Applying ANN to the AI Utilization in Forecasting Planning Risks in Construction

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Abstract

A long-standing problem in the field of automated reasoning is designing systems that can describe a set of actions (or a plan) that can be expected to allow the system to reach the desired goal. Artificial Intelligence (AI) techniques provide the means to generate plans and to reason with as well as provide explanations from stored knowledge. However, these methods, which employ little domain knowledge and are originally used in AI for planning, proved inadequate for complex real-life problems such as project planning. As a result, more recent research adopts the knowledge engineering methodology as an efficient approach for developing planning systems. This paper highlights the limitations of existing project planning tools. It also illustrates the power of AI techniques in the construction planning domain through a summary and critique of previous and current research in AI planning. It then concludes with a suggested approach for development. From the study, it was found out that a proper application of the AI technology requires full support in form of a Data Bank, which, unfortunately, becomes one of the most significant hurdles in its adoption. To deal with this limitation, it is recommended to adopt the ANN.

Keywords –

Risks Planning; Construction Planning; Risks forecasting; Neural Network; Support Vector Machines

1 Introduction

Utilization of artificial intelligence in planning involves the use of a planner generator which follows the sequence of actions for presenting the solution of a problem. Artificial intelligence can provide a powerful tactic for managing the risks and ambiguities in construction planning. Utilization of artificial intelligence can be efficient when employed in different phases of construction which involves estimation of production, management of risks, and plan schedules. With the recent development in the construction industry, different artificial intelligence systems have been used and widely applied for forecasting risks [1]. The economics of the developed countries can be improved and fulfil the crucial role of the construction sector. Time, cost, and quality performance the construction project my years though successful construction projects. The duration of the construction project can be a problem as accurate predictability is hard to be achieved. It is not the cause the construction process usually faces many factors that sometimes involve unpredictable variables that can be the result of various factors [2]. These variations or changes usually hinders the completion of projects in the estimated time and become the reason to lead the way towards the latest in the process of construction [3].

The prediction of risk regarding the construction project is based on both internal and external sources which upon identification can help the project managers to have a clear and accurate forecast for the effective management approach towards the construction project. Construction projects are complex and dynamic [4]. Providing an efficient tool for the analysis of the factors which are involved in the risk can provide an accuracy of determining the factors in the construction projects. Recently several models of artificial intelligence have been applied in different fields of engineering and science. Various studies included and researched on the involvement of various artificial intelligence models for the completion and conduction of the research regarding construction project management [5]. Different artificial intelligence methods are being used in the forecasting of the final project duration and risks.

2 Literature Review

2.1 Decision trees

Morgan and Sonquist (1963) dealt with the automatic interaction detection and proposed a fresh method for the regression and analysis of data which is being recognized as decision tree learning [6]. Breiman et al., (1984) also suggested the idea of the algorithm that majorly consisted of 2 phases; In the 1st phase, this solution space is separated with a binary or multi-way split. in the second phase, to every node of partition, a constant model is applied. these well-known procedures are subjected to two pitfalls which are named as overfitting and selection bias. and this method is collectively known as classification and regression trees [7]. This method is not perfect as the overfitting problem emerged as a result of the lack of significance of statistical data. Although some of the information is maximized to divide the decision tree, there is no other significant method of determining whether the split is justified or not. Another major limitation of this processing includes the selection bias which is derived from the fact that most points are preferred.

To upgrade the shortcomings or trees, another method known as bagging predictors was introduced. It involves the arrangement of different trees on the bootstrap on the test set giving us the final estimation by the prediction of average values from each tree. To remove the barriers in begging predictions another method known as random forests were introduced which involves the selection of random numbers of the predictors from each split [8].

Despite the fact that there have been a number of literature that attempt to discuss about AI application, there is none discussing about how ANN may help project managers establish and maintain proper Data Bank. Thus, this is where this study is attempting to fill as it looks to close this gap in the field of research.

