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Comparative analysis of the financial discount rate and of the net present value of a public investment project throughout its life

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Abstract. *This paper sets out to identify the correlation between the variations in spending and revenue as the investment progresses through time and the evolution of the financial discount rate and of the net present value; it also seeks a method for computing the probability of reaching a certain value. The project's performance indicators are established at the "0" moment, when costs and revenues are estimated for the entire life of the project. It would be useful for any investor, even if they are local administrations, to follow the actual evolution of their investments as they develop through time. The positive or negative deviations from the performance indicators can determine the investor to adopt tailored decisions for each particular case in order to maintain a minimum set-performance for the project.*

Keywords: discount rate, sensitivity analysis, net present value.

JEL Classification: G11.
REL Classification: 11D.

Introduction

Public projects are the instruments used by public administration and by public authorities in general to implement their strategy. This is done through the use of investment resources over a limited period and with a strict delimitation at either a local or a national level. Through projects of infrastructure, the various investors always seek to meet the goals formulated in the local or regional development strategies and policies.

The desired development of the local community is achieved by combining the resources and solutions available at a certain time into local investment projects, which are initiated by the administrations within the constraints of the allocated funds.

Apart from the initial starting capital, any investment project must be attributed with further capital in order to insure proper functioning throughout the exploitation period, when there will be a need to replace or modernize the machines and equipment in use.

The advantages associated with infrastructure investment projects are the useful results, anticipated and expected by the local administration (the investor) after realizing the goal set out by the projects and by their final beneficiaries of as well (the local communities).

The return on capital is the investor's payoff and it is the main advantage enjoyed for the risk and financial effort made in infrastructure projects. The advantages earned after a project is complete are the compensation between the costs incurred by the project both in the building and in the exploitation phase on the one side, and the expected benefits on the other.

The calculations necessary for the evaluation of investment projects are realized in a time period which, usually, long precedes the starting date. Also, the forecasts consider a relatively large timespan for the use of the goods (buildings, installations, equipment etc.) which are a result of the investment projects. A project analysis must observe two important aspects: the cost of realizing the project and the expenditure generated by the existence of the investment. From the point of view of the cost of realization the investment effort can be easily determined with sufficient accuracy, as it implies expenditures and resources which will transform into equipment, machines, buildings and special constructions etc. within the very near future. Looking at the effects of revenues and anticipated costs, the starting-point forecast is based on hypotheses and information which are prospectively estimated by looking farther into the future. Predictions are made on: the exploitation period, the performance and functioning parameters of the future structures being built, the commercial aspects of the activity (even if it only deals with the delivery of drinking water by a water-supply system) by convincing the population that the water resource which bears a “cost” is safer and healthier than the previously used resource – the well – which did not require upkeep, and all this taking into account the supply of raw materials (both for the potable water system as well for the sewerage and for the wastewater treatment), the sales situation (the market, the demand, the volume of sales, the acquisition and the selling prices, the revenues a.s.o.), the running costs and the final financial results (Anica-Popa, Alexandru, 2008, pp. 99-106).

All of these increase the level of uncertainty when evaluating the size of the profit and the forecasted level of efficiency. The advantages and efficiency of infrastructure investment projects must be evaluated while looking into the future and are thus attributed with a certain degree of risk.

As such the responsibility of the analysts and of the beneficiaries (local administrations) is evident, as they draw out the investment decisions, the necessity for comparative studies and analyses etc. all with the final goal of obtaining and supplying correct and credible evaluations on the efficiency of their investments.

The lowest accepted level of efficiency in infrastructure investments implies the judicious use of allocated resources. The financial resources are not wasted and an acceptable profit is set with regard to the costs attracted, while the functioning and quality parameters are guaranteed for the products offered by the projects (drinking water and treated water).

When looking at the specifics of infrastructure investment projects aimed at water supply and sewerage we notice that these are entirely self-financed, as the investment effort is recuperated in its entirety throughout the life-cycle of the projects and their exploitation is made according to the principles of autonomous management.

If the fundamental objective in the evaluation of private commercial projects is the profit, which defines their existence and their success, when it comes to public projects there are multiple objectives of an economic, social and ecological nature as well as issues of a cultural nature.

The money flows in the initial years of the investments are usually negative and turn positive after several more years. Because they decrease with time, the negative values if the initial years carry more weight than the positive values of the later years. This means that choosing a time span is crucial when determining the net present value. Furthermore, the choice of discount rate influences the evaluation of the net present value.

When there is a positive net present value, it means that the project generates a net benefit. In other words it can be an appropriate measure for the added value brought to society by the project, in money form. Also, the net present values are useful in the rating of the projects and in deciding which one of them is best.

