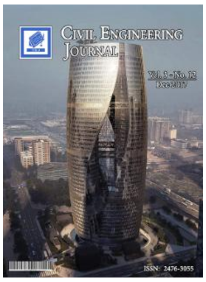
Available online at www.CivileJournal.org

Civil Engineering Journal

Vol. 3, No. 12, December, 2017



Risk Response Selection in Construction Projects

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Received 28 September 2017; Accepted 17 December 2017

Abstract

Risk and its management is important for the success of the project, the risk management, which encompassed of planning, identification, analysis, and response has an important phase, which is risk response and it should not be undermined, as its success going to the projects the capability to overcome the uncertainty and thus an effective tool in project risk management, risk response used the collective information in the analysis stage and in order to take decision how to improve the possibility to complete the project within time, cost and performance. This stage work on preparing the response to the main risks and appoint the people who are responsible for each response. When it's needed risk response may be started in quantitative analysis stage and the repetition may be possible between the analysis and risk response stage. The aim of this research is to provide a methodology to make the plane for unexpected events and control uncertain situations and identify the reason for risk response failure and to respond to risk successfully by using the optimization method to select the best strategy. The methodology of this research divided into four parts, the first part main object is to find the projects whose risk response is failed, the second part includes the reasons for risk response Failure, the third part includes finding the most important risks generated from risk response that leads to increasing the cost of construction projects, the fourth part of the management system is selecting the optimal risk response strategy. An optimization model was used to select the optimal strategy to treat the risk by using Serval constraints such as the cost of the project, time of the project, Gravitational Search Algorithm and particle swarm used. The result of the risk response selection shows that The investment (contractor, bank) strategy shows a very good strategy as it saves the cost about 30%, while the Mitigate (pay for advances with interest 0. 1) Strategy show saving the cost 40% and giving land to contractors show saving the cost 40% finally the BIM strategy show saving the cost 25%. The risk response is an important part and should give a great attention and it must be used sophisticated method to select the optimal strategy, the two techniques both show high efficiency in selecting the strategy but Gravitational Search Algorithm show better performance.

Keywords: Risk Management; Risk Response; Particle Swarm; Gravitational Search Algorithm.

1. Introduction

The method that used to manage risks effectively has been considering the central arena of project management for a long time because projects are gradually exposed to high risks [1]. when the project complexity increase the impact of risks can be much higher [2].

The risks can be defined as an uncertain condition or event that its occurring has an influence on at least one of the objectives of the project. Objectives can involve scope, schedule, quality, and cost. The causes of risk may more than one, hence his occurring has more than one impacts. The requirement, constraint or assumption may be the cause that generates the outcome with possibility been negative or positive [3].

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http://dx.doi.org/10.28991/cej-030950

Risk management is defined as the process that able to find the risks and analysis these risks using a suitable method and then put the appropriate response to eliminate those risks or reduce them and thereby increasing the success of the project and the achievement of its goals [4].

The risks have a high effect on the construction industry and these risks if not been handled correctly will lead to poor performance of the projects [5] commonly, each construction process activity is related to risk. For instance, the of designing and execution phases are related to a specific degree of inaccuracy commonly increased by poor, insufficient and inconsistent construction project risk communication. According to Nasirzadeh [6], a large number of risks are included in construction projects that have an extensive complicated structure coming from components that are multiple and interdependent. The features of these have an influence on the overall probability of occurrence through the feedback loop of a cause and effect. The above may be increased by the overall influence of risk that considers indirect and secondary as generated from another risk. The risk considers the main factor during the management of any project, risk management that can be regarded as integral part of project management that requires further research.

Ogunsanmi [7] show that 37 risk factors that influence on the design and project resulting that designers and contractors should pay attention to the following risks, cost overruns and poor quality which consider the main risks in each phase of the construction process that requires risk application, the estimation process of construction cost contingency most often lack a scientific basis.

Gul Polat [8] they made a study to investigate the reason to lead to cost overruns in micro-scaled construction companies, the questionnaire includes ten questions which collected from the previous studies and distributed to 136 companies, the fount of their results that the reason for cost overruns were, related factors in the contract, time factors, quality factors, cost factors, human resource factors, communication factors and other risks.

Kasimu M. A [9] used a qualitative research approach to achieve the important information of the main factors leading to the cost overrun in the building construction projects. The factors were classified according to the significant degree as evaluated by the respondents and the reasons for cost overruns as follow, fluctuation of the materials price, lack of experience in contracts works, insufficient time, and incomplete drawings.

Therefore, risk and its management are important for the success of the project, the risk management, which encompassed of planning, identification, analysis, and response has an important phase, which is risk response and it should not be undermined, as its success going to the projects the capability to overcome the uncertainty and thus an effective tool in project risk management, risk response used the collective information in the analysis stage and in order to take decision how to improve the possibility to complete the project within time, cost and performance. This stage work on preparing the response to the main risks and appoint the people who are responsible for each response. When it's needed risk response may be started in quantitative analysis stage and the repetition may be possible between the analysis and risk response stage [10].

Basically, previous studies on management of project risk were conducted along with a typical project risk management methodology involving risk identification, analysis, response conceiving, and monitoring and control [11]. Risk management is defined as the process that enables the analysis and managing the risk related to the project and its aim to reduce the risk that threatens the goal of the project and hence its take the responsibility of increasing the opportunity for the competition of the project in time, cost, and quality [12].

The risk management most significant stage is risk response, but it's an area which has not been studied, where at this stage the decisions about the risks should be taken by the project managers. Even though much of the time and cost has not been sacrificed by the manager in responding to risks, planning of risk response is an ignored part of project risk management [13].

