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Provide a model for manpower scheduling using a hybrid meta-innovative algorithm in the Water and Sewerage Company

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Abstract

One of the biggest challenges of projects is the limitation in human resources and, more clearly, the limitation in the number of skilled workers. Proper allocation of workers can increase the quality of production. Production workers, as the largest producer of the production leap, play a key role in improving the country's production system. Therefore, their proper timing is very important. In this research, by developing the concept of fatigue caused by the same work into two types of positive and negative fatigue caused by doing similar work and not just the same, a new and flexible model is presented that uses it Tasks can be scheduled so that similar tasks are assigned to each operator in the smallest programmable period and dissimilar tasks in the largest programmable period, so that the total allocation cost (including the total cost of doing the work and the total cost of fatigue). Because the proposed workflow scheduling model is formulated as a multi-period BoH allocation model and formulated as a nonlinear integer model, it falls into the category of compositional optimization. To overcome its algorithmic complexity, the Simulated Anealing algorithm is developed.

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Introduction

Shift work, especially night work, has adverse effects on the physical and mental health of shift workers and will lead to many problems such as fatigue, health disorders, disruption of social life, reduced productivity and reduced safety. One of the groups in which there are always work shifts are personnel working on construction projects, especially water and sewage. (Nakhaei, 2017)
Manpower scheduling is divided into two general categories. The first category involves determining the number of workers required from each different skill level to cover the demand of each department in each shift. But in the second category, which is much more common, the number of workers of each skill level is specific and limited, and the goal is to properly allocate the workers in each of the sections and shifts so that various limitations, including individual preferences, are met. (Jafari, 2017)
Therefore, preparing a favorable schedule for work shifts and workflow of employees with the approach of human factors engineering requires careful attention to employee characteristics such as satisfaction, health, stress, motivation and .... To increase productivity, reduce fatigue, satisfaction and health of employees, using job rotation is not a very suitable method. (Jafari, 2017)
In this paper, a set of formulas for measuring and predicting human fatigue in the workplace with the availability of data such as motivation range and individual fatigue is introduced. In the presented formulas, the level of employee motivation in each time unit of the planning period is calculated based on the initial level of operator motivation, duration of work and scope of worker motivation. Similarly, the operator fatigue level is presented as a function of the maximum fatigue level, the time elapsed from the start of the operator motivation reduction and the operator fatigue range. Both proposed models can be used to develop appropriate strategies such as job rotation, job redesign and improved relationships to deal with human fatigue in the workplace.
The workflow scheduling problem is a subset of the human resource scheduling problem, which aims to allocate jobs to operators over specific time periods, so that the costs of allocation include labor costs and opportunity costs. Opportunity costs are those costs that result from reduced individual productivity, ergonomic and safety-related issues, or both. Individual productivity can include learning, gaining more skills, motivation and job satisfaction, and the risks of working environment, working with a car, cases, etc. are also notable in the field of ergonomic and safety issues. According to Feiq, the main question is whether the workflow scheduling problem can be solved using a simulated melting algorithm?

Literature review

The workflow scheduling problem is a subset of the human resource scheduling problem, which aims to allocate jobs to operators over specific time periods, so that the costs of allocation include labor costs and opportunity costs. Opportunity costs are those costs that as a result of reducing individual productivity can be named learning, gaining more skills, motivation and job satisfaction, and the risks faced by the work environment, working with machine materials, etc. are also possible. Mention is made in the field of ergonomics and safety issues (Spichakova, 2016) (Burke & Moore 2018) Application and workflow of a wide range of manufacturing companies, a variety of tasks, advanced industrial systems such as cellular manufacturing industries and service organizations such as hospitals, police departments , Includes firefighting, bus traffic, etc. (behrozy, 2016), but research on the effects of employing workflow in practice has yielded contradictory results, so that it is not conclusively advantageous. In early research on workflow, Wilkinson and Edwards showed that workflow in a two-person system resulted in higher performance than in a three-person system without a workflow (Santos, toffolo, gomes &Ribas, 2016) Powell et al (2015) with A case study has concluded that turnover has reduced the workload of operators. In his research, Girfin evaluates the success of job rotation in improving the level of motivation and job satisfaction. According to Cleary, Sayers, Lopez, and Hungerford (2017) from the results of research by Cunningham and Abrel, as well as Davis and Taylor, although job turnover has improved job satisfaction, it has not improved performance.

