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Optimisation and Economic and Energy Efficiency in Investments from the Facility Management Perspective

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Abstract: ***Facility management is a field that contributes to the sustainable development by innovative solutions. The innovative solutions lead to economic optimisations by efficiency measures as for the consumptions regarding the operation and functionality of buildings. The technological investments in the field show long lasting economic, social and environmental advantages. The comparison between two investments in a building management system for an office building presented in this article gives us an overview of the relation between technological investments in the facility management domain – energy efficiency – costs optimising.*** ***The comparison between two investments in a building management system for an office building presented in this article gives us an overview of the relation between technological investments in the facility management domain – energy efficiency – costs optimising.***

Keywords: efficiency, optimising, investments, building management system

1. Introduction

In the economic life, the investments are placed in the centre because any strategic decision of investment generates important effects.

The investments upheld by facility management represent optimising and efficiency factors as their advantages have a positive long lasting impact upon the company.
Facility management is a recent concept recent that found its place in the business language of our country and it becomes more and more present due to the speedy development of the services industry.

Facility management contributes to a sustainable development both at a business and macroeconomic level by means of the innovative integrated solutions given for the building and business supporting by supporting processes. As the minimisation of a company costs and the efficiency measures of the business model represent the bases of the strategic directions, the facility management provides the entire support through optimal solutions.

Studies show that the investments in equipment and technologies integrated in the facility management area of activities may lead to cost efficiencies up to 30% within the company because facility management is the second large cost centre of an organisation.

The early identification of the need to invest, optimise and for efficiency is vital for further adapting to the new reality, to innovation and progress.

2. Economic Efficiency of Investments

In a general framework, investment is seen as an act of increasing the initial assets, as for example new buildings, new equipment, purchasing machinery, machines, etc. But it is a profitable activity that increases the value of the invested capitals. In a practical sense, it represents a resource consumption of a diverse nature.

Among all the definitions of investment, the most accepted is the one belonging to Pierre Masse, according to which investment means "*replacing an immediate and safe gratification to be waived in exchange for a future hope which can be obtained and is based on the invested assets"* [1], shortly „*an uncertain expense for an uncertain future*".

In the context of the sustainable visions, the investment decision should be made according to some rigorous criteria having the clearest advantages (maximum results), in the condition of minimum economic efforts. The activity can be performed only in such way.

The efficiency is the attribute of any human action of producing the useful desired effect, being an objective proportion between effects and the efforts made in order to get them. An enterprise is efficient when it gets the maximum effects/ results with minimum efforts/ expenses.

The higher the level of efficiency, the stronger the useful effect per unit of effort spent or the smaller the effort made as compared to a useful effect unit.

The investment activity implies working with certain data as for the efforts (investment costs) and with forecasted data (values, sizes, costs, profitability, efficiency) as for effects, thus implying a certain level of uncertainty and risk.

The assessment of investment projects aims to reveal the costs and revenues produced with an impact upon the whole financial situation of the company and, in the meantime, upon the national economy as they have a long term impact and an uncertain nature, and therefore, the assessment should also include the risk incurred.

Only when the activity performed by the company exceeds the level of losses, it can be considered as being efficient and having an optimal outcome. The two terms, "efficient" and "optimal" are used in correlation because they are interdependent. *"Performing an optimal activity appears as a consequence of strict necessity for each individual economic operator, in order to ensure a maximum efficiency"* [2].

3. Economic Efficiency Assessment Indicators

The economic efficiency of investments is the investor's main concern, and a project will be efficient if the efficiency indicators calculated in this respect meet the decision-makers' requirements.

The economic indicators from the analysis of the economic efficiency have the role of expressing the real content of the different economic characteristics, such as the ratio between their sizes, the correlations, evolutions etc. These characteristics are of a quantitative nature and they are obtained by processing the initial data and they offer the decision-makers information about the economic system at the time.

The economic analysis of investments implies the knowledge of some difficult quantifiable components or which interrelate and aim at a value system that must be taken into account. These result in a great variety of indicators and their particularities.

- The investment value/ the volume of the invested capital represents "*the value expression of consumption of resources assigned for the achievement of the objective had in view*" [2] and it includes the total effort made for the investment, as follows:

$$I_t = I_d + I_{col} + I_{con} + C_s \quad (1)$$

Where:
I_t = total investment
I_d = direct investment (reflected through the general estimate)
I_{col} = collateral investment (access roads, ensuring the power supply etc.)
I_{con} = related investment (expenses regarding the initial equipment, additional expenditure)
C_s = additional investment expenditure (design, preparing the human resources necessary for the new objective, etc.)

