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OPTIMIZATION THE COSTS AND DELAY OF THE PROJECT TO REALIZE A TECHNICAL PRODUCT USING PROJECT MANAGEMENT AND TAKING INTO ACCOUNT THE RISKS

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Abstract: *This paper presents the main aspects of a project tasks modelling regarding the case study in which are included the activities' risk durations, the risks concerning the costs are included and when two models for activities rank correlation assessment based on Spearman and Pearson models taken into consideration. We propose the use of "cruciality" as parameter obtained from multiplication of correlation ranks of two sets of values: sensitivity and the degree of criticity. For an industrial case we've determined the tasks with the highest cruciality, the probabilistic finish durations of the project, the costs and we have proposed solutions for the improvement of results. We have used Microsoft Project software and PertMaster Project Risk.*

Key words: *project management, risk, optimisation of the costs, correlation of the activities and stocks.*

1. INTRODUCTION

Launching a new product, practically, presume the assumption of some unavoidable risks due to the market fluctuations, the market competition and the unforeseeable character of innovation. In project management we cannot influence the causes of unforeseen phenomenon, but we can diminish their effects using impact attenuation of the consequences.

Risk management aims to annihilate or minimise the negative results in a company, witch risks might cause. The risks effects are more important when the events are strongly connected to each other. Each cause has more effects, but each effect results from more united causes. The correct assessment of risks is usually made by their quantitative analysis.

Therefore, we follow successively the following phases: risks identification, probability quantification, evaluation of consequences over the project. These consequences must be taken into consideration in the costs, delivery terms and technical content plan. Among the risks that appear in a project, some of them can be counter-balanced by favourable events; those are the normal risks of the company. Others have only negative consequences for the project objectives, company and the personnel; those are risks necessary to be assured.

The project manager will always have difficulties choosing between a gainful risky project and a less gainful less risky project. The decision will be adopted based on the manager experience, but it is recommended that this decision should be always based also on the results obtained by the evaluation instruments of risk [1].

2. RISK MANAGEMENT BASED ON PROJECT COMPLEXITY

The processes used in risk management ca be modified based on the project necessities and then included in a document named *Procedure for Project Management* and created in the first phases of project design process.

Small complexity projects do not present a high risk because of their small duration and small number of tasks that can be disturbed along their evolution.

For the *medium-sized projects*, for every identified risk, a qualitative level is allocated. The risk level is called "qualitative" because it represents a quick approximation and does not represent the hardness of a detailed numerical analysis. The risk level can be high, medium or low sized depending on the impact severity and probability of occurrence. In order to obtain a higher accuracy, the number of options for the risk probability can be increased [2]. For example, we can create a five numbers probability scale as shown in the Table 1.

Another example of increasing the assessment precision of risk is the use of five values scale, as follows: 1) low impact (or without impact) over the project cost and finish date; 2) impact of 2%–4% over the project cost and finish date; 3) impact of 5%–7%; 4) impact of 8%–10%; 5) high impact, over 10% over the project cost and finish date. The next step is to create a response plan for every high level risk that has been identified in order to ensure a effective risk management. This plan must contain all the activities for the risk management, the allocated resources, the final dates and periodical dates of project evolution tracking.

Table 1

Probability of risk occurrence

Probabilities	Low impact	Medium impact level	High impact
Very improbable < 10%	Low	Low	Low
Improbable < 35%	Low	Low	Medium
Probable 35%–65%	Low	Medium	Medium / High
Probable > 65%	Low	Medium / High	High
Very probable > 90%	Low	Medium / High	High

The risk management process for high complexity projects resemble to the process for medium-sized projects but have two more elements. The first element is the use of the techniques for quantitative risks analysis (beside the qualitative techniques). The second element is an evaluation plan of risk consequences over the project if risk plans does not work and risk really occur.

We mention that the provided sum for each individual risk is not enough to cover the cost for risk occurrence. All the same, it is less probable that all risks appear, so the back-up budget for every risk is enough to cover every individual risk that occurs [6].

3. CALCULATION METHODS FOR CORRELATION RANK OF DIFFERENT TYPES OF TASKS

Sensitivity is the measure for the correlation rank of two sets of values (ex: duration of a task and duration of all technological cycle).

In order to quantify the correlation between two sets of values, we use two methods: Spearman's correlation rank; Pearson method.