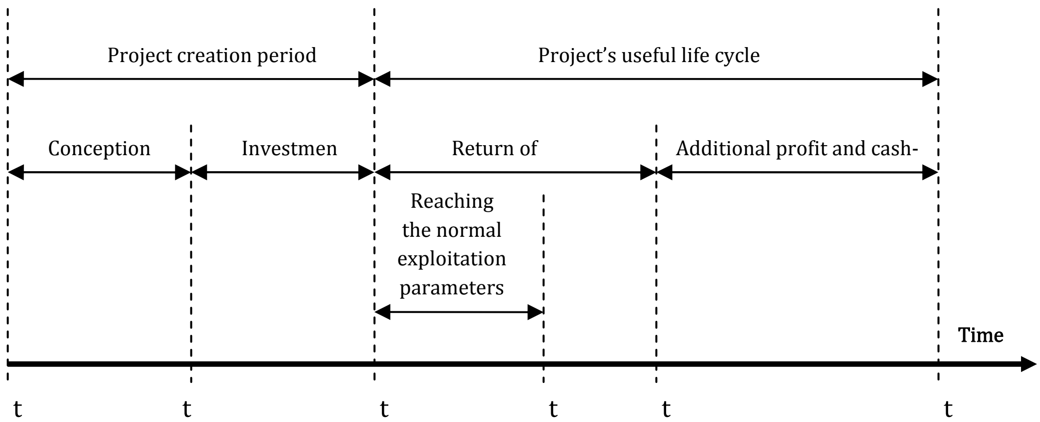
The usefulness of financial analysis at the start of the investment project is in calculating its internal rate of return and comparing it to the discount rate. For each type of project, and especially for those which generate profit, it would be useful to employ an analysis which keeps track of the meeting of performance indicators throughout the exploitation period.

1.1. The lifecycle of infrastructure investment projects

The lifecycle of an infrastructure investment project in water-supply and sewerage is comprised, time wise, from the time interval which begins at the start of the project (the "t_0" moment) and the "t_5" moment. This time interval refers to several periods, steps and stages which succeed each other from the moment when the idea for the project emerges to the expiration of the investments, through decommissioning or demolition etc. Within the life cycle of infrastructure projects a series of operations and activities occur, which are integrated into a unitary process for using the goods of said project.

From a temporal point of view, we first distinguish in the life cycle of a project a series of milestones which are characteristic to any investment decision-making process. Thus, the starting "0" moment is the emergence of the idea of an infrastructure investment project. Beginning from this moment enough time passes in order for the future investment decision to be prepared by means of studies, research and specific documentation. In other words, a journey is made from idea to project generation: identifying the need and the opportunity, creating feasibility studies, technical projects, execution details etc.

Figure 1. *The life cycle of infrastructure investment projects*



Source: Prelipcean, 2008, p. 47.

The "t_1" moment marks the start for the spending of the funds allocated to the infrastructure investment project. From this moment (t_1) the investment process begins in a restricted sense: the investment objectives are set out, the physical capacities are appraised for the production of drinking water, of water supply and sewage networks, of treatment plants and of adjacent services.

The "t_2" moment signals the beginning of the exploitation of the water and sewer networks and of the treatment plant which constitute the objectives of the investment project. This phase also includes the technological test and the instruction of personnel. The investment process ends and the exploitation activity begins. The "t_2" moment also marks the beginning of the useful life cycle of the freshly commissioned facilities.

From an economical and managerial standpoint the "t_2" moment is particularly important in defining any investment project. It reveals the length of time spent from the initiation of work to the final commissioning and bring about the benefits which were expected from the beginning of the project.

The "t_3" moment sits at the end of the period needed for the facilities to reach normal functioning parameters. The newly built infrastructure for water supply and sewerage has reached the proper technical, economic and financial indicators. The "t_3" moment also marks the critical point (the neutral point, or the point of balance in the exploitation) when the revenues precisely match the costs and the profit is zero. From now onward the efficient exploitation begins, which generates profit and cash-flow and provides the expected advantages envisioned by the investors.

The "t_4" moment marks the end of the economic process meant for the recovery the initial invested capital from the profit and cash-flow generated since "t_3".

At "t_5" the economic life of the investment has expired and the disinvestment decision is adopted.

For calculating the performance indicators for the project the moment of reference is "t_0", as it was then that the revenues and costs for the exploitation period have been forecasted. For any investor, even if they are local administrations, it would be useful to follow the evolution of their investment throughout their exploitation cycle. The positive or negative divergence for the performance indicators may determine them to adopt decisions specific to each case, in order to maintain the minimum established performance for the project. As such, the analysis for the meeting of the performance indicator can be done at any point between "t_2" and "t_5".

1.2. The description of the investment

The object of the analysis will cover the network of potable-water fountains, in order for the necessary pressure and debit to be met. The realization of this potable-water distribution network and the creation of future prerequisites for the introduction of tap water to individual households are elementary conditions for increasing the comfort level of households and the general quality of life for the population. The evacuation of wastewater is to be done through a sewer system which will transport the sewage of households, public institutions and commercial entities to a treatment plant where it will be cleaned, disinfected and released into the hydrographic circuit. All the facilities will not induce further negative effects to the soil, drainage, microclimate, surface water, vegetation or fauna; they won't add to the noise levels or ruin the landscape. The estimated value of the investment is 1,543,563 euro and it will be completed in 12 months.

Due to the higher investment costs implied by the acquisition of high-tech equipment and technologies, which will insure a superior performance throughout the life of the project, it is natural for any investor to expect lower running costs, a higher productivity, lower specific consumption, a higher revenue and a greater profit. In infrastructure investment projects, the annual running costs are with raw materials, fuel and energy, personnel, taxes and duties etc.

1.3. Establishing the costs and revenues for the forecasting period

The possible costs and revenues are established for any investment project in its feasibility stage, looking forward into a reasonably long time period in order to determine the efficiency indicators.

The point of departure is from the studies on the demand of potable water for the population, animals and irrigation on the one hand and the quantity of water which needs to be treated, on the other hand.