2.2 AI Limitation

The limitation of this increase includes their instability even when there is a small difference in the learning data. Selection of the variables and cut points for the selected variables hang on the observations made in the learning sample. If there is a change in the first splitting variable due to a minor change in the learning data, then there is a probability that the structure of the entire tree might have been altered. Therefore it can be concluded that the single predictions have a high variability rate [9].

2.3 Construction simulation

Most of the construction projects involve repetitive activities such as the movement of the projects. If the decisions taken goes in the wrong direction they can cost a lot of expense along with time and energy. while if the project planning involved the right decisions at the right planning state a substantial time, money, effort, and energy can be spared. Due to the stochastic nature of the process of construction, the data collected from the preceding experiences and projects can help in the elimination of errors and risks. Because planning engineers can make an improved evaluation of expected productivity rates [10]. In the traditional method, the planning engineers manually add and adjust the productivity record for the establishment of expected values and figures. Due to the rising complexity and size of the project decision making and planning were becoming inaccurate because of human errors. To ease this complexity of estimation introduction of simulation, pickney has helped in various operational and managerial projects. it is a powerful tool that is being used as artificial intelligence in the systems for the prediction and accuracy of estimations regarding the construction processes.

Although construction simulation is a potent tool that is being applied by various companies for resource planning, designing, and analysis of the construction method. It is still dependent upon the human corrections as it only estimates depending upon the data which is being saved and processed in this system. As it cannot make any assumptions irrespective of the data. Therefore, it does not provide complete independence [11].

2.4 Productivity Assessment

These days productivity management is considered a key concern regarding the management of projects in the industry of construction. As the project varies, the level of productivity regarding construction also varies according to the atmospheric and organizational situations. the impact of factors affecting the productivity of the project is considered important in the productivity estimations. These factors can affect both positively and negatively on productivity. Human factors, weather conditions, change orders, and materials management can be the possible factors for determining the productivity rate of any construction project. At the initial step in the creation of a model for the productivity estimation identification of these factors can lead to better planning utilizing artificial intelligence because AI can predict possible risks through effective calculations [12].

Moselhi et al. [13], Introduced a supportive system that was able to make the decision named WEATHER for the prediction of climatic conditions regarding the efficiency of operations during the construction. This model was developed to make the estimations in the construction productivity to have a better prediction regarding activity durations and patterns of weather to

improve the planning and scheduling of the model to reduce the risk which can affect productivity. Moslehi et al. [14] then utilized the simulation system in 57 different projects to check the impact of changes during construction projects.

It was then discovered that there is a straightforward correlation between labor components of change orders and production damage in all kinds of projects. These predictions from then are being used in the estimation of losses regarding the changes.

2.5 Artificial Neural Network – ANN

ANN is a mathematical model that is being used to search for the finding the patters among t eh huge datasets when during the construction planning there are complicated relationships found between inputs and outputs. Through ANN attempts are made to stimulate and make it able to function and operate as a human neural network system. One of the major achievements is the capability to learn from the mistakes and this system due to this ability is approaching the heights of perfection. As ANN Act like a black box and cannot be used for the explanation of the reasoning process Therefore it can be restricted to the areas where there is no need for the explanation. It is well suited to the problems where the value of input-output relations is not being researched [15].

In recent years ANN has been widely used in the forecasting and prediction of the models which are being used in the construction industry. Researches are being made in different areas of construction management which includes cash flow predictions, risk analysis, optimization of resource, and construction productivity assessment.

2.6 Fuzzy Logic

As compared to ANN fuzzy logic was developed and introduced to resolve the necessity for systematic reasoning that can improve conform to human logic. Fuzzy logic is aimed at connecting the input space to an output space. Fuzzy models have their basic rule which contains the list of all the rules. Through the parallel evaluation, the inference procedure is performed. In different areas and fields of construction management, the concept of fuzzy reasoning is being applied. Car and Tah [16], used the fuzzy model to relate and address the risk assessment and analysis. They explained that risk information of a specified project is based on the items and procedures which are to be utilized during the process. These items are catalogued and are customized for each project. Therefore, the results would be according to the requirement of that project. The implementation of fuzzy logic makes the use of descriptive linguistic variables for the description of risks and their associated consequences.

