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Teaching module 6. Environmental projects management

6.2 Resources management. Risk management

Resources management. Risk management

Daniel Jiroveanu – Bucharest University of Economic Studies

Florin Anghel – Bucharest University of Economic Studies

Contents

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Introduction

The implementation of environmental projects involves the use of material, human and financial resources, the allocation of which conditions the execution of activities, the observance of budgets and the achievement of the expected results. Resources are, along with time and quality, one of the three essential parameters that a project manager must monitor during the development of environmental projects.

In environmental projects it is the responsibility of the project manager to identify and establish the resource requirement for the project, both in the long term, within the general planning, and in the short term, for the detailed planning. It must determine what resources will be needed, when they should be available and in what quantity.

The availability of resources in environmental projects is not always certain because various factors such as seasonal constraints, competition for resources between project managers within the same organization, difficulties in carrying out procurements can occur. Therefore, the use of resources in environmental projects must be carried out knowing the methods and techniques specific to resource management.

As they are carried out, environmental projects may face a number of specific risks, the materialisation of which may have an effect on the duration, quality and cost of projects. The ability of the teams that carry out environmental projects to identify and analyze risks depends to a great extent on knowing the content of the stages that make up the project risk management process.

This unit of the course has as main topics resource management and risk management in environmental projects. After studying this unit, students will have the opportunity to know:

- the way resources are used in environmental projects;
- determining the need for material resources for a project;
- programming of material resources in environmental projects;
- improving the programming of material resources by allocating and leveling resources;
- the specific stages of the risk management process;
- specific methods and techniques applicable in the risk management process.

By knowing the essential elements regarding resource management and risk management, students will be able to apply them in the future environmental projects in which they will be involved so that they achieve their objectives in terms of ensuring the necessary resources and minimizing the impact of potential risks.

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Chapter 1 – Resource management in environmental projects

1.1. The particularities of the resources used in environmental projects

The changes that have occurred lately have a major impact on the environment. Statistics confirm negative records in many respects: temperatures, storms, pollution, fauna and flora. Most of these changes are closely related to social activities (production, transport, consumption, etc.) which, according to studies, have a major impact on the environment.

In this context, environmental projects are of particular importance and the need to implement them is urgent. Their role is determined either by the need to reduce the impact of social activities on the environment, or to protect it or to restore the environment where this is still possible (Figure 1). At the same time, the opportunities regarding environmental projects must be used as a priority because the time needed to achieve results is limited

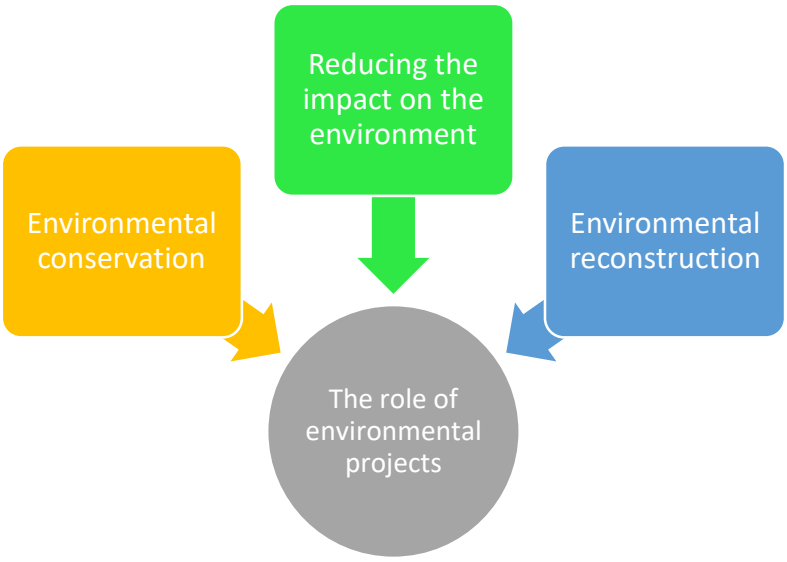

Figure 1. The role of environmental projects
source: own creation

Due to the significant results that are pursued through the implementation of these projects, they are characterized by a high degree of complexity with a significant impact on resources. Regarding this aspect of environmental projects, both the resources used in the projects and the resources as a result of the environmental

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projects must be taken into account; for example reducing consumption, conserving and regenerating resources (fi.