Therefore, a management system and measures should be developed to ensure the success of risk response and to reduce the risks effects (cost, delay). According to -Hällgren & Wilson [14]to manage risks in the project, there are tools and techniques, but there isn’t much research available for risk response in respect to the project success. (Hällgren,2011). It is known that the success of response measures is possibly being different from project to project, and obviously, housing projects required different measures than the implemented in school projects and that because their various uses and that requires a different response. [15].

According to Yao Zhang and Zhi-Ping Fan [16], there are the different methods used to select risk response strategy. which one of them is the approach based on optimization-model.

The method that's based on the model of optimization is to build a mathematical model for the selection of risk response strategy problem solution. Communally, the objective function of the model is the cost of implementing strategies minimization, and the constraints include combinations of the strategies [17].

With the help of the optimization method, this study aims to select the optimal risk response strategy. Because of the complex process of this selection, the following was conducted, the initial risks were analysis then the risk response was measure then the risks generated from risk response was analysis and finally the optimal risk response strategy selected.

The paper is organized as follows:

1) Literature review;
2) Methodology of the research;
3) optimization model;
4) Concluding remarks.

2. Literature Review

Aven [18], introduce a basic risk theory depend on a brief selected review that over the last 15-20 years and he presented the risk concept evolution in Oxford English Dictionary since 1679, the definition followed the environment evolution. Veland and Ave [19], introduce the same based classification of risk given by Aven (2012), the different definition of risks discussed how the risk perspectives affect the risk communication between the decision-makers, the risk analysts, experts and lay people. Indeed, for Karimiazari [20], view of the engineers, designers, and contractors in the risk from the perspective of the technological, while lenders and developers tend to assess it from the economic and financial side. So, the question is: what is a risk? The first answer, the risk is the probability that an event or action may adversely affect the organization [21]. For Mazouni [22], the risk is a basic property of any decision, it is evaluated by a combination of several factors (severity, occurrence, exposure to, etc.), although it is communally limited to two factors: severity and frequency of occurrence of potentially damaging accidents that incorporate some exposure factors.

Risk management is the process whether the risk is acceptable or the implementation of action to minimize the significances or the probability of occurrence of an adverse event [23] Risk management refers to strategies, methods and supporting tools to identify and control risk to an acceptable level.

The methodology of project risk management including risk identification, analyzing, response conceiving, and monitoring and control have been generally distinguishing and applied to construction project risk management ([25,11,26]. Risk identification is a stage where the risks that effect on the project are identified with recording its characters which include the risks that affect inversely on the goals of the project that supposed to be Implemented as required and then classified it in lists and under each class a group of possible risks which have been identified [27].

The main goal of a risk analysis or evaluation is identified risks evaluate depending on the occurrence frequency and perceived consequences of those risks on each project objective [28]. Normally, viewpoints of experts are gained to help in risk evaluation. Strategies of conceiving risk response authorize a series of procedures and techniques to be developed to reinforce opportunities and reduce threats from risks to projects [29]. The last step concentrates on monitoring residual risks, new risks identification, and evaluating the overall effectiveness of project risk management plans.

Risk response is considered to be a very important stage in risk management because if it's finding the projects lead to create opportunities and decrease the threats that indicate how well are the managers [15]. To be specific, the plan of risk response has the possibility to make the conditions which considered to be essential for optimal identification of risk and evaluation, hence, the action of risk response should be designed, classified and justified on systematic principle [13].

Optimization considers one of the toll to select the risk response strategy which can be defined as the process of earning the result that regards the best under given conditions. In design, construction, and maintenance of any system in engineering, at many stages, numerous technological and management decisions must be taken by the engineers. The ultimate objective these decisions are either desired benefit maximization or to the effort required minimums [30].

Yao Zhang and Zhi-Ping Fan [16], Their study provides an approach to solve the selection problem of risk response strategy in PRM. In the approach, they developed an optimization model, which combine three critical elements that are the project cost, project quality, and project schedule. When the model solved, the optimal solution might be obtained so that the most required risk response strategies to overcome the risk events can be determined. If this method doesn't satisfy the manager another method used which cakes tradeoff. The method of the optimization discrete optimizer LINGO.

Rahman Soofifard, Morteza Khakzar Bafrue [31], produce a mathematical model that study the effect of the risk response reduction measures and the effect on each other, and also the capability of optimizing different criteria regarding the objective function depending on the type of project.

R. Soofifard and M. Gharib[32] proposes a model for the selection of proper risk response from the responses portfolio with the objective of optimization of defined criteria for projects. This research has taken into consideration the relationships among risk responses; especially the relationships between risks, which have been infrequently considered in previous works. This model is capable of optimization of different criteria for the objective function based on the proposed projects. Multi-objective Harmony Search (MOHS) is used to solve this model and the numerical results obtained are analyzed.

This paper introduces two type of techniques used in the optimization model which are particle swarm and Gravitational Search Algorithm.

3. Methodology

3.1. Introduction

The methodology of this research divided into four parts, The first part main object is to find the projects whose risk response is failed.

The questionnaire was distributed to the owners, the contractor and other parties involved in the project, 5 projects were taken and the questionnaire was distributed to 15 people who worked on the projects. The questionnaire includes the strategies for each risk, five measurements were used that are low, too low, high, medium, and too high, the risks of the projects were distributed during the period of 2014-2016. For the measurement of risk response, the Likert scale used which range from one to five. The risks for this period are shown in the table1.

Table 1. Risks during the period 2014-2016

Risk	N	Qualitative analyses	Quantitative Analyses
Wrong estimation	30	0.086	Medium
Financial difficulty by contractor	30	0.196	High
Financial difficulty by owner and delay in making the decision	30	0.3234	Too high
Delay in completing the project	30	0.1219	Medium
Delay in agreement of design	30	0.096	Medium
Delay in delivery of equipment		0.1431	Medium
Exceptional circumstances and risks	30	0.248	High

The second part includes the reasons for risk response Failure through the questionnaire that distributed to the owners, the contractor and other parties involved in the projects.