The starting tariff is of 0.5 euro/m^3 for the potable water delivered into the network and 0.75 euro/m^3 for the drained and cleaned water, at 2006 price levels. The values are established based on the running costs of the installations.

We consider these tariffs as constant, without looking at the future effects of inflation (there is the possibility that the negative effects on the tariffs meant for the population will be supported by the local budget, in the form of subsidies). In the future, the rising volume of water delivered, drained and cleaned will generate an increase of total revenues to a greater extent than the increase in costs, due to the nature of variable and of fixed costs. The variable costs will expand with the volume of delivered, drained and cleaned water (the cost of the reactive used, for example), while the fixed costs will stay relatively constant (amortization costs). This will lead to a reduction in the cubic meter costs of the delivered and drained water, and that of the cleaned water.

As an example we will take an integrated system for water delivery and drainage. During operation we can identify a series of costs which are generated by the existence of the water and drainage systems.

The running costs refer to the costs incurred by the personnel who service the delivery and cleaning stations, the costs of the reactive compounds and of the disinfectants, the cost of the electricity used by the pumps and the cost for transporting the sludge from the cleaning station to the storage locations approved by the environment agency.

The annual personnel costs will be:

- **For the water delivery facility:**

2 pers X 250 euro/month X 12 months X 1.28 = 7,680 euro

- **For the drainage installation:**

2 pers X 250 euro/month X 12 months X 1.28 = 7,680 euro

The electricity consumption will be calculated by looking at all the consumers which have been determined for the two networks.

- **For the water delivery facility:**

No.	Description of the consumer	No. of pcs.	Unit power kW	Installed power kW	Functioning power kW	Number of functioning hours [hours/day]	Energy consumed kWh/day	Energy consumed [kWh/year]
1	Submersible drilling pump	2	1.7	3.40	3.40	7.00	11.90	4,343.50
2	Chlorine pump	1	0.5	0.50	0.50	7.00	3.50	1,277.50
3	Exterior lighting elements	4	0.3	1.00	1.00	5.00	5.00	1,825.00
	TOTAL			4.90	4.90	-	20.40	7,446.00

- **For the drainage installation**

The energy consumption has been determined according to the power of the wastewater electric pumps, the treatment facility and the power draw of the lighting elements.

No.	Description of the consumer	No. of pcs.	Unit power kW	Installed power kW	Functioning power kW	Number of functioning hours [hours/day]	Energy consumed kWh/day	Energy consumed [kWh/year]
1	Submersible electric pump Q =1-2m³/h, H=12-47 mCA	3	1.00	3.00	2.00	11.00	22.00	8,030.00
2	Power draw of cleaning station	1	10.22	10.22	10.22	11.00	112.42	41,033.30
3	Exterior lighting elements	2	0.25	0.50	1.00	6.00	6.00	2,190.00
	TOTAL			13.72	13.22	-	140.42	51,253.30

The demand of raw materials for the two networks will be:

- **For the water delivery facility:**

Water consumption for the inhabitants supplied by the water system is:

Qzimed = 68.2 m^3/day or 2.84 m^3/h

Mean hourly sodium hypochlorite quantity is determined with the formula:

$$q = \frac{Qzi.med \times D}{1000}[Kg / day]$$

Where: D is the sodium hypochlorite dosage which during disinfection is:

D = 1.2 mg/L (or g/m^3)

From the above we determine the mean hourly quantity:

Q = 0.00341 Kg/day or 1.2 Kg/year

The number of containers needed given that one container holds 50 Kg pf chlorine:

Nb = 1.00

The yearly cost of the containers is:

1 container X 280 euro = 280 euro

- **For the drainage installation**

The running costs for the reactive compounds are based on the following quantities demanded by the volume of water meant to be carried and treated:

No.	Description of consumables	Unit of measure	Annual quantity	Cost (euro) w/o VAT	Total (euro) w/o VAT
1	Bio-compound for sediment stabilization	kg	1.50	98.00	147.00
2	Bio-compound for sediment mineralization	kg	1.50	98.00	147.00
3	Bio-compound for foaming reduction	kg	1.50	98.00	147.00
4	Bio-compound for fats break-up	kg	1.50	98.00	147.00
5	Potable water	m^3	20.00	0.40	8.00
	TOTAL CONSUMABLES				596.00

Looking at the classes of costs mentioned above we can determine the following annual costs and the cost for the quantity of potable water delivered or cleaned:

- For the water delivery facility

Total spending:

No.	Description of the expenditure	Unit of measure	Price per Unit [euro w/o VAT]	Annual quantity [Unit/year]	Annual expenditure [euro w/o VAT/year]
1	Electrical energy	kWh	0.08	7,446.00	575.58
2	Reactive compounds	Kg	280.00	1.00	280.00
3	Carried water	$1000m^3$	7.70	24.89	191.68
4	Maintenance, replacement parts and other costs		1,248.00	1.00	1,248.00
5	Personnel		7,680.00	1.00	7,680.00
	TOTAL				9,975.25

The cost of delivered potable water $= \frac{total\_\exp enditure}{volume\_of\_delivered\_water} = 0.40$ euro/m^3

- For the drainage installation

No.	Description of the expenditure	Unit of measure	Price per Unit [euro w/o VAT]	Annual quantity [Unit/year]	Annual expenditure [euro w/o VAT/year]
1	Electrical energy	kWh	0.0737	51,253	3,777.37
2	Consumables		596.00	1.00	596.00
3	Maintenance, replacement parts and other costs		1,500	1.00	1,500.00
4	Personnel		7,680	1.00	7,680.00
	TOTAL				13,553.37

Qzimed = 61.01 m^3/day

Cost of cleaned water $= \frac{total\_\exp enditure}{volume\_of\_cleaned\_water} = 0.61$ euro/m^3

For the outflows the price of purchase of the products and services will be considered, as these are necessary for the functioning of the installations as well for the supplementary services delivered. The financial inflows are based on the taxes and tariffs placed on the water delivery service. The tariffs for the collection and drainage of pluvial and residual waters will also be considered.

