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Multi-Objective Optimal Construction Site Layout Planning with Maximize Approach of Safety and Environment(Case Study: Mahestan Residential-Commercial complex)

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Abstract. Construction Site layout optimization is one of concern in recent years In the field of construction management. Site layout planning is an important step in building a development project is considered if a suitable design and optimization will have a large impact on efficiency and save resources. In previous research various approaches According to the designers look To solve this problem there The approaches Commensurate with the nature of the projects Are different. These research efforts as a model of multi-objective optimization Sort workshop for development aims at increasing safety and environmental aspects And also provide a lower cost. To solve the problem Sort Multi-Objective Particle Swarm Optimization algorithm As a meta-heuristic algorithms Used. Also in this study, In order to achieve a real model, A construction project in the city of Tehran. Put the study. In this model, The possibility of embedding the entrance and exit Facilities and buildings is considered.

Keywords: Multi-objective optimization, locating planning workshop, Multi-Objective Particle Swarm Optimization algorithm, artificial intelligence

1- Introduction

Construction Site layout a layout concept Temporary facilities required Is within the boundaries of a workshop .The main task of optimizing the process Is to achieve an arrangement of Temporary Facilities Fashion designers meet goals .From the beginning of the investigation in this context ,There have been several goals based on vision and design look But because Construction industry is one of the most expensive, One of the goals fixed and permanent designer In discussing the layout optimization Has been cutting costs. With the development of optimization research And more thorough research in recent years The use of artificial intelligence And a variety of developmental Popularity among researchers created And the use of these methods This allows designers has To simultaneously Multiple target In order to optimize the layout used. According to various reports, health and safety agencies, Statistics show that in most countries building industry is one of the most eventful industries (1)

In a more detailed statistics The events of tower cranes From 2000 to 2009, 872 accident occurred That 668 cases have been fatal (2).

Layout design process workshops One of the important processes Many parameters Such as project cost, safety workshops, project execution and ease of implementation of the projects affected. With convenient layout optimized The time and cost of the project was to significantly save While creating a safer workplace (1).

Tommelein as one of the first researchers In discussing the layout optimization modeling believes The workshop layout is a routine task For managers of a project And states that alignment Many effects on the

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movement of workers, activities and the efficiency will be .It also notes that reduce commuting time The workshop will lead to reduced congestion [3.[The "(zhang)" temporary facility layout In order to increase the efficiency and safety is essential and this is due to the uniqueness of Each project is complex (4).

Among the various objectives of the workshop building layout optimization, Reduce costs and increase workplace safety Most popular among researchers In recent years there have (6, 5).

As noted in research Workshop layout optimization, there are different approaches ,In most approaches The aim is to minimize transport costs The main purpose of the facility and has been stable (7)

Research in the last few years index Sort workshops on the subject Safety and cost have been working in the field of optimization ,Can be researched (Khalafallah) [8] pointed out in 2005 The new function of safety With three parameters: Risks related to the proximity of the facility, tower crane and interactions Directions Using a genetic algorithm. In 2008 Mr. (Sanad) and colleagues (9)

The concept of forbidden zone To check the safety of their facilities That due to the proximity to neighbors must workshop ,Near the borders with its neighbors are away. In this study, a genetic algorithm was used. In the year 2013 (Ning) and colleagues (10) .

The risks associated matrix adjacent to the facility In order to increase safety Using ant colony algorithm used. In 2014 he (Yahya) and other partners Risks associated with defined matrix adjacent to the facility, but A phased approach and dynamic by using Artificial bee colony algorithm The workshop's layout optimization In order to achieve the objectives of the study and problem solving (layout) defined From an evolutionary algorithm The name of MOPSO Which is one of the new methods of Artificial Intelligence Used. Research in recent years shows Artificial intelligence methods ,Evolutionary Algorithms To solve widely Have been used .Among the models Using a genetic algorithm (GA) The popularity of many (5)

The evolutionary algorithm used One objective particle swarm algorithm (PSO) is First by Kennedy and Eberhart In 1995, inspired by the social behavior of animals Such as fish and birds were presented. Particle swarm algorithm (PSO) High performance is optimized for the many hardware issues Moreover, the convergence rate is faster and more stable Compared with other population -based optimization methods The advantages of this algorithm . Zhang a Wang in 2008 The first of these algorithms In order to solve the problem of single-objective optimization workshop layoutUsed successfully (11)

In 2012 Mr. (Jiuping XU) a (Zongmin)First algorithm (MOPS) Used to solve the optimization problemThis algorithm first developed by Professor (Coello) was introduced in 2004.

1. Sort Workshops development planning process

The purpose of locating Workshops development Identify processes temporary facilities To (Support) From the creation of a development project, Choose and define the size and shape of their dimensions And finally put them on the optimal location The workshop is [12, 13].

By definition Workshop facilities refers to the elements The main purpose of its construction (Support) Operating activities During construction Common is that they are temporary. Although some of these elements After completion of the project Are used the same way as previous changes Such as offices or residences. So you can manage this process Divided into the following steps:

1. Identification and selection facilities

2. Determination shape and size of facility

3. Optimal layout, reasonable and appropriate.

In the first stage of the process And to identify Facilities) necessary Tommelein in 1991 Facilities in terms of function Classified into three groups:

1. Long-term facilities, That is present in almost all for projects And rarely change Such as administrative offices

2. Medium-term facilities, That is present in all phases of project Like (Storage)

3. Short-term facilities, That in short time periods used And quickly moved Like (operating storage). You can also view how The facility is divided into two general categories (9)

1. Facilities non-operational, Workshop to provide amenities and work Embedded (such as accommodation, dining) Operating

2. Facilities Directly enables the project to meet the specialized activities (Such as (batching plant) laboratories). (Rad) "in its investigation By sending a questionnaire to a reputable company contract In America the numbers To identify and determine the necessary dimensions collected And the facilities and reference dimensions Was used in subsequent studies In addition to the systematic selection of accommodations Mr. Suleiman and al-Shawi in 1995 Of Data-Flow-Diagram) DFD used (14) . Also referring to the Mobilization plans available As well as resources such as research Rudd and Bradley Can be a set of common components in most workshops gained access (15)

In this study In order to identify the facilities required for the workshop, With the facilities required for other similar workshops And available resources The facilities listed And then building industry experts By sending a questionnaire about the facilities required And it is necessary dimensions. After the identification process And selection of the required workshop facilities, Ordering process facilities must be done in the workshop. Researchers construction industry Locating were many ways to resolve issues But because of the complexity of the issues And the answer is always in the past two decades The use of artificial intelligence As well as evolutionary algorithms Which are a subset of artificial intelligence They have been widely used. Extent research on problem solving workshop layout Because of the diverse approaches to this problem have been designers. The first attempts using artificial intelligence Can be R "a" in 1995 Using neural network And Mr. Lau, but in 1998 Using genetic algorithms noted (16 and 17).

