MODEL FOR OPTIMIZING THE FINANCIAL RESOURCES ALLOCATION IN PROJECT MANAGEMENT USING DEPENDENCY STRUCTURE MATRIX (DSM)

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Abstract
Optimizing the resources allocation is one of the most essential aspects in a project management. Any financer or donor requires efficiency in using their funds. The paper outlines the possibility to use Dependence Structure Matrix (DSM) in the project financial management, in order to optimise the financial resources allocation between activity packages, during the project implementation, by focusing on higher risks areas. The effectiveness of the proposed tool was validated by its application to an illustrative example dealing with project resources allocation problem.
Key words: project management, financial resource allocation and optimization
JEL Classification: C 61, D81, D 82

1. Introduction

The project management process encounters a decisional process of project organizing and supervising aiming at achieving all as it was planned in terms of outputs, time and costs (*Neagu*, 2010).

In order to reveal the risks encountered in the project implementation process, there is an important need to detect the areas where the project manager should pay higher attention, as there are higher risks associated with it. As a fact, the resources allocation is mainly influenced by identifying the potential risk areas in the implementation process. An appropriate tool to realize this allocation can be the use of dependency structure matrix tool.

The Dependency Structure Matrix (DSM) also referred to as design structure matrix, dependency structure method, dependency source matrix, problem solving matrix (PSM), dependency map or design precedence matrix is a visual representation of a system or project in the form of matrix.

It is a tool used in systems engineering and project management to model the structure of complex systems or processes, in order to perform system analysis, project planning and organization design. The method was developed by Steward D. (1981) and applied for design engineering process.

DSM is an effective tool to display the dependency relationship. A DSM can represent system architecture in terms of the relationships between its constituent

components (*Tyson*, 2001).
The DSM has been widely used in product development, system engineering and organizational design (*Chen et al.*, 2003), as a powerful tool in planning the activity sequences by representing the feedback loops and also in identifying and managing information exchanges (*Yassine et al.*, 1999; *Eppinger et al.*, 1994 and 2008).
DSM provides a systematic mapping among design components (*Steward*, 1981; *Yassine*, 2004; *Eppinger et al.*, 2008) and it can be used to generate and analyse decision alternatives.
The DSM concept was applied in various design domains such as: construction (*Austin et al.*, 1996; *Maheswari et al.*, 2006), manufacturing (*Eppinger et al.*, 1994; *Tang et al.*, 2000), aerospace (*Rogers and Salas*, 1999; *English et al.*, 2001) or automotive (*Krishnan*, 1993).

2. Methodology

DSM is a matrix representation of a graph (Figure 1), revealing the connections between activities. The components of a graph are: vertices (nodes) and edges. Nodes may or may not have a weight and the edges may or may not have directions and/or costs. If there is an arrow with edge from A to B this means that activity A is an input for activity B.

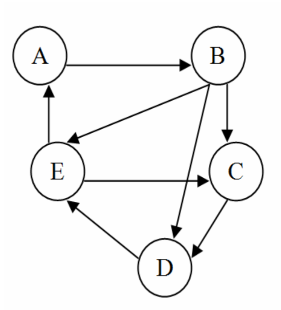

Figure 1. A graph example

	A	B	C	D	E
A		x			
B			x	x	x
C				x	
D					x
E	x		x		

Figure 2. DSM matrix

The vertices of the graph, representing the components in a complex system, correspond to the column and row headings in the matrix (*Eppinger et al.*, 1994; *Yassine et al.*, 2003) as it is shown in the Figure 2. The arrows, representing relationships between components, correspond to the x marks inside the matrix. The diagonal cells generally have no value but the duration for each activity can be included. The activities have to be read along the columns as "gives information to" (or "inputs for") and along the rows as "needs information from" (or "outputs from").

The paper uses data from the project "The impact of the human capital quality on the social and economic cohesion in the border area" financed by European Union through Hungary-Romania Cross-border Cooperation Programme 2007-2013, under European Regional Development Fund. The significant project activity packages (AP) are: AP1 Project management, AP 2 Communication Activities, AP 3 Research activities AP 4 Cross border forum for companies from the border area, AP 5 Cross border job fair for companies and people from the border area.

The soft used for this paper was Project DSM Tool (www.projectdsm.com).

Taking into considerations the connections between activity packages as information exchange, the project graph is presented in figure 3.

