THE FINANCIAL ANALYSIS OF A MODERN SCHEME FOR MANAGING WASTE PROPOSED FOR THE URBAN COMMUNITY ARIEŞ, CLUJ COUNTY

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Abstract

This paper presents a scheme for managing waste, proposed for the urban community of Arieş, Cluj County, in which we are going to show the main activities that should be accomplished with the support of the local public administration. Based on the analysis of the waste flows, the demographic trends and the waste generating trends, we propose a scheme for managing waste that has a major investment component, an administrative re-organizing component and an educational one. We suggest a scheme which includes advanced techniques and methods for treating waste. Moreover, we demonstrated that the efficiency of the scheme cannot be conceived outside a circuit for valorizing and recycling the useful materials contained in the waste.

1. Introduction

Any human activity generates waste. If it is found in big quantity in a certain perimeter any waste produced by a human activity may cause damage to the environment. The environment has a certain self-generating characteristic; it absorbs the waste by preserving its basic features. If this capacity of regeneration is exceeded, the degradation starts a process which can become very accelerated and irreversible at a certain moment. Due to these considerations, acknowledged both by the international organizations and by the local specialists and administration, a series of systems for managing the waste in order to limit the negative impact on the environment were elaborated. The proposed scheme serves a group of associated communities that includes **two urban communities and six rural communities**, which make up **the Urban Community Arieş** (117.780 inhabitants).

2. Purpose, objectives and location

The situation of waste management which describes the researched area cannot be accepted any further, as the requirements of the European Union in this field are very clear. The main purpose of the present paper lies in the presentation of a scheme for waste management proposed for the Urban Community Arieş, according to the requirements of the European Union. At the present moment, in this area there is no adequate system for waste management, and the uncontrolled accumulations of waste have a negative impact on the environment and on the citizens' health. In the financial analysis undertaken by us, we demonstrated the profitableness and the suitability of the proposed scheme for this area.

By applying this investment project we aim at (1) increasing the citizens' awareness concerning the practical activities of selective waste collection, (2) increasing the number of sanitation services at affordable prices, (3) minimizing the quantities of waste that are eliminated, and (4) valorizing the useful materials contained in waste. All these actions attempt to provide a healthy and clean environment.

The Urban Community Arieş is an association of local authorities from the Arieş-Turda-Câmpia Turzii area; it is granted with public institutions and attributions for cooperation created through the free will act expressed by the participating Local Councils, according to their legal prerogatives, the current regulations and the regulations of the European Union. The legislatures bestowed on the member councils to perform for them and on their behalf the common interest public services. For each Local Council the fundamental criteria for joining and participating in the Urban Community Arieş are the efficient access to common resources and their rational and integrated management, aiming at environmental protection.

Table 1: The Urban Community Arieş

The Urban Community Arieş	
Urban Area	Turda Câmpia Turzii
Rural Area	Mihai Viteazu Călăraşi Frata Aiton Luna Petreştii de Jos Sănduleşti Tritenii de Jos Viişoara

The waste management scheme proposed for the Urban Community Arieş includes the following actions: (1) waste pre-collection at the source (in the apartment or house), (2) waste collection (at the collection container, where the responsibility of the public service starts), (3) waste transportation with special vehicles, (4) intermediary waste storage (at the transfer station placed between Turda and Câmpia Turzii), (5) valorization of the selected fractions, made by the recyclers, and valorization of mixed collected waste, treated in the sorting/treating station placed on the platform of the former Chemical Plant in Turda, (6) final storage of the remaining waste at the ecological warehouse, ought to be opened in Feleacu village.

Regarding **waste collection**, the project proposal has the following aims:

The urban areas. The non-selective collection of waste means taking the waste from each household that has collection containers (gate to gate collection), respectively taking the waste from the non-selective collection points which are placed in the blocks area (there will be non-selective collection points for about 100 flats). In order to collect waste selectively, we propose the organization of selective collection points. There will be four containers for collecting the recoverable waste. We suggest the collection of recoverable waste in four fractions: (1) glass, in a two-compartment container, (2) metal, (3) paper and cardboard, and (4) plastics. In the household area, for every 100 houses there will be a selective collection point, and for the blocks area there will be similar points for every 200 flats. Exclusively for the urban region, for social-administrative areas (administrative and commercial units, schools and nurseries) we intend to purchase a number of collection containers with a capacity of $1.1m^3$.