The sample of the questionnaire was the University of Diyala and the question that asked was: please specify the main reasons for the weakness and failure of the risk response phase in construction projects, the reasons for risk response failure are shown in table 2.

Table 2. Risk response failure during the period 2014-2016

Variable	N	Mean	Std Dev	Score
Poor performance of project managers	30	2.33	0.88	scarcely
The inability to introduce sophisticated management methods to respond to risks	30	4.17	0.79	Often
Multiple decision sources for selecting a risk response strategy	30	2.53	0.94	scarcely
Competency migration in relation to the choice of risk response team	30	2.57	0.86	scarcely
Failure to complete the risk response plan in a timely manner	30	2.80	0.66	Some time
Neglecting the role of supervisors in the process of monitoring the risk response plan	30	4.00	0.83	Often
Lack of funds for training and continuous development of the risk response team	30	3.83	0.99	Often
Rely on the manager only in choosing a risk response strategy	30	3.37	0.81	Some time
Inadequate strategy with high risk	30	4.10	0.88	Often
Delay in the disbursement of financial dues by the responsible party	30	4.33	0.71	Always
Changes in the cost criteria that have been estimated at the planning stage of the project to the implementation stage	30	3.50	1.07	Often
The difficulty of implementing the risk-response plan correctly for internal factors (terrorism and sabotage)	30	4.37	0.67	Always

The third part includes finding the most important risks generated from risk response that leads to increasing the cost of construction projects.

This part also includes the probability of risks to occur and its impact on the cost and then finding the qualitative analysis of these risks. Depending on the probability and the impact it can say that some risks have high probability, but their impact is medium or low and vice versa, there for each risk is analysis depending on these two factors as shown in table 3.

Table 3. Risks generated from risk response

Risks	Risk response	Risk generated
Delay in completing the project	Acceptance	Delay in completing the project
Exceptional circumstance and risks	Acceptance	Depressions
Wrong estimation	Avoidance	Wrong estimation
Wrong estimation	Acceptance	Wrong estimation
Finical difficulty by the contractor	Acceptance	Poor quality at work
Finical difficulty by the owner	Avoidance	Delay in disbursing advances to contractors
Finical difficulty by the contractor	Avoidance	Delayed implementation of commitments

The fourth part of the management system is selecting the optimal risk response strategy, four risks were taken for five projects in order to select the best strategy, the risks are wrong estimates, Finical Difficulty by the owner Change in the cost of equipment and material, Exceptional circumstances and risks as these risks consider the most repeated and costly.

An optimization model was used to select the optimal strategy to treat the risk by using Serval constraints such as the cost of the project, time of the project.

3.2. Particle Swarm

Kennedy and Eberhart in 1995 produce the algorithm of the PSO. The base of this algorithm is on the theory that the information social sharing among species members provide an evolutionary benefit [33]. Lately, the PSO has the advantage of the following applications of diversity in the design of the engineering like the design of logic circuit [34], control design [35] and design of the systems of power [36].

The natural process of particle swarm is stochastic; the update of the current position is done by using velocity vector of every swarm particle. The vector of the velocity is updated depending on each particle memory that earned in the process, conceptually resembling memory of an autobiography, also the knowledge earned by the swarm as a whole [33]. Hence, the position of the particle in the swarm is updated depending on the swarm social behavior that adjusts to its environment by a recurrence to promising space regions that formerly discovered and better positions are been looking for over time. Numerically, at iteration k+1, the x position of my particle is updated as:

$$\mathrm{X^ik + 1 = x^ikv^ii + k\Delta t} \tag{1}$$

Where v^i_{k+1} is the representation of the vector of velocity updated, and Δt is the value of the time step that regarded as a unity [37]. Each vector of velocity of the particle is calculated as:

$$\mathrm{V^ik + 1 = wv^i_k + c_1r_2(p^ik - x^ik/\Delta t) + c_1r_2(p^gk - x^ik/\Delta t)} \tag{2}$$

Where V^ik is the vector of velocity at iteration k, pick considering the best value of the particle i and p_k^g consider the best position of the global for the whole swarm until the present iteration k and r, is a random number in the [0,1] interval. The other symbols are parameters of configuration that take a significant role in the convergence behavior of PSO. The c_1 and c_2 symbols symbolize settings of trust that respectively denoted to the degree of the confidence in the best solution determined by every particle of the individual (parameter of cognitive as c_1) and by the whole swarm (parameter of social as c_2) [33].

3.3. Gravitational Search Algorthm

GSA was produced by Rashidi et al. In 2009 and is prepared to solve problems of optimization. The algorithm considers heuristic algorithm [38].

Gravitational Search Algorithm GSA is classified under the approach of the population and is reported to be more conjectural [39]. In the population-based algorithm, the algorithm has the intention to improve the exploration and exploitation capabilities, performance, depending on the rules of the gravity. However, lately, GSA has been reviewed for not truly depending on the gravity law [40].

The basis of this algorithm is gravity law and interactions of mass. The algorithm consists of agent's collection, the search that interacts with one another through the gravity force [38].