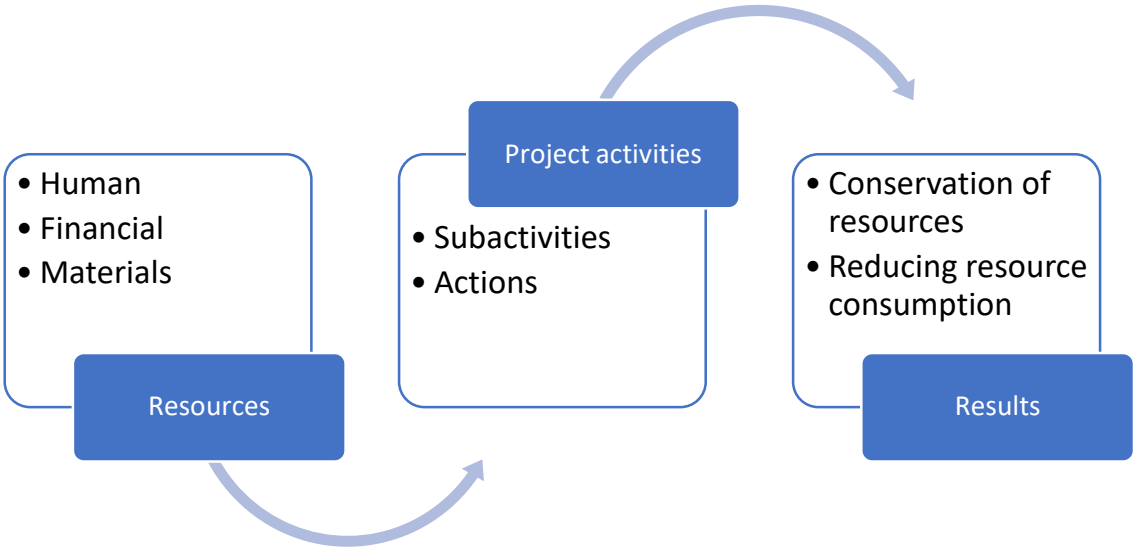

Figure 2. The role of resources in environmental projects

source: own creation

Next we will focus our attention on the material resources used in environmental projects. These resources are divided into several categories according to their nature. Energy resources are resources that allow, through their consumption, the carrying out of processes involving machines, machinery and equipment that work efficiently only by using large amounts of energy. (figure 3)

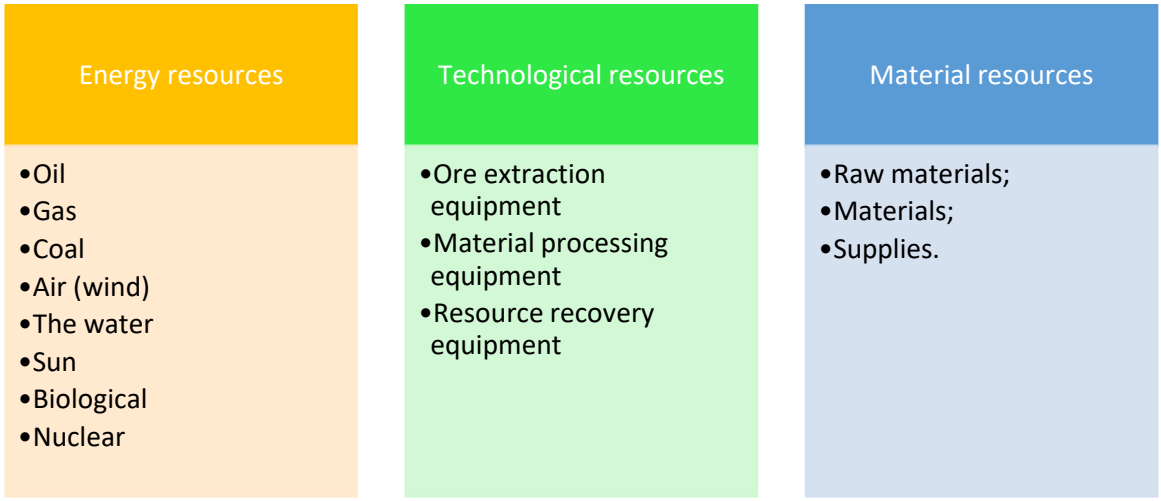

Figure 3. The main categories of resources

source: own creation

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These resources require optimal use because some are irrecoverable (e.g. gas and oil) and others are hardly renewable (those of a biological nature). As far as the environment is concerned, the use of these resources must be as environmentally neutral as possible, the impact on it must be minimal. At the same time, the equipment and materials used on the technological flow from extraction (extraction) to consumption (the final customer) must involve as little impact on the environment as possible and a low energy consumption. Last but not least, extensive environmental recovery/regeneration operations must be considered. (Figure 4).