The rural areas. The collection and transportation equipments will take over the non-selected waste from each gate in the village. In order to collect selectively there will be collection points at the level of each village. The selective collection points from the villages will serve 150 rural households, as a result of a reduced quantity of waste compared to the urban area. The structure of the collection points is identical to the one in the urban area (three containers per collection point, adding to those a two-compartment container)

3. Data for analysis and interpretation

The proposed waste-management scheme is designed for an area including **117.780 inhabitants** dispersed in two towns and nine villages. As the next step after the analysis and the description of the waste management scheme we detailed the object estimates of the investment components, as well as the general estimate of the proposed management scheme, as follows:

Object estimate 1**: Setting up 388 collection points   211.217 euro (with VAT)**
Object estimate 2**: Purchasing transportation means   773.500 euro (with VAT)**
Object estimate 3: **Setting up the transfer station   450.466 euro (with VAT)**
Object estimate 4: **Setting up the sorting/treating station   4.838.724 euro (with VAT)**
Object estimate 5: **Purchasing and distributing collection containers to the population – 555.603 euro (with VAT)**
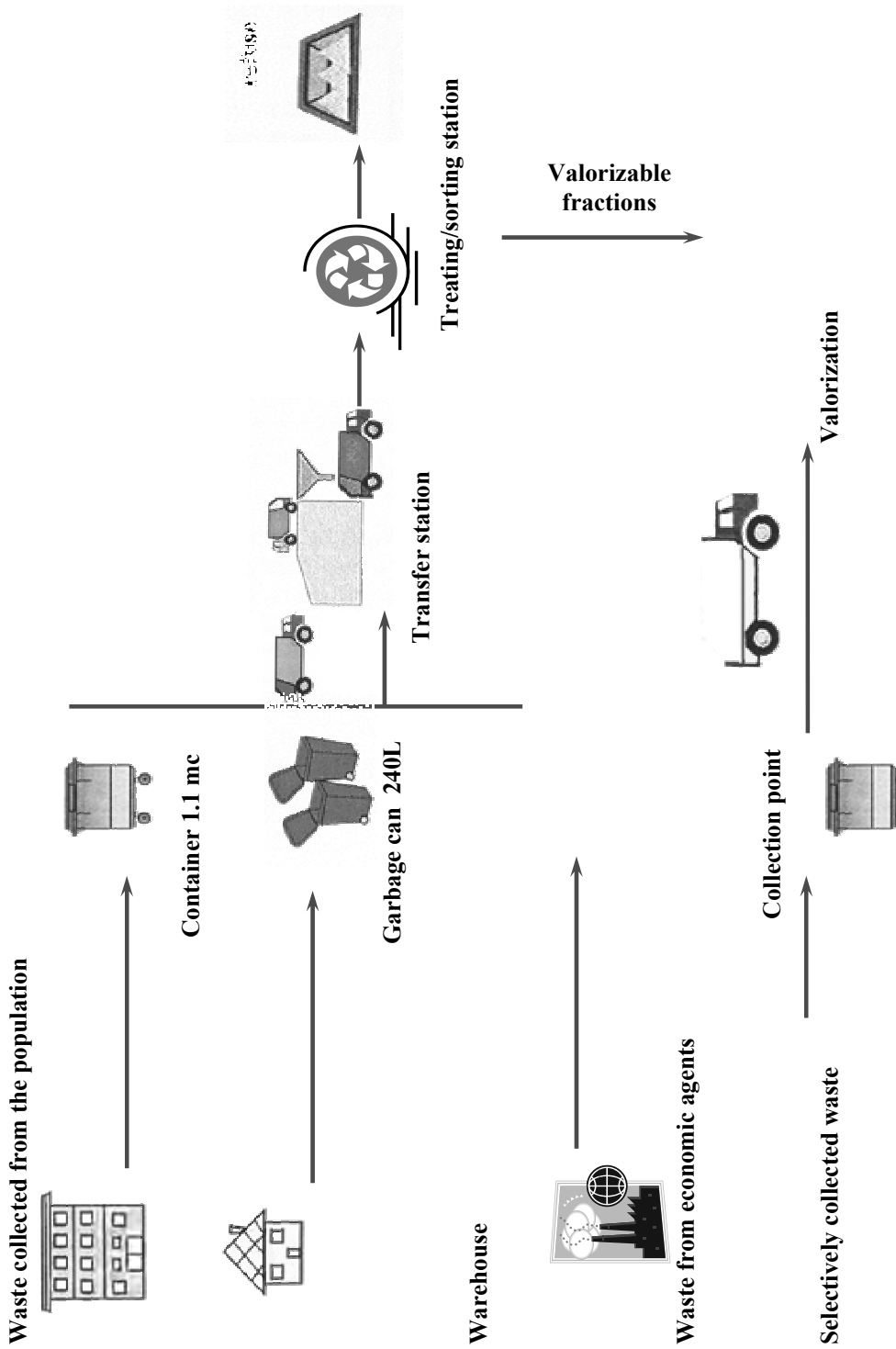
Figure 1: The functional scheme for waste management

Waste collected from the population

Container 1.1 mc

Garbage can 240L

Transfer station

Treating/sorting station

Valorizable fractions

Valorization

Collection point

Warehouse

Waste from economic agents

Selectively collected waste

The calculations at the local level revealed the following inventory of collection containers and collection points (selective and non-selective):

