence. Through the analysis of the questionnaire it was found that the most important of which was the lack of awareness and lack of knowledge of the benefits and advantages of this use. It was concluded that there are five basic points for these seven.

KEYWORDS

Artificial intelligence, Construction projects management, Project stages, Obstacles of using artificial intelligence.

1. INTRODUCTION

The definition of artificial intelligence has taken several forms since its inception in the fifties and sixties of the last century, and it continues to develop and grow. Since then, artificial intelligence has gone through several periods of ups and downs, and financing has played an important role in that. The European Union Commission on Artificial Intelligence has defined artificial intelligence as a set of software systems and devices designed by humans for difficult and complex goals to understand the environment that are being dealt with by understanding and analyzing a quantity of data to arrive at the best solutions and procedures to reach the desired goal (Rampini and Re Cecconi, 2022). Artificial intelligence has the ability to adapt and learn by accurately interpreting external data and benefiting from it to reach specific goals, such as making decisions and future expectations of an event (Rampini, Khodabakhshian and Cecconi, 2022; Kaplan and Haenlein, 2019). Artificial intelligence includes several stages, starting with collecting and feeding the system with information and data. This is followed by a stage of organizing and classifying this information and data, after which the process of data analysis and machine learning and benefiting from it takes place. As for the advanced stage, it takes place through deep learning, through the contribution of several levels of grid cells in interpreting and analyzing information and data and making difficult decisions. This process is somewhat similar to the process of Educating decisions through the interconnection of human neurons (Rampini and Re Cecconi, 2022) . This research aims to identify the reasons that hinder the use of artificial intelligence in construction projects in Iraq although the benefits of using artificial intelligence in solving many problems that can be occur within construction project stages.

2. ARTIFICIAL INTELLIGENCE IN CONSTRUCTION PROJECTS APPARATUS AND PROCEDURES

Artificial intelligence has entered into many uses in various aspects, including construction projects, where artificial intelligence can help solve many difficult and complex matters, control them, and reduce errors, especially since construction projects take on great importance as they consume more resources and natural sources than any other projects (Desruelle et al., 2019) . It also has a significant impact on emissions and global warming, especially CO2 (Huang et al., 2020). It is expected that artificial intelligence will occupy a larger space in construction projects in the near future (Holzmann and Lechiara, 2022) Artificial intelligence has many uses within the various stages of the project (Korke et al., 2023) as follows:

2.1. PROJECT DEFINITION AND FEASIBILITY STUDY STAGE

Artificial intelligence can determine priorities from the beginning of the formation of the project idea by studying the needs, costs, nature of the area and its surrounding environment, and

possible alternatives. It is also possible to conduct a cost and economic feasibility study according to the relationship between costs and benefits and the availability of the required resources of materials, manpower and machines. That can be done according to the importance and size of the benefits. It can also identify potential environmental and geographic impacts and their relationship to the community. Artificial intelligence can help in forecasting climate impacts, studying the risks that may occur, and even security risks, and all of this is reflected in costs and time (Fridgeirsson et al., 2021),(Klosowski and Gola, 2016),(Davahli, 2020).

2.2. Project planning stage

At this stage, artificial intelligence can have a significant contribution in determining all the various details such as dividing the project into different items, scheduling such items, calculating the durations and costs for each of them, estimating the costs and the total duration of project completion. Also the critical path, the workflow, selecting and distributing workers, and preparing the required materials and machinery according to the related schedules can be determined by artificial intelligence(Foster, 1988),(Elmousalami, 2020), (Victor, 2023). Artificial intelligence can also direct the project and make relevant decisions and determine responsibilities as well as help in choosing the designer and procurement approach in a way that achieves the best results with the least costs and risks.

2.3. PROJECT APPROVAL STAGE

After completing the calculation of costs and durations and determining the size of the benefit for each project, these projects are included to await the process of approving their implementation within the plan and the size of the budget. Several points are adopted in determining priorities for implementation according to the (benefit/cost) ratio. Here there are several factors that affect decision-making, such as the size and nature of the beneficiary entity and the opinion of officials and decision-makers. Therefore, artificial intelligence has an important role in identifying projects for approval according to their importance and the size of the benefit, away from external interference.