Zhang et al. [17], demonstrated the relevance of fuzzy logic in discrete event simulation. The fuzzy simulation uses the fuzzy sets to explain the quantity of the resources which are required for the activation of an activity. These activities are regarded as constants incorporating the fuzzy logic rule to control the stimulation of behaviors. They further explained that the length of the construction project changes with the change in amounts of supplies implicated in the procedure of action. Fuzzy simulations give an alternative to the uncertainties of the models by contemplating the dynamic characters of the operations being done during construction in real-time situations. The results of experiments depict that flexibility in demand regarding the resources can have a positive effect on productivity which is being practiced at construction sites.

Paek et al. [18], implemented a multi-criteria methodology of decision-making with the use of a fuzzy-logic system for the selection of a design or build proposal. To reduce the cost of construction and reduction of time and money, several design projects are introduced and proposed in opposition to the traditional methods for the building. However, for this purpose there is a need to maximize the degree of technical factors and minimizing the cost of construction, the evaluation method is filled with uncertainties. To remove or minimize these uncertainties, this study was aimed at utilizing the criteria of decision-making method with efficient usage of a fuzzy logic system. This system is introduced to assist in making the decision which is a better-suited design proposal to satisfy the needs and requirements regarding the physical and environmental conditions along with the reduction of cost.

Fuzzy logic and ANN both complement each other. ANN can learn from the data, but its limitation involves the unavailability of explanation regarding the value of the input-output mapping process. Fuzzy reasoning offers a systematic reasoning procedure which is more compatible and closer to human logic and intuition. But its limitations include the need to make itself to adopt techniques of self-regulation to differentiate it from other areas. The constraints of these two procedures led to the introduction and development of another AI system known as a neuro-fuzzy system. Hybrid intelligent systems include the term neuro fuzzy as the fusion of both techniques i.e. ANN and fuzzy logic [19]. This fusion led to overcome the restrictions of both techniques as the shortcoming of one technique is covered by another. Although the utilization of neuro-fuzzy technique is being practiced it still is not common.

2.7 Genetic Algorithm

Genetic algorithm (GA) is it mattered which is developed by the optimization of artificial intelligence

base techniques, which imitates the natural mechanism of evolution. The genetic algorithm has boosted the structure optimization and parameter fine-tuning procedure of neuro-fuzzy systems. An evolutionary approach is used to find the solution to problems for finding the best options for a potentially better future. In GA random individuals are selected for the production of a population which then evolves itself through the evolutionary procedure in a natural way by mutating and altering the properties of a population. The performance of every representative of the population depends on some standards of fitness. These fitness criteria then determine the basis on which the next generation is selected and which characters are to be migrated in the next generation [20].

Due to advancements in technology AI has made its way in every field of life including construction planning and risk management along with better decision making to minimize the costs and effects of the variables. AI has enabled the planning engineers to go for more complex construction plans minimizing the efforts, costs, and errors regarding construction projects. These days the use of hybrid systems which includes the use of artificial intelligence can enhance the accuracy and productivity of the construction operations and projects. Further modifications in the upgrade of these systems are making its marks in these systems predicting the variables with much more accuracy and precision. The limitations of artificial intelligence or systems including AI is sticking of these systems to the data provided. Even the hybrid systems like neuro-fuzzy systems are unable to follow the rules through which the human intuition can be proposed. In other words, it can be interpreted as it functions like neural networks as a black box without having a clear interference of human thinking procedures. The method for the selection of variables is not conducted even in the advanced systems of AI for the selection of input variables which are necessary for the specification of neutral or deteriorating factors [21]. The major restriction of AI is its inability to make decisions as it is still dependent upon the humans for the data entry. It only analyzes and interprets the data that is being fed to the system. But still, these limitations cannot deny the usefulness of its use in various engineering fields and especially in construction planning which is helping this industry by minimizing the risks of aftershocks from the variables.