1.4. Calculation of the net present value and of the internal rate of return for the starting year

The internal rate of return (IRR) iVezs the value which, when used as a discount rate in computing the net present value (NPV), leads to NPV = 0, or respectively to an equal value of investment expenditure and of the sum of the discounted financial flows generated by the project. Also, the IRR describes the level of the interest rate which matches the discounted revenues resulted from the investment with the discounted expenditures/costs implied by the investment and which also makes the value of the discounted net revenue equal to zero.

The IRR is the solution to the equation:

$$NPV = 0 \Leftrightarrow \sum_{i=1}^{n} \frac{CF_i}{(1+IRR)^i} + \frac{RV}{(1+IRR)^i} = II$$

Where:
CF is the cash flow generated strictly by the project, without the influence of the current activity, calculated as the difference between the net financial cash flows generated by the enterprise when implementing the investment, and the net financial cash flows generated by the enterprise in option zero;
RV is the residual value;
II is the initial investment;
n is the total life of the project;
IRR is the discount rate for which the NPV is 0.

Another useful indicator in the evaluation of investment projects is the Net Present Value (NPV). The net present value is a very concise performance indicator for the investment project: it represents the present value of all the net flows generated by the investment, expressed through a single value.

$$NPV = \sum_{i=1}^{n} \frac{CF_i}{(1+d)^i} - I_0$$

Where:
d is the discount rate;
CF_i is the cash flow for the “i” period;
I_0 is the value of the investment;
n is the number of years forecasted.

Project flows determined for the moment „t_0" 2006 - euro

Indicators	1	2	3	4	5	6	7	8	9	10
Supply of household water	0	99,983	104,982	110,232	115,743	118,058	120,419	122,828	125,284	127,790
Supply of public water	0	1,095	1,150	1,207	1,268	1,293	1,319	1,345	1,372	1,400
Supply of water for irrigation and for animals	0	1,004	1,054	1,107	1,162	1,185	1,209	1,233	1,258	1,283
Supply of water for firefighting	0	0	0	0	0	0	0	0	0	0
Drainage and cleaning system	0	11,402	11,972	12,570	13,199	13,463	13,732	14,007	14,287	14,573
Revenues from services	0	113,484	119,158	125,116	131,372	133,999	136,679	139,413	142,201	145,045
Revenues from other services	0	0	0	0	0	0	0	0	0	0
Residual value of the infrastructure	0	0	0	0	0	0	0	0	0	0
Total revenues	0	113,484	119,158	125,116	131,372	133,999	136,679	139,413	142,201	145,045
Operation										
Labor force	0	15,360	16,128	16,934	17,781	18,670	19,604	20,584	21,613	22,694
Raw materials (reactive compounds and other materials)	0	1,068	1,121	1,177	1,236	1,261	1,286	1,312	1,338	1,365
Power for pumps and installations	0	4,353	4,571	4,799	5,039	5,140	5,243	5,348	5,454	5,564
Maintenance	0	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Cost of sludge removal	0	895	940	987	1,037	1,057	1,078	1,100	1,122	1,144
Total operating costs	0	23,176	24,260	25,398	26,593	27,628	28,711	29,843	31,027	32,266
Total costs for the investment	1,543,563	0	0	0	0	0	0	0	0	0
Replacement cost for short-life components	0	0	0	0	0	0	0	0	0	0
Total expenditures	1,543,563	23,176	24,260	25,398	26,593	27,628	28,711	29,843	31,027	32,266
Net cash flow	-1,543,563	90,308	94,898	99,718	104,779	106,371	107,968	109,570	111,173	112,779

