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IDENTIFYING MONETARY VALUE OF ESG ACTIONS IN THE CONSTRUCTION SECTOR USING THE RETURN ON SUSTAINABILITY INVESTMENT (ROSI) FRAMEWORK

PANAGIOTIS PANAGIOTOPOULOS

SCHOOL OF HUMANITIES, SOCIAL SCIENCES AND ECONOMICS

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Student Name: PANAGIOTIS PANAGIOTOPOULOS

SID: 1101200006
Supervisor: Dr. A. SIKALIDIS

I hereby declare that the work submitted is mine and that where I have made use of another's work, I have attributed the source(s) according to the Regulations set in the Student's Handbook.

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Abstract

This dissertation was written as part of the Executive Master's in Business Administration at the International Hellenic University.
In this thesis the connection between sustainability actions and corporate financial performance is investigated. Specifically, the construction sector is under the focus as it is one of the most environmental damaging sectors while sustainability practices are very slowly introduced in the industry. Analytically, based on actual data we are comparing 2 construction projects, one executed from 2013-2016 without any sustainability actions used and the other executed from 2017-2020 with very high priority in Environmental Social and Governance practices. In our research the ROSI (NYU Stern) framework is used as the main tool to quantify and monetize the benefits of the various sustainability practices.

The results are overwhelming, we calculated a net benefit of around €20 million or 5.5% of the project value due to the sustainability actions adopted in the second project. We found that the mediating factor which acted as the most beneficial to the project was operational efficiency through the improved waste management and after the greater customer loyalty and improved sales and marketing, due to the establishment of sustainable product / service presence.

This thesis has as an objective to be used as a guide for academics and professionals from the construction industry showing how the monetary value of sustainability actions can be estimated easily so that the ESG practices can be seen not as a luxury and an additional cost but on the contrary as financially beneficial actions which add value to the firm, environment and society.

Keywords: (sustainability, financial performance, construction)

Panagiotis Panagiotopoulos
28/02/2022

Preface

Everything started 2 years ago when I accidentaly read in a Greek newspaper one article about a professor in Harvard Business School (Professor George Serafeim) who along with other academics “proved” that Milton’s Friedman “profit maxim” was no longer the correct theoritical basis for the operation of corporations. It was the moment that I felt how revolutionary and impactful this is, since after almost 20 years of industry experience in my mind was that the profit is the obvious and sole target for a firm. During the last 6 months, I had a really enjoyfull journey inside the global research in ESG for the preparation of this thesis.

I would like to sincerely thank my supervisor Professor Alexandros Sikalidis who gave me the oppurtunity to work in such an important subject and opened my horizons to the research of the most innovative academics in the field of Sustainability. Also, I would like to express my respect and support to the International Hellenic University for running this amazing course. To my director from work Mr. Dimitris Tamvakis, I would like to express my gratitude for supporting the subject of this thesis and facilitating me access to all necessary data.

I sincerely thank my family who were so patient with me during the last two years and most importantly I would like to thank God for helping me so much in every aspect of my life, for giving me the strength to attend this study, without His help I would have never even applied for this program..

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1. INTRODUCTION

Environmental, Social and Governance (ESG) practices are considered today to be in the forefront of research as the academic together with the business community and various institutions are facing very strong challenges regarding the financial reporting, the correct metrics and the suitable regulations that must be followed in every industry.

The construction sector is one of the most environmental damaging sectors since it is generating 30% of the total greenhouse gas emissions and uses the 32% of the world's natural resources (UN Environment Program 2020). It is obvious that the construction sector should be transformed rapidly and extended ESG practices should be adopted such as, material recycling, waste management and other practices from the circular economy concept.

In this thesis, the main idea is to track and present comprehensively the monetary value of sustainable actions in the construction industry to help other professionals, institutions and construction firms to realize the full benefits of ESG practices on the corporate financial performance (CFP). The importance of this research is very high since construction industry left for many years with old concepts and ideas and now new research work must be presented to change not only the techniques and the concepts but also the mentality of the professionals.

The hypothesis in this thesis is that by using sustainability practices in construction projects, companies can be financially benefitted through operational efficiencies such as waste reduction, production cost reduction, decrease in resource consumption, decreases in emissions and recycling end-of-life products while other factor such as Customer Loyalty, Employee Relations, Sales and Marketing, Risk Management, Supplier Relations can also contribute considerably.

To confirm or reject this hypothesis, real data have been used from 2 different construction projects within the same construction firm. The first one was the construction of the Psychiatric Department within a regional National Hospital with budget of € 7,96 million while the second one was the Engineering Procurement and Construction (EPC) contract of the reconstruction and expansion of 14 regional airports all over the mainland and islands of Greece with a budget of € 357 million. The main difference between those 2 projects is that the first one was executed on the period 2013-2016 when at that time there was not a strong sustainability and environmental department within the company while the second project was executed from 2017-2020 when the environmental and sustainability department was established and closely monitoring the project due to the new Greek regulations, the contractual obligations of the project and the company's decision to invest in sustainability practices. The data of those 2 projects are analyzed using mainly the ROSI Framework (adopted by NYU Stern Center of Sustainable Business).

This thesis can be used as an example in national and international level of how sustainability practices within the construction projects can be monetized using the ROSI Framework, proving to all stakeholders that sustainability practices not only serve high ideals that an organization should follow such as protecting the environment for the future generations, respecting its stakeholders and caring for their well-being but also bringing clear financial benefits which can be monitored and monetized.

As the ROSI framework is a general one with extended use in the manufacturing industry, this thesis is trying to act as an introduction for academics and professionals from the industry who can either use the same framework in different projects or use other frameworks (even create new ones) to monitor and measure the financial benefits of the sustainability practices which have adopted.

In the next chapter, a literature review is presented with information regarding the works of other professionals and academics in this subject but since this is the first time that the ROSI framework is being used in the construction industry examples from other industries (manufacturing, farming) are presented.

