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ORGANIZATIONAL CHANGE, A MATHEMATICAL MODEL FOR THE OPTIMAL RESOURCES SHARING

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Abstract: *The main purpose of the paper is to present a mathematical model for the optimization for the sharing of resources in parallel running subprojects of organizational change projects. A few years ago it was said that in today's unstable, chaotic markets, the companies which are able to adapt faster to the environment will be able to draw apart from the competition and to get in front. Only a few years later it can be observed that it is not a question of getting ahead but more and more about survival – "Adapt or die", or as Daryl R. Conner puts it, the very core of success is in the midst of transition.*
Key words: *organization, change, management, mathematical model, strategy.*

1. INTRODUCTION

Due to the global economic context and to the markets in constant change we can say that we live uncertain times governed by turbulence and uncertainty, in which even with massive quantities of information it is very difficult to define the right organizational behavior able to guarantee survival.

Change is a word leaders or individuals who have leadership positions should get used to. Even if some prefer to use other terms instead they are talking about the same thing and it means that stability and equilibrium are no longer the prevalent conditions of our age. As Daryl Conner states "The very core of success is in the midst of transition". (Daryl R. Connor, 1998)

As the world grows more turbulent, organizations unable to execute critical change initiatives will find themselves at a great competitive disadvantage. Change can't be avoided anymore and it must be embraced. This is the only path for survival. For successful change the management model has to be tailored. Managers have to create new, nimble businesses capable of responding to the chaotic conditions produced by constant change.

Organizational change projects are very complex, high risk ones, as they have to approach all the dimensions of the organization usually at the same time. This means that such a project is comprised of many parallel threads or subprojects that must run in an optimal way, not to affect the others and the entire project. In this case an optimum sharing of the available resources is vital.

2. A MATHEMATICAL MODEL FOR OPTIMAL RESSOURCES SHARING IN PARALEL RUNNING PROJECTS

The way resources are assigned and shared over multiple sub projects of a main project is a highly discussed subject in the project management literature. This is one of the main aspects that could lead to the success or to the failure of projects. This is also the case in the organizational transformation projects. The difference consists in the fact that in case of a project, a failure will only impact the costs and duration of the project, while in the case of an organizational transformation project, a failure could destabilize the entire organization. This paper, proposes a mathematical model, adapted from Wiley (1998), for the optimal sharing of resources in multi - project program or in a project that has multiple parallel subtasks.

The model variables:

-c_{ij}: the number of resources that has to be added or taken off from task (i,j) in order to complete it;

-B_r: human resources program allocated budget;

-B_{rk}: human resources allocated budget for project k;

-I: the number of connections (i,j) of the program;

-I_k: the number of connections (i,j) of the project k;

-T_{ij}: the duration of task (i,j);

-y_{ij}: maximal number of time units on which task (i,j) is accelerated;

-z_{ij}: maximal number of time units on which task (i,j) is decelerated;

-E_{ij}^l: the number of type l human resources allocated to the task (i,j) before the acceleration or deceleration;

-h_l: the cost of the l type human resources per time unit and person under normal conditions;

-S_{ijl}: the cost per time unit of the type l human resources allocated to the task (i,j) for its acceleration;

-V_{ijl}: the cost per time unit of the type l human resources allocated to the task (i,j) for its deceleration;

-C_l: maximal amount of type l human resources available for the program;

-C_k^l: maximal amount of type l human resources available for project k;

Objective function:

$$Min\ z = \sum_i \sum_j \sum_l (S_{ijl} y_{ij} c_{ij}^l + V_{ijl} z_{ij} c_{ij}^l) \quad (1)$$

The minimization of the objective function has the following constraints:

Human resources budget:

$$\sum_i \sum_j \sum_l (h_l T_{ij} E_{ij}^l + S_{ijl} y_{ij} c_{ij}^l + V_{ijl} z_{ij} c_{ij}^l) \quad (2)$$

- In the most restrictive case:

$$B_r = \sum_i \sum_j \sum_l h_l T_{ij} E_{ij}^l \quad (2.1)$$

- In the less restrictive case:

$$B_r \geq \sum_i \sum_j \sum_l h_l T_{ij} E_{ij}^l \quad (2.2)$$

Maximal number of type l human resources available for the program:

$$\sum_i \sum_j (E_{ij}^l \pm c_{ij}^l) \leq C^l \quad (3)$$

+ if task (i,j) can be only accelerated

- if task (i,j) can be only decelerated

- In the most restrictive case:

$$C^l = \sum_i \sum_j E_{ij}^l \quad (3.1)$$

The human resources extracted from the decelerated tasks are allocated for the acceleration of the others and: $\sum_i \sum_j \sum_l \pm c_{ij}^l = 0$