- The investment performance term is characterised by the fact that until the commissioning time of the investment, the related financial sources are withdrawn from the economic circuit of the company. If the commissioning takes place before the scheduled term, the undertaking will have an economic advantage. In case of delays, the costs become higher but in the meantime for a long term performance the costs spread over time are preferable, with the most valuable allocation at the end of the performance period.
- The operation time of the asset (measured in years or hours) starts upon its commissioning; the operation time is intended to be as long as possible, which can be obtained by a proper and smooth functioning of the asset invested and which ends by rendering it inoperative (its decommissioning).
- The payback period is one of the decisive indicators for choosing one of the possible investments options. The question arises: *How long does it take to recoup the invested capital from the net revenue obtained as a result of the asset performance?* For its determination, different calculation methods are applied, according to the investment type:

For new assets:

$$D = \frac{I_t}{P_h} \quad (2)$$

Where:
D = Payback period
I_t = total value of the invested capital
P_h = annual profit

For assets to be modernised:

$$D = \frac{I_m}{P_{hm} - P_{h0}} \quad (3)$$

Where:
D = payback period
I_m = value of the capital invested in modernisation
P_{hm} = annual profit got after modernisation
P_{h0} = annual profit got before modernisation – it will be recouped from the extra profit obtained as a result of the investment

- The economic efficiency coefficient is calculated as the reverse of the payback; as a consequence, the simultaneous calculation of the two indicators is not necessary as the last one is used especially for the national economy.
- The economic return on the investments is considered to be the most comprehensive indicator because it takes into consideration the whole investment process: form the works start until the invested asset is rendered inoperative. According to Românu, the invested funds should be compared to the profit gained during the entire period of performance. This indicator shows how many final lei – profit can be obtained for one capital invested leu or how many lei – profit can be obtained after recouping the investment for each invested leu [3].

$$R = \frac{P_t - I}{I} = \frac{P_h \times D}{I} - 1 \quad (4)$$

Where:
P_t = total annual profit
P_h = net annual profit got after having recouped the investment, until the end of the operation time
I = total volume of investment
D = operation time

- Investment payback speed shows how many times the investment can be recouped during the operation time.

$$V_r = \frac{D_f}{D} \quad (5)$$

Where:
V_r = payback speed
D_f = operation time of the asset
D = Investment payback period

4. More Efficient through Facility Management

As we stated above, there are necessary optimal strategic activities in order to obtain high economic efficiencies. The investments represent long term activities, with a major impact upon the economic outcomes and performance of an undertaking. In a similar way, the facility management activities represent a central aspect/factor in the decision-making process of an undertaking, because this business sector represents, after the personnel costs, the second cost factor of an undertaking.

The investments in the facility management domain are a smart strategy for increasing the efficiency, mainly the investments focused on modern technology.

5. Facility Management – Conceptual Framework

The numerous definitions of facility management start from the common elements that are the basis for the maintenance, operation and monitoring of buildings. "Facility management is an interdisciplinary field aiming to ensure the optimal functionality of the built environment, by integrating people, places, processes and technologies" [4], developing in time the perception of the services and scope of this field to "all support services of the primary activities" [5].

In other words, EN15221-1 first part, describes the facility management activities as being *"the support for the primary activities of an organisation. By coordinating the assets and services, using management skills and handling many changes in the organisation's environment, Facility Management influences its ability to act proactively and meet all its requirements. This is also done to optimise the costs and performance of assets and services*." [5] The previous assertion reveals the importance of Facility Management in the sustainability of organisations through economic increase of efficiency and value creation.

The evolution of Facility Management sector is linked to the dynamics of the business environment that has, at a strategic level, to move towards cost management and efficient workspace management (representing up to 35% of the company fixed assets) [6].

Studies show that the second large category of the total company costs is represented by the Facility Management costs with a share of 10-30% [4].

If we refer to the life cycle of a building where the company carries out its activity, then it should be specified that 80% of its total cumulated cost is represented by the facility management building [7].

The two previous assertions prove us the importance of this business sector and the need to pay more attention in this respect to the strategic decisions of costs reduction.

