METHODS FOR SIZING BUDGETS THAT CAN BE USED IN A PROJECT

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Abstract: Nowadays, more and more companies, regardless of the field to which they belong, operate through projects. Due to this, it is necessary to have a more detailed and precise knowledge of how projects are carried out in order to achieve the expected results. The most important thing that must be mentioned from the beginning is that all the activities that take place in a project will be translated into money in the form of costs. The challenge for the project manager is to complete the project on time and to fit the actual costs in the established budgets. Obtaining financial efficiency in the development of the project will be considered a strong point for the Project Manager that turns him into a professional. The responsibility for sizing the budgets in a project lies with the Project Manager, as well as fitting the actual costs in the established budget.

Keywords: project management, project, budget, cost, time

1 INTRODUCTION

The budget represents the totality of the estimated revenues and expenses for the implementation of a project. It is considered a basic element of a project proposal, and its erroneous preparation may lead to the rejection of the project.

The budget of a project does not have a standard structure that fits any type of project, it will be done depending on the field to which it belongs, the type of activities carried out and the resources involved. Also, in the case of projects implemented with the support of funds external to the organization, it is mandatory that the budget be broken down by types of income and expenditure that must very clearly highlight the source and how the money is spent. These elements are also highlighted in the Project Management Body of Knowledge (PMBOK Guide, 2013).

Budget management is the science and/or art of using specific techniques and tools in the activity of financial sizing of the activities that make up the action plan and implicitly of the project. Budgeted cost is the maximum amount available for a particular category of expenses. The transfer of budgeted amounts from one category to another in a project is done only with the agreement of the funder.

The actual cost is the amount spent because of carrying out the activities of the project action plan. It is necessary that the cost of activities is less than or equal to the budgeted cost.

The financial efficiency of a project can be highlighted by the ratio of budgeted costs (estimated) to actual costs (obtained). (PMBOK Guide, 2013)

$$E_p = \frac{\sum_{i=1}^{k} cb_i}{\sum_{i=1}^{k} ce_i} \qquad (1.1)$$

condition:

$$cb_i \geq ce_i \qquad (1.2)$$

where:
Ep – financial efficiency of the project;
cb_i – budgeted cost of the category „i";
ce_i – the actual cost of the category „i";
k – the number of activities or categories.

2   COST MANAGEMENT IN A PROJECT

Cost management represents the way in which expenditure incurred by type of expenditure (eligible and/or ineligible) and categories of budgeted costs are managed. These elements can also be found in the Introduction to Microsoft Project (Roşca L., Roşca L., Oleksik L., 2021)

The following activities are required for drawing up a budget:
➤ identification of all the necessary activities in a project;
➤ identification and allocation of the necessary resources for each activity;
➤ estimation of expenses made on real fundamentals (e.g.: average market price);
➤ grouping costs by categories of expenditure (e.g.: human resources expenditure, endowment expenditure, overheads, etc.;
➤ detailed knowledge of the financing requirements imposed by the funder;
➤ the classification of costs by type of expenditure (e.g., eligible and ineligible);

➤ indication of the funding sources for each activity in the project, etc.

The plan for managing expenses is not a standard one for all organizations. It is customized by developing documentation that includes methodologies, policies and procedures, with the role of providing guidance on how to manage expenses during the project.

The responsibility for defining the management plan lies with the management of the organization that finances the project. If we are talking about external financing, this plan comes in the form of a guide for financing the project, imposed by the funder.

The spending management plan should provide answers to some key questions, such as:
➤ what types and categories of expenses will be allowed?
➤ what are the methods and procedures for making the expenses?

An expenditure plan must include the following elements:
➤ units of measurement (days, km, liters, m2 ... etc.);
➤ precision levels (rounding up or down: 500.45 euro to 500 or 501 euro);
➤ control thresholds (e.g.: 10,000 euro);
➤ performance measurement indicators;
➤ standardized forms for reporting (format and frequency of reports);
➤ additional details, if necessary, depending on the specifics of the project, etc.

Reducing expenses in a project can be achieved by:
➤ use of cheaper materials;
➤ use of existing equipment;
➤ obtaining higher discounts in the supply process;
➤ outsourcing of some activities etc.