2.4. Project design stage

It is clear that the various project designs are of great importance and care must be taken because they include many properties of the materials involved in the design. Also multiple safety requirements, especially since there are unusual shapes and sizes of structures. Due to the development and growth in the size of projects and the requirements for modern designs, which include the concepts of performance and sustainability as well as safety, the designs have become more complex and require artificial intelligence to solve them. Artificial intelligence has had a well-known role in the field of civil engineering and architectural designs (Adio-

moses, Adebayo and Obiozo, 2015)(Adio-moses, Adebayo and Obiozo, 2015)(Liengpunsakul, 2021)(Luo, 2022) . As for concrete mixes, it is possible, through artificial intelligence, to arrive at accurate designs with a minimum number of trial mixes, and several variables can be included in the design of the mixes at the same time(Gupta, 2013)(Yousif, Thaher and Abdulkareem, 2010)(Engineering, Scholar and Engineering, 2022)(Ziolkowski and Niedostatkiewicz, 2019) . A three-dimensional BIM model of the facility can be designed according to the designs prepared to monitor costs and time and to study any changes that may occur during construction, and this is what can be done using artificial intelligence (Elmousalami, 2020),(Eber, 2020),(Chen and Ying, 2022).

2.5. Project assignment stage

The assignment of the project requires studying the following points:

• Available capabilities that include consultants, designers, technical workers, providing materials and equipment at the required time, etc.

• Project characteristics, size and requirements

• The time required to complete the work

• The size of the budget allocated to the project

• The required quality of work

Here, artificial intelligence can choose the best method for the assignment, as well as the contractor to carry out the work in a way that achieves the best results with the least costs and risks, and reaches the best results in the shortest possible time.

2.6. Project implementation stage

At this stage, it may require follow-up by those with experience and skill, but artificial intelligence can make the right decisions at the appropriate time. Also it can monitor the workflow, address risks, and control changes, especially within the BIM model. Studies indicate that it is possible for artificial intelligence to reduce the project duration by 40%. Reducing the total cost by 20% (Victor, 2023).

The application of artificial intelligence for construction project planning

2.7. PROJECT OPERATION, STRUCTURAL HEALTH MONITORING AND MAINTENANCE STAGE

The performance and safety of the facility is usually checked periodically after use through several methods, especially for important facilities or those exposed to special conditions, in order to preserve it for the longest possible period as follows:

• Through computers connected to sensors that are placed during or after construction in specific places to monitor any changes that occur and affect the safety of the structure.

• Through periodic visits that are programmed according to the importance of the facility or

when any developments occur that require determining its safety, during which damages are monitored visually and with the help of some tools, devices and non-destructive tests.

Here, artificial intelligence has a clear role in interpreting data, making appropriate decisions, and taking the correct steps to evaluate the facility, following up on maintenance, completing all deficiencies, defects, and damages once and for all, and terminating all related matters(Mohapatra, Mohammed and Panda, 2023),(Shibu et al., 2023),(Altabey and Noori, 2022),(Vijayan et al., 2023),(Singh, Ahmad and Yadav, 2020),(Mondal and Chen, 2022) .

2.8. COMPLETION AND DEMOLITION OF THE PROJECT STAGE

Here the project is removed and demolished, and artificial intelligence must have a role in determining the appropriate demolition method and making use of the post-demolition materials as much as possible in other construction projects. Artificial intelligence can help for choosing sites according to the requirements through reuse or recycling of the demolished construction materials to reduce the environmental impact and costs (Sharma, Kumar and Walia, 2020),(Buller et al., 2020)(Shooshtarian et al., 2020).

