Modeling Disputes -RMFA- as Decision Support System -DSS- To Proceed Through Arbitration

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Abstract—Although the scale size of disputes in construction projects mainly follows the claim amount disputed, going through arbitration is considered as a one scale from the client point of view. So, study of foreseen risks for current and future situations is worthwhile to move in effective claim. Actually, due to the multivariate nature of construction contracts, things never go as planned. Thus, humans have developed many methods to resolve disputes, and arbitration is one of them. The study focused on modeling disputes occurring in construction industry field especially in Gaza Strip. Mathematical model, Regret Model for Arbitration (RMFA), has been built as a Decision Support System (DSS) which will recommend the user (contractor) whether to proceed to arbitration or not. The developed model depends on Regret Approach mainly and two logical and mathematical methods; Net Present Value (NPV) and Multi Criteria Analysis (MCA) to obtain more accuracy. This required to survey thirty questionnaires of respondents and some interviews with arbitration experts for identifying the influential evaluation criteria that need to be input into the model. After statistical analysis process using Statistical Package for the Social Sciences (SPSS) for these evaluation criteria which have been selected and weighed in order to measure their relative importance and impacts for the three probability values (Pe, Pf and Po) winning, current loses and future losses probabilities respectively which will be determined automatically by the RMFA, the weight values range of the selected ten evaluation criteria was (3.62 – 5). The Contract criterion is the highest and the Time and BoQ criteria are the lowest. Results of the model were tested in comparison with actual four disputes cases and the efficiency of the model achieved 75%.

Index Terms—Arbitration, Modeling, Regret approach, RMFA, MCA and NPV.

I INTRODUCTION

The nature of human relationships is harmony or difference stimulating the disputes usually, so we face various disputes in our life; social disputes, financial disputes, political disputes, job disputes, etc. But the adorable thing is that humanity has legislated different lawful effective methods to resolve these disputes. This paper focused on the dispute which occurs between the contractor and the client or the owner in engineering construction projects. The followed approach to solve such dispute is Arbitration based on legal references. There are many methods to resolve disputes and arbitration is one of these methods which also include Conciliation, Mediation, Mooting, Early Neutral Evaluation (ENE), Fact Finding Method and Med- Arb. They are widely used in dispute resolution and each one has some advantages and disadvantages points.

Arbitration is considered one of recently regulated dispute resolution methods in constructions in Gaza Strip, and the Engineering Arbitration Center (EAC) is considered the first responsible dispute resolution center in Gaza Strip.

The importance of arbitration increases as the projects sizes increase. Primarily, classification of the projects size depends on the budget. Recently, Palestine as a developing country has got many funds to implement vital projects in various fields especially after the last sequent three wars in

2008, 2012 and 2014 years which have been triggered by Israel against Gaza Strip. Actually, due to the multivariate nature of construction contracts, things never go as planned. So, many conflicts were raised by some contractors as an official claim that is considered a very critical step which most of contractors try to avoid it. The method of resolving conflicts and disputes may have differing consequences. Going to arbitration to resolve construction disputes may not be an easy thing to do because the consequences may be dire. A contractor's reputation may be affected by the arbitration case. Even if the contractor is certain to win an arbitration case, it may lose any potential future projects with the same client or even others in the market. Therefore, the long-term losses to the contractor may overweigh its immediate benefit in going through the arbitration. Therefore, going through arbitration may be a reason of regret [1]. This paper illustrates a mathematical Regret Model For Arbitration (RMFA) proposed as a decision support system for going through arbitration using a regret theory approach including some uncertain factors that will be extracted accurately by two mathematical logical methods; Net Present Value (NPV) and Multi Criteria Analysis (MCA) used to obtain more accurate results.

