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PLANNING THE STAGES OF A LICENSE (BACHELOR) / MASTER THESIS WITH CLASSICAL METHODS OF GRAPH THEORY

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Abstract: This paper describes the process of planning the realization stages of a research thesis (license/master) and classical methods of graph theory are applied to the proposed ones. It is proposed a project model for planning the stages of realization of a thesis by using project management concepts, taking into account the requirements of the guide for the elaboration of a license/master thesis and methods of planning in applied mathematics (the Graph theory). In this paper the solution of the proposed problem was determined by the following methods: Gantt, Critical Path Method and PERT. It is advisable to run the research work for each method and the differences between methods.

Keywords: Project, CPM, PERT, the earliest time, the latest time, critical path, critical events, probability factor.

UDC:378.2

The license (bachelor)/ master thesis is a research project, conducted by students or master students at the end of their studies. The paper represents the results of the candidate's skills and abilities during the years of study, being developed and applied using scientific research methods and intellectual capabilities.

Developing a license or master thesis is a difficult process when if it is not planned. It is very important to make a correct and clear planning in order to achieve the main purpose, the realization of a scientific research finalizing with a scientific work.

The failure to plan a license/master thesis project leads to an unpleasant end, the reason for not planning being the following : I do not have time; I have to finish the sentence faster, etc. If there is no plan there is no control of the stages of the plan.

It is proposed a project model for planning the stages of realization of a license/master thesis using project management concepts, taking into account the requirements of the guide for the elaboration of a license/master thesis and methods of planning in applied mathematics (graph theory).

Many economic situations involve the application of applied mathematics, namely the concepts of graph theories in project management. Not many economic activities can be accomplished without mathematical calculating tools.

A project is a work consisting of several activities that are carried out once and which has some established terms of initiation and financing, on a well-defined work area, a budget and a temporary team that will be dismantled when the work is over. All projects are limited by some performance, time, cost and domain requirements [4, p.26].

The phase of designing and implementing a project are [4, p.21; 14]:

- 1. The initiation phase is the beginning of the project. In this phase, the idea for the project is explored and elaborated. Concept of the project. Marketing's contribution and competence study.
- 2. Identify and define the project's problem. Development of a vision. Formation of the mission. In this phase, the requirements that are associated with a project result are specified as clearly as possible.
- 3. Project planning. Strategy development, implementation planning, risk control. In the design phase, one or more designs are developed, with which the project result can apparently be achieved.
- 4. Implementation and execution of the project. Control of the whole work. Making the necessary corrective action. Potential suppliers or subcontractors are brought in, a schedule is made, materials and tools are ordered, and instructions are given to the personnel and so forth.
- 5. Done. Final finishing touches. Concluding and evaluating the project.

The article involves going through of the 5 phases of a project with a comprehensive and detailed study in the project planning phase. The obtained is a scheme that a student has to pass in order to be able

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to plan the stages of the thesis in a successful and well-organized manner. At the same time, the importance of the interdisciplinary link between applied mathematics in the economy is indicated.

In order to carry out the proposed project, is the completion of a research thesis, either undergraduate or master, it is necessary to formulate a problem to be solved.

For a more successful approach of the proposed problem it is necessary to answer the basic questions of the design phase [4, p.24]: What should be done? Who should do it? How should it be done? When should it be completed? How much does it cost? Through the life cycle of the project we will answer these questions.

It is a matter of planning the stages of the execution of a thesis, to develop a license/master thesis. In order to solve this problem, the terms set by the conditions of the license/master thesis and the predefined times are taken into account.

The general activities and periods for the development of a license/master thesis are [9]:

- 1. Establishing the theme (the theme of the scientific leader is set or the student proposes a theme) 11.09-05.10.
- 2. Documenting and processing information 05.10-31.10.
- 3. Drawing up and approving the master thesis plan 01.11-08.11.
- 4. Elaboration and presentation of Chapter 1. 09.11-05.12.
- 5. Elaboration and presentation of Chapter 2. 06.12-11.01.
- 6. Elaboration and presentation of Chapter 3.12.01-01.03
- 7. Final presentation of the practical application. 02.03-30.03.
- 8. Preventive Presentation at the Department 25.04.
- 9. Presentation of the master thesis at the Chair with the opinion of the scientific leader 12.05.