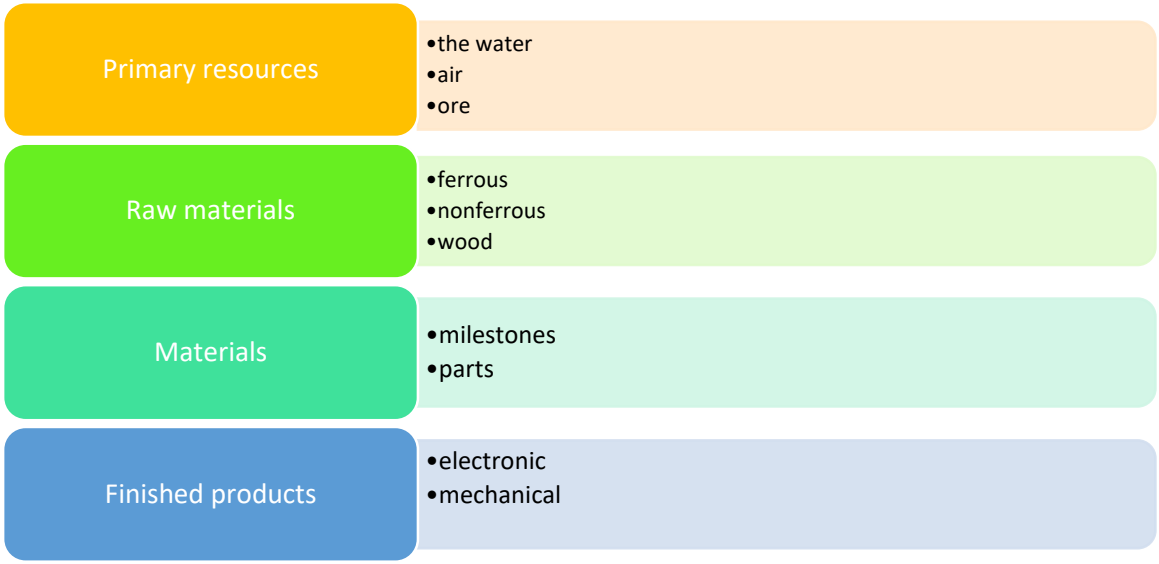

Figure 4. The main stages of product production

source: own creation

The development of society at an increasingly accelerated pace is due to the growing social needs, but also to the technology that has generated an explosion of innovations. In this context, social, economic and technological activities have constantly developed. New products and services were discovered or invented that required the development of new factories or the reconfiguration of already existing productive flows. All these actions cause a substantial impact on the environment due to the growing need for resources (minerals and energy).

In this context, environmental projects are of particular importance and aim either at reducing or reducing the impact of human activity on the environment or at measures to regenerate and restore the environment. The complexity of these projects is also given by the fact that the environment comprises a set of interconnected elements, the most important of which are:

- Material and energy resources;
- Complex systems (ecosystems) comprising all interconnected elements of a social, cultural, economic, technological nature in a given geographical area.

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Environmental projects take into account the complexity of ecosystems that are complex in nature and function as true organisms. Damage to a single component of them can generate a major impact, rapid deterioration, often of an irreversible nature. Thus, environmental projects are complex projects with a major direct or indirect impact on geographical, biological, climatic factors, etc. For example, the objectives of environmental projects are currently focused on the possibility of carbon storage, reduction of the quantities generated by human activities, etc. In addition, a number of secondary objectives whose value is difficult to quantifiable but which areof particular importance may be considered:

- improvement of the effects of harmful climatic factors;
- reducing soil erosion;
- mitigating the effects of climate change;
- improving the water retentioncapacity;
- improvement of water quality;
- increasing the use of renewable energy sources.

1.2. Procurement and use of resources in environmental projects

The realization of environmental projects involves going through the standard stages of a project: elaboration, implementation and evaluation. At the planning stage, special attention is paid to the resources involved in the project. The main categories of resources used in the project are: material, human and financial resources.

As far as material resources are concerned, at the stage of drawing up environmental projects, these resources must be sized in detail in terms of quantity, quality, value, temporary and bureaucratic. The establishment of the necessary resources and details of these resources are carried out starting from the activities to be carried out in order to achieve the objectives proposed by the project. Thus, starting from the project graph that highlightsthe activities, the plan for the acquisition and use of resources is built. In Figure 5, an example of a graph for an environmental project is shown.

No	Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Providing the necessary material resources																								
2	Field studies (soil, water, temperature, wind, etc.)																								
3	Specific activity 1																								
4	Specific activity 2																								
5	Specific activity 3																								
6	Specific activity 4																								
7	Specific activity 5																								
8	Reporting																								

Figure 5. Simplified example of an environmental project
source: own creation

The provision of resources is a vital stage in the development of environmental projects, as it has the role of providing the necessary resources in qualitative and quantitative parameters specified for the good implementation of

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the project. The duration of these activities is influenced by the nature of the resources, their availability, the storage possibilities and the evolution of their prices. Thus, material, energy and technological resources will be treated differently.

Material resources are resources that, with small exceptions, can be stored, which allows them to be purchased in advance. The advance purchase decision must be based on cost calculations so that the time when the cost of these resources is minimal is capitalized.

Energy resources are resources that can also be stored under certain conditions and spaces. However, those resources, in order to be stored, involve relatively high costs, which often obliges the adoption of contracting decisions for the purpose of supply at the time of use.

Technological resources (equipment, machinery) are resources that cannot be stored, and in their case it is extremely important to ensure availability at the time of use. And these resources require pre-contracting, with guarantees of availability at the time necessary for use.

Thus, in the example presented above, the activity of purchasing resources can be extended until the month of 20 when the material resources necessary for the last month specific to the activity number 5 can be obtained.

The costs of the resources used are substantial and require a number of measures to reduce them. In order to reduce these costs, the acquisition costs (which depend on the availability of resources at the time of purchase) and the storage costs should be taken into account if they are purchased in advance and require a storage period.

The study section has the role of identifying both the current situation of the main environmental characteristics and their dynamics, with emphasis on the future evolution and highlighting the possible degradations of the environmental components. This activity is extremely useful for identifying the conditions for the development of the project, but also involving significant costs.

Starting from the graph of activities shown in figure 5, a schedule of acquisition and use of resources by activity is detailed. One such example is shown in Figure6, where the columns show the evolution over time of the project; the time is expressed inmonths. This example can be filled in, in colored cells with values representing, for example, the required quantities in each resource, for each planned delivery and use.

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No.	Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Providing the necessary material resources																								
	Resource 1																								
	Resource 2																								
	Resource n																								
2	Field studies (soil, water, temperature, wind, etc.)																								
	Resource 1																								
	Resource 2																								
	Resource n																								
3	Specific activity 1																								
	Resource 1																								
	Resource 2																								
	Resource n																								
4	Specific activity 2																								
	Resource 1																								
	Resource 2																								
	Resource n																								
5	Specific activity 3																								
	Resource 1																								
	Resource 2																								
	Resource n																								
6	Specific activity 4																								
	Resource 1																								
	Resource 2																								
	Resource n																								
7	Specific activity 5																								
	Resource 1																								
	Resource 2																								
	Resource n																								
8	Reporting																								

Figure 6. Example of staggering of the acquisition and use of resources in environmental projects

source: own creation

In the previous example, it is noted that the project uses three resources, generically denoted r1, r2 and r3. In terms of resources, the activities fall into two main categories:

- purchasing activities (in our case activity 1) and
- use activities (in our case activities 2 – 7).