II MODELLING DISPUTE-RMFA

A Research Concept

Regret Model For Arbitration (RMFA) has been built as a Decision Support System (DSS) advising the user (Contractor) whether to proceed to arbitration or not. Figure (1) shows the framework of this mathematical model which consists of three stages (Input, Analysis and Output), The method of Regret Approach has been developed by two mathematical logical methods (Multi Criteria Analysis MCA and Net Present Value NPV) in order to obtain more accuracy in the results in which, results of a mathematical model depend on efficiency of entered data, in other words, uncertain inputs leads to inaccurate outputs produced by analysis stage in any mathematical model. The developed mathematical model RMFA has taken into consideration the flexibility of the required data that need to be input into the model. Some of these variable data are factors in regret approach method as probable percentages, these probabilities will be a source of error if the user could not estimate them professionally. so, this model has been adjusted and regulated to help the user to avoid uncertain data and enter confirmed data related to financial data mainly, then the probable variables in regret approach will be calculated automatically during analysis stage. Based on that, there are two classes of variables that need to be input into the model by the user (evaluation criteria and historical data) as shown in table (1). Finally, the predicted outcome of the model allows the decision-maker to understand whether or not raising a claim is worth the risk.
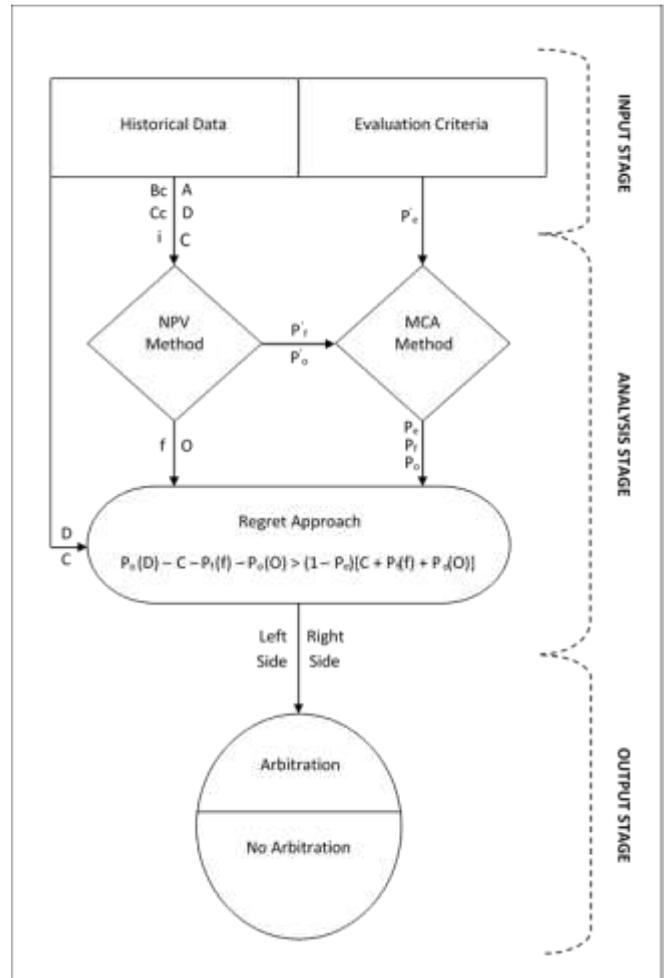
Table 1
Input data into the Model

CLASS	REQUIRED DATA	INPUT
Evaluation Criteria	Crit. 1	1 – 5
	Crit. 2	1 – 5
	Crit. 3	1 – 5
	Crit. 4	1 – 5
Historical Data	Net Cost of Projects with Client yearly (Cc) - $	
	Payments from Client yearly (Bc) - $	
	Internal Rate (i) - %	
	Budget of Project (A) - $	
	Cost of the Claim (C) - $	
	Disputed claim amount (D) - $	

Figure 1 Framework of Mathematical Model RMFA

Practically, this model, RMFA, has been programmed and enhanced by a specific programming language to be presented simply as shown in figure (2) (interface of the model) in order to facilitate dealing with it at all steps; data entry, analyzing processes and results presentation. In addition to that, the model was tested to calibrate its results by four real previous disputes cases which were projected to the model and analyzed, then the results of actual disputes were compared for each case study and they were almost matched.
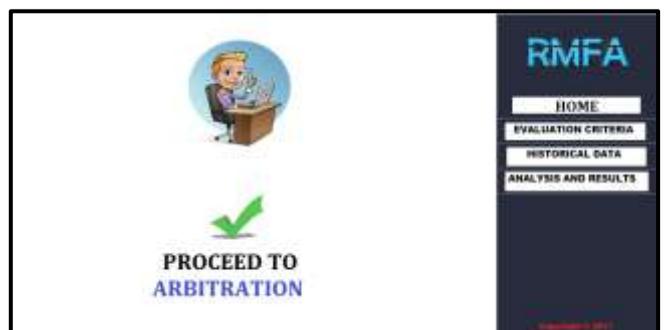

