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Reducing Construction Claims in Egypt

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Abstract
Nowadays, construction claims have become an indispensable part of the construction projects. It is commonly recognized that the number of claims and disputes has been increasing and has become a burden to the construction industry. Avoiding claims requires the understanding of such claims causes.
Since the importance of claims in construction projects as claims have pronounced effects on the project implementation, the need for claims mitigation method is evident. In this research, a literature review was conducted to identify the reducing factors of claims in international literature. Using expert interviews the factors modified according to Egyptian construction industry by.
A mathematical model was presented to be a management tool can be used to mitigate claims. Analytic Hierarchy Process (AHP) and goal programming was used to determine the best minimizing factors of claims. Using AHP pairwise comparisons of causes of claims have been conducted based on their importance in avoiding or mitigating claims. Also comparisons of the importance of reducing criteria of claims have been investigated for the purpose of determining the most important reducing factors. A case study is presented to demonstrate the proposed model application.
Keywords: Construction projects, Claims, Egypt, AHP.

I. Introduction

In general, avoidance of claims needs real desire and complete coordination between parties. A policy of claims avoidance should be adopted by all concerned with the project. This policy should apply like quality assurance from the day the owner takes the decision to build until the final account is agreed Bassioni1 el al. (2007).

The objective of this paper is to present a decision support system can lead to prevent or mitigate claims in construction projects in Egypt. This achieved through identifying a list of reducing factors from international literature, then modifying the list through expert interviews. Then data were collected in AHP format to get the weightings of causes of claims and identification of the importance of reducing factors for the claims.

II. Methodology

The research methodology is developed to select the best reducing criteria of claims based on its effects on time, cost ,and quality of project activities. A combination of analytical hierarchy process and goal programming by Bertolini and Bevilacqua (2006) is developed in this research. In the proposed model the results of AHP are incorporated in GP model. This approach consists of two phases the first is priority of reducing criteria of claims according to cost time and quality of project. The second phase, formulation of the GP model to find the best appropriate reducing factors for each of the claim causes.

The case study is used in this research as an applicable tool to show how can the system be applied for construction projects.

Case studies have been used as a research tool for deep and narrow investigation into a certain topic. Case studies are used in this research as a tool to demonstrate the system of mitigating construction claims in construction projects.

The structure of case study includes a description of the background of the project, followed by an overview of each of the claims involved and the appropriate criteria for mitigation.

The following case study are for a Residential buildings in north coast..8 floors. The owner of these buildings decided to contract a professional project management firm. The project was tendered using a cost

plus contract and via a specific selected contractors. The planned duration was 42 monthes . Also the original contract cost was 10 milliar Egyptian Pounds (EGP) and was increased to 13 milliar EGP.
Reducing criteria of construction claims gathered from literature review were encountered and modified as shown in Table 2. The experts were asked to determine the causes of claims and selecting the reducing criteria as shown in Table 3 and Table 4.

