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Automating Pre-award Contractual Risks Identification Process using Artificial Neural Networks

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ABSTRACT

This research provides an overview of project management across various domains, focusing on the automated identification of contractual risks during the pre-award stage using Artificial Neural Networks (ANNs). The pre-award phase of construction projects involves evaluating contractual risks to ensure successful project execution. Traditional methods of contract analysis are often time-consuming, manual, and prone to human error. To address these challenges, the integration of AI, specifically ANNs, offers a promising solution to automate risk identification and assessment, leading to more efficient decision-making processes. This research explores methodologies for developing a sophisticated and reliable model, with the input of software developers serving as subject-matter experts based on a qualitative analysis of data extracted from domain expert interviews. This research conducts a comprehensive literature review on AI applications in construction project management and risk assessment. The literature review aims to identify gaps in the field where ANNs can significantly impact pre-award contractual risk identification. The expected outcome of this research is to present a suitable approach for developing an ANN-based framework to automate risk identification regarding contractual risks during the pre-award stage, demonstrating the benefits of automating this stage in the project life cycle. The objective of this research is to harness comprehensive data, including prior studies on risk identification in contract stipulations and the application of Artificial Neural Networks in construction contracts. The study's scope is limited to construction projects governed by the FIDIC 99 Redbook, highlighting previously limited trials in this regard, and after analyzing them, introducing a suitable direction for automating this process. The findings of this research will direct future research to the development of a comprehensive contract risk analysis model utilizing ANN, enhancing decision-making processes in construction projects.

Keywords: Artificial Intelligence, Risk Management, Machine Learning, Artificial Neural Networks, Construction Management, Construction Industry.

1. INTRODUCTION

The realm of project management applications in construction is witnessing a paradigm transformative shift with the advancement of Artificial Intelligence (AI). This transformative technology is not only enhancing the construction industry but also redefining the way traditional processes are applied through automation. It brings forth unprecedented opportunities for innovation

and efficiency, ushering in a new era of precision and effectiveness. The purpose of this research is to examine the impact of AI applications on project management in various domains and provide a detailed analysis of the benefits that arise from integrating automation and AI in construction processes. Specifically, this study focuses on the assessment of risks in contract conditions analysis and explores the potential for automating the contract review process during the tender stage by utilizing Artificial Neural Networks (ANNs).

Construction contracts analysis: for generating risk assessment is going to heralds a significant advancement whenever the use of AI in this trade start to be maturely applied. It worth to highlight that project management research usually spanned various domains, yet the full advance integration of AI methodologies is still relatively nascent in this filed. Algorithms AI, being able to process vast datasets in short duration, offers a nuanced risks identification, enabling a proactive approach towards risk mitigation and possible elimination.

The predictive capabilities of AI should be harnessed to extend to contract analysis, where it can identify potential risks by automating the contract review process. This application of AI holds immense potential to revolutionize contract analysis and risk assessment, providing tools for more accurate decision-making and safeguarding contractors from known risks and contractual pitfalls.

In the pre-award phase of construction projects, commonly referred to as the tendering stage, contractors face the challenge of identifying and evaluating contractual risks within a constrained timeframe. Traditional manual methods for this task are not only time-consuming but also prone to human error. By supporting contractors in identifying contractual risks during the tender stage, we can significantly enhance pricing accuracy and reduce the likelihood of future disputes between contracting parties.

Research gap was identified in construction as this industry faces a significant challenge during one of the most important stages in project life cycle which is the tender stage. The tender stage is timeframe constrained for providing accurate price and contracts review. Usually, contractors don't have the necessary time for identifying the contractual potential risks, leading to inaccurate

pricing based on unidentified risks. Automating the contract review process and risk identification enhancing the accuracy of cost estimations by identifying contrails risks at this stage by the integration of Artificial Neural Networks (ANNs) presents a great promising solution for this problem.

Automation of a certain manual traditional processes in pricing stage process by the deployment of AI driven system revolutionizes construction process, reducing human error, decreasing the necessary number of experts needed for this job, enhancing team productivity. There are manifold benefits from integrating AI application in construction, ranging from optimized workflow, reducing error to improved resource allocation and increase the overall efficiency.

The main goal of This research is to delve into the massive benefits of the integration of AI application in construction, shedding the light on how AI can identify, categorize, and mitigate future risks and disputes in construction projects.