- In the less restrictive case:

$$C^l \geq \sum_i \sum_j E_{ij}^l \quad (3.2)$$

The human resources extracted from the decelerated tasks and the resources allocated for the acceleration of the others are not specifically the same and: $\sum_i \sum_j \sum_l \pm c_{ij}^l \geq 0$

Human resources budget for project k:

$$\sum_i \sum_j \sum_l (h_l T_{ij} E_{ij}^l + S_{ijl} y_{ij} c_{ij}^l - V_{ijl} z_{ij} c_{ij}^l) \quad (4)$$

- In the most restrictive case:

$$B_{rk} = \sum_i \sum_j \sum_l h_l T_{ij} E_{ij}^l \quad (4.1)$$

- In the less restrictive case:

$$B_{rk} \geq \sum_i \sum_j \sum_l h_l T_{ij} E_{ij}^l \quad (4.2)$$

Maximum number of type l human resources available in project k:

$$\sum_i \sum_j (E_{ij}^l \pm c_{ij}^l) \leq C_k^l \quad (5)$$

+ if task (i,j) can be only accelerated

- if task (i,j) can be only decelerated

- In the most restrictive case:

$$C_k^l = \sum_i \sum_j E_{ij}^l \quad (5.1)$$

The human resources extracted from the decelerated tasks are allocated for the acceleration of the others and:

$$\sum_i \sum_j \sum_l \pm c_{ij}^l = 0 \quad (5.1.1)$$

- In the less restrictive case:

$$C_k^l \geq \sum_i \sum_j E_{ij}^l \quad (5.2)$$

The human resources extracted from the decelerated tasks and the resources allocated for the acceleration of the others are not specifically the same and:

$$\sum_i \sum_j \sum_l \pm c_{ij}^l \geq 0 \quad (5.2.1)$$

The bottom limit value of c_{ij}^l for the acceleration of the task (i,j)

$$\frac{y_{ij}}{T_{ij}} E_{ij}^l \leq c_{ij}^l \quad (6)$$

The top limit value of c_{ij}^l for the deceleration of the task (i,j)

If z_{ij} is lower than T_{ij} the following constraint is to be considered:

$$c_{ij}^l \leq \frac{z_{ij}}{T_{ij}} (E_{ij}^l - 1) \quad (7.1)$$

If z_{ij} is higher than T_{ij} the following constraint is to be considered:

$$c_{ij}^l \leq \frac{T_{ij}}{z_{ij}} (E_{ij}^l - 1) \quad (7.2)$$

Non negativity:

$$c_{ij}^l \geq 0 \quad (8)$$

3. MODEL APPLICATION

A program containing two projects, A and B is considered. Each project has more successive phases. The conceptual diagram of the program is presented in Figure 1. Both projects have the same end date. It is assumed that that each phase, task, starts as early as possible. In the diagram in Figure 1, the arrows (arcs) are the tasks and the nodes are the start and the end dates of each phase of the project. Critical tasks are marked by a strong line and the nodes are numbered.

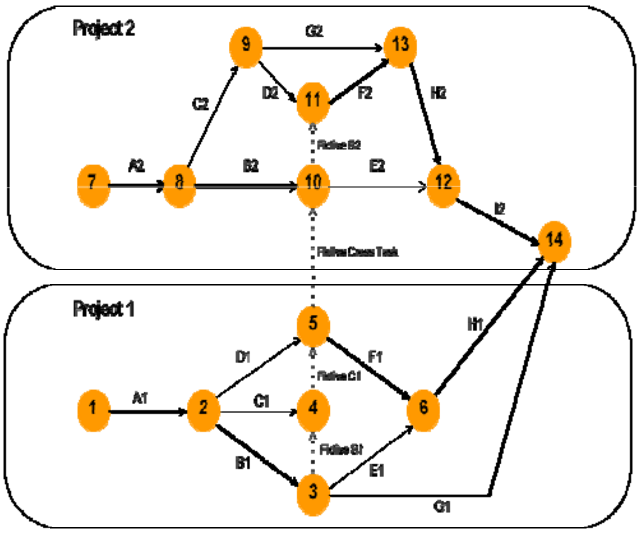

Fig. 1. Project Diagram

The characteristics of the projects are presented in Tables 1, 2 and 3. Only the model relevant data will be presented.