All these solutions, if not evaluated in detail, can generate negative effects on the results.

If we customize the notion of expense management on a type of product and take into account the life cycle of the product, we can say

that the price of a product made following a project should necessarily contain two categories of costs, namely: the cost of the project, which represents all the expenses incurred in making the product and the maintenance cost, during the warranty period of the product.

By the data published in Table 2.1. the importance of the two costs in determining the budget of a project for products including a guarantee is highlighted.

According to the above, through the activity of reducing expenses in a project one can move from profit to loss. If we use cheaper (substitutable) raw materials, the product may have more expensive interventions during the warranty period (line 2, tab. 2.1.) than the variant in which we will use those originally established. With this example, it is intended to highlight the importance of costs in sizing the total budget for a project. After the completion of a project and the delivery of the client's results, the expenses will not stop, due to the legal clauses regarding the warranty of the results.

Table. 2.1 Analysis of the total cost of a product

Case	Project Name	The project cost [euro]	Cost of warranty [euro]	The total cost of a product [euro]
Situation 1	Project A	10.000	500	10.500
Situation 2	Project A	8.000	3.000	11.000

Any project is evaluated by the management of the organization from the perspective of the benefits it brings or attracts, these being financial, image, opportunity benefits, etc. Regardless of what the benefit sought in the evaluation process will be, the project must cover its costs. An often-circulated expression is that "paper supports anything", even minus values, without immediately realizing the effects. In the execution phase of a project, minus values mean activities that will not be carried out due to illiquidity, which means that the project will stop. Its continuation obliges the organization to find financing solutions for the completion of the project and the recovery of investments, following the delivery of the product to the beneficiary.

Another solution applied to reduce expenses is to purchase as much goods as possible, in order to get as much discount as possible. This variant can hide certain risks, in some cases, such as the purchase of a large quantity, which means storing a part for a longer term. The main negative effects would be blocking financial liquidity in stocks of raw materials or investments, increasing the expenses for storing purchased goods, etc.

Table. 2.2. Supply cost analysis

Case	Project Name	Procurement cost [euro]	Storage cost [euro]	Total cost of goods [euro]
Situation 1	Project B	2.000	0	2.000
Situation 2	Project B	1.800	300	2.100

According to the situation in Table 2.2., the attempt to obtain financial advantages has reached the other extreme, the goods being more expensive, due to the omission of factors in the decision-making process, such as the cost of storing the goods. If there are no additional

storage costs and there is sufficient financial liquidity, preference is given to the acquisition of larger quantities.

Sizing the budget needed for a project as precisely as possible is essential, as it can decide whether the project proposal will be approved or abandoned (Wright JN, 1997). It is recommended that the following aspects be taken into account in the budget sizing process:

➢ recourse to a graphic method such as: WBS, PERT, Cause-Effect Diagram, etc., which should highlight all the activities necessary to carry out the projects;

➢ sizing depending on the elements necessary for the activity, in case of need requiring collaboration with the person performing the activity;

➢ making a good argumentation of any budget change;

➢ the need to recalculate the budget for any change;

➢ establishing a plan to counteract the risks that may influence the project budget.

According to the expression time is money, it can be said that these costs of the project increase in relation to the size of the allocated time. A solution to reduce costs in a project can be achieved by reducing the durations for the tasks that make up the critical path in a project. Improving activities on the critical path can lead to shortening the duration of a project and forming another critical path.