Despite the interest of researchers in studying the effects of workflow, so far little research has been done to develop and solve workflow scheduling models. The problem of workflow scheduling has been modeled and solved for the first time by Kranahan et al. (2013). The researchers designed a multi-period allocation model that is programmed with integer variables and then proposed a solution using a genetic algorithm. This model is solved by entering the assumptions of the work tour scheduling problem from the Refrigeration Simulation (SA) and Ant Colony (ACO) algorithms. As mentioned, despite the development of these models, the main problem is that the models used in practice have not performed well in improving individual productivity. According to Marion, Gaynor and Graham (2016), this issue goes back to the methods of scheduling tasks. The researchers believe that the weakness of current models is the use of very simple and non-innovative rules to determine how tasks are rotated. It can also be argued that resource modeling of opportunity cost creation, in addition to the need for creativity in defining the model function, the multi-objective nature of the workflow scheduling model makes it more consistent with the facts.

Material and methods

The research method is applied in terms of purpose and mathematically descriptive in terms of method and the researcher intends to first model a workflow problem and then solve it using a simulated melting algorithm algorithm. Data analysis method Using the basics of the simulated algorithm and the software will be done. As mentioned in the previous section, the basis of the models that have been proposed so far for the workflow scheduling problem is the multi-period allocation model. The objective function in this model is of the type of total cost minimization due to allocation and decision variables of integer type (zero one). In this paper, by adding new assumptions and definitions of fatigue, the structure of the multi-period allocation model is developed to formulate the workflow scheduling problem based on the assignment of tasks to operators during several planning periods with the aim of minimizing total allocation costs.

Research Methods

The data required for the parameters of the research model using the questionnaire in the company are bad. In this way, as a result of the collected questionnaires, the matrix of preferences of each nurse is obtained. The matrix of preferences of each operator shows whether in each shift and in each period the workforce has a plan to do the same work or not, this number is determined by zero and one.

From all the distributed questionnaires, the similarity matrix is also obtained, which shows that through the labor force, workers are compared to any amount. The amount of this numerical analogy is between zero and one. The number zero indicates that the two works have no analogy with each other, and the number one indicates that the two works are quite similar.

In the proposed model, mathematical programming is used for modeling, and also for solving the model, the algorithm method is generally used for the missing particle initiative. By delivering the results obtained from the proposed model, the amount of components in the operational theories specified in each operator, the length of the rotation period and the appropriate level of operators are considered taking into account the optimization condition in the model.

Explanatory design and modeling

The objective function in this model is to minimize the purity resulting from the dynamic assignment of tasks to other people and the structural model to formulate the time of use of business tourism scheduling with special features to operators during different periods (fixed characteristic). With the aim of minimizing the level of satisfaction of individuals according to the operator's preferences to simile and not encourage. Also, in this model, the characteristics of the works in each rotation period, which includes one or more planned periods, are considered constant.

Using the schedule required by operator I, work J, and R, we have a planning period, which is divided into N attribute maintenance periods of length X_n. This task is assigned to the I operator in such a way that over-consideration of certain assumptions reduces the neutrality of the operators by considering their preferences. In fact, there were N inputs, and the number of periods of efficient attribute maintenance indicates that you mean to maintain a particular attribute, to remain constant in one period for each attribute maintenance period for an operator, for cases where your job is to be an operator. This attribute is when it is in your period, ie it remains constant during period x. X is also a variable that indicates the length of the feature retention period. When j is assigned to operator i in period r, $a_{\mathrm{i}}\mathrm{r}_{\mathrm{j}}$ is equal to one and otherwise zero. In this feature, p_{jk} shows the similarity of the two tasks k, j and C_{in}. The preferences of operator i in the rotation period n to repeat or interrupt the work, both of which exist as matrix inputs for other conditions. If my operator, in period n, the tendency to repeat the work is the same as one, otherwise it is zero. The similarity matrix and the operator preferences matrix are available in calculating the purity of the operator to determine the amount of efficient encouragement or non-encouragement according to the operator's preference in repeating or interrupting the work. Finally, after the implementation of efficient models during the planning period, it is determined to the operators according to their preferences, which if the feature is used, the similar and dissimilar characteristics are reduced and makes the appropriate level of operator conditions and length of the period. Circulation and matrix are specified to be assigned to the operator.