Evolutionary algorithms used in the initial investigation Single-minded approach pursued But over the years and with discovery Artificial intelligence capabilities on multi-objective approach Workshop layout optimization studies Research has found popularity. In this study, a case study On one of the construction sites User-commercial building in Tehran, To design a model for multi-objective optimization With the aim of reducing costs (transportation) Between convenience and enhanced safety and environmental aspects will be discussed. In this version of the function to reduce cost Conventionally been used in many studies The spacing facilities And weighting the relationship between the facility is known. But the aim of increasing safety New function in this model has been used To consider Tower crane safety parameters, Air pollution and noise pollution control, In terms of safety and environmental aspects and finally increase. Modeling workshop layout optimization problem studied In this study In the first step optimization In order to identify the required workshop facilities studied ,The experts were used. For this purpose By sending a questionnaire to 80 reputable company building They were asked to The facilities needed According to the project And their dimensions are necessary. Location of project In Figure 1 is shown The 333-unit residential and commercial project Located in West Tehran. Which consists of 3 separate blocks The 18-storey tower And an area of over 16,000 square meters is the The projects of the

type (steel(And roof classes of type (Metal Deck) is. Facility area gathered The questionnaire was analyzed using SPSS software And N as input Known. The numbers in table (1) is.

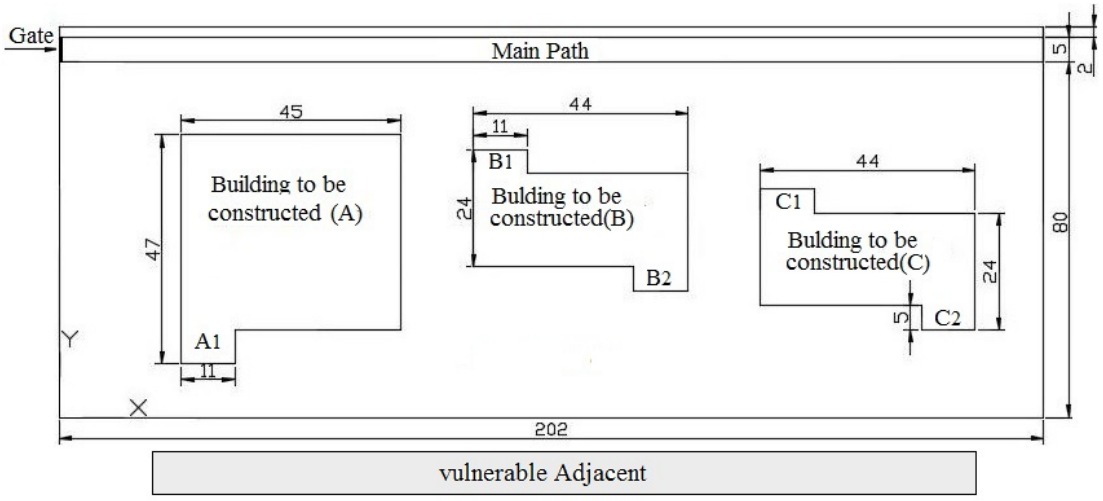


Figure 1. Location of study project.

Table 1. Selected results of the questionnaire as a temporary facility input.

Area(m^2)	Location	Name	Num	Area(m^2)	Location	Name	Num
45	changeable	Material Storage	17	30	changeable	HSE	1
25	Fix	Security	18	60	changeable	Technical Office	2
100	Fix	Parking	19	25	changeable	Procurement	3
1800	Fix	Permanent Building(A)	20	15	changeable	Staff restroom	4
77	Fix	Permanent Building (A-1)	21	15	changeable	Labors restroom	5
836	Fix	Permanent Building(B)	22	180	changeable	Residence	6
55	Fix	Permanent Building (B-1)	23	140	changeable	Management Office	7
55	Fix	Permanent Building (B-2)	24	150	changeable	Steel Equipment Storage	8
836	Fix	Permanent Building(C)	25	6	changeable	Power generator 1	9
55	Fix	Permanent Building (C-1)	26	6	changeable	Power generator 2	10
55	Fix	Permanent Building (C-2)	27	25	changeable	Fire Fighting	11
6	Fix	Tower Crane 1	28	20	changeable	Fuel Storage	12
6	Fix	Tower Crane 2	29	20	changeable	Water Storage	13
1010	Fix	Main Path	30	300	changeable	Rebar Storage	14
202	Fix	Supposition Area(S.A)	31	30	changeable	Wastage	15
5	Fix	Gate (g*)	32	20	changeable	Workshop	16

Objective functions

This research In order to optimize the plant layout Objective approach With the aim of reducing costs And improving safety and the environment will follow. In order to solve the problem One of the powerful new evolutionary algorithms The name (MOPSO) is used.

