Environmental and economical viability associated to the sustainability criteria applied in commercial buildings

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ABSTRACT: The main challenges and contributions for the sustainability dissemination in construction are to recognize and prove the effective outcomes (economic and environmental) that could be obtained with the implementation of sustainability criteria. It means that more important than recognize the sustainability through the implementation of a sustainable voluntary tool, is to assure (and verify) the positive effects that could be reached with the application of the methodology or the classification obtained.

In this context, this paper will present the results obtained within a research project developed in Portugal with the objective of determining the economic and environmental feasibility of the criteria defined by a British Sustainable Voluntary Tool (BREEAM - Building Research Establishment Environmental Assessment Method) that has been applied in a shopping centre under the construction phase. The referred shopping has a Gross Leasable Area (GLA) of 70.488 m^2.

1 INTRODUCTION

Economic factors have always influenced and promoted the use of new practices in the market, as is the case with sustainability in construction. Before considering a sustainable project, investors, real estate promoters and customers need to clarify the question "What is the cost of sustainability?" and "What are the actual economic and environmental advantages that result from applying sustainable practices?"

The answer to these questions is often left unanswered due to the lack of information, as well as the lack of long term studies that compare the benefits of sustainable practices with more conventional ones. In the particular case of Portugal, the difficulties lie in the limited number of sustainable buildings and the lack of observational data (and economic studies) on these buildings during the different stages of the project. What is available, on an international basis, is few and far between, such as:

- "The costs and financial benefits of Green Buildings" report written by Gregory Kats (2003) which compares 33 buildings (certified or in the process of obtaining LEED certification) with other conventional buildings. The study concluded that an average investment of 2% over initial costs (compared to that of conventional buildings) will yield financial benefits which are 10 times greater than the aforementioned investment (for a 20 year period). This takes into consideration the analysis of operational costs, maintenance, the emission of pollutants and productivity;
- The "Costing Green: A comprehensive Cost Database and Budgeting Methodology" report, written by David Langdon (2004), which aimed to analyze only the expenses

that were associated to the construction phase of ecological buildings. The study concluded that many projects attained a sustainable certification with reduced initial budgets, or small supplemental investments (on average 2%);

- The article "Environmental certification for commercial real estate assets: the value impacts" (Franz Fuerst and Patrick McAllister, 2008) aimed to investigate the existing price differential between LEED and Energy Star certified constructions and non-certified buildings. The study concluded that the rent of certified building was 11% higher than that of non certified buildings.
- Similar to the previous study, the recent article "Doing Well by Doing Good? Green Office Buildings" (Eichholtz P. et al, 2009) published by the University of California, also compared Energy Star and LEED certified buildings and non-certified buildings in the same location. The results clearly demonstrated the importance of certification (especially Energy Star) when it came to increasing the value of commercial spaces and rental rates. There was roughly a 3% increase in rental rates per square meter and a 6% increase per square meter on effective rents. Selling prices were higher in about 16%.

2 COST-BENEFIT ANALYSIS OF SUSTAINABLE PRINCIPLES

The above mentioned studies were based on a relevant number of certified and non-certified buildings commonly found in certain countries such as the U.S.A and U.K. (up to February 2008, 1283 and 1358 non-residential buildings, respectively, were certified) (Saunders, T. 2008). In Portugal there is a very limited number of buildings with sustainability certification and there are no published economic studies which make difficult the practice of studies similar to those mentioned above. As such, the aim of this paper is to present an economic viability study and the environmental impacts linked to sustainability criteria applied in only one case study. In other words, the aim is to present the needed investment to improve the final classification of a building, as well as the economic and environmental implications associated with sustainability criteria that were implemented in the construction.

As such, the first task was to identify the sixty-one elements (defined for the case study) included in the BREEAM assessment tool (Building Research Establishment Environmental Assessment Method) for the scheme "Retail", through different pre-established groups of analysis, including:

- (Group A) – Identification of criteria included in National/European legislation;
- (Group B) – Identification of criteria unsuitable for the Portuguese context;
- (Group C) – Identification of criteria that is complex to quantify and assess, or in other words, those in which direct or indirect benefits (social and environmental) are evident but their economic quantification is complex. Measures related with biodiversity, ethical values, indoor environmental quality and the choice of materials are included within these criteria;
- (Group D) – Identification of quantifiable criteria. The viability and economic performance of criteria included in this group was studied through the analysis of the Net Present Value, the Internal Rate of Return and the Payback period (Return of Investment). On the other hand, these values are also identified and analyzed according to their environmental impact (CO_{2eq} emissions and energy and water consumption). These criteria, on the main, refer to energy and water management issues.