Figure 2 RMFA Interface

B Materials and Methods

As shown in the previous section-figure (1), The improved mathematical model, RMFA, using regret theory approach depends on two methods (MCA and NPV) in order to support decision more accurately for going through arbitration. These methods will be discussed as follows:

B.1 Regret Theory Approach

Theoretically, the regret could be interpreted simply by the following famous example; During winter season, the chance for rain is 50%, so taking an umbrella or not will be referred to traditional decision-theory completely. There are four different scenarios that may be decided in these events. Respectively, the first two scenarios have positive outcomes and the other two scenarios have negative outcomes, 1) the person who does not take an umbrella and it does not rain or, 2) the person who takes an umbrella and it rains, 3) the person who may decide to take the umbrella, but it does not rain, causing the person to regret his choice, and 4) the person may choose not to take an umbrella and it rains. However, due to uncertainty, the person cannot truly predict the outcome. Hence, there is a 50% chance of positive or negative outcome equally. Although the chances of the outcomes are equal, the person will regret one of those outcomes more than another [2]. Therefore, it does matter which choice the person makes even though the chances are equal, due to regret. Since arbitration may cause uncertain consequences on how both parties react to the procedure, then it is evident that a regret model is better for decision-making.

The Regret Approach depends on different factors which are taken into consideration in dispute resolutions and arbitration cases. Since arbitration takes a long time costly, then different factors need to be assessed to understand the overall risk of going through arbitration, the predicted results, and the benefits. The following factors are inputs into the regret equation as shown in equation [3] (1):

$$P_e(D) - C - P_f(f) - P_o(O) > (1 - P_e)[C + P_f(f) + P_o(O)] \qquad (1)$$

Disputed claim amount (D)
Cost of arbitration (C)
Probability of winning (Pe)
Amount of possible effects on current projects' losses (f)
Probability of current projects' losses (Pf)
Amount of future opportunity loss (O)
Probability of future opportunity loss with the same client or others (Po)

Where; the probability of winning (Pe), probability of current (Pf) and future opportunity loss (Po) are ranged between (0-1). The probability of winning depends on having strong evidence. Also, the costs that will be estimated by the contractor within this model must be dependent on real present values of the future costs or benefits [1]. The outcome of Regret Approach will advise the user to proceed to arbitration if the left-side value is higher than the right-side value.

B.2 Net Present Value (NPV)

Net Present Value method is considered as a financial indicator to study the feasibility of the financial step which will be decided. Theoretically, NPV is the difference between the present value of cash inflows and the present value of cash outflows as the following equation (2) [4].

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_o \qquad (2)$$

where;
Ct = Net cash inflow during the period t
Co = Total initial investment costs
r = Discount rate, and
t = Number of time periods

So, this method has been utilized to extract accurately some financial factors which are included in regret theory approach. These factors are the amount of possible effects on current projects' losses and the amount of future opportunity loss. Actually, the results of NPV method may be net positive or negative revenue for limited period, this value will be translated to the lost value currently or in future if the contractor decides to go through arbitration. and the bottom side of the Cash Flow Diagram (CFD) illustrated in representative figure (3) represents the expected current and future losses as negative cash flows related to NPV for going through Arbitration.
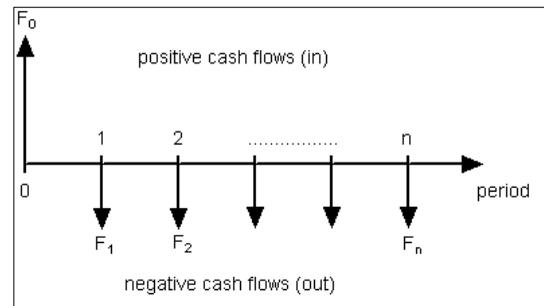

Figure 3 CFD for going through Arbitration

In addition, the upper side of CFD which represents the current paid payments or disputed claim amount (D) and other financial commitments to be paid by the Client to the Contractor as positive cash flows. Net cash inflow (Ct) during an identified period (t) will be the sum of positive and negative cash flows.