The agents are regarded as objects and masses considers the performance of the objects. A global movement is caused by the gravity force in which all objects transfer with heavier masses towards the other objects. The step of exploitation of the algorithm is guaranteed by the heavier mass slow movement and corresponds to solutions that consider good. The masses actually follow the gravity law as shown in Equation and the law of motion [38].

$$F = G(M1\ M2/R^2) \tag{3}$$

$$a = F/M \tag{4}$$

3.4. Problem Definition and Mathematical Formulation

The problem is to choose the most optimal risk response strategies. In order treat the risk, zero–one decision variables are used to refer whether or not to select the risk response strategy. If the risk response strategy is chosen, the decision variable is equal to one; otherwise, it is equal to zero. Two techniques were used to select the best strategy (Yao Zhang and Zhi-Ping Fan, 2014) [16] The variables are:

C_i means cost of the risk response, S_j is The number of days delayed of project after risk occur, $S_{i,j}$ The number of days delayed of project after risk response implementation, $E_{i,j}$ is risk response effectiveness, T is a time of the project, B is the cost of the project, i is risk response, j risks, $x_{i,j}$ is decision variable which considers binary integer. $x_{i,j}$ is equal to 1 if risk the response strategy A_i is executed for risk event R_j and otherwise x_{ij} is equal to 0. These variables were taken depending on historical information and expert experience, the formulation of the optimization was adjusted from the original to suit the condition of the environment as follows:

$$\sum \mathrm{C_i} \times \mathrm{MAX_j}(\mathrm{x_{i,j}})\ \mathit{less}\ 0.6\mathrm{B} \tag{5}$$

$$\sum \mathrm{S_j} - \sum\sum \mathrm{S_{i,j}} \times \mathrm{x_{i,j}} \leq 2\mathrm{T} \tag{6}$$

$$\mathrm{x_{i,j}} + \mathrm{x_{ij}} \leq 1\ \ \mathit{no\ one\ selected} \tag{7}$$

$$\mathrm{x_{i,j}} - \mathrm{x_{ij}} \leq 0\ \ \mathit{select\ both\ them} \tag{8}$$

$$\mathrm{X_{ij}} = (0-1) \tag{9}$$

$$\mathrm{MAX\ Z} = \sum\sum(\mathrm{e_{i,j}} \times \mathrm{x_{i,j}}) \tag{10}$$

In the model, the objective function is to maximize all the estimated risk response effects.

Constraint (1) the cost of the risk response must not exceed 0.6 of budget.

Constraint (2) the time required for implementing the risk response strategy must not exceed 2 by the time of the project.

Constraint (3) indicates that if both strategies are less or equal one no one selected.

Constraint (4) indicates that if both strategies are less or equal zero select both strategies.

Two techniques were used which are particle swarm and Gravitational Search Algorithm.

The strategies for the risk as following:

Table 4. Shows the risks and strategies

Risks	Strategies
Wrong estimation	Accept (emergency) Using BIM Mitigate (pay for advances with interest 0. 1)
Finical Difficulty by the owner	Investment (contractor, bank) Accept (emergency) Private sector (contractor, bank)
Change in the cost of equipment and material Exceptional circumstances and risks	Accept (emergency) Insurance Mitigate (pay for advances with interest 0. 1)

4. Illustrative Example

In this part, an example is introduced to explain how to use the optimization method to solve the risk response strategy selection problem by taking 5 projects.

4.1. Problem Description and Analysis

5 construction projects are taking, the risks and strategies are shown in appendix 1, after the investigation of their initial risks, risk response failure, the risks generated from risk response and then selecting the optimal risk strategy as shown in the flowchart.

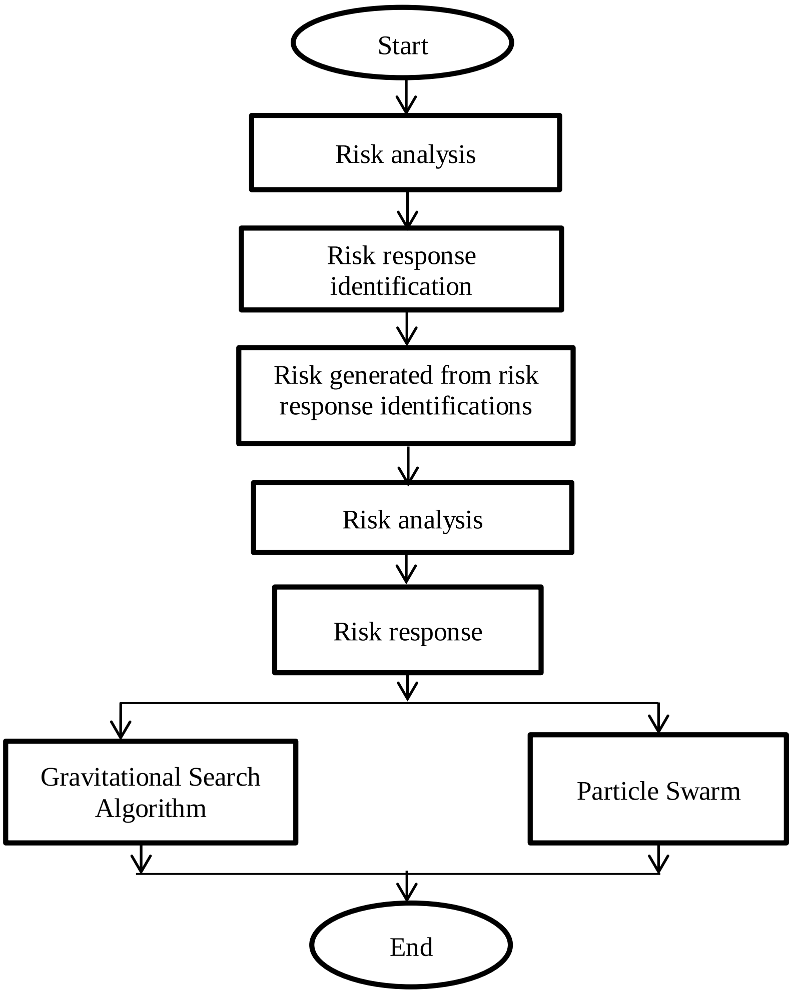

Figure 1. Structure of the risk response selection

Then the budget and the time for each project are collected, after that, a questionnaire is made to investigate the effectiveness of the proposed risk response.