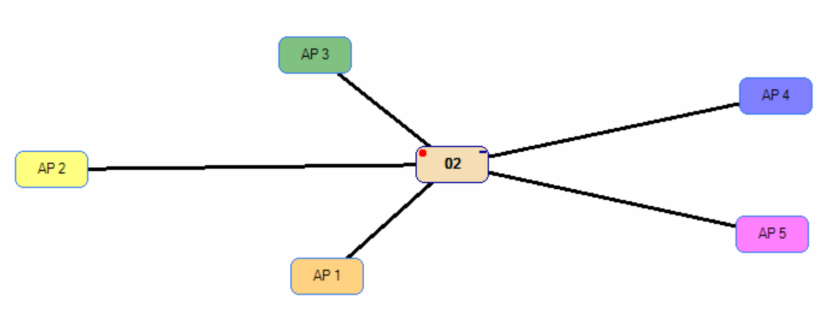

Figure 3. The project graph
Source: Export from Project DSM Tool

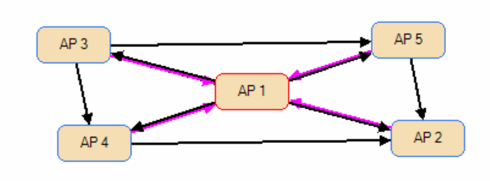

Figure 4. The project dependencies map
Source: Export from Project DSM Tool

In the project implementation the following dependencies were identified (Figure 4):

- AP 1 is depending on AP 2, AP 3, AP 4, and AP 5;

- AP 2 is depending on AP 1, AP 3, AP 4, and AP 5;
- AP 3 is depending on AP 1;
- AP 4 is depending on AP 1 and AP 3;
- AP 5 is depending on AP 1 and AP 3.

According to the dependencies map the DSM matrix is generated (Figure 5):

#	Task	1	2	3	4	5
1	AP 1	●	●	●	●	●
2	AP 3	●	●	□	□	□
3	AP 4	●	●	●	□	□
4	AP 5	●	●	□	●	□
5	AP 2	●	●	●	●	●

Figure 5. DSM Matrix
Source: Export from Project DSM Tool

According to figure 5, the project manager has to consider AP1 for further testing due to the fact that is the most complex activity on which are depending all other activity packages.

Name	Sequence	Description	Effort (days)	Total Cost	Duration (days)
AP 1	1	Project management	720	59940	720
AP 3	2	Research activities	1440	178380	1440
AP 5	3	Cross border jobfair	10	7200	10
AP 4	4	Cross border forum	10	6700	10
AP 2	5	Communication Activities	90	12800	90

Figure 6. Defining resources and expenses in the Project DSM Tool
Source: Export from Project DSM Tool

For each activity package, we defined human resources (project manager, financial manager, research experts) and expenses (external services, equipment and administrative). For instance, for Project management, the project manager work 720 hours, with an hourly cost of 30 $ and administrative cost in amount of 1500 $. The results are displayed in Figure 6.

3. Results and discussion

Based on the data input above, we obtained the following results in the Project DSM Tool: DSM matrix (Figure 5) and combined resource allocation assessments (Figure 7).

The DSM matrix shows the areas with potential high risk of material misstatements based on dependencies between activity packages as described in the previous section. We noticed three areas with potential higher risk that should be considered when planning the financial resources and project activities: the first row, the first and the second column.

We notice as well, that the most complex activity is AP 1 Project management, on which depend all other activity packages and all of them are, in return, inputs for AP 1. It means that, during the project implementation, AP 1 collect feed-back from all other activities (as costs, resources and outcomes) and use them to make decisions and inputs for all other activity packages.

The combined resource allocation table (Figure 7) shows the total allocated resources and costs considering the dependencies described in the previous section for AP 1 (firs row of DSM matrix) and a rework for costs optimizing. The possible actions are ranked by their potential to minimize the rework cost and a higher score means a smaller rework cost. Thus, it will be optimal if we simplify the dependence of AP 3 Research activities on AP 1 Project management activities.

Score	Action	Complexity	Costs	Efforts
69	Simply: AP 3 depends on AP 1	36	69	63,4
69	Promote element 3: AP 3	36	69	63,4
19	Promote element 1: AP 1	96	76,8	68,3
17	Delay element 1: AP 1	36	69	63,4
8	Delay element 3: AP 3	96	31	36,6
5	Simplify: AP 2 depends on AP 1	36	5	4
5	Delay element 2: AP 2	36	5	4
1	Delay element 4: AP 4	36	2,6	0,4
1	Promote element 4: AP 4	36	2,6	0,4
1	Promote element 2: AP 2	36	5	4
0	Delay element 5: Ap 5	36	0,2	0,4

Figure 7. Combined resources allocation
Source: Export from Project DSM Tool

This type of analysis can help the management team to choose the most efficient allocation of resource while covering all significant risks of misstatement.

6. Conclusions

Optimizing of resources allocation is one of the most essential aspects in a project management and a requirement of project efficiency during planning and implementation requested by any financer or donor for their financial support.

As shown in this paper, DSM can provide useful information in detecting risk areas in significant activity packages of a project and options for costs minimizing.
DSM matrix is recommended in the planning phase of a project in order to avoid redundancies in the implementation phase.

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