Engineering and Applied Science Research 2021;48(5):570-580 Research Article

Engineering and Applied Science Research

https://www.tci-thaijo.org/index.php/easr/index

Published by the Faculty of Engineering, Khon Kaen University, Thailand

An efficient claim management assurance utilizing monarch butterfly optimization approach based EPC model

Mukilan K*, Rameshbabu C and Velumani P

Department of Civil Engineering, Kalasalingam Academy of Research and Education, Krishnankoil, India

Received 11 November 2020
Revised 19 February 2021
Accepted 8 March 2021

Abstract

The Engineering Procurement Construction (EPC) contract frameworks have been broadly used to play out various developments works by the private sector. The aim of the study is to reduce the claim issues such as time and cost and increase the profizility and productivity one of the popular and important construction models is EPC that incorporates work among construction, procurement, and engineering in the single contract. Engineering Procurement Construction (EPC) utilizes the project's structure of contract systems. Based on large-scale infrastructure projects, the EPC contract models are utilized with a private zone to execute the construction work. This study proposes the methodology is Monarch Butterfly Optimization (MBO) algorithm-based claim management system via the EPC mechanism. The time and cost are the major objective functions to be solved in this paper. The construction techniques and design substitutes in which it satisfies the minimum requirements of the Engineer. Thereafter, the final decision is made with the project manager views the document via cost and time. The experimental analysis for the EPC approach is reviewed in terms of utilizing the risk level classification. By using the MBO algorithm to minimizes the cost and time for the EPC construction process. The claim management problems are effectively analyzed in the result section.

Keywords: Claim management, Monarch Butterfly Optimization (MBO) algorithm, Construction industry, Risk management, Claim factors

1. Introduction

Recently, the most common competitive and demanding environment is the construction industry, in which participants unite through their level of building knowledge, unity, skills and different viewpoints. Each of them has their own goals with the participants from different professions in this complex environment [1]. The conflicts become inevitable, since variations in perceptions between the project participants in the construction industry. They suddenly turn into disputes whenever the conflicts are not well managed. One of the complexities in construction is a dispute. The construction industry has been qualified the effective statements, complexity in reaching reasonable statements, and an increase in disputes [2]. Because of decreasing productivity, cost overruns, and delays with the construction conflicts have made huge damages. According to the basic construction procedures, the construction enterprises or construction project owners make the agreements. The decision-making process is very complex because it has to consider a number of factors of different, complicated and still unexplored nature [3].

The completion of construction projects is successfully prevented by the major factors of disputes [4]. In order to finish the construction projects in the preferred quality, budget, and time in which the project completion is important to be aware of disputes cause. Each construction project founded the construction claims [5]. The huge amount of project complexity is resultant with the increasing volume of claims. More contractors and owners take the legal methods and the price model of the construction industry [6]. The construction projects are risky based on different kinds of contract. Engineering Procurement Construction (EPC) utilizes the project's structure of contract systems. The EPC contract models are utilized with a private zone to execute the construction work based on large-scale infrastructure projects. The efficiency of contractors is improved by the EPC model in case of construction and procurement, and design and continual improvement at each stage of product or providing services in construction represent the basis for the achievement of high quality [7].

One of the popular and important construction models is EPC that incorporates work among construction, procurement and engineering in the single contract. It is necessary that owners should pay progress payment to contractors on time because it affects the contractors' ability to finance the work [8]. The owner contains the responsibilities of ranging from materials procurement and construction appoints to the general contractor in an EPC project [9]. Many researchers establish the effects of magnitude from the construction claims on project time and cost [10]. The main attention of construction, in recent years, is focused on economic and financial performance [11] and important place should be given to the management of construction costs [12]. The common in construction projects are increased with the crucial disputes concerning construction contracts during the past two decades.

*Corresponding author. Tel.: +97 9027 6885
Email address: mukicivil@gmail.com
doi: 10.14456/easr.2021.59

2. Literature review

The overall EPC projects typically tackle the extensive dangers of procurement, design, estimation construction, finance, and their connection. The risk appraisal measure is predominantly to distinguish the risk items associated with the project development, while the hazard part leads in the designation of a renewed individual in the group [13], and it provides an introduction to the claim management. The legitimate request is a claim for extra compensation or contractual milestone in case the contract changed. The argument over the claim quantum is raised whether the contractor claims are not managed well. Efficient dispute management and construction claims are more critical due to the increasing amount of recent construction claims. Based on the Engineering Procurement Contract (EPC) of a project lifetime, the construction project risks are reviewed [14]. The construction contract type, procurement, and engineering with the owner project perception risk are analysed by [14]. The assessment impact and form identification are the primary data collection, thereby the questionnaires and interviews obtain the probability risk. The risk ranking is determined with the help of a risk breakdown structure.

Waziri et al [15] have proposed the Artificial Neural Network (ANN) for decision making, cost prediction, claims, risk assessment, scheduling and dispute resolution outputs. Moreover, statistical and traditional mathematical techniques [16] are used to solve the complex issues in ANN. So, the authors have combined and used soft computing methods with the integration of ANN. When contrasted to the conventional ANN, the ANN with the soft computing model accomplishes comprehensive ANN repute. Hasnain et al [17] have developed an ANP based decision support system via the local construction industry with a brief questionnaire survey to validate the selection process. Furthermore, the decision support systems are evaluated by completed road construction projects with five case studies. This concept is applied to residential, commercial and high-power buildings. Finally, the valuable and precise results with appropriate data banking are obtained.