1-1-3- Cost reduction function

In most studies, Price on minimizing the cost of transport functions Between the components of focused workshops. In this study, in order to Minimize costs From the equation (1) is used Which was first presented in 1999 by Tomlin and Zoin And used a lot of research [18.[

$$\text{Total Cost(TC)} = \text{Min} \sum_{1}^{f-1} \sum_{f}^{f} W_{ij} * d_{ij} \qquad (1)$$

$$\text{City Block Distance}: \left\| \vec{X} \right\|_1 = |x_1| + |x_2| \qquad (2)$$

in this connection TC represents the costs of transport Each of the projects is the layout. One of the new aspects of this research How to determine the distances between facilities and buildings The model is presented. In this regard, as shown dij (2)

Represents the distance between the buildings. Unlike previous studies In this model, the entrance and exits of buildings Instead geometric centers The basis for calculating distances considered And the method (City Block Distance) Instead of (Euclidean norm) According to equation (2) is used .f equal to the total number of facilities is available at the workshop. Weight Wij parameters i and j are neighborhoods between two buildings And indeed parameter That alternative shipping fees Nfl Between the two facilities And the matrix table (3) is. In this table because summarization Number of facilities (32 buildings) The project studied Avoid putting all the weight on the table. And weights 10 first building Table 1 selection. The weight between the two buildings adjacent to high Means a high level of communication And their frequency And lower weight Means of communication between the two buildings is less. The numbers for weight loss Wij parameter function is intended According to Table 2, based on the proposed fuzzy numbers Albltaqy (Elbeltagi) [19.[

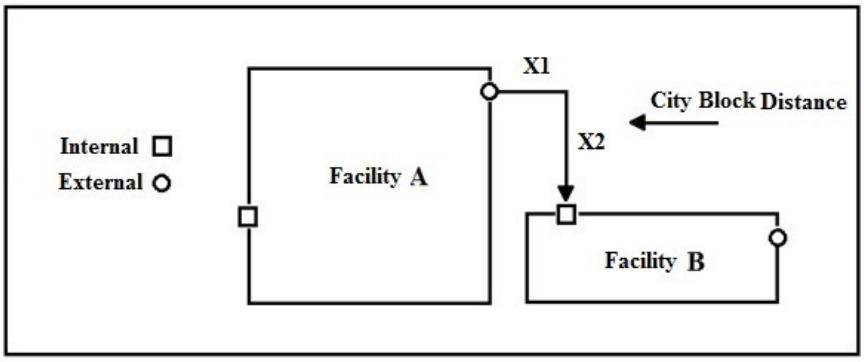


Figure 2. How to consider the distances between facilities.

Table 2. The weight values in the neighborhood, according to the proposed weights Albltaqy.

Desired relationship	Proximity weight
Absolutely important	6^5=7776
Especially important	6^4=1296
Important	6^3=216
Ordinary	6^2=36
Unimportant	6^1=6
Undesirable	6^0=1

Table 3. Matrix associated buildings weights (weights based on Albltaqy.

n	1	2	3	4	5	6	7	8	9	10
1	0									
2	6^2	0								
3	6^1	6^3	0							
4	6^1	6^3	6^2	0						
5	6^1	6^1	6^1	6^1	0					
6	6^2	6^2	6^1	6^2	6^2	0				
7	6^1	6^3	6^1	6^3	6^1	6^1	0			
8	6^0	6^1	6^1	6^1	6^3	6^0	6^1	0		
9	6^0	6^0	6^0	6^0	6^0	6^0	6^0	6^3	0	
10	6^0	6^0	6^0	6^0	6^0	6^0	6^0	6^1	6^1	0

taking- of place in the model input and output facilities To calculate the entrance and exits of buildings Figure (3) Each of the vertices of the rectangular shapes of buildings With the numbers 0 and 1 are numbered. The advantage of this is the interval That this all ties As standard Zero and a written And are compatible with each other. Due to the location of the input or output In terms of diagnosis During the interval between vertices of the Takes, It is The equation of the line defined intervals. in Figure (3) w is the width of a building And h is equal to the length it is intended. Relations between the vertices according to the equations (3) presented. According to this relationship r between the range of variables to be selected. Each line in the interval Has two linear equations For x and y coordinates of their Which are presented in accordance relations. By defining the relationship between the inputs and outputs On each of the lines possible And defined.

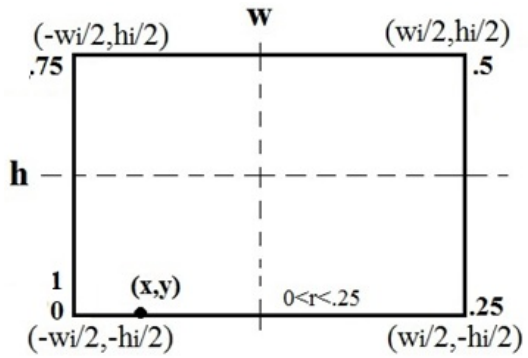


Figure 3. Considering the peculiarities of the inputs and outputs.

$$\begin{cases} 0 \le r \le .25; x = \frac{-w_i}{2} + 4rw_i \\ 0 \le r \le .25; y = \frac{-h_i}{2} \\ .25 \le r \le .5; x = \frac{w_i}{2} \\ .25 \le r \le .5; y = \frac{-h_i}{2} + h_i(4r-1) \\ .5 \le r \le .75; x = \frac{w_i}{2} - w_i(4r-2) \\ .5 \le r \le .75; y = \frac{h_i}{2} \\ .75 \le r \le 1; x = \frac{-w_i}{2} \\ .75 \le r \le 1; y = \frac{h_i}{2} - h_i(4r-3) \end{cases} \quad (3)$$

1-2- The definition of the target (Safety and Environment)

In this study ,To enhance the safety and environmental aspects of the layout of temporary facilities workshop The new approach compared to other similar research field Used, The proposed function of 3 separate parameter is as follows:

1- Safety control tower crane (Crane Safety Control)

2- Control of Noise (Noise Pollution Control)

3- Air pollution control (Air Pollution Control)

The overall safety and the environment According to equation (4) is. In this regard, all the individual parameters of safety and the environment In the form of a function is gathered .In this regard the importance of Each of the weights in the table (4) is assigned These weights Based on the severity of the damage of life and property of the According to numerous classified low And to every parameter is assigned .For the coefficients of the function of the experts project Used .CSC function control tower , NPC function control noise pollution , APC is subject to air pollution control.

Maximize Safety and Environment =

$$\text{MAX}\ [W1\ CSC + W2\ NPC + W3\ APC] \quad (4)$$

Table 4. Weight of the importance of each function in the overall safety and the environment.