As Hellerforth shows, in the real estate field costs can be reduced to 30-50%, and in the energy management up to 80% [8]. Detailed data have not been published so far. Various publications state that the optimising potential through facility management is of 10-20% [9]. A study, made by Hauk [10], confirms, and later it is reconfirmed, that increases of efficiency, of productivity and costs optimisations may be obtained through optimisations within facility management. The study shows that the major optimisations are obtained in areas such as: energy management, cleaning, personnel, maintenance/repairs, security, by investments in equipment, new technologies, reorganisations, synergies (through updated technology) and more [11].

6. Savings with Facility Management

Facility management holds an important role in an organisation from the strategic and costs point of view, proving to be an enormous saving potential, meaning that the decisions follow two directions:

- Costs reduction;
- Cost optimisation: determined by a long term costs reduction through innovations and investments that on short term may have a negative financial impact, but which may have a long term impact upon the economic situation of the organisation.

It should not be underestimated the fact that each of the two options have both advantages and risks [12]:

Table 1: Costs reductions vs. costs optimisation

	Costs reduction	*Costs optimisation*
Advantages	• Short term cost reduction • Reaching the short term profitability objectives	• Maintaining performance • Obtaining outcomes • Maintaining quality • Medium and long term reduced cost
Risks	•Risk of injury •Decline in the quality of services, internal dissatisfaction •Long term deterioration of the customers' image about the organisation •Non-compliance with the law • Interruption, blocking the basic activity	• Longer period of implementation • Instant failure to reach the profits • Non-alignment of the stakeholders • Shareholders' increased pressure

Examples of possible costs optimisations are:

- Reuniting the individual building related services into one package of services [13];
- Use of the new technologies in the fields of buildings, information and communication [9];
- Technical maintenance: reduction of the preventive maintenance measures for air conditioners by investing in new technologies [14];

- Speeding up the investment decisions up to 20-30% [9];
- A higher percent of the data quality [9].

According to the strategy of the organisation decisions of reduction or optimisation through investments (equipment, technologies, modernisation, etc.) shall be made.

7. Case Study - Investment in a BMS System

7.1 Introduction in the case study

XX company of Brasov uses an old administrative building where they want to invest in a BMS system, decision upheld by the company strategy to adapt to the technological progress presenting social, environmental and most important economic advantages.

BMS - Building Management System is a discipline that comes under the umbrella of facility management and it is responsible for technical installation and building management. It is a control system that can integrate, monitor and control the signals from several types of mechanical and electrical equipment of a building such as power systems, video surveillance, access control, lighting, ventilation, etc.
The investment decision follows an analysis of the advantages it determines, advantages taken from different sources:

a) Technical data of the individual BMS equipment;
b) Previous projects implemented by the two tenderers; example [15], [16], [17]:
   - Davis School District Utah – reduction of the energy consumption by 7% for a surface increase of 18%;
   - Hotel Sheraton on the Park in Sydney – reduction by 15% of the energy costs ;
c) Previous projects implemented at an international level; examples:
   - Microsoft Campus – reduction of the energy consumption by 6-10% [18];
   - International Hotel of Iași – three times less energy consumption [19];
   - Siemens: BMS implementation with a reduction impact of 40% of the total energy costs, 38% reduction of CO2 emissions, 71% reduction of the electric power consumption [18].

The annual comparative surveys of TU Vienna support Hauk's theoretical assertions and prove that 56% of the companies get reductions of the energy consumptions and optimizations of the organisations from the facility management activity [20], [21].

7.2. Description of the Building Current State

The building was constructed in 1966-1970, it has one floor, a total area of 919 sq. m. and a useable area of 797 sq. m., where 56 employees work 40 hours weekly. It is structured as follows:

- 2 restrooms, each of them with 3 toilets;
- 6 offices;
- 1 IT office with servers;
- 1 kitchenette;
- 1 secretary's office;
- 2 offices for the managers;
- 1 storage for office supplies;

It has the following technical equipment:

- Electrical system;
- Gas central heating – power of 93 kW;
- Radio burglar alarm system with 32 detectors;
- Air conditioning devices – 12.000 BTU;
- water supply system and sewage;

The consumptions and costs of the utilities for the years 2014 and 2015 are presented in the following table together with their graphic representation:

