



Designing an optimization model for preventing the waste time in the activity cycle of an organization

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Abstract

This article proposes an optimization model for preventing the waste of time in the educational and research activities' cycle of an organization such as a university. For this purpose and in order to increase efficiency and prevent the waste of time; the graph theory models have been used. The educational and research activities diagrams of a supposed university is drawn by the use of graphs theory model, and then these graphs are analyzed, then in order to design a model, the units, activities and the time of doing each activity are symbolized, and the collected data are presented in the form of matrix. In this article two procedures are suggested for optimization; using subgraphs for every activity cycle in order to shorten the activity cycles and minimizing the time of doing each work. The algorithm of time minimizing is based on recognizing and determining the edges with the most weight as the maximum time. Also the influential factors on the waste of time in activity cycle are recognized and then replaced or omitted.

Key words: Graph Theory, subgraph, optimization, Activity cycle, unit, work, working Time.

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1 Introduction

Nowadays, paying attention to the rate of efficiency in organizations is one of the serious subjects in management. Providing optimized services and trying to meet customer satisfaction are the noticeable subjects in global management systems. In Iran, governmental organizations are trying to pay attention to these subjects too. [6]

One of the most important factors for customer dissatisfaction is the waste of their time in the activities cycle of organization. Wasting of time has a close (indirect) relationship with rate of efficiency in an organization, and the rate of efficiency is dependent on the speed, accuracy, and correctness of work. It is clear that examining these factors needs an understanding about the quality and method of doing works in an organization. The first step in analyzing a system, is recognizing the ways of doing work as they are performed. In this article, it is tried to show the work Flow diagram as a graph. The graph Theory has been used for modeling most of the matters in most of the science branches such as engineering, medicine, basic sciences and even human sciences like management or social science; for example this theory has been broadly applied in the subject of social networks.[2]

The work flow diagram of some of educational and research activities of a supposed university is drawn by use of graphs theory models, and then it is analyzed for optimization.

2 Problem Recognition

Determining the purposes and recognizing the problem needs to study and collect precise and comprehensive information about system. In order to do this, a field

study about the structure and cycle of activities in research and educational office of universities was done; and several meetings with related experts in each unit was helpful to collect the needed information.

3 Problem Analysis

System improvement in an organization needs special tools and techniques to explore the defects and losses and find a cure to remove them. One of these techniques is developing work table; a table which shows the works that employees do in a specific time and the hours that they spend to do these works. With the help of this table, it is possible to inform about the actual work load and the quality of its distributing in organization, also it is possible to recognize the work load and human resource crowding places, the repetition and interference of duties, gain information about the ways of allocation time to different duties and also the ways of adapting the kind and nature of duties with the specialty of employees. It is possible to find the actual number of human resource that is needed; and finally this table is a basis for evaluating employees and developing their salaries. [5] In this article, it is tried to analyze with the help of drawing graphs for each activity cycle. The basic purpose of this analysis is to measure and minimize time. The analysis is done through classifying information, designing matrixes, examining the relationships of units, determining the activity of each unit and measuring the time of doing each activity. [4]

4 Algorithm Designing

The algorithm of minimizing time is based on recognizing the edge or edges with maximum weight as maximum time and replacing them with minimum ones in a cycle. Then the maximum and the probable minimum times are calculated. Here, three suitable algorithms are designed for automatic calculation and optimization. [1]. Now before describing the model, it is better to define some of the concepts;

5 Organization

Organization is a system involving interrelated components with a special discipline which they are active to reach specific goals. [5]

Graph

Graph is shown as $G = (V, E)$; V is a nonempty set of elements which is called vertex and E is a set of duals from the elements of V (it is obtained from the multiplication of V by itself), which is called edge.

These two collections are as below:

$$V = \{v_1, v_2, \dots, v_n\} \quad n \in \mathbb{N}, \quad V \neq \emptyset$$

$$E = \{e_1, e_2, \dots, e_m\} \quad m \in \mathbb{N}$$

$$e = \langle v_i, v_j \rangle$$

Subgraph

$G_1 = (V_1, E_1)$ is a subgraph of $G = (V, E)$ if; $V_1 \subseteq V, E_1 \subseteq E$.