The multi-objective optimization model was proposed by [18], their study deliver the Pareto front concept based optimal solution. The genetic algorithm introduction, fitness function definition, optimization objectives, data structure establishment steps are used to formulate the Pareto front concept. The efficiency and effectiveness of time-cost trade-off issues in construction were evaluated. Experimentally, the CO2 emission trading cost, maintenance cost, operation, and investment cost are assessed. The SCL protocol-based delay calculation methods were introduced [19]. Around the world, each project is suffering from delays, but it contains a few drawbacks. The amounts of project delays are calculated by using SCL protocol methods. The problems and obstacles are multifaceted in most projects regarding changes in basic schedules, numerous revisions, many extension period requirements, work stops, and low-speed work. The numerous project life cycle difficulties are regarded based on their executive records in projects. Moreover, discrete and continuous delays are analyzed with the usage of the integrated method. The more complex problems are continuously dealt with legal issues [20]. Many novel techniques such as ANN, SCL, multi objective optimization model are applied to solve conflicts in construction schemes. All the models are proposed and developed to solve the time or cost problem only, but this paper develops the Monarch Butterfly Optimization (MBO) algorithm-based claim management system using the EPC scheme. In this work, the authors focus on time and costs are the objective functions.

The contributions of this paper are summarized as follows:

- The Monarch Butterfly Optimization (MBO) algorithm is utilized to obtain an efficient quality system with minimum cost and time.
- The study analyzes the risk of the project with its designing, constructing as well as procuring types of equipment and materials via EPC.
- The present research identifies and solves the few problems, including spotting the dispute and the party who made the claim thus calculating the time and the cost to overcome the claim.

The rest of the paper is organized as follows: Section 2 explains the methodology. Section 3 describes the proposed work, and the result is discussed in section 4. Finally, Section 5 concludes the paper.

3. Proposed methodology

In this paper, the authors have proposed the Butterfly Optimization (MBO) algorithm-based claim management system via the EPC mechanism. The time and cost are the major objective functions to be solved in this paper. The 600 set of EPC questions were prepared and disseminated to various disciplines such as project managers, -project engineers, site engineers, purchase officers, contractors at various locations in India in the period of 2018 and 2019, and we have received 524 responses from various disciplines. The proposed flow model is explained in the following sub-section.

3.1 Engineering procurement construction (EPC)

The vulnerability in a task is overseen by the arrangement of strategies is called hazard the board. Both client and contractor concerning given the interruption type happen to authoritative in EPC contracts. In the past applications, the blueprint of exemplary frameworks is perceived by the project manager. The associations are natural by a couple of these components, which can control it [21]. The agreement term is explored that expects the risk, uncertainty and opportunity. The uncertainty comprised the information on future occasions' need. The chance perspectives are an ideal likelihood. Fundamentally, the arrangement of the board techniques is used to control the task uncertainty. Hence, the EPC contact named dependent on disturbance type happening to an authoritative term. It is concerned by contractors and clients [22]. The set of methods manages the uncertainty in a project is called risk management. Both contractor and employer concerning based on the disruption type take place to contractual in EPC contracts. In the previous applications, the outline of classic systems is recognized by the project managers. Figure 1 explains the assurance between the owner (client) and the contractor. Based on the owners and contractors in the construction environment, the gap occurs among the previous risk management and its applications. The cumulative effect if uncertain chances are project risk. The contract strategy determines the allocation of risks, which plays a significant role in concern risk investigation [6]. The management method anticipates the worst-case scenario, and the risk events deals to make the provision.

Risk management usually involved the sequence of tasks, namely documentation, monitoring, treatment and planning, assessment, and identification based on the establishment of risk management. Modelling information scope conceptualizes the architectural and construction risks. The interrelationships between concepts, hierarchies, and rules are more helpful to model the engineering and architectural notations [23]. Over the product life cycle, risk control in design is tedious because the goal roles continue to shift. The format of the risk breakdown structure for the construction plan is illustrated in Table 1. The risk handling of contractor tendency changes if the few risk event condition probability is uncontrollable. Generally, many related activities and procedures present in the EPC contract structure. Proactive and reactive treatments are important factors in risk treatment. The most popular traditional kinds within risk management are a proactive treatment that anticipates the impact risks and high probability. The planned treatment concepts are executed according to the agreed threshold.

