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The importance of logic planning in case of IT and innovation projects

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Abstract: In case of using methodology of project planning, in the first step we had to create a "good" logic network. We had to determine the successors and predecessors of the tasks. However, usually successors and predecessors proceed from the technology, sometimes (especially in case of IT and innovation projects) these relations between tasks are not explicit.
In case of projects, especially IT and innovation projects, one of the most critical points of view is the phase of logic planning. However, it is a very important phase, only slightly supported by any kind of Project Management tools. Our goal was to support the logic planning phase. In our paper a new planning method, namely SNPM (Stochastic Network Planning Method) is introduced through some practical applications. SNPM can determine all feasible solutions with the help of stochastic variables and can also take into consideration all possible precedents. The parameters of logic relations can be changed if the impacts on the project change. With this method the most probable project scenario can be determined taking into account costs and resource demands.

Key words: Stochastic Network Planning Method, Project Expert Matrix, logic planning of IT projects

1. Introduction

IT projects play an important role in businesses; however their time and cost demands are very high. (*Szabó*, 2006) As a result of stochastic characteristics of IT projects, the planning phase has high priority. (*Dawson,* 1998)

There is an important difference between construction and IT projects. In case of IT projects certain task sequences can be repeated and reversed. According to the specialties of IT and innovation projects, the classic project scheduling techniques cannot be used exactly, because sometimes the sequences of the tasks cannot be determined. Therefore simple AoA and AoN project networks are not the best methods for modeling these projects.

A typical IT project could be the introduction and installation of an ERP system which could be a large project. (*Yusuf,* 2004) If the parent company intends to introduce the selected system at its subsidiaries the experiences of earlier installations can be used in the new introductions. Previously it was hardly possible to use the experiences of earlier installations. Although project templates could be reused it was not a great solution, since every implementation differs from each other. Instead of storing complete project templates it is more useful to store relations between various tasks. This paper aims to solve above mentioned problems with the help of a new method.

IT projects can be approached from two directions. On the one hand the process of software development can be regarded as a project. There are several models to plan software development. The oldest is the waterfall model, which is very inflexible, since there is a lack of feedback. The agile program planning and extreme programming are becoming more and more popular.

On the other hand there are the procurers and users. A typical example of an IT project is the introduction of an ERP system. The task sequence of the introduction can be regarded as a project. Although in case of more introductions following each other at different subsidiaries they are rather regarded as processes. (The practical example relates to an ERP system introduction, so details are not provided here.)

A software developing process has six phases: analysis, specification, planning, implementation, testing and installation. All program development models contain these phases. There are two kind of marginal cases: the unique and the standard software introduction and development. The difference between them is, that the analysis is realized on different sides and in case of a standard software the planning and implementation phase can be drawn together and replaced by configuration.

For example at a spiral model the process of development runs again and again. Closing down each cycle the planning phase will start again to develop the software, to correct the errors, as a result of new demand. These activities assure the continuous compliance of the software.

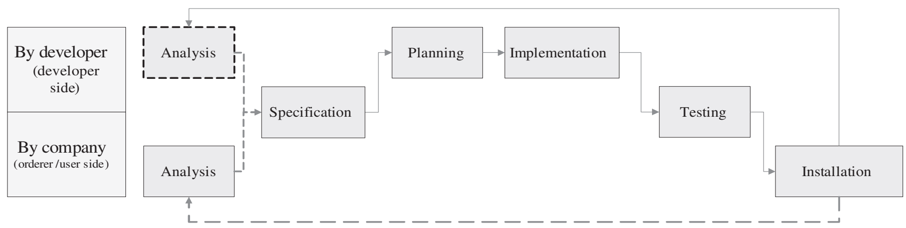


Figure 1: The process of software development with spiral model

It can be seen on *Figure 1* that on the developer side it is not certain whether an analysis need to be completed or not, so that it is illustrated by dashed lines. Between some of the phases the relation is represented by dashed lines, it refers to an uncertain relation. The classic AoN project planning techniques cannot be suitable to depict such a logic plan, because they cannot handle the possible solutions and possible relations between two tasks. GERT and eEPC are suitable to handle the selection between tasks, branches and interconnections, but they cannot handle possible relations. In the course of our research a method was developed which can solve these problems. In this paper we concentrate on handling of uncertain relations. Later research will focus on handling of possible circles on project network.