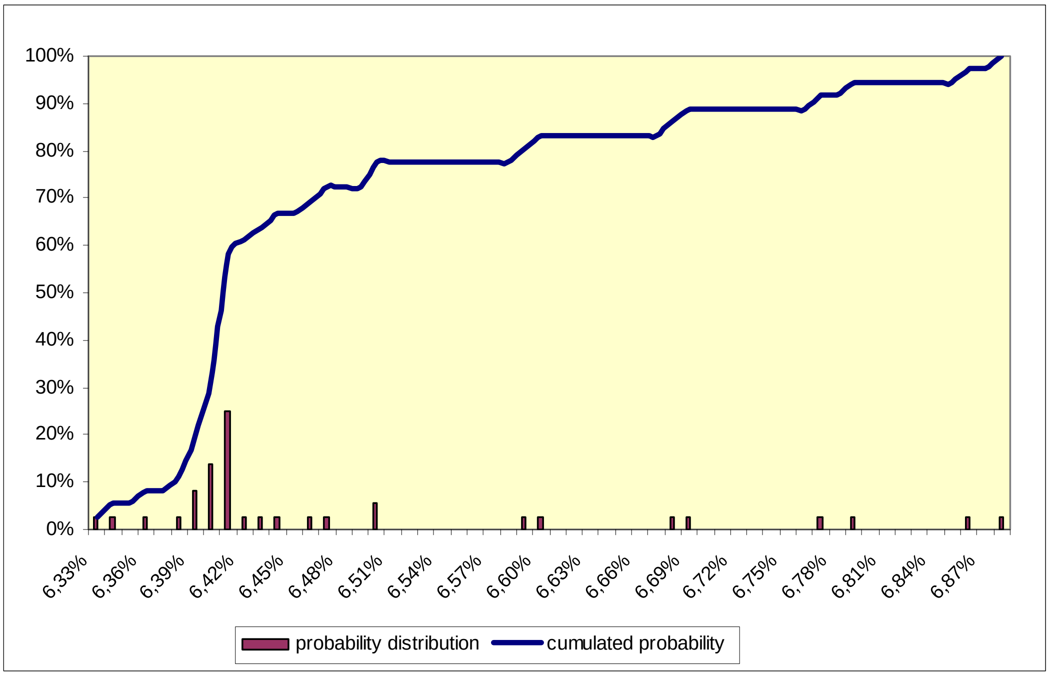
Indicators	11	12	13	14	15	16	17	18	19	20
Supply of household water	127,790	127,790	127,790	127,790	127,790	127,790	127,790	127,790	127,790	127,790
Supply of public water	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400
Supply of water for irrigation and for animals	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283
Supply of water for firefighting	0	0	0	0	0	0	0	0	0	0
Drainage and cleaning system	14,573	14,573	14,573	14,573	14,573	14,573	14,573	14,573	14,573	14,573
Revenues from services	145,045	145,045	145,045	145,045	145,045	145,045	145,045	145,045	145,045	145,045
Revenues from other services	0	0	0	0	0	0	0	0	0	0
Residual value of the infrastructure	0	0	0	0	0	0	0	0	0	0
Total revenues	145,045	145,045	145,045	145,045	145,045	145,045	145,045	145,045	145,045	145,045
Operation										
Labor force	22,694	22,694	22,694	22,694	22,694	22,694	22,694	22,694	22,694	22,694
Raw materials (reactive compounds and other materials)	1,365	1,365	1,365	1,365	1,365	1,365	1,365	1,365	1,365	1,365
Power for pumps and installations	5,564	5,564	5,564	5,564	5,564	5,564	5,564	5,564	5,564	5,564
Maintenance	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Cost of sludge removal	1,144	1,144	1,144	1,144	1,144	1,144	1,144	1,144	1,144	1,144
Total operating costs	32,266	32,266	32,266	32,266	32,266	32,266	32,266	32,266	32,266	32,266
Total costs for the investment	0	0	0	0	0	0	0	0	0	0
Replacement cost for short-life components	0	0	0	0	0	0	14,000	0	0	0
Total expenditures	32,266	32,266	32,266	32,266	32,266	32,266	46,266	32,266	32,266	32,266
Net cash flow	112,779	112,779	112,779	112,779	112,779	112,779	98,779	112,779	112,779	112,779

Indicators	21	22	23	24	25	26	27	28	29	30
Supply of household water	127,790	127,790	127,790	127,790	127,790	127,790	127,790	127,790	127,790	127,790
Supply of public water	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400
Supply of water for irrigation and for animals	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283
Supply of water for firefighting	0	0	0	0	0	0	0	0	0	0
Drainage and cleaning system	14,573	14,573	14,573	14,573	14,573	14,573	14,573	14,573	14,573	14,573
Revenues from services	145,045	145,045	145,045	145,045	145,045	145,045	145,045	145,045	145,045	145,045
Revenues from other services	0	0	0	0	0	0	0	0	0	0
Residual value of the infrastructure	0	0	0	0	0	0	0	0	0	437,609
Total revenues	145,045	145,045	145,045	145,045	145,045	145,045	145,045	145,045	145,045	582,653
Operation										
Labor force	22,694	22,694	22,694	22,694	22,694	22,694	22,694	22,694	22,694	22,694
Raw materials (reactive compounds and other materials)	1,365	1,365	1,365	1,365	1,365	1,365	1,365	1,365	1,365	1,365
Power for pumps and installations	5,564	5,564	5,564	5,564	5,564	5,564	5,564	5,564	5,564	5,564
Maintenance	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Cost of sludge removal	1,144	1,144	1,144	1,144	1,144	1,144	1,144	1,144	1,144	1,144
Total operating costs	32,266	32,266	32,266	32,266	32,266	32,266	32,266	32,266	32,266	32,266
Total costs for the investment	0	0	0	0	0	0	0	0	0	-437,609
Replacement cost for short-life components	0	0	0	0	0	0	0	0	0	0
Total expenditures	32,266	32,266	32,266	32,266	32,266	32,266	32,266	32,266	32,266	-405,342
Net cash flow	112,779	112,779	112,779	112,779	112,779	112,779	112,779	112,779	112,779	987,996

At the “t_0” moment the following performance indicators for the project are being considered:

Indicators	Value
Internal rate of financial return	6.41%
Financial net present value	288,365 euro

Figure 2. *The probability distribution and the cumulated probability of the internal rate of return*



The curve of the cumulated probability allows us to consider a degree of risk, of the cumulated probability is greater or smaller than the reference value which is considered critical.