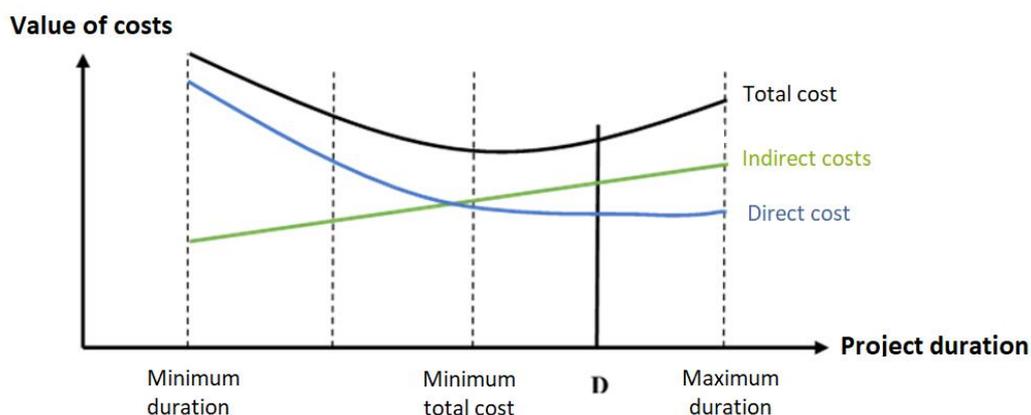In Figure 2.1, it is possible to analyze the evolution of costs over the lifetime of a project.

Figure. 2.1 Dependence between costs and project duration (Abrudan, I., Cândea, D., 2002)

Indirect costs are those expenses which cannot be directly identified on the results obtained and are distributed on the basis of a coefficient. Moreover, they are not conditioned by the achievement of the results of a project and do not increase in direct proportion to their volume, but in most cases remain constant and manifest themselves until the closure of the project. The longer the project duration, the higher the value of indirect costs.

Direct costs can be accurately identified in the process of obtaining results and increase in direct proportion to the volume of results. If a minimum duration is desired to carry out the activities of a project, an increased effort is required, which means additional costs in carrying out the activities. Duration D, according to Figure 2.1, represents the optimal time to carry out activities in order to achieve maximum efficiency.

The total cost is the amount spent on carrying out a project and consists of direct costs, indirect costs plus other project-specific costs.

Optimizing an activity from a time and cost perspective is based on the following assumption. According to graph 2.2, the execution of an activity can be hastened, if it is

allocated an additional number of resources, which is an "execution in assault" for an activity.

Any task sized in a project can be completed sooner or later than the scheduled date.
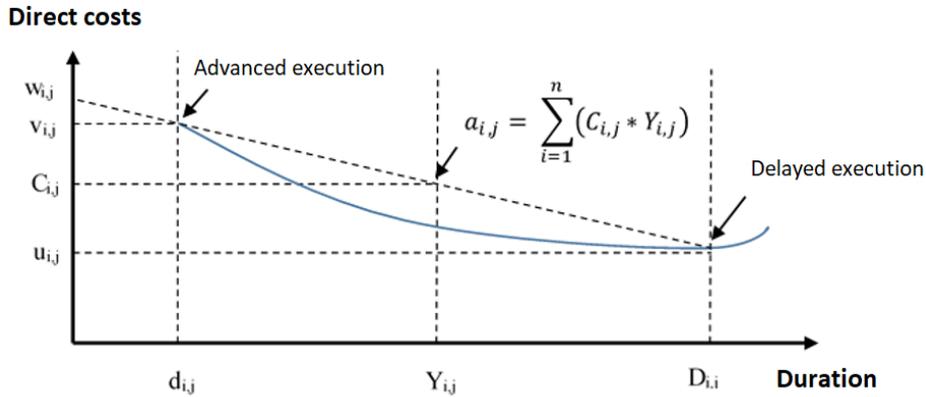

Figure. 2.2 Direct cost curve (Abrudan, I., Cândea, D., 2002)

According to a personal statistic, I have encountered situations in which the activities were completed up to 30% earlier, but with an additional effort. There are also situations in which the completion deadline was exceeded by up to 50%. If we try to define a time frame in which an activity could be completed, without taking into account the cost of the allocated resources, it would be [-25%, +50%]. According to this hypothesis, the size of the interval would be 75% of the duration of the activity. If a general formula is desired for determining the cost of an activity, the following can be used: (Abrudan, I., Cândea, D., 2002)

$$C_j = \sum_{i=1}^{n}\big(a_{i,j} * Y_{i,j}\big) \qquad (2.1)$$

where:
C_j = Direct total costs for the activity „j";
$a_{i,j}$ = Resource cost "i" per hour for the task „j";
$Y_{i,j}$ = Duration of use of resource "i" in the task „j";

It is worth mentioning that the duration of the activity cannot be reduced below a certain limit ($d_{i,j}$) that was noted in the figure as the execution in assault, which means the allocation of additional resources in order to carry out the work in the shortest possible time. There is another point ($D_{i,j}$), called delayed execution, which corresponds to the achievement of the

task by the established technology, but at the time when the resources are available. The two points have associated the durations of the respective $d_{i,j}$ and $D_{i,j}$. and we are only interested in the central part of the curve, between them (the 75% range assigned to the duration of an activity).