The table below shows the number of the projects, the cost of implementing each strategy, the delay as effect of risk, the time of implementing the risk response strategy, the effectiveness of the risk response strategy and the time and cost of the projects.

Table 5. Shows risk response strategies parameters

Project	Ci	Sj	Sij	B	T	e	Effectiveness
11	1.06E+08	287.2	4.786667	3.51E+09	718	0.95	0.9405
12	3.51E+08	430.8	1.196667	3.51E+09	718	0.95	0.9405
13	35081053	366	0.983562	3.51E+09	718	0.9	0.728625
21	4.11E+08	354.5	11.81667	3.7E+09	709	0.88	0.8712
22	3.7E+08	283.6	0.787778	3.7E+09	709	0.89	0.875045
23	3.7E+08	141.8	0.393889	3.7E+09	709	0.9	0.891
31	8.47E+08	147.2	0.408889	1.69E+09	368	0.9	0.891
32	1.69E+08	184	0.511111	1.69E+09	368	0.8	0.714728
33	84665425	356.5	0.511111	1.69E+09	368	0.9	0.891

41	45846248	468	1.3	3.27E+09	780	0.95	0.9405
42	3.27E+08	546	1.516667	3.27E+09	780	0.88	0.86619
43	1.64E+08	312	0.866667	3.27E+09	780	0.9	0.891
51	1.89E+08	378.5	1.051389	1.89E+09	757	0.8	0.792
52	1.89E+08	302.8	0.841111	1.89E+09	757	0.9	0.891
53	94709650	378.5	1.051389	1.89E+09	757	0.9	0.891

4.2. Computational Results and Discussion

Selecting a group of risk response strategies to achieve a desirable total risk response effects requires balancing cost, time depending on the requirements of the objective function, the following are the results of the two techniques.

Table 6. Shows the results of particle swarm for risk response selection generated from risk response

Project	x	pso	V1	Fitnees1
11	0.99	0.9405	0	0.9405
12	0.99	0.9405	0	0.9405
13	0.809584	0.728625	0	0.728625
21	0.99	0.8712	0	0.8712
22	0.983196	0.875045	0	0.875045
23	0.99	0.891	0	0.891
31	0.99	0.891	0	0.891
32	0.893409	0.714728	0	0.714728
33	0.99	0.891	0	0.891
41	0.99	0.9405	0	0.9405
42	0.984307	0.86619	0	0.86619
43	0.99	0.891	0	0.891
51	0.99	0.792	0	0.792
52	0.99	0.891	0	0.891
53	0.99	0.891	0	0.891

The figures below show some example about the method of searching using the PSO.

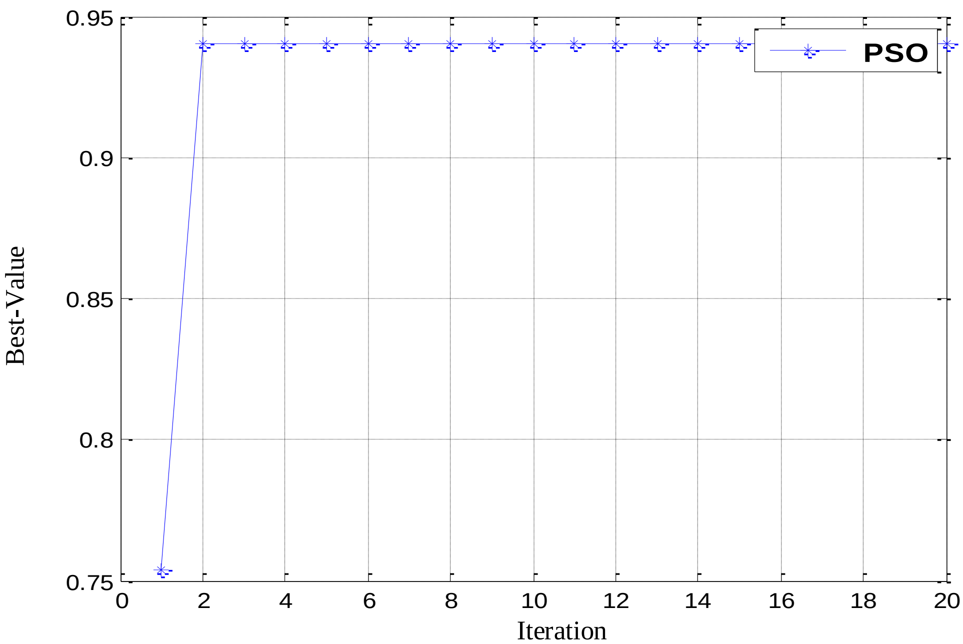

Figure 2. The results of particle swarm for the project 1, case 1

The figure above shows the result of the project one, case one which is delay in disbursement of the advance and have three strategies, mitigate (Giving land to contractors), mitigate (contractor bank with private sector) and mitigate (contractor bank with investment), the strategy that shows the high efficiency is mitigated (Giving land to contractors) and the technique gives the result in the second iteration, that lead to proving the effectiveness of the technique.