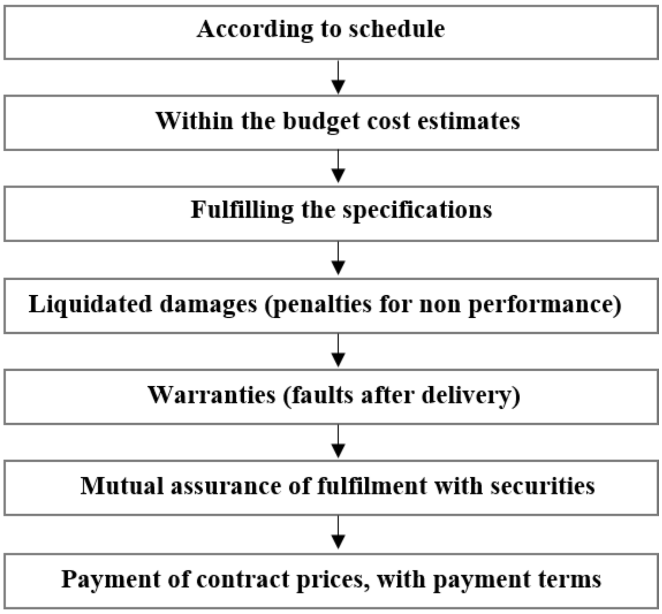

Figure 1 The assurance between the owner and contractor

Table 1 Format of risk breakdown structure for the construction plan

Letter	EPC steps	Risk addressed	External factors	Materials
P	Procedure	Political risk	Governmental regulations and acts	Permits Tax changes
			Public disorders	War Demonstration
			Environmental	Water Noise Air
C	Claim contract risks	Contractual risk	Labor disputes	-
			Change orders	Design changes Delays
			Coordination failure	Contractor Owner
			Delay disputes	-
			Payment failure	Contractor Owner
E	Engineer	Economical risk	Currently fluctuation	-
			Financial uncertainty	Designer Contractor Owner
			Energy shortage	-
			Inflation	Equipment Labor Material

3.2 Construction claim management

Each construction project is determined by construction claims. The relationship between the dispute, claim, and conflicts are described. The connection between claims, conflicts, and disputes are depicted in Figure 2. In general, claim construction alongside owners is suffering from different kinds of reasons, including expediting, contract accelerations, omissions, errors, constructive variation orders, scope changes, and poor project planning. Two basic kinds of claims, such as additional money increasing out of contract and additional time to finish the contract are the claim objectives. The process of dealing with or managing things or people is termed as management. The process of dealing or managing the seeking of consideration or change with single parties constructs claim management. Different kinds of basic procedures involve the settlement and dispute resolution, claim negotiation, changing pricing, time and cost variation, accurate and systematic documentation, change notification, change the identification, and recognition are indicated for change order administration and claims.

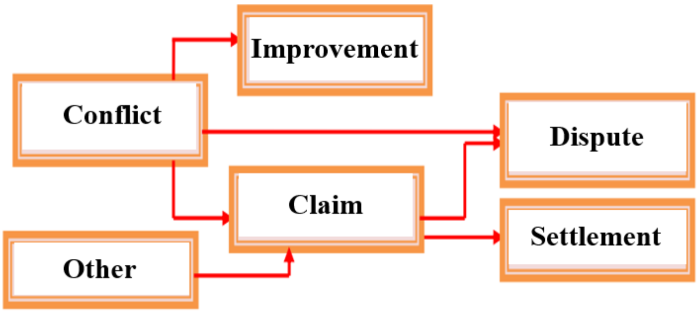

Figure 2 The connection between claims, conflicts and disputes

Change of identification and recognition: The accurate and timely detection of claim construction is included in the construction claim identification and recognition.

Change of cost and time impacts: The events entitling rights to claim causes the calculation process of the cost and time impacts. The cost impact and time impact analysis are the two important classes.

Change of accurate and systematic documentation: The vital role in settlement of contract claims is records and documentation. The project delay impact is determined via different kinds of documentation.

Change notification: Alerting the other party of potential issues involved in the notification of construction claims. One of the critical and important limit requirements is time.

Change of price: The brief description of cost is important to justify, negotiate, and understand the additional contract cost. Post and forward pricing are two important roles of pricing. The different kinds of claims with its component are illustrated in Table 2.

Table 2 Different kinds of claims with its component

Different kinds of cost claimed	Changing the site condition claim	Acceleration claims	Scope of work claims	Delay claims
Equipment rental cost	Usually included in the claim	Usually included in the claim	Usually included in the claim	Usually included in the claim
Additional sub-contractor cost	Usually included in a claim	Sometimes included	Sometimes included	Usually included in a claim
Extra direct labor hours	Sometimes included	Usually included in the claim	Sometimes included	Usually included in the claim
Opportunity profit loss	Sometimes included	Sometimes included	Sometimes included	Sometimes included
Profit	Usually included in the claim	Sometimes included	Sometimes included	Usually included in the claim
Company overhead costs (Fixed)	Sometimes included	Not included	Sometimes included	Usually included in the claim
Quality of extra material	Sometimes included	Sometimes included	Usually included in the claim	Not included
Price of extra material	Sometimes included	Sometimes included	Usually included in the claim	Usually included in the claim

3.3 Construction claim management via MBO algorithm

In this section, the minimum cost and delay are obtained in the claim management system using the MBO algorithm based on EPC. The factors such as time, cost, and quality are considered by the owners/engineers for construction projects. In this work, the trade-off between the cost and time is obtained by the Monarch butterfly optimization algorithm (MBO) according to the claim management system [24]. The proposed the Monarch Butterfly Optimization (MBO) algorithm, which starts with the behaviour of monarch butterflies with uniform and random populations [24]. The solutions to the candidate's issues are included in the population of butterflies. The Land one (L_O) and Land two (L_T) are the two classifications of the MBO algorithm. The following equation explains the number of the individual monarch butterfly in the sub-population.