2. Materials and Methods

In case of IT projects it is practical to handle possible project structures on the level of relations. Therefore it is important to make a distinction between certain and uncertain relations. In case of certain relations tasks have successors and predecessors, and the order of tasks is determined (in our method we use probability value 1 to describe certain relations). In case of uncertain or possible relations two tasks can follow each other, but it is not certain that there is relation between them. The intensity of relation in case of possible relations is between probability 0 and 1. There are some important questions to consider. For example: how can the intensity of relation be determined, how can possible solutions be determined and how can the best solution be selected from these with a quick method? Our method described below gives answers to these questions.

2.1 Supporting logic planning with matrix methods

It is an easy way of planning and scheduling projects and processes using adjacency matrices. **DSM** (Dependency Structure Matrix) serves to plan the order of tasks. The great advantage of the matrix method is the consistency and the easy review independent from the size and the relations between tasks. The matrix is a useful tool of planning tasks' order. (*Maheswari,* 2005) It provided the idea of making the Stochastic Network Planning Method (**SNPM**). The advantage of SNPM is that this method can identify the feasible solutions while taking into consideration the intensity of relation between tasks. The probability variables of the intensity of relation between the tasks show the preferences of the decision makers. But this model with some restrictions can also use the management preferences. The SNPM can determine all feasible solutions with the help of stochastic variables and taking into consideration all possible precedents. (*Kosztyán,* 2008)

2.2 Representation of SNPM – finding possible solutions

The inputs of the method are the logic plans derived from experts or from earlier experiments, which can be indicated by different techniques (like CPM, MPM, PERT, GERT, eEPC – on *Figure 2*). (*Stoop,* 1996) (*Fatemi Ghomi,* 2003) (*Pritsker,* 1966) (*Scheer,* 2000) (*Van der Aalst,* 1999)

Relation matrices can be made taking into account each possible logic plans. The intensity of relations could be a (weighted) average of every possible project scenario, which was taken as adjacent matrices. In this way the earlier experiences of success projects can be taken into account.

2.3 The improved method – handling logic plans

The SNPM, showed earlier, can give and represent all possible solutions taking into account the restrictions; moreover it is possible to select the optimal solution from the feasible solutions according to a target function (like minimal duration time, minimal cost demands etc.).