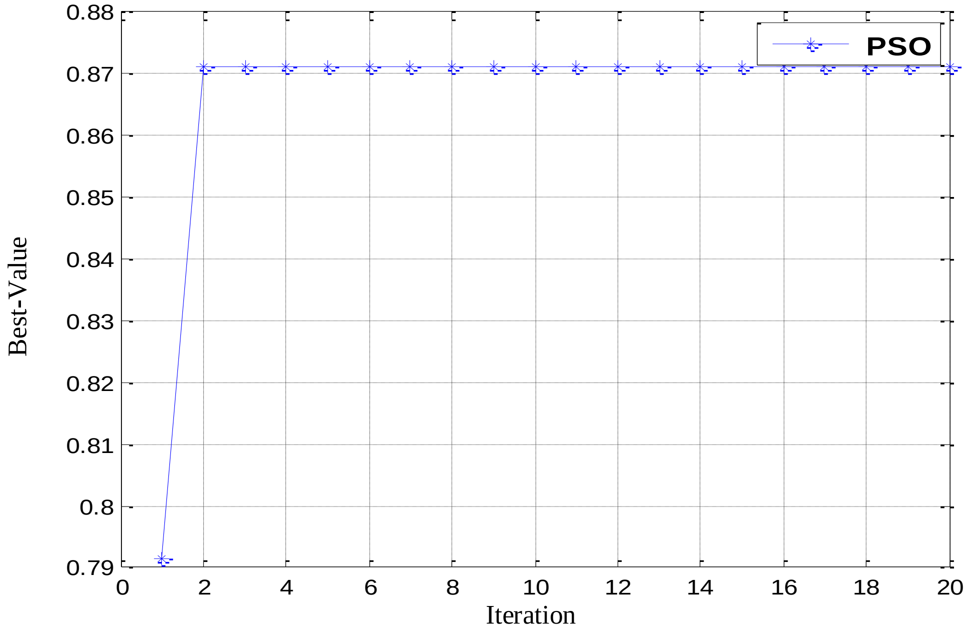

Figure 3. The results of particle swarm for the project 2, case 1

The figure above shows the result of the project two, case one which is delay in disbursement of the advance and have three strategies, mitigate (Giving land to contractors), mitigate (contractor bank with private sector) and mitigate (contractor bank with investment), the strategy that shows the high efficiency is mitigated (Giving land to contractors) and the technique gives the result in the second iteration, that lead to proving the effectiveness of the technique.

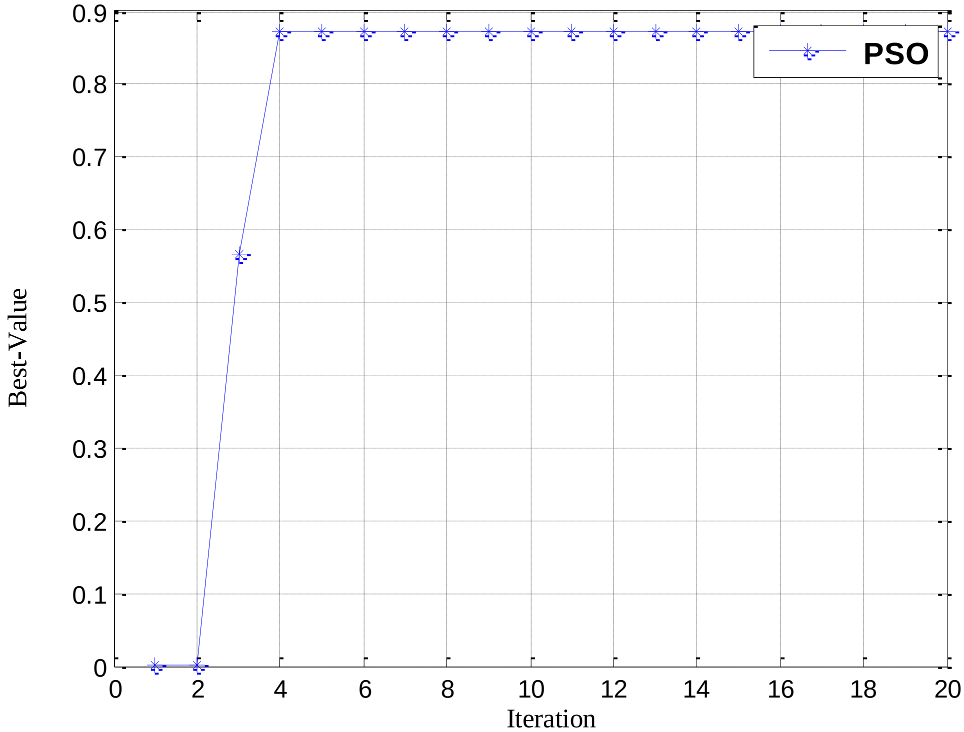

Figure 4. The results of particle swarm for the project 3, case 1

The figure above shows the result of the project three, case one which Delay in implementing the commitment and have three strategies, mitigate (contractor bank with investment), accept(emergency) ,mitigate (contractor bank with private sector), the strategy that show the high effective mitigate (contractor bank with investment and the technique give the result in the fourth iteration, that leads to proving the effectiveness of the technique .

While the results of the Gravitational Search Algorithm show different behavior in term of searching and the velocity as this technique is faster and smoother in searching, as shown below.

Table 7. Shows the results of GSA of risk response

Project	x	GSA	V	Fitnees
11	0.99	0.9405	2.62E-11	0.9405
12	0.99	0.9405	5.45E-07	0.9405
13	0.990178	0.891	0.000178	0.792
21	0.99	0.8712	2.83E-09	0.8712
22	0.990356	0.8811	5.41E-08	0.8811
23	0.99	0.891	3.01E-06	0.891
31	0.99	0.891	3.58E-06	0.891
32	0.99	0.792	1.67E-09	0.792
33	0.990002	0.891	2.37E-06	0.891
41	0.990001	0.9405	1.73E-08	0.9405
42	0.99	0.8712	2.51E-12	0.8712
43	0.99	0.891	2.46E-08	0.891
51	0.987853	0.792	-6.79E-08	0.787068
52	0.99	0.891	2.36E-05	0.891
53	0.990004	0.891	4.28E-06	0.891