Final Weight of each part(%)	Average(%)	Severity of Casualties(%)	Severity of Financial damage (%)	Weight Hazard
58	87.5	75	100	w_1(Crane
17	25	25	25	w_2(Noise Pollution
25	37.5	50	25	w_3(Air Pollution
100%	Total			

Note: huge hit with the number 100,

75 high severity,

The 50 severely damaged, Little damage equal to the number 25 And no damage has been considered equal to zero.

3. 1. 3. safety control tower crane (Crane Safety Control)

So far, different approach To reduce Tower crane accidents and injuries And there has been an increase in safety. The study also In order to increase the safety level associated with locating, This parameter has the function. Overall, in this study, Two approaches to increase the safety level layout In dealing with the tower there. The first approach is That in order to avoid the vicinity of the facility That manpower in the fall By maintaining a minimum distance fixed, Away from the tower And distance. The second approach also Assign different weights According to the importance and risk The risk of injury from falling objects takes place The facility is And mechanisms far and near Or minimum and maximum distance of The tower crane is thus controlled. In this study Tower crane used A tower crane tower (Potain) Model k30 With a height of 60 m And the arm 45 And up to 50 meters Its coordinates are fixed. In the first part The minimum possible distance To protect the privacy of tower crane According to safety regulations Observe 8.1 meters is required They are also given Fixed position of tower crane The restrictions were applied. But for the second part of the allocate Weights equation (5) is provided.

$$\text{Crane Safety Control(CSC)} = \text{Max} \sum_{1}^{f-1} \sum_{k}^{f} TW_{ik} * d_{ik} \qquad (5)$$

in this connection TW_{ik} ,The weights assigned to the facility, Based on the amount of risk The reversal of tower crane And failure of ecological materials tower crane On facilities And those happen And on the table (5) The classification is made on the basis of low to high risk. (Sensitivity) Low This is an indication that the The amount of damage In the event of falling objects On the facilities is very low Such as water storage And photo sensitive medium And above represents The more damage By falling objects On those facilities are Such as facilities, staff offices. d_{ik} Like the function (2)

Are the input and output tower crane Other facilities That should be the maximum. .k represent the number of tower crane in the workshop.

Table 5. The sensitivity of the vulnerability of each facility against falling objects tower crane.

Facilities	HSE	Technical Office	Procurement	Staff restroom	Labors restroom	Residence	Material Storage
Sensitivity(TW_{ik})	15	20	20	15	15	20	0
Facilities	Management Office	Steel Equipment Storage	Wastage	Rebar Storage	Fuel Storage	Water Storage	Power generator
Sensitivity(TW_{ik})	20	0	0	0	20	10	0

(Weight values of the neighborhood is considered as follows: No sensitivity (0), low sensitivity (5), sensitive (10), high sensitivity (15), high sensitivity (20))

3. 1. 4. Control of Noise Pollution (Control Noise Pollution)

In this study In order to increase safety As well as environmental aspects Function according to equation Provided (6).

Facilities or buildings That make noise On the basis of decibels Noise weighting in Table 6. They belong According to the general definition of the function, Between the buildings Of vulnerable facilities Is the maximum. What is new in this function It is in this regard In order to avoid damaging noise pollution Adjacent to the building site, The borders of the workshop In the vicinity of residential areas, hospitals, schools and. . . Were Also with a hypothetical area As shown in (4), as the building is considered to be, The building is hypothetical S.A will be given the name of the function, To maximize its distance The maximum volume of the production facilities.

$$\text{Noise Pollution Control(NPC)} = \sum_{i}^{f-1}\sum_{j}^{f} NW_{ij} * d_{ij} \qquad (6)$$

in this connection NW_{ij}

The risk matrix Between facilities (8) Given the severity of noise weight in Table 6. The distance between the two buildings is The previous functions are calculated. It should be noted that the matrix table (8) As the cost function matrix Due to the large number of buildings Summary of the And amounts written weights 10 elementary buildings.

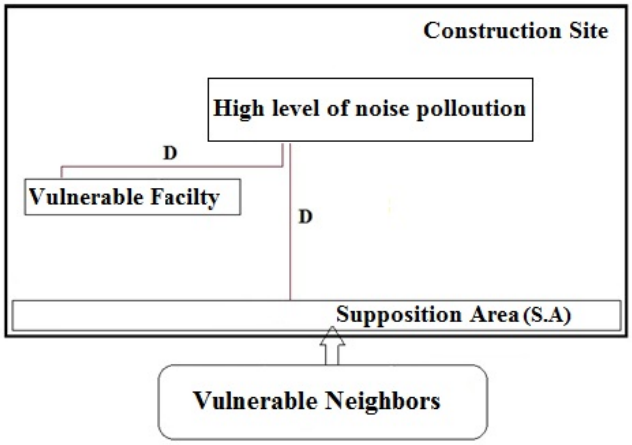


Figure 4. Area hypothetical SA to reduce noise pollution damage.

Table 6. Wij equal to the weight of the volume of production.

)db(Generation Sound	Weight(W_{ij})
0-55	(0)
55-85	Low(5)
85-100	Medium (10)
100-140	High (15)
140-upper	Very High (20)

Table 7. Production volume facilities.

References	Generation Sound level(db)	Name	Number
	0	Facilities based on staffing	1
Washington state department of Health	92	Steel Equipment Storage	2
Center to Protect Workers Rights	97	Power generator	3
	0	Water Storage	4
	0	Fuel Storage	5
Occupational noise exposure(OSHA)	87	Rebar Storage	6
	0	Material Storage	7
	0	Fire Fighting	8
	75	Parking	9
Occupational noise exposure(OSHA)	105	Permanent Buildings	10
	0	Security	11
Washington state department of Health	90	Tower Cranes	12
-	0	Wastage	13
Occupational noise exposure(OSHA)	87	Workshop	14

Table 8. Matrix control noise pollution) NW_{ij}(

Facility	1	2	3	4	5	6	7	8	9	10
1	0									
2	0	0								
3	0	0	0							
4	0	0	0	0						
5	0	0	0	0	0					
6	0	0	0	0	0	0				
7	0	0	0	0	0	0	0			
8	10	10	10	10	10	10	10	0		
9	10	10	10	10	10	10	10	0	0	
10	10	10	10	10	10	10	10	0	0	0

3.1 5. The air pollution control (Air Pollution Control)

In order to Reducing environmental pollution In this study The new mechanism In the form of a function (Nexus 7) Provided, The mechanism has been tried Distance commuting Related Machine The facility is a minimum. For this purpose, as shown in Figure (5) The distance from the entrance to the workshop With those facilities Which are associated with machines Minimize, The movement of machines less Resulting in less air pollution Will be produced. The workshop input As a hypothetical area (g *) Considered to be Distance to the entrance with related facilities Be minimized. Negative power function Is meant to increase safety By minimizing the distances involved. The proposed function according to equation (6) is.