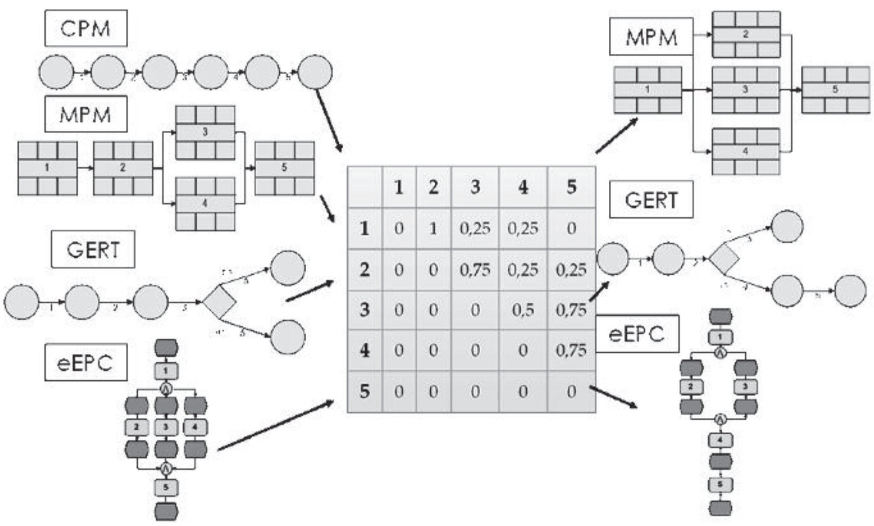


Figure 2: Representation of SNPM

Table 1: Relation matrix

$SNPM_k$	A_1	...	A_i	...	A_n
A_1	0				
⋮		0			
A_i			0		
⋮				0	
A_n					0

Table 2: Modified relation matrix

PEM_k	A_1	...	A_i	...	A_n
A_1	δ_1				
⋮		⋱			
A_i			δ_i		
⋮				⋱	
A_n					δ_n

Our method can summarize more input logic plans, which can derived from earlier experiences or from experts. So probabilities can be objective or subjective. The intensity of relations determined by experts could be handled as a vote of these experts.

If we take some possible project scenarios, there could be some tasks, which is not in every possible project scenario. SNPM could not handle this problem so we had to improve our method. In order to handle this problem we can determine the modified relation matrix, where the diagonal represents the occurrence of tasks in the input project plans. (For example, if the given task can be found in all project scenarios, the value is 1.) The values of **PEM** (Project Expert Matrix) are the averages of the probabilities in the cells of the modified relation matrix, also included in the average of the probabilities in the diagonal.

After representing all possible relations in SNPM or in PEM matrices, the next phase is to represent all possible solutions in a representation graph, and from this the most probable solution can be determined. The SNPM can give and represent all possible solutions according to restrictions; moreover it is possible to choose the optimal solution according to a determined target function.

Henceforward, we summarize the steps of the algorithm method which is the base of our research, and after that we detail the usage of the method. Our method can find good solution relatively quick, because it proceeds from all possible solutions and it searches logic nets with the most possible occurrence probabilities.

2.4 Details of the method

Logic planning is difficult, because it is hard to predict the tasks, the order of tasks, successors and predecessors, durations, cost and resource data. It is true especially in case of stochastic time projects and processes, eg. IT projects.

If there are lots of uncertain factors in the course of planning, practically more experts are requested to make logic plans. It is possible to determine the optimal logic plan from the different plans, so it is already a good estimation of the expected duration of the project and process.

Experts can make their plans with using of different techniques and methods. Plans have to handle as AoN nets, which show the logic structures.

Depending on that all plans given by the experts include all tasks or not, relation matrices (SNPM – $\delta = 0 \iota = j$) or modified relation matrices (PEM – $\delta(A_i, A_i) \in [0,1]$) are made to all logic plans.

The number of experts: $k=1,2,\ldots,m$, kN.

The average of the probabilities by cells in the relation matrix gives the intensity of relation between two tasks, and in the diagonal it is the occurrence of the tasks in the logic plans. The average values are depicted in averaged relation matrix or in project expert matrix.

Count of occurrence probability:

– **In case of SNPM:** it is the product of the intensity of relation of tasks, which are in the logic plan and the negated probabilities of tasks (it means the probability multiple –1), which are not in the logic plan.

– **In case of PEM:** it is a complex product, which concludes three components. One of them is the product of the probabilities of the diagonals in case of the logic net included in the tasks. The second part is the product of opposite probability of tasks, which are not in the logic plan. The third component is the product of the weights of the edges (intensity of relation) of the graph.

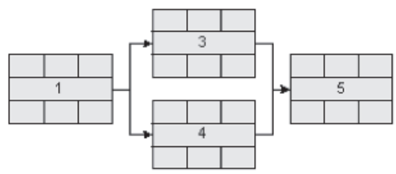
On the basis of the averaged relation matrix or PEM the representation graph is drawn up, which includes in all possible relations between tasks. The graph edges show the intensity of relation between tasks.