$$L_O = MP_1 \times D(q \times MP) \tag{1}$$

$$L_T = MP - MP_O \times MP_T \tag{2}$$

Where, the entire number of population-based on Land one (L_O) and Land two (L_T) are denoted as MP_1 and MP_T. The neighboring integer value is *D(y)* that is greater than or similar to *y*. The Land one (L_O) and Land two (L_T) of monarch butterflies are expressed as *q*. For Land one (L_O), the parent monarch butterflies with conception depend upon the new child population is explained as below:

$$Y_{i,j}^{T+1} = Y_{r1,j}^{T} \tag{3}$$

At *T+1* generation, the j^{th} element with the monarch butterfly position is described as $Y_{i,j}^{T+1}$ The element Y_{r1} updated to the j^{th} position is $Y_{r1,j}^{T}$ The number of iterations is *T* and the Land one randomly selects the individuals are *r*. The variable *r* is expressed if it is equal to or less than *q*.

$$r = \chi \times \eta \tag{4}$$

From the above equation, χ and η represent the uniform and a random number of the migration period. For Land two (L_T), the parent monarch butterfly with conception depending upon the new child population is explained as below:

$$Y_{i,j}^{T+1} = Y_{r2,j}^{T} \tag{5}$$

For Land two (L_T), the random number is expressed as r_2. The variable r is expressed as below if it is equal to or less than q.

$$Y_{i,j}^{T+1} = Y_{b,j}^{T} \tag{6}$$

Where, Y_b is the best optimal solution employs in the j^{th} element.
If $r < \eta$, then

$$Y_{i,j}^{T+1} = Y_{r3,j}^{T} \tag{7}$$

Where, $r_3 \in \{1, 2, ... MP_T\}$. This $Y_{r3,j}^{T}$ represents the j^{th} element selected randomly from L_T with Y_{r3}.
If $A_R < \eta$, then

$$Y_{i,j}^{T+1} = Y_{i,j}^{T} + \gamma \left[dY_j - \frac{1}{2}\right] \tag{8}$$

Hence, the j^{th} element expresses the individual random step walk as dY_j

$$dY = l_{evy}\left(Y_j^T\right) \tag{9}$$

$$\gamma = \frac{N_{SW}}{T^2} \tag{10}$$

Where, γ and N_{SW} are the weighting coefficient and maximum walk step. This $Y_{i,j}^{T}$ tends to exploit the scheme if the value γ is small. This $Y_{i,j}^{T}$ tends to exploration scheme if the value of γ is larger. The minimized cost and time based on the claim management system using EPC are obtained with the help of the MBO algorithm.

Algorithm 1 explains the MBO algorithm for the claim management system.

Algorithm 1: MBO algorithm for claim management using EPC

Input: MBO parameters and EPC and claim management documents
Output: Minimum cost and time
While $T < T_{max}$ **do**
    Classify the population of butterfly
    Classify the population into Land one (L_O) and Land two (L_T)
    For *j=1* to MP_O **do**
    Execute the migration operator
    End
    For *j=1* to MP_T **do**
    Execute the adjusting operator of butterfly
    End
    Compute individual butterfly fitness
    T=T+1
End
Minimized cost and time

4. Experimental analysis and design

A group of experts consisting of 13 participants [25] with extensive expertise in international EPC or NPP projects has selected the criteria for the analysis. They are also involved in previous NPP initiatives, including core managers of engineering, procurement, construction, and start-up tasks, and the development of infrastructure [26]. The risk is detected by the probabilities and the impacts from the primary data are collected. The resultant data is collected by employing various materials like magazines, papers based on particular research topics, books, and construction project data. The decision-makers linked to particular projects are considered as persons who offer feedback. The data assessment procedures were executed out utilizing a risk breakdown structure by allotting a rank to every risk.

4.1 Risk analysis for the EPC approach

The risks in the EPC process is analyzed based on the following lifecycle procedure presented in Figure 3. The project lifecycle comprises three phases namely Engineering, Procurement, and Construction. In these three phases, a total of 15 risks were identified.

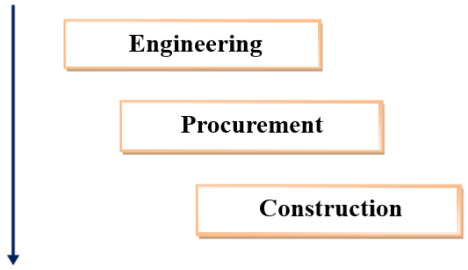

Figure 3 Lifecycle of the project

Risk elements were evaluated by individual assessors with a five-level (very high, high, moderate, low, and very low) degree of importance and their results are demonstrated in Table 3. Then a hypothesis analysis is conducted to determine whether a risk factor is statistically important concerning the critical value, which is between moderate and high. The risks in the EPC process is analyzed based on the following lifecycle procedure presented in Figure 4. The project lifecycle comprises three phases, namely Engineering, Acquisition, and Construction. In these three phases, a total of 15 risks were identified in Table 4 and Table 5.