There are also environmental projects, in which the schedule of activities includes, for each activity separately, a sub-activity of purchasing the necessary resources strictly for that activity. This way of organizing over time is specific to environmental projects where activities use distinct resources. It is not recommended if the same resources are used in more than one activity.

As for the first resource (in green), it is noted that it has a purchase duration of two months and is purchased for each activity in which it is involved. In the case of this resource, only one contract may be concluded, but with delivery in three lots (at the end of months 3, 12 and 15). The resources that are the subject of such planning, in environmental projects, are technological resources, and sometimes energy resources.

As can be seen in the previous graph, the second resource (customized in orange) is a resource similar to the first and is procured distinctly for each task in which it is involved (four purchases for four activities in which the resource is used). This resource belongs to the category of resources that for various reasons (economic or technical)

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cannot be stored or is not available in the total quantity so that it is purchased only once. At the same time, there may also be a situation in which the storage or procurement in a single batch generates a substantial financial effort (with a major impact on the cash flow).

The last resource in this example (the third resource customized in yellow) is a resource that is purchased in a single batch and used in four tasks (tasks with numbers 3, 4, 6, and 7). The resources that are procured and used in such a way are the material ones that have the property that they can be stored for longer periods of time and at relatively low cost. Obviously, if the storage costs are high, it is recommended to purchase them and deliver them in several lots, by correlating with the activities in which they will be used (not to generate delays in carrying out the activities).

Next, for managing resources in environmental projects, it is recommended to generate a custom graph for each resource. For example, we will refer to the first resource (green in color) for which we will generate detailed representations in order to highlight the efficient use of this resource.

No.	Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Providing the necessary material resources																								
	Resource 1		60									120			90										
2	Field studies (soil, water, temperature, wind, etc.)																								
	Resource 1				20	20	20																		
5	Specific activity 3																								
	Resource 1													40	40	40									
6	Specific activity 4																								
	Resource 1																30	30	30						

Figure 7. Graph of the acquisition and use of resource 1

source: own creation

The graph of resource 1 is detailed not only in terms of time, but also in terms of the required quantity. This resource has a purchasing period of two months, calculated from the moment of launching the order to delivery. As can be seen in the previous graph, in the second month of the project, 60 u.m. of the resource necessary to be used in activity 2 (months 4 – 6, 20 u.m. are ordered each month). The second batch of the resource, in the amount of 120 u.m. is ordered in the 11th month and will be used in the 5th activity (months 13 – 15, 40 u.m. every month). The last batch, necessary for activity 6 is ordered in the 14th month, in the amount of 90 pieces.

For each resource, it is recommended to use a similar graph that highlights the following:

- the activities of purchasing the respective resource and the delivery lots, if the purchase of the resource is carried out in a sely way;
- the activities in which that resource is used and the quantities used (preferably detailed by month, week, day, depending on the detail of the graph);

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- within each activity, quantitative (kg, piece, set for raw materials, hours for human and technological resources) or value (euro, dollars, i.e. the cash equivalent of the quantities specified above) are specified.

All these aspects are specific to the planning activity. The graphs correspond to an estimate in terms of the procurement and use of each resource involved in the environmental project. Once the planning work is completed, you can proceed to the project implementation stage. Ideally, the estimates made in the planning process correspond entirely to the achievements in the implementation phase. The differences that may occur between the two stages are generated by the manifestation of phenomena that influence the achievement of the proposed objectives. These phenomena are characterized by the probability of occurrence and impact and are specific to the risks of environmental projects that will be detailed in the next chapter.

A project to create a waste collection and recycling system, including underground, at the level of Ghimbav, Brașov county, involves the use of material resources (bins, compactor, bell) and human resources (project manager, designer, worker) . The list of resources is shown in figure 8.

	Resource Name	Type	Material Label	Initials	Group	Max. Units	Std. Rate	Ovt.	Cost/Use
1	Underground ecological island K10	Work		I		2%	$0.00/hr	$0.00/hr	$0.00
2	Ecolbell 3 mc	Work		E		3%	$0.00/hr	$0.00/hr	$0.00
3	Compostainers 310 l	Work		C		700%	$0.00/hr	$0.00/hr	$0.00
4	Bins 120 l	Work		P		700%	$0.00/hr	$0.00/hr	$0.00
5	Compactor K Solar 10 mc	Work		C		4%	$0.00/hr	$0.00/hr	$0.00
6	Bell IGLUS 3 m3	Work		B		15%	$0.00/hr	$0.00/hr	$0.00
7	Consultant	Work		C		2%	$0.00/hr	$0.00/hr	$0.00
8	Project Manager	Work		P		100%	$0.00/hr	$0.00/hr	$0.00
9	Designer	Work		D		100%	$0.00/hr	$0.00/hr	$0.00
10	Worker	Work		W		500%	$0.00/hr	$0.00/hr	$0.00

Figure 8. List of resources in MS Project for the recycling project

source: own creation in MS Project

The graph of the use of human resources (project manager, designer, worker) for the construction project of a waste collection and recycling system, including underground, at the level of Ghimbav locality, Brașov county is presented in figure 9.