Model assumptions

The assumptions used to model the workflow scheduling problem are:

The number of jobs is more than the number of operators, so at least one job is assigned to each operator in each planning period.

Each task in each planning period must be assigned to only one operator.

Each task should be done only once in each planning period.

The number of planning courses is predetermined and more than one course.

The set of tasks must be assigned to each planning period to be performed and no task will be postponed to the next period.The assignment of similar tasks in each rotation period is evaluated according to the preferences

The number of operators and tasks in each planning period remains constant.

of the operator, favorable or unfavorable.The number of tasks, the number of operators and the number of maintenance periods are fixed during the planning period.All tasks must be assigned to operators in each planning period.

Model definitions and symbols

If the number of programming periods is equal to R, the number of rotation periods (fixed allocation) is equal to N, the number of operators is equal to I, and the number of tasks is equal to J, the numerator indexes of the parameters and the decision decision variables and symbols are symbolized as follows: Be.

Index:

i :Operator counter (i = 1,2,…, I)

J: Job counter (j = 1,2,…, J)

r: period or day counter (r = 1,2,…, R)

n: Allocation retention period counter (n = 1,2,…, N)

Parameters:

p_{jk}: The degree of similarity of the two works j, k such that:

∀ j, k: P_jk = P_kj; 0≤P_jk≤1

C_{in}: The preferences of operator i, in the period n, to repeat or interrupt work, ie to do similar or dissimilar tasks.

Decision variables:

$a_i r_j$: If work j is assigned to operator i in period r, it will be equal to one, otherwise it will be equal to zero.

$a_i n_j$: If job j is assigned to operator i in period n, it will be equal to one, otherwise it will be equal to zero.

X_n: The length of the rotation period

B_i: The level of fatigue of each operator

Degree of similarity of the two works:

The degree to which one task is similar to another, and is naturally a number between zero (in the absence of similarity) and one (in the case of complete similarity, which is clearly established for two identical tasks).

Operator fatigue during the allocation maintenance period:

If the operator preference during the nth allocation retention period is similar ($C_{in} = 1$). Then to calculate the operator fatigue in this maintenance period we have the allocation:

$$B(i,n) = 1 - \frac{1}{(\sum_j 2^{a_{inj}})} \sum_j \sum_k a_{injk} \cdot p_{jk} \qquad \forall\, i,n \qquad (1)$$

Also, if the operator preference in the allocation retention period is dissimilarity ($C_{in} = 0$). Then to calculate the operator fatigue in this maintenance period we have the allocation:

$$B(i,n) = \frac{1}{(\sum_j 2^{a_{inj}})} \sum_j \sum_k a_{injk} \cdot p_{jk} \qquad \forall\, i,n \qquad (2)$$

Total operator fatigue:

It is the fatigue that the operator feels during the planning period and is equal to the maximum operator fatigue in each allocation maintenance period