Table 3 : Causes of claims for the case study

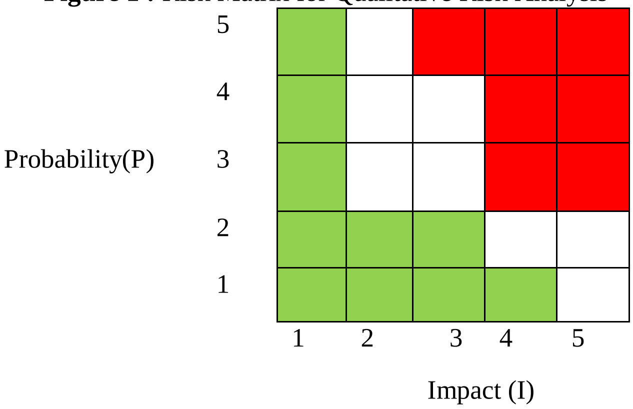
Category	**Causes of Claims**
Behavioral	1- Bad communication between parties
	2-Owner's slow decisions
	3-Lack of trust among project parties
Contractual	4-Delay in Supply of Drawings
	5-Delay in Payments
	7- Design errors or omissions incomplete
	8-inadequate or incomplete specifications
	9-Inadequate bid information
	10-Change in work scope
	11-Changes in plans and specifications during construction
	12-Error/defect/ contradiction in project documents
	13 -Ambiguities in contract documents
	14-Different interpretations of the contract provisions (poorly written contracts)
	16-Unclear scope of works
	17-Low contract price due to strong competition
	18-Contractor is not well organized
	19- Suspension of works
	20- Termination of works
	21- Specifications and drawings inconsistencies
	22- Material changes or out of specification
	23-Changes in design
	24-Acceleration Claims
	25- Inadequate risk identification/allocation
	26-Owner furnished material
	27- Economic inflation - Changes of currency value
Operational	28-Delay in Handing over the Site
	29-Delay in Supply of materials
	30-Absence or Low quality control and assurance in the project
	31- Variations in quantities
	32- Variations or (change orders)
	33-Lack of experience of the supervision team
	34-Inadequate of investigation of site
	35-financial failure of the contractor
	36-Strikes by Workers
	37-Accidents
	38-Increase in Material Cost
	39-Site possession with obstacles
	40-Adverse Weather Conditions
	41-Force majeure such as earthquakes floods etc.
	42-Unforeseen site conditions: subsurface problems
	43-Subcontractors problems . (Lack of capable -inefficiency)
	44-Government regulations : building -environmental and changes
	45- Execution errors
	46- The additional works
	47-Shortage in resources
	48- Disruption
	49-Poor management and administration of the construction site.

Table 4 : Reducing factors of claims for the case study

	Reducing criteria
1	Minimum Changes or modification of scope
2	Allow reasonable sufficient time for the design team to produce clear and complete contract documents with no or minimum errors and discrepancies
3	Both of performance and price should be the base of selecting the contractors.
4	Read the contract several times before signing it to understand any unclear clauses
5	Clients must make quick decisions to solve any problem that arise during the execution
6	Encourage contractors to visit the site of the project during the bidding stage to inspect it and check its accessibility, weather conditions, services, bylaws, etc.
7	Written specifications should be reviewed to avoid ambiguities and conflicting requirements
8	Owners are recommended to pay progress payment to contractors on time because it affects the contractors' ability to finance the work

To prepare qualitative risk analysis of claims we can use risk matrix. Then the experts evaluate the probability and impact from 1 to 5 for each claim cause. From the risk matrix, the claims risks are grouped into low risk, medium risk, and high risk, as shown in Low risks are ignored in this study.

Figure 1 : Risk Matrix for Qualitative Risk Analysis



2.3. Analytical Hierarchy Process (AHP)

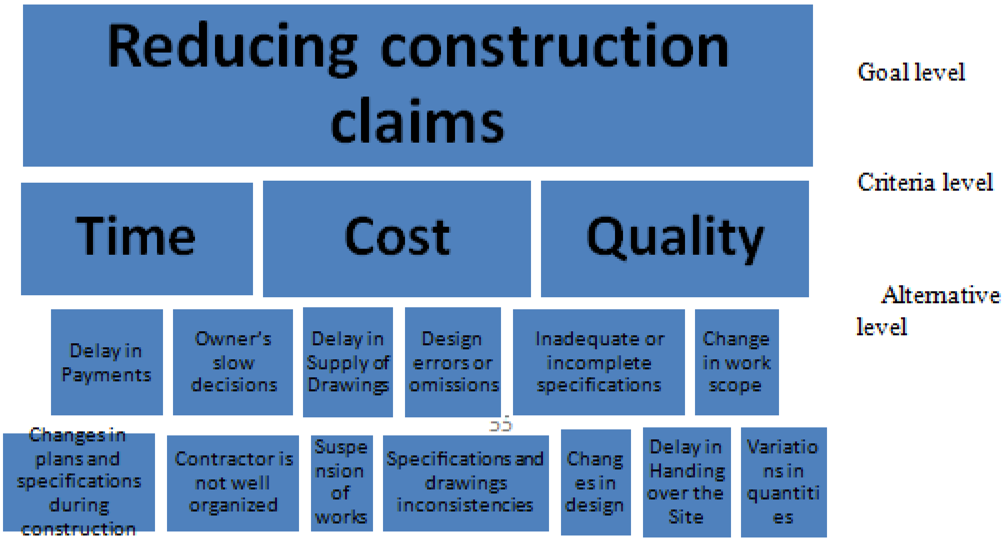
AHP is a precise multi criteria decision making method and systematic procedure for dealing with complex decision making problems that's have many alternatives. The aim of AHP is to quantify the relative priorities for a set of alternatives, after ranking a set of quantitative or/and qualitative criteria for these alternatives to achieve the overall goal and give a decision about the solution of the problems (Saaty, 1990; Vavatsikos & Anagnostopuolos, 2006).