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Resource Name	Work	Details	T	F	S	Jan 23, '22 S
Staff training for exploitation	112 hrs	Work				
Final documentation	56 hrs	Work				
Project manager	1176 hrs	Work	16h	16h		
Documentation	160 hrs	Work				
Lands	320 hrs	Work				
Machinery and equipment contracting	112 hrs	Work				
Water supply	56 hrs	Work				
Construction works	160 hrs	Work	8h	8h		
Electrical installations	96 hrs	Work	8h	8h		
Installation of technological equipment	160 hrs	Work				
Staff training for exploitation	112 hrs	Work				
Designer	216 hrs	Work				
Documentation	160 hrs	Work				
Final documentation	56 hrs	Work				
Worker	1888 hrs	Work	64h	64h		
Construction works	800 hrs	Work				
Electrical installations	288 hrs	Work	24h	24h		
Installation of technological equipment	800 hrs	Work	40h	40h		

Figure 9. Resource usage chart in MS Project for the recycling project

source: own creation in MS Project

1.3. Resource allocation and leveling in environmental projects

Improving resource scheduling is done by allocating and leveling the use of resources.

The allocation of resources aims at obtaining some programs with the minimum execution time, taking into account the existing (available) amounts of resources. This implies the distribution of existing resources so that the profile of the required resources does not exceed the profile of the available resources, the duration of the project being within the limit of the critical path (Radu, 2008).

However, some resources may be overallocated. Figures 10 and 11 show the graphs showing the overallocation of resources for the project manager and worker resources in the case of the waste collection and recycling system project.

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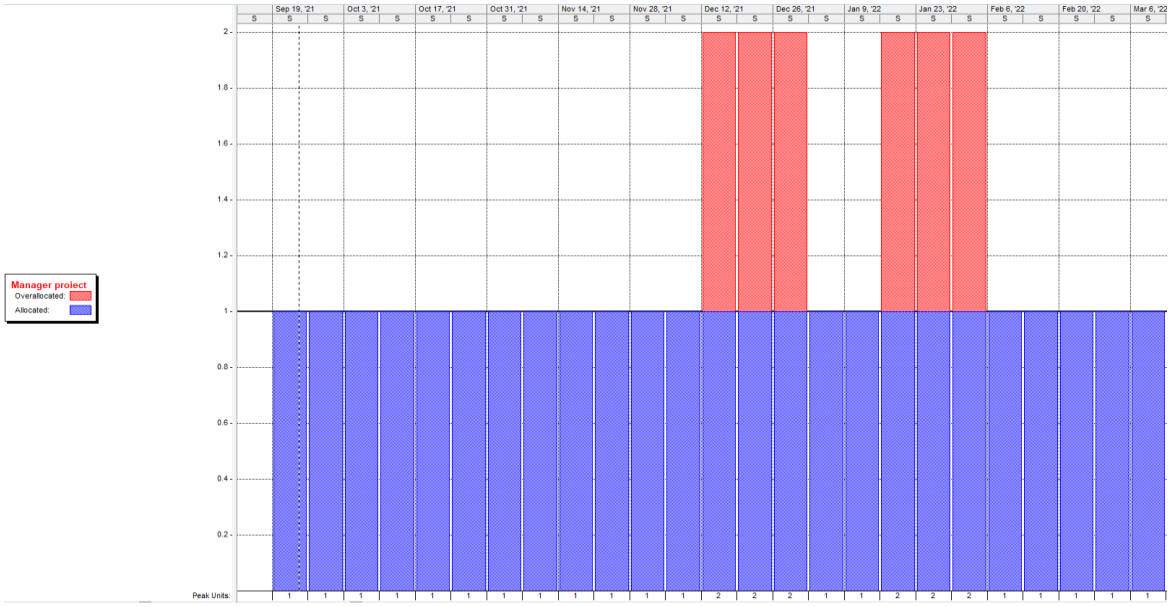

Figure 10. Graphical overallocation of the "project manager" resource in MS Project for the recycling project