The fixed periods are guidance periods and may vary from day to day. For each stage it is necessary to consider meetings with the scientific leader for any obtained result or any question related to the request process.

When preparing the plan, the candidate is the most responsible person in terms of the content and form of the work and should be permanently guided by the scientific leader.

For presentation of a project and for better organization, networks are used, these being arrows or bars. The project representation network is the tool used for planning, calendar scheduling, and monitoring the progress of project work. The network is constructed on the basis of the information gathered from the division by activity structure and is a graphical representation of the work plan of a project [1; 3, p119; 7].

A package of operations is defined independently of the other work packages, has defined start and end points, requires specific resources, involves technical specifications, and has its own estimated cost [1; 3, p.121].

- The most known programming methods in project management using networks are:
- 1. Gantt's diagram or bar chart.
- 2. Critical Path Method method (CRM).
- 3. The PERT method (Program Evaluation and Review Technique).

The end of the project will be the actual presentation of the thesis / master thesis, the evaluation being the mark obtained at the public presentation of the researched work.

Expenses related to the realization of the project depend on its field of researched. Generally, the cost is the lowest cost because it is a personal project and represents an initiation in the field of scientific research.

Considering the formal terms and periods established for achieving project milestones can develop activities to be covered. A reformulation of the above mentioned activities and a clearer presentation of the project are given in Table 1. Each activity has a duration calculated after the period established in the calendar for the elaboration of the Theses Union. Taking into consideration that the process of realizing the thesis dates from October with the proposed research topics and according to the calendar, it finishes in May, the approximate number of days may be 239 calendar days [9].

Table 1: The activities and the duration of the stages of elaboration of the license / master thesis

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Name of activities (Noting activities)	Past mandatory activities	Duration (Days)
1.Establishing the theme (A)	-	5
2. Selection and organization of information sources (B)	A	20
3. Research and analysis of selected bibliographic sources (C)	В	10
4. Defining the topic and writing the thesis (D)	В	
5. Establishing the objectives and elaborating the methodological	D	10
framework for the application (E)	C,E	8
6. Problem formulation and development of research tools (F)		
7. Chapter 1. Analysis and data processing (G)	F	5
8. Chapter 1. Comparison of Existing Results (H)	F	
9. Chapter 2. Establishing a theoretical support for the realization of	H,G	18
Chapter 3 (I)		14
10. Chapter 3. Practical implementation of proposed research objectives (J)	I	22
 Chapter 3. Theoretical description of the obtained results (K) Drawing of the thesis with introduction and conclusions. 	J	36
Preventive Presentation (L)	К	35
14. Permanent meetings with the scientific coordinator (N)	L	21
	м	30
		18

We have some restrictions on chronological sequences of activities: we can not start some activities until the previous ones end.

Finding the way into a project allows us to determine the impact on it of a change in sphere or priority. It will know what activities will have a greater impact and what needs to be done to recover the lost time [4, p.61].

A Gantt chart, commonly used in project management, is one of the most popular and useful ways of showing activities (tasks or events) displayed against time. On the left of the chart there is a list of the activities and along the top there is a suitable time scale. Each activity is represented by a bar; the position and length of the bar reflects the starting date, duration and the ending date of the activity http [13].

This allows you to see at a glance [13; 3, p.169-176]:

- 1. What the various activities are.
- 2. When each activity begins and ends.
- 3. How long each activity is scheduled to last.
- 4. Where activities overlap with other activities, and by how much.
- 5. The start and end date of the whole project.

The Gantt chart (Figure 1) can be customized for each student/master, independent of the field of research, the periods of work can be modified.

The Critical Path Method (CPM) consists of determining the maximum path in a non-circuit oriented network [6, p.133]. This method determines the minimum time to complete the project after all activities have been completed.

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Figure 1: The Gantt chart

This method is very useful due its simplicity. It's based on the arrows network. We can define an arrow network as a graphical representation of a project which shows us the relationships between success and tasks. The main characteristics of this network are the graphics. Each activity is represented with a unidirectional segment, that is to say one arrow. This arrow has a beginning and an end determined for a node, usually drawing with a circle and also known as an event [10].

There is a situation of adding 2 value 0 activities that do not influence the determination of the critical road.