The NPV method helps to measure the value of future cash flows. Because of the time value of money (TVM), money in the present is worthy more than the same amount in the future. This is both because of earnings that could potentially be made using the money during the intervening time and because of inflation. In other words, a future opportunity loss in the future won't be worthy as much as one lost in the present.

B.3 Multi Criteria Analysis (MCA)

In general, Multi-criteria analysis is undertaken to make a

comparative assessment between heterogeneous measures. In the evaluation field, multi-criteria analysis is usually an evaluation tool, and is particularly used for the examination of the strategic choices. In this study, MCA was used to expect the accurate values of probability of the following measures: 1- Current projects' losses (Pf), 2- Future opportunity loss (Po) and 3- Winning (Pe). whereas these probabilities will be crucial factors used in regret theory approach, The influential criteria on these values were studied well and determined by questionnaire survey developed and designed in Arabic language to be more understandable to the targeted population then was analyzed by Statistical Package for Social Sciences (SPSS). The generated evaluation criteria were weighed as a first step in multi-criteria analysis in order to measure their relative importance and impacts for the three probability values (P'e, P'f and P'o) which will be determined by the NPV method then it could expect Pe, Pf and Po values accurately by the following equations (3) and (4) [5].

$$Impac = \sqrt{\frac{C^2+B^2+T^2+R^2+S^2+SE^2+M^2+TI^2+P^2+IC^2}{10}} \quad (3)$$

Where; table 2 shows all variables generated as selected evaluation criteria which have the most impact on the expected values (Pe, Pf and Po).

Expected Values **%** (Pe, Pf ,Po) = Probability of (P'e, P'f ,P'o)* Impact   (4)

Table 2
Selected Evaluation Criteria

No.	ID	Evaluation Criteria	Description
1	C	Contract	The agreement made between the contractor and the client which creates legally binding obligations between them and sets out those obligations and the actions that can be taken if they are not met.
2	B	BoQ	Document prepared by the cost consultant that provides project specific measured quantities of the items of work identified by the drawings and specifications in the tender documentation.
3	T	Time Schedule	The Document collecting all the work needed to reflect all of the work associated with delivering each activity and overall the project on time.
4	R	Reports	All technical reports performed during the Design stage and all progress reports of implementation stage (daily, monthly, quarterly and annual).
5	S	Specifications	The Document which refers to a set of documented requirements to be satisfied by a material, design, product, or service. In addition to the defined technical standard related to all project's activities (civil, mechanical, electrical … etc.)
6	SE	Correspondences	The modern or traditional communications ways which are agreed between the project participants on various technical, commercial and other project management related aspects.
7	M	Minutes of Meetings	The Document ensuring accountability and follow–through which need to be written through every meeting then distributed after that– and then agreed upon.
8	TI	Time	Total duration of the project.
9	P	Attitude of claim	Legal procedures which are followed by the contractor.
10	IC	Independence and truthful of the arbitration Institution.	Technical strong and clear independence of the institution who is responsible to resolution disputes.

Evaluation Criteria

The literature review and some interviews with arbitration experts and all the information that could help in achieving the study objectives were collected, reviewed and organized to be suitable for the study survey, then a questionnaire was developed with closed and open-ended questions. The question follows a scale as in the following table (3) Likert quintuple criterion used in the study [6].

Table 3
Used Scale of Questions

Level	Scale
Strongly agree	5
Agree	4
Neutral	3
Disagree	2
Strongly disagree	1

Statistical Package for Social Sciences (SPSS) was utilized to analyze the questionnaires data targeted to obtain the Evaluation Criteria which have been ranked according to their effects on the extent of arbitration as a dispute resolution indicator.