3. THE REALITY OF CONSTRUCTION PROJECTS IN IRAQ

In its modern history, Iraq has gone through several crises and wars, where many service and infrastructure projects, as well as development projects and other projects, suffered from deterioration and neglect (Fadhil and Burhan, 2021). Contractors in that period suffered from many difficulties, most of which were due to the lack of justice for contractors' rights and the payment of amounts and dues after the completion of those projects. After the change was made in 2003, the situation changed completely, as a lot was wasted on projects that were not completed and left by the implementers after many advances were withdrawn more than what the project deserved at that stage. There are a number of fictitious projects, in addition to the fact that the control work on quality, costs and time was below the required level due to the deteriorating security situation and the absence of monitoring and accountability at that time. Projects are still lagging due to the circumstances that the country is suffering from, represented by the interference of some influential parties as required by interests. Weakness of government decisions by state departments, and the failure to assume moral and legal responsibility and hold negligent and abusers accountable can be added to the same previous content. In the same field the emergence of the values and customs of the clans, which often stand before the law, in addition to the widespread state of ignorance and corruption can be added. There are other circumstances that indirectly contributed to weak control over these projects, such as poor electricity services and the delivery of potable water, as well as the presence of traffic congestion that hinders the timely arrival of materials and machinery. The high temperatures in

summer, which reach more than 50 degrees, have added a number of problems to the concrete while it is soft and when it hardens. In general, the problems of control and management of construction projects in Iraq include all the stages described previously, from the beginning to the end(Melkamu, 2025) .

4. BARRIERS TO THE USE OF ARTIFICIAL INTELLIGENCE IN CONSTRUCTION PROJECTS IN DEVELOPING COUNTRIES

The use of artificial intelligence in the construction industry faces many challenges in developing countries such as in Africa. For example in Ethiopia and Ghana, suffer from a lack of culture, awareness, education and training in the field of using artificial intelligence in the construction industry and other industries, and this requires support from all concerned parties, especially the government sector (Mustapha et al., 2024),(Rane, Desai and Rane, 2024) . Also in India, there are still some barriers to these uses in the construction industry, such as the availability of skills and supportive leadership, resistance to change, lack of understanding and awareness of the capabilities of artificial intelligence, and concerns about data security and privacy, also, the high initial investment costs and the need for continuous training and upgrading of the workforce skills pose major challenges. In Malaysia, there are still barriers to using artificial intelligence in the field of communications, and the lack of sufficient technologies, with concerns among specialists in the construction industry (Hilmy et al., 2024). Even in Iceland, which is one of the developed countries, a number of master's degree holders are counting on the use of artificial intelligence. Such studies, have more uses in the future of project management in the next ten years in the field of time, cost and risk management, as well as in the process of planning, coordination and monitoring (Fridgeirsson et al., 2021) .

In general, there is a need for support, especially for the government sector in the field of finance, education, training and conducting research in the field of sustainable development. Such support can be adopted by using artificial intelligence in construction projects instead of traditional methods, especially with the growth of complexities in the construction industry (Regona et al., 2024),(Rampini and Re Cecconi, 2022). There is another study (Daniel et al., 2024) that included a review of 88 research papers on the barriers facing the application of digital technologies that focus on artificial intelligence in the field of health and safety of the construction industry. Such study for both developed and developing countries, as developed countries face technical and financial obstacles and knowledge gaps that require training. As for developing countries, the size of the challenges is greater in financial matters and in the field of knowledge, in addition to the fact that the infrastructure and documentation process are insufficient.

5. METHODOLOGY

The aim of the research has achieved through two stages, firstly the obstacles to the use of artificial intelligence for construction projects has been identified from theoretical references. Secondly, the extent of these obstacles in construction projects in Iraq despite the severe need and problems that these projects suffer from was studied by conducting a field questionnaire. After a pilot study for AI application in construction projects in Iraq, a questionnaire form was organized for a sample of civil engineers and academics that have sufficient experience in this field to identify these obstacles. The questionnaire included two parts. The first part included information about the respondents. The second part of the questionnaire included a five- point Likert type scale ranging from (strongly agree=5 to strongly disagree=1). 70 questionnaire forms was distributed, and 50 answers that met the conditions were analyzed. Fig. 1 shows the educational attainment of the sample members, as 20 members (40%) had master degree, 18 members (36%) had BSc degree, and 12 members (24%) had PhD. Degree in civil engineering. Fig. 2 shows the number of years of experience for the sample. The questionnaire answers were analyzed using SPSS 28 through descriptive statistical analysis (mean, Standard Deviation S.D), also Relative importance (RII) for each obstacle was determined as in Eq.1. (Tholibon et al., 2021)

$$RII = \frac{\sum W}{A*N} \quad (1)$$

Where,

W: the weight of each obstacle that represents responses answers

A: the highest possible rating in the adopted scale in the study

N: the total number of respondents (50)

The results obtained for obstacles were arranged in descending order.

