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Construction Dispute Resolution Framework Based on Extrinsic And Intrinsic Factors Influencing Arbitral Decision Making

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***Abstract* - Occurrence of disputes is a common feature in construction contracts which result in time and cost overruns and further damages the relationships between the parties. If the parties to a dispute can predict the outcome of the dispute with some certainty, they are more likely to settle the matter out of court resulting in avoidance of expenses and aggravation associated with adjudication. The outcome of construction disputes are affected by a large number of complex and interrelated factors. Dispute settlement is mainly based on the facts of the case like conditions of the contracts; actual situations on site; documents presented during arbitral proceedings etc which are termed as intrinsic factors. It is also observed that though the case may be the same but it is interpreted differently at different levels. This suggests that there may be other factors related to the arbitrator's characteristics and other psychology aspects further termed as extrinsic factor influencing decisions.. The paper focuses on the feasibility of the Artificial Intelligence approach in predicting the outcome of construction dispute and enlists the various extrinsic factors. The tool so developed would result in dispute avoidance to some extent and would reduce the pressure on judiciary.**

Keywords: **Construction Disputes, Dispute Resolution; Intrinsic factors; Extrinsic factors; Artificial Intelligence Techniques.**

I. Introduction

The Indian construction industry is an integral part of the Indian economy. The construction sector, largely a project-based sector, thrives on delivering unique projects that accomplish the various needs of the society. Occurrence of disputes is a regular feature in construction contracts. The parties to the contract pursue their own goals and needs, and maximize their own benefits. The owner seeks quality output with minimum expenditure and the contractor on the other hand intends to maximize his returns (Brown and Marriott, 1999). This leads to claims and ultimately construction disputes. The delay in settlement of disputes through litigation and arbitration hampers project progress, contributes to the cost and time overruns and damages relationship between parties to contract (Iyer et al., 2008). If the parties would know the decision of the court ahead of time with some certainty, they are more likely to settle the matter out of court rather than incurring the expenses and aggravation associated with court proceedings.

The decisions of construction disputes are affected by a large number of complex and interrelated technical factors in construction and also by the characteristics of the arbitrators which makes it difficult to interpret. Hence the use of artificial intelligence technologies is proposed in order to reach predictions that are close to court decisions based on the various factors influencing the decisions and their interrelations. The research attempts to identify these factors and also tries to understand the role of human element in judicial decision making. It involves development of dispute resolution framework for variation and deviation clause related claims in Indian construction contracts by using neural networks.

II. Factors Influencing The Decisions of The Arbitrators

Arbitral decision making is mainly based on the facts and findings of the case related to the claims, conditions of contracts and actual situations experienced on site during execution of project, the actual documents presented during arbitration proceedings etc. Literature review of legal studies conducted by Singhi and Jangir (2010), Goel (2011), Motiwal (2011), Seth (2011), revealed that apart from the facts of the case, evidences and documents put forth during the arbitral proceedings, there are several other indirect factors, which influence the decision making of arbitrators. The experience, technical expertise, cognitive skills, decision making approach, background characteristics, human nature etc of the arbitrators can be cited as examples of the factors apart from facts and evidences of the case.

The study attempts to identify factors influencing the decision of arbitrators and understand the role of human element in judicial decision making. These factors can be broadly segregated into two groups – one which is directly related to the facts and situations of the case termed as "Intrinsic Factors" and the other that are not directly related to the case but are related to the arbitrator's qualities or characteristics termed as "Extrinsic Factors". In Indian context there is no research reported which explores the extrinsic factors related to resolution of construction disputes and their impact on arbitrator's decision.

A. Intrinsic Factors

For the present study more than 100 arbitration cases and court cases were collected from offices of practicing arbitrators, government and non-government offices and from published sources like Arbitration Law reporter, All India Reporter and Law Journals. Study of these arbitration awards and settled court cases was used to develop dataset in the form of spreadsheet containing details of the parties, arbitration tribunal, contract conditions, important dates of the project execution, claims and their causes, amount claimed, whether claim allowed, rejected or partially allowed, amount awarded, claimant's contentions, respondent's arguments and reasons behind the arbitrators' judgment. From this dataset, data pertaining to variation and deviation claims was extracted.

It was observed that variations are caused mainly due to two reasons namely change in specifications of work and change in quantity of items of work. The first reason includes change in designs; change in bill of quantities; change in drawings, change in scope, un- contemplated items at the time of tendering; unforeseen circumstances. The other reason is either increase in quantity (positive variation) or decrease in quantity of work (negative variation). The variation claims are categorized into the two main types and studied for identifying the intrinsic factors influencing dispute resolution decisions by arbitrators.

The identification of factors is explained with the help of two cases. In one case a claim for dewatering of foundation was raised by the contractor. The arbitrator in his reasoned award stated that both the parties agreed that the work was necessary and the condition was unforeseen at the time of tendering. Correspondence between authorities also proved that extra cost can be given to the claimants according to conditions of contract and the record of pumping hours is also acceptable to both the parties hence 100% claim granted.