Calculation *method proposed is based on Spearman's correlation rank* and takes into account the duration sensitivity of project tasks. During the risk analysis the iterations generate task duration and project duration. After the analysis the task durations are ranked. The smallest duration is given a rank of 1 and the largest duration a rank equal to the number of iterations. The project durations are ranked in the same way. Then all the values are put into Spearman's rank correlation equation:

$$R = \left(1 - \frac{6\sum D^2}{n(n^2-1)}\right) \cdot P_i, \qquad (1)$$

where: R = correlation (value between – 1 and 1 that is converted to a percentage for displaying); D = difference in ranks between data values in the same pair; n = number of iterations task existed (usually the total number of iterations performed unless task was probabilistic); P_i = percentage of iterations task existed (value from 0 to 1).

The above equation can equally be applied to task cost and project cost to calculate the cost sensitivity for a task or for the whole project.

If values are the same then they are ranked depending on the iteration number that created them. For example if a value appeared in the first iteration then it would be ranked higher than the same value that appeared in any subsequent iteration.

Calculation method based on Pearson model ignores automatically tasks when the task duration or cost does not change during the risk analysis, *e.g.* milestones (always zero duration) and tasks that do not have a cost or duration distribution. This is due to the fact that "x – mean(x)" is zero when the values do not change.

To find the correlation, the Pearson method calculates the correlation value r, using the equation 2:

$$r = \left[\left(\frac{\sum (x-\bar{x})(y-\bar{y})}{n-1}\right) \Big/ \left(\sqrt{\frac{\sum (x-\bar{x})^2}{n-1}}\sqrt{\frac{\sum (y-\bar{y})^2}{n-1}}\right)\right] \times P_i . \quad (2)$$

where: x = value from first data set (e.g project duration, project cost, summary task duration, task completion date); y = value from second data set (*e.g.* task duration, task cost); r = correlation (value between – 1 and 1 that is converted to a percentage for display); n = number of iterations task existed (usually the total number of iterations performed unless task was probabilistic); P_i = percentage of iterations task existed (value from 0 to 1).

The above equation can equally be applied to other values such as task cost and project cost to calculate the cost sensitivity for a task.

Sensitivity can be measured for task cost and the task duration. It gives an indication of how much the cost and duration of each task affects cost and completion of other tasks or the entire project. It can be used for identifying tasks that are most likely to cause delay or increase the cost of a project.

The duration sensitivity is a measure of the correlation between the duration of a task and the duration of the project. The task with the highest duration sensitivity is the task that is most likely to increase the project duration.

The cost sensitivity is a measure of the correlation between the cost of a task and the cost of the project. It is similar to that of the duration sensitivity but looks at costs instead of durations.

The task with the highest cost sensitivity is the task that is most likely to increase the project cost. For the sensitivity calculation other alternatives are possible and are taken into consideration before the risk calculation (Fig. 1). A macro-activity contains many tasks and can be delayed by reason of a sensitivity of elementary tasks that are contained. If there are not elementary tasks, that affect the macro activity duration, the sensitivity value is zero.

In Fig. 2 is presented the inserting option of a correlation regarding the task duration. We have considered the task "row-material supply" as being correlated 60% with "cutting-off" tasks at the same working post.

The project analysis using *PertMaster Project Risk* can be made in many ways. All these alternatives are based on iterative probabilistic calculations. A recommended alternative of setting-up a risk analysis is stopping the iterations when project finish date and project cost are convergent as shown in the Fig. 3. We have chose the alternative for the analysis to stop when the project finish date and project cost are modified with less than 1% for 100 consecutive iterations.

The analysis can be stopped for convergent data and for the following three alternatives: project finish date

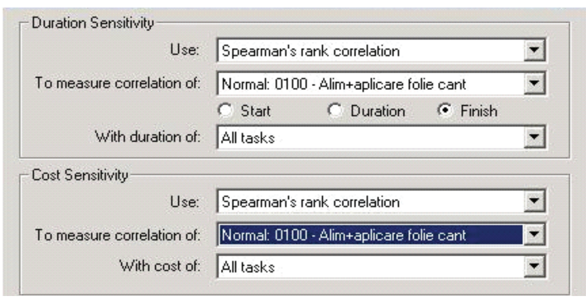

Fig. 1. Sensitivity analysis options using Spearman's correlation rank.