The probabilities for the IRR to be greater than a certain value can also be determined, in which case this value will be set as a limit. For the project under analysis the is null probability that the IRR is smaller than 6.33%.

With the passage of time different values from those initially forecasted will be recorded, both for the revenues as well as for the expenditures incurred by the project.

Thus, for the years 1 to 5 of project exploitation (and respectively the years 2 to 6 for the forecasts) the actual values of revenues and expenditures will be considered.

Bellow we can see the actual revenues and expenditures registered up to the 6^{th} year of the forecast, with the rest of the values corresponding to the 7 to 30 forecasted years being left at the level previsioned in the initial year.

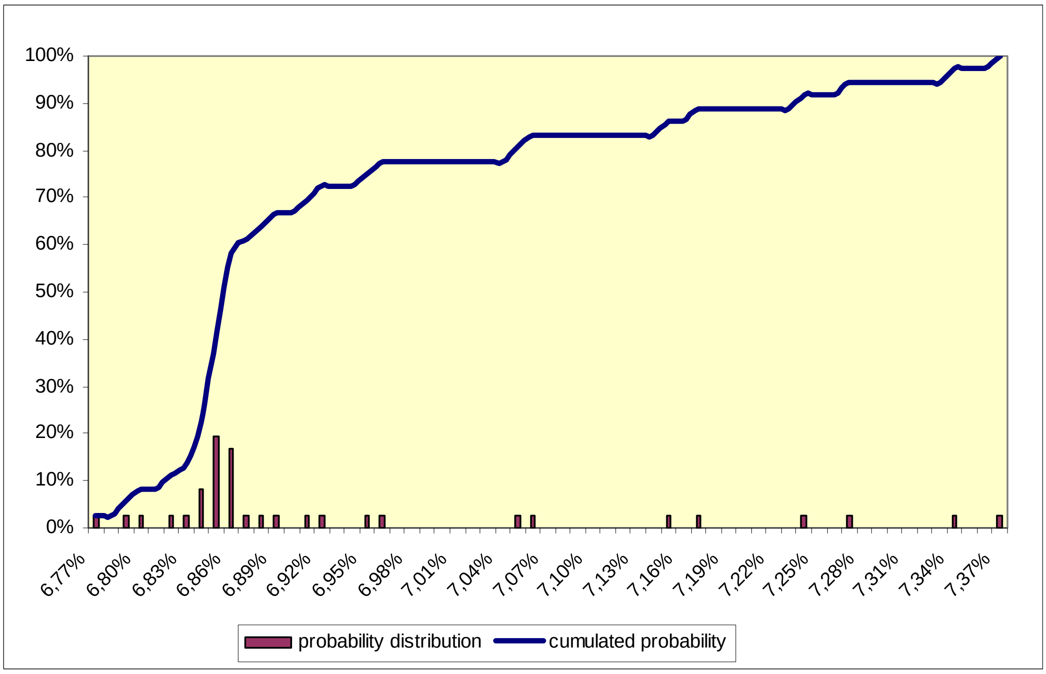
Project flow determined for year 5 of the exploitation period, year 2011 - euro

Indicators	1	2	3	4	5	6	7	8	9	10
Supply of household water	0	95,074	116,347	155,621	147,439	165,439	120,419	122,828	125,284	127,790
Supply of public water	0	913	1,643	2,008	2,199	2,065	1,319	1,345	1,372	1,400
Supply of water for irrigation and for animals	0	1,186	1,460	2,373	2,463	3,833	1,209	1,233	1,258	1,283
Supply of water for firefighting	0	0	0	0	0	0	0	0	0	0
Drainage and cleaning system	0	11,402	11,949	13,572	13,572	13,572	13,732	14,007	14,287	14,573
Revenues from services	0	108,575	131,399	173,572	165,672	184,908	136,679	139,413	142,201	145,045
Revenues from other services	0	0	0	0	0	0	0	0	0	0
Residual value of the infrastructure	0	0	0	0	0	0	0	0	0	0
Total revenues	0	108,575	131,399	173,572	165,672	184,908	136,679	139,413	142,201	145,045
Operation										
Labor force	0	17,069	18,288	19,934	20,432	21,863	19,604	20,584	21,613	22,694
Raw materials (reactive compounds and other materials)	0	1,368	2,121	2,376	2,494	2,868	1,286	1,312	1,338	1,365
Power for pumps and installations	0	6,205	6,217	8,573	8,770	9,273	5,243	5,348	5,454	5,564
Maintenance	0	1,350	2,541	1,450	2,145	1,584	1,500	1,500	1,500	1,500
Cost of sludge removal	0	895	871	1,223	1,172	1,612	1,078	1,100	1,122	1,144
Total operating costs	0	26,887	30,038	33,555	35,014	37,200	28,711	29,843	31,027	32,266
Total costs for the investment	1,543,563	0	0	0	0	0	0	0	0	0
Replacement cost for short-life components	0	0	0	0	0	0	0	0	0	0
Total expenditures	1.543.563	26.887	30.038	33.555	35.014	37.200	28.711	29.843	31.027	32.266
Net cash flow	-1.543.563	81.687	101.361	140.018	130.658	147.708	107.968	109.570	111.173	112.779

At the end of the fifth year of exploitation the following recalculated performance indicators for the investment project are being registered:

Indicators	Value
Internal rate of financial return	6.86%
Financial net present value	370,407 euro

Figure 3. *The probability distribution and the cumulated probability of the internal rate of return calculated for year 5 of the exploitation*



For the project under analysis in the fifth year of exploitation there is a null probability that the IRR is smaller than 6.86%.