In another case, claim for use of extra cement in executing the work of M-25 concrete was raised. The extra consumption was due to the change in slump of 10 cm from 7.5 cm. The change was ordered by the engineer and amounted to variation as per provision of a clause in the contract. The calculations were independently done by the arbitrator and a compensation of 58% of the claim amount was awarded.

In the above cases it can be observed that *unforeseen condition at the time of tendering, correspondence between the parties, conditions of contract, evidence of recorded data, work ordered as per instructions of the Engineer, work done without consulting the Engineer* can be considered as the important facts based on which the arbitrators decided their judgments whether to allow the claim, reject the claim or partly allow the claim. These can be considered as factors influencing the decisions of the arbitrators. These factors are directly related to the facts of the cases and can be termed as Intrinsic Factors of the case.

The intrinsic factors initially developed are enlisted in Table I.

TABLE I INTRINSIC FACTORS INFLUENCING DISPUTE RESOLUTION DECISIONS BY ARBITRATORS RELATED TO CLAIMS OF VARIATION IN CONSTRUCTION CONTRACTS

Sr. No	Intrinsic factors related to variation claims due to change in specifications
1	provision of express condition in the contract for compensation of variation work
2	extra work / variation ordered by owner
3	change orders issued in writing
4	change in specifications due to inconsistency in documents
5	variation work outside the scope of work /extra work
6	insufficient data at the time of tendering
7	un-contemplated item of work at the time of tendering
8	unforeseen /physical conditions beyond the control of contractor
9	extra work necessary for completion of work
10	change in the rate of item of work due to change in specifications
11	contractor conveyed the change in rate of item of work to the owner
12	extra work/ change caused due to reasons attributable to contractor /owner
13	execution of variation work supported by documents
14	extra work/ revised rates mutually agreed by both parties
15	variation within the deviation limit
16	miscalculation / recalculation of claim amount
	Intrinsic Factors related to variation claims due to change in quantities
1	positive variation or negative variation
2	variation within the deviation limit
3	execution of variation work supported by documents
4	change in rate of extra work affect the workability of contract
5	revised rates mutually agreed by the parties
6	provision of express condition in the contract for compensation of variation work
7	change in work necessary for completion of work
8	miscalculation / recalculation of claim amount

B. Extrinsic Factors

As stated earlier these are the factors which are not related to the facts and findings of the case directly; however they influence the decisions of the arbitrators. The research conducted by Flood and Caiger (1993) wherein a number of arbitrators were interviewed stated that experience and expertise of the arbitrators matters in making them good and successful arbitrators. The research further stated that there are divergent views about the impact of the arbitrator's characteristics over their decision making approach and outcome (Flood and Caiger, 1993). Wiener *et al.* (2006) draws focus on research in social and cognitive psychology and reveals that judges, jurors, attorneys, experts, eyewitnesses, litigants, police, and everyday citizens anticipate the emotional consequences (both pleasant and unpleasant) that are likely to follow from their choices, decisions, and inferences. Feigenson and Park (2006) state that emotions and moods may influence decision makers in 3 ways: by affecting their information processing strategies, by inclining their judgments in the direction of the valence of the emotion or mood, and/or by providing informational cues to the proper decision. Crow and Logan (1994) in their research in labour arbitration to examine the impact of the arbitrators' personal characteristics and their decision making history, the likely effects of the gender of arbitrators and grievant, and presence of legal counsels on the arbitral outcomes concluded that these non-case related issues do not have a significant effect.

With the help of literature survey and discussion with the experts like arbitrators, counsellors, psychologists a list of extrinsic factors is formulated which includes i) age ii) gender iii) education (technical/legal) iv) experience iv) occupation v) geographical location vi) professional activities vii) number of issues arbitrated viii) number

of times appointed by owners / contractors and ix) personality traits like a) scepticism/suspiciousness b) morality c) dominance d) conscientiousness e) fairness f) neuroticism g) alertness h) trustworthiness. These factors will be finalized through a panel of experts by using the method of Delphi round. The research will further obtain the data related to the arbitrators' characteristics and their judgments on formulated arbitration cases and will compare the judgments given by different arbitrators.