Table 3 Risk analysis in the engineering class

Code	Risk element	Level of risk	Category of risk	Impact factor	Risk probability	Risk ranking
E1	The design was changed and rescheduled	11	High	3	2	2
E2	Design quality	4	Medium	2	1	10
E3	Design capability	3	Low	3	3	13
E4	Design process and skills	2	Low	2	2	11
E5	Error in design and omission of design	9	High	5	1	3

Table 4 Risk assessment in the procurement class

Code	Risk identified	Level of risk	Category of risk	Impact factor	Risk probability	Risk ranking
P1	Designing of standard and codes	9	High	4	2	4
P2	Schedule of purchasing the material and delivery	8	Medium	2	3	5
P3	Device quality	6	Medium	3	2	8
P4	Subcontractors technologies and retailers	2	Low	5	3	14
P5	Material and devices purchasing	11	High	5	2	6

Table 5 Risk assessment for the construction class

Code	Risk identified	Level of risk	Category of risk	Impact factor	Risk probability	Risk ranking
C1	Supply the product and technical knowledge of human resources	5	Medium	2	2	15
C2	Scheduling the time and planning the construction	3	Low	1	1	9
C3	Specifications of the constructions and techniques	5	Medium	2	2	7
C4	Safety program for the workers such as worker's accident	1	Low	1	1	12
C5	Changes in the field design and quality of the construction	11	High	3	3	1

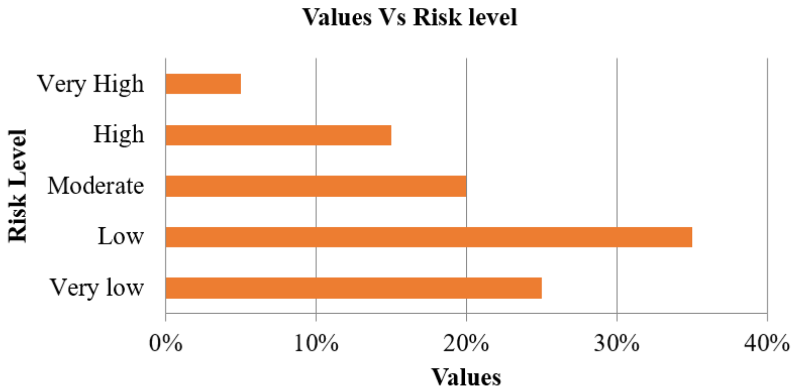

Figure 4 Risk level categorization based on the owners view for the EPC construction process

The risk level was classified into five types: very low, low, medium, high, and very high. The risk assessment results are described in Figure 4. From Figure 4, it is clear that most of the risks belonged to the very low category is 30%, and risks belonged to the low category is 25%, the 15% risk belongs to the high category, 10% risks belonged to the very high category. 20% of risks belonged to the moderate category.

4.1.1 Contribution of risk by different groups

The below figure depicts the various risk groups and their involvement to cost overruns. The owner, finance, and material and equipment risk groups provide more than 50% of the project risks [27]. The other groups, such as managerial, consultant, and contractor provide more than 30% of overruns cost. The owner related risk provides 23% of the causes of the cost of the overruns. The material and equipment provide 12% of overruns cost. 15% contributes to financial risk. Figure 5 represents the contribution of risk among various groups.

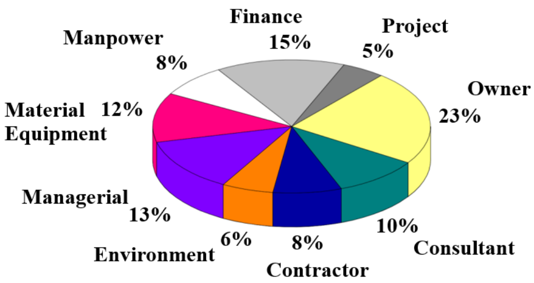

Figure 5 Contribution of risk among various groups

4.2 Claim management

The sequence of interviews was conducted by industry experts. The information about the interviewees is summarized in Table 6. The interview was carried out by 15 experts from six construction companies and just one construction claim consultant [28]. The experts have a combined knowledge of more than 16 years. They are listed in the Engineering News-Record (ENR) magazine and are involved in projects worldwide. The international contractor has been responsible for these ENR rankings for five years.

Table 6 Summary of the information regarding the interviewees

Company	Industry sector	Number of interviewees	ENR grading
A	Civil	1	1-50
B	Building	1	50-100
C	Claim consulting	2	Not Available
D	Building	4	100-150
E	Plant	1	200-250
F	Plant/Civil	6	1-50

4.2.1 Problems with claim management

If the proposal recovers costs accepted by the clients from the claims, the argument output will be comparatively strong. The claim approval rate is the proportion of additional approved costs from the claims to the total cost of the project, which shows the performance of the claim management. The factors that influence the claim management process are listed in Table 7.

Table 7 Factors influence the process of claim management

	I	II	III	IV	V	VI	VII	Total
(I) Variations by the business region		X					X	2
(II) Insufficient reflection on indirect compensation	X			X		X		3
(III) Influence from the regional variations	X							1
(IV) Political scheme varied by the projects	X				X			2
(V) Variation in the skill of clients	X		X	X			X	4
(VI) Allowance varied for the clients	X	X	X	X	X	X	X	6
(VII) Variations in the type of contract				X	X			2

Differences in customer allowance affect the claim approval rate. If the consumer is given an additional project budget, the contractor will have the extra space to collect further customer approval costs. The approval rate may be less if the client has a fixed budget. Therefore, the result is not important as contractors administer their claims depending on customer budget criteria. However, both claims and contract management compare the level of customer expertise. Customers with a high level of competence have a lower approval rate compared to the lower level of skill. Customers could be better prepared for claims for projects with high skill levels. It makes added expense from the claims an even tougher challenge, contributing to a poor acceptance rate for the lawsuits.