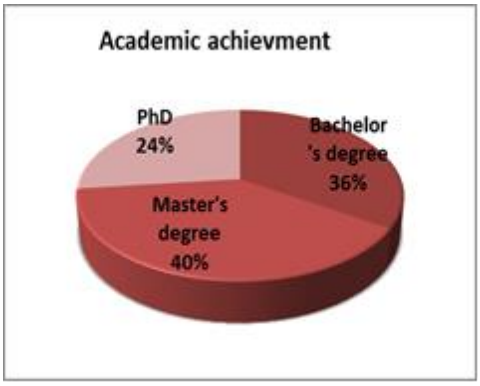

Fig.1 Academic achievement of the sample

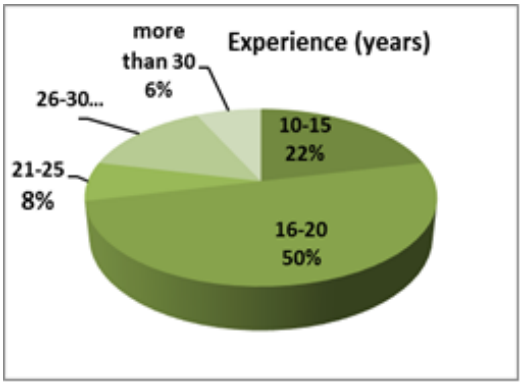

Fig. 2 Experience for the sample

The figure mentioned in reviewer comment as (Fig. 1 is deleted) (For Fig. 2, There was a survey on the need for artificial intelligence and there was another survey on the obstacles that prevent its use for a sample of experts who have knowledge in the use of artificial intelligence).

6. RESULTS AND DISCUSSION

The reliability of the questionnaire was examined using Cronbach's alpha coefficient and the result was as (α =0.76), while the acceptable limit is ($\alpha \geq 0.7$) (Izah, Sylva and Hait, 2024). Table 1 shows the results obtained, where the obstacles were arranged in descending order according to statistical analysis.

Table 1 Obstacles of using artificial intelligence in construction projects

Rank	Obstacles to the use of artificial intelligence	Mean	S.D.	RII
1	Lack of awareness and information	4.221	0.786	0.836
2	Lack of the necessary experience and skill	4.052	0.817	0.814
3	Curricula, support, and incentives are not available	3.901	0.829	0.806
4	Fear of losing job status	3.682	0.842	0.795
5	Fear of not controlling artificial intelligence	3.548	0.879	0.783
6	Inadequate information and communications technology	3.372	0.903	0.764
7	Insufficient data and information required for feeding	3.105	0.968	0.636

1. Absence of awareness and lack of sufficient information about the benefits and uses of artificial intelligence among employees and officials alike get the first rank with (RII=0.836).
2. The lack of sufficient experience, knowledge and skill to deal with artificial intelligence, as construction projects are usually designed, managed, followed up and controlled according to familiar methods got the second rank with (RII=0.814).
3. The lack of curricula, incentives, and support got the third rank with (RII=0.806), through which this system can be adopted, as the academic curricula are still the same as those that were taught since ancient times. No changes have been made to them to be compatible with the adoption of artificial intelligence, and there are no incentives or support that push and encourage the use of this method.
4. Fear of losing job status got fourth rank with (RII=0.795) .There is a fear among some officials and employees of losing their current jobs, as some believe that artificial intelligence does not need these jobs.
5. There is a fear of not controlling the use of artificial intelligence in the rapidly developing future, as this obstacle got (RII=0.783).
6. The available information technology and communications systems are insufficient for artificial intelligence applications, as this obstacle got (RII=0.764).
7. Finally Insufficient data and information required for feeding got (RII=0.636), which reflects The lack of documented data and sufficient information, as the documentation of data suffers from a lot of neglect and lack of attention and from the damage caused by wars and arson fires.