III. Neural Network Applications in Construction Management

Applications of neural nets in construction management cover a range of studies grouped as construction scheduling and management; construction cost estimation; resource allocation; and construction litigation (Dikmen and Birgonul, 2004,). Neural network based methodology is applied for predicting the level of organizational effectiveness in a construction firm (Sinha and McKim, 2000); estimating the construction resource requirements at the conceptual design stage (Elazouni et al., 1997); predicting the adoption potential or acceptability of a new formwork system (Elazouni, 2005). For risk management, neurofuzzy decision support system for efficient risk allocation (Jin, 2010); a back- propagation neural network application for bridge risk assessment to model bridge risk score and risk categories (Taha et al., 2007) and Neuronet model as a decision support tool that can classify international projects with respect to attractiveness and competitiveness based on the experiences of contractors in overseas markets (Dikmen and Birgonul, 2004) was developed. An attempt to predict the outcome of court decision was made using boosted decision trees by Arditi and Pulket (2005) which achieved a high prediction rate of 90%. Another attempt was made using of a novel methodology based on ant colony optimization to predict outcomes of construction litigation which resulted in a prediction rate of 92% (Pulket and Arditi, 2008). In construction litigation the use of neural network is not common. Arditi et al. (1998) employed neural networks for predicting outcome of litigation by identifying the hidden relations among the factors influencing the court decision. Chau (2007) adopted particle swarm optimization model to train perceptrons in predicting the outcome of construction claims in Hong Kong. But other than these not much work is reported in this area.

The present study attempts to model a specific type of construction dispute arising from variation clause in the Indian construction industry. It aims at developing a neural network prediction model based on the significant legal factors governing verdicts in this type of disputes. The model will help in faster resolution of disputes and can also be considered as a means of litigation avoidance to some extent.

IV. Development of Neural Network Framework For Predicting The Outcome of Claims

The neural network framework was developed by using Neuro Solutions. The development steps are data conversion, training, validating and testing of neural network and finally implementation or production.

The dataset created was organized into a data file that is compatible to the software which requires input and output variables. The input variables are the intrinsic factors illustrated in table I. The output of the neural network will be 'claim allowed', 'claim rejected' and 'claim partially allowed'. For each and every claim in the case study the input and output variables are identified. These input variables will be assigned value -1; 0; 1. For example for the factor *'instructions ordered by owner'* will be assigned value '1' if specific orders to change in work are given by the owner and it will be '-1' if there is specific mention that orders are not given and if there is no mention regarding this in the case the value will be '0'. Each claim may have one or more factors. Outcome of the claim is considered as the output of the NN model which is expressed as '1' for claim allowed, '-1' for claim rejected and '0' for claim partly allowed.

Training the network is a process where training cases and the corresponding inputs and outputs are fed to the network. The network performs number of training runs and acquires the complete knowledge of the database fed to it and allots appropriate weights to the interconnections. Based on the data training, the network when fed with input data of a known case not belonging to the training pairs generates the output of it which is compared with the expected output. If any discrepancy is observed between the expected output and obtained output, it is clarified by adjusting the weights and minimizing the error by the

network tool itself. Once the error is minimized, the network is said to be accurately validated. For testing process, cases whose outputs are to be predicted are fed to the network which generates output through number of training runs. Finally the production process is carried out where cases are fed without output and the results obtained are compared with the actual output and the prediction rate is calculated. The whole process is repeated with different combinations of input parameters, permutations and shuffling of training and validation data and changes in other parameters, on the rate of prediction.

Current study is conducted considering 55 claims for the development of the neural network framework. Out of the various types of network provided by the software for network development, Generalised Feed Forward (GFF) network and Multi-Layer Perceptron (MLP) was used. Back propagation with supervised learning mechanism was used for prediction purpose. Combination of 30 cases for training; 10 cases each for cross validation and testing and 5 cases for production was considered for the development of the software.

Various testing combinations for training and results of rate of prediction are shown in table2. For various testing combinations the MLP network gives prediction rate varying from 60% to 100% whereas GFF gives a prediction rate varying from 20% to 100%. The optimum prediction rate obtained by the NN model is 100% wherein the first 10 cases were fed as testing cases, next ten cases for cross validation, next thirty cases for training and remaining five for production.

TABLE II RATE OF PREDICTION FOR VARIOUS COMBINATIONS FOR MLP AND GFF

Combi-nation No.	Arbitration Claims											Rate of prediction (MLP)		Rate of prediction (GFF)	
	1 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45	46 to 50	51 to 55	Testing %age	Production %age	Testing %age	Production % age
1	Training						Testing		CV		Production	(7/10) 70 %	(4/5) 80%	(6/10) 60%	(1/5) 20%
2	Testing		CV		Training						Production	(9/10) 90%	(5/5) 100%	(9/10) 90%	(3/5) 60%
3	CV		Testing		Training						Production	(10/10) 100%	(4/5) 80%	(9/10) 90%	(5/5) 100%
4	Training			CV		Testing		Training			Production	(9/10) 90%	(3/5) 60%	(8/10) 80%	(1/5) 20%
5	Training			Testing		CV		Training			Production	(9/10) 90%	(3/5) 60%	(7/10) 70 %	(5/5) 100%

V. CONCLUSION

The study reveals twenty four intrinsic factors influencing the decisions related to variation claims. It also enlists the extrinsic factors and proposes to explore the impact of these factors on the decision making of the arbitrators related to variation claims. In NN model developed it was observed that MLP network gives better results as compared to GFF.

Same methodology can be expanded for resolution of construction disputes arising out of other dispute prone claims and when fully developed, the proposed NN model may be consulted by contractors, owners or arbitrators to facilitate their decision making process.

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