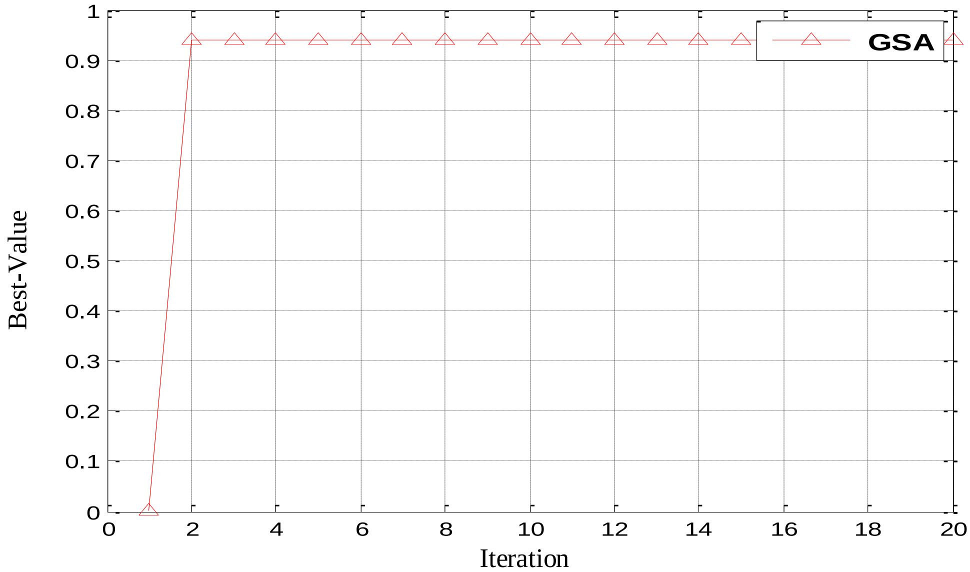

Figure 5. The results of GSA for the project 1, case 1

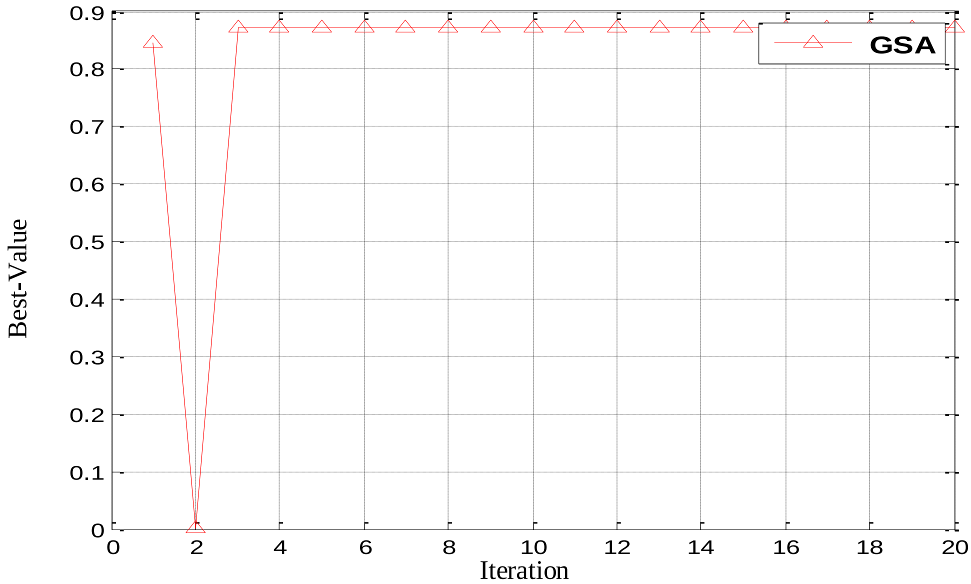

Figure 6. The results of GSA for the project 2, case 1

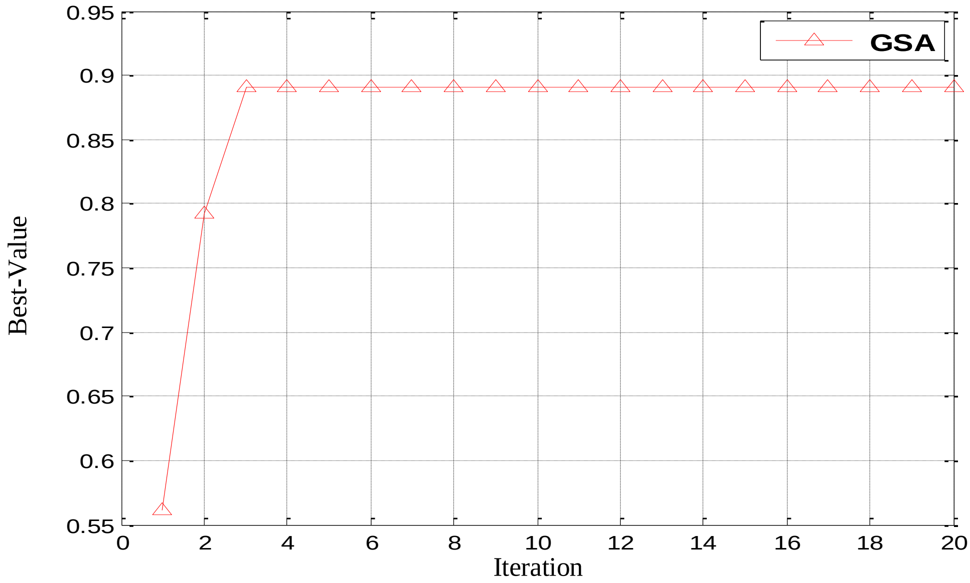

Figure 7. The results of GSA for the project 3, case 1

As results from using these two techniques, the following saving in the cost.