It is clear from the results of the questionnaire that there is a real problem in adopting artificial intelligence for construction projects, and this is evident in the points indicated above, and

attention must be paid. Fig. 1 summarize the reasons that hinder the use of artificial intelligence in construction projects in Iraq.

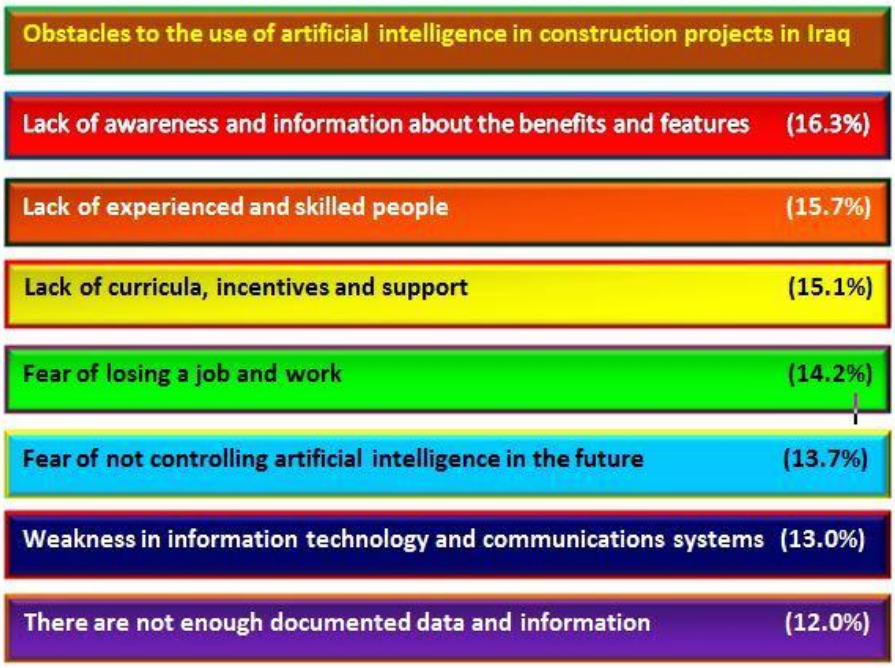

Fig. 4 Obstacles of using artificial intelligence in construction projects

7. CONCLUSIONS

After combining the paragraphs that are close to each other and adding their percentages, it is clear that there are five main reasons worth considering that stand in the way of adopting artificial intelligence for use in construction projects, and the points shown below can be concluded (see Fig. 5):

Absence and weakness in educational centers, curricula and other means of education such as courses, workshops, seminars and conferences, as well as social media and other media to create the necessary awareness and knowledge and to find the necessary skills and expertise to work within this field.

The absence of incentives and support necessary to encourage those concerned and interested in artificial intelligence to adopt the use of artificial intelligence in construction projects.

Fear of losing one's job and work due to the use of artificial intelligence. Adopting artificial intelligence will reduce some jobs and businesses and will create other jobs and businesses that this procedure requires and that are not currently available.

The fear of not controlling artificial intelligence, which is developing rapidly, and the possibility of not being able to control the results and decisions issued by it, is not a justification for not adopting it, as this procedure can be used in a way that can be controlled, especially when people with experience and skill are available.

Weakness in the currently existing information technology and communication systems, as what is available is insufficient to adopt artificial intelligence in construction projects. Also, attention must be paid to documenting the data, as well as providing the required and necessary information for that.

As shown in the points above, the following points can be suggested to overcome these obstacles:

1- There is a need for financial support from the relevant authorities, especially the government sector, to provide the requirements for using artificial intelligence from advanced computers, servers, etc.