In the chapter 3 the ROSI framework methodology is presented in detail, while in chapter 4 a full analysis of how the empirical work was approached is described and the style and techniques followed are explained. The necessary data for the calculations through the ROSI framework are identified and limitations of the model are reported. In the chapter 5, all results of the research are presented in tables and graphs. The findings indeed confirm the hypothesis that the sustainability practices can bring financial benefits to construction projects through the operational efficiencies and in detail 6 mediating factors can lead to improved financial performance. Finally, in the last chapter a summary of the thesis is presented, the recommendations for further research along with limitations of this project due to the methods employed.

2. LITERATURE REVIEW

2.1 RESEARCH ON HOW SUSTAINABILITY PRACTICES IMPACT CFP

There are several studies published the last years with the main question if and how much Environmental, Social and Governance (ESG) actions can have positive impact on corporate financial performance (CFP). Tensie Whelan, Ulrich Atz, Tracy Van Holt and Casey Clark. (2021) performed meta-analysis to over 1.000 studies published from 2015-2020 regarding the relationship between ESG and Financial Performance and found "*a positive relationship between ESG and financial performance for 58% of the "corporate" studies focused on operational metrics such as ROE, ROA or stock price, 13% showing a neutral impact, 21% mixed results and only 8% a negative relationship".* On the same line Clark, Freiner, and Viens (2014) with their meta-analysis showed *"90 percent of the reviewed studies found firms with high sustainability enjoyed lower cost of capital; 88 percent had a positive correlation between sustainability and operational performance and 80 percent had a positive correlation between sustainability and superior financial performance".* Ali Alshehhi, Haitham Nobanee and Nilesh Khare (2018) after gathering 132 papers from top-tier journals that perform content analysis and found the there is a 78% positive relationship between corporate sustainability and financial performance. Duc Cuong Pham, Thi Ngoc Anh Do, Thanh Nga Doan, Thi Xuan Hong Nguyen and Thi Kim Yen Pham (2021) study the impact of sustainability practices on financial performance and examined 116 listed Swedish companies for the year 2019 and their results indicate positive relationship between sustainability and financial performance by means of return an asset, return on equity and return on capital. Christopher Jerry Thomas, Jasman Tuyon, Hylmee Matahir and Samih Dixit (2021) studied 36 listed companies in Malaysia for the period 2015 – 2019 which constantly implemented and published ESG practices, the results reveled again a positive relationship between ESG and financial performance. Robert G. Eccles, Ioannis Ioannou and George Serafeim (2012) examined a sample of 180 US companies including firms which adopted very early (1993) sustainability practices (*High Sustainability Companies)* compared their performance by year 2009 with companies which did not follow any of sustainability practices. Even so many years ago, the High Sustainability companies outperform the Low Sustainability ones as per their stock and accounting performance (even when the market did not expect that) and benefited more in the sectors of B2C, extraction of natural resources and where brand and human capital played the most important role in the success.

Regarding the mechanism that connects ESG practices and CFP Ioannou and Serafeim (2019) found out that *sustainability should be considered both strategic approach and common practice.*

Kotsantonis, Sakis, Christopher Pinney, and George Serafeim. (Spring 2016) exposed that there were several myths regarding the financial performance on sustainable investing including (abstract from study): "*ESG practices reduce returns on capital*, *companies cannot influence what kind of shareholders that buy their shares, ESG data are scarce and unreliable"* and they proceed with the correction of those myths by

stating "*many ESG factors have shown to have positive correlations with corporate financial performance and value".*

2.2 THEORIES SUPPORTING THE RESEARCH EVIDENCE

2.2.1 Stakeholder Theory

The Stakeholder Theory was introduced by Freeman (1984) and it is against the idea of profit maximization as the sole goal of a firm (Milton Friedman, 1962). In detail according to the stakeholder theory, maximization of firm's profit is not the goal but the outcome which is the result from the maximization of stakeholder's wealth. Stakeholders of a firm are the customers, the employees, local communities, suppliers and others who are affected by the firm's aims. Although shareholders are as well stakeholders the theory implies that sustainability actions will create long term value to the firm which in the long term will increase earnings while limiting the risks (Jerry Thomas et al. 2021).

2.2.2 Legitimacy theory

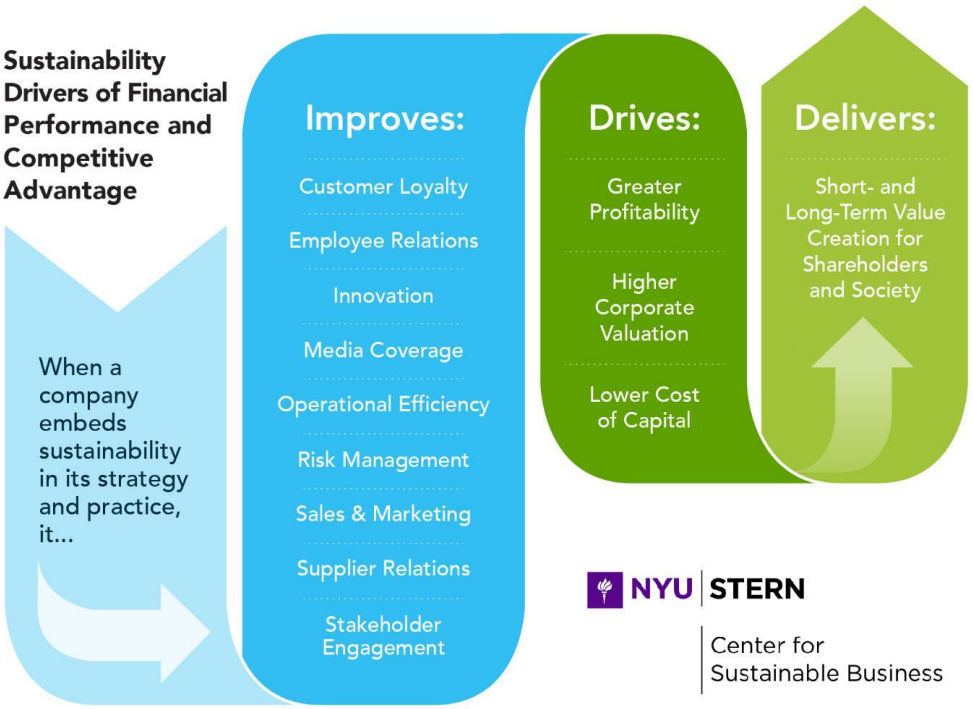
Firas Alshouha (2021) note that Legitimacy theory suggests that firms may follow sustainable practices in order to keep their legitimacy and good reputation in their stakeholders (Deegan et al. 2002) while investments will follow to those firms since investors will use this information (Frynas et al 2016) and eventually valuation of those firms will also be increased (Schadewitz et al. 2010).