To represent the chart of activities in Table 1 or to restore the notations, the activities will be the arcs of the graph, the points that link the activities will be nodes. Activities I and J will be formal activities and will precede the activities H and G respectively. The new revolutions of the activities will be: I precede H, J precedes G, K precedes I and J, L precedes K, M precedes L, N precedes M, O precedes N and P precedes A (Figure 3). Fictive activities are activities I and J.

The graph representing the activities is a graphical graph (Figure 2) with 14 points and 16 arcs representing the activities.

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Figure 2: The activity graph given by the CPM method

Using the CPM method, the critical path of the critical events 1, 2, 3, 5, 4, 6, 7, 8, 10, 11, 12, 13, 14 was obtained by the sequence A-B-D-E-F-G-J-K-L-M-N-O. The estimated duration of the critical road is 210 days.

As we studied in the previous chapter, CPM method is a deterministic method. That means that it's necessary to know the approximately duration of the activities based on the experience and the available resources. But what happens when we can't determine the duration of the activity? P.E.R.T helps us in these cases. By means of this method we will be able to estimate some times for each activity for after calculating the probability of accomplishing it in the estimated dates. Therefore a difference of CPM, P.E.R.T. is a stochastic method based on the probability [10].

The value of the different times that we will use in this method are based on the statistics information and the time estimation realized regarding to mathematics methods. The correct estimation of the times is very important to carry out the method in a right way [10].

This different times mentioned before will be three: Optimistic, pessimistic and more probable.

- t_o -optimistic time. It's the lower duration of one activity. It's the optimal time and it is reached if we don't have any setbacks.
- t_m pessimistic time. It's the highest duration for one activity. We will reach this time in the worst case.
- t_p more probable time or normal time. It will be the value that appears most often in a set of data with the same circumstances, the statistic mode.

The data with duration of time for corresponding the activity are in Tabale 2.

These estimates are calculated by averaging and dispersion, the errors being maintained within a normal distribution curve, characteristic of each type of project [15].

The next step is to calculate the estimated time regarding with the three times that we obtained. The estimated time is the weighted average of the three values. The definition of this time could be the time that we expect to finish the project. We will give more importance to the normal time so thereby the equation will be thereby [10,15]:

$$t_e = \frac{t_o + 4t_m + t_p}{6}.$$

Table 2: Activities of the PERT method

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Name of activities (Noting activities)	Past mandatory activities	Duration (Days)		
		optimum	probable	pessimistic
1.Establishing the theme (A)	-	3	5	7
2. Selection and organization of information sources (B)	А	18	20	23
3. Research and analysis of selected bibliographic sources (C)	В	9	10	12
4. Defining the topic and writing the thesis (D) 5. Establishing the objectives and elaborating the	В	5	10	12
methodological framework for the application (E) 6. Problem formulation and development of research tools (F)	D	5	8	9
7. Chapter 1. Analysis and data processing (G) 8. Chapter 1. Comparison of Existing Results (H)	C,E	2	5	6
9. Chapter 2. Establishing a theoretical support for the realization of Chapter 3 (I)	F	17	18	22
10. Chapter 3. Practical implementation of proposed research objectives (J)	F	13	14	16
11. Chapter 3. Theoretical description of the obtained results (K)	H,G	20	22	24
12. Drawing of the thesis with introduction and conclusions. Preventive Presentation (L)	I	35	36	40
13. Review of the thesis and final presentation of the thesis (M)	J	34	35	36
14. Permanent meetings with the scientific coordinator (N)	К	15	21	22
	L	20	30	31
	М	17	18	50

Having calculated this variable we will calculate the variance. The variance is a measure of how far a set of numbers is spread out. It is one of several descriptors of a probability distribution, describing how far the numbers lie from the mean (expected value). It's exactly what we want to know, how far our project to the expected objective is. We will define the variance as. The variance is the squared of the difference between latest time and the earlier time, all divided in to 36. We will get for all the activities [10,15]:

$$\sigma_e^2 = \frac{\left(t_p - t_o\right)^2}{36}$$

Average time and dispersion for the activities of Figure 2 are given in Table 3.