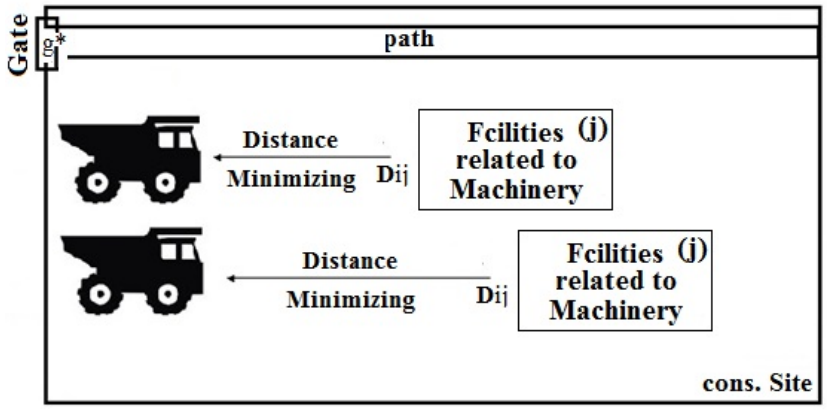


Figure 5. Area hypothetical g * to reduce air pollution.

$$\text{Air Pollution Control (APC)} = \sum_{i}^{f-1} \sum_{j}^{f} (AW_{ij})^{-1} * d_{ij} \quad (7)$$

AWij weight matrix of communication

Facility input

Input here (* g) Its representative Machines With facilities in accordance with Table (9) is , Dij is the distance between the input area (* g) And other facilities and functions to be calculated.

Table 9. Matrix weight Facilities AWij.

Facilities	HSE	Technical Office	Procurement	Staff restroom	Labors restroom	Residence	Material Storage
Weight(AW_{ij})	0	20	20	0	15	0	20
Facilities	Management Office	Steel Equipment Storage	Wastage	Rebar Storage	Fuel Storage	Water Storage	Power generator
Weight(AW_{ij})	0	10	15	10	15	5	0

3-3- Restrictions optimization

This section outlines (constraint) Which in this case was used Paid .In our model In order to ensure placement All buildings within the workshop(Overlapping) facilities with each other, No (Violation) it As well as compliance Regulations related to safety ,The following restrictions will be Apply. These limits In order to enhance applications The more models and layout workshop And observe the constraints,It seems necessary. broadly speaking The restrictions can be Divided into three types of constraints:

1- Limits (boundary) Workshop

2- Limits (Overlapping) facility

3- Safety limits

The aim of the workshop border restrictions ,Ensure placement facility And buildings Within the boundaries of workshop Figure 9 is To achieve this purpose the relationship (8) provides:

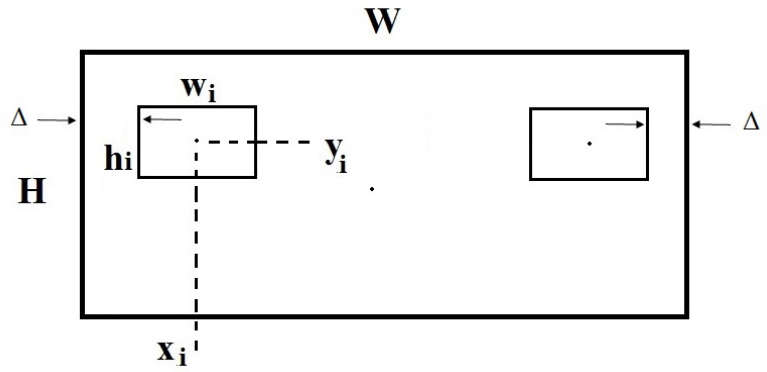


Figure 9. Border restrictions workshop.

$$\begin{cases} \frac{w_i}{2} + \Delta \le x_i \le W - \frac{w_i}{2} - \Delta \\ \frac{h_i}{2} + \Delta \le y_i \le H - \frac{h_i}{2} - \Delta \end{cases} \quad (8)$$

The relationship between W and H Site respectively width and length of the workshop, wi and hi i is equal to the width and length of facility And xi and yi is the i-th corresponding to the coordinates of the facility .Δ Indicates the minimum distance to facilities The borders of the workshop. A necessary condition for the integration of facilities Within the boundaries of workshop This is in accordance relations The central coordinates (yi xi,) Each facility Have more than half its width and length The number can be as needed With Δ equal to the minimum desired distance The boundaries of the workshop is to be assembled. The coordinates (yi xi,)n Each facility Should be less than the width and length of workshop And half of the width and length And, if need be arbitrary Δ . The coordinates (yi xi,) Each facility must Be between the minimum and maximum values The amounts are equal to the above equations. The second restriction The research is That none of the facilities and buildings within the site Should not be any (Overlapping) Together have For this purpose, the general assumption It will be for overlap A building It overlaps with other buildings If any of the vertices of the square Placed inside another building . Form (10) Must coordinate differences x Each of the buildings nMore of the half of them And Δ is the minimum distance. This is the y-coordinate differences Each of the buildings The same holds true. Thus the overall relationships, according to Equation (9) states that:

$$\begin{cases} |x_i - x_j| \ge \frac{w_i + w_j}{2} + \Delta \\ |y_i - y_j| \ge \frac{h_i + h_j}{2} + \Delta \end{cases} \quad (9)$$