The vertexes of graphs are shown with small circles and edges shown as connection lines to vertexes. [2]

Model Design

The modeling of activities' cycles by using graphs is designed as follows;

It is supposed that all of the units of an organization are as $u = \{ u_1, u_2, u_3, \dots, u_n \}$ and the work of each unit are as $w = \{ w_1, w_2, w_3, \dots, w_m \}$. Each work is a collection of some activities which is shown as $A = w_i = \{ A_1, A_2, A_s, \dots, A_k \}$ each unit in an organization has some works to do, and in order to do each work, some activities are needed. The cycle of each work can be drawn as a graph. In this graph each vertex shows each unit and each edge shows the activity between two vertexes; it shows the work which has been done and also shows the work referring from one unit to another unit. The obtained graph is a labeled and weighted graph. The vertexes have the labels to show the number of each unit and edges show the time of doing activities. [3]

Defining Time Function for each Activity

If it is supposed that A is the collection of activities and u is the units of an organization; then the time function of each activity will be as below:

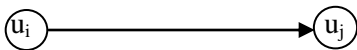
$$A = \{ A_1, A_2, \dots, A_n \}$$

$$U = \{ U_1, U_2, \dots, U_n \}$$

$$T = \{ t_1, t_2, \dots, t_k \}$$

$$F: U \times A \rightarrow T$$

$$F((u_i, A_j)) = t_j \quad t_j \in T \ \& \ T \text{ is a set of time.}$$



Now it is needed to design suitable matrixes to process data automatically.

A - The matrix of unit's activity:

Table 1, are designed to show this matrix, in this table $a_{ij} = \begin{cases} 1 \\ 0 \\ 2 \end{cases}$

Table (1): Determining the units' activity.

A	A_1	A_2	A_3	.....	A_k
U					
u_1	A_{11}	a_{12}	a_{1j}	.....	a_{1k}
.	.				.
.	.				.
.	.				.
.	.				.
u_i	...			.....	a_{ij}
.
.
.
u_n	a_{n1}	a_{n2}	a_{nj}	.....	a_{nk}

In this matrix when $a_{ij} = 1$, it means that the u_i unit is either the doer or receiver of A_j activity. when $a_{ij} = 2$, u_i is both doer and receiver of A_j and when $a_{ij} = 0$, u_i is neither doer, nor the receiver of activity. The sum of elements on each column is 2 which shows the edge $A_r = u_i u_j$ and the sum of elements on each line specifies the number of activities for each unit.

Table 2, is related to symbolization of research units in university.

Table (2): symbolizing the research units.

The name of unit	u
The university Research Assistance	U ₁
The university Research council	U ₂
The Research affairs office	U ₃
Library, documents & computer center	U ₄
Publishing & press	U ₅
The Faculty Research Assistance	U ₆
The Faculty Research council	.
The Educational Group Director	.
The Educational Group Council	.
The Research financial office	.
The Judges of Research projects	U _n

B – The Matrix of Activity and Time:

This matrix specifies the time of doing activities in the organization. The Times are measured in two ways; The maximum time (pessimistic) and the minimum time (optimistic) of each activity are measured and then it can be possible to obtain the probable minimum time through the following relation, in this relation

a, b, c are in order as the minimum, most likely (probable) and maximum times.
 [1]

$$t = \frac{a + 4b + c}{6}$$

Table (3): Determining the type and time of the activities of u₆ (The Faculty Research assistance).

The Activity symbol	The type of Activity	Time duration in terms of day	Time duration in terms of minute
A ₁	First examination of project	2 days	10 minutes
A ₂	Examining, checking and giving opinions about approving, correcting or rejecting the proposal project	15 days	30 minutes
A ₃	Examining the find report of project and in the case of approving; delivering it to the Research Affairs office	15 days	30 minutes

C - The Matrix of work cycle based on Activity:

The work progress diagram shows the various phases for doing a work, form the first to the last. With the help of work progress diagrams, it is possible to search the problem reasons on a piece of paper easily, and explore the best work progress shape by continuous experiments, changing the order of work phases, and doing other necessary changes.