Table 2: The inventory of collection containers and collection points

Community	Population	Total collection containers	Out of which:			Number of collection points
			Garbage cans 240 l	Containers 1.1m³	Containers 0.6 m³/two-compartment	
Turda	55.887	4.523	3.894	93	536	134+68
Câmpia Turzii	26.823	3.413	3.027	46	340	85+23
Mihai Viteazu	5.749	809	757	0	52	13
Călăraşi	4.450	830	790	0	40	10
Frata	4.382	655	615	0	40	10
Aiton	1.338	345	333	0	12	3
Luna	4.450	473	433	0	40	10
Petreştii de Jos	1.891	429	413	0	16	4
Sănduleşti	1.892	497	481	0	16	4
Tritenii de Jos	5.066	731	687	0	44	11
Viişoara	5.852	964	912	0	52	13
Total	117.780	13.669	12.342	139	1.188	388

The general total sum of the investment, as it results from the general estimate, including VAT, is situated at **9.687.679 Euros**. This value, although it seems a high value, compared to the usual schemes promoted in our country (see PHARE CES programs 2004, 2005, 2006 where the total budget of the project is limited to approximately 1.000.000 Euros because of the conditions imposed by the financier for non-reimbursable financial assistance) cover those segments of the management scheme which are not usually included in the budgets of the projects which need financing, such as the distribution of collection containers to the population, including in the rural area, as well as the expenditures for setting up a modern sorting/treating station.

The specific investment value of de **82.25 Euros/inhabitant** is justified by the costs for the modern sorting and treating station, as well as by the inclusion of the containers necessary for the population in the rural area, without which we consider the proposed scheme impossible to be transposed in reality. The respective value is similar to the typical values from the ISPA waste management schemes.

In the waste management scheme proposed for The Urban Community Arieş we took into account the pre-existing endowments of the local sanitation systems and this is why we also considered the fact that a part of the population living in private houses and a part of the economic agents already own adequate containers for waste collection. In this respect, we included investment costs just for the difference in the containers inventory, costs which would be directly recovered from the direct beneficiaries based on a conscription tariff. Thus, it is considered that the local authorities will distribute

these containers in adequate conditions, and will charge a tariff from those who will benefit from the respective services, recovering in this way their equivalent value. We cannot consider the free distribution of these containers based on the following assumptions:

(1) The equivalent value of these garbage cans is very high (12.342 garbage cans x 35 Euros/garbage can = **431.970 Euros without VAT**) and has an important ratio in the total investment. (The **2.68%** ratio represents the garbage cans distributed directly to the population in total general estimate, respectively **4.07%** represent the total of endowments with collection containers, in total general estimate).

(2) If the distribution of these pre-collection containers is done for free, those who previously purchase adequate containers would be in disadvantage in comparison to those who would get them for free; in this way the fundamental principle of chance equality would be broken. Thus, the project implementation funds would be supported exactly by those persons who do not make the smallest effort or show the minimum interest for the problem of waste management.

(3) If the entire population has to support equally the costs of this action, this would lead to an increase in tariffs over the acceptable level, which would also affect those who before the implementation of the waste management scheme manifested a minimum effort for the adequate management of waste by purchasing containers. This situation can be also characterized as unfair.

4. The presentation of the scenarios for the proposed financial analysis

a. Alternative Zero (no investment)

From the citizens' point of view, the non-selective collection of solid waste probably represents the most convenient method, in terms of time and space. In this case, in the Urban Community Arieş - UCA - there will be no investment for organizing a selective collection system of the waste, setting up the transfer station and the sorting-treating one, as well as for transporting the final waste to the ecological county warehouse from Feleacu. However, according to the current legislation The Urban Community Arieş will have to find the necessary funds for closing the existing urban warehouses (Turda and Câmpia Turzii), and the inadequate storage points from the rural area. Under these circumstances, the investment costs would be reduced to those necessary for closing the urban warehouses from UCA. Moreover, we must take into account the necessity of transporting the collected waste to the warehouse to be opened in Feleacu, a fact that will create supplementary costs for the transportation and storage.

b. The proposed alternative (with investment)

This option includes the alternative analyzed in this paper: ensuring the selective collection service, operating a transfer station, operating a sorting-treating station, transporting the useful fractions to the recyclers, and transporting the remaining waste to the ecological warehouse of Cluj County. For a successful alternative, an awareness and publicity campaign will be created to convey to the citizens the different problems

associated with uncontrolled generation and storage of waste. In this scenario, the sorted waste will be valorized by selling it directly to the recyclers. Thus we can obtain revenues which will allow the support of exploitation expenditures with direct impact on the tariff settled for the sanitation service.