2.3 ROSI FRAMEWORK

In NYU Stern Center for Sustainable Business (CSB) after reviewing academic and corporate research identified the mechanisms that lead to positive "financial performance when companies integrate material sustainability factors in their strategy" argue that embeded sustainability in strategy and paractice 'drives financial and stakeholders benefits' (NYU STERN, 2019). The financial and stakeholder's benefits can be monetized through conventional accounting methods or Impact-Weighted Accounting (IWA) (Tensie Whelan and George Serafeim, 2021). This framework can be used practically for any industry and can be applied to firm level of in the value chain. The financial benefits of the ESG practices implemented or contemplated can be projected into the present or future (NYU STERN, 2019).

In our case, conventional accounting is applied to sustainability practices to monetize tangible and intangible assets and in particular 9 mediating factors are used that connect financial performance and sustainability actions. (Ulrich Atz et al. 2019). Those factors: customer loyalty, stakeholder engagement, employee relations, innovation, operational efficiency, risk management, sales and marketing, media coverage and supplier's relations.

Figure 1: The 9 mediating factors that can be identified and monetized to link sustainability practices with financial benefits (ROSI Framework, adopted by the NYU Stern Center for Sustainable Business).



Based on the ROSI framework, there are available many publications which monetized the sustianability benefits in various industries. For example, Tensie Whelan, Bruno Zappa, Rodrigo Zeidan and Greg Fishbein (2017) proved that in Brazil's Breef industry sustainable and deforestation – free practices had an positive impact to rangers ($ 18 million to $ 23 million) , to slaughterhouses ($ 20 million to $ 120 million) and to retaillers ($ 13 million to $ 62 million). In addition, Tensie Whelan and Elyse Douglas (2021) after establishing 16 sustainability practices on the automotive industry, a net benefit of $ 5 billion yielded in one year (!). Finally, Sophie Rifkin, Rithu Raman (2021) by introducing sustainability practices to a apparel company manage to save around $ 2.4 million from transportation costs and $ 1.8 million net benefits from a new circular program.

Conclusively, it can be realized that many researchers are dealing with the same subject in different industries with the question of not only if the sustainability actions improve the CFP of a corporation, since extended literature answered the question positively the last years, but also how that sustainability practices can be monitored and monetized. As it was referred, in the apparel industry, the car manufacture industry as well as the beef industry they have achieved precise monetary results after detailed analysis of the sustainability actions through the 9 mediation factors. In our case, in this thesis the construction industry is analyzed and although this is the first time the construction projects are examined through the lens of the ROSI framework this work should be considered as a continuation of the research.

3. METHODOLOGY

In this dissertation the CSB ROSI framework is used to monetize the benefits of sustainability since it is designed as a simpe and comprehensive process that indentifies sustainability strategies and the consequent practices, quantifies and monetizes the benefits through the 9 mediating factors (Figure 1), (NYU STERN, 2019).
This framework requires the following 5-steps process:

Step 1: Identify Material Sustainability Strategies and Actions

The potential or already applied material sustainability practices are identified. A company's Environmental Social and Government strategies and actions can be assessed through the guidelines of Sustainability Accounting Standards Board (SASB), the Global Reporting Initiative (GRI) or the UN Global Compact framework. Information can be retrieved from the company's own sustainability report, assessment and interviews by key personnel in the organization on the design and implementation of the ESG practices.

Step 2: Determination of the potential benefits that can drive financial and societal value from sustainability-focused practices.

The benefits that result from sustainability practices and actions can be identified through the 9 mediating factors (figure 1) which includes better risk management, more innovation, higher operational efficiency, greater customer loyalty, improved supplier relations, better employee relations, improved sales and marketing, better media coverage, and more value-added stakeholder engagement. Sustainability actions and practices may benefit through more than one mediating factor.

Step 3: Quantify the benefits associated from the sustainability actions

Calculation of savings, net earnings as well as costs for every benefit identified in the Step 2. The calculations should be based mainly on data and reports but also on detailed described assumptions. Since in reality data are missing or are not complete, assumptions should be based on academic publications, business reports and interviews (Ulrich Atz, 2019).

Step 4: Calculate the monetary value for all benefits

Application of a monetization process to calculate the value for tangible as well as intangible benefits (NYU STERN, 2019).

4. DATA ANALYSIS

4.1 MATERIAL SUSTAINABILITY STRATEGIES / ACTIONS

The material sustainability actions / strategies identified for our construction site works case, include improved waste management, reduced emissions – carbon, establish sustainable product presence, avoidance of stakeholder dissatisfaction, improve productivity and increase supplier's compliance to sustainability standards. For the identification of those strategies actions interviews with key personnel of the firm took place several times, included company's director of environmental and sustainability and various site managers from the 14 construction sites. In our case SASB has been used only as reference to identify strategies and actions initially but later our research did not follow the SASB guidelines, but the identified actions found in practice.