3 Research Methodology

Because of the risk management, the executives have become a fundamental strategy in the advancement of any development venture; by and by, its usage includes the utilization of the essential ideas, for example, "Hazard" and "Vulnerability". These ideas are regularly befuddled and used like equivalent, in any event, when they are unique as seen in Figure 1.

Risks: are recognizable and quantifiable potential occasions or factors; from which, negative (perils) or positive (possibilities) results may happen 250.

Vulnerability: alludes to obscure and unforeseeable occasions or factors; which no measurement or practically no distinguishing proof is conceivable.

Subsequently, it's essential to separate between these two ideas; a large portion of the dangers are conceivable to recognize and control, they can be arranged in Perils and Possibilities, while vulnerabilities are consistently startling and additionally not quantifiable. Figure 1 presents the conduct of vulnerability and hazards through the diverse venture stages. At the early stages, the vulnerability has a significant impact on the venture condition than dangers; therefore, as the task progress along the improvement stages, the nearness of risks become higher than the vulnerability, or the most part since vulnerabilities are distinguished and measured as explicit undertaking dangers. A short time later they are overseen to accomplish the undertaking possibilities and to keep away from its risks.

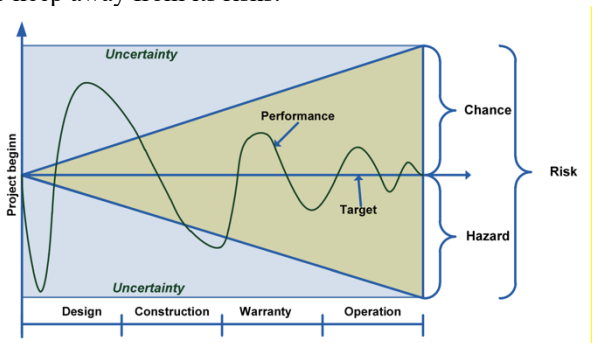

Figure 1. Risks & Uncertainty

3.1 Risks Evaluation Methods

Risks examination strategies manage the assessment of dangers; Risks measurement implies that probabilities can be related to anticipated qualities or results; nonetheless, its adequacy relies upon the past strides in the RMP because those means are the establishment of the entire procedure. The arranging procedure for executing Risk the board is a critical stage, it gives the chance to the venture and hazard supervisors to clarify and depict in subtleties what chance administration is about, why it is imperative to have a risk group, what is normal from them and what are the expectations. Consequently, threat reporting and verbal exchange play a crucial function beneath the threat analysis process; it is also an outstanding chance to discover with the crew any doubts or questions about the threat management method and also a risk for convincing the project stakeholders, the executives and the relaxation of the

crew about the advantages of imposing a serious quantitative risk analysis.

Risk analysis is the most important milestone for performing an advantageous quantitative assessment. All these processes outline the requirements to be attended on the search of inputs and the definition of stochastic fashions and their functions; consequently, the utilization of quantitative strategies like Monte Carlo Simulation shall turn out to be a requirement for danger analysis. Checklists are in most cases used for threat identification; they are necessary and beneficial for the identification but not sufficient for the analysis.

3.2 Artificial Neural Networks

Although this approach is relatively new in the business world, the unique idea used to be developed in the '60s together with the algorithms and some theoretical approaches. Nevertheless, the lack of ability with the computers´ processors stored this technique in the shadow for many years. ANNs comprise their structure, exclusive sections of layers, the middle ones generally are known as the hidden layers. The conceptual process of ANNs is conformed of an enter vector, a switch function, and an output vector (see Figure 5).

The switching characteristic with its limits is very frequently referred to as a "black box", this is due to the fact at this phase an inside system for adjusting and calculating new weight for the network is performed and this system is now not found by means of the designer.

The foremost gain of ANNs is that the entire process (training and testing) mimics the human's intelligence reasoning. In different words, it learns via the experience: Once an excellent database is developed, the chances to acquire dependable predictions with ANNs are very feasible.