The duration proposed for the implementation of the investment project at the level of the Urban Community Arieş is 24 months; the execution period would last 12 months. The exploitation period calculated in the analysis is 20 years.

Table 3: The forecast for the dynamics of the population in the proposed scheme

Year	Population URBAN	Population RURAL	TOTAL Population	Economic agents/institutions
2009	82.710	35.070	117.780	2.975
2010	82.462	34.965	117.427	2.966
2011	82.214	34.860	117.074	2.957
2012	81.968	34.755	116.723	2.948
2013	81.722	34.651	116.373	2.939
2014	81.477	34.547	116.024	2.931
2015	81.232	34.443	115.676	2.922
2016	80.989	34.340	115.329	2.913
2017	80.746	34.237	114.983	2.904
2018	80.503	34.134	114.638	2.896
2019	80.262	34.032	114.294	2.887
2020	80.021	33.930	113.951	2.878
2021	79.781	33.828	113.609	2.870
2022	79.542	33.727	113.268	2.861
2023	79.303	33.625	112.929	2.852
2024	79.065	33.525	112.590	2.844
2025	78.828	33.424	112.252	2.835
2026	78.592	33.324	111.915	2.827
2027	78.356	33.224	111.579	2.818
2028	78.121	33.124	111.245	2.810
2029	77.886	33.025	110.911	2.801
Population decrease factor: 0,003				

For the discussed environments (urban and rural) the forecast for the generation of collected waste is made based on the following indicators: (1) the evolution of the population at county level, (2) the evolution of the waste generation index.

Table 4: The forecast of the waste quantities
generated by the Urban Community Arieş

Year	Quantity population urban - tones -	Quantity population rural - tones -	Quantities economic agents - tones -	Total quantities - tones -	Indicator waste generation kg/person/day - urban -	Indicator waste generation kg/person/day - rural -
2009	27.170	5.120	13.127	45.417	0,90	0.40
2010	27.414	5.166	13.232	45.812	0,91	0.40
2011	27.660	5.212	13.338	46.210	0,92	0.41
2012	27.907	5.259	13.445	46.611	0,93	0.41

Year	Quantity population urban - tones -	Quantity population rural - tones -	Quantities economic agents - tones -	Total quantities - tones -	Indicator waste generation kg/person/day - urban -	Indicator waste generation kg/person/day - rural -
2013	28.158	5.306	13.552	47.016	0,94	0.42
2014	28.410	5.354	13.661	47.424	0,96	0.42
2015	28.665	5.402	13.770	47.836	0,97	0.43
2016	28.922	5.450	13.880	48.252	0,98	0.43
2017	29.181	5.499	13.991	48.671	0,99	0.44
2018	29.442	5.548	14.103	49.094	1,00	0.45
2019	29.706	5.598	14.216	49.520	1,01	0.45
2020	29.973	5.648	14.330	49.951	1,03	0.46
2021	30.241	5.699	14.444	50.384	1,04	0.46
2022	30.512	5.750	14.560	50.822	1,05	0.47
2023	30.786	5.802	14.676	51.264	1,06	0.47
2024	31.062	5.854	14.794	51.709	1,08	0.48
2025	31.340	5.906	14.912	52.158	1,09	0.48
2026	31.621	5.959	15.031	52.612	1,10	0.49
2027	31.905	6.012	15.151	53.069	1,12	0.50
2028	32.191	6.066	15.273	53.530	1,13	0.50
2029	32.479	6.121	15.395	53.995	1,14	0.51

Based on this scenario we will make a prognosis for the expenses and the incomes that the waste management scheme involves, as well as for the determination of the efficiency of such a system.

5. The presumed evolution of the incomes obtained in the proposed scheme

There are three different income sources in the proposed waste management system which will cover the operation and maintenance costs. These are (1) incomes from the sanitation tariffs for waste from physical entities, (2) incomes from the sanitation tariffs for waste from economic agents, and (3) incomes from selling the recovered materials (selectively collected waste and the bio-degradable waste sorted in the sorting station).

Table 5: Total forecasted incomes

Year	Total value recoverable materials (Euros)	Equivalent value services Physical entities (Euros)	Equivalent value services legal entities (Euros)	Total incomes (Euros)
2009	964.547,68	1.413.360,00	234.410,71	2.738.297,26
2010	1.002.840,13	1.440.120,56	239.567,75	2.807.512,80
2011	1.042.866,71	1.467.387,80	244.838,24	2.878.976,15
2012	1.084.708,15	1.495.171,32	250.224,68	2.952.774,63
2013	1.128.448,95	1.523.480,90	255.729,62	3.028.999,28
2014	1.174.177,57	1.552.326,48	261.355,68	3.107.745,08
2015	1.221.986,59	1.581.718,23	267.105,50	3.189.111,12
2016	1.271.972,95	1.611.666,49	272.981,82	3.273.200,73
2017	1.324.238,11	1.642.181,78	278.987,42	3.360.121,76
2018	1.378.888,29	1.673.274,85	285.125,15	3.449.986,73
2019	1.436.034,66	1.704.956,63	291.397,90	3.542.913,02
2020	1.495.793,62	1.737.238,28	297.808,65	3.639.023,16