From our research, we found that the improved waste management was a very important action (if not the most important action) as not only causes directly benefits with the highest financial returns but also acts as catalyst for other important sustainability actions as reducing the emissions-carbon as well as avoidance of stakeholder's dissatisfaction. Analytically, improved waste management leads to cost avoidance by traditional waste disposal, cost avoidance from using recovered materials, revenues from recycling end-of-life products plus constitutes the key factor to the decrease in operational risk, decrease in regulatory risk and decrease in contractual risk.

Following waste management, the strategy of establishing a sustainable product service strategy should be highlighted as the benefits can be considered potentially unlimited since is directly connected with new commissions / projects from important national and international clients with high sustainability demands. It is becoming very common that most large clients of construction projects to pay more and more attention to sustainability as a key parameter in their bidding procedures. In many cases, the weight of the sustainability factor can reach the 30% to 50% on the total summary and by this way exclude firms which traditionally give large discounts but do not take into account environmental regulations and ESG practices and create increased risks for their firms and the construction project.

Finally, strategies with less tangible and measurable benefits as the improvement of employee's productivity were included in the analysis, as it is universally accepted that training, along with job satisfaction from the fact that they are working for firm which care about sustainability and apply relevant actions, increase job productivity and retention rate.

4.2 DETERMINATION OF BENEFITS

The total benefits identified in our research were 11 and include cost avoidance of traditional waste disposal, cost avoidance from using recovered materials, decrease in operational risk, revenues from recycling end-of-life products, reduced need for carbon credits, award of new construction projects by the client, revenues from construction projects (new client), decrease in operational risk, decrease in regulatory risk, decrease in contractual risk and higher output from employees. Those benefits are according to 6 mediating factors of the ROSI, higher operational efficiency, improved sales and marketing, greater customer loyalty, better risk management, better employee relations and improved supplier's relations. Of the 11 identified benefits, 3 were increasing revenues, 2 were reducing costs, 5 were avoided cost and 2 were not included in the monetization model even though for the 1 net benfit was calculated.

Analytically in terms of the mediating factor of higher operational efficiency, the benefit of cost avoided of traditional waste disposal refers to the better arrangement of the construction demolition wastes as well as the better management of the soils which emerged from all new buildings constructions works. In this case, most of the materials (if not all) were kept on site and so large costs were avoided from the transport of all those massive quantities of materials to landfills. Complementary, those materials as kept on sites, were intelligently used for several purposes after some adjustments, for example crushing the construction and demolition wastes (CDW) to smaller particles in order to be used as aggregates in soil works, so that the benefit of cost avoidance from using recovered materials to be accomplished and produce a considerable financial and environmental value. The avoidance of removing waste materials from site (soils and CDW) lead into decrease in operational risk as road incidents were minimized (if not being zero) since thousands of truck rides to landfills were not performed which also caused large savings in carbon emissions undoubtfully extremely environmentally and financially beneficial.

In terms of the mediating factor of improved sales and marketing, the fact that a new major client awarded the firm with a new construction project with very high environmental and sustainability demands it was a large benefit. In detail, Ellinikon S.A. which might be considered as the largest private client in the Greek construction industry, awarded a 30mln euro project to the firm, based on the successful completion of the 14 regional airports project with such high sustainability demands. The new project is a technically and environmentally difficult project which has a very large symbolic and practical importance to the client since it consists of the demolition of all existing buildings in the Ellinikon area in order for all new construction works for the redevelopment of the area can to start. Within the same mediating factor, the benefit of recycling end-of-life products refers to metallic products found mainly in one construction site (the largest SKG), old copper cables, old steel lighting poles, old minor steel constructions which were sold to recycling companies.

In terms of the mediating factor of better risk management, the very well designed and executed environmental policies which were used in the project's execution

resulted in practically zero allegations and court disputes from citizens or organizations, no fines imposed from regulatory authorities although many times controls were performed and finally, practically no contractual problems from the client or the Independent Engineer regarding the environmental and sustainability management of the project.

In terms of the mediating factor of greater customer loyalty, a very large success should be considered the award of a new construction project by the same client (not yet announced) which confirms the client's loyalty and satisfaction.

Finally, for the last mediating factors of better employee relations and improved supplier relations, in the first case rigorous trainings were performed to all site personnel and extra training were provided to key staff. Following that training, an atmosphere of a strong team with common goal the project's minimum environmental and sustainability footprint was accomplished elevating staff's performance as well as retention rates at that time. In terms of the suppliers, in depth research were performed in all suppliers and subcontractors and in the cases of non-compliances with sustainability standards (environmental policies execution, health and safety policies execution as well as fair pay policy) the supplier / subcontractor was changed.

4.3 QUANTIFICATION OF BENEFITS

To quantify and monetize the benefits of the sustainability strategies / actions various techniques, models and approaches have been used as described in the table 10-12. In each case the decision for the method used was based on the available data, for example on the case of the data for the benefits of "cost avoided of traditional waste disposal", "cost avoided from using recovered materials" and "revenues from recycling products at end-of-life" the excel spreadsheet developed by NYU ROSI was absolutely the best method to be used with small alteration on the spreadsheet, while for benefits as "reduced need for carbon credits" and "higher output per employee" other resources have been used.

In general, for the application of the excel spreadsheet from the NYU ROSI framework, our project was "compared" by the benchmark construction project where no specific sustainability actions have been applied (construction took place from 2013-2016) as the relevant department of the firm did not have the same form as today (less staff with no allocated responsibilities). In this way, the spreadsheet quantifies and monetizes a certain benefit, by comparing the data from the project under evaluation (construction of 14 regional airports) with the benchmark project (construction of psychiatric department in a regional hospital).

In the next paragraphs analysis for all benefits is presented, exposing the methodology of quantification and monetization in detail.