Suggested model

According to the definitions provided in the previous section, the structure of the multi-period allocation model is developed to formulate the workflow scheduling problem according to the operator preferences as follows. The objective function in this model is the sum of each operator's fatigue due to his feeling of fatigue due to the assignment of similar or dissimilar tasks according to his preferences over the planning horizon, which is formulated in a non-linear wa

$$Min\ Z = \sum_i B(i) \qquad (3)$$

S.t:

$$\sum_{i=1}^{I} a_{irj} = 1 \qquad \forall\, j = 1,2, \dots J \quad \forall\, r = ,2, \dots R \qquad (4)$$

$$\sum_{j=1}^{J} a_{irj} \geq 1 \qquad \forall\, i = 1,2, \dots I \quad \forall\, r = 1,2, \dots R \qquad (5)$$

$$\sum_{n=1}^{N} x_n = \mathrm{RI} \qquad (6)$$

$$a_{irj} = 0,1 \qquad (7)$$

$$a_{inj} = 0,1 \qquad (8)$$

$$\sum_{r=1}^{x(n)} a_{irj} = x_n . a_{inj} \qquad \forall\, i = 1,2, \dots I \quad \forall\, j = ,2, \dots J \qquad (9)$$

$$(10)\ x_n \geq x_{n+1} \qquad \forall\, n = 1,2, \dots N$$

Equation (4) states that each job in each planning period should be assigned to only one operator, and Equation (5) guarantees that each operator in each planning period will be assigned at least one job and Equation (6) and (9) express the sum of the length of the periods and the constancy of the assignment, and equations (7) and (8) indicate the integer number of the model.

Summary of model input data

The model presented in this research works for the operators of each shift, according to the two matrices of operator preferences and similarity of tasks, workflow division. In order to obtain the similarity matrix of works in this study, questionnaire A was included in Annex 1. The questionnaire was distributed among shift nurses and they were asked to determine the similarity between tasks by scoring from zero to 10 {dissimilarity (0) .... Very Similar to (10) The results of the similarity matrix can be seen in Table 1.

Table (1) Matrix of similarity of operations of the operational department of the Water and Sewerage Company

Non-destructive testing	lowering	welding	excavation	mapping	jobs
0.36	0.61	0.43	.087	1	mapping
0.31	0.76	0.53	1		excavation
0.59	0.89	1			welding
0.44	1				lowering
1					Non-destructive testing

The operator preferences matrix was also collected by the second question of the distributed questionnaire. In this way, each operator was asked to express their preference for doing the same work in each of the work shifts (morning shift, evening shift and night shift). The number one (1) indicates the willingness to do the same job and the number zero (0) indicates the unwillingness to do the same job in each shift or retention period. The matrix of preferences obtained for shift operators A can be seen in Table (2).

Table (2) Workforce Preference Matrix Shift A

Night turn	Evening turn	Morning turn	Workforce / Course (Shift)
0	1	0	Employee1
1	1	0	Employee2
1	0	1	Employee3
0	0	1	Employee4
0	1	0	Employee5
1	1	1	Employee6
1	0	1	Employee 7
0	0	0	Employee 8
0	0	1	Employee 9
1	1	1	Employee 10
1	0	0	Employee 11
1	0	0	Employee 12
1	0	1	Employee 13
0	1	1	Employee 14
0	0	0	Employee 15
1	1	0	Employee 16
0	1	1	Employee 17
1	0	1	Employee 18
0	1	0	Employee 19
1	1	0	Employee 20
1	1	1	Employee 21
1	0	1	Employee 22
1	0	0	Employee 23
1	1	1	Employee 24
0	0	0	Employee 25
1	0	0	Employee 26
1	0	0	Employee 27

Also, the number of planning periods, ie the total number of days of a work cycle, which includes morning, evening and night shifts, is 9 days for each shift, and the number of allocation maintenance periods, ie the number of shifts per work cycle (morning shift, evening shift, night shift). There are 3 courses, the length of each course is 3 days. The length of the period in the model is considered as a decision variable enters the model, but in the study of this study, ie workforce shift, we have considered this variable as an input parameter.

Workforce shift and workflow scheduling

The workflow schedule for shift A has been calculated. Shift A data is as follows:

- The matrix of operators' preferences for shifts can be seen in Table (1).

- Number of planning courses (number of days per work cycle) 9 days

- Number of allocation retention periods (number of work shifts) 3 days

- The length of each planning period (length of each shift) is equal to 3 days

The results of scheduling and workflow design obtained from the proposed algorithm of this research for shift workforce A of water and sewage projects can be seen in Tables (3) to (5).