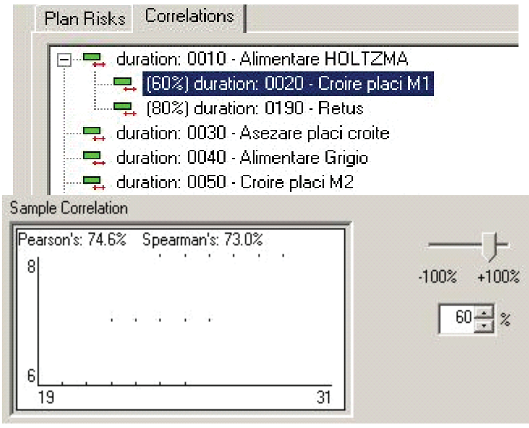

Fig. 2. Imposing a correlation between project tasks.

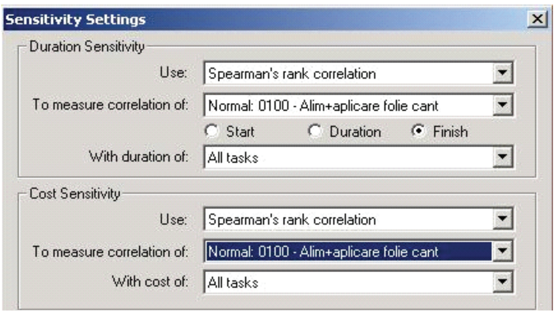

Fig. 3. Setting-up a risk analysis when project finish date and total project cost are convergent.

and project cost convergence; imposed project finish date convergence; total project cost convergence.

We propose the use of "cruciality" as parameter obtained from multiplication of correlation ranks of two sets of values: sensitivity and the degree of criticity. Cruciality is the most important parameter for a project task.

4. INDUSTRIAL CASE – FURNITURE MANUFACTURING AT *MODUL DESIGN*

The structure of the manufacturing cycle of Module Design represents 65…85% by the total duration of the auxiliary operations (manipulation, transport, waiting, warehousing). The balance of these auxiliary operations related to the product cost reach 30% for some of the analysed products.

Therefore it was necessary to develop an instrument to analyse and design the technological flows in order to reduce or eliminate the auxiliary operations, to optimise the structure and dimensions of the manufacturing system and the correlation of material and informational flows [3].

After the flow optimisation using *Witness* and taking into account technological process of the product D80 (Fig. 5), all activities corresponding with technological flow were specified in the software *Microsoft Project* and after that imported in *PertMaster Project Risk* module.

We have analysed the product's group manufacturing period taking into consideration the fact that a part of project tasks have a probable duration and that the resources are also probabilistic.

The main objective was to optimise the manufacturing process (Fig. 4) into a unitary mode, starting with the

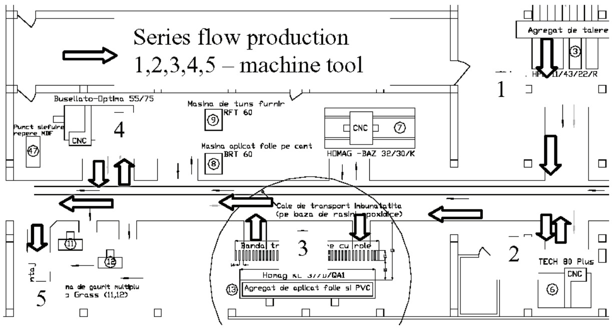

Fig. 4. Configuration of the system before optimisation.

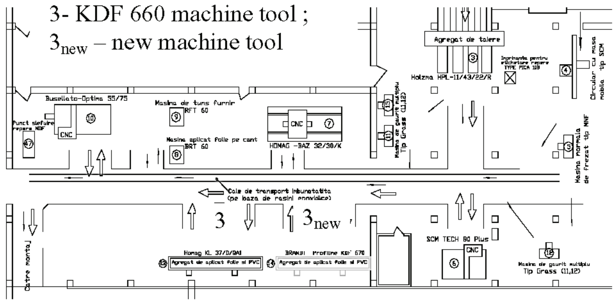

Fig. 5. Manufacturing system after Witness optimisation.

raw-material and finishing with the product assemble and optimisation of project duration and product total cost [4].

The Fig. 6 presents the Gant chart for the activities to produce D80, and the Fig. 7 the results obtained using Monte–Carlo simulation, to estimate the entire duration of the project.

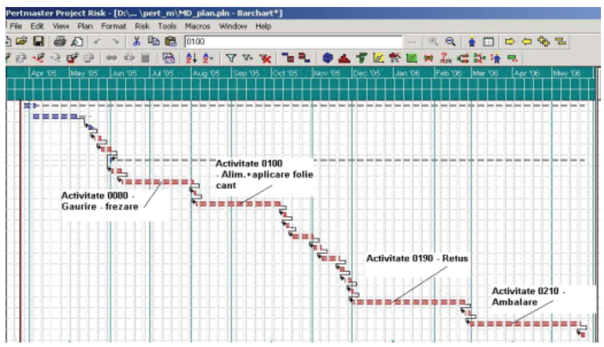

Fig. 6. Detail of the Gant chart for the important activities of the product D80.