Year	Total value recoverable materials (Euros)	Equivalent value services Physical entities (Euros)	Equivalent value services legal entities (Euros)	Total incomes (Euros)
2021	1.558.287,01	1.770.131,15	304.360,44	3.738.445,01
2022	1.623.642,35	1.803.646,82	311.056,37	3.841.312,02
2023	1.691.993,17	1.837.797,06	317.899,61	3.947.763,48
2024	1.763.479,22	1.872.593,91	324.893,40	4.057.944,79
2025	1.838.246,80	1.908.049,61	332.041,06	4.172.007,73
2026	1.916.449,07	1.944.176,62	339.345,96	4.290.110,78
2027	1.998.246,35	1.980.987,66	346.811,57	4.412.419,36
2028	2.083.806,46	2.018.495,68	354.441,43	4.539.106,23
2029	2.173.305,09	2.056.713,88	362.239,14	4.670.351,75

Table 6: Forecasting the operating costs in the proposed scheme

Year	Storage fee (euro/tone)	The value of the storage fee (euro)	Overheads (euro)	Expenses for fuel and maintenance vehicles (euro)	Depreciation (euro)	Equipments maintenance (euro)	Salaries (euro)
2009	8,00	137.238,06	31.200,00	83.660,00	430.289,00	64.264,00	383.160,00
2010	8,60	146.366,27	31.824,00	85.333,20	430.289,00	64.264,00	417.644,40
2011	9,20	155.198,61	32.460,48	87.039,86	430.289,00	64.264,00	455.232,40
2012	9,80	163.701,63	33.109,69	88.780,66	430.289,00	64.264,00	496.203,31
2013	10,40	171.839,71	33.771,88	90.556,27	430.289,00	120.000,00	540.861,61
2014	11,00	179.574,94	34.447,32	92.367,40	215.145,00	120.000,00	589.539,15
2015	11,60	186.866,97	35.136,27	94.214,75	215.145,00	120.000,00	642.597,68
2016	12,20	193.672,88	35.838,99	96.099,04	215.145,00	120.000,00	700.431,47
2017	12,80	199.947,05	36.555,77	98.021,02	215.145,00	120.000,00	763.470,30
2018	13,40	205.640,95	37.286,89	99.981,44	215.145,00	120.000,00	832.182,63
2019	14,00	210.703,05	38.032,63	101.981,07	215.145,00	120.000,00	907.079,07
2020	14,60	215.078,58	38.793,28	104.020,69	215.145,00	120.000,00	988.716,18
2021	15,20	218.709,39	39.569,14	106.101,11	215.145,00	120.000,00	1.077.700,64
2022	15,80	221.533,72	40.360,53	108.223,13	215.145,00	120.000,00	1.174.693,70
2023	16,40	223.486,04	41.167,74	110.387,59	215.145,00	120.000,00	1.280.416,13
2024	17,00	224.496,80	41.991,09	112.595,35	215.145,00	120.000,00	1.395.653,58
2025	17,60	224.492,23	42.830,91	114.847,25	215.145,00	120.000,00	1.521.262,40
2026	18,20	223.394,05	43.687,53	117.144,20	215.145,00	120.000,00	1.658.176,02
2027	18,80	221.119,31	44.561,28	119.487,08	215.145,00	120.000,00	1.807.411,86
2028	19,40	217.580,01	45.452,51	121.876,82	215.145,00	120.000,00	1.970.078,93
2029	20,00	212.682,91	46.361,56	124.314,36	215.145,00	120.000,00	2.147.386,03
Increase storage fee rate (Euros): 0.60							
Salary increase factor: 0.09							

The analysis of the efficiency of an investment project can be done with the help of an investigation instrument which is represented by the investment efficiency indicators.

The indicators used in the financial analysis aim at quantifying the efficiency of a project taking into account the costs and the effects that the investment project involves at investor level or investment objective. The main efficiency indicators calculated and interpreted are the benefit-cost ratio (BCR), the net present value (NPV), and the internal financial rate of return (IRR).

The first analysis indicator results from comparing the costs and benefits for the entire life duration of the project, an indicator represented by **the benefit-cost ratio (BCR)** and which results from the comparison between the present value of benefits and the present value of costs.

$$BCR = \frac{PVB}{PVC}, \text{ where: BCR - the benefit-cost ratio; PVB - the present value of benefits; PVC - the present value of costs.}$$

From the point of view of this indicator, the condition for financial efficiency is that the benefit-cost ratio should be more than 1, which means that the present value of benefits should be bigger than the present value of costs. In this case, *the benefit-cost ratio isn't more than 1*, at an adequate updating rate, we don't recover the total updated expenses, thus the project is inefficient and the investment of the capital is not justified.