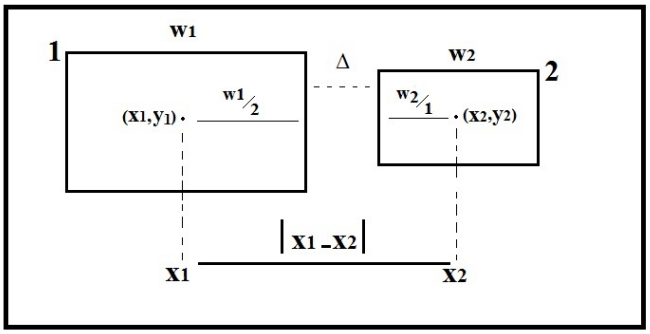


Figure 10. The limitations of overlapping facilities

4. Multi-objective particle swarm optimization algorithm MOPSO (MOPSO) Generalized model One objective swarm algorithm (PSO) is classic That due to the success of this algorithm The objective was to solve problems In 2004 Presented by Professor Coelho and colleagues [20].

This optimization The sub pattern Swarm intelligence methods Or (Swarm Intelligence) Considered to be. Swarm intelligence A kind of artificial intelligence methods The purpose of which is To call on the behavior of the group. If the agents to call Each alone can not The purpose of the process With the crowd on a And work together to achieve the desired response.

4.1 Method MOPSO Search

In this algorithm, any (solution) As one (Swarm) Considered to be, Such as chromosomes The genetic algorithm. Then the batch The particles are dispersed in search With regard to the objectives defined optimization Some particles Better and more decent position Compared to other particle So other particles According to group behavior they try To your position The particles position themselves more worthy, However, the position of superior particle Is also changing. The position of each particle According to the motion happens A combination of the following actions [20]:

1. Experience of bit and repeat the previous movements last

2. Experience of best place Which is a particle in the search space (Personal Best)

3. (Global Best).

In fact, every bit of advantage Whether advantages compared to other particles And also that of the whole group is aware. According to the description mentioned The new speed and new position A point in space is defined according to the relationship.

$$\begin{cases} v_i(t+1) = wV_i(t) + c_1 r_1 \ (p_i(t) - x_i(t)) + c_2 r_2 \ (g_i(t) - x_i(t)) \\ x_i(t+1) = x_i(t) + v_i(t+1) \end{cases} \quad (10)$$

The relations

(T + 1) Vi new velocity vector equation of motion of the particle

, (T) vi previous speed particle

, (T + 1) Xi to the new position of the particle,

, (T) Xi current position of the particle

, W inertia ratio or speed ratio previous

, C1 nostalgic factor

, C2 acceleration factor And r1 and r2 are random constants Between 0 and 1. And p and g, respectively, represent the best (Personal Best) And the collective memory of the particles (Global Best) are.

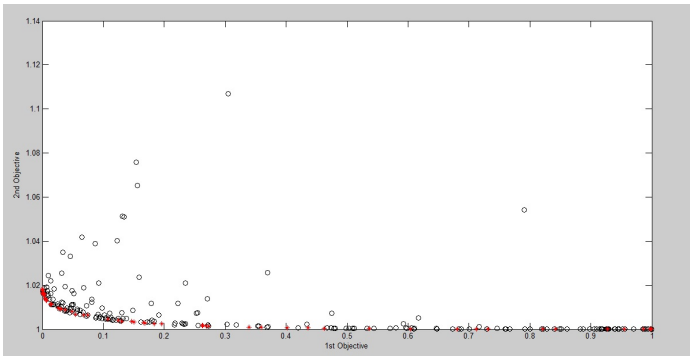
4.2 MOPSO and PSO difference classic

MOPSO and PSO difference classic In fact, in choosing the best particle And the best personal recollection Is in the process of algorithm, As in classical PSO One objective with regard to the issue, The answer is clear The multi-objective problems The space is not feasible arranged And are not defined. So should a change occur in the algorithm. Changes in MOPSO Concept (Repository) added This means that a separate archive answers found Outside the algorithm stored in the archive [20]

Members of the approximate archive Is the Pareto Front. So multi-objective algorithm Each particle in the third His motion that mimics The collective memory of the particles (Global Best) is, Of their leader Randomly selected from the archive stems. Another difference multi-objective version MOPSO In determining the best personal recollection (Personal Best) is That should be the new position of each particle Compare the best personal recollection If the new location was more appropriate point This point will become the best personal recollection of the particles.

4.3 implementation model

After the completion of parts of the model, Algorithms with MATLAB Version 2013 Written And numerous performances Considering the variety of iterations done To output a variety of layouts Obtained as a response And evaluated the effectiveness of the algorithm. Then, algorithm parameters In the first iteration as follows :The number of population of particles (n) 45, The number of particles in the archive (m) 20, Inertia coefficient (w) 0.5, The maximum repetition (T) 100, Acceleration factor for the personal memory (C1) to 1And the acceleration factor for the collective memory (C2) is equal to 2. Mutation rates (Mu) is 0.1. The values of these coefficients based on the same research papers and reference is considered. Figure (11) Pareto Front The response of the population Frequently tank As an example of the output of the algorithm Repeat rates respectively "100" is shown. Horizontal and vertical curves And represents the goal of cost and safety functions defined.



11. The response of the crowd and the response of the reservoir with 100 repeat The algorithm is designed, Proposed plan After successive output The program can be extracted. samples algorithm output Sort projects (12) and (13) shown In this project The numbers of each of the buildings To the facilities listed in Table 1 is. This response plan designed The lowest transport costs The environmental and safety aspects.