Artificial Neural Networks (ANNs) have been instrumental in advancing project management. Their ability to adapt and learn has proven beneficial in both project management and decision making. Previously published papers after reviewed reveal positive impact of ANNS on schedule adherence, cost estimation and overall project performance. ANNs can learn patterns based on historical data, which can then be used to estimate values that depend on several inputs, such as project duration, complexity, number of resources, and projected cost [1].

This is also emphasis more on the scarcity of published research for the utilization of ANNs application in contract review and analysis. Confirming that this AI application step in contractual risk identification must be conducted. Regarding the scarcity of published research on the utilization of ANNs in contract review and analysis, it's true that while ANNs have been widely used in science and engineering, their adoption in project management has been slower, possibly due to a lack of awareness.

Today the role of AI applications in construction projects is poised to expand, as we are standing on the brink of a new technology, there is a great potential that AI will vastly transform the construction industry in the near future as we will see projects are executed with higher efficiency and unprecedent accuracy.

1. LITERATURE REVIEW

Artificial Neural Networks (ANNs) are increasingly being integrated into the domain of construction management, recognized for their proficiency in addressing multifaceted issues. The deployment of ANNs within risk prediction frameworks for construction endeavors constitutes a pivotal research domain. These frameworks are designed to prognosticate potential risks associated with temporal and financial excesses, which are prevalent impediments in construction ventures.

The realm of construction often witnesses disputes escalating into extended legal confrontations, attributable to the intricate and fluid nature of contractual agreements, coupled with the substantial financial stakes typically involved. Traditional litigation processes for dispute resolution are marked by their protracted duration and exorbitant costs, thereby underscoring the imperative for more efficacious predictive mechanisms.

Neural networks represent an intriguing and potent segment of artificial intelligence, emulating the cognitive functions of the human cerebrum to assimilate data and formulate decision-making patterns. These networks comprise a series of interlinked nodes, reminiscent of the extensive neuronal network within the human brain, collaborating to decipher complex challenges. Neural networks excel in discerning latent correlations within datasets through an operational paradigm that parallels cerebral functions.

Within the construction sector, neural networks have been harnessed for a broad spectrum of applications, fundamentally transforming project management and execution methodologies. They are instrumental in anticipating project trajectories, refining resource distribution, and bolstering decision-making protocols. For example, neural networks are capable of predicting temporal and financial deviations in construction projects, evaluating risks, and even appraising construction expenses with a higher degree of precision than conventional techniques. By capitalizing on historical datasets and pattern recognition, these networks furnish critical insights that contribute to minimizing resource wastage, augmenting safety measures, and ensuring project completion in adherence to budgetary and temporal constraints.

Artificial Neural Networks (ANNs) have increasingly been applied in construction management (CM) over the past decades. This study reviews 112 articles published from 2000 to 2020, focusing on ANN applications in CM. This field has not seen comprehensive systematic reviews recently, hence the current effort to assess the state of research, identifying gaps, trends, and evolution in ANN applications within CM.

Construction projects are multifaceted and encompass a multitude of risks that can highly impact the project's schedule and budget. The precocious identification and prognostication of these perils are imperative for efficacious project pricing. Artificial Neural Network (ANN) models are especially advantageous in this milieu, as they possess the capability to assimilate voluminous datasets and discern correlations that might may not be apparent through conventional analyses.

The incorporation of ANN into the management of construction projects signifies a paradigmatic transition to heightened efficiency. This integration empowers project participants to appraise the fiscal significance of prospective risks and formulate commensurate strategies for risk mitigation.

The following part of this research delves into the extant models and trials within the research domain, critically examining their constraints, breadth, application, and precision. It also illuminates potential advisements pertinent to these models. The construction sector is notoriously fraught with a plethora of indeterminate risk that emerge throughout the construction process, potentially imperiling the results of the project [2], as evidenced by the prevalence of litigations and claims [3].

Recently published research focusing on machine learning strategies application, using ANNs, for the purpose of predicting both construction projects time and cost overrun. It emphasizes the importance of identifying risk indicators and proposes a model that is both accurate and easy to understand. Research Gap was identified highlighting the need for accurate and comprehensible models for risk indicator identification. The study likely employs K-nearest neighbor and ANN algorithms, focusing on enhancing prediction accuracy and simplicity. The proposed model aims to be both accurate and user-friendly and regrading its validation the results were 83.76% in the KNN model and 99.28% in the ANN model [4].