The second indicator for an investment project analysis is **the net present value (NPV)**, which is a fundamental financial analysis indicator for an investment project. This indicator also refers to the effort and the effects of the investment project for the whole duration of the project; it reflects the difference between the present value of benefits and the present value of costs (capital expenditure and operating costs).

$$NPV = PVB - PVC$$

The condition for the investment project to be efficient is that the net present value should be positive (NPV>0).

The internal financial rate of return (IRR) represents the fundamental indicator for accepting a project. It refers to the updating rate for which the present value of the benefits equals the present value of the costs, consequently the benefit-cost ratio equals 1 and NPV equals 0.

The IRR calculation is done through successive approximations, where we determine the net present value at a corresponding updating rate, considered to be the minimum rate and for which it should be positive. Then, we calculate the net present value at a higher updating rate than the minimum rate, high enough to obtain a negative net present value. In the end, the exact determination of the internal financial rate of return is done through interpolation, according to the relation:

$$IRR = R_{min} + (R_{max} - R_{min}) \times \frac{NPV(+)}{NPV(+) + |NPV(-)|}$$

where: IRR - the internal financial rate of return;
R_{min} - the minimum present rate;
R_{max} - the maximum present rate;
NPV (+) - the positive net present value, obtained at the minimum rate;
NPV (-) - the negative net updated income, obtained at maximum rate.

Table 7: The structure of the investment
project proposed for the Urban Community Arieş

Year	Updating factor (a = 5%)	Annual incomes	Annual updated incomes	Operating costs	Updated operating costs	Annual investments (Euros)
2008	0,952	-	-	-	-	4.687.679,00
2009	0,907	2.738.297,26	2.483.716,34	699.522,06	634.487,13	5.000.000,00
2010	0,864	2.807.512,80	2.425.235,11	745.431,87	643.932,08	-
2011	0,823	2.878.976,15	2.368.540,81	794.195,35	653.386,48	-
2012	0,784	2.952.774,63	2.313.576,18	846.059,29	662.909,59	-
2013	0,746	3.028.999,28	2.260.285,90	957.029,48	714.150,13	-
2014	0,711	3.107.745,08	2.208.616,41	1.015.928,81	722.001,64	-
2015	0,677	3.189.111,12	2.158.515,93	1.078.815,66	730.184,90	-
2016	0,645	3.273.200,73	2.109.934,38	1.146.042,39	738.749,14	-
2017	0,614	3.360.121,76	2.062.823,28	1.217.994,15	747.742,75	-
2018	0,585	3.449.986,73	2.017.135,79	1.295.091,91	757.213,42	-
2019	0,557	3.542.913,02	1.972.826,54	1.377.795,82	767.208,27	-
2020	0,530	3.639.023,16	1.929.851,68	1.466.608,74	777.773,93	-
2021	0,505	3.738.445,01	1.888.168,77	1.562.080,28	788.956,69	-
2022	0,481	3.841.312,02	1.847.736,76	1.664.811,07	800.802,59	-
2023	0,458	3.947.763,48	1.808.515,94	1.775.457,50	813.357,54	-
2024	0,436	4.057.944,79	1.770.467,87	1.894.736,82	826.667,40	-
2025	0,416	4.172.007,73	1.733.555,39	2.023.432,79	840.778,12	-
2026	0,396	4.290.110,78	1.697.742,51	2.162.401,80	855.735,82	-
2027	0,377	4.412.419,36	1.662.994,45	2.312.579,53	871.586,90	-
2028	0,359	4.539.106,23	1.629.277,52	2.474.988,26	888.378,14	-
2029	0,342	4.670.351,75	1.596.559,15	2.650.744,86	906.156,79	-
TOTAL	-	-	41.946.076,70		16.142.159,45	
Updating rate:	0.05				NPV (Euros):	16.804.313,66

