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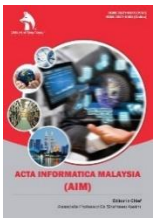

RESEARCH ARTICLE

THE BENEFITS OF ARTIFICIAL INTELLIGENCE IN CONSTRUCTION PROJECTS

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ABSTRACT

Nowadays, Construction project faces many challenges in term of a control system and monitoring tools as well. Besides that, the construction projects building energy applying artificial intelligence (AI) systems play an essential role in the energy management of buildings and also the way to conservation it. By taking into account that using artificial intelligence (AI) systems can assist the construction project to evaluate the effectiveness of the different buildings such as conduct building commissioning energy efficiency, and even though detect and diagnose construction project system faults. However, construction projects are how artificial intelligence (AI) systems implemented their strategies. Thereby, construction project indicators of efficiency are still limited without implemented artificial intelligence (AI) system. In this study, artificial intelligence (AI) is a serious situation that has a high efficiency that can positively affect construction projects. Positive result estimation can be suggested in terms of an identified critical element of success.

KEYWORDS

Artificial Intelligence, Analytic Hierarchy Process (AHP), Fuzzy logic System (FLS), Genetic algorithms (GA), Back-Propagation (BP) Neural Networks

1. INTRODUCTION

With the wide adoption of artificial intelligence (AI) systems, a construction project in both of engineering field, as well as management field, is facing the challenge of rising digital transformation (Pan and Zhang, 2021). By taking into account that artificial intelligence (AI) systems can be a significant solution for many issues in construction projects. Moreover, the topic of artificial intelligence (AI) system has currently become the research domain to focus on, it enquires to be more clear and comprehensively established (Allal-Chérif et al., 2021). The population of human beings has been continued to increase and economic development in massive ways propelled energy and material consumption to a greater degree than threatens the very existence of our Earth in near future (Wang and Srinivasan, 2017).

In a global sense, a construction projects in buildings reached approximately 30% of the entire energy usage (Wang and Srinivasan, 2017). Any attempt to reduce building energy usage greatly decreases global energy demand. The impact of the construction project in building energy efficiency cannot be underestimated and a considerably vast inventory of buildings are now being used by over-extending their usable lives by re-enhancing structural improvements in some situations (Wang and Srinivasan, 2017). The most construction project in buildings constructed in the mid-20th century, the isolation criteria have not insulation requirements, which may eliminate heat loss or gain.

Furthermore, the failure or inaccuracy of calibrated energy and illumination sensors is a continuing project to track, regulate and reduce energy use effectively. In recent decades there was an increase in study activities in the field of the evaluation of energy usage especially by using artificial intelligence (AI) systems with new facilities posing a challenge to overall energy efficiency. Many investigators by academic researchers have been increased in terms of requirement, estimation energy usage, efficiency in the construction project area (Wang and Srinivasan, 2017). For improved process efficiency, it sounds reasonable to take proper construction project maintenance. When the production volume for the building reaches 50% to 60% or even more, an extra $1.6 billion is supposed to increase the output of the industry's value per year and further improve the worldwide gross domestic product. It is important to mention that safety risks can be minimized, and injuries reduced in the construction project sector which should be done based on artificial intelligence (AI) system sustainably.

In this regard of artificial intelligence (AI) system, the construction project is going through constant innovations forward both of digitalization as well as intelligence, in term to realize a considerable boost in automation, productivity, and reliability in the construction project area (Ngarambe et al., 2020; Allal-Chérif et al., 2021). What is more, the construction project is re-designing along the whole construction value chain, including development, construction, installation, and maintenance. To set up true digital initiatives within the construction project, the artificial intelligence (AI) system is the foundation for increasing the efficiency of a building project.

As a computer science field, AI drives computers to detect and learn inputs, such as human beings, for interpretation, representation of information, rationalization, creative thinking, and planning, which can deal actively, intelligently, and adaptively with mis defined and complex problems. Investment in artificial intelligence (AI) systems has been increasing steadily, with machine learning comprising a vast proportion of the machines' information to obtain sufficiently powerful data from a range of sources (Allal-Chérif et al., 2021). Artificial intelligence (AI) system has now enhanced every aspect of life that has substantial potential to improve job productivity by 40% and double the annual economic rate of growth by 2035. More and more companies are interested in various types of Artificial intelligence (AI) systems, in which machine learning is particularly considered for a closer spotlight and

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extends the reach of its deployment in particular the essential.