Another research introduced Artificial Neural Network (ANN) model for predicting the final cost of construction (FCC) at an early stage in Saudi Arabia. the challenges of accurate cost forecasting in the construction industry were addressed. Also, the need for and importance of a predictive cost model was explained as to enhance accuracy in cost estimation. It highlights the growth of Saudi Arabia's construction market and the necessity for adopting modern technologies in construction management. Data from 135 Saudi Arabian construction projects were collected and analyzed to develop the ANN model. ANN model utilizes contract cost, duration, and project sector as inputs, employing the Zavadskas and Turskis logarithmic approaches and the Pasini method to handle limited data. The model underwent a two-stage development process, including data enhancement and abnormal data identification. The research adds emphasis on the need for intelligent models that can interpret time and cost forecasting and analyze input parameters. The ANN model demonstrated a mean absolute percentage error (MAPE) of 18.7%, which reduced to 8.7% after eliminating data with high errors. The model's effectiveness in predicting FCC allows stakeholders to evaluate financial risks and develop risk management strategies early in the project lifecycle. It is concluded that cost models underscores that the ANN based model's potential to transform cost estimation practices by

providing a reliable tool for early-stage cost prediction in construction projects [5].

Shifting the research to green building projects (GBPs) in addressing climate change and sustainability, highlights the challenges particularly in cost and schedule overruns, introducing machine learning (ML) as a solution for accurate cost and duration prediction. GBPs considered essential for reducing the environmental impact of buildings, which are major contributors to energy consumption and carbon emissions The study emphasizes the need for accurate predictions to avoid overruns and improve project performance. The research employs historical data from 198 GBPs in Hong Kong to develop deep neural networks (DNN) and support vector regression (SVR) models. These models aim to predict project cost and duration based on various parameters, including green building ratings. The Data collection was gathered from BEAM Plus-certified projects, including scores in different green building categories and other project features. Interviews with project stakeholders provided additional cost and duration data [6].

The data underwent preprocessing to address issues like domain shift and selection bias. The study used statistical measures like MAPE and RMSE to validate model accuracy. The integrated DNN-SVR models showed improved prediction accuracy for GBP cost and duration. The study also developed a web application for automated predictions. The research concludes that the integrated ML models can significantly enhance the prediction accuracy of GBP cost and duration. It also finds that green building ratings are not the most influential factor in cost and schedule overruns, contrary to common belief. The research study provides valuable insights for policymakers and practitioners in the construction industry.

Since cost estimation in construction projects considered to be important factor in projects success, which is affected by a wide range of variables, another trail was applied. This time the research was targeting more efficient cost prediction and control using Artificial Intelligence model using deep learning track. As the researcher find that there is a lack of dynamic and intelligent cost estimation models. A model utilizes Deep Neural Networks was introduced to identify significant cost components and variables, aiming to improve operational efficiency and competitiveness in construction firms for the preliminary cost of building projects and dynamic management of the control system [7].

Construction project considered to be a high risk industry in terms of budget and legal dispute, this study focuses on the delays impact on the cost overruns based on certain risk. It emphasizes the importance of early risk prediction to ensure project success and introduces an artificial neural network (ANN) approach for risk prediction. Literature review and a questionnaire survey involving 100 respondents, the research identifies 60 risk factors and employs MATLAB software to develop an ANN model3. This model effectively predicts risks at early stages, aiding in the management of time and cost risks in construction projects. The required data was collected through distributed survey among industry professionals focusing on cost and time risks. The responses helped in determining mean values and critical risk factors, which were then used as input for the ANN model. The study introduced early risk prediction methodologies by proposing an ANN-based model using MATLAB software, which is a novel approach in the construction industry for forecasting risk impacts on project time and cost.

The study results Concluded that ANN model demonstrated high accuracy in predicting risks, with the potential to be applied to various types of construction projects. Emphasizing that such predictive models can significantly contribute to risk management and the successful completion of construction projects within budget and schedule. Future research could explore other machine learning algorithms for risk prediction and compare their effectiveness [8].