Build a hierarchy for the decision (decision modeling)

This step is to identify the problem, the alternatives and evaluation criteria. Which the problem is structured in all its aspects. The goal is to structure the problem into a hierarchy. A hierarchy is a tree like structure that represents a complex problem on a number of levels .

The first step in an AHP is to build a hierarchy for the decision. This is also called decision modeling and it consists of building a hierarchy to analyze the decision. The analytic hierarchy process (AHP) structures the problem as a hierarchy. Figure 1 shows the hierarchy proposed for the case study.

Figure 2 : Decision hierarchy for reducing claims



The first level of the hierarchy is the goal, reducing construction claims. The second level in the hierarchy is constituted by the criteria used to decide. In the case study, we have mentioned the criteria represent time cost and quality. The third level consists of the available alternatives. In the case study alternatives represent risk response actions.
At the end of the AHP following steps the outputs will be obtained are:
Weights of risk selection criteria:

$$W = w_t + w_c + w_q = 1 \qquad (1)$$

Where wt, wc and wq are the weights of time, cost, and quality criteria respectively.
Local priority for risk response actions:

$$S_{k,i} = \begin{bmatrix} S_{t,1} & S_{t,2} & S_{t,3} \dots S_{t,i} \\ S_{c,1} & S_{c,2} & S_{c,3} \dots S_{c,i} \\ S_{q,1} & S_{q,2} & S_{q,3} \dots S_{q,i} \end{bmatrix}$$

Where k = t, c and q, i : risk response actions 1,2,3,…i. Sk,i local score of risk response action i for criteria k and $S_{k,1}+S_{k,2}+S_{k,3}+ \dots +S_{k,i}=1$
Global priority for risk response actions:

$$S_{AHP,1} = w_t * S_{t,1} + w_c * S_{c,1} + w_q * S_{q,1} \qquad (2)$$

$$S_{AHP,2} = w_t * S_{t,2} + w_c * S_{c,2} + w_q * S_{q,2} \qquad (3)$$

$$\vdots \quad {}_{t} * S_{t,i} + w_c * S_{c,i} + w_q * S_{q,i} \qquad (4)$$

2.3.1. Deriving Priorities (Weights) for criteria

The pair-wise comparisons are guided by a nine-point scale as depicted in Table 11. Adopting the nine point scale, the experts would be able to express their judgment subjectively. Relative importance of the each of the elements is compared to each other in pair-wise comparison matrix. The use of the AHP technique enables the decision- maker to structure a complex problem in the form of a simple hierarchy and to evaluate a large number of qualitative and quantitative factors in a systematic manner under multiple criteria (Cheung et al., 2001).

To incorporate their judgments about the various elements in the hierarchy, the decision makers compared the causes of claims to reflect how important they were to the decision makers, with respect to the Goal. The AHP methodology compares reducing criteria with respect to each cause of claims, in a pairwise mode using the fundamental scale of absolute numbers developed by Saaty (2012) as shown in Table 5.

Table 5 : Saaty's pairwise comparison scale (2012)

Verbal judgment	Numeric value
Extremely important	9
	8
Very Strongly more important	7

	6
Strongly more important	5
	4
Moderately more important	3
	2
Equally important	1

The comparison matrix in Table 6 shows the pairwise relative priorities for the criteria. We need to calculate the overall priorities or weights of the criteria. There are two methods for this purpose: the exact and the approximate. We will use the approximate method in our example due to its simplicity. However, keep in mind that this method provides a valid approximation to the overall weights only when the comparison matrix has a very low inconsistency.

The approximate method requires the normalization of the comparison matrix; i.e., add the values in each column. Next, divide each cell by the total of the column to get the normalized matrix. From this normalized matrix, we obtain the overall or final priorities simply calculating the average value of each row.