4. CONCLUSIONS

The resources allocation in multi – project management is a real challenge, as a result of the interaction between time and resources involved in the program. Because of this, an optimal sharing of these resources could facilitate the concurrent advantage of the organization, in the today's chaotic markets. This article presents a mathematical model for the optimal planning of the resources. The model allows also the optimization of the additional costs and a maximization of the winning through the deceleration of some of the subprojects.

The above presented model only addresses the human resources but it can be further extended.

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Table 1 - Program Parameters (Adapted from Wiley, 1998)

HR Types	Type 1	Type 2	Type 3
Maximal quantity of human resource (type l) available on the program [person]	60	81	166
Cost of type l HR ressource (h_l) / day	240	120	80
Costs of added type l human resource, in case of acceleration /day (S_{ijl})	360	180	120
Costs of withdrawn type l human resource, in case of deceleration /day (V_{ijl})	180	90	60
Program budget dedicated to human resources funding $B_{r1}+B_{r2}=B_r$	53900€ +77280€ = 131180€		

Table 2 - Project 1 Parameters (Adapted from Wiley, 1998)

Name	Task (i,j)	Predec.	Normal Duration T_{ij} [days]	Final Durations $T_{ij}-y_{ij}+z_{ij}$	Normal Cost D_{ij} [€]	Hum. Res. of type 1, E_{ij}^1 [persons]	Hum. Res. of type 2, E_{ij}^2 [persons]	Hum. Res. of type 3, E_{ij}^3 [persons]
A_1	**12**	**--**	**2**	**1**	**3000**	**1**	**2**	**4**
B_1	**23**	**A_1**	**7**	**7**	**10800**	**2**	**3**	**6**
C_1	24	A_1	4	6	4800	3	1	2
D_1	25	A_1	2	6	2400	1	2	6
E_1	36	B_1	4	4	6000	3	2	4
F_1	**56**	**B_1, C_1, D_1**	**6**	**5**	**16000**	**2**	**2**	**4**
G_1	324	B_1	3	5	2400	1	1	2
H_1	**624**	**E_1, F_1**	**2**	**2**	**12000**	**4**	**6**	**12**
			Critical Duration 17	New Critical Duration 15	57400 [€]			

Table 3 - Project 2 Parameters (Adapted from Wiley, 1998)

Name	Task (i,j)	Predec.	Normal Duration T_{ij} [days]	Final Durations $T_{ij}-y_{ij}+z_{ij}$	Normal Cost D_{ij} [€]	Hum. Res. of type 1, E_{ij}^1 [persons]	Hum. Res. of type 2, E_{ij}^2 [persons]	Hum. Res. of type 3, E_{ij}^3 [persons]
A_2	**78**	**--**	**3**	**3**	**16000**	**2**	**4**	**8**
B_2	**810**	**A_2**	**8**	**7**	**20000**	**2**	**4**	**8**
C_2	89	A_2	3	3	4000	1	2	4
D_2	911	C_2	1	2	1000	1	1	2
E_2	1012	B_2	3	4	12000	2	4	8

F_2	**1113**	**B_2, D_2**	**5**	**5**	**20000**	**2**	**5**	**12**
G_2	913	C_2	2	3	1000	0	1	2
H_2	**1312**	**G_2, F_2**	**3**	**1**	**1200**	**1**	**0**	**1**
I_2	**1224**	**E_2, H_2**	**2**	**1**	**1000**	**1**	**1**	**1**
			Critical Duration 21	New Critical Duration 17	76200 [€]			

Schimbarea organizationala, un model matematic pentru partajarea optima a resurselor

Scopul acestei lucrari este acela de a prezenta un model mathematic pentru optimizarea partajarii resurselor, in cadrul proiectelor de schimbare organizationala care ruleaza in paralel. Cu cativa ani in urma, obisnuia sa se spuna ca in pietele economice actuale, piete atat de instabile si haotice, companiile care se adapteaza mai repede mediului vor fi cele care se vor detasa de concurenta. In prezent se observa ca nu este vorba de detasare, ci despre supravietuire. “Adapteaza-te sau mori”, sau asa cum Daryl R. Conner spune, succesul se gaseste in ceata schimbarii.

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