This paper will only consider the analysis of group C and D taking into consideration that the criteria included in these groups were voluntarily introduced in the case study and are associated to a not foreseen initial investment.
In relation to the other groups, namely Group A, the costs associated to these groups will not be analyzed as they include mandatory measures relating to national legislation or common market practices. In other words, the needed investment was already considered before the introduction of new sustainability criteria.

3 DEFINITION OF THE CASE STUDY

The criteria of the BREEAM tool were applied in the Centro Commercial Dolce Vita Braga (DVB) (Dolce Vita Braga Shopping Centre) belonging to the real estate company Chamartin. The construction of the building in Braga, with a total gross leasable area of 70 488 m^2, began in April 2008 and is scheduled to open its doors to the public in October 2010. The project includes spaces for reading, shops, restaurants, a supermarket, parking, cinemas, health clubs and ample common areas.

The typology chosen for this analysis was based on its relevant impact on the "Triple Bottom Line" (baseline of sustainability). The construction of a shopping mall generates significant alterations, including environmental impacts resulting from the construction and operation phases, and social and economic impacts resulting from future alterations, such as the creation of new jobs and the alteration of local traffic.

During the initial stage, a pre-assessment, based on the BREEAM tool, was carried out to assess sustainability, in order to verify the rating of the construction without any type of improvements (initial proposal). The result was a compliance with 48.78% of the criteria which corresponds to a rating of "Good".

4 SUSTAINABILITY CRITERIA

This study proposes to analyze and present the results of two intervention scenarios applied to the initial proposal of DVB. The objective was to gradually improve the classification from "Good" to "Very Good" (rating defined by the BREEAM tool for buildings that show a compliance with more than 55% of the listed criteria) and, in a second phase, to "Excellent" (compliance with more than 70% of the listed criteria).

Based on the additional criteria, an individual and a global analysis were carried out in order to identify the real economic and environmental impacts, as shown in Figure 1.

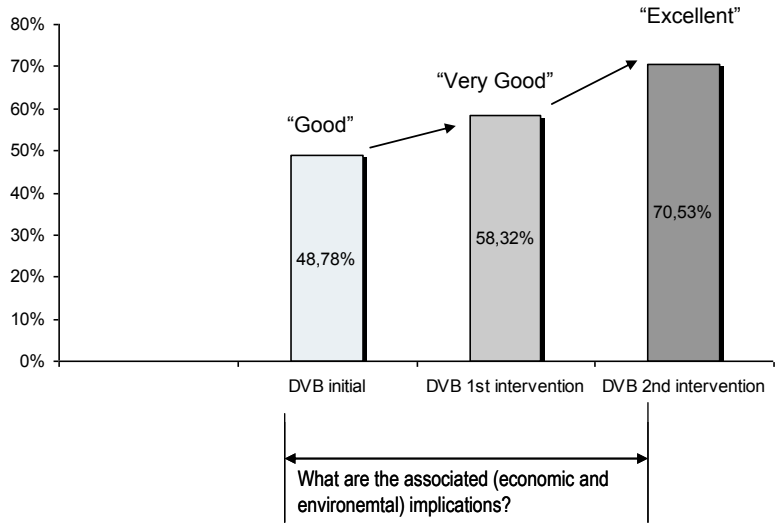

Figure 1. Comparison between the different stages

The following table lists criteria that were used during the different stages of intervention. The fourteen points that constitute part of group C and D represent those that were selected and gradually introduced, based on how well they could be adapted to the project in the construction phase, and those that had a better return on the economic investment that was required. These aspects were essential to guarantee an improvement in the classification to attain the desired rating.