2.3.2. Check Consistency

After judgments have been put, it is necessary to check that they are consistent in AHP. the consistency ratio is defined as CR where CR = CI/RI. Saaty (2012) has shown that a consistency ratio (CR) of 0.10 or less is acceptable to continue the AHP analysis. If the consistency ratio is higher than 0.10, it is necessary to revise the judgments to find the cause of the inconsistency and correct it The calculated CR for each pair wise comparison matrix has the following steps.

a) Calculating λmax

Use the priorities as factors (weights) for each column. Multiply each value in the first column of the comparison matrix in by the first criterion priority then continue this process for all the columns of the comparison matrix. Add the values in each row to obtain a set of values called weighted sum.

Divide the elements of the weighted sum vector by the corresponding priority of each criterion as. Calculate the average of the values this value is called λmax.

b) Calculating the Consistency Index (CI)

The calculation of CI was by subtracted n from λmax then divided the result by (n-1)

n: is the alternatives in one hierarchy

$$\mathrm{CI} = \frac{\lambda\max - n}{n-1} \qquad (5)$$

c) Selecting Appropriate Value of the Random Consistency Ratio (RI)

Appropriate value of random consistency ratio, RI, was selected from Table 8, depending on the matrix size (value of n) .

Table 6: Random Index (Saaty, 1980)

n	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0.58	0.9	1.12	1.25	1.32	1.41	1.45	1.49	1.54	1.48	1.56	1.57	1.59

d) Calculate the Consistency Ratio (CR)

CR was calculated by dividing CI by RI as follow:

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}} \qquad (6)$$

f) Checking the Consistency of the Pair-Wise Comparison Matrix

It’s to check whether the decision maker’s comparisons were consistent or not.

CR = < 0.10 Ok It’s consistent.

2.3.3. Derive local priorities

The next step is deriving the priorities of the alternatives with respect to each criterion. Since the priorities are valid only with respect to each specific criterion, they are called local priorities to differentiate them from the overall priorities to be calculated later. For this purpose, we do a pairwise comparison using the numeric scale from Table 5 of all the alternatives, with respect to each criterion, included in the decision making model. We obtain the priorities for each of the alternatives by normalizing the matrix and averaging the rows. Because these priorities apply only to one criterion, they are called local priorities with respect to time We repeat the steps pairwise comparison and set priorities of all the alternatives, with respect to each criterion, to get local priorities of alternatives (risk response actions) included in the decision making model.

2.3.4. Derive overall priorities

We have obtained local priorities which indicate the reducing factor with respect to each criterion. In this step, we need to calculate the overall priority for each criterion; that is, priorities that take into account not only our preference for each criterion but also the fact that each criterion has a different weight. Given that we are using all the values provided in the model, this step is called model synthesis.

We start the calculation of the overall priority using the local priority of each alternative as the starting point. Next, we need to take into consideration the priorities of the criteria and for this purpose they are inserted in the table of the local priority. Multiply each value in the first column of the local priorities in by the first criterion weight then continue this process for all the columns of the table. Finally, the overall priority of each alternative is obtained by adding these results along the row. This procedure is repeated for each of the alternatives being evaluated.

In this research was developed an Excel sheet for applying the AHP method step by step through it, the Excel sheet could calculate all the steps illustrated in the AHP.

2.4. Mathematical model

Local and global priority of different risk response strategy actions were calculated using AHP analysis. These outcomes are added to goal programming method to develop combine of AHP and goal programming model for prioritizing risk response actions is presented to solve the problem of selecting appropriate risk response actions.

The objective function of the goal programming model to minimize the unwanted deviations from the specific target values.