2- Attention to preparing the basic requirements in preparing curricula and scientific studies and supporting training, research and development processes for specialists

3- Increasing the cultural awareness of officials and specialists in the capabilities of artificial intelligence and removing concerns related to that.

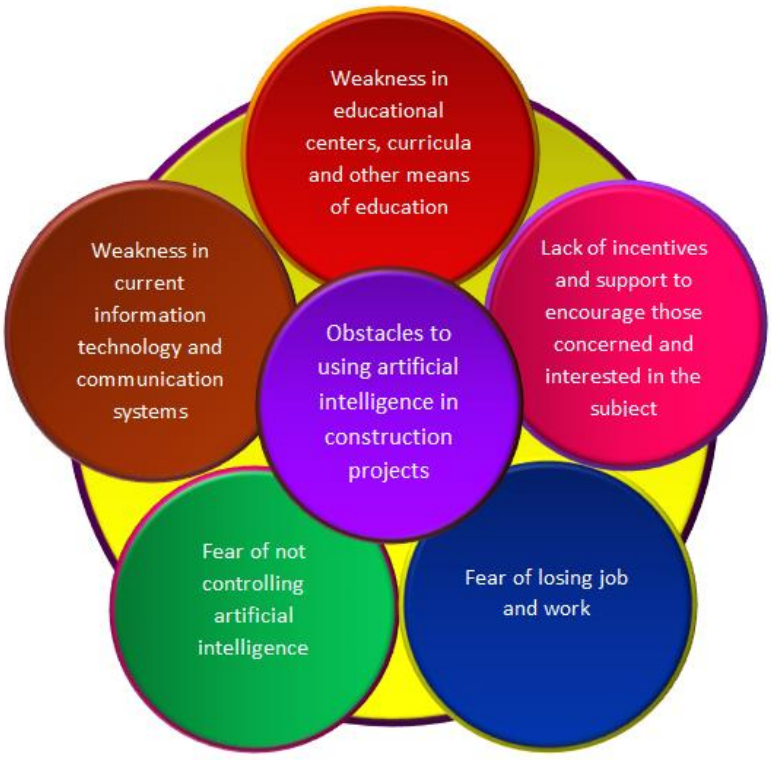

Fig. 5 the main concluded reasons obstruct the use of artificial intelligence in construction projects

ACKNOWLEDGEMENTS

The authors would like to thank the generous efforts of the Quality Control Section at the Central Station in Baghdad/ Iraq Republic Railways Company, and would like to thank the support of Mustansiriyah University in the present work (www.uomustansiriyah.edu.iq) Baghdad – Iraq

8. REFERENCES

Adio-moses, D., Adebayo, A. and Obiozo, R. (2015) 'Green architecture with prefab systems', in Proceedings of CIB W107 Conference (611-626) Lagos: CIB W.

Altabey, W. A. and Noori, M. (2022) 'Artificial-intelligence-based methods for structural health monitoring', Applied Sciences (Switzerland), 12(24), pp. 12-15, available: https://doi.org/10.3390/app122412726.

Buller, A. H. et al. (2020) 'Reuse of construction and demolished waste as aggregates in concrete: A review', Journal of Computer Engineering in Research Trends, 7(8), pp. 41-48, available: https://doi.org/10.22362/ijcert/2020/v7/i08/v7i0807.

Chen, H. P. and Ying, K. C. (2022) 'Artificial intelligence in the construction industry: Main development trajectories and future outlook', Applied Sciences (Switzerland) Mdpi, 12(12), p. 5832, available: https://doi.org/10.3390/app12125832.

Daniel, E. I. et al. (2024) 'Barriers to the application of digital technologies in construction health and safety: A systematic review', buildings', Mdpi, 14(8), 2386.

Davahli, M. R. (2020) 'The last state of artificial intelligence in project management', arXiv Preprint arXiv:2012.12262, available: http://arxiv.org/abs/2012.12262.

Desruelle, P. et al. (2019) 'Digital Transformation in Transport, Construction, Energy, Government and Public Administration'. Joint Research Centre (Seville site) available: https://doi.org/10.2760/689200.