4.3.1 Quantification of "cost avoided of traditional waste disposal" benefit

In this case, the excel spreadsheet from the NYU ROSI framework has been used and the factor of cost of material disposal for every euro of sales (total cost of material disposal divided by the full amount of the construction contract) was calculated for

both projects (the benchmark and the actual) and after the contractual amount of the actual project was multiplied by this factor. In this way, the sustainability actions have been identified (by the comparison), quantified and monetized. In this model, 2 different calculations have been performed, one for the soil materials and one for the construction demolition wastes (CDW). The data used for those calculations have been received by the firm's environmental manager, the site managers of various construction sites and have been officially submitted to the client and to the relevant environmental authorities.

Since there were missing data regarding the actual amount of soils excavated initially, (while the amount of soils kept on site was mapped) the retention rate of soils from the 5 largest airports where data were available, was used in the rest 9 airports while this assumption was confirmed by the site managers of those airports. This assumption is presented in the table 1. The prices for the calculation are the average market prices for transportation cost of soil material to a landfill 5.5 €/ton and cost for the environmental system administrator of 3 € /ton. The calculation of the monetized value for this benefit using the excel spreadsheet from the ROSI framework is presented in table 2 (with red the changes in titles to adopt the model to our project).

Table 1: Soils retention rate calculation.

SITE	TOTAL EXCAVATION (TONS)	EXCAVATION MATERIALS REMAINED ON SITE (TONS)	RETENTION RATE	METHOD
CHQ	11000	3000	0,95	FROM DATA
SKG	198000	198000		FROM DATA
SMI	19500	19500		FROM DATA
KGS	78000	68000		FROM DATA
EFL	24000	24000		FROM DATA
JMK	2931,16	3100		RETENTION RATE
MJT	12291,98	13000		RETENTION RATE
JSI	15705,37	16610		RETENTION RATE
RHO	74130,11	78400		RETENTION RATE
ZTH	7091,53	7500		RETENTION RATE
KVA	1891,07	2000		RETENTION RATE
PVK	14183,06	15000		RETENTION RATE
SUMMARY:	**458724**	**448110**		

The same exactly procedure was used for the construction demolition wastes (CDW) but since data were available for all airports where CDW existed, no assumptions were necessary. Regarding the prices for the calculation, the average market prices where used, cost transport of CDW to a landfill 5.5 €/ton and cost for the environmental system administrator of 5 € /ton.

Table 2 : ROSI excel spreadsheet analysis regarding the benefit of par.4.3.1

Cost avoided of traditional waste disposal	Methodology or example	Unit	Data
Total weight of construction waste produced - base case SOILS	Using available data sources, input the average quantity of waste generated per unit of production, before the sustainable initiative was implemented	Tonnes	32.220
Percent reduction in construction waste from more efficient manufacturing		%	
Total weight of construction waste produced - after	Using available data sources, input the average quantity of waste generated per unit of production, after the sustainable initiative was implemented	Tonnes	10.615
Total sale - base case benchmark project		€	7.960.022
Total sale – after, actual project		€	357.000.000
Cost of waste disposal	Drawing data from available sources (i.e., waste disposal bills), include the total cost of waste disposal	€ / tonne	8,50 €
Per € sale cost of waste disposal - base case	Calculated	cost (€) / sales (€)	0,03441 €
Per € sale cost of waste disposal - after		cost (€) / sales (€)	0,00025 €
Per € sale waste disposal savings		cost (€) / sales (€)	0,03415 €
Cost avoided	**Multiply the per unit savings by the total production volume**	**EUROS**	**12.192.601,6**
Total weight of construction waste produced - base case CDW	Using available data sources, input the average quantity of waste generated per unit of production, before the sustainable initiative was implemented	Tonnes	840

Percent reduction in construction waste from more efficient manufacturing		%	
Total weight of construction waste produced - after	Using available data sources, input the average quantity of waste generated per unit of production, after the sustainable initiative was implemented	Tonnes	12.781
Total sale - base case benchmark project		€	7.960.022,00
Total sale – after, actual project		€	357.000.000,00
Cost of waste disposal	Drawing data from available sources (i.e., waste disposal bills), include the total cost of waste disposal	€ / tonne	10,50 €
Per € sale cost of waste disposal - base case benchmark project	Calculated	cost (€) / sales (€)	0,00111 €
Per € sale cost of waste disposal - base case actual project		cost (€) / sales (€)	0,00038 €
Per € sale waste disposal savings		cost (€) / sales (€)	0,00073 €
Cost avoided	**Multiply the per unit savings by the total production volume**	**EUROS**	**261.368,75848**

4.3.2 Quantification of “cost avoided from using recovered materials”

In analogy with the previous paragraph, in this case the excel spreadsheet from the NYU ROSI framework has been used and the 2 construction projects (benchmark and actual) have been compared so that the sustainability action can be identified and quantified. Analytically, from the amount of reused soil materials in both cases the percentage of reusage was calculated for both projects but in contrary with the previous paragraph the spreadsheet calculates the financial benefit by directly multiplying the cost of new soil material with the amount of the material left on site minus the amount of materials left on site from the benchmark project. The prices for the calculation are the average market prices for a new soil material from a landfill 7 €/ton.

Identically, the same procedure has been used for the CDW with the price for the calculation of 8 € / Ton used crashed aggregates. In order the CDW to be converted to crushed aggregates and be reused in the construction project a crusher was used and the relevant cost have been also introduced in the spreadsheet. Due to missing data for various airports, the cost of crushing CDW per ton has been used from airports where data were available to rest airports with no actual cost data but again with the

confirmation from the site managers of those construction sites. This assumption is presented in the table 3 (numbers with red color). The calculation of the monetized value for this benefit using the excel spreadsheet from the ROSI framework is presented in table 4 (with red the changes in titles to adopt model for our project) and in table 5 is presented the actual operational costs for the sustainability actions realization (which included in the calculation).