Year	Month	Gas			Electricity			Water		
		Total cost (Lei)	Lei/MWh	Consumption (MWh)	Total cost (Lei)	Lei/MWh	Consumption (MWh)	Total cost (Lei)	Lei/m³	Consumption (m³)
2014	January	7.462,10	112,39	66,39	1.448,39	46,35	31,25	291,13	3,52	82,71
	February	8.853,23		78,77	2.424,19		52,30	287,10		81,56
	March	15.508,06		137,98	3.591,94		77,50	384,68		109,28
	April	6.063,71		53,95	399,19		8,61	249,19		70,79
	May	7.929,03		70,55	359,68		7,76	316,94		90,04
	June	918,55		8,17	641,94		13,85	328,23		93,25
	July	2.486,29		22,12	896,77		19,35	427,42		121,43
	August	466,94		4,15	210,48		4,54	365,32		103,78
	September	725,81		6,46	662,50		14,29	361,29		102,64
	October	2.450,00		21,80	919,35		19,84	256,45		72,86
	November	3.737,90		33,26	416,13		8,98	340,32		96,68
	December	7.108,06		63,24	1.174,19		25,33	311,29		88,43
	Total	63.709,68		566,86	13.144,76		**283,60**	3.919,35		**1.113,45**
2015	January	8.043,55	112,69	71,57	929,03	46,85	19,83	391,13	3,68	106,29
	February	5.568,55		49,55	140,32		3,00	337,10		91,60
	March	19.937,90		177,40	928,23		19,81	262,10		71,22
	April	8.058,87		71,70	356,45		7,61	951,61		258,59
	May	7.461,29		66,39	458,87		9,79	472,58		128,42
	June	4.530,65		40,31	1.662,90		35,49	289,52		78,67
	July	4.183,06		37,22	1.024,19		21,86	694,35		188,68
	August	669,35		5,96	1.741,94		37,18	413,71		112,42
	September	129,84		1,16	334,68		7,14	370,97		100,81
	October	1.980,65		17,62	1.191,94		25,44	595,97		161,95
	November	2.067,74		18,40	1.681,45		35,89	425,81		115,71
	December	6.562,10		58,39	1.041,94		22,24	440,32		119,65
	Total	**69.193,55**		**615,66**	**11.491,94**		**245,29**	**5.645,16**		**1.534,01**

Figure 1: Consumptions and costs of the utilities for the years 2014 and 2015

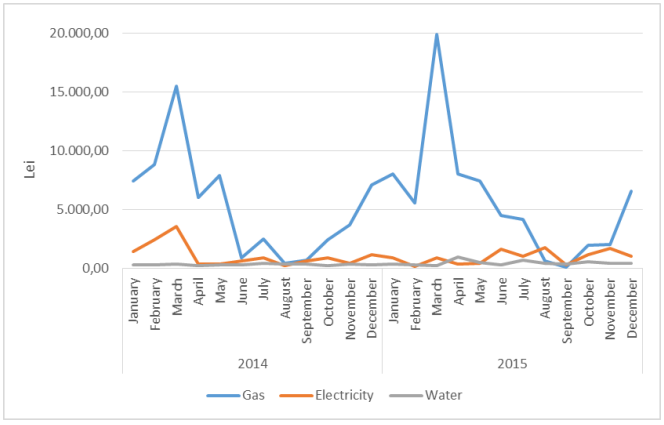

Figure 2: Costs of the utilities for the years 2014 and 2015

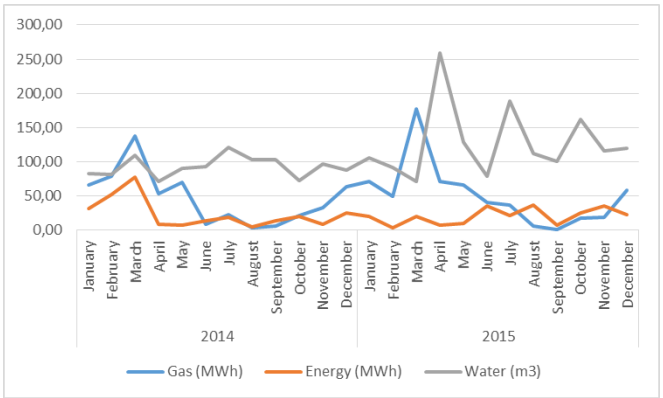

Figure 3: Consumptions of the utilities for the years 2014 and 2015

7.3. Presentation of the investment alternatives

As a consequence of a market study and the tenders sent, the investing company drew their attention to two offers:

- Offer 1: lei 225,900 VAT excluded
- Offer 2: lei 220,005 VAT excluded

Both offers include the inclusion into BMS of:

- Centralised security system;
- Fire protection system: monitoring and warning in case of fire;
- Integrated HVAC;
- Lighting system using sensors;
- Water sensors system;
- Integrated software;
- Computer to operate the software;
- Room controller (for temperature and ventilation);
- All the field equipment.