If an estimated project completion time T_f was considered, the PERT method includes the probability factor Z of framing the estimated duration of the critical road T_e in the term T_f [15]:

$$Z = \frac{T_p - T_e}{\sqrt{\sigma_p^2}}.$$

Table 3: Average duration and dispersion

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Activity	t _e	σ_e^2
А	5	0,44
В	20,17	0,69
С	10,17	0,25
D	9,50	1,36
E	7,67	0,44
F	4,67	0,44
G	18,50	0,69
Н	14,7	0,25
I	0,00	0,00
J	0,00	0,00
К	22,00	0,44
L	3,50	0,69
М	35,00	0,11
N	20,17	1,36
0	28,50	3,36
Р	23,17	30,25

The graph of activities represented by the PERT method is given in Figure 3.





Using the PERT method, the critical path given by the ABDEFGJKLMNO sequence to critical events 1, 2, 3, 5, 4, 6, 7, 8, 10, 11, 12, 13, , And the total dispersion is 10.06.

Conclusions. Considering the estimated term T_f of finalizing the paper, the PERT method includes the calculation of the probability factor Z of the estimated duration of the critical road $T_e = 207, 67$ in the final term $T_f = 210$ with a value of Z = 0,735 and the probability of completion of 75%.

The results obtained by both methods lead to the conclusion that a master / master work can be done in 207, 67 days minimum and 210 maximum days. With deviations of 10, 06 days. Following the diagram of Gantt (Figure 1) we can follow the realization process and the periods of realization.

This article is a good guide for graduates of the university studies in the elaboration of the research paper, it can also be consulted by the teachers for a better organization of the process of guiding the student in the scientific research.

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http://jees.usch.md/

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- 1. Androniceanu, A., Comănescu, M., Sabie, O. *Managmentul proiectelor publice cu finanțare internațională* –B.:Ed. Universitară, 2010. 665 p. ISBN 9789737499929.
- 2. Mureşan, Anton S., Blaga, P. *Matematici aplicate în economie*. Editura: Transilvania Press, vol. 2, C., N.: 1996. pag. 205, 279 p.
- 3. Bușe, F., Simionescu, A., Bud, N. *Managmentul proiectelor.*-B.: Ed. Economică, 2008. 426 p. ISBN: 9789737094049.
- 4. Chirleşan, D. *Gestiune proiectelor: teorie şi modele*.I.: Universitatea "A.I. Cuza", 2008. 398 p. ISBN: 9789737033659.
- 5. Ciobanu, G., Nica, V., Mustata F. Cercetări operaționale cu aplicații în economie: Teoria grafurilor. Analiza drumului critic. –B.: Matrix Rom, 1996. 208 p. ISBN: 9739254136.
- 6. Ciurea, E., Ciupală, L. Combinatorică și grafuri. Bv.: 2003, 137 p.
- Florescu Margareta, Marton Balogh, Neamţu Bogdana, Natalia Balogh. Managementul proiectelor. Dezvoltare durabilă. Suport de curs. Cluj-Napoca. 2011. 118 p, Disponibil: http://www.apubb.ro/wp-content/uploads/2011/03/Managementu-proiectelor_Dezvoltare_ durabila.pdf.
- 8. Neață, V. Cercetări operaționale. -S.:Ed. Universitară "L.Blaga" din Sibiu, 2004. 261 p. ISBN: 9736518485.
- 9. GHID privind elaborarea și prezentarea tezei de licență/master. Universitatea de Stat "B.P.Hasdeu" din Cahul. 2013. p.16.
- 10. The Practice of Scheduling, Disponibil: hhttps://riunet.upv.es/bitstream/handle/10251/35292/ diplomaprojectcarlosgonzalezperez.pdf?sequence=1.pdf.
- 11. http://web.rau.ro/mycourses/2004-2005/im_co/Curs-Grafuri-Drum%20Critic.pdf. (văzut 6.07.2017)
- 12. http://www.mpt.upt.ro/doc/curs/gp/Managementul_proiectelor/Cap3.pdf.(văzut .07.2017)
- 13. www.gantt.com/ (vizitat 6.07.2017)
- 14. https://www.projectmanagement-training.net/follow-up-phase/ (vizitat 06.07.2017).
- 15. http://www.mpt.upt.ro/doc/curs/gp/Managementul_proiectelor/Cap3.pdf (văzut .07.2017)

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