A collective study was introduced presenting a scientometric review of the application of Artificial Neural Networks (ANN) in Construction Management (CM), highlighting the increasing use of ANN as a powerful AI tool in CM over recent decades. It addresses the lack of systematic commentary on state-of-the-art research in this domain, particularly since the last comprehensive review published in 2000. Utilizing scientometric analysis, the study examines 112 articles from seven authoritative journals published between 2000 and 2020. The analysis includes co-authorship networks, collaboration networks of countries/regions, co-occurrence networks of keywords, and timeline visualization of keywords, revealing the main research interests and their evolution in the field [9].

The interdisciplinary nature of CM led to the selection of the Web of Science database for its comprehensiveness and scientific robustness. Articles in the study were chosen based on their impact and quality in CM, with a focus on those that featured ANN as a main technology or played a significant role. The paper identifies a gap in systematic research and sufficient attention to ANN applications in CM. Certain challenges was introduced such as data collection, storage, stakeholder collaboration, confidentiality of information and systematic platform design are noted as areas needing further exploration. It was concluded that there is a need for more systematic research in ANN applications within CM. The paper calls for increased collaboration among stakeholders, researchers, and countries to overcome

challenges and improve platform design, ultimately enhancing the performance of CM through intelligent technology. This research insights are valuable for researchers and construction industry practitioners committed to advancing ANN in CM as it argued most of the recent published research.

Previous remarkable research addressed the challenge of predicting court decisions in construction contract disputes due to the dynamic and complex nature of the construction industry. It references studies highlighting the financial impact of disputes on construction projects introducing an early way to predict court decision using Fuzzy-Logic. The study introduces a two-layered fuzzy logic model for prediction, utilizing 100 cases from Iranian courts. For model preparation a questionnaire is designed to extract fuzzy rules and important decision parameters from experts with over ten years of experience in relevant fields. The proposed model incorporates a two-layered fuzzy logic-based decision-making architecture, trained using 10-fold cross-validation. It aims to establish interpretable AI models using argument before machine learning (ML).
Research results analysis shows that contract clauses related to termination of contracts significantly impact construction disputes and that the hierarchical fuzzy system correctly predicts nearly 60% of the test data, furthermore, the study identifies 15 key factors influencing court decisions the major three of them are project conditions, contracting parties' conditions, and root causes of the disputes. it was concluded that a fuzzy model with a hierarchical structure can serve as an efficient method for predicting court decisions in construction contract disputes. It also highlights the model's resistance to missing data and its potential for practical application [10].

In addition to the previously mentioned aspects, the duration of construction projects is a critical factor in their study and success [11]. The importance of adhering to the project's completion timeline necessitates early and thorough planning of project resources and accurate estimation of project duration [12]. Furthermore, it is essential to incorporate mitigation measures for cash flow and material planning [13]. Consequently, the estimation of project duration using Artificial Neural Networks (ANN) is vital. Research has demonstrated the effectiveness of a two-stage ANN in predicting the duration of construction projects, even with limited information available at the early stages.

The previous literature review highlights clearly the deficiency in models aimed at identifying and categorizing contractual risks during the tender stage, mainly most of the previous established models were targeting either cost estimation or cost overrun. Previous attempts to automate this process have been notably limited, primarily due to three constraints: the scarcity of confidential contractual information, the limited availability of domain experts in construction contracts and claims, and the shortage of programmers capable of recommending appropriate model types and their applications expect for very limited research as the following one.

2. RESEARCH RATIONAL, PROBLEM STATEMENT AND OBJECTIVE

Previous research underscores the criticality of integrating robust project management methodologies to enhance the overall performance if construction projects, as evidenced by [14]. The advent of Artificial Intelligence (AI) within the realm of construction industry is anticipated to be a pivotal instrument in propelling and achieving project success.

The constraint of limited time during the tendering phase significantly impedes the identification of potential contractual risks [15]. Failure to clearly identify these risks at this stage can result in inaccurate pricing and subsequent disputes between parties. Effective project management practices are essential for enhancing the overall performance of construction projects [14]. Additionally, the application of Artificial Intelligence in the construction industry is anticipated to be a highly effective tool, substantially contributing to the success of construction projects.