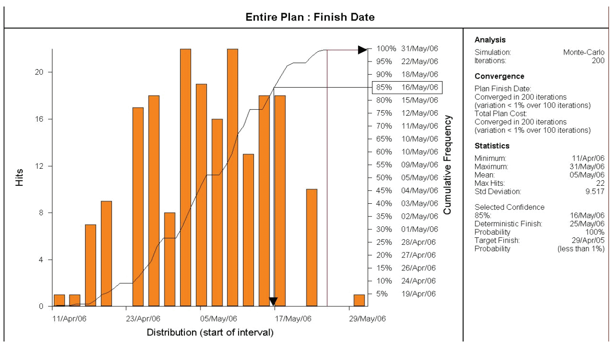

Fig. 7. Results of the analysis, using Monte–Carlo simulation, to respect the deadline of the project.

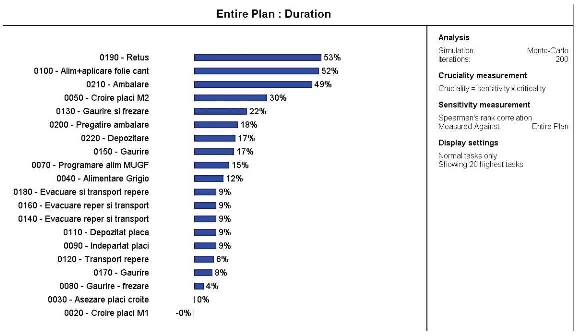

Fig. 8. Cruciality of the activities and the influence on the total duration of the D80 manufacturing – TORNADO-Graph.

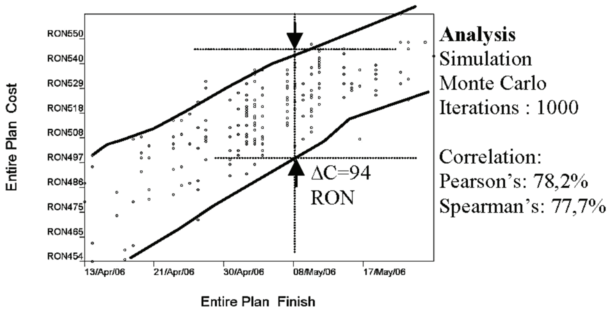

Fig. 9. Cost calculus of the manufacturing process depending on the time finalisation.

Cruciality of the activities and the influence on the total duration of the D80 manufacturing, were studied using the TORNADO-Graph presented in the Fig. 8 and the minimum probabilistic cost for the manufacturing of the product is 454 RON (Fig. 9).

5. CONCLUSION

Necessary activities to obtain the furniture product D80 was simulated using PertMaster Project Risk and the durations of activities were considered with triangular distribution (minimum, most likely and maximum duration). Gant chart details and the highest duration activities are presented in the Fig. 16, where we can remark the following activities: 0080 – drilling-milling processes; 0100 – feeding CNC KDF Profiline machine and laminating edgebander; 0190 – manual correction; 0210 – assembly of the product and finalize the manufacturing cycle.

Transportation of the pieces between different operations was considered completely automated (using roller transporters units) and they are deterministic activities (it's no dependence on human manipulations).

Total duration of the manufacturing cycle is a probabilistic value and could be considered 438 minute that corresponding with 85% probability to finish at the deadline the manufacturing cycle.

Considering cruciality of activities (sensitivity percentage multiplied with percentage of criticity) and studying theirs influence on the total duration of the project (TORNADO-Graph) presented in the Fig. 8 is emphasized to survey with priority manual correction activity (53% cruciality), laminating edgebander (52%) and assembly operation (49%).

Because the manual correction activity is not important for a series production and because assembly operation is made always manually, consequently, laminating edgebander is a critical operation and a flow manufacturing concentrator.

To eliminate the flow concentrator was proposed and realized the implementation in the production line of a new edgebander laminating machine – Profiline KDF 660.

Probabilistic cost of the product D80 is situated into the interval 454–550 RON depending on the total time of the manufacturing cycle, according with the diagram on the Fig. 9 [1].

The most probably duration of the activity with highest cruciality (activity consisting to laminate edgebander) is 46 minutes for the whole series of 12 pieces after optimisation process.

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