Weighting Criteria

One of the rules in multi-criteria analysis is to weigh these criteria using the relative important index and the mean values were used in this study. the relative index techniques have been widely used in construction study for measuring attitudes with respect to surveyed variables. Triple scaling was used for ranking questions that have an agreement levels. The respondents were asked to give their perceptions in group of questions on five-point scale which reflects their assessment regarding the arbitration procedures. The importance index was computed using Formula Relative Importance Index (5) [7]:

$$\frac{\sum w}{AN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N} \quad (5)$$

Where w is the weighting given to each factor by the respondent, ranging from 1 to 5, (n1 = number of respondents who Strongly disagree, n2 = number of respondents who disagree, n3 = number of respondents for neutral, n4 = number of respondents who agree, n5 = number of respondents for strongly agree. A is the highest weight (i.e 5 in the study) and N is the total number of samples. The relative importance index ranges from 0 to 1 [8].

III MATRIX AND ANALYSIS

The presented model in this paper provides the user the final result for Regret Approach which is whether to proceed through arbitration or not. Regret approach consists of main four steps to reach the final step 5th called Regret Approach as shown in equation (1) with taking into consideration additional two significant factors as follows [1]: 1) Total contract amount (A) and 2) Acceptable negotiated amount (N). In addition to that, the developed model has a basic step (step 0) in order to determine the probability of winning (Pe) automatically using MCA and NPV methods then going ahead in the other steps sequentially (from 1st step, 2nd step, 3rd step and 4th step) as shown in figure (4). Each step has a specific result recommending the user to do necessary action. These sub results are considered very important for the decision-maker to understand the risks involved to make a decision whether or not to raise a claim without current or future losses. According to decision theory, the following would describe the typical decision flow of going to arbitration.

STEP 0: Expecting the Probability of winning
   MCA & NPV methods, then
STEP 1: Decision to raise a claim
   $Pe(D) > C$? If yes, then
STEP 2: Decision to negotiate
   $Pe(D) - C > N$? If yes, then
STEP 3: Decision to accept an amicable settlement
   Is $((Pe(D) - C)/A)$ significant? If yes, then
STEP 4: Decision to arbitrate
   $Pe(D) > C + Pf(f) + Po(O)$? If yes, then proceed to arbitration.

Figure 4 Claim's Flowchart

However, when looking at it from a regret theory approach, the maximum regret coincides with the maximum loss, which would be due to losing the arbitration case or losing the opportunity of winning the claim if the case went to arbitration. In such a case, the reputation of the contractor falls through in addition to loss of future opportunity with the same client. Therefore, an additional step needs to be included to understand the cost that would be least regretted. [1]
The best outcome is $Pe(D) - C - Pf(f) - Po(O)$.
and on the other hand, the worst outcome is the total cost of $C + Pf(f) + Po(O)$.
STEP 5 (Regret Approach): Decision of arbitration

$$Pe(D) - C - Pf(f) - Po(O) > (1 - Pe)[C + Pf(f) + Po(O)]$$
? If yes, then proceed to arbitration.

In the extra step above, it is important to predict the outcome whether or not regretting the decision of proceeding with arbitration and losing, or not proceeding to arbitration and winning. The last step for a regret approach may be adaptable to any other model available, as the principle of regret is a major factor in realistic decision-making. [1]

IV RESULTS AND DISCUSSIONS

The results which have been obtained by the developed mathematical model RMFA were almost expected and satisfying. As mentioned above, this model depends on some evaluation criteria related to the disputed issue that need to be estimated by the contractor within a scale (1-5). The selected evaluation criteria have been determined by a questionnaire distributed to thirty dispute parties of questionnaires then analyzed by Statistical Package for Social Sciences (SPSS) and the results were as shown in the following table (4):

Table 4
Evaluation Criteria Analysis

Criteria	Freq.	mean	Relative Index (%)	Evaluation	Weight
Contract	98	4.7	93.33	Strongly agree	5.00
BOQ	71	3.4	67.62	Agree	3.62
Time Schedule	76	3.6	72.38	Agree	3.88
Drawings	65	3.1	61.90	Neutral	3.32
Specifications	81	3.9	77.14	Agree	4.13
Correspondences	91	4.3	86.67	Strongly agree	4.64
Witness	62	3.0	59.05	Neutral	3.16
Truthful of company and market reputation	60	2.9	57.14	Neutral	3.06
Correlation between others	60	2.9	57.14	Neutral	3.06
Time	71	3.4	67.62	Agree	3.62
Attitude of claim	78	3.7	74.29	Agree	3.98
Independence and truthful of the arbitration Institution	85	4.0	80.95	Agree	4.34
Project Budget	51	2.4	48.57	Disagree	2.60
Disputed claim amount	56	2.7	53.33	Neutral	2.86
Previous technical problems with client	53	2.5	50.48	Disagree	2.70
Previous financial problems with client	47	2.2	44.76	Disagree	2.40
Reports	91	4.3	86.67	Strongly agree	4.64
Minutes of Meetings	95	4.5	90.48	Strongly agree	4.85