Table (3) Results of Job Scheduling and Workflow Morning Shift Workforce Shift A Water and Wastewater Projects by the Proposed Algorithm

Labor preference	Similarities	Assignments in the morning shift		employee	row
0	0.31	44	15	Employee1	1
0	0.76	36	17	Employee2	2
1	0.87	22	4	Employee3	3
1	0.61	43	6	Employee4	4
0	0.53	33	18	Employee5	5
1	0.87	5	21	Employee6	6
1	0.87	23	12	Employee 7	7
0	0.53	32	25	Employee 8	8
1	0.61	39	10	Employee 9	9
1	0.43	2	29	Employee 10	10
0	0	–	48	Employee 11	11
0	0.31	47	19	Employee 12	12
1	0.76	37	14	Employee 13	13
1	0.76	24	40	Employee 14	14
0	0.43	35	1	Employee 15	15
0	0.61	42	3	Employee 16	16
1	0.87	11	26	Employee 17	17

1	0.53	13	30	Employee 18	18
0	0.43	8	34	Employee 19	19
0	0	–	9	Employee 20	20
1	0.76	16	38	Employee 21	21
1	0.76	20	41	Employee 22	22
0	0	–	27	Employee 23	23
1	0.36	7	45	Employee 24	24
0	0	–	28	Employee 25	25
0	0	–	31	Employee 26	26
0	0	–	46	Employee 27	27

Table (4) Results of job scheduling and turnover of labor shift shift A of the Water and Sewerage Company by the proposed algorithm

Labor preference	Similarities	Assignments in the evening shift		employee	row
1	0.61	39	3	Employee1	1
1	0.76	25	37	Employee2	2
0	0.31	22	47	Employee3	3
0	0	–	8	Employee4	4
1	0.87	23	5	Employee5	5
1	0.53	34	19	Employee6	6
0	0	–	18	Employee 7	7
0	0.53	14	29	Employee 8	8
0	0	–	2	Employee 9	9
1	0.87	7	15	Employee 10	10
0	0.59	32	48	Employee 11	11
0	0.43	30	10	Employee 12	12
0	0.53	33	21	Employee 13	13
1	0.76	40	17	Employee 14	14
0	0	–	16	Employee 15	15
1	0.87	1	26	Employee 16	16
1	0.61	12	42	Employee 17	17
0	0.44	45	43	Employee 18	18
1	0.61	41	9	Employee 19	19
1	0.87	6	13	Employee 20	20
1	0.61	38	11	Employee 21	21
0	0	–	24	Employee 22	22
0	0.43	4	35	Employee 23	23
1	0.44	36	44	Employee 24	24
0	0.43	31		Employee 25	25
0	0.31	20	46	Employee 26	26
0	0.53	28	27	Employee 27	27

Table (5) Results of Scheduling and Job Turnover of Night Shift Workforce A of Water and Sewerage Company by the Proposed Algorithm

Labor preference	Similarities	Assignments in the evening shift		employee	R
0	0	–	16	Employee1	1
1	0.36	48	8	Employee2	2
1	0.43	12	30	Employee3	3
0	0.59	34	47	Employee4	4
0	0.87	5	23	Employee5	5
1	0	–	4	Employee6	6
1	1	6	2	Employee 7	7
0	0.61	36	3	Employee 8	8
0	0.31	17	46	Employee 9	9
1	0.53	35	21	Employee 10	10
1	0	–	19	Employee 11	11
1	0.87	15	7	Employee 12	12
1	0	–	14	Employee 13	13
0	0.53	32	27	Employee 14	14
0	0.59	33	45	Employee 15	15
1	0.76	25	37	Employee 16	16
0	0.87	11	20	Employee 17	17
1	1	38	39	Employee 18	18
0	0.89	29	43	Employee 19	19
1	0.53	28	22	Employee 20	20
1	0.31	44	26	Employee 21	21
1	0	–	13	Employee 22	22
1	0	–	42	Employee 23	23
1	0.87	24	9	Employee 24	24
0	0.43	31	1	Employee 25	25
1	1	41	40	Employee 26	26
1	0.87	18	10	Employee 27	27

In the following, the results obtained from the scheduling and job rotation of the proposed method for the workforce of the Water and Sewerage Company are compared with the scheduling and job rotation of the traditional method, which is currently planned by the shift manager. To make this comparison, we have considered the difference between the operator's preference in choosing similar / dissimilar work and the similarity between the two tasks assigned to him.