A salient repeated challenge encountered by contractors in construction industry is the invariably constrained timeframe allocated for them in the tender stage, which is mostly insufficient for conducting a comprehensive review of all the contract documents including contract terms and conditions, thereby impeding the required identification of possible contractual risks. The tending phase is characterized by its stringent time constraints and its paramount significance.

This discourse delves into prospective and historical trajectories of AI's role in construction. Complementary research by [16] elucidates the synergy between AI applications and Construction Engineering and Management (CEM), delineating cutting-edge research that substantiates the advantages of AI integration in the process of CEM.

Implementation of automated risk identification processes during this pivotal juncture could significantly augment the efficiency and expeditiousness of risk detection and impact evaluation, particularly during the tender phase, directly exerts a pronounced impact on two principal determinants of project success: cost and time. Accurate cost and time estimation are instrumental in mitigating the frequency of disputes among contracting entities in the latter stages of a project.

An AI model can be devised to bolster this aspect within construction contracts. The proposed methodology encompasses the risk identification and prioritization for contract clauses across various construction contracts. Risks are classified according to their likelihood and potential impact, culminating in the creation of a database of high-risk clauses. Subsequently, the necessary criteria for creating a model should be identified as to streamline the process of risk identification and classification for contractors during the tendering phase.

3. RESEARCH METHODOLOGY

This study utilizes extensive research on previously formulated AI models to facilitate rigorous scholarly inquiry. This examination is crucial for comprehending the foundational principles of these models, examining their primary inputs, and identifying both their merits and weaknesses. Such an analysis is instrumental in refining current applications and circumventing known limitations. Moreover, the discourse extends to debates on methodologies for crafting a more sophisticated and dependable model. Upon defining the optimal criteria and framework for the model, its practicality is influenced by software developers who serve as subject-matter experts.

In collaboration with domain experts, a dataset is utilized to identify high-risk contractual provisions, classify them, and evaluate their potential influence on the financial and temporal aspects of construction projects. These experts are entrusted with identifying risky clauses that should be considered during the tender phase and appraising their potential ramifications on project budgets and schedules. This procedure is executed through methodical interviews with eight seasoned professionals in construction management, focusing on contract and claim negotiations.

The interviews were structured to facilitate a thorough examination of the experts' insights and proficiencies. Given the scope of the research, the discussions were concentrated on the widely recognized FIDIC Red and yellow books with their versions published in 1987 and 1999. Authentic construction contracts were procured, and their clauses were systematically cataloged, ensuring a comprehensive evaluation during the interview process. The interviews were structured around pre-established inquiries concerning the risk assessment of each clause within the FIDIC four books and their anticipated impact on project duration and/or expenditure.

The formulated questions were presented to the domain experts, and subsequent discussions were initiated to evaluate and refine their responses, as a polit study 2 interviews were conducted with each expert on one of the four FIDIC books, considering the different in nature between the FIDIC Yellow book which is a design build contract form as the design to be executed by the contractor and the nature of the FIDIC Red book which is a construction only contract form and the design to be provided by the employer. It was concluded that gathering information for the two types of books and initiating the required questions for the interview will not be practicable due to the differences nature between the forms that requires several paths of data collection and different type of experts to be able to reach accurate data analysis. Therefore, it was concluded that focusing on the FIDIC Red book two versions will be more efficient.

Further step in interviews process it was also discovered that FIDIC organization changed the forms a lot between the Red book versions published in 1987 4th edition and the released one in 1999, the number of the articles decreased massively regarding the liabilities and obligation.

Formulated questions were presented to domain experts, followed by discussions to evaluate and refine their responses. As a pilot study, two interviews were conducted with each expert, focusing on one of the FIDIC books. The FIDIC RED Book two version 1999 & 1987, a construction-only contract form where the employer provides the design. It was concluded that gathering information for both types of books and formulating the required questions for the interviews would not be practical due to the differing natures of the forms. This would necessitate multiple data collection paths and different types of experts to achieve accurate data analysis. Therefore, it was decided to focus solely on the one version of the FIDIC Red Book for efficiency.

Accordingly, and for the efficient of the model the conclusion was to work on a single base form with is the FIDIC 1999 Red book targeting more efficient data collection and model prediction accuracy.