Finally from the representation graph the optimal solution(s) have to be chosen on the basis of occurrence probability. All tasks have to be in the solution, because the graph is built up according to the most probable relations. To solve the minimal cost spanning tree problem, (where the cost could be the logarithmic values of 1-probabilities of relations) the Kruskal can be used. After using any kind of MST algorithm, we received a directed acyclic graph, where product of probabilities is maximal. The only disadvantage of this method is this tree could have more than one source (initial activity), and more than one sink (finish activity). This problem can be handled, if we use virtual tasks as start and finish point, or use relations (where intensity of relation is under 0,5) to give project net (directed acyclic graph with only one source and only one sink).

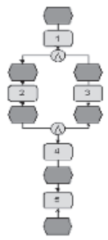
A simple exercise is shown on Table 3 according to the exercise of representation (on *Figure 2*) to the usage of these methods. The activity 2 is left from the MPM, so PEM has to be used.

The relation matrices were made on the basis of the logic plans in *Table 3*. **Table 4** shows the Project Expert Matrix, which includes in the average of relation matrices.

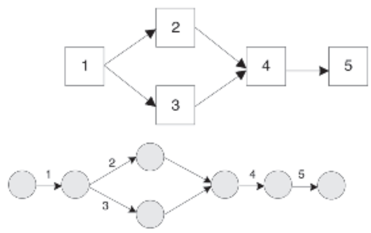
Table 3: Logic plans and their relation matrices



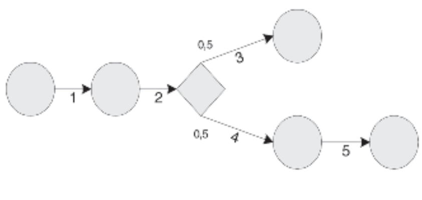
MPM 1m	1	2	3	4	5
1	1	0	1	1	0
2	0	0	0	0	0
3	0	0	1	0	1
4	0	0	0	1	1
5	0	0	0	0	1



eEPC 1	1	2	3	4	5
1	1	1	1	1	0
2	0	1	0	0	1
3	0	0	1	0	1
4	0	0	0	1	1
5	0	0	0	0	1



CPM1	1	2	3	4	5
1	1	1	0	0	0
2	0	1	1	0	0
3	0	0	1	1	0
4	0	0	0	1	1
5	0	0	0	0	1



GERT 1	1	2	3	4	5
1	1	1	0	0	0
2	0	1	1	0	0
3	0	0	1	1	1
4	0	0	0	0,5	0
5	0	0	0	0	0,5

The representation graph (on *Figure 3*) contains all possible relation including in the averaged relation matrix.

Optimal solutions can be selected from representation graph with the help of Kruskal algorithm (in *Table 5*).

Table 4: Project Expert Matrix

PEM	1	2	3	4	5
1	1	0,750	0,500	0,500	0,000
2	0,000	0,75	0,500	0,000	0,250
3	0,000	0,000	1	0,500	0,750
4	0,000	0,000	0,000	0,9	0,750
5	0,000	0,000	0,000	0,000	0,9

3. Results and discussion

A practical exercise to an ERP introduction

By a company group an ERP system is introduced following a roll-out strategy firstly by a subsidiary. Before the actual introduction a pilot version is introduced, but the tasks are nearly the same in both introductions. As an example the series of tasks are presented, which have to be completed in the pilot version. In case of two task packages (2.3 and 2.5) tasks have to be carry out in a given period of time, but they can be realized earlier. Hencefor-ward, we show the completing plans of the task package 2.3. Planning serial and parallel and in a possible executing order are represented in Gantt diagrams and in their relation matrices (in *Table 6).*

After that the average of the probabilities of the three possible solutions gives the averaged relation matrix (in Table 7).

On the base of the averaged relation matrix we can draw up the representation graph which shows all the possible relations between tasks (on Figure 4). From these we can choose the optimal solution(s) according to the occurrence probabilities.

To execute an IT project successfully it is necessary to plan the project accurately. But the classic methods were not developed for these projects, so they cannot be used properly. Project planning methods are not applied in many cases so probability of unsuccessful projects is increasing. The reason for this is that the planned project time, cost and resources are exceeded.