The smaller the difference, the closer the work is to the operators' preferences, and as a result, their fatigue should be reduced. Table (5) shows the difference between the operator's preference in choosing similar / dissimilar work and the similarity between the two tasks assigned to him in the results of the two traditional methods and the proposed method in the morning shift.

Table (6) The difference between the operator's preference in choosing similar / dissimilar work and the similarity between the two tasks assigned to her in the results of the two traditional methods and the proposed method in the morning shift

Proposed method		Traditional method		employee
Labor preference	Similarities of assigned tasks	Labor preference	Similarities of assigned tasks	
0	0.31	0	0.31	Employee1
0	0.76	0	0.43	Employee2
1	0.87	1	0.87	Employee3
1	0.61	1	0.61	Employee4
0	0.53	0	0.76	Employee5
1	0.87	1	1	Employee6
1	0.87	1	0.53	Employee 7
0	0.53	0	0.36	Employee 8
1	0.61	1	1	Employee 9
1	0.43	1	0	Employee 10
0	0	0	1	Employee 11
0	0.31	0	1	Employee 12
1	0.76	1	1	Employee 13
1	0.76	1	0.53	Employee 14
0	0.43	0	0.87	Employee 15
0	0.61	0	0.44	Employee 16
1	0.87	1	1	Employee 17
1	0.53	1	0	Employee 18
0	0.43	0	1	Employee 19
0	0	0	0.36	Employee 20
1	0.76	1	0	Employee 21
1	0.76	1	0.87	Employee 22
0	0	0	0.87	Employee 23
1	0.36	1	0.31	Employee 24
0	0	0	0.53	Employee 25
0	0	0	0.76	Employee 26
0	0	0	0.43	Employee 27

Figure (1) shows the difference between the operator's preference and the similarity of tasks assigned to him in the morning shift of A in the traditional way, which is planned by the shift supervisor and management.

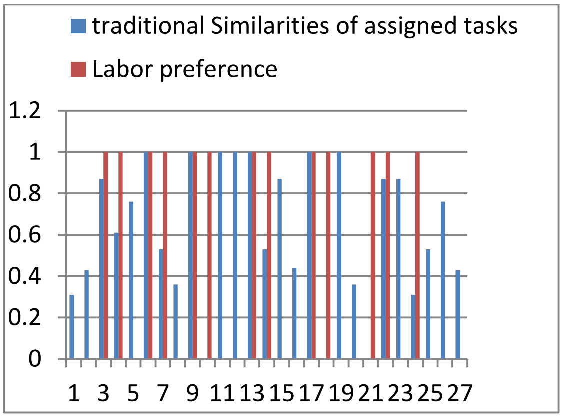

Figure (1) The difference between the operator's preference and the similarity of the tasks assigned to him in the morning shift of the traditional method A

Figure (2) shows the difference between the operator's preference and the similarity of the tasks assigned to him in the morning shift of shift A as proposed in this study.