7.4. Assessment of the investment economic efficiency by calculating the indicators

A partial calculation will be made about the economic efficiency indicators of both possible investments in order to take the most efficient investment decision.

- Investment value / volume of the invested capital:

Investment 1:

$$I_{1t} = 225{,}900 + 1{,}500 + 800 + 200 = lei227{,}005$$

Investment 2:

$$I_{2t} = 220{,}005 + 1{,}500 + 800 + 200 = lei221{,}160$$

- Investment performance term

Investment 1: 5 months starting from the signature date of the contract

Investment 2: 8 months starting from the signature date of the contract

- The operation time of the asset

For both investment alternatives, the following operation times correspond [22]:

  - Site controllers – 15-20 years
  - Land equipment – 15-20 years
  - Computer – 3-5 years
  - Software BMS – 3-5 years

- Investment payback period

Investment 1:

$$D_1 = \frac{227{,}005}{916{,}144 - 817{,}446} = 2.3\ years$$

Investment 2:

$$D_2 = \frac{221{,}160}{916{,}144 - 817{,}446} = 2.24\ years$$

Year	Net annual profit (lei)	
2014	772.780	
2015	792.099	↗2,5%
2016*	817.446	↗3,2%
2017*	916.144	↗3,5%
2018*	948.209	↗3,5%
2019*	986.137	↗4%
*estimated		

Figure 4: Annual net profit

For the payback period, the net profit is estimated to increase by 3.5%, and afterwards it will stay constant for the period of the investment performance.

- Economic efficiency coefficient

Investment 1: 0.4348

Investment 2: 0.4464

- Economic return on the investment

We consider the operation period of 15 years and the net profit of lei 916.144-817.446 = lei 98.698.

Investment 1:

$$R = \frac{98{,}698 \times 15}{227{,}005} - 1 = 5.52$$

Investment 2:

$$R = \frac{98{,}698 \times 15}{221{,}160} - 1 = 5.69$$

The best investment alternative is the one maximising the indicator, respectively in our case, investment 2.

- Investment payback speed shows how many times the investment can be recouped during the operation time.

Investment 1:

$$V_r = \frac{15}{2.3} = 6.52$$

Investment 2:

$$V_r = \frac{15}{2.24} = 6.70$$

7.5. Estimating the consumptions after investments

Starting from the experiences of the two tenderers, the future consumptions can be estimated in both cases:

In case of investment 1, a reduction of the total energy consumption is estimated to 35%, out of which the largest component is the electric consumption (69.67%), due to the efficient equipment provided for the building.

The reduction of consumption since 2017, the investment implementing year, represented in the chart, refers to the 7 months of the year in which the investment is functional.

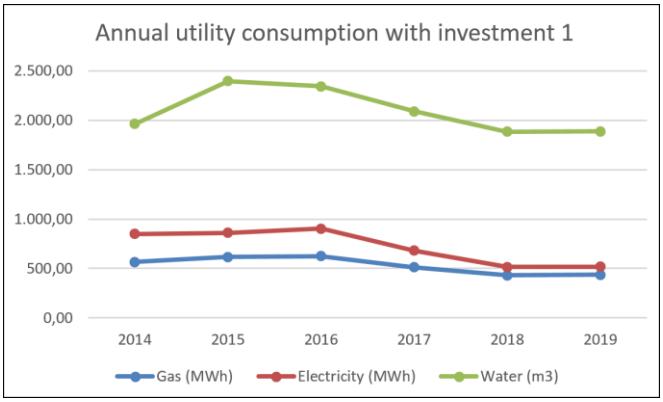

Figure 5: Evolution of annual utility consumption with investment 1

Investment 1	Gas (MWh)		Energy (MWh)		Water (m3)	
2014	566,86		283,60		1.113,45	
2015	615,66		245,29		1.534,01	
2016	623,56		278,90		1.440,76	
2017	511,44	↓ 31%	168,90	↓ 68%	1.407,33	↓ 4%
2018	430,26	↓ 31%	83,67	↓ 70%	1.368,72	↓ 5%
2019	436,49	↓ 30%	80,88	↓ 71%	1.368,72	↓ 5%
Total ↓35%		**↓ 30,67%**		**↓ 69,67%**		**↓ 4,67%**

Figure 6: Annual utility consumption with investment 1

In case of investment 2, a reduction of the total energy consumption is estimated to 31.22%, out of which the largest component is the electric consumption (64%), due to the efficient equipment provided for the building.