As Artificial intelligence (AI) system, AI approaches are assumed to be the next digital limit, easy to turn vast data into valuable information that contributes to a high degree of manufacturing and industrial automation and intelligence (Pan and Zhang, 2021; Sohn and Kwon, 2020). While a large number of engineering data in construction projects rises unprecedentedly, the implementation of AI system techniques in other sectors is still behind the process. Therefore, a wide number of the construction project in AI approaches are immensely involved in seizing the lucrative potential for digital growth for greater efficiency and profitability (Pan and Zhang, 2021).

A recent study by the author has been addressing the cost overrun dilemma is exacerbated by ambiguous risk data and the sophistication of the risk network in building projects (Afzal and Yunfei, 2019). To the degree that the difficult and unpredictable risks of building details have been addressed, several model risk management approaches based on AI have been utilized to resolve the AI system. This study offers a thorough understanding of methods for cost overrun risk management to capture dynamic risk interdependencies in the disciplines of construction. From 2008 to 2018, much of the literature was found in leading newspapers and publishers. The content analysis demonstrates the popularity in the construction of hybrid AI approaches like the following for instance the Fuzzy Monte Carlo simulation (FMCS), Fuzzy Analytical network processing (FANNs), and Fuzzy Bayesian belief network (FBBNs).

Although results appear consistent with prior research, they appear inconsistent with systematic analysis suggest as following (i) the number of studies using smart applying intelligent techniques (ASD) has increased, (ii) uncertainty reasoning, search-based approach and machine learning are the smart techniques most commonly used for applying intelligent techniques (ASD); (iii) software engineering management is the predominant target, in particular, effort estimate 680 requirements prioritization (Perkusich et al., 2019). (iv) the safety risks of the existing solutions are limited and (v) the monitoring and evaluation procedures for the new solutions need to be defined clearly.

This has been discussed by authors in literature utilized the IA techniques interface can be applied in a linguistic structure, using the professional values common for applications and user judgment functionalities in a non-structured play, in contrast with the traditional information systems. In the context of a knowledge base and means of deductive and plausible conclusions, artificial intelligence represents the models of the subject and the system under investigation. In addition to the ability to function with missing or incorrect information, the process of IA techniques may describe its behaviours and instruct users on how to insert the necessary parameters accurately.

The main objective of this study is the evaluation, analysis, and performance defining Artificial intelligence (AI) based on building applications, particularly for energy-efficient building and zero energy (Yan et al., 2020). The proposed improvements to the AI system-based methodology based on the latest developments in the study first examine the applicable rules, laws, and requirements (Ngarambe et al., 2020). Therefore, the key features of the Artificial intelligence (AI) system solution infrastructure are closely analyzed and compared in buildings. This paper presents a comprehensive literature review on artificial intelligence in construction projects. Section 2 introduces Artificial intelligence (AI), including the basic concept of artificial intelligence (AI), artificial intelligence (AI) Architecture. Section 3 investigates the Artificial intelligence (AI) techniques, in particular, analytic hierarchy process (AHP), fuzzy logic system (FLS), genetic algorithms (GA), back-propagation (BP) neural networks; Section 4 deals with the conclusion of this study.

2. Artificial Intelligence (AI)

An artificial intelligence (AI) in general term is a biologically inspired computational model, which made of processing elements (known as neurons) and interfaced between them with high coefficients (called weights) bound to the integration (Somasundaram et al., 2020; Le and Juszczyk, 2018). This integration constitutes the neuronal structure and gained to this structure are training and recall algorithms (Juszczyk, 2017). Neural networks are called the connectionist models because of the interconnecting find between the neurons (Vázquez-Canteli et al., 2019; Juszczyk, 2017). In addition to that definition shows the ANN from its almost similar to the human brain such as functioning as shown in (Figure 1). The accepted inclusion of new brain research initiatives that the human brain is much more complexed as many of its cognitive operations are still unknown. On other hand, the following are the major characteristics counted and presented as general operations in artificial and real networks.