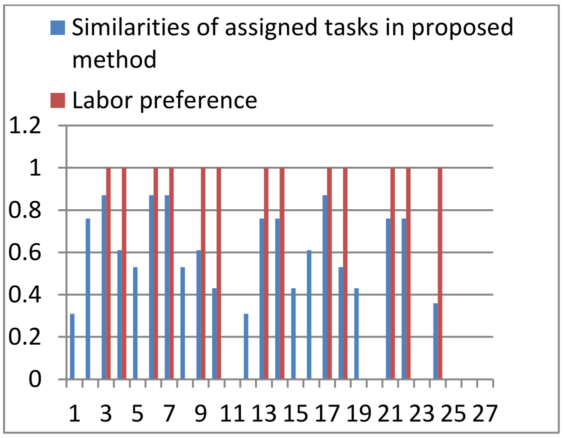

Figure (2) The difference between the operator's preference and the similarity of the tasks assigned to him in the morning shift of shift A in the proposed method

As can be seen in the two diagrams (1) and (2), in the job cycle and the proposed schedule of this research, the degree of similarity of the assigned tasks has become closer to the preferences of the operators.

The results of the optimal fatigue obtained in the output of MATLAB software in shift A are shown in the table below. In the model considered for this research, the optimal fatigue of each operator is his maximum optimal fatigue during each planning period, and the optimal fatigue is obtained by minimizing the total function of the total fatigue of the operators.

Table (7) Optimal fatigue for the workforce in shift A.

Optimal fatigue	Number of jobs	Number of workforce	shift
0.654	48	27	A

Conclusion:

Job turnover is one of the job design strategies that is used to increase the motivation of the employee to perform repetitive tasks or tasks. Most organizations use this strategy to multi-function and multi-skill employees in the form of workflow scheduling programs. The main topic of this study is the issue of workflow scheduling to calculate the fatigue caused by similar or dissimilar jobs, which considers the preferences of the individual, which is an innovative aspect of this study, in the workplace. Usually, in order for employees to work easily and efficiently in their work environment and bring good results to their organizations, it is necessary to be in a suitable environment and in accordance with their preferences, both physically and mentally, and in terms of how tasks are assigned. Take. The role of each person in the workplace is very important because of guiding and doing several things. Also, the person has always wanted it as much as possible, the way he works according to his preferences. In fact, considering a person's preferences about how to allocate in terms of how to repeat and discontinue tasks can have a significant impact on his or her performance. Each person has different short-term motivations in performing their duties, depending on their tenure, background and other unique characteristics.

This research deals with the scheduling of the labor force of the Water and Sewerage Company. The workforce may tend to do similar work in a short period of their working time, for example, shift or evening or night, and in other periods, such as night shift, tend to be dissimilar in their assigned tasks. Consideration of manpower preferences in a multi-process guidance environment to reduce fatigue was not addressed in any of the workflow scheduling articles. The proposed model incorporates this parameter, which expresses the innovation of the research. In fact, the consideration of fatigue due to repetition or interruption of allocation based on one's preferences in the workplace has given a more realistic aspect to the issue of determining the work rotation plan. In this modeling, we considered the case that the number of jobs is more than the number of workers and at least one job should be assigned to each workforce in each planning period. Also, in the job allocation, the matrix of labor preferences is considered. We used an integer nonlinear programming model to calculate the fatigue of assigning similar or dissimilar tasks according to workforce preferences. Important outputs of the model include the matrix of assigning tasks to operators and the level of fatigue.

The main question of this research: Can meta-heuristic algorithms (PSO particle swarm algorithm) achieve a more efficient shift schedule than traditional methods with human factor engineering approach (fatigue and workflow)?

In the fourth chapter, after calculating the workflow schedule according to the proposed method, we compared the results with the traditional method, which was planned by the shift manager and supervisor. The results of comparison for the morning shift show that the workflow scheduling of the proposed method is more efficient than the traditional method and is closer to labor preferences. Therefore, the main hypothesis of the research is confirmed: Mathematical programming methods are more efficient. Therefore, by the particle swarm algorithm, the proposed model for shift A of the workforce of the Water and Sewerage Company was implemented and solved in MATLAB software and the comparison of the results showed that the proposed method was superior to the traditional method. It has been closer to the operators' preferences.

It is suggested that for future research, other aspects of workforce preferences in the workplace be considered in addition to preference in job allocation, such as preferences in working hours and days. On the other hand, for the development of the model, the existence of time constraints and considering the effect of fatigue on the time of work by the operator can be considered

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