Table 8: The calculation of the internal financial rate of return IRR

Year	Annual investments (Euros)	Operating costs (Euros)	Annual incomes (Euros)	Cash flow (Euros)	Updating factor (a = 30%)	Updated cash flow (Euros)
2008	4.687.679,00	0,00	0,00	-4.687.679,00	0,769	-3.605.906,92
2009	5.000.000,00	699.522,06	2.738.297,26	-2.961.224,80	0,592	-1.752.204,02
2010	0,00	745.431,87	2.807.512,80	2.062.080,92	0,455	938.589,41
2011	0,00	794.195,35	2.878.976,15	2.084.780,80	0,350	729.939,71
2012	0,00	846.059,29	2.952.774,63	2.106.715,33	0,269	567.399,69
2013	0,00	957.029,48	3.028.999,28	2.071.969,80	0,207	429.262,85
2014	0,00	1.015.928,81	3.107.745,08	2.091.816,27	0,159	333.365,05
2015	0,00	1.078.815,66	3.189.111,12	2.110.295,46	0,123	258.700,01
2016	0,00	1.146.042,39	3.273.200,73	2.127.158,35	0,094	200.590,17
2017	0,00	1.217.994,15	3.360.121,76	2.142.127,62	0,073	155.385,98
2018	0,00	1.295.091,91	3.449.986,73	2.154.894,81	0,056	120.240,06
2019	0,00	1.377.795,82	3.542.913,02	2.165.117,20	0,043	92.931,12
2020	0,00	1.466.608,74	3.639.023,16	2.172.414,42	0,033	71.726,41
2021	0,00	1.562.080,28	3.738.445,01	2.176.364,73	0,025	55.274,49
2022	0,00	1.664.811,07	3.841.312,02	2.176.500,95	0,020	42.521,50

Year	Annual investments (Euros)	Operating costs (Euros)	Annual incomes (Euros)	Cash flow (Euros)	Updating factor (a = 30%)	Updated cash flow (Euros)
2023	0,00	1.775.457,50	3.947.763,48	2.172.305,98	0,015	32.645,80
2024	0,00	1.894.736,82	4.057.944,79	2.163.207,97	0,012	25.006,98
2025	0,00	2.023.432,79	4.172.007,73	2.148.574,94	0,009	19.106,02
2026	0,00	2.162.401,80	4.290.110,78	2.127.708,98	0,007	14.554,21
2027	0,00	2.312.579,53	4.412.419,36	2.099.839,83	0,005	11.048,90
2028	0,00	2.474.988,26	4.539.106,23	2.064.117,96	0,004	8.354,57
2029	0,00	2.650.744,86	4.670.351,75	2.019.606,89	0,003	6.288,01
TOTAL:						-1.245.180,00
Updating rate:		0.3000		NPV (Euros):	-1.245.180,00	

Graphically, the internal financial rate of return is at the intersection of the abscissa with the line that joins the points of the coordinates minimum rate and positive net present value, respectively maximum rate and negative net present value. The higher the internal financial rate of return, the more viable the project is, its efficiency being increased. From the point of view of this indicator, the efficiency condition of a project is that IRR should be superior to the corresponding updating rate.

6. The results of the research

The three main efficiency indicators have clearly demonstrated the profitableness and the suitability of the waste management scheme proposed for the Urban Community Arieş, as follows:

$$BCR = \frac{41.946.076,70}{16.142.159,45 + 8.999.603,58} = 1,66 > 1$$

The 1,66 value obtained for BCR being more than 1 proves the fact that the project is efficient, justifying by this the capital investment.

Through its content, NPV characterizes in absolute value the gain, or the reward for the invested capital. In this case, the net present was calculated at a minimum present rate of 5%.

NPV = 41.946.076,70 – (16.142.159,45 + 8.999.603,58) = 16.804.313,66 Euros

$$IRR = 5 + (30 - 5)x \frac{16.804.313,66}{16.804.313,66 + 1.245.180} = 28,28\%$$

IRR = 28,28% (the rate is high, much higher rate than the minimum rate, which proves once again the viability of the proposed project).

The analysis of the efficiency of an investment project, but especially its financial analysis can be considered complete only after making **the sensitivity analysis** (known also as the sensitivity analysis of the internal financial rate of return). The sensitivity analysis consists of modifying certain variables and re-calculating the efficiency indicators for the investment project under the new circumstances.

Next we will be making a detailed analysis of the sensitivity by studying the tendencies of the financial indicators according to the evolution of the relevant variables, both for

the collection activity and the waste transportation, as well as for the activity of the transfer and the sorting-treating stations. This analysis studies the influence that the relevant variables have on the profitableness of the investment project for the Urban Community Arieş.

The variables with the highest impact upon the profitableness of the project are: **(1) the variation of the sanitation tariffs for waste, (2) the variation of the selling price for the recyclable materials sold to recyclers and of the compost, and (3) the variation in operating costs.**

We present below the variation of the main parameters of the project between the limits -/+ 20% and the impact of the critical parameters on IRR:

Table 9: The main parameters of the project

Impact on:				The internal financial rate of return (**IRR**)				
The critical parameter:				SANITATION TARIFF				
28,28%	0,80	0,85	0,90	0,95	1,00	1,05	1,10	1,15	1,20
	26,22%	26,83%	27,37%	27,85%	**28,28%**	28,65%	29,00%	29,31%	29,60%

Impact on:				The internal financial rate of return (**IRR**)				
The critical parameter:				THE SELLING PRICE OF THE RECYCLABLE MATERIALS				
28,28%	0,80	0,85	0,90	0,95	1,00	1,05	1,10	1,15	1,20
	26,88%	27,28%	27,64%	27,97%	**28,28%**	28,55%	28,81%	29,04%	29,26%