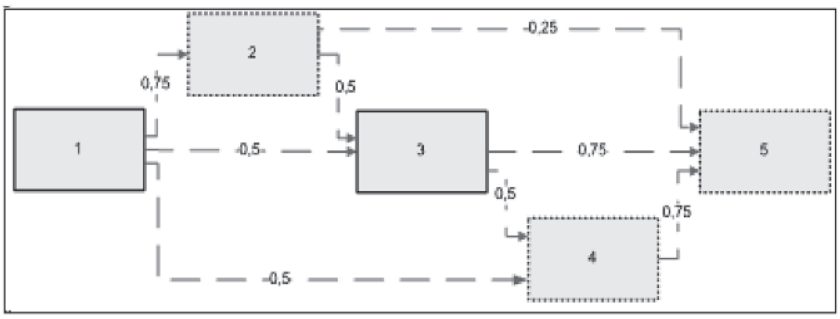


Figure 3: The representation graph of PEM

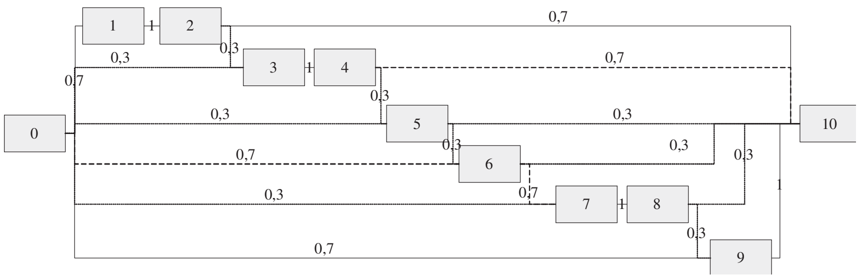


Figure 4: The representation graph of the example

Table 5: Optimal solutions

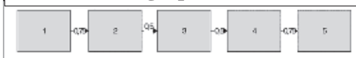
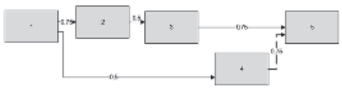
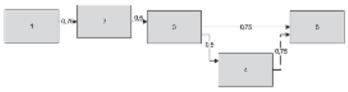
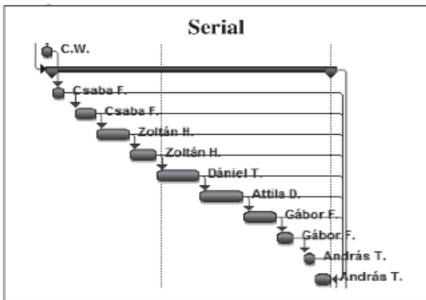
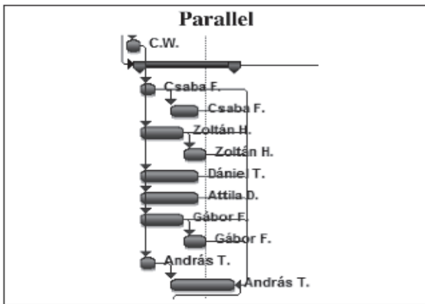
Logic plan	Occurrence probability (P)
	P = (0,75*0,9*0,9)*0,75*0,5*0,5*0,75 = **0,08543**
	P = (0,75*0,9*0,9)*0,75*0,5*0,75*0,5**0,75 **=0,0640**
	P = (0,75*0,9*0,9)*0,75*0,5*0,5*0,75**0,75 **=0,0640**

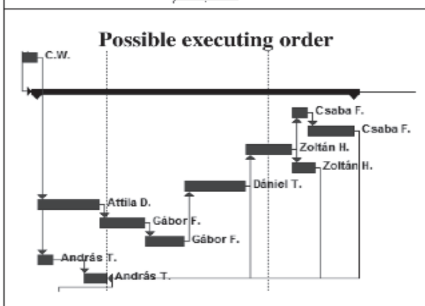
Table 6: The possible executing ways of the task package 2.3.