One instance of the practicability of the ANNs is the Neuronal Risk Assessment System (NRAS) developed by using Maria-Sanchez. 254 This approach indicates a very practical manner for implementing ANNs for assessing the risks in infrastructure projects. The essential goal of the gadget is to decide the contingency quantity based on unique mission risks. The consequences exhibit the capabilities of ANNs to mimic the data, offering a wonderful new strategy for performing chance analysis. In addition, in modern times it is feasible to discover business reachable ANN tools.

3.3 Support Vector Machines

The SVM is a technique from the synthetic Genius that has proven excessive attainable for its applicability in the threat analysis. Vapnik defines this technique as a statistical mastering theory; [22] it works below the identification, screening, and separation of the information in hyperplanes primarily based in a support vector. In this form, the information is categorized in various dimensions (hyperplanes); as a 2d step simulations are done via growing statistics internal of the numerous hyperplanes. The SVM lets in to research from a described database and from this gaining knowledge of the procedure to forecast feasible results, in this form it is possible to perform simulations with a greater legal responsibility derivate from the studying process.

From these three techniques SVM represents a very promising technique because it allows us to examine from the statistics and simulating besides assumptions (like MCS); the simulation is primarily based on the recognized hyperplanes, which make bigger certainty. However, the technique is based on the synthetic talent theory and requires a considered quantity of facts to operate its learning process.

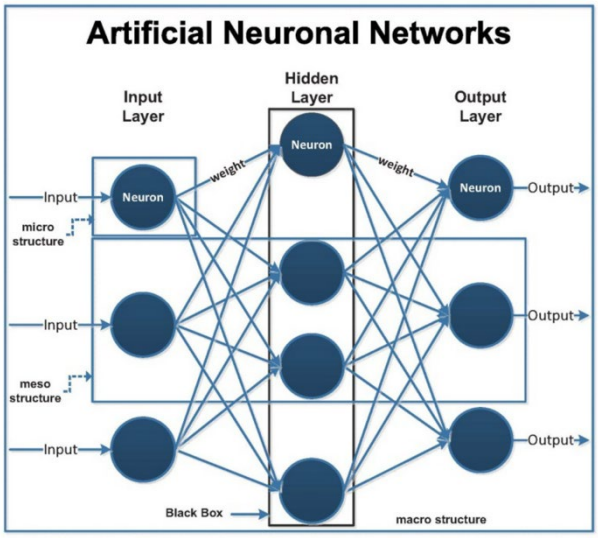

Figure 2. Artificial neuronal Networks Functionality

4 Experiment

The Support Vector Machine ought to emerge as a methodology of the synthetic intelligence that will be used in the chance analysis; it lets in a first step to perform a studying system to display screen and separate the before amassed data in hyperplanes. As 2d step, it implements a simulation system in order to convey probabilities to the anticipated danger or value. But the utilization of danger analysis in the praxis relies upon the availability of the required tools to operate this kind of evaluation for the threat evaluation practitioners. Until these days there is no commercial application of the SVM, therefore for its employment is crucial to create computer programs.

Thus the mixture of ANNs and MCS shall emulate its functionality, from existing commercial programs. The downside of MCS is the use of assumptions in its

procedure. This can lead to dispersion will increase with the inputs and in the corresponding delivered results, or in in the worst case, into blunders and misconceptions; for example, when the threat analyst does now not have ample experience, can create ambiguous surroundings to the whole process and this can affect the excellent and outcomes of the complete implementation.

MCS allows simulating dangers but the inputs nevertheless need to be described as a section of the qualitative analysis. Better inputs can be observed through ANNs: They enable predicting values from defined records banks; therefore it represents an essential useful resource for the definition of inputs for the MCS. Consequently, the mixture of both strategies shall minimize the opportunity of mistakes, by means of defining the initial values with the ANNs and the use of MCS for the simulation process.