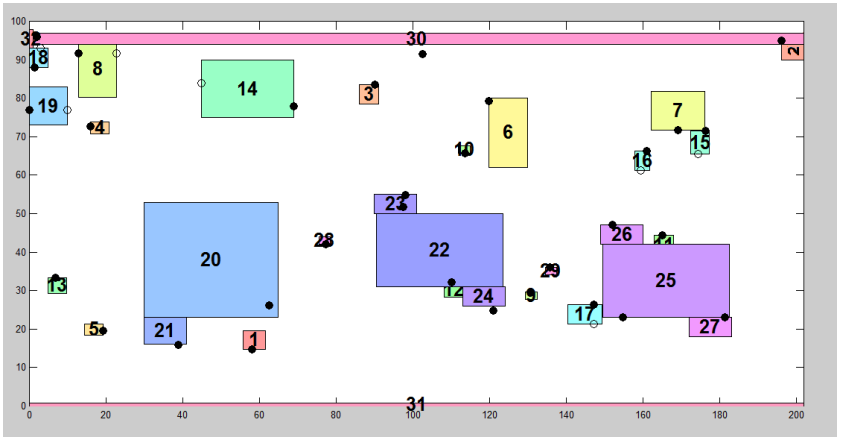


Figure 12. A proposed plan with targets at least cost and maximum safety provided by the algorithm.

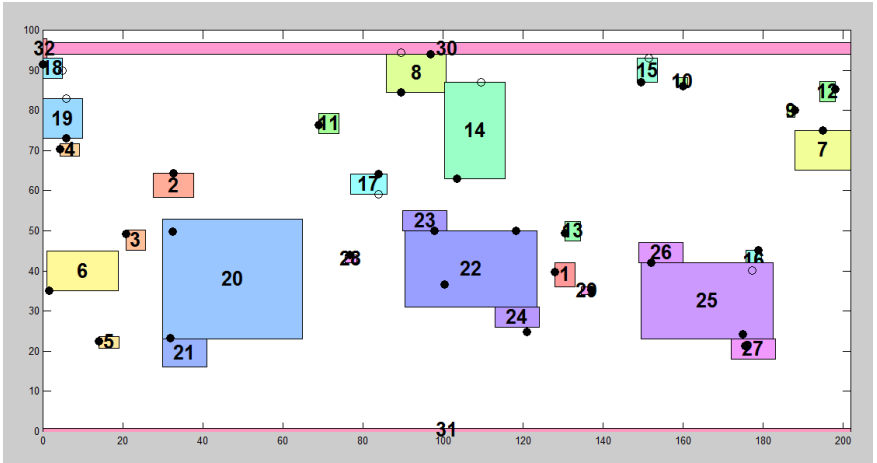


Figure 13. The two proposals submitted by the algorithm with minimum cost and maximum safety goals4.

4 Evaluation criteria algorithm outputs As in other similar studies Is mentioned During the optimization process A certain optimal solution No issues Instead, There is a set of optimal solutions. The reason for this continuous space The answer is that The optimization problems And, especially, multi-objective optimization problems Is established. The study also After running the algorithm and the resulting output plans A measure that would order trial And the accuracy of the results with them Expressed tested. First, to assess the optimum design One of the outputs of the algorithm Repeat with the maximum amount specified intended And the amount of the cost of the project (Best cost) Also extracted We will be able to consider The cost amounts for each period Or repeating the processing algorithm compares And we see the results. In Figure (14) and (15) Cost values (without units) The "100" and "200" Repeat processing algorithms, is shown. It should be noted that the Charts Similar values The middle part of repetitions Has been deleted because summarization The results show the amount of costs That by analyzing a period of analysis, To reduce amounts And the optimization of gone And algorithm optimization function has been successful

Figure 14. Results of repeated doses of cost per analysis algorithm (100 repetitions).

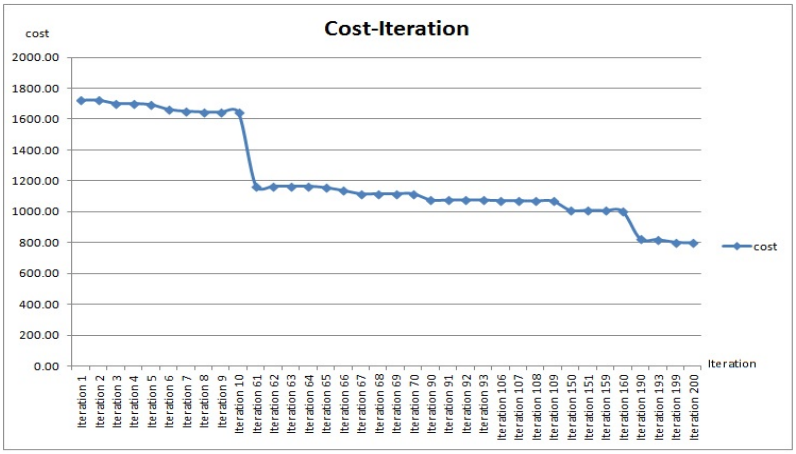


Figure 15 - Results of repeated doses of cost per analysis algorithm (200 repetitions) The quantitative assessment of the optimal cost And their values, In order to evaluate the safety and the environment And the quality of the algorithms used, The comparison between the optimal layout designs And optimal

use. The method of installation projects With maximum safety and minimum cost (as the best) Figure (12) and (13) is provided The Layout Designer Workshop According to the figures (16) and (17) And maximum safety with minimum cost (as a non-optimal plan) are compared.

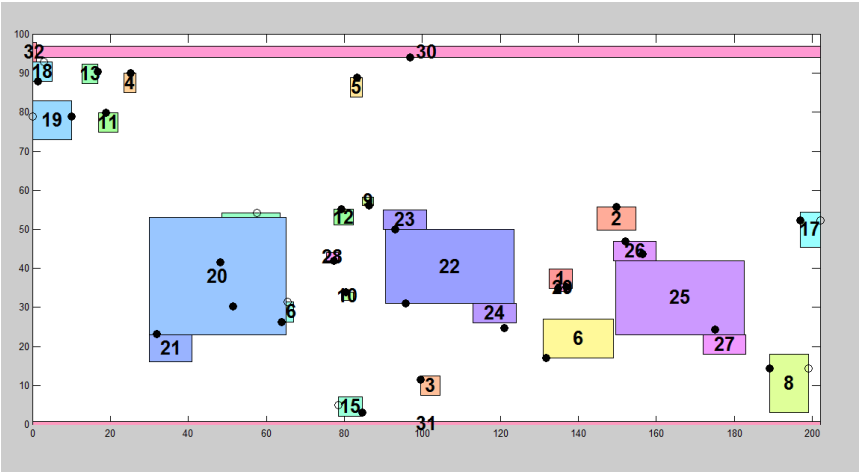


Figure 16. The development of a proposal submitted by the algorithm targets at least cost and maximum safety (non-optimized).