As a result, the problem of time-cost optimization can be defined as follows: it is known the D duration of the project and the unlimited resources, find the durations of the activities and their programming so that the execution of the project is carried out with minimal costs: (Abrudan, I., Cândea, D., 2002)

$$\max Z = \sum_{i,j \in retea}^{n}\big(a_{i,j} * Y_{i,j}\big) \qquad (2.3)$$

where:

$$T_i + Y_{i,j} - T_j \leq 0 \qquad (2.4)$$
$$Y_{i,j} \leq D_{i,j} \qquad (2.5)$$
$$-Y_{i,j} \leq -d_{i,j} \qquad (2.6)$$
$$T_n - T_1 \leq D \qquad (2.7)$$

It is denoted with T_i the advanced beginning in node "i" and "n" is the terminal node of the network. All $Y_{i,j}$ and T_i are decision variables.

The first condition (2.4) imposes the relations of precedence - succession between

activities. Conditions (2.5) - (2.6) require that the duration of $Y_{i,j}$ be between the two extreme points of the direct cost-duration curve. The difference (T_n-T_1) represents the total duration of the project and (2.7) expresses the condition that this duration does not exceed the maximum required D.

By solving the model, the durations of the activities and the values of the advanced beginnings can be obtained in all the nodes and based on them the optimal program of the project can be drawn up.

Project management does not provide a standard solution that suits any type of problems or project but provides solutions that can be applied according to the criteria and conditions identified by the project manager. All the solutions presented are effective if they are used professionally. Depending on the state of the project and the professionalism of the project manager, the most appropriate option is chosen.

3   CATEGORIES AND TYPES OF COSTS ENCOUNTERED IN PROJECTS

Most of the types of costs we encounter in a project are found in almost any organization. Among the most common we can mention:
  ➢ human resource costs;
  ➢ costs with the purchase of goods;
  ➢ manufacturing costs;
  ➢ quality costs;
  ➢ costs to mitigate risks;
  ➢ the cost of waiting;
  ➢ financial costs;
  ➢ costs for events;
  ➢ consulting costs etc.

Human resource costs. This type of cost is directly proportional to the number of hours worked by a given resource, not to the duration of the project. The project team will work with service contracts in agreement and not in directing. The difference between them is that these agreement service contracts are directly related to the measurement of the results obtained for a team member and can earn different rates per hour, if during the same period they work in several projects. During a month, an employee can work in several projects that do not have to have a fixed schedule of hours per day, but is conditioned to work a maximum number of hours established by the labor legislation in force, maximum 12 hours per day.

The costs of purchasing goods. This category includes several types such as: the cost of the raw material and the materials necessary to obtain the result of the project, the purchase of equipment necessary for the operations in the project, the purchase of consumables or whatever is needed to carry out the project in good conditions.

Manufacturing costs. This category may contain two or more types of costs, depending on how the organization in which the project is carried out is structured. The management of the production unit includes a series of costs for carrying out the activities, such as: the cost of electricity, space heating, cleaning and / or any type of expense required in the production unit to carry out the project. The management of the enterprise includes all the expenses necessary for the organization's activity to be carried out in good conditions, for example: the costs of office space for the organization's management, the cost of salaries of people who do not have a direct contribution to the project but support the project.

Quality costs. Starting from the specific quality requirements that the result of a project must meet, the necessary methods and procedures to be applied at the stage of execution of the result will be defined in order to obtain the expected results. All expenditure incurred for this purpose will fall into this category.