Table 1. BREEAM Tool Criteria analyzed during the economic and environmental study (Source: BREEAM, 2008 - adapted)

Ref.	Breeam Criteria selected for the analysis (elements from Group C and D)
Hea14	Office space
Ene1	Reduction of CO2 Emissions
Ene5	Low or zero carbon technologies
Ene7	Cold food storage
Ene8	Lifts
Tra3	Cyclist Facilities
Tra4	Pedestrian and cycle safety
Tra7	Travel information space
Wat1	water consuption
Wat3	Major leak detection
Wat4	Sanitary supply shut off
Wat5	water recycing
Mat6	Insulation
Wst5	Composting

5 BASE CONDITIONS

One of the key elements needed to carry out the analysis of the cost benefits for each one of the principles (criterion) was the use of a holistic analysis, whenever possible, not only examining the initial investment (cost of construction) but also other expenses, like operation and maintenance costs, incurred throughout the lifecycle of the building under analysis (considering a period of analysis of 20 years).
The selected criteria, which will be presented in this paper (Sustainable Proposal), were compared against the initial proposal (with conventional solutions). The economic assessment criteria used in this study were based on the following presuppositions:

- A 5% discount rate used when calculating the NPV;
- A 20 year analysis period;
- An annual inflation rate of 2%.

The results were framed according to the following indicators:

- Initial investment – this refers to the difference between the investment on the initial proposal and the investment applied on the sustainable proposal;
- Return on Investment (expressed in years) – period (years) that the promoter will have to wait to recover the investment made on the project;
- NPV (Net Present Value) – in a simple manner, this value is used to determine the net value of an investment at time 0 (date of investment) calculated based on the annual cash flows generated by the investment during a period of 15 to 20 years;
- IRR (Internal Rate of Return) – to measure the profitability of the project through the IRR implies obtaining a IRR (%) that is higher than the stipulated interest rate (stipulated at time of financing), in this case 5%.

The environmental indicators are expressed according to the reduction in energy and water consumption and the reduction of CO_{2eq} emissions.

6 RESULTS

The following figures and tables provide the economic and environmental results of the interventions carried out.

The obtained results from the first intervention with the objective of upgrading the rating from "Good" to "Very Good" can be observed in Figure 2. This first intervention included the implementation of ten criteria from groups C and D. From among the proposed principles, there are criteria with and without economic benefits. In the case of the criteria without economic benefits, these presented a reduced initial investment and important environmental advantages. Thus, as can be observed in table 2, the joint analysis of all the criteria does not hinder the final results.

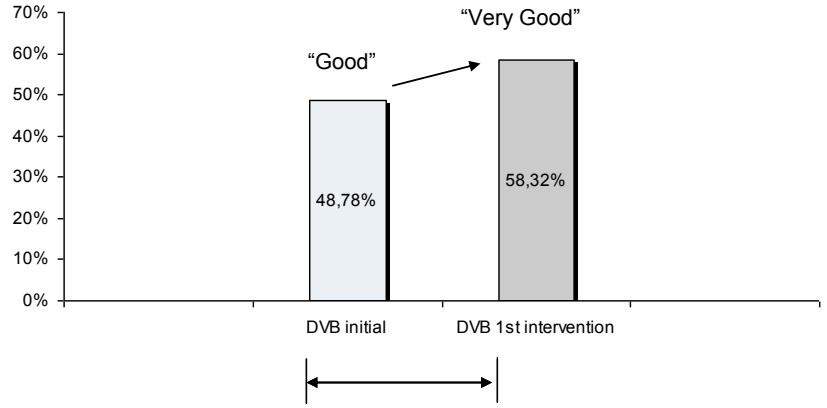

Figure 2. Alteration of rating from Good to Very Good following the first intervention criteria

The application of the additional ten principles in the first intervention, as demonstrated in table 2 was quite positive, as it was possible to demonstrate that an additional investment of 220 443.41€ (representing roughly 0.30% of the investment quota budgeted for the construction of DVB) is recoverable within an average period of 5 years.
These results, in large part, are a consequence of the measures implemented to improve the efficiency of water management, which were, on the whole, quite reasonable in what concerns the required investment, and were rapidly recoverable (in less than one year).