The conclusion which can be inferred would be that at the end of the fifth year of exploitation (year 2011) the efficiency indicators for the project are looking better due to greater revenues being achieved than it was initially forecasted. The growth rate of the revenues was clearly superior to the growth rate of the expenditures incurred by the exploitation of the project.

1.5. The comparative analysis if the net present value and of the internal rate of return throughout the exploitation of the project

Reviewing the project phases presented above, we can see that a fundamental principle and an essential component in the evaluation of water supply and drainage infrastructure projects is the time factor, due to its impact on the efficiency of the investment.

The dynamic approach to project evaluation is meant to reveal and to convey the impact of the time factor in measuring, describing and analysing the economic and financial efficiency of such infrastructure investments.

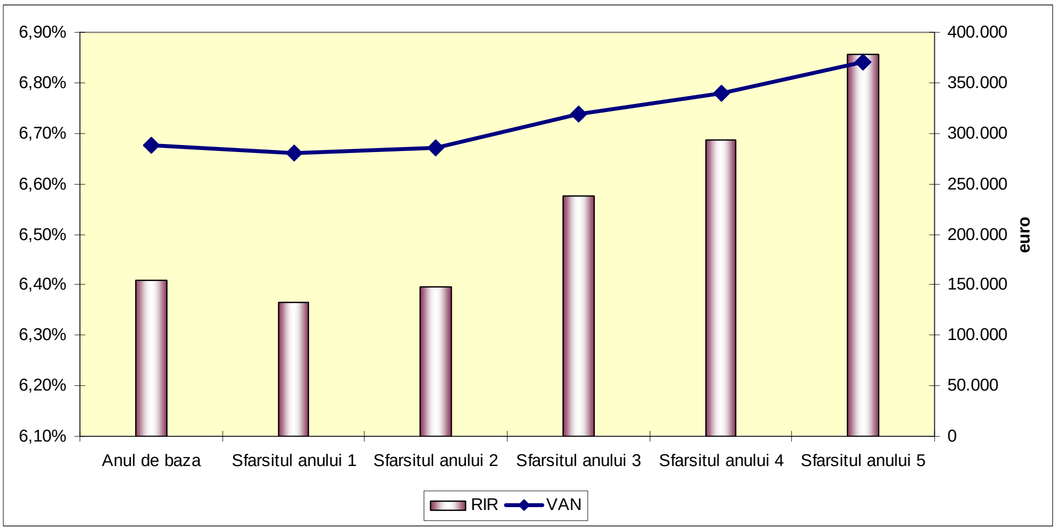
The concept of the dynamic evaluation of the efficiency of infrastructure projects from the perspective of local administrations offers extended options for the consideration of various aspects, effects and consequences, either positive or negative, of the impact of the time factor throughout the life cycle of the project or for each stage or phase within it.

In the dynamic approach for evaluation the efficiency of infrastructure projects, the criteria and the indicators will present time as a multiplying factor of costs and advantages, they will look at the dynamic and the variation in time of the financial flows which correspond to the processes and phenomena occurring within the established timespan or within the project's lifespan.

No.	Description	Starting year	End of year 1	End of year 2	End of year 3	End of year 4	End of year 5
		2006	2007	2008	2009	2010	2011
1	IRR	6.41%	6.37%	6.40%	6.58%	6.69%	6.86%
2	NPV	288,365 euro	280,547 euro	286,130 euro	319,284 euro	339,561 euro	370,407 euro

Thus, by reanalysing the performance indicators each year we discover that these can be either above or below the initially established level, a situation in which the decision makers – the administrators of the infrastructure – will have to adopt decisions specific to each case, in order to maintain the minimum of performance which has been established for the project.

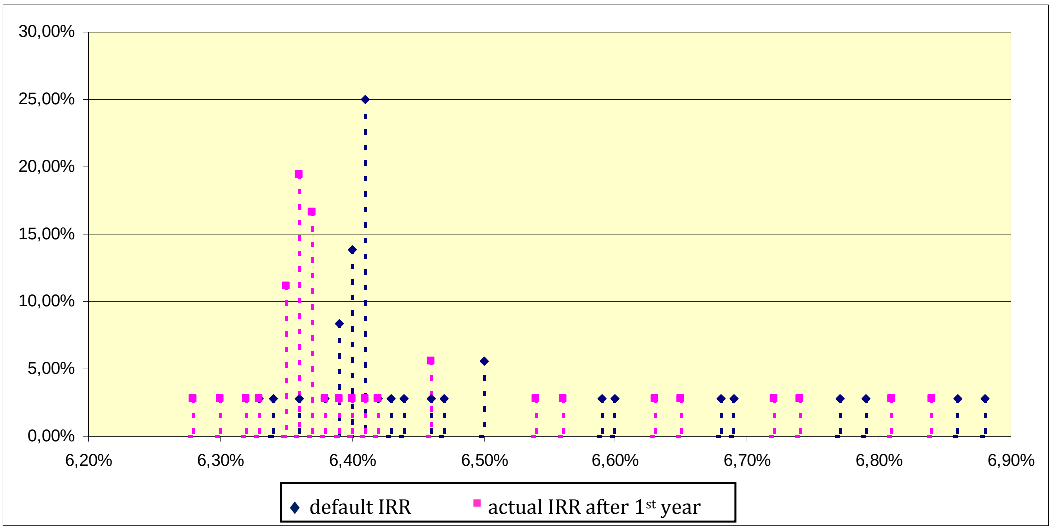
Figure 4. *The evolution of the IRR and NPV indicators through time*