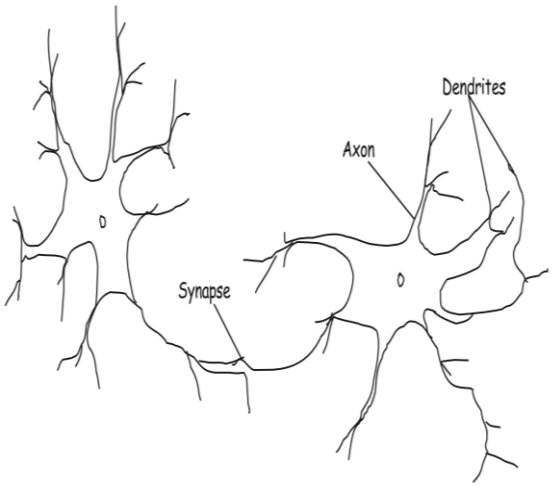

Figure 1: Biological Neuron (Le and Juszczyk, 2018)

The artificial intelligence (AI) approach is an information processing technique based on simulating the human brain (Zhao et al., 2019). It is usually applied to establish forecast and evaluation models. ANN is defined as "a computational mechanism able to acquire, represent, and figure mapping from one multivariate space of information to another, given a set of data representing that mapping" (Alaloul et al., 2018). artificial intelligence (AI) is composed of many mutually connected neurons (interconnecting processing elements) grouped in layers. Usually, artificial intelligence (AI) has three types of layers i.e. input, hidden, and output layers (Somasundaram et al., 2020). The input layer receives data about the inquiry from the outside. Hidden layer (s) does not connect to the outside but connects to other layers. The output layer sends the result outside. Network types are classified according to the number of layers (one-layered and multi-layered networks), connection type between neurons (layered, fully connected, and cellular), and learning process (feed-forward and feedback) (Alaloul et al., 2018). A typical architecture of the feed-forward artificial intelligence (AI) structure is shown in Figure 2.

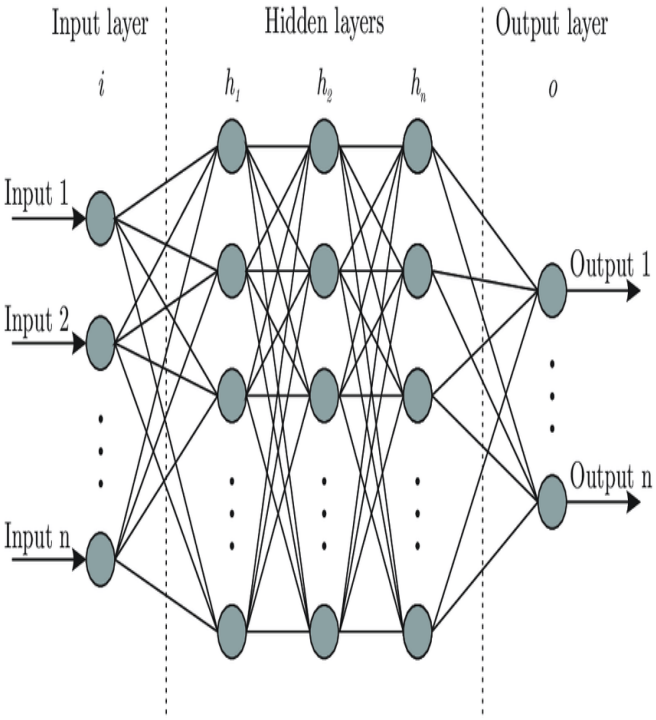

Figure 2: A typical architecture of the artificial intelligence (AI) structure (Le and Juszczyk, 2018)

2.1 Basic Concept of Artificial Intelligence (AI)

Artificial intelligence AI is advanced math models inspired by biological neurons, and in the modeling of non-linear processes and system

recognition, they are commonly used as seen in Figure 2. Its efficient information processing concept relies in general on four variables, which are network unit (neurons) input-output characteristics, network topologies (neurons), relation weight (synaptic strength), and neuron thresholds (special connection weights). An ANN typically consists of several layers of input, hidden layers, and output layer. Moreover, the number of layers and neurons in each layer is defined by the user concerning the size of the issue. Each layer contains several neurons. It is important to mention that the interconnections of all neurons in the formation are identical to the biological nervous system. In this regard, the ANN moves the latent information or laws of the corresponding input to the network site by input processing and contains general rules obtained from the numerical input measurements or instances (Mofidi and Akbari, 2020; Sohn and Kwon, 2020).

2.2 Artificia Intelligence (AI) Architecture

The artificial intelligence AI model was constructed in unprecedented in Figure 3. Which is replicate the roles of the biological neural network.