Table 8 Complexities associated with claim management

	I	II	III	IV	V	VI	VII	Total
(I) Confused data layout		X					X	2
(II) Inadequate time impact assessment				X				1
(III) Improper work allocation among the branches		X	2	X				2
(IV) Shortage of qualification of the person in charge					X			2
(V) Shortage of advance evaluation and the claim presentation	X			X			X	3
(VI) Complexity in time-bar observance		X		X				2
(VII) Documents for the site are not updated properly		X	X	X	X	X		4

The claim management process [28] analyzes the performance by evaluating it. However, the authors have endeavored to detect the problems with the claim management process by creating metrics that are capable of capturing these problems. Table 8 demonstrates concerns with the method of claim management. As described in Table 8 above, four companies described "documents are not being properly updated" as being the issue with the claim management process. “Shortage of the advance evaluation and the claim presentation” is another issue described by the practitioners. “Improper work allocation among the branches” is another issue regularly described. The process of integrative work among the head office and construction site is more significant for efficient claim management [27]. The teams employed for the claim management process include the frequency of entitlement losses, the frequency of missing the delay, and the insufficiency frequency when site papers are provided.

4.3 Delay analysis

The delay in the project mainly happens whenever the time of the project completion exceeds beyond the given specified time. It may also be described as the situation in which the contractor, Owner, and Technician have the connection by the increase in the project's deadline [29]. The major delays caused in the construction of residential areas are demonstrated in Table 9.

Table 9 Critical delays caused in the construction project

Delay reason	Rank			
	Owner	Contractor	Expert	Overall
Improper planning by the contractor	1	5	3	1
Poor site management	6	4	5	5
Insufficient experience for the contractor	7	2	1	2
Insufficient financial resources by the clients	4	1	2	3
Inappropriate scheduling and planning	21	16	5	5
Inadequate technical support	7	1	6	8
Deficiency in proper management	3	7	9	6
Shortage in materials	11	8	8	3

The delay and cost optimization is provided for the construction of residential areas are illustrated in Table 10. The main motive of this paper is to minimize the two stated objectives using the MBO algorithm. These two values are minimized on the fitness function. Therefore, the proposed MBOA algorithm enhances the construction plan quality by time and cost.

Table 10 Construction cost for the steps in the residential area

Type of activity	Number	Precedent activity	Time duration (in days)	Cost (in dollars)	Optimized time duration	Optimized cost
Site preparation	1	-	10	1200	13	800
Excavation and PVC	2	1	21	5000	19	3500
Plinth Beam and slicing	3	1	19	6000	15	5000
Masonry of brick	4	1	25	22000	17	20000
Door window lintel	5	-	12	14000	8	13000
Electrical & Plumbing	6	1	12	12000	10	10000
Roof construction & Flooring	7	1	14	25000	12	21000
Internal finishing & wooden works	8	-	21	21000	18	19000

4.4 Comparative analysis of various optimization algorithms

This section provides the comparative analysis of the proposed monarch butterfly optimization algorithm (IMBOA) with several other algorithms, namely Particle Swarm Optimization (PSO) algorithm [30], Artificial Neural network (ANN) [31], Ant colony optimization (ACO) [32] and Genetic algorithm (GA) [33]. The graphical analysis is plotted between cost and number of approaches. The graphical analysis reveals that the proposed IMBOA approach provides minimum cost with better quality when compared with all other approaches, as shown in Figure 6.

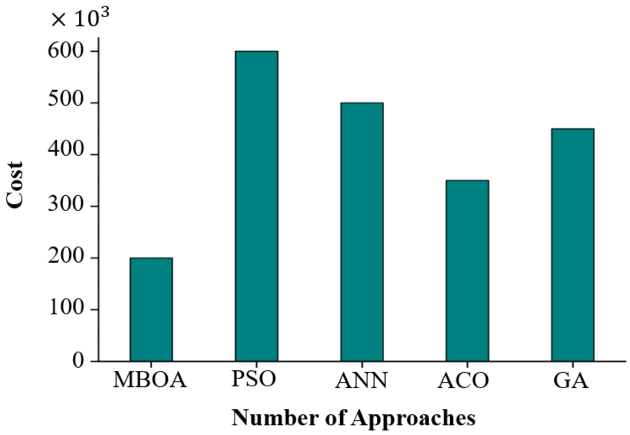

Figure 6 Comparison of cost to other approaches

5. Results and discussion

Project Completion activities are generally categorized by three based on the responsibilities, such as Engineering, Procurement and Construction. Each is having equal responsible, 30% of the impact by procuring, 20% of impact by engineering and 50% impact by construction.