The reduction of consumption since 2017, the investment implementing year, represented in the chart, refers to the 4 months of the year in which the investment is functional.

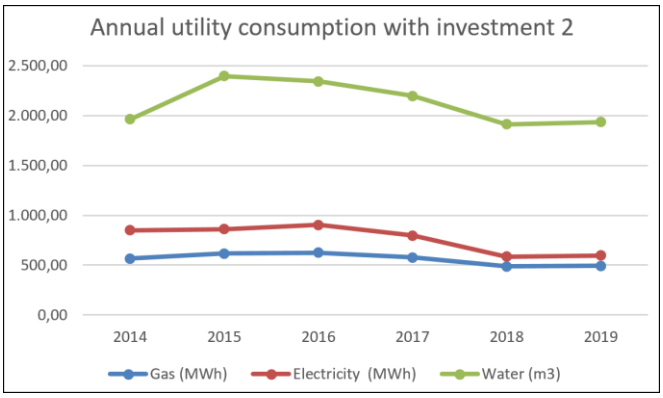

Figure 7: Evolution of annual utility consumption with investment 2

Investment 2	Gas (MWh)		Energy (MWh)		Water (m3)	
2014	566,86		283,60		1.113,45	
2015	615,66		245,29		1.534,01	
2016	623,56		278,90		1.440,76	
2017	578,29	↓ 22%	219,08	↓ 65%	1.397,97	↓ 9%
2018	486,38	↓ 22%	100,40	↓ 64%	1.325,50	↓ 8%
2019	492,61	↓ 21%	103,19	↓ 63%	1.339,91	↓ 7%
Total ↓31,22%		**↓ 21,67%**		**↓ 64%**		**↓ 8%**

Figure 8: Annual utility consumption with investment 1

It is worth mentioning that around 80% of these consumption savings are due to the improvement of the heating and cooling systems, and only 20% from the lighting system [23].

In the meantime, the advantages of investing in a BMS do not refer only to the energy consumption and its costs, but also to the three strategic directions they reach: economic, environmental and social. Due to the modern technology, there are also advantages such as:

- Increased comfort of the building's occupants;
- Level of satisfaction of the building's occupants;
- Labour productivity growth;
- A more efficient control of the entire comfort of the space occupied;
- Reduction of CO2 emissions;
- Electricity consumption may be monitored;
- The whole activity of the building may be monitored;
- The emergency cases can be identified and alerted in good time;
- The building may be monitored and controlled in a flexible way.

7.6. Investing in BMS Final Outcomes

Analysing the indicators of the investment economic efficiency, it is obvious that the investment decision is efficient in the case of second offer:

Indicator name	Investment 1	Investment 2
Investment value	227,005 lei	221,160 lei
Completion time	5 months	8 months
Operation time	15-20 years	15-20 years
- Site controllers	15-20 years	15-20 years
- Land equipments	15-20 years	15-20 years
- Computer	3-5 years	3-5 years
- BMS Software	3-5 years	3-5 years
Payback period	2.3 years	2.24 years
Economic efficiency coefficient	0.4348	0.4464
Economic return	5.52	5.69
Payback speed	6.52	6.7

Figure 5: Investment economic efficiency

If we strictly analyse the annual consumptions, we notice that investment 1 is more profitable because of the significant reductions of the utilities consumptions.

Utilities consumption	Investment 1	Investment 2
Gas	↓ 30.67%	↓ 21.67%
Electricity	↓ 69.67%	↓ 64%
Water	↓ 4.67%	↓ 8%
Total	**↓35%**	**↓31.22%**

Figure 6: Utilities consumption evolution

The final decision of the management will be taken according to the strategy of the investing company, and to the degree of aversion to the technological progress and its advantages.

8. Conclusions

Generally, companies should look into the future, taking into account the social, economic and environmental effects of their actions.

The investments belonging to the activities and technologies of the facility management field support this approach and increase the efficiency of the whole company activity, just through the multidimensional advantages they have after being implemented.

When making an investment decision in a building management system (BMS), the investment proves to be efficient from an economic point of view, as this paper has demonstrated, but also from a social and environmental point of view, having a long term impact upon the increased efficiency of the whole activity of the investing company.

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