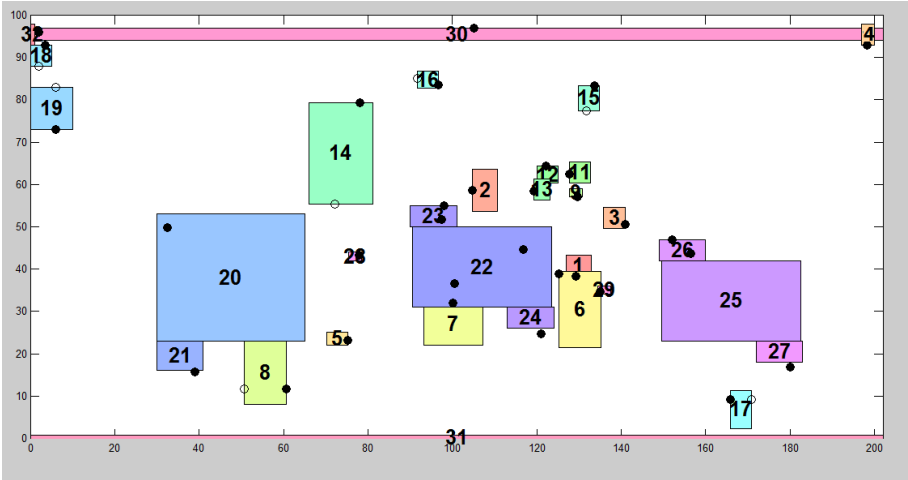


Figure 17 - The two proposals submitted by the algorithm targets at least cost and maximum safety (non-optimized) As compared Sort images optimized and non-optimized view of the screw In non-optimal designs Building operations "Warehouse equipment Steel" show number "8" "Technical workshops" with the number "16" Which was a lot of noise pollution The southern border of the workshop The location is adjacent to neighbors Vulnerable close In addition, it A little distance from vulnerable buildings in the workshop Such as the building of the "logistics" Or "of safety and health care" are. But unlike the projects The optimal\ arrangement of forms (12) and (13) Facilities or buildings listed Production of noise pollution Greater distance Borders are vulnerable workshop As well as the distance As the number of "1", "2" and "7" The "safety and health unit" "Technical Offices" and "administrative offices" is the maximum. In the case of defined parameters Parameter damage control tower cranes Increase the level of safety in the workplace, As the image (18) is seen Location of buildings vulnerable Accommodation manpower Such as buildings' residence and the chapel "with the

number" 6 " Building "administrative and technical offices" with the number "2" And building "office management and governance" with the number "7"

\ Are located outside of the canvas Tower crane This reduces the risks Or create hazards caused by falling materials will be the same. The buildings' reinforcement workshop "with the number" 14 " And building "materials storage" with the number "17" Located within the boundaries of what Tower crane This is expected to lead to increased productivity.

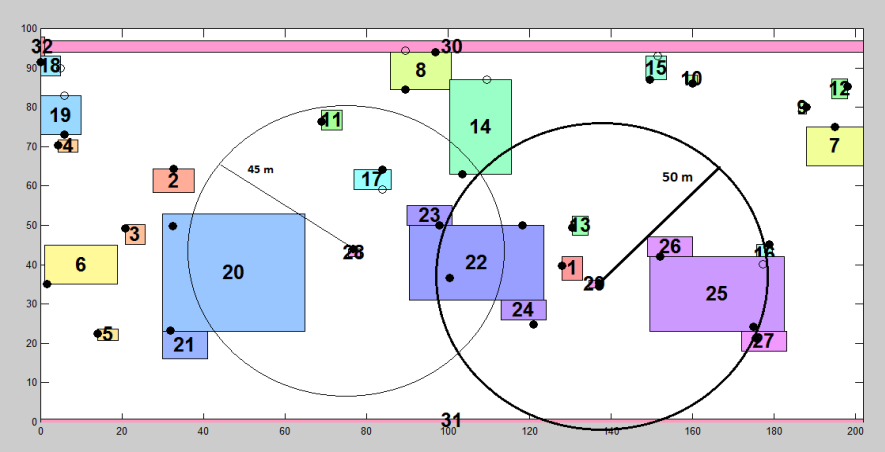


Figure 18 - Evaluation criteria Tower crane control parameter in layout design optimization The parameters of air pollution control Defined function, As the image of the optimal arrangement (12) can be seen Buildings With more vehicles on the Such as buildings "workshop reinforcement" "Warehouse equipment Steel" and "Warehouse Building" by the numbers "14", "8" and "17" With minimal input from the workshop This facility is the minimum distance vehicles. The non-optimal plan forms (16) and (17) He has a maximum distance between the buildings Input workshop And the success of this new function provided The research result.

5. The final conclusions

The research Trying to model In order to optimize the Locating facilities development workshop By focusing on the case study The sample is real. This optimization approach Costs of transport Between buildings As well as safety and environmental issues As well as new parameters in the model Such as air pollution and sound pollution provided And tried , Given the proximity to neighboring construction site A new approach in discussing the environmental aspects Provide. Also consider The ability of facilities The model also consider The input and output Each of the buildings Another aspect of the new facilities have been modeled. To solve such a model One of the newest methods of artificial intelligence The algorithm (MOPSO) Using MATLAB is used The effectiveness of this method, Output successful The case study provided. As a conclusion expressed I mentioned Just as The multi-objective optimization problems Sort The answer is a clear and unique Instead a series of Answers There are various iterations rate. As graphics images The costs shown The cost amounts Sort Different iterations rates Decreasing trend And this confirms the success of minimizing the Costs and its function is defined. Also in the comparison between the optimal designs And non-optimized layout was conducted Influence any of the parameters Safety and the environment at the function were used Identified and therefore It was shown to increase the level of safety and environmental workshops.

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