This model is a multi-objective optimization model which considers the three objectives of time, cost, and quality simultaneously. The purpose of this model is to minimize the total undesirable deviations between the targets (expected values of cost, time and quality) and the optimal solution. Deviation from any of the targets can be positive or negative, but since the minimum cost increase, minimum time delay and minimum quality decrease are desirable for us, the total undesirable deviations include the sum of the positive deviations from the expected cost increase of each discipline, the sum of the positive deviations from the expected time delay of each discipline, and the sum of the negative deviations from the expected quality decrease of each discipline, which are presented in the following objective function, respectively

$$\text{Min } Z = P1\,(d^{-}AHP) + P2\,(d^{+}t) + P3\,(d^{+}c) + P4\,(d^{-}q) \qquad (7)$$

These constraints are formulated as following

1 : global scores for risk response actions:

$$S_{AHP1}, X_1 + S_{AHP2}, X_2 + \dots + S_{AHPi}, X_i + d^{-}_{AHP} - d^{+}_{AHP} = 1 \qquad (8)$$

S_{AHP} : global priority through risk response actions

$X_1, X_2 \dots X_i$: alternative risk response actions

d^{-}_{AHP} and d^{+}_{AHP} : deviations from the target

2 : local scores for risk response actions according to time

$$St1, X1 + St2, X2 + \dots + St,i, Xi + d^{-}_{t} - d^{+}_{t} = T_t \qquad (9)$$

$S_{k,i}$: local priority through risk response actions with respect to k : time, cost and quality

d^{-}_{k} , d^{+}_{k} : deviations from the target according to k for each criteria , d^{-}_{k} , $d^{+}_{k} > 0$.

The deviation variable equals the difference between the target value and the achieved value for each goal. The positive value of d_k means the tagert value is exceeded. The negative value of d_k means the tagert value is not met.

T_k : the sum of the two highest score S_k values according to Badri (1999, 2001)

3 : local scores for risk response actions according to cost

$$Sc1, X1 + Sc2, X2 + \dots + Sc,i, Xi + d^{-}_{c} - d^{+}_{c} = T_c \qquad (10)$$

4 : local scores for risk response actions according to quality

$$Sq1, X1 + Sq2, X2 + \dots + Sq,i, Xi + d^{-}_{q} - d^{+}_{q} = T_q \qquad (11)$$

III. Results and Conclusion

The selection appropriate reducing claims methods' point of views was adapted through the application of the AHP methodology discussed in the previously. In the first step was determined the priority weights of criteria, the second step was determined the local and global priorities of risk response actions (reducing factors), and finally was selected the appropriate risk response actions that achieve the overall criteria.

3.1. Main Criteria weight

Although there is no standardized way of presenting the results, showing the comparison matrix with the original judgments with the calculated priorities obtained. It is a useful way to see the judgments and priorities at the same time, as it can be seen in Table 7.

Table 7 : Pairwise comparison matrix and priority weights of criteria for owner's slow decisions

Reducing construction claims	Time	Cost	Quality	Priority
Time	1	4	7	1
Cost	0.25	1	3.00	0.25
Quality	0.14286	0.3333	1	0.14286

λmax = 3.032576, CI = 0.016288, RI = 1.49, CR = 0.028083< 0.1 OK.

 The time criterion had the top priority; this criterion had received a percentage of 70.14%. The cost criterion had the second priority with a percentage of 21.32%. In the third priority the criterion quality received a percentage of 8.53%.

3.2. Local priority of alternatives

Table 26 shows the final results of reducing factors pairwise comparison with claim cause of Owner's slow decisions. Also it shows the priority with numerical presentation for the reducing factors in achieving claim cause. As previously indicated, the priorities (preferences) of the alternatives, with respect to each criterion, are called local priorities (or preferences). The summary of the local priorities for each alternative is shown in Table 27

Table 8 : Pairwise comparison and local priorities of alternatives with respect to owner's slow decisions

Time	1	2	3	4	5	6	7	8	Priority
1-Minimum Changes of scope	1	0.125	6	5	0.1428	0.3333	1	0.5	0.0906
2-Allow reasonable 3-sufficient time for contract documents	8	1	4	5	0.1666	0.3333	5	7	0.1807
4-Performance and price are the base of selecting the contractors.	0.1667	0.25	1	0.5	0.125	1	2	1	0.0473
5-Read the contract several times before signing	0.2	0.2	2	1	0.2	0.3333	4	3	0.0722
6-Clients must make quick decisions during the execution	7	6	8	5	1	7	6	9	0.396
7-Contractors should visit the site of the project during the bidding stage	3	3	1	3	0.1428	1	2	4	0.1236
8-Written specifications should be reviewed	1	0.2	0.5	0.25	0.1667	0.5	1	5	0.0544
9-Pay progress payment to contractors on time	2	0.1429	1	0.3333	0.1111	0.25	0.2	1	0.0351

CR = -0.67902 < 0.1 OK.