Table 11 Average result of engineering, procuring and construction

Code	Risk identified	Level of risk	Category of risk	Impact factor	Risk probability	Risk ranking
1	Engineering	5.8	2	3	1.8	7.8
2	Procurement	7.2	2.2	3.8	2.4	7.4
3	Construction	5	1.8	1.8	1.8	8.8

The table values are tabulated by the average values of the Table 3, Table 4 and Table 5. Level of risk is more in construction activities. The sequences of activities are much important in the construction. Construction works are involved in various activities such as execution, planning and scheduling, quality control, estimation etc. It is giving more weightage than other activities. Based on the Table 11 results, the level of risk and risk ranking bestows the high impact in construction projects. Category of Risk, Impact factor and Risk probability is bestowing the high impact in Procurement. Engineering part is giving less impact in the construction activities in all aspects.

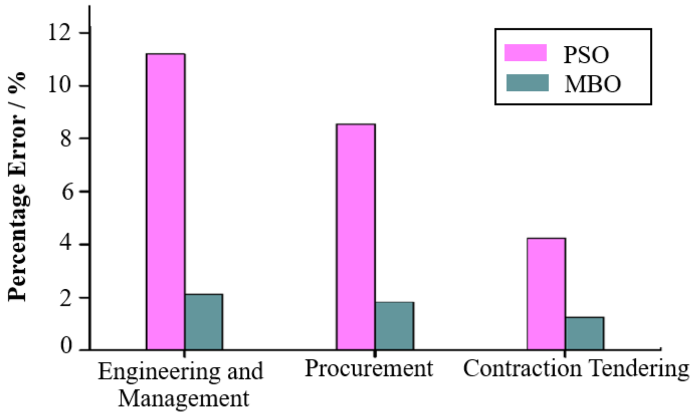

Figure 7 Comparison of percentage error of MBO and PSO models

To evaluate the MBO and PSO models in terms of percentage error and average training time, the three stages in EPC projects namely engineering and management, procurement, and construction and tendering are taken as shown in Figure 7. The percentage error is the difference between the expected value (achieved solution) and the actual value (optimal solution) and is expressed as a percentage as opposed to the actual value. In other words, the percent error is the relative error multiplied by 100. For the three EPC phases, the percentage error of the MBO algorithm is relatively low when compared with the PSO algorithm. The average training time taken by the PSO is higher because it is often struck into the local optimal solution. Hence the MBO offers higher global search performance by avoiding the local optimum.

6. Conclusion

Construction project ordinarily includes complex tasks, including the diverse EPC stages and assessments by both experts and non-experts. The construction project achievement consistently relies on the exact coordination, and the difficulties present in the construction business regularly prompts lackluster performance. To upgrade the presentation of the development organizations, their resources (materials, laborers, cost, time, and so forth) must be used effectively. The current construction models are fit for enhancing just a single objective, such as time, cost, delay, and so on, which is not productive in improving the model's exhibition. The proposed Monarch Butterfly Optimization (MBO) algorithm based claim management system through the EPC framework and at the same time, expands the nature of the task and improves the performance. In this work, the researchers consider both time and cost are the objective functions. The project lifecycle comprises three phases, namely Engineering, Procurement, and Construction. The experimental results demonstrated minimum cost and time-based on claim management in the EPC process. The proposed MBO algorithm is compared with the existing Particle Swarm Optimization (PSO) algorithm, Artificial Neural network (ANN), ant colony optimization (ACO), and Genetic algorithm algorithms. Anyway, the proposed MBO least expense with better Optimization when compared results than previous methods. The MBO algorithm strategies are offered the best outcomes as expected time and cost of Engineering Procurement Construction only. The equivalent strategies might give the compactible outcome in case of other resources such as labor, machinary, and materials. In the future, an optimized deep learning approach can be introduced for the economical risk assessment of large-scale construction projects. Future research also intends to improve the effectiveness and efficiency of engineering standards and thus guide building construction to less hazardous sites and less fragile structures.

7. References

[1] Tavakolan M, Nikoukar S. Developing an optimization financing cost-scheduling trade-off model in construction project. Int J Construct Manag. 2019:1-16.

[2] Yang JB, Huang KM, Lee CH, Chiu CT. Incorporating lost productivity calculation into delay analysis for construction projects. KSCE J Civ Eng. 2014;18(2):380-8.

[3] Białas A. Cost-benefits aspects in risk management. Pol J Manag Stud. 2016;14(1):28-39.

[4] Merritt GM, Smith GP. Techniques for managing project risk. Field Guide Proj Manag. 2004;2:202-18.

[5] Prayogo D, Cheng MY, Wong FT, Tjandra D, Tran DH. Optimization model for construction project resource leveling using a novel modified symbiotic organisms search. Asian J Civ Eng. 2018;9(5):625-38.

[6] Leśniak A, Juszczyk M. Prediction of site overhead costs with the use of artificial neural network based model. Arch Civ Mech Eng. 2018;18:973-82.

[7] Czajkowska A, Kadłubek M. Management of factors affecting quality of processes in construction enterprises. Pol J Manag Stud. 2015;11(1):28-38.

[8] Toan NQ, Tam NV, Hai DT, Quy NLD. Critical factors affecting labor productivity within construction project implementation: a project manager's perspective. Enterpren Sustain. 2020;8(2):751-63.