Table 8. Shows the effectiveness of the proposed risk response strategies

Risks	Proposed	Cost
Finical difficulty of the owner	The strategy was investment (contractor, bank)	The cost of the response about 10% of the budget
Wrong estimation	The strategy was used BIM	The cost of the response about 5 % of the budget
Change in the cost of equipment and material In exceptional circumstances and risks	Mitigate (pay for advances with interest 0. 1)	The cost of the response about 0.014 % of the budget

5. Conclusion

This paper presents an approach for solving the risk response strategies selection problem, through the results the following can be concluded, two techniques were used; Gravitational Search Algorithm has better performance than particle swarm in term of speed as also the method of searching.

The results of the questionnaire show that the risks are the financial difficulty by the contractor, the financial difficulty by the owner, that means the owner of the project show inability to pay for the contractor that lead to stop the project and cause delay, wrong estimation , this risk is lead to change order that requires cost and time and considers risk with high impact and exceptional circumstances and risks, all these risks have the highest qualitative analysis, but the delay of the projects, increase in the cost of design team performance, changes in the purchase costs or delay in the delivery of equipment and machinery, has a medium qualitative analysis which means fewer effects on the cost.

The most important reasons for risk response failure were negligence of supervisors in the follow-up to the risk response plan, lack of funds for training and continuous development of the risk response team, inadequate strategy with high risk, delay in the disbursement of financial dues by the responsible party, the difficulty of implementing a risk-response plan correctly for internal factors (terrorism and sabotage) and the inability to introduce sophisticated management methods to respond to risks, all these reasons have direct impact that lead to second risk.

There are many reasons that led to risk response failure in construction projects due to the condition of the country.

The results of the questionnaire show that the risks generated from risk response were a delay in disbursing advances to contractors, delay of the projects, delayed implementation of commitments, wrong estimation, and depressions has the highest qualitative analysis.

The investment (contractor, bank) strategy shows a very good strategy for the Finical difficulty of the owner, Ability to construct, Delay in completing the project, Delay in implementing the commitment as show saving in the cost about

30%, while mitigating (pay for advances with interest 0. 1) Strategy shows a very good strategy for the Change in the cost of equipment and material and Exceptional circumstances and risks as show saving in the cost 40%.

Giving land to contractor's strategy show a very good strategy for the Delay in the disbursement of the advance as show saving in the cost 40%. Using BIM strategy show a very good strategy for the wrong estimation as show saving in the cost 25%.

Finally, it can be concluding that the risk response is an important part and should give a great attention and it must be used sophisticated method to select the optimal strategy, the two techniques both show high efficiency in selecting the strategy but Gravitational Search Algorithm show better performance.

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Appendix I

Table 9. show risk ID and risk response selection for risk generated from risk response

Risks ID	Risks	Risk response	Effectiveness
11	Delay in disbursement of the advance	Mitigate (Giving land to contractors)	0.95
11	Delay in disbursement of the advance	Mitigate (contractor bank with private sector)	0.7
11	Delay in disbursement of the advance	Mitigate (contractor bank with investment)	0.9
12	ability to construct	Accept (emergency)	0.5
12	ability to construct	Transfer (insurance)	0.8
12	ability to construct	Mitigate (pay with advance 0.1 on serval month)	0.95
13	Depression	Accept (emergency)	0.65
13	Depression	Continues maintenance with 1% from project budget	0.9
13	Depression	Transfer (insurance)	0.8
21	Delay in disbursement of the advance	Mitigate (Giving land to contractors)	0.88
21	Delay in disbursement of the advance	Mitigate (contractor bank with private sector)	0.66
21	Delay in disbursement of the advance	Mitigate (contractor bank with investment)	0.85
22	ability to construct	Accept (emergency)	0.69
22	ability to construct	Transfer (insurance)	0.77
22	ability to construct	Mitigate (pay with advance 0.1 on serval month)	0.89
23	Delay in completing the project	Accept (emergency)	0.45
23	Delay in completing the project	Mitigate (contractor bank with private sector)	0.8
23	Delay in completing the project	Mitigate (contractor bank with investment)	0.9
31	Delay in implementing the commitment	Accept (emergency)	0.9
31	Delay in implementing the commitment	Mitigate (contractor bank with private sector)	0.7
31	Delay in implementing the commitment	Mitigate (contractor bank with investment)	0.8
32	Delay in completing the project	Accept (emergency)	0.55
32	Delay in completing the project	Mitigate (contractor bank with private sector)	0.68
32	Delay in completing the project	Mitigate (contractor bank with investment)	0.8
33	Depression	Accept (emergency)	0.49
33	Depression	Continues maintenance with 0.05 % from project budget	0.9
33	Depression	Transfer (insurance)	0.8
41	Delay in disbursement of the advance	Accept (emergency)	0.7
41	Delay in disbursement of the advance	Mitigate (contractor bank with private sector)	0.9
41	Delay in disbursement of the advance	Mitigate (contractor bank with investment)	0.95
42	Delay in implementing the commitment	Accept (emergency)	0.56
42	Delay in implementing the commitment	Transfer (insurance)	0.77
42	Delay in implementing the commitment	Mitigate (contractor bank with investment)	0.88
43	Depression	Continues maintenance with 0.05 % from project budget	0.9
43	Depression	Transfer (insurance)	0.87
43	Depression	Mitigate (contractor bank with investment)	0.89
51	Delay in disbursement of the advance	Mitigate (Giving land to contractors)	0.8
51	Delay in disbursement of the advance	Mitigate (contractor bank with private sector)	0.77
51	Delay in disbursement of the advance	Mitigate (contractor bank with investment)	0.8
52	ability to construct	Accept (emergency)	0.67
52	ability to construct	Transfer (insurance)	0.8
52	ability to construct	Mitigate (pay with advance 0.1 on serval month)	0.9
53	Depression	Accept (emergency)	0.55
53	Depression	Continues maintenance with 0.05% from project budget	0.9
53	Depression	Transfer (insurance)	0.89