Table 11 : Local Priorities of the alternatives with respect to each criterion for cause of claim1

Alternatives	Time	Cost	Quality
1-Minimum Changes of scope	0.0906	0.0906	0.0906
2-Allow reasonable sufficient time for contract documents	0.1807	0.1807	0.1807
3-Performance and price are the base of selecting the contractors.	0.0473	0.0473	0.0473
4-Read the contract several times before signing	0.0722	0.0722	0.0722
5-Clients must make quick decisions during the execution	0.396	0.396	0.396
6-Contractors should visit the site of the project during the bidding stage	0.1236	0.1236	0.1236
7-Written specifications should be reviewed	0.0544	0.0544	0.0544
8-Pay progress payment to contractors on time	0.0351	0.0351	0.0351

3.3. Overall Priority for alternatives

As shown in Table 15 is given the importance (or weight) of each criterion, the reducing factor Clients must make quick decisions during the execution is the most important reducing factor (overall priority = 0.396) and more important compared to the factor Allow reasonable sufficient time for contract documents (overall priority = 0.1807) which has higher priority than the factor Contractors should visit the site of the project during the bidding stage (overall priority = 0.1236).

Table 12 : overall priority of alternatives

Alternatives	Overall priority
Minimum Changes of scope	0.0906
Allow reasonable sufficient time for contract documents	0.1807
Performance and price are the base of selecting the contractors.	0.0473
Read the contract several times before signing	0.0722
Clients must make quick decisions during the execution	0.396
Contractors should visit the site of the project during the bidding stage	0.1236
Written specifications should be reviewed	0.0544
Pay progress payment to contractors on time	0.0351

The calculations for each alternative are shown in Table 13. The model synthesis process is convention of showing the local priorities of alternatives and the weights for each criterion are at the top of each column as shown in Table 13.

Table 13 : Synthesis of the model

	Time	Cost	Quality	Overall priority
Criteria weights	0.7014	0.2132	0.0853	
Minimum Changes of scope	0.0906	0.0906	0.0906	0.0906
Allow reasonable sufficient time for contract documents	0.1807	0.1807	0.1807	0.1807
Performance and price are the base of selecting the contractors.	0.0473	0.0473	0.0473	0.0473
Read the contract several times before signing	0.0722	0.0722	0.0722	0.0722
Clients must make quick decisions during the execution	0.396	0.396	0.396	0.396
Contractors should visit the site of the project during the bidding stage	0.1236	0.1236	0.1236	0.1236
Written specifications should be reviewed	0.0544	0.0544	0.0544	0.0544
Pay progress payment to contractors on time	0.0351	0.0351	0.0351	0.0351

As mentioned previously the first step in performing AHP analysis is the estimation of the priority weights of the selection criteria from pair-wise comparison matrix. Table 14 represents priority weights of the selection criteria for causes of claims. The second step, is the estimation of the local scores of the alternatives (risk response actions) based on each selection criteria from pair-wise comparison matrix. Local priorities risk response actions according to each cause of claims as shown in table 15 The third step is calculating the global priorities of risk response actions. Table 16 represents the global priorities for each cause of claims. Note that the in consistency ratio is calculated for each cause of claim and it must be less than 0.1.

Table 14 : Weights of the criteria for each cause of claims

Cause of claims	Wt	Wc	Wq
1-Owner's slow decisions	0.7014	0.2132	0.0853
2-Delay in Supply of Drawings	0.6393	0.0869	0.2737
3-Delay in Payments	0.6194	0.2842	0.0964
4- Design errors or omissions incomplete	0.1741	0.1033	0.7225
5-inadequate or incomplete specifications	0.5119	0.3601	0.1279
6-Change in work scope	0.2	0.2	0.6
7-Changes in plans and specifications during construction	0.5455	0.37	0.0845
8-Contractor is not well organized	0.08	0.5364	0.3836
9-Suspension of works	0.7071	0.2014	0.0915
10- Specifications and drawings inconsistencies	0.2611	0.3278	0.4111
11-Changes in design	0.2519	0.1593	0.5889
12-Delay in Handing over the Site	0.7513	0.1497	0.0991
13-Variations in quantities	0.6479	0.2299	0.1222