Table 3 : Crusher cost rate calculation.

SITE	CDW (TON)	CRUSHER TOTAL COST	COST (€/TON)	METHOD
SKG	19396	74.962,00 €	3,85 €	DATA
KGS	40000	145.000,00 €		DATA
SMI	7442	37.500,00 €		DATA
RHO	82520	317.869,54 €	3,85 €	RATE
EFL	14735	56.759,67 €	3,85 €	RATE
JSI	2725	10.496,78 €	3,85 €	RATE
SUMMARY:		**642.587,99 €**		

Table 4 : ROSI excel spreadsheet analysis regarding the benefit of par.4.3.2

Cost avoided from using recovered materials	Methodology or example	Unit	Data
Total construction waste SOILS- base case benchmark project		TON	44.327
% construction waste SOILS recovered and reused in construction - base case		%	28,4%
Weight of waste recovered and reused in construction - base case		TON	12.600
Annual improvement in incorporating recovered material into new construction, actual project		%	
% construction waste recovered and reuse in construction – actual project		%	97,6%
Weight of waste recovered and reused in production SOILS – actual project		TONS	448.110

Weighted Average Unit Price of Comparable Virgin Materials		€ / tonne	7,00
Cost avoided	**Multiply the value of the virgin raw materials replaced by the volume of waste recovered and reused**	**€**	**3.048.570,00**
Cost avoided from using recovered materials	Methodology or example	Unit	Data
Total construction waste CDW- base case benchmark project		TON	840
% construction waste CDW recovered and reused in construction - base case benchmark project		%	0,0%
Weight of waste recovered and reused in construction - base case		TON	-
% construction waste CDW recovered and reuse in construction – after, actual project		%	92,9%
Weight of waste recovered and reused in production CDW – after, actual project		TONS	166.816
Weighted Average Unit Price of Comparable Virgin Materials		€ / tonne	8,00
Cost avoided	**Multiply the value of the virgin raw materials replaced by the volume of waste recovered and reused**	**€**	**1.334.528,00**

Table 5 : ROSI excel spreadsheet with the costs associated with the benefits realization

Relevant cost and investments			
Cost of sustainability initiative	**Methodology or example**	**Unit**	**Data**
Operating expenses	Salaries of employess worked into sustainability practices design and implementation (3 years)	Euros	325.000
Cost of time to implement initiative	Cost of crusher in all construction sites	Euros	642.588
Any other variable cost not covered above	Cost to form the department in each construction site (14 sites)	Euros	12.350
Total cost	**Sum of fields above**	**Euros**	**979.938**

4.3.3 Quantification of “revenue from recycling of products end-of-life”

Excel spreadsheet from NYU ROSI framework was used as well in this case and according to its formula, from the total scrap material sold in the actual project the amount of scrap material in the benchmark case (1st project) is extracted. Since the model uses only one line for the price of the scrap material it was decided all different materials to be changed to the equivalent quantity of steel material. In the table 6 all data for the actual scrap materials are presented while the prices used was the average market prices at the time of construction (2017-2020).

Table 6 : Actual End-of-life material revenues

	PRICE (€/TON)	QUANTITY (TON)	AMOUNT
SCRAP STEEL	0,2	110200	22.040,00 €
SCRAP ALUMINUM	1	2000	2.000,00 €
SCRAP COPPER	5	1200	6.000,00 €
SCRAP CABLE	1,35	5900	7.965,00 €
SUMMARY:			38.005,00 €

Table 7 : ROSI excel spreadsheet analysis regarding the benefit of par.4.3.3

Revenue from recycling of products at end-of-life	**Methodology or example**	**Unit**	**Data**
% of Total End-of-Life Product Weight that is Recovered and Recycled - base case		%	0%
Amount of End-of-Life Product that is Recovered and Recycled - base case		tonnes	0,0
Amount of End-of-Life Product that is Recovered and Recycled - new		tonnes	190
Average unit price of recovered and recycled materials sold		Euros / tonne	200
Total Benefit	**Multiply revenues earned from recycling end of life product, by weight of recovered end of life product that is recycled**	**Euros**	**38.000,00**

4.3.4 Quantification of “reduced need for carbon credits” benefit

This benefit is absolutely connected with the previous benefits of “reduced construction waste disposal” and “usage of recovered materials” and is a perfect example how sustainability actions may offer multiple environmental, societal and financial benefits. In detail, the amount of heavy load truck rides to landfills which

were avoided from the recovery of the CDW and soil materials and the total emissions-carbon saved is calculated. For the calculation, it was assumed 20 km distance to landfill from every construction side (which is very realistic) while for the emissions, data was used from the very helpful resource https://www.theyworkforyou.com/wrans/?id=2013-03-01a.144740.h. In this resource, carbon emissions for all types of heavy trucks are available with full or empty load and for this analysis we used EURO IV category of trucks since those were the most frequently used in the construction project. Finally the total amount of emissions saved were multiplied by 60 Euro/Ton as the mid-range benchmark of carbon costs in 2020 from the resource (https://www.oecd.org/tax/tax-policy/effective-carbon-rates-2021-0e8e24f5-en.htm) .