source: own creation in MS Project

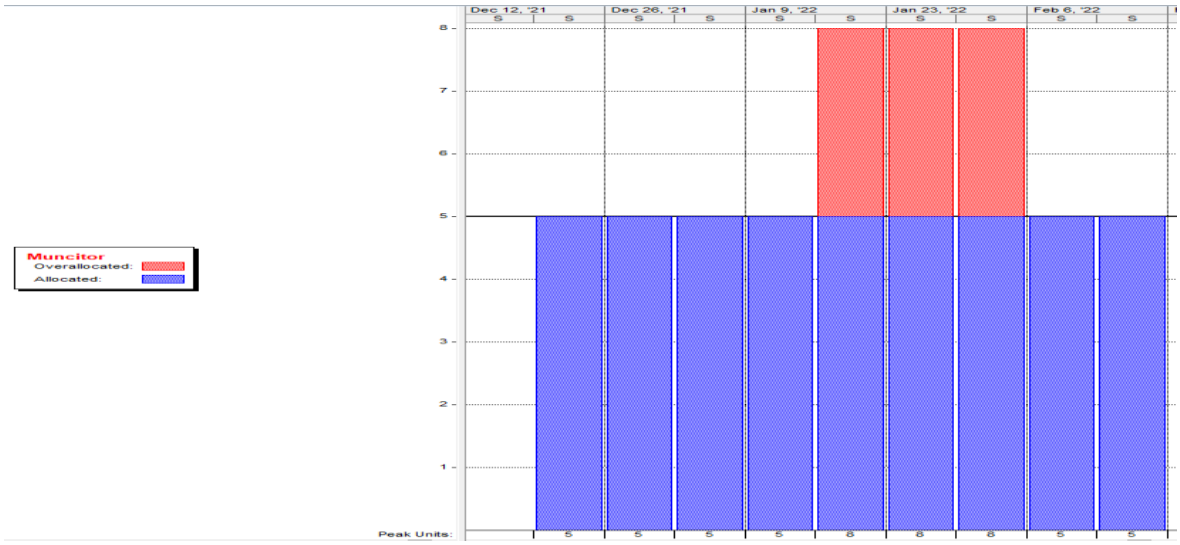

Figure 11. Graph overallocation of the "worker" resource in MS Project for the recycling project

source: own creation in MS Project

The leveling of the use of resources aims at obtaining minimum durations for the realization of the projects, under the conditions of equalizing the consumption of resources for the entire duration of the execution of the project, or for determined time intervals. It consists in establishing a work program whose duration does not exceed

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the length of the critical path but which presents an improved profile of resource consumption (Radu, 2008). Figure 12 shows the Gantt chart of the execution of the recycling project before resource leveling.

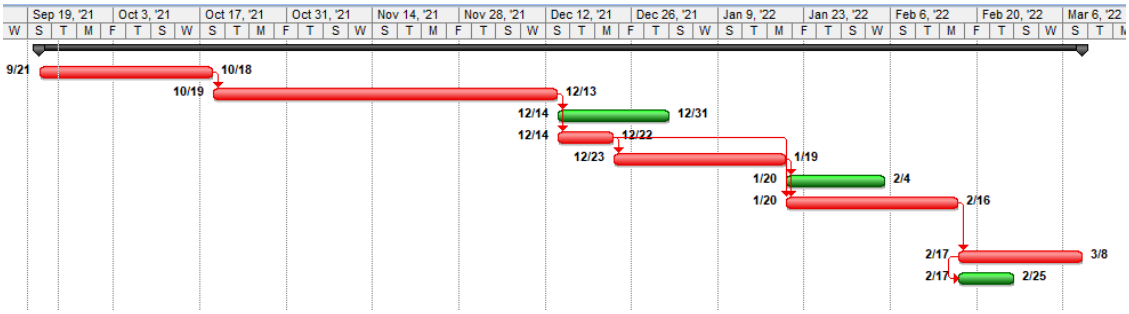

Figure 12. Gantt chart before leveling in MS Project for recycling project

source: own creation in MS Project

The following figure shows the Gantt chart of the execution of the recycling project after the leveling process.

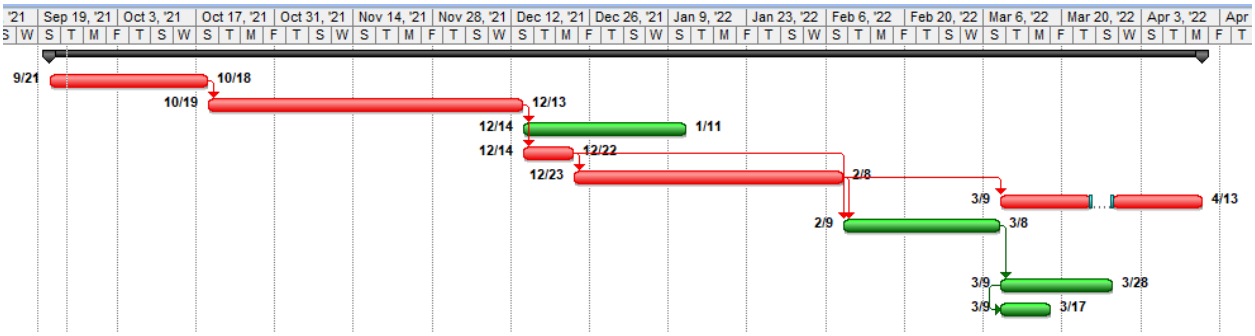

Figura 13. Gantt chart after leveling in MS Project for recycling project

source: own creation in MS Project

Chapter 2 – Risk management in environmental projects

2.1. Stages of the risk management process

Environmental projects are projects with a high degree of complexity and require special attention to planning and implementation activities. As regards the planning work, it is characterised by the need to make the most precise estimates of the durations, resources involved and the costs necessary for the implementation of the project. This activity also includes a section highlighting the dangers that can manifest and negatively influence the project. These hazards lead to the diminishing of the effects or the increase of the efforts necessary to carry out the project, which is why they must be identified and diminished. Thus, the risk section of environmental projects has the role of highlighting, analyzing and counteracting these dangers.

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These dangers determine the reduction of the effects or the increase of the efforts necessary to realize the project, which is why they must be identified and reduced. Thus, the risk section of environmental projects has the role of highlighting, analyzing and counteracting these dangers. There are also specialist approaches that treat risk both as a potential danger and as a potential opportunity (Sholarin & Awange, 2015). The PMI specialists believe that *"an event or an uncertain condition that, if it occurs, has a positive or negative effect on the project's objective... Project risk includes both threats to the project's objectives and opportunities to improve these objectives"*(Project Management Institute, 2013). Risks also arise from little control over projects. (Wysocki, 2009).