[9] Ko CH, Liao HS. Reducing ineligible contractor disputes in government procurement: a lesson from Taiwan. KSCE J Civ Eng. 2014;18(2):409-18.

[10] Tochaiwat K, Chovichien V. Contractor's construction claims and claim management process. Eng J Res Dev. 2004;15(4): 66-76.

[11] Androniceanu A. Social responsibility, an essential strategic option for a sustainable development in the field of bio-economy. Amfiteatru Econ. 2019;21(52):503-19.

[12] Bozgulova N, Parmanova R, Abenova M, Ivanyuk T, Aryshev V. Calculation methods for cost management in the construction industry. Enterpren Sustain. 2019;7(2):1450-61.

[13] Khekale C, Futane N. Management of claims and disputes in construction industry. Int J Sci Res. 2015;4(5):848-56.

[14] Nurdiana A, Susanti R. Assessing risk on the engineering procurement construction (EPC) project from the perspective of the owner: a case study. IOP Conference Series Earth and Environmental Science; 2019 Oct 1-2; Surabaya, Indonesia. Bristol: IOP Publishing; 2020. p. 1-6.

[15] Waziri BS, Bala K, Bustani SA. Artificial neural networks in construction engineering and management. Int J Architect Eng Construct. 2017;16(1):50-60.

[16] Androniceanu A. The social sustainability of smart cities: urban technological innovation, big data management, and the cognitive internet of things. Geopolitics Hist Int Relat. 2019;11(1):110-5.

[17] Hasnain M, Thaheem MJ, Ullah F. Best value contractor selection in road construction projects: ANP-based decision support system. Int J Civ Eng. 2018;16(6):695-714.

[18] Koo C, Hong T, Kim S. An integrated multi-objective optimization model for solving the construction time-cost trade-off problem. J Civ Eng Manag. 2015;21(3):323-33.

[19] Rooholelm V, Aboumasoudi AS. Designing pattern for project delay analysis with several periods extension of time, continuous and discrete (Pr-to-Pr). Comput Ind Eng. 2020;146(10):106576.

[20] Park SH, Kim YS. An assessment of contract management capabilities for overseas construction projects. KSCE J Civ Eng. 2018;22(7):2148-58.

[21] Mohamed HH, Ibrahim AH, Soliman AA. Reducing construction disputes through effective claims management. Am J Civ Eng Architect. 2014;2(6):186-96.

[22] Lv X, Wang Y, Deng J, Zhang G, Zhang L. Improved particle swarm optimization algorithm based on last-eliminated principle and enhanced information sharing. Comput Intell Neurosci. 2018;2018(14):1-17.

[23] Yao L. Research on collaborative design of traffic network and landscape construction on urban residential area. 2017 2nd International Conference on Education, Sports, Arts and Management Engineering (ICESAME 2017); 2017 Apr 29-30; Zhengzhou, China. Paris: Atlantis Press; 2017. p. 843-6.

[24] Bao S, Ebadi A, Toughani M, Dalle J, Maseleno A, Yıldızbasi A, et al. A new method for optimal parameters identification of a PEMFC using an improved version of monarch butterfly optimization algorithm. Int J Hydrogen Energ. 2020;45(35):17882-92.

[25] Mukilan K, BalaNivetha M, Velumani P, Christopher GS. A qualitative study and analysis of causes and disputes in claims in construction industry. Int J Civ Eng Tech. 2019;10:951-7.

[26] Yoo WS, Yang J, Kang S, Lee S. Development of a computerized risk management system for international NPP EPC projects. KSCE J Civ Eng. 2017;21(1):11-26.

[27] Islam MS, Nepal MP, Skitmore M. Modified fuzzy group decision-making approach to cost overrun risk assessment of power plant projects. J Construct Eng Manag. 2019;145(2):04018126.

[28] Seo W, Kang Y. Performance indicators for the claim management process of construction projects. In: Cho YK, Leite F, Behzadan A, Wang C, editors. ASCE International conference on computing in civil engineering 2019; 2019 Jun 19; Atlanta, USA. Reston: American Society of Civil Engineers (ASCE); 2019. p. 611-7.
[29] Islam MS, Trigunarsyah B, Hassanain M, Assaf SA. Causes of delay in construction projects in Bangladesh. The 6th international conference on construction engineering and project management; 2015 Oct 11-14; Busan, Korea. Busan: Korea Institute of Construction Engineering and Management; 2015. p. 82-6.
[30] Kennedy J, Eberhart R. Particle swarm optimization. Proceedings of ICNN'95-international conference on neural networks; 1995 Nov 27- Dec 1; Perth, Australia. New York: IEEE; 1995. p. 1942-8.
[31] Ansal V. ALO-optimized artificial neural network-controlled dynamic voltage restorer for compensation of voltage issues in distribution system. Soft Comput. 2020; 24(2):1171-84.
[32] Dorigo M, Stutzle T. Ant colony optimization: overview and recent advances. In: Gendreau M, Potvin JY, editors. Handbook of metaheuristics. 3rd ed. Boston: Springer; 2019. p. 311-51.
[33] Metawa N, Hassan MK, Elhoseny M. Genetic algorithm based model for optimizing bank lending decisions. Expert Syst Appl. 2017;80:75-82.