The annually recalculated efficiency criteria and indicators help identify aspects such as:

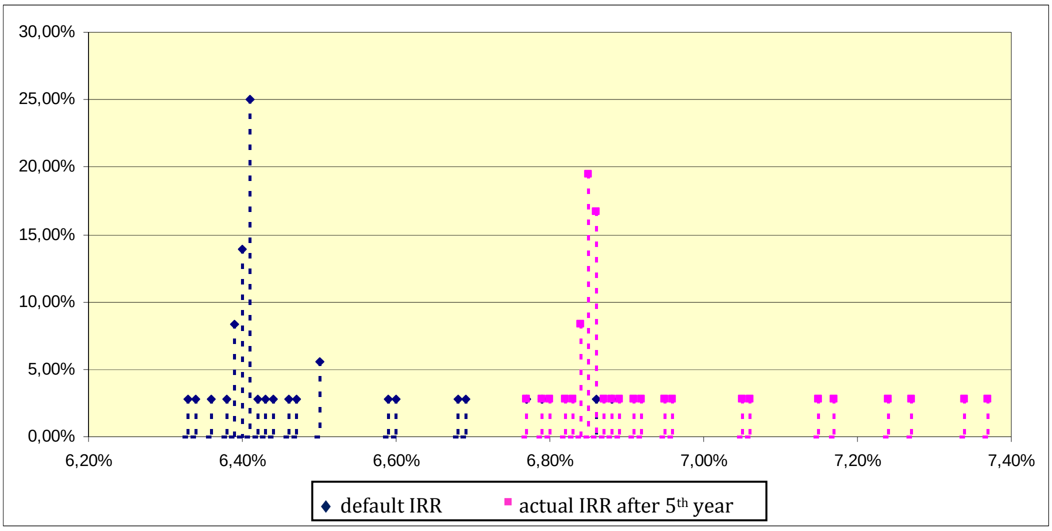
- The effect of the delay in the need for replacement investments when dealing with greater periods of exploitation. This shows up in a more distant future when compared to the cases with a shorter span of useful life;
- The effects of faster replacement and of reducing the number and value of spending on capital repairs whenever the total service lives are shorter;
- The additional cost of investment demanded by the guarantee of a longer service life;
- The influence of a drop in efficiency coupled with the increase in maintenance and repairs costs in time, as the degree of wear increases, in the case of greater periods of exploitation;
- The reduction of annual amortization in the case of longer service lives;
- The increase in the specific consumption of raw materials, energy etc. and in the end the increase in the exploitation costs when dealing with greater periods of functioning.

Figure 5. *Comparative view of the relative probability curve of IRR calculated for years "0" and "1"*



From the graphic above we can deduce that at the end of the first year of exploitation (year 2007) the efficiency indicators for the project are below the initially forecasted level due to the registration of lower revenues to the ones foreseen in the beginning. The growth pace of revenues was inferior to the rhythm in which project related expenditures have developed. This predicament was reached because in the first year of exploitation of the water supply and drainage networks not all of the households which have agreed to connect during the conception of the project have actually done it.

Figure 6. *Comparative view of the relative probability rate of IRR calculated for years "0" and "5"*



The increase in the volume of water supplied, drained and cleaned has led to an increase in total revenues, but to a greater extent to that of the costs, when considering the nature of fixed and variable costs. The variable costs have grown together with the increase in the volume of water supplied, drained and cleaned, while the fixed costs have stayed relatively constant, thus reducing the cubic meter costs of the supplied drinking water, drained water and cleaned water.

At the end of the fifth year of exploitation (year 2011) the efficiency indicators of the project are above the initially forecasted level due to the occurrence of greater revenues than originally previsioned. The growth rhythm of revenues in the 2008-2011 period was superior to the growth rate of expenditure associated with project exploitation. This was due to the fact that after the first year of service a greater number of households than originally scheduled have connected to the water supply and drainage networks. Also, there was a revenue increase due to a greater consumption of network-supplied potable water by the population and by animals and due to a shunning of the "unsafe" water from wells.

As such the dynamic evaluation of the efficiency of infrastructure projects throughout their lifespan will provide:

- A dynamic reflection of the previsioned flows in the costs of exploitation and in the estimated advantages, for each year of their respective stages.
- A picture of the economic effects of the multiple consequences brought by the differences in the variable exploitation periods of component elements and their impact on the efficiency of the project.

- A determination of the optimal period of economic exploitation and of the optimal moment for the replacement of used machines and equipment.

Conclusions

Financial analysis at the start of the investment project is useful because it provides the calculation for the project's internal rate of return and compares it to the discount rate. With the dynamic approach in evaluating the efficiency of infrastructure projects, the indicators will reflect the dynamics and the time variation of financial flows corresponding to the phenomena and processes which take place within the analysed period or for the entire project's life cycle. It is useful for any investor, even if they are public administrations, to be able to follow the actual evolution of their investments throughout their period of exploitation. The positive or negative deviations from the performance indicators may determine them to take specific decisions in different situations in order to maintain the minimum level of performance established for the project.

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