The resulting environmental impacts of these measures are the following:

- Reduction of 248.85 ton in CO_{2eq} emissions, which is equivalent to the emissions produced by 40 European inhabitants;
- Reduction of 260.4 MWh/year in the energy consumption, which is equivalent to the energy consumption of 45 European inhabitants;
- Reduction of 15,143 m^3 of water consumption, which is equivalent to the water consumption of 226 European inhabitants.

The results of the second intervention, with the objective of upgrading the rating from "Good" to "Excellent" are demonstrated in Figure 3. In addition to the ten principles used in the first intervention, four more were applied from Group D. Among the proposed criteria, only the one with the reference Ene1 (promote the reduction of CO_{2eq} emissions) was not between those with economic benefits. The compliance with this criterion is, however, linked to the environmental benefits (reduction of CO_{2eq} emissions) resulting from the use of the remaining additional criteria, not implying, this way, any additional investment.

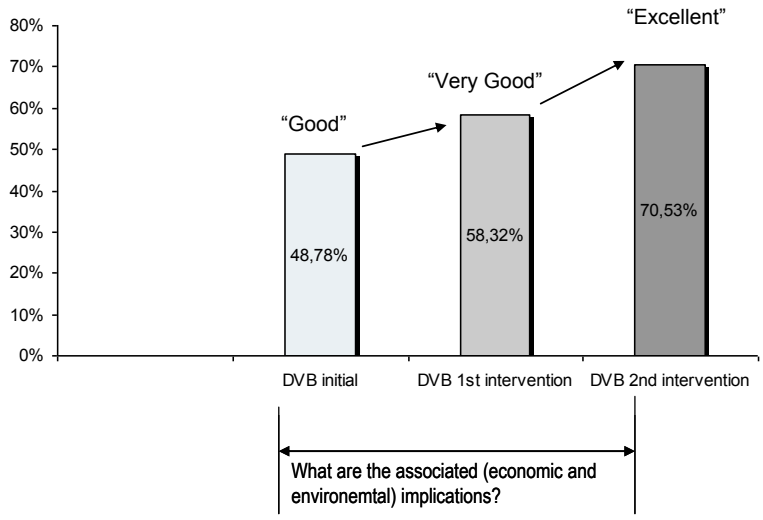

Figure 3. Alteration of rating from "Good" to "Excellent" obtained from the second intervention.

The results obtained from both interventions, shown in table 2, display the advantages of upgrading a "Good" construction into an "Excellent" construction, according to BREEAM criteria. Despite a considerable investment of approximately 4,806,982.86€ (6.62% of the investment quota budgeted for the construction of DVB), results suggest that the amount is recoverable within an average period of 5 years. The environmental advantages resulting from these measures are as follows:

- Reduction of 4,023.85 ton in the annual CO_{2eq} emissions, which is equivalent to the emissions produced by 574 European inhabitants;
- Reduction of 11,594 MWh/year in energy consumption, which is equivalent to the energy consumed by 2,031 European inhabitants;
- Reduction of 43,437.7 m^3 in water consumption, which is equivalent to the water consumed by 650 European residents.

Table 2. Summary of results obtained during the analysis.

Additional measures 1st intervention Initial proposal (Good) to (Very Good)(Criteria from Group C and D)											
Breeam-Retail			Economical data					Environmental data			
Related category	Ref.	Criteria	Inicial investment (€)	Payback (years)	NPV (15 years) (€)	NPV (20years) (€)	IRR 15(TX Val 5%)	$TonCO_{2eq}$ reduction/year	Reduction of energy (MWh/year)	Reduction of water (M^3)	Breeam Points
Health & wellbeing	Hea14	Environmental comfort of office space	3.500,00 €	-	-	-	-	0,035	-	-	3
Energy	Ene8	Lifts – Solutions for greater energy efficiency	170.840,00 €	10,0	29.759,55 €	94.840,24 €	7%	125	250,4	-	2
Transport	Tra3	Facilities for cyclists	850,00 €	-	-	-	-	1,66	-	-	1
Transport	Tra4	Pavement for Pedestrian and cycle safety	0,00 €	-	-	-	-	n.q.	-	-	2
Transport	Tra7	Spaces for Public transportation information	0,00 €	-	-	-	-	n.q.	-	-	1
Water	Wat1	Measures to reduce water consumption 1- Dual flush toilets	3.435,00 €	<1 year	161.011,75 €	205.577,02 €	401%	43,00	-	5.291,0	1

Table 2.(cont.) Summary of results obtained during the analysis.