When developing Artificial Neural Network (ANN) models, determining an adequate sample size is essential for ensuring accuracy and reliability. Research suggests that the sample size should be proportional to the model's complexity, particularly the number of weights or parameters. A common guideline is to have a minimum sample size of fifty times the number of weights in the ANN the rule of thumb [17]

$$Nw = (I + 1) \times H + (H + 1) \times O \quad (1)$$

The questionnaires for the newly structured interviews were prepared and then the interviews were applied. These interactions occur either in person or via virtual meetings, adhering to the best practices suggested by [18], with each session spanning approximately 3 to 4 hours. The interview framework is meticulously designed to elicit detailed information regarding the participants' (a) background and proficiency in construction contracts,

(b) perspectives on the risk magnitude and consequences for each clause, (C) acquaintance with the FIDIC 99 Redbook provisions, and (d) prognostications on the potential impacts emanating from each clause. The insights from these interviews are crucial in constructing a repository that encapsulates a comprehensive analysis of the clauses, focusing on risk factors and their potential effects.

This research endeavors to translate theoretical constructs, gleaned from an extensive literature review, into practical applications aimed at developing an essential contract risk analysis model. In this endeavor, numerous challenges are encountered. To eliminate these obstacles, experimental approaches are undertaken, starting with the selection of an appropriate programming environment and language aligning with the model's objectives. While prior studies have predominantly utilized MATLAB or analogous established software, this investigation shifts its focus to programming languages that provide greater flexibility and scalability for model development. Unlike preconfigured software such as MATLAB, which is constrained by its predefined functions, programming from the ground up offers the opportunity to tailor the model to the specific research needs.

Engaging with expert programmers and reviewing contemporary literature on machine learning and AI. It becomes apparent that Python has become the most suitable programming language for machine learning and AI applications. Consequently, the research advances with Python as the cornerstone for model development. Following extensive consultations with seasoned programmers and a thorough review of extant literature on machine learning, it has been ascertained that Python is the optimal programming language for supporting Machine Learning and Artificial Intelligence endeavors. Consequently, the research trajectory has been steered towards the development of a Python-based model within the sphere of contract management. Post-analysis of antecedent studies, this model is posited as an innovation paradigm. To ensure the robustness of model development, the involvement of a programmer with a high degree of expertise and proficiency is considered essential. Subsequently, a series of workshops with Python programming specialists were convened to identify the main architecture of the model, with further details to follow.

The objective of this research is to harness the most comprehensive array of accessible data, including prior studies pertinent to risk identification within contract stipulations, as well as the application of Machine Learning, Natural Language Processing, and Artificial Neural Networks in construction contracts. This endeavor aims to facilitate the discernment of high-risk clauses within the FIDIC 99 framework, their classification, assessment of potential impacts, and the selection of an appropriate AI trajectory for model formulation. The study's scope is confined to construction ventures conceptualized by clients and implemented by contractors under the FIDIC 99 Redbook template. The identification of risk-laden clauses is based on the insights and experience of domain experts, based on their involvement in previous construction projects governed by the FIDIC 99 Redbook conditions.

4. THE PROPOSED MODLE FRAMEWORK

Through the earlier introduced literature review and programmers' conducted workshops, analysis was applied regarding the previously established model for comparing their automated mechanism basis and the globally introduced machine learning and neural network techniques, for selecting the most proper efficient features and function that will be suitable for the expected target model. Mainly 6 machine learning algorithms were identified either by the programmers as the domain experts in the trade or utilized in the identified models in the literature review. It is identified that the six methods can be grouped under two main category, first group is Traditional Machine Learning Algorithms which also called as Classical Machine Learning Models and the second group is Deep Learning Models or Neural Network Architectures, here find below the details and explanation of each group.

Group number (1) Traditional Machine Learning Algorithms contains 4 methods. Naïve Bayes (NB) which is widely used in spam filtering, sentiment analysis, and document classification due to its simplicity and effectiveness with textual data, it assumes feature independence and predicts category, its simple and fast, effective on numeric and textual data but performs poorly with correlated features. Logistic Regression (LR) is commonly applied in medical fields for disease prediction and in marketing for customer churn prediction, it correlates categorical dependent variables with independent variables, it also requires small training data, effective in predicting categorical outcomes, provides certainty with probability values but its shortage is that it Assumes data point independence, struggles with non-linear problems. Support Vector Machines (SVM) is considered to be effective in image classification and bioinformatics, where clear separation of categories is crucial SVM creates a hyperplane to categorize samples with a wide margin, its Effective for linear and non-linear data, robust against overfitting, good for multi-label classification but the results can lack transparency, memory complexity issues. Decision Trees (DT) uses a tree structure of rules to classify data. *Applications*: DT is helpful in customer segmentation and fraud detection, offering easy-to-understand decision-making processes, it is easy to understand, reduces problem complexity, processes qualitative features well but the problem is it

takes longer training time, prone to overfitting, poor out-of-sample prediction.