The main steps to be taken for the management of risks specific to environmental projects are presented in Figure 14.

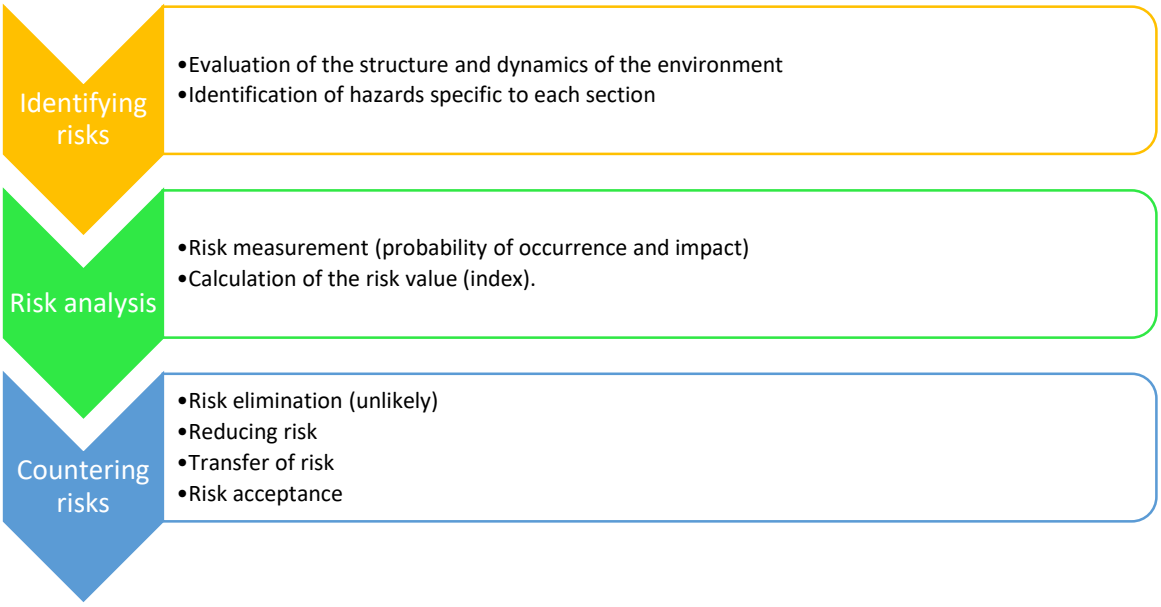

Figure 14. Stages in the management of risks specific to environmental projects

source: own creation

The risk management process is one of developing and documenting a comprehensive and interactive approach to identifying and analyzing risks, developing response plans and risk monitoring (Kerzner, 2009).

2.2. Risk identification

The first stage, that of risk identification, takes place in the generation of a list of risks specific to environmental projects. This list (table) includes the risks, the area of origin, details and possible effects. Regarding the area of origin, figure 15 details the structure of the environment for easier identification of risks. Risks can be internal and external to projects (Turner , 2009).

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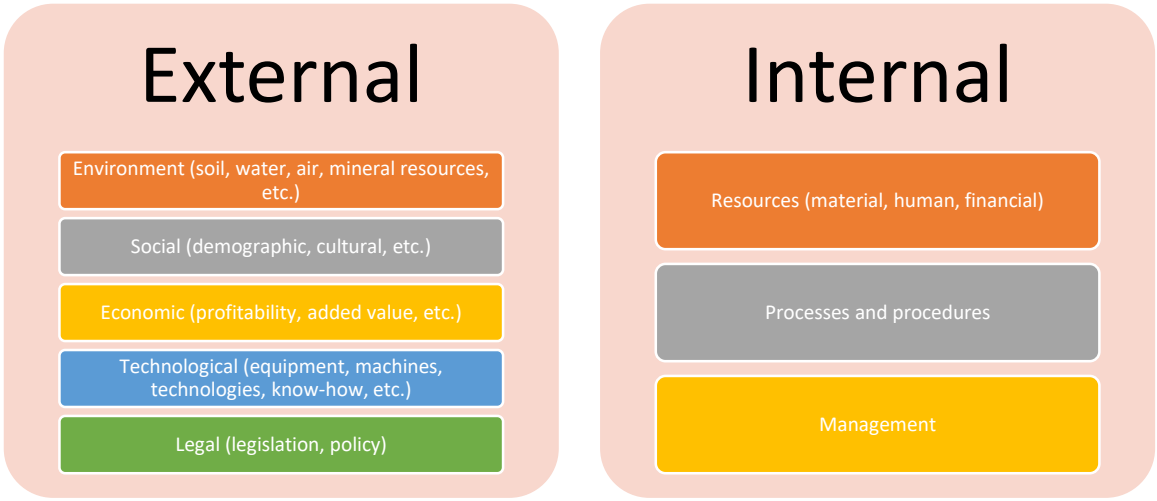

Figure 15. Main risk sources for environmental projects

source: own creation

Based on the structure shown in the previous figure, it is recommended to follow in detail each section as well as their dynamics. It is not recommended to summarize only from a structural point of view because the dynamics of some environmental factors can cause rapid changes in some risk-generating parameters. An example of this is the accelerated deterioration of the climate under the impact of pollution, with increasingly unfavourable effects on the environment and, implicitly, on environmental projects.