Costs to mitigate risks. Any activity carried out in the future may or may not be carried out as planned, due to internal or external

disturbance factors. The project manager must anticipate them and provide for measures to counteract them and mitigate the effects. All these specific measures or preparations will generate expenditure that will be classified in this category.

The cost of waiting. It occurs at the time when the delays in the project occur. Any activity, which is on the critical road and is not carried out according to the action plan, will cause delays, which lead to possible contractual penalties. The same can be found in the case of activities that are not on the critical road, if they are delayed, they can generate waiting costs by extending the activities. All resources that will be available, according to calendar schedules (time or day), by extending the activity due to the delay will cause additional costs for the respective period.

Financial costs. Any project means an investment that, after completion, must be recovered. An investment means spending an amount of money that may come from the organization's own funds and/or the loan. If the amount is from the bank loan, then during the loan period there will be financial costs for its repayment. If the amount is from own funds, then there will be the financial opportunity cost.

Costs for events. This category appears only if it is necessary to carry out events such as: promoting the project, attracting funding, meetings between several partner organizations and / or any event organized in the interest of the project.

Consulting costs. They occur in a situation where there are certain bottlenecks, due to the lack of information or experience in the field for writing and implementing the project. It is allowed or recommended, if necessary, to call a specialized consultancy firm for support type activities, being meant to contribute to the successful realization of a project.

Another classification of costs, depending on how it manifests itself, is the following:
- ➢ variable costs - this type of costs changes in direct proportion to the amount of the results. (e.g., wages, consumption, raw material processing, etc.);
- ➢ fixed costs - these types of costs do not change in direct proportion to the increase in results, but remain constant throughout the project but steadily increase with the duration of the project. (e.g., rental cost, cost of certain kings, cost of maintenance, etc.);
- ➢ direct costs - are those costs that can be identified directly on an activity or process. (wages, equipment, etc.);
- ➢ indirect costs - are overhead costs that cannot be identified directly on an activity or process and will be distributed based on coefficients.

4   METHODS FOR SIZING BUDGETS

The sizing of a project's budget at the initiation stage is a summary one that does not focus on details, but it is comprehensive enough to determine a total project budget value, ranging from -25% to +50. On a quick analysis, we can see that the aforementioned range may generate an estimation error of up to 75%, in the most unfavorable situation. It is very difficult to accurately estimate the project budget (Creedy, G. D., Skitmore, M., Wong, J., 2010)

The planning stage requires that the error range be narrowed from -10% to +25%, resulting in an error interval with the size of 35% of the project value. This option is accepted by the funder.

There are situations when an even narrower range of up to 25% is required, which means that the estimation range reaches from - 5% to + 15%. In order to obtain an increased accuracy of the results, mathematical methods must be applied that allow this fact, such as three-point or parametric estimation.

A very important condition is that this Total Project Cost is less than or equal to the Total Project Budget.

Estimating the cost of a resource in a task can be done using the following variants:

> estimation by the average market price of the resources involved - this method is effective, when there is a financial stability at country level, which implies a very small fluctuation of the exchange rate, low inflation, etc., all these elements can give confidence to the Project Manager in the activity of sizing budgets for each category. If some elements are unfavorable, the maximum market price of resources can be chosen to avoid a minus financial situation, at the project execution stage;

$$p_i = p_{mediu} \ \text{sau} \ p_i = p_{maxim} \qquad (4.1)$$

> estimation of costs by analogy - this variant involves studying other projects carried out by the organization with similar activities to establish costs, by making a comparison between the resources involved and their performance. (e.g. people, equipment, investments, kings, taxes, financial fluctuations, etc.);