ANNs are one of the new strategies from the synthetic Genius discipline that have emerged and observed its applicability in risk analysis. It has two key steps for enforcing in danger management. However, a vast database is wished in order to educate and check the network. Different network designs can be done and for some algorithms, the training and trying out process can be extra effortlessly done if the design is environmentally friendly and practical.

4.1 ANNs Prediction

The software of the ANNs needs a facts bank of the advantageous ability relying on the relevant criteria. For lack of measured web site facts, it was created based totally on the components and values through the ability of the addition technique in building machines. The statistics bank includes a wide variety of 12 criteria; via the formulation, we can decide the "exact" end result (important for the check of the ANNs) of the superb capacity. For each of the 12 standards a range was determined and thru the utilization of a random generator quantity one thousand one-of-a-kind result combos have been created, having the end result and criteria a direct relation.

The textual content criteria have been created with the utilization of numerical facts and they were replaced with text for its checking out in ANNs. At the give up each and every system was once deleted, final just the numbers and text without any relation rule, for the assessment of the ANNs.

ANNs estimate the manufacturing-based totally in the Data Bank, the regular manner with the aid of ANNs is as seen in Figure 3. The Data Bank needs to be elaborated and loaded into the ANN program, the impartial and dependent criteria must be specified.

The second step is to get to know the method (training) for the ANNs has to be described properly with error tolerance. Afterward, when gaining knowledge of the procedure is concluded, the trained ANN ought to be examined for its liability. When the checking out system is efficiently achieved, the prediction takes place.

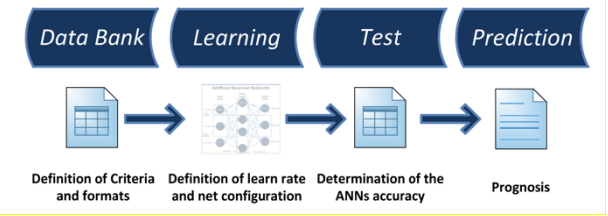

Figure 3. Artificial neuronal Networks Functionality

For the present instance, two results/outputs were searched. It is necessary to remark that these two consequences had been acknowledged through the formula, for that reason it was once extensive to affirm how dependable had been the outcomes produced through the ANNs.

5 Conclusion

The utilization of the ANNs collectively with the MCS permits increasing the simplicity in the data with the aid of identifying the inputs for the simulation process. The studying manner contained in the ANNs permits to decrease the variant (maximum and minimum values used with the distribution functions and for this reason in the histograms) delivered by means of the MCS. This system mimics the human procedure. Each and every deliberation carried out through experts, resumes the comparison of similar standards and experiences from completed comparable situations reproduces this contrast system with excessive liability. Pondering by the different facet does now not permit to function such dependable quantitatively valuation; the subsequent utilization of MCS lets into combination editions in a smaller range collectively as correlations with different criteria. Finally, the MCS grants better hazard evaluation and reliable quantification of risks.

Another advantage is that the learning process approves to encompass concerns of uncertainty. In the presented instance each result was once created for the checking out of the ANNs.

When actual facts are collected, they represent real results. For this reason, the ANNs will analyze to simulate the issues of uncertainties and would provide results that could be nearest to reality.

An important hurdle for the ANNs is the required Data Bank. One of the most attribute houses of the development enterprise is the specialty of each and every infrastructure project; therefore, the variations in the standards are not constant or similar in many cases. This may complicate the improvement of an accountable Data Bank. On the other hand, the consideration of text and

uncertainty influences in the amassed criteria may additionally even confer simpler tasks and flexibility once a Data Bank is created. The mixtures of these two threat evaluation techniques possess an outstanding possibility for imposing threat administration with the use of defined databases. The project managers typically remember in specialist support for deciding price estimates, project planning, sources needed, etc. ANNs are the perfect system to furnish this understanding as soon as an ideal database is available. For example, if a set of fees estimate statistics is available, then an ANN can be constructed based on that records and complete price predictions can be gained whilst simulating the networks.

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