Group number (2) Deep Learning Models contains 2 methods. Convolutional Neural Networks (CNN) uses convolutional layers to extract features for classification. It is primarily used in visual recognition tasks, such as facial recognition and autonomous vehicle navigation, highly effective for image processing, pooling layers reduce computational complexity but requires large training data, slow training, theoretical understanding is challenging. Recurrent Neural Networks (RNN) processes sequential input features, updating with each new feature. RNN is suitable for time series analysis, natural language processing, and speech recognition, leveraging its sequential data processing capability, Flexible, handles noisy data well, processes sequential data effectively, retains past knowledge but it requires High computing cost, requires large training data.

From the above, it is identified that group (1) characteristics, are model simplicity; these algorithms are generally simpler and faster to train compared to deep learning models, Interpretability; they offer better interpretability, meaning it's easier to understand the reasoning behind their predictions and less data requirement; they can perform well with a smaller amount of data and are less prone to overfitting when the dataset is limited. This group's advantages are faster to train and deploy, easier to interpret and debug and less prone overfitting with small datasets but there are some crucial disadvantages such as it may not capture complex patterns as effectively as deep learning model and often require manual feature engineering. Regarding group (2) the identified characteristics and their common features are the ability of handling complex patterns; capable of handling more complex patterns and interactions in the data with strong ability for large data handling, these models generally require and excel with large amounts of data and, they can automatically extract and learn features from raw data, which is particularly useful in image and language processing.

From the previous analysis and further workshops with domain experts, the available date and the expected model features, and the expected model target output, group (2) methods are selected as it is more fitting for required application. As the expected data input for this type of model is huge, it was found the training model utilizing RNN is designed for handling sequential data and for model training will consume a huge time in case of large dataset. It was recommended by the domain experts to use Transformers. Transformers utilize attention mechanisms for efficient deep learning, Transformers have revolutionized natural language processing tasks like translation, text summarization, and question-answering due to their ability to handle long-range dependencies in text. Unlike RNNs, Transformers provide parallel processing. They can process entire sequences simultaneously, which allows for faster training, they have achieved state-of-the-art results in various tasks, especially in natural language processing. Regarding performance, Transformers generally outperform RNNs and CNNs in tasks that require understanding of long-range dependencies in the data.

The model base was selected to be single base FIDIC 99 Redbook for better performance, and the data collection strategy to be through interviews with contracts and claims specialist in which they have an advance level of experience in dealing with this type of contract forms, the target was identified to clause to establish a model that can support the contractors in the tender stage for contractual risk identification aiming to automate this part of the process as to identify as much risks as possible targeting to decrease the possible disputes that might arises between the contracting parties in a later stage of the project.

The integration of Artificial Intelligence (AI) into construction project management is transforming traditional practices. This research focuses on AI's impact, particularly in risk assessment during contract analysis and the feasibility of automating contract reviews at the tender stage using Artificial Neural Networks (ANNs). Key benefits of AI integration include Speed and Efficiency: Faster contract reviews and risk identification. Risk Mitigation: Enhanced detection of potential risks. Pricing Accuracy: Improved cost estimations. Dispute Reduction: Fewer disputes due to clearer contract terms. AI-driven automation promises a new era of precision, efficiency, and innovation in the construction industry.

The collected dataset will needs a pre-processing stage to implement a certain format for being proceed by the target model. The model will be programmed in Python, employs transformers to predict the risk rank of clauses and their potential impact. The dataset recommended to be divided into 80% for training and 20% for validation. It's recommended that this target model be used for high prediction and efficiency is for FIDIC 99 RED BOOK contracts only.