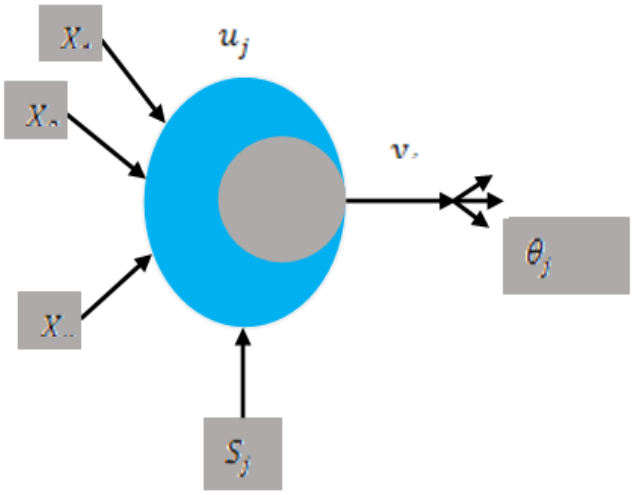

Figure 3: Artificial neuron

The artificial neuron is shown in Fig. 3. is well known as a neuron or even though node. Where U_j is referred to the internal state of the neuron, θ_j is presented to the threshold, x_i is called the input signal, S_j is known as the external input signal, ω_{ji} is defined the link weights from u_i to u_j, and y_j is referred to as the output signal. And the artificial intelligence model is demonstrated throughout several artificial neurons, which are interfaced by weights based on the interconnected mode.

3. Artificial Intelligence (AI) Techniques

In this section, the Analytic Hierarchy Process, Fuzzy logic System (FLS), Genetic algorithms (GA), Back-Propagation (BP) Neural Networks have been enhanced and applied in many different areas.

3.1 Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process (AHP) is one widespread decision-making technique that can be significantly applied in many applications especially construction projects (Mehmood et al., 2019). It is worthy to mention that the AHP technique has been introduced by Saaty. In addition to that, the merits of the technique include its advanced mathematical properties, gaining the input data requirement, and the matter of fact that one advantage of decision-making tool which can have the ability to figure out many issues and provide answers to complex issues in the system. AHP can break down into some parts such as criteria, sub-criteria. Even though can be operated as multiple hierarchical levels which helps the system to increase the performance (Olabanji and Mpofu, 2021).

However, the next duty of decision-makers is to take place as comparisons function for increasing their knowledge as well as experience. This technique can have its judgments on the system. By giving more details of design features, the design concepts of AHP are clear that allows achieving feedback process of the system to minimize the error which can occur any second on the system (Olabanji and Mpofu, 2021). In this regard, the signal of feedback is placed an important role decision process of the system. this target is achieving by the sensitivity analysis of the system. To give more understating of AHP. Figure 4 presents the design of a concept analytic hierarchy process.

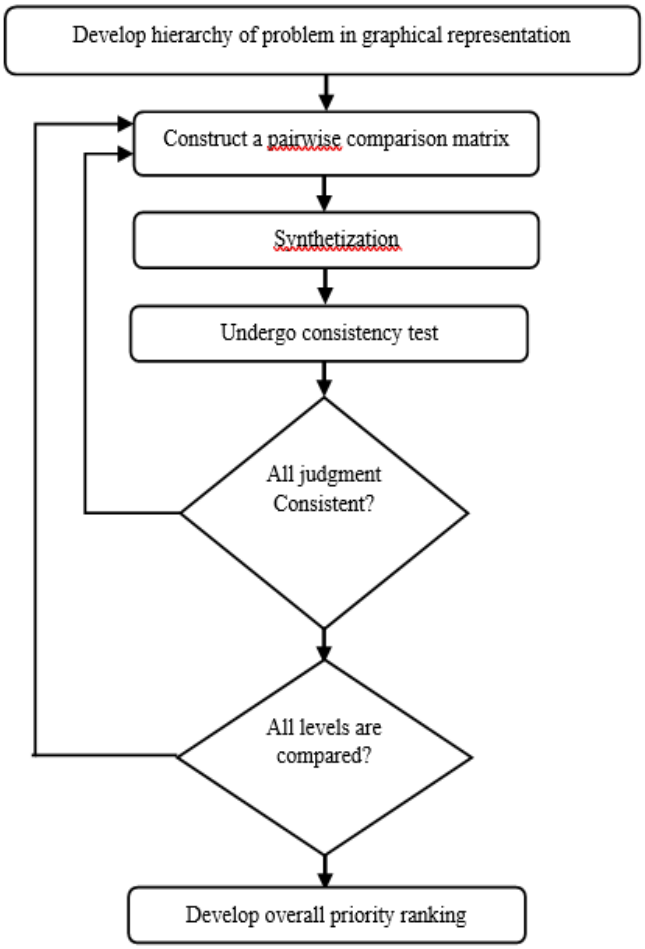

Figure 4: The design of a concept analytic hierarchy process (Olabanji and Mpofu, 2021)