Table 8 : Emissions-carbon saved from CDW recovery

DESCRIPTION	AMOUNT	UNIT
TOTAL WASTE (CDW) RECOVERY:	166818	TON
TOTAL HEAVY TRUCK FULL LOADS (20 tons / ride):	8340,9	RIDES
TOTAL KM HEAVY TRUCK TO "DUMP YARDS" WITH FULL LOAD (20 km):	166818	KM
TOTAL KM HEAVY TRUCK TO "DUMP YARDS" WITH EMPTY LOAD (20 km):	166818	KM
TOTAL EMISSIONS FOR EURO IV ON FULL LOAD RIDES (800 gr/km) :	133454400	GRAMS
TOTAL EMISSIONS FOR EURO IV ON FULL LOAD RIDES (448 gr/km):	74734464	GRAMS
TOTAL EMISSIONS SAVED:	208188864	GRAMS
TOTAL EMISSIONS SAVED:	**208,188**	**TON**

Table 9 : Emissions-carbon saved from SOILS recovery

DESCRIPTION	AMOUNT	UNIT
TOTAL SOILS REUSED RECOVERY:	448110	TON
TOTAL HEAVY TRUCK FULL LOADS (20 tons/ ride):	22405,5	RIDES
TOTAL KM HEAVY TRUCK TO "DUMP YARDS" WITH FULL LOAD (20 km):	448110	KM

TOTAL KM HEAVY TRUCK TO "DUMP YARDS" WITH EMPLTY LOAD (20 km):	448110	KM
TOTAL EMISSIONS FOR EURO IV ON FULL LOAD RIDES (800 gr/km):	358488000	GRAMS
TOTAL EMISSIONS FOR EURO IV ON FULL LOAD RIDES (448 gr/km):	200753280	GRAMS
TOTAL EMISSIONS SAVED:	559241280	GRAMS
TOTAL EMISSIONS SAVED:	**559,24128**	**TON**

4.3.5 Quantification of “decrease in operational risk” benefit

Since the data available from various organizations in E.U., U.K and U.S. are enormous regarding traffic accidents with heavy trucks involved along with the financial impact, we decided to base our calculation from data received from interviews of truck owners. Those people are the ones who worked on the actual construction sites and they knew better than anyone else the road difficulties of the sites and could describe us the rates and accident types which usually occur in those cases.

Truck owners informed us that accidents are quite often in the cases of loading and removing materials from site to landfills but mainly are with small impact and without injuries. An average of 3 truck accidents per construction site was decided to be used in the calculation with an average cost of 3.500 euro in each accident.

Although in this quantification the assumptions were very conservative, since costs of injuries or even fatalities were not taken into consideration, nevertheless the calculation shows that even with those assumptions the cost avoided was more than 100.000 euros for the project.

4.3.6 Quantification of “award of new project” benefit

This is very important benefit for the firm and for the confirmation of the project success. Specifically, the client after the completion of the project decide to award the firm with a new construction project with value of around € 100 million showing in the best way its satisfaction or according to the mediating factor “greater customer loyalty”. In this case for the quantification of the benefit it was supposed that net earnings of 7% of contract value will emerge from this project while the successful sustainability management of the project influence the decision of the client to award the project by 35% (the rest percent is other factors as price, experience, ability to complete the works on time and others). In this quantification, has not taken into account the possible increase in the firm’s stock price (after the official announcement), the increase in the brand value of the firm as well as more construction projects which can emerge after the successful completion of it (from the same or other client).

4.3.7 Quantification of “revenues from new construction projects” benefit

Another benefit that confirmed the successful completion of the 14 regional airports project was the fact that another major client (currently the largest private client for construction works) “Ellinikon S.A.” awarded the firm with a very symbolic and key project. Specifically, the client who has the responsibility for the redevelopment of the old Ellinikon airport (an investment which roughly is estimated to reach € 7 - € 8 billion within the next 5-10 years) decide to allocate the firm to perform the task of demolishing all remaining buildings in the area along with the all the relevant procedures to acquire the necessary building permits. This is a very sensitive and key project as the completion of the demolition works will signal the commencement of all other construction works including infrastructure, roads, utilities, skyscrapers, shopping malls, casino, marina and public spaces. Like in the previous paragraph, in the quantification process the impact of the project in the firm’s stock price and brand image was not taken into account but only the expected net earnings from this project (in this case 5%) which was multiplied by the contract amount (€ 30 million). In order to take into consideration the impact of the sustainability factor in the decision of the client, a factor of 50% was used (not 30% as in the previous paragraph) due to the project’s very strict sustainability demands, it was the most important factor for the client (after price, firm’s integrity and ability to complete the works was followed).

4.3.8 Quantification of “lower operational risk” benefit

Generally, lawsuits and court disputes are very often met in the construction projects and especially for environmental and sustainability issues. In the benchmark project, this was the case and a court dispute was created from a dissatisfied citizen because (the municipality did not rent his land) and he decided to sue everybody involved in all construction sites running at that time for unlawful environmental management of wastes. The case went on court where the judge fortunately decided that the environmental law has not been violated but nevertheless this allegation cost the firm approximately € 15.000. In the actual project since it was comprised of 14 remotes construction sites, it was decided to assume that at least one court dispute would have happened regarding the waste management if the sustainability actions were not performed.

Conclusively, for the quantification of this benefit the amount of the benchmark project’s cost for the court dispute was multiplied by 14 for each construction site. This assumption is again a very conservative one, since removing thousands of tons through narrow and not well-preserved roads in remote locations (islands) result in dust creation, sound pollution and other phenomena which affect the well-being of the residents who in the end claim reimbursement.

4.3.9 Quantification of “decrease in regulatory risk” benefit

In the same line with quantification method used in the previous paragraph, the example of the benchmark project was used to conclude what the value of this benefit is in our case. Respectively, in the benchmark project together with the court allegation a fine from the environmental authority was imposed to the firm, although afterwards the court decided that the firm has not violated the law, and so it is assumed that for every construction site in the project at least one fine would have

been imposed by authorities if all those sustainability actions would not have taken place.

The value of fine it was calculated to 2.500 euros and so the total amount of the cost avoided is the amount of the fine for each construction site (14 in total). Once more, it is noted that those are very conservative assumptions which in reality keep very low the value of this benefit since in serious environmental incidents or not compliances the fines can reach several thousand euros plus the costs for rectifying any wrongdoing in environment.