In this matrix $a_{ij} = \begin{cases} 1 \\ 0 \end{cases}$

Table (4): The work cycle matrix based on Activity.

A W	A ₁	A ₂	A ₃	.....	A _k
W ₁	a ₁₁	a ₁₂	a _{1j}	.....	a _{1k}
.
.
.
.
.
W _i	a _{ij}
.
.
.
.
.
W _n	a _{n1}	a _{n2}	a _{nj}	.....	a _{nk}

When $a_{ij} = 1$, it means that A_j is a activity of W_i . The sum of each line specifies the relevant activites with each work.

D- The Matrix of unit, Activity & Time:

This matrix shows the spended time for doing the activity. With the help of this matrix, it is possible to calculate the time of daily, monthly, and yearly activities of each unit. ($t_{ij} \geq 0$)

t_{ij} is the needed time for the activity A_j which is done by u_i .

Table (5): The matrix of unit, Activity & Time .

U \ A	A ₁	A ₂	A ₃	.....	A _k	Σ
u ₁	t ₁₁	t ₁₂	t ₁₃	.....	t _{1k}	T ₁
u ₂	t ₂₁	t ₂₂	t ₂₃	.....	t _{2k}	T ₂
U ₃	t ₃₁	t ₃₂	t ₃₃	.....	t _{3k}	T ₃
.
.
.
.
U _n	t _{n1}	t _{n2}	t _{n3}		t _{nk}	T _n

With the use of this matrix, each activity's graph can be drawn; then they will be analyzed for optimization. This is done in two ways:

- 1- Determining the subgraphs which are related to each graph.
- 2 – Designing a suitable algorithm for time minimizing. It is possible to determine the related subgraphs for each work cycle with specifying the parallel activities, critical lines, or eliminating some vertexes or edges.

Job Efficiency

The desired expectation of each unit's output based on the type of their duties is called Job Efficiency. Because of the qualitative nature of this subject, it can be considered as a Fuzzy amount. One of the suggested relations is as follows:

$$P = C \frac{A}{B}$$

In this relation, P is the amount of efficiency, C is the coefficient which is related to conditions, A is the number of performed activities, and B is the number of referred activities.

Order to design a suitable algorithm for minimizing the spending time of each unit,

$(0 \leq a_{ij} \leq 1)$ is considered as the efficiency index for that unit which will be multiplied by the measured time of each activity. The amount of a_{ij} has a contrary relation with the rate of efficiency that is determined by experts. [6]

Three Suggested Algorithms:

Now, three suitable algorithms for automatic calculating and also for optimization are designed as follows:

1- Time optimization Algorithm for work cycle:

1-1) Read the weight of edges which are related to the W_i work cycle graph (optimistic and pessimistic times)

2-1) Find the maximum weighted element in each case.

3-1) Determine the activity which is related to the maximum weight.

4-1) Calculate the sum of graph's weight in each case.

5-1) Calculate the time difference between optimistic and pessimistic times.

6-1) Calculate the optimized time through this equation:

$$t_{opt} = P_{ui} \cdot t_{Ai}$$

End.

2- Units' efficiency measurement Algorithm:

1-2) Calculate the sum of times of referred works.

2-2) Calculate the sum of times of performed works.

3-2) Calculate this ratio: $P = C \frac{A}{B}$

End.

3- The Algorithm of drawing related graph with activities cycle:

1-3) Draw the graph with the use of work / Activity matrix.

2-3) Read the edges' weight from the Activity / Time matrix.

3-3) Specify the activity with maximum time

End.

6 Conclusion and Suggestions

Preventing the waste time is one of the subjects in optimization; and in this article it was tried to study and examine this subject by suggesting a mathematical model and designing some algorithms. The purpose of this article was offering a model for preventing the waste of time in a supposed organization like university, so the units, activities and times of doing each activity were titled by use of mathematical symbols and then offered in form of tables and matrixes.

Based on this study and analysis, here are some suggestions offered for preventing the waste of time;

- 1- using automatic system and management software like Excel, Access, ...
- 2- Using Internet and Electronic Mail for judging projects.
- 3- Reducing time intervals of council meetings convening for decision making.
- 4- Qualitative and quantitative supervision and evaluation of activities by managers.

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