Wt : weight for time, Wc : weight for cost and Wq : weight for quality

Table 15 : Local priorities of alternatives for each cause of claims

Cause of claims	1-	2-	3-	4-	5	6	7	8
1-Owner's slow decisions	**0.0906**	**0.1807**	**0.0473**	**0.0722**	**0.39597**	**0.1236**	**0.0544**	**0.0351**
2-Delay in Supply of Drawings	**0.21061**	**0.3725**	**0.04505**	**0.1784**	**0.0377**	**0.0271**	**0.0984**	**0.0303**
3-Delay in Payments	**0.08748**	**0.0461**	**0.0317**	**0.05009**	**0.1705**	**0.0629**	**0.0967**	**0.45445**
4- Design errors or omissions incomplete	**0.3453**	**0.2058**	**0.0445**	**0.1688**	**0.0667**	**0.0435**	**0.0851**	**0.0403**
5-inadequate or incomplete specifications	**0.1284**	**0.19203**	**0.0282**	**0.1751**	**0.06988**	**0.0421**	**0.3376**	**0.0266**
6-Change in work scope	**0.4117**	**0.190996**	**0.0405**	**0.1386**	**0.0354**	**0.08904**	**0.0585**	**0.0352**
7-Changes in plans and specifications during construction	**0.10123**	**0.2281**	**0.0361**	**0.2248**	**0.0516**	**0.0424**	**0.280093**	**0.0357**
8-Contractor is not well organized	**0.0604**	**0.1471**	**0.3378**	**0.1416**	**0.0526**	**0.13301**	**0.0802**	**0.0473**
9-Suspension of works	**0.04595**	**0.1211**	**0.0505**	**0.1679**	**0.14331**	**0.03347**	**0.0502**	**0.3874**
10- Specifications and drawings inconsistencies	**0.0438**	**0.13296**	**0.1199**	**0.23309**	**0.0379**	**0.0339**	**0.3453**	**0.0531**
11-Changes in design	**0.36536**	**0.30952**	**0.0538**	**0.1191**	**0.038**	**0.0405**	**0.03711**	**0.0367**
12-Delay in Handing over the Site	**0.04857**	**0.1245**	**0.1331**	**0.1678**	**0.0344**	**0.39359**	**0.0641**	**0.0338**

13-Variations in quantities	**0.3056**	**0.30537**	**0.05501**	**0.1541**	**0.0299**	**0.02707**	**0.05632**	**0.0666**

Table 16 : Global priorities of alternatives for each cause of claims

	Risk response actions							
Cause of claims	**Minimum Changes of scope**	**Allow reasonable sufficient time for contract documents**	**Performance and price are the base of selecting the contractors.**	**Read the contract several times before signing**	**Clients must make quick decisions during the execution**	**Contractors should visit the site of the project during the bidding stage**	**Written specifications should be reviewed**	**Pay progress payment to contractors on time**
1-Owner's slow decisions	0.0906	0.1807	0.0473	0.0722	0.3960	0.1236	0.0544	0.0351
2-Delay in Supply of Drawings	0.2106	0.3725	0.045	0.1784	0.0377	0.0271	0.0984	0.0303
3-Delay in Payments	0.0875	0.0461	0.0317	0.0501	0.1705	0.0629	0.0968	0.4545
4- Design errors or omissions incomplete	0.3453	0.2058	0.0445	0.1688	0.0667	0.0435	0.0851	0.0403
5-inadequate or incomplete specifications	0.12842	0.192	0.0282	0.1751	0.0699	0.04212	0.3376	0.0266
6-Change in work scope	0.4117	0.191	0.0405	0.1387	0.0354	0.0890	0.0586	0.0352
7-Changes in plans and specifications during construction	0.1012	0.2281	0.0361	0.2248	0.0516	0.04236	0.2801	0.0357
8-Contractor is not well organized	0.06041	0.1471	0.3378	0.14155	0.05261	0.13301	0.0802	0.0473
9-Suspension of works	0.0460	0.1211	0.0505	0.1680	0.1433	0.0335	0.0502	0.3874
10- Specifications and drawings inconsistencies	0.0438	0.133	0.1199	0.2331	0.0379	0.0335	0.3453	0.0531
11-Changes in design	0.3654	0.3095	0.0538	0.1191	0.038	0.0405	0.0371	0.0367
12-Delay in Handing over the Site	0.0485	0.1245	0.1331	0.1678	0.0344	0.39369	0.06414	0.0338
13-Variations in quantities	0.3056	0.3054	0.055	0.1541	0.0299	0.02707	0.0563	0.0666