The process of identifying risks in environmental projects requires the use of specific methods. To identify risks, can be used methods such as: risk control lists; risk table; the logical tree of the hazard; using the intuitive experience of managers; standard questionnaires completed by the people involved in the project activities; fault tree analysis; structured interviews; the risk breakdown structure (Radu, 2008). The risk breakdown structure is one of the most widely used approaches for identifying project risks (Hillson , 2002).

2.3. Risk analysis

The second stage, that of risk analysis, requires the use of mathematical and statistical models or calling on specialists to determine the probability of the occurrence of risks. This indicator (probability) is quantified with values between 0 and 1 or 0 and 100%. To determine the impact on environmental projects, it is recommended to determine the impact of risk manifestations on the project. For this purpose, several methods of determination can be used, the most important of which are:

- *using a scale with values from 1 to 5.* In this case, values from 1 to 5 will be given for each identified risk according to the estimated impact;
- *using percentages to determine the impact on the project structure (quality, time, budget)*. In this case, percentages from 1% to 99% are used to establish the impact of each risk on the structure. For

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example, a risk regarding the procurement of resources, if manifested, can generate an impact on the duration of the project, causing it to increase by 30%, or a risk regarding the increase in the price of material resources, which causes an increase in the project budget by 15%;

- *the use of a system for quantifying the impact strictly in money.* In this case, both the quality, the budget and the time will be converted into monetary values, and any exceeding of the time, the budget causes penalties that can be precisely calculated and therefore expressed values.

Based on the probability of risk occurrence and their impact, the risk index is determined according to Figure 16. The result of this step is a list of risks placed in descending order according to this index. The first positions will be the 'serious' risks that require permanent monitoring and immediate and detailed action plans. Less 'serious' risks require regular monitoring and more synthetic action plans. If, as a result of risk monitoring, changes and increases in indices are found, the list shall be updated. Following the update, some risks may become 'serious' and will impose detailed action plans.

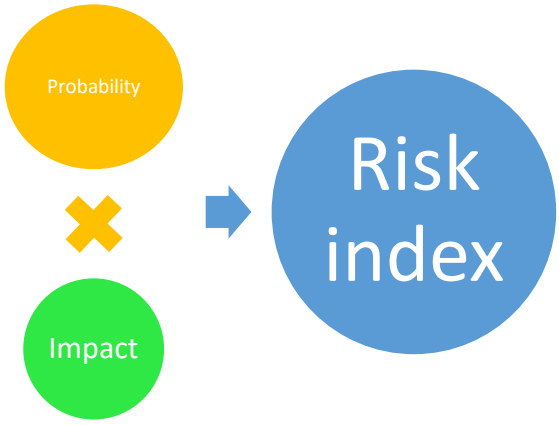

Figure 16. Determination of the risk index

source: own creation

The most important risk analysis methods in environmental projects are: the expected monetary value method, the standard normal deviation method, probability-impact matrices, sensitivity analysis and simulations. Other specialists also recommend the use of decision trees (Havranek, 1999).

2.4. Risk countering

The thirdstage, the one of countering risks, involves the development of action plans that take into account the following aspects:

- *The elimination of risks,* an example of this is the risk of destruction of archives by fire. To eliminate this risk, the archive is kept in digital format and in several locations, including cloud solutions.
- *Risk mitigation* is considered if the risk cannot be eliminated. Measures will be taken to reduce either the likelihood of occurrence or the impact.

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- *Transfer,* is a damage solution and must be treated with the utmost care. This involves moving the impact between the structural elements of the environmental project. For example, if there is a risk of exceeding the duration of the project, efforts can be made to expedite the activities, which generally involve additional costs (e.g. overtime work). If the project budget provides for reserve amounts or savings could be made during the project, then they can be used for such risk transfer.

For example, if there is a risk of exceeding the duration of the project, efforts can be made to expedite the activities, which generally involve additional costs (eg working overtime). If the project budget provides reserve amounts or savings could be made during the project, then these can be used for such a risk transfer.

All these risk sections must be included in environmental projects. On the basis of these sections, certain decisions will be taken at the implementation stage on the implementation of action plans to address risks. Knowledge of the risks at the planning stage and the development of plans to counter them allows for actions to be carried out to ensure that the risks affect the environmental project to the least extent possible.

2.5. Risk register

Identified and analyzed risks can be entered into databases and/or risk registers so that their tracking and response actions are facilitated. Risk registers can have various forms and fields depending on the organization's experience in risk management and the specifics of the environmental projects being implemented. The following table presents a risk register for a composting project.

Tabel 1. Risk register for the composting project

No.	Description of the risk	Project activity affected	Probability	Impact (euro)	Expected value	Response actions
1.	Difficulties in recruiting the technical responsible for the project	Personnel recruitment for the project team	10%	1000	100	Allocations by expenditure chapters in the project budget
2.	Repetition of the procurement procedure due to non-compliance of offers	Procurement procedure for composting containers and facilities	20%	500	100	Introduction of a clarification period for the offers received
3.	Delay in landscaping works	Arrangement of composting spaces	10%	1500	150	Delay penalties provided for in

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						the contract
4.	Incomplete reporting on the results of the monitoring process	Monitoring the composting process	30%	500	150	Restructuring of project progress reports

Analyzing the risk register, it can be seen that minor risks (those that have a less significant impact on project activities) have higher probabilities of occurrence, while important risks have a rarer frequency. That is why the calculation of the expected value of the risk (or the risk index) allows a ranking of the risks.

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