Water	Wat1	Measures to reduce water consumption 2 - Waterless No-Flush urinals	6.327,41 €	<1year	228.312,72 €	291.977,39 €	311%	62,00	-	7.558,0	1
Water	Wat3	Water leak detection system	3.500,00 €	-	-	-	-	17,00	-	2.010,0	1
Water	Wat4	Sanitary supply shut off	5.400,00 €	9,0	2.375,58 €	4.765,17 €	10%	2,33		283,68	1
Materials	Mat6	Use of insulation with less environment impact	33.491,00 €	-	-	-	-	646,6 (1ºano) 4,82	- 10,0	-	1
waste	Wst5	Composting	-6.900,00 €	-	-	-	-	29,00	-	-	1
Additional investment associated with changing a rating of **good to Very good**			220.443,41 €	5 anos	380.137,83 €	555.838,04 €	23%	931,45 (1ºano) 284,85	260,4	15.142,7	

Additional measures - VERY GOOD to EXCELLENT (Criteria from Group D)

	Breeam-Retail		Economical data					Environmental data			
Related category	Ref.	Criteria	Inicial investment (€)	Payback (years)	NPV (15 years) (€)	NPV (20years) (€)	IRR 15(TX Val 5%)	$TonCO_{2eq}$ reduction/year	Reduction of energy (MWh/year)	Reduction of water (M^3)	Breeam Points
Energy	Ene1	Emission of CO_2	-	-	-	-	-	-	-	-	10
Energy	Ene5	Low or zero emission technologies	2.693.000,00 €	4,0	6.620.766,53 €	9.387.604,30 €	29%	3.727	11.333,29	-	3
Energy	Ene7	Cold storage	1.785.304,00 €	6,0	2.217.162,76 €	3.425.764,66 €	18%	0	0,00	-	1
water	Wat5	Recycling of water from rain (including watering)	108.235,45 €	2,0	753.315,24 €	991.661,99 €	67%	12	-	28.295,0	1
water	Wat1	Measurements to reduce water consumption (1+2) conjugated with Wat 5	9.762,38 €	1,0	163.687,02 €	211.023,05 €	149%	100,00	-	12.849,0	2
Additional investment associated with changing a rating of **Very good to Excellent**			4.586.539,45 €	5,0	9.591.244,53 €	13.805.030,95 €	25,98%	3.739,00	11.333,29	28.295,0	

Additional measures 1st intervention Initial proposal (Good) to (Excellent) (Criteria from Group C and D)

	Breeam-Retail		Economical data					Environmental data			
Related category	Ref.	Criteria	Inicial investment (€)	Payback (years)	NPV (15 years) (€)	NPV (20years) (€)	IRR 15(TX Val 5%)	$TonCO_{2eq}$ reduction/year	Reduction of energy (MWh/year)	Reduction of water (M^3)	Breeam Points
Additional investment associated with changing a rating of **Good to Excellent**			4.806.982,86 €	5,0	9.745.744,91 €	14.074.337,63 €	25,42%	4.670,45 4.023,85	11.593,68	43.437,7	

7 CONCLUSION

This article provides evidence of the results obtained from introducing sustainability criteria using the BREEAM tool, applied to a shopping centre in the north of Portugal. It was concluded that it was possible to obtain a better rating (from Good to Excellent) with relatively low financial investment, and significant environmental advantages. In the concrete case of the Dolce Vita Braga Shopping Centre, an additional investment of 6.62% over the initial cost of construction would allow the building to obtain a rating of Excellent. This amount would be rapidly recoverable, with a

20 year NPV three times greater than the amount invested. In relation to the environmental results, the reductions obtained in energy and water consumptions and CO_{2eq} emissions were quite reasonable, taking into consideration that the avoided consumption could supply the consumption needs of a significant number of European inhabitants.

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7.2 *Acknowledgement*

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