Solver add-in software is used to run the goal programming model to select the best risk response actions. Table 17 the results the selection of each risk response actions

Table 17 : Results of the selection of each risk response actions

Causes of Claims	The best risk response actions
1-Owner's slow decisions	Clients must make quick decisions to solve any problem that arise during the execution
2-Delay in supply of drawings	Allow reasonable sufficient time for the design team to produce clear and complete contract documents with no or minimum errors and discrepancies
3-Delay in payments	Owners are recommended to pay progress payment to contractors on time because it affects the contractors' ability to finance the work
4- Design errors or omissions incomplete	Allow reasonable sufficient time for the design team to produce clear and complete contract documents with no or minimum errors and discrepancies
5-Inadequate or incomplete specifications	Written specifications should be reviewed to avoid ambiguities and conflicting requirements
6-Change in work scope	Minimum Changes or modification of scope
7-Changes in plans and specifications during construction	Written specifications should be reviewed to avoid ambiguities and conflicting requirements
8-Contractor is not well	Both of performance and price should be the base of selecting the contractors.

organized	
9-Suspension of works	Clients must make quick decisions to solve any problem that arise during the execution
10- Specifications and drawings inconsistencies	Read the contract several times before signing it to understand any unclear clauses
11-Changes in design	Allow reasonable sufficient time for the design team to produce clear and complete contract documents with no or minimum errors and discrepancies
12-Delay in Handing over the Site	Encourage contractors to visit the site of the project during the bidding stage to inspect it and check its accessibility, weather conditions, services, bylaws, etc.
13-Variations in quantities	Allow reasonable sufficient time for the design team to produce clear and complete contract documents with no or minimum errors and discrepancies

IV. Conclusions and recommendations

The results obtained from the mathematical model showed that. Allow reasonable sufficient time for the design team to produce clear and complete contract documents with no or minimum errors and discrepancies is the best solution for the claims resulting from delay in supply of drawings, design errors or omissions incomplete, changes in design and variations in quantities which means that it is the most important factor that can reduces many causes of claims. Written specifications should be reviewed to avoid ambiguities and conflicting requirements is the best reducing factor of claims that is the best solution for inadequate or incomplete specifications and changes in plans and specifications during construction. Clients must make quick decisions to solve any problem that arise during the execution is the most important risk response action to solve the problem of owner's slow decisions Owners are recommended to pay progress payment to contractors on time because it affects the contractors' ability to finance the work to solve the problem of delay in payments. Its recommended to minimize Changes or modification of scope. Both of performance and price should be the base of selecting the contractors that is the main cause to avoid the factor of contractor is not well organized. Clients must make quick decisions to solve any problem that arise during the execution that leads to suspension of works. Read the contract several times before signing it to understand any unclear clauses is the best way to avoid specifications and drawings inconsistencies. Encourage contractors to visit the site of the project during the bidding stage to inspect it and check its accessibility, weather conditions, services, bylaws, etc. is the best method for delay in handing over the site.

The recommendations to industry to avoid or at least reduce claims in Egyptian construction are: □ using well balanced contracts, in terms of the contractor / consultant / and owner rights and responsibilities, such as FIDIC contracts; □ giving special consideration to contract clauses especially those related to times of owner/consultant replies, approvals, variations, inspections and payments; □ good choice of experienced consultants, especially in construction management; □ owner to allow reasonable time for design team to produce clear and complete drawings and specifications; □ provision of a proper mechanism for processing and evaluating variations and claims in the contract; □ use of proper project management and control techniques; □ presence of a maximum or anticipated time for owner / consultant to reply to contractor request; and □ all parties to develop their human resources capabilities, especially in the areas of construction and general management skills

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