3.2 Fuzzy Logic System (FLS)

Throughout the past two decades, fuzzy logic systems (FLS) have been growing to solve many issues such as construction projects, manufacturing, and energy as well (Raza, 2019). A fuzzy logic system (FLS) is a popular AI technique and not complex to understating as compared to several AI techniques. Thus, the merits of Fuzzy Logic System (FLS) are abundant to be implemented in any system which can be mentioned as following the experience of experts, capability for modeling non-linear functions, tolerance of imprecise information, and ability to use in hydride control techniques. These merits can be because of the natural language of the fuzzy logic toolbox provided by MATLAB. By introducing the basic structure, fuzzy logic system (FLS) can be set using the degrees of membership. Thus, FLS does not deal with absolute membership. Besides, Fuzzification, Interference, and Defuzzificaion are the major step to operate the fuzzy logic system (Yazdanbakhsh and Dick, 2018).

It is important to note that the variables of the fuzzy logic system are a range between zero and one (Yazdanbakhsh and Dick, 2018). With the inaccuracy in the model, faulty reasoning opens up the prospect of using inaccurate inputs and inaccurate thresholds Likewise, the model can be made up of 'linguistic variables,' along with large and small, large and minor, and low/medium/high without being specifically specified (Raza, 2019; Suganthi et al., 2015). The fact that unreliable metrics such as the professional information available in form of verbal explanations are integrated into these indicators is a very clear feature of fading logic modeling. The decision maker's linguistic thinking method is trained and quantified by sophisticated logic and approximate reasoning.

3.3 Genetic Algorithms (GA)

Genetic algorithms (GA) are methods that are based on the fittest principle of survival that can be used in the construction project field. Genetic algorithms are considered potential solutions to a dilemma and their creation is observed over time. The genetic algorithm uses the discovery,

crossover, and mutation of three principal operators. A health function tests the individual's ability to solve this issue and is introduced in the reproductive phase after every generation. The proportion of reproduction is directly related to the health of every organism. That is, the better an entity or a solution is, the greater his chances of being passed by his offspring to the next generation. Some genetic algorithms generate specific reproductions of people to find a possible solution to a query. Only the population with better odds of success continues to the next generation according to the theory of survival of the fittest. The task of genetic operators is to form new or improved descendants. If an optimal solution to the problem has been discovered, the algorithm proceeds after a certain number of generations.

3.4 Back-Propagation (BP) Neural Networks

Nowadays, among several ANN models, both radial basis function (RBF) models and back-propagation (BP) networks have obtained a wide range of expertise in tunnel deformation prediction terms. To sort of illustration, RBF is a high-performance feedforward neural network as an optimization technology with higher computing dimensions, which has several advantages, such as a powerful estimation, improved global optimization capability, easy structure, and quick training speeds in comparison with other feedforward networks. It is worthy to mention that the RBF neural network has also been frequently utilizing in pattern recognition and non-linear approximation. However, ANN approaches have been influential in the field because of their advantages in many domains such as construction projects.

To emphasize more, the BP Neural Network seems to be the most frequently adopted prediction system among the very unique predictive models in tunnel projects for its non-linear mapping capabilities, robustness, and fast realization, being used to correct the link weight between network layers from the back layer and the previous layer. The BP system has obtained three layers includes, the reference layer, the secret layer, and the output layer as seen in Fig. 5. Each neuron receives environmental or other neuronal signals in an ANN model. The neurons can have complete signals. The impulses are perfectly described in the neuron and then distributed to the neurons. The impulses are highlighted in the nucleus and sent to the associated neurons afterward.