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



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



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

The goal of our research has been to develop a new method, which is suitable to support the logic planning, which depict the relation between tasks. Our method can determine all possible solutions, but it represents a great combinatorial problem, because it can be 2^k solutions (where k means the number of the relations between tasks). With our method the number of possible solution are restricted, because starting from the representation graph we choose the solutions with the greatest occurrence probability. From these we can choose the optimal solution according to a given target function. The optimal solution can be easily estimated by the summary of expert opinions or previous experiences.

SNPM and PEM can be the base of an expert or decision support system in the future. Such a system can be a useful help for the company experts and project managers especially in case of IT projects which contain great uncertainty. Through this method the experiments of the earlier, similar projects and processes will be usable to increase the success and effectiveness of the execution of later projects and processes (shorter duration, less cost, optimal use of resources, etc.)

The experiences about the realization of the project can modify the intensity of the relation, and this way the number of feasible nets can be modified. Logic net can be used or reused not only as a project template, but also indicating the intensity of the relation and this way all alternative solutions can also be determined. Besides finding the relevant logic plan and determining the durations of tasks, the cost and resource demands (e.g. minimal total cost and minimal total project time, etc.) can be useful to find the best project plan. This method can even help the project manager to rank the feasible solutions sorted by TPT, total cost etc, and find the most probable project scenario.

Acknowledgements

The authors would like to thank Polák-Weldon Réka for her support.

Table 7: Averaged relation matrix of the task package 2.3.

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

References

Dawson, RJ. – Dawson, CW. (1998): *"Practical proposals for managing uncertainty and risk in project planning,"* International Journal of Project Management, Vol. 16, No. 5, pp. 299–310, ISSN 0263–7863

Fatemi Ghomi, SMT. – Rabbani, M. (2003): *"A new structural mechanism for reducibility of stochastic PERT networks,"* European Journal of Operational Reseedgeh, Vol. 145. pp. 394–402,

Kosztyán Zsolt Tibor, Dr. – Fejes János – Kiss Judit (2008): *Sztochasztikus hálóstruktúrák kezelése projektütemezési feladatokban*, Szigma XXXIX. pp. 85–103.

Kosztyán Zsolt Tibor, Dr. – Kiss Judit: *Stochastic Network Planning Method*, International Joint Conference on Computer, Information and System Sciences and Engineering, Conference: 5-13 december 2008.

Maheswari, J. Uma – Varghese, Koshy (2005): *Project Scheduling using Dependency Structure Matrix,* International Journal of Project Management, ISSN: 0263-7863,Volume 23, Issue 3, April 2005, Pages 223–230

Pritsker, A.A.B. – Happ, W.W. (1966): *"GERT: Graphical Evaluation and Review Technique,"* The Journal of Industrial Engineering,

Scheer, August-Wilhelm (2000): *ARIS – Business Process Modelling*, Springer-Verlag Berlin, ISBN 3-540-65835-1 3rd edition,

Stoop, PPM. – Wiers, VCS. (1996): *"The complexity of scheduling in practice,"* International Journal of Operations & Production Management, Vol. 16. No. 10., pp. 37–53. © MCB University Press, 0144-3577

Szabó Lajos, Dr. – Gaál Zoltán, Dr. (2006): *"Project Success and Project Excellence, Sharing Knowledge and Success for the Future,"* Congress reports of 18th EUROMAINTENANCE 2006, 3rd WORLDCONGRESS of MAINTENANCE. Basle / Switzerland, pp. 194–198

van der Aalst, W. M. P. (1999): *Formalization and verification of event-driven process chains*, Information and Software Technology, ISSN: 0950-5849, Volume 41, Issue 10, 15 July 1999, Pages 639–650

Yusuf, Yahaya, Gunasekaran, A. – Abthorpe, Mark S. (2004): *Enterprise information systems project implementation: A case study of ERP in Rolls-Royce*, International Journal of Production Economics, ISSN: 0925-5273, Volume 87, Issue 3, 18 February 2004, Pages 251–266