As illustrated in the previous table, the weight value is considered by comparison. These weights reflect the difference of impacts force on the three probability values (Pe, Pf and Po) which will be determined automatically by the RMFA. The highest weight value is (contract) and the lowest weight value is (Previous financial problems with client), and in total there are ten influential criteria highlighted by gray color and they have been identified according to the weighting analysis.

these selected criteria have been presented in chart (1) with their weight values which are ranged between (3.62 – 5), the maximum value was the (Contract) which is considered the main reference of the relationship between the contracted parts because it includes the legally binding obligations between them. Also, the contract sets out those obligations and actions that can be
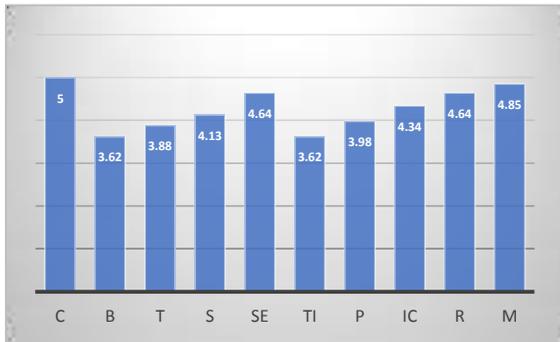
taken financially and legally if they are not met. The minimum values were (Time & BoQ) and other values which have lower effect on the three probability values (Pe, Pf and Po) are not reliable sources relatively because they could be attacked under the pretext fraud reasons.

Chart 1 *Wight of Selected Evaluation Criteria*

Simply, the evaluation criteria support the user to utilize regret approach in expecting the probability of winning then going ahead through other steps.

The final result will be recommended by the model (RMFA) as follows "Arbitration" or "No Arbitration", But what will happen if the contractor goes through the opposite way. For this, the accuracy of the model results was tested by setting four real previous disputes cases into the developed model as several case studies in transportation, structural buildings, infrastructure fields (Sources: Association of Engineers in Gaza Governorates and the Contractors), then by comparison between actual actions and the model recommendation for each case study. the results have almost matched as shown in detailed table (5) that evidences the high accuracy in the model efficiency which is 75% at least. This percent is dependable relative to easy and quick action using the model (RMFA).

Table 5
Efficiency of the RMFA

No.	Project	Location	Client/Owner	Disputed Amount	Real Action	Model Recommendation	Efficiency
1	Construction of Residential Tower	Gaza Strip, Palestine	Individual	100,000 $USD	Arbitration	Arbitration	100%
2	Upgrading and Installation of Solid Waste Equipment		Municipality	70,000 $USD	No Arbitration	No Arbitration	100%
3	Construction of Mosque		Local Institution	34,080 $USD	Arbitration	Arbitration	100%
4	Construction of Highway		International Institution	32,000 $USD	Arbitration	No Arbitration	0%
	Overall Efficiency						75%

V CONCLUSION

The developed model including mainly Regret Approach and two logical and mathematical methods; Net Present Value (NPV) and Multi Criteria Analysis (MCA) produces accurate results for some probability values (Pe, Pf and Po) winning, current loses and future losses probabilities respectively which will be determined automatically by the model. This required to survey thirty questionnaires for identifying the influential evaluation criteria that need to be input into this model. The selected evaluation criteria were weighed in order to measure their relative importance and impacts for the three values. The weight values range of the selected ten evaluation criteria was (3.62 – 5) the Contract criterion is the highest and the Time & BoQ criteria are the lowest. Results of the model were tested in comparison with actual four disputes cases and the efficiency of the model achieved at least 75%, Whereas this percent is dependable with the multivariate nature of construction contracts. Thus, using Regret Model For Arbitration, RMFA, is considered an abridged and quick action to make decision for going to arbitration or not; to save time, cost and thinking.

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