5. CONCLUSION

The construction industry, as a vital contributor to the global worldwide economy, undertakes increasingly complex projects. These endeavors wide span diverse domains, from infrastructure development to commercial and residential construction. However, the escalating scale, technical demands, and interdependencies inherent in modern construction projects pose significant challenges. As industry grows more rapidly and embraces novel materials, designs, and technologies, the imperative

for automation becomes evident. By integrating Artificial Intelligence (AI) and other automated solutions, construction professionals can enhance efficiency, mitigate risks, and ensure sustainable progress in this dynamic sector.

The integration of Artificial Intelligence (AI) into project management within the construction industry represents a profound transformation. By leveraging AI, we not only enhance existing practices but also redefine the very fabric of traditional processes. This research focused on the impact of AI application across various domains of project management, with a specific emphasis on risk assessment during contract conditions analysis. Furthermore, we explored the feasibility of automating the contract review process during the tender stage using Artificial Neural Networks (ANNs).

Tender stage is a critical juncture in the project life cycle. During this phase, contractors face significant time constraints while providing accurate price estimates and reviewing contracts. Unfortunately, due to these time limitations, contractors often struggle to identify potential contractual risks. As a result of that, pricing decisions are made without a comprehensive understanding of these hidden risks, leading to inaccuracies. This research highlights the immense promise of automating the contract review process during the tender stage. By integrating ANNs, several key challenges can be addressed.

Speed and efficiency, automating contract reviews significantly accelerates the process. Contractors can swiftly assess contract terms, identify risks, and make informed decisions. Risk Mitigation, ANNs excel at risk identification. By analyzing historical data and patterns, they can pinpoint potential pitfalls that might otherwise go unnoticed. Pricing Accuracy, with automated risk assessment, contractors can refine their cost estimations. Pricing decisions become more accurate, minimizing the chances of unexpected financial setbacks. Dispute Reduction, by proactively identifying risks, we reduce the likelihood of disputes arising later in the construction project. Clear contract terms lead to smoother execution.
A New Era of Precision is expected in the case of full integration of AI in the construction industry, as AI continues to evolve, the construction industry stands on the cusp of a new era. Precision, efficiency, and innovation are no longer aspirational; they are within reach. By embracing AI-driven automation, we can transform project management practices, enhance decision-making, and foster collaboration across stakeholders.

The realm of contract analysis in construction projects necessitates robust methodologies that balance efficiency and accuracy. Previous studies have explored various models, each with its advantages and disadvantages. In this research, we critically examine established methodologies and propose a novel approach centered around Transformers—a class of deep learning models known for their sequence-to-sequence capabilities. Specifically, we advocate for the adoption of Python as the optimal programming language for implementing these models. Furthermore, we recommend that the model's training and evaluation be based on a single contract form, such as the FIDIC 99 Redbook. By doing so, we anticipate improved efficiency and more precise results in contract analysis within the construction domain.

Finally, automating the contract review process during the tender stage holds immense potential. It not only streamlines operations but also safeguards against pricing risks and future disputes. As construction professionals, we must embrace this transformative technology to usher in an era of unparalleled efficiency and excellence.

The research highlights the increasing complexity and challenges in modern construction projects, driven by rapid growth and the adoption of new materials, designs, and technologies. This necessitates the integration of automation to enhance efficiency and sustainability. The study specifically examines the impact of Artificial Intelligence (AI) on risk assessment during contract conditions analysis and the feasibility of automating contract reviews using Artificial Neural Networks (ANNs). Automating the contract review process with ANNs addresses these challenges by improving speed, efficiency, risk mitigation, pricing accuracy, and dispute reduction.

The proposed methodology for contract analysis involves establishing an AI model using Transformers, a class of deep learning models, with Python recommended as the optimal programming language for implementation. For accurate and efficient results, model training and evaluation should be based on a single contract form, such as the FIDIC 99 Redbook.

Future recommendation regarding Expand AI Integration: Further research should explore the integration of AI across more domains within the construction industry to enhance overall project management practices. Focus on Training Data Quality: Ensure high-quality, diverse training data for AI models to improve their accuracy and reliability in contract analysis and risk assessment. A large dataset is highly recommended to enhance the full automation process with high accuracy.

These findings and recommendations underscore the transformative potential of AI in the construction industry, paving the way for more efficient, accurate, and innovative project management practices.

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