Eber, W. (2020) 'Potentials of artificial intelligence in construction management', Organization, Technology and Management in Construction', DeGruyter i Građevinski Fakultet Sveučilišta U Zagrebu, 12(1), 2053-2063, available: https://doi.org/10.2478/otmcj-2020-0002.

Elmousalami, H. H. (2020) 'Artificial intelligence and parametric construction cost estimate modeling: State-of-the-art review', journal of construction engineering and management', American Society of Civil Engineers, 146(1), 3119008, available: https://doi.org/10.1061/(asce)co.1943-7862.0001678.

Engineering, C., Scholar, U. G. and Engineering, C. (2022) 'Real time concrete quality control at site using artificial', 7(5), pp. 602-606.

Fadhil, G. A. and Burhan, A. M. (2021) 'Investigating the effects of economic crisis on construction projects in Iraq', In E3S Web of Conferences. Edp Sciences, p. 2005.

Foster, A. T. (1988) 'Artificial intelligence in project management.', Cost Engineering (Morgantown, West Virginia) American Association of Cost Engineers, 30(6), pp. 21-24, available: https://doi.org/10.33516/maj.v54i3.34-37p.

Fridgeirsson, T. V. et al. (2021) 'An authoritative study on the near future effect of artificial intelligence on project management knowledge areas', Sustainability (Switzerland) Mdpi, 13(4), pp. 1-20, available: https://doi.org/10.3390/su13042345.

Gupta, S. (2013) 'Concrete Mix design using artificial neural network', Journal on Today's Ideas-Tomorrow's Technologies, 1(1), pp. 29-43, available: https://doi.org/10.15415/jotitt.2013.11003.

Hilmy, N. A. S. et al. (2024) 'Potential applications of artificial intelligence (AI) for malaysian construction industry', In International Conference on Innovation & Entrepreneurship in Computing, Engineering & Science Education (InvENT 2024) Atlantis Press, pp. 119-129.

Holzmann, V. and Lechiara, M. (2022) 'Artificial intelligence in construction projects: An explorative study of professionals' expectations', European Journal of Business and Management Research, 7(3), pp. 151-162, available: https://doi.org/10.24018/ejbmr.2022.7.3.1432.

Huang, H. et al. (2020) 'Optimum insulation thicknesses and energy conservation of building thermal insulation materials in Chinese zone of humid subtropical climate', Sustainable Cities and Society', Elsevier, 52, 101840, available: https://doi.org/10.1016/j.scs.2019.101840.

Izah, S. C., Sylva, L. and Hait, M. (2024) 'Cronbach's alpha: A cornerstone in ensuring reliability and validity in environmental health assessment', Es Energy and Environment, 23, pp. 1-14, available: https://doi.org/10.30919/esee1057.

Kaplan, A. and Haenlein, M. (2019) 'Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence', Business Horizons', Elsevier, 62(1), 15-25, available: https://doi.org/10.1016/j.bushor.2018.08.004.

Klosowski, G. and Gola, A. (2016) 'Risk-based estimation of manufacturing order costs with artificial intelligence', In Proceedings of the (2016) Federated Conference on Computer Science and Information Systems, FedCSIS 2016. Ieee, Pp. 729-732, available: https://doi.org/10.15439/2016F323.

Korke, P. et al. (2023) 'Role of artificial intelligence in construction project management', 04012, pp. 1-15.

Liengpunsakul, S. (2021) 'Artificial intelligence and sustainable development in china', chinese economy', Elsevier, 54(4), 235-248, available: https://doi.org/10.1080/10971475.2020.1857062.

Luo, J. (2022) 'A bibliometric review on artificial intelligence for smart buildings', Sustainability (Switzerland) Mdpi, 14(16), p. 10230, available: https://doi.org/10.3390/su141610230.

Melkamu, M. (2025) 'Artificial intelligence implementation challenges in industries: Developing countries prospective', Artificial Intelligence, 2(01), pp. 175-180.

Mohapatra, A., Mohammed, A. R. and Panda, S. (2023) 'Role of artificial intelligence in the construction industry - a systematic review', Ijarcce, 12(2) available: https://doi.org/10.17148/ijarcce.2023.12205.