Impact on:				The internal financial rate of return (**IRR**)				
The critical parameter:				OPERATING COSTS				
28,28%	0,80	0,85	0,90	0,95	1,00	1,05	1,10	1,15	1,20
	29,30%	29,07%	28,83%	28,56%	**28,28%**	27,95%	27,60%	27,21%	26,78%

Impact on:				The internal financial rate of return (**IRR**)				
The critical parameter:				COMBINED IMPACT OF THE 3 CRITICAL PARAMETERS				
28,28%	0,80	0,85	0,90	0,95	1,00	1,05	1,10	1,15	1,20
	26,49%	27,01%	27,47%	27,89%	**28,28%**	28,84%	28,93%	29,22%	29,49%

Necessary data for the graph of the sensitivity analysis

-20,00%	-15,00%	-10,00%	-5,00%	0,00%	5,00%	10,00%	15,00%	20,00%
26,22%	26,83%	27,37%	27,85%	**28,28%**	28,65%	29,00%	29,31%	29,60%
26,88%	27,28%	27,64%	27,97%	**28,28%**	28,55%	28,81%	29,04%	29,26%
29,30%	29,07%	28,83%	28,56%	**28,28%**	27,95%	27,60%	27,21%	26,78%
26,49%	27,01%	27,47%	27,89%	**28,28%**	28,62%	28,93%	29,22%	29,49%

Taken individually, none of the selected variables can jeopardize the IRR level so as to put under question the feasibility of the investment, as the IRR modifications are very small. For a combined modification of the critical parameters, the IRR variation is also reduced (1-2%) proving that the project proposed for the Urban Community Arieş

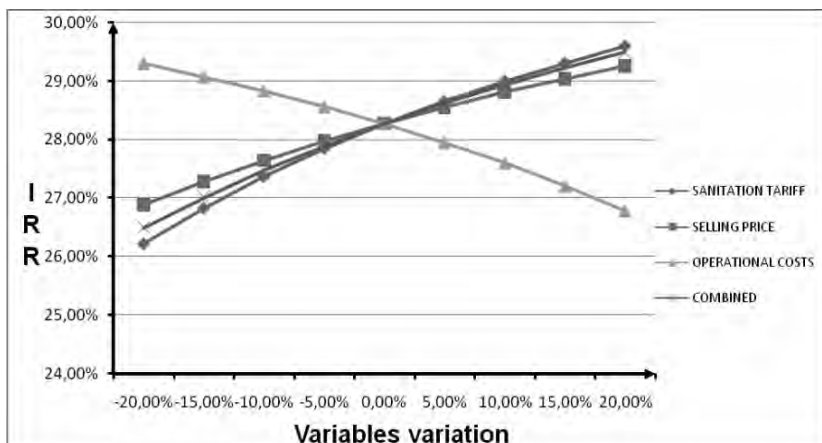is not sensitive to the modifications that may appear in time, therefore this investment objective is functioning.

Figure 2: The graph of the sensitivity analysis of IRR

7. Conclusions

The proposed and analyzed waste management scheme is based on the access of the population to sanitation services, according to which the public authorities are responsible for organizing public utility services for the community so that all the members of the community should have equal access to these services. It is supposed that the waste management targets and objectives must comply with the national strategic plan, the specific policies in the field and the specific national objectives. Consequently, we stated in the analysis made in this paper that these sanitation services must be provided in such a way as to ensure the availability of the tariffs and equal access of the population to these services.

The proposed scheme solves the problem of waste management at local level, introducing directly, both at the level of the urban population and the rural population, the selective collection of the waste generated in households, the advanced treatment of all collected fractions, including an adequate step for reducing the organic charge of the waste sent for final storage, by valorizing their energetic potential.

However, besides the quantifiable benefits, the project also brings non-quantifiable benefits that we consider to be the most important gains for the citizens from the researched area:

– The improvement of the environment and the population's health as a consequence of developing an efficient system for waste management, due to improvement of water, soil and air quality;
– The increase of life expectancy due to reduced pollution;
– The increase of the real estate value (land and buildings);
– The development of tourism in an area in which there is a suitable waste management system, as a consequence of the esthetical and hygienic aspect of the area;
– The attraction of the investors and the creation of workplaces for citizens.

The calculated values of the financial indicators demonstrate the fact that waste management in compliance with the harmonized European policy in this field is benefic, which shows the real importance that should be given by local public authorities to this sector.

The values of the investment effort, when there already exists a correct project for suitable storage, financed from other sources (the so-called ecological waste warehouses), are not very high and they are easy to be borne by the regional and county authorities, a fact which makes these local public authorities responsible for the future of the waste management schemes at the local level.

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