4.3.10 Quantification of "improve productivity" benefit

Extensive research studies proved that employee productivity is increased considerably due to training and firms who initiate rigorous training schemes are the one who are receiving back many times the cost of this training. In more detail professional services company Accenture showed that the cost of training is returned to the firm by 353% (https://www.thegrowthfaculty.com/blog/TheGoodNewsstaffbenefitgivesyou353ROIforevery1spent).

In our actual project it was calculated that approximately 25.000 euros have been spent for staff training during the 3 years of operation and so if we multiply this figure by a factor of 2.5 to 3, we can calculate the minimum possible value the firm earned from its employees due to training.

4.3 CALCULATION OF MONETARY VALUE FOR ALL BENEFITS

All benefits analyzed in previous paragraphs, in this section are summed by adding all the increased revenues with the cost savings and cost avoided minus the costs associated with the application of the sustainability actions. The results calculated in terms of net operating earnings and since this was an one-off project, there was no ground to assume that those actions would continue to create value and to calculate the net present value of earnings (NPV) for a certain period of time in the future (for example 5 to 10 years period). In the next tables 10-13 all relevant calculations are presented for each analyzed benefit.

5. RESULTS / DISCUSSION

5.1 MONETARY VALUES OF SUSTAINABILITY STRATEGIES / ACTIONS

All results are presented in the following tables which are formulated in such way so that not only their layout to fit in the page and be easily read but also per sustainability strategies followed (operational efficiency strategy, reduce Emissions – Carbon, Establish Sustainable Product / Service Presence and Increase supplier compliance with sustainability standards).

Table 10 : Results of improved waste management strategy

STRATEGY	**Improved waste management**			
BENEFIT	Cost avoided of traditional waste disposal		Cost avoided from using recovered materials	
DETAILS	Reduced construction wastes (soils) disposal	Reduced construction wastes (CDW) disposal	Usage of recovered construction materials (soils)	Usage of recovered construction materials (CDW)
MEDIATING FACTOR	Higher Operational Efficiency			
MONETIZATION METHOD	Savings from not sending excessive soils to landfil, considering the average market cost for transport and material recycling	Savings from not sending excessive construction demolition wastes to landfil, considering the average market cost for transport and material recycling	Savings from not buying new soil materials but use the recovered ones after selection and modification process	Savings from not buying new crashed aggregate materials but use the recovered CDW, after modification process with a crusher to change their size
NET EARNINGS	€ 12.192.601,60	€ 261.368,76	€ 3.048.570,00	€ 354.590,00 €

Table 11 : Results of waste management and reduce emissions – carbon strategy

STRATEGY	**Improved waste management**		**Reduce Emissions – Carbon**
BENEFIT	Decrease in operational risk	Revenue from recycling of products at end-of-life	Reduced need for Carbon Credits
DETAILS	Minimization of road incidents due to avoidance of carrying materials to landfills	Revenue from recycling of end-of-life metals (scrap)	Total emissions saved due to avoidance of carrying materials to landfills
MEDIATING FACTOR	Higher Operational Efficiency	Improved Sales and Marketing	Higher Operational Efficiency
MONETIZATION METHOD	Estimation of average cost from a collision of a truck with other vehicles on the roads outside the construction sides (damages plus increase in fees in insurance contracts).	Calculation by multiplying the quantity of end-of life materials sold on recycling by the average market price of the material at that time.	Estimation of total number of trucks loads which should transfer to landfills all excessive materials if were removed from sites. The average distance of landfills from sites was assumed as 20 km. Then, the amount of carbons emissions saved calculated by tables (emissions kg. / km)
NET EARNINGS	€ 147.000,00	€ 38.000,00	€ 12.490,80

Table 12 : Results of sustainable products / service presence and avoidance of stakeholder dissatisfaction strategy

STRATEGY	**Establish Sustainable Product / Service Presence**		**Avoidance of Stakeholders dissatisfaction**
BENEFIT	Signing New Project		Lower operational risk
DETAILS	Award of new large construction contract from the Client	"Ellinikon S.A." award a new construction project with high-end sustainability demands	Zero allegations, court disputes from citizens / organizations
MEDIATING FACTOR	Greater Customer Loyalty	Improved Sales and Marketing	Better Risk Management
MONETIZATION METHOD	Earnings were calculated taken into consideration that for a similar project the average net earnings can be around 7% of the project and so the contract amount was calculated with the markup. It was considered that the sustainability criteria had a weight of 35% in the decision of the client and so the earnings are multiplied by this factor.	Earnings were calculated taken into consideration that for a similar project the average net earnings can be around 5% of the project and so the contract amount was multiplied with the markup. It was considered that the sustainability criteria had a weight of 50% in the decision of the client and so the earnings are multiplied by this factor.	Taking into consideration that in the baseline project there was 1 court dispute with citizen which costed firm a certain amount before resolved, it was supposed that 1 court disputed per construction site would have happened without the sustainability actions applied and so the relevant cost was multiplied by 14 (sites).
NET EARNINGS	€ 2.450.000,00	€ 750.000,00	€ 210.000,00

Table 13 : Results of stakeholder dissatisfaction / improve productivity and increase suppliers compliant to sustainability standards strategy

STRATEGY	Avoidance of Stakeholders dissatisfaction	Improve Productivity	Increase suppliers compliant to sustainability standards
BENEFIT	Decrease in regulatory risk	Higher output per employee	Higher output from supplier
DETAILS	No fines imposed from regulatory authorities	Due to extended employee training, output improved	
MEDIATING FACTOR	Better Risk Management	Better Employee Relations	Improved Supplier Relations
MONETIZATION METHOD	Taking into consideration that in the baseline project there was 1 fine imposed by the environmental authorities before resolved, it was supposed that 1 fine for the 10 small construction sites, would have been imposed without the sustainability actions and 2 fines respectively for the 4 large construction sites.	Extensive research proved quantified and certain financial benefits from