Mondal, T. G. and Chen, G. (2022) 'Artificial intelligence in civil infrastructure health monitoring-Historical perspectives, current trends, and future visions', Frontiers in Built Environment', Frontiers, 8, 1007886, available: https://doi.org/10.3389/fbuil.2022.1007886.

Mustapha, Z. et al. (2024) 'Limitations for the implementation of artificial intelligence in construction health and safety in Ghana', Baltic Journal of Real Estate Economics and Construction Management', Sciendo, 12(1), 103-118.

Rampini, L. and Re Cecconi, F. (2022) 'Artificial intelligence in construction asset management: A review of present status, challenges and future opportunities', Journal of Information Technology in Construction, 27, pp. 884-913, available: https://doi.org/10.36680/j.itcon.2022.043.

Rampini, L., Khodabakhshian, A. and Cecconi, F. R. (2022) 'Artificial intelligence feasibility in construction industry', In Proceedings of the European Conference on Computing in Construction. University of Turin, Pp. 99-106, available: https://doi.org/10.35490/EC3.2022.189.

Rane, N. L., Desai, P. and Rane, J. (no date) 'Acceptance and integration of Artificial intelligence and machine learning in the construction industry: Factors, current trends and challenges' (2024) pp. 134-155.

Regona, M. et al. (2024) 'Artificial intelligence and sustainable development goals: Systematic literature review of the construction industry', Sustainable Cities and Society. Elsevier, p. 105499.

S. C. Izah, L. Sylva, and M. Hait, "Cronbach's Alpha: A Cornerstone in Ensuring Reliability and Validity in Environmental Health Assessment, " ES Energy Environ., vol. 23, pp. 1-14, 2024, available: https://doi.org/10.30919/esee1057.

Sharma, A., Kumar, P. and Walia, A. (2020) 'Use of recycled material in wma- future of greener road construction', transportation research procedia', Elsevier B.v., 48, 3770-3778, available: https://doi.org/10.1016/j.trpro.2020.08.042.

Shibu, M. et al. (2023) 'Structural health monitoring using AI and ML based multimodal sensors data', Measurement: Sensors', Elsevier, 27, 100762, available: https://doi.org/10.1016/j.measen.2023.100762.

Shooshtarian, S. et al. (2020) 'Using recycled construction and demolition waste products: A review of stakeholders' perceptions, decisions, and motivations', Recycling, 5(4), pp. 1-16, available: https://doi.org/10.3390/recycling5040031.

Singh, P., Ahmad, U. F. and Yadav, S. (2020) 'Structural health monitoring and damage detection through machine learning approaches', In E3S Web of Conferences. Edp Sciences, P. 1096, available: https://doi.org/10.1051/e3sconf/202022001096.

Tholibon, D. A. et al. (2021) 'Relative importance index (rii) in ranking the factors of employer satisfaction towards industrial training students', International Journal of Asian Education, 2(4), pp. 493-503, available: https://doi.org/10.46966/ijae.v2i4.187.

Victor, N. O. C. (2023) 'The application of artificial intelligence for construction project planning', Journal of Advances in Artificial Intelligence, 1(2), pp. 67-95, available: https://doi.org/10.18178/jaai.2023.1.2.67-95.

Vijayan, D. S. et al. (2023) 'Development of intelligent technologies in shm on the innovative diagnosis in Civil engineering-a comprehensive review', Buildings. Mdpi, 13(8), p. (1903) available: https://doi.org/10.3390/buildings13081903.

Yousif, salim taib, Thaher, majid ali and Abdulkareem, omar mohammed (2010) 'Design of concrete mixes using artificial neural network', The 2nd Regional. Conf. for Eng. Sci. /College. of Eng. / Al-Nahrain University /1-2/12/2010, (January), pp. 449-459.

Ziolkowski, P. and Niedostatkiewicz, M. (2019) 'Machine learning techniques in concrete mix design', Materials, 12(8) available: https://doi.org/10.3390/ma12081256.