> analytical estimation of costs based on managerial experience - this method can be applied when the manager is not at the first meeting with this type of project and tasks, in addition, he has access to the resources that will be involved in the task, with which he can negotiate a certain time for carrying out the task. Based on time, the cost of the activity will be calculated. An additional margin of 10-15% is also allocated to the negotiated cost to cover any financial fluctuations or delays in the project;

$$p_i = p_{mediu} * 10 \div 15\% \qquad (4.2)$$

> analytical estimation of costs in three points - this method is also known in the literature as a triangular law or PERT. The method involves estimating the cost on the basis of three elements: the lowest price identified on the market for a given good, the average price and the maximum market price;

$$p_i = \frac{p_{minim}+p_{probabil}+p_{maxim}}{3} \qquad (4.3)$$

> analytical estimation of costs in three points and a coefficient β - The method is similar to the one presented above, with the exception that the beta coefficient, additionally introduced, contributes to the accuracy of the results. The Beta coefficient will increase the importance of the average price for a more accurate estimate;

$$p_i = \frac{p_{minim}+\beta*p_{probabil}+p_{maxim}}{\beta+2} \qquad (4.4)$$

> analytical estimation of the costs of standard deviation. p_i – can be considered the average market price or the price estimated by the manager for a good, p_{min} – represents the lowest price found on the market for a particular good and p_{max} – represents the maximum price in the market. Depending on the level of vulnerability of the economic environment, the value of the deviation may be added or decreased.

$$t_i = p_i \pm s_d \qquad (4.5)$$

$$s_d = \frac{p_{min}-p_{max}}{2} \qquad (4.6)$$

5 CONCLUSIONS

Sizing the budget of a project is a complex process that requires increased attention in the process of setting budgets. The results obtained will contribute majorly to the final decision on whether or not to carry out the project.

Because all projects include features such as uniqueness and uncertainty, it is necessary to apply methods and tools for the most accurate estimation of budgets due to the disruptive factors that may occur.

In order to achieve financial efficiency, it is necessary to identify all types of costs that may arise within the activities carried out in the project and to establish the size of the resources allocated for carrying out the activities under the established conditions.

For all these challenges, the work presents a series of methods and tools that can facilitate the achievement of the expected result. It is worth mentioning that all the variants published in this article can help the project manager in estimating the costs if the correct version is chosen, depending on the available information held by the project manager and his professionalism.

BIBLIOGRAPHY

Abrudan, I., Cândea, D. (2002), *Manual de inginerie economică: Ingineria şi managementul sistemelor de producție*, Editura Dacia, Cluj-Napoca

Bojan, I., Filip, D., (2010) *Planificarea resurselor întreprinderilor – Sisteme ERP., Managementul sistemelor logistice*, MANUALUL CALIFICĂRII, Editura U.T. Press, Cluj-Napoca, pag. 337-418. ISBN 978-973-662-578-7.

Cândea, D., Abrudan, I., ş.a., (2002) *Programarea producției de unicate, Manual de Inginerie Economică - Ingineria şi Managementul Sistemelor de Producție*, Cluj-Napoca, Editura Dacia.

Creedy, G. D., Skitmore, M., Wong, J. (2010). Evaluation of risk factors leading to cost overrun in delivery of highway construction projects. *Journal of Construction Engineering and Management*, 136(5), 528–537.

Filip D., Lungu F., (2013) *The management of small and unique production series, LAP LAMBERT Academic Publishing*, ISBN-13:973-3-659-31753-8, https://www.lap-publishing.com;

https://searchsoftwarequality.techtarget.com/definition/PERT-chart (2021)

Liu, QH, Chen, JD., Wang, WX., Qin, Q., (2021) Conceptual Design Evaluation Considering Confidence Based on Z-AHP-TOPSIS Method, *Applied Sciences-Basel*, Volume 11, DOI 10.3390/app11167400

Negulescu, OH., Doval, E., (2021) Ergonomics and time management in remote working from home, *Acta Technica Napocensis Series-Applied Mathematics Mechanics And Engineering*, Volume64, Page99-108

PMBOK Guide, (2013), *Project Management Body of Knowledge*, https://www.pmi.org/pmbok-guide-standards/foundational/pmbok

Roşca L., Roşca L., Oleksik L. (2021) *Introducere în Microsoft Project*, Editura Universităţii "Lucian Blaga" din Sibiu, ISBN 978-973-739-821-5

Vlad, RC., (2020), Simulation based evaluation and analysis of the production capacity, *Review of Management and Economic Engineering*, Volume 19, No. 4

Wright JN (1997), Time and budget: the twin imperatives of a project sponsor, *International Journal of Project Management*, Volume 15, Issue 3, Pages 181-186