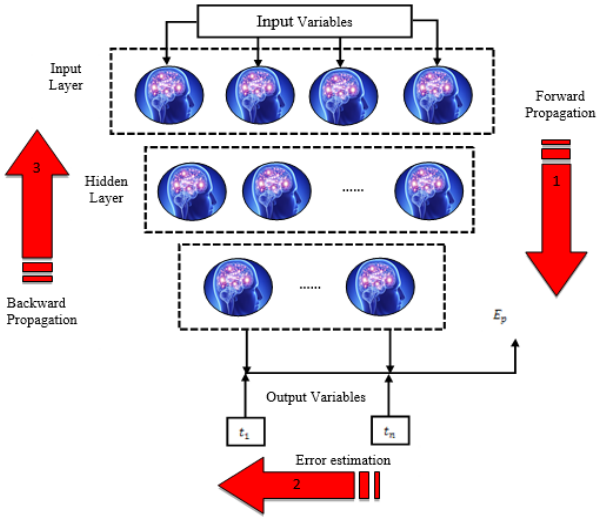

Figure 5: Typical structure of a BP network (Lai et al., 2016)

The BP network was firstly introduced by Werbos, which utilizes the technique of descent gradient for levels with minimal error, to find the error surface (error dependent on ANN weights), and in the mid-1980s more attention was received. As only basic problems in the pattern classification can be only solved via the perceptron (an initial learning algorithm of ANN), the BP Network can approximate any nonlinear function within multi-layer ANN. More specifically, Hecht-Nielsen has introduced that a hidden layer of BP neurons is adequate to model any realistic surface solution. The field has met with great success in many problems especially construction projects. The progress of the hidden layer neurons has a positive performance optimization of the BP network and a hidden layer of more than ten neurons does not significantly increase the performance of the neuronal network. Definition of the input and output vector (i.e. input and output layer neurons), and selection of the number of hidden layers and neurons on the hidden layer, as seen in Figure 6, is the layout of BP network architecture.

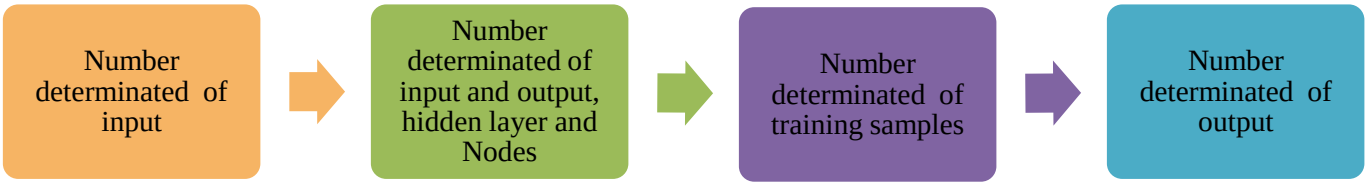

Figure 6: BP network design frame

A BP network can improve training and predictive performance by the number of nodes in the hidden layer of neurons in each layer. The number of neurons in the input and output layers corresponds to predicted input and output variables. The output variables and input variables are necessary responses to the problem, which influence results. In the BP network samples can be measured that is used for machine memory and learning. The number of samples must also satisfy the learning criteria that are determined by the foundational questions. Increase the effects and the outcomes. However, the number of neurons in the input and output layers is associated with the predicted variables of input and output. The output variables are the predicted answers, and the input variables influence the results. And the samples used for system memory and learning should also be determined in the BP network. The number of samples should also fulfill the learning criteria that are decided by the basic questions of the study. The training samples often improve correspondingly with the increase in effect variables and outputs. In the network, BP will then measure samples, which are utilizing for system memory and learning.

4. Conclusion

Artificial intelligence in a construction project has many series of challenges in near future. Minimizing energy consumption and enhancing occupant comfort state are some of the main concerns in the field of construction projects. Thus, artificial intelligence in construction projects can have the ability to focus on both aims simultaneously, making decisions related to the indoor environment and the outdoor environment in the construction project sector. In general, reviewing artificial intelligence in a construction project, Artificial intelligent techniques are discussed that might be solutions to simultaneously provide occupant comfort and minimize such as the energy in the construction project. With the increasing development of digital electronics, wireless communication technologies, microprocessors, and artificial intelligence techniques, the paper has discussed several artificial intelligent techniques that significantly improve construction projects. To sum up, AI techniques have their strengths by implementing them in the right way. To illustrate more, GA is one of the best techniques to handle dynamic issues as compared to AHP or FLS. However, FLS is useful to implement for non-linear demand. Moreover, FLS has high performance to deal with uncertainty and subjectivity issues. However, the AHP is kind of simple and systematic technique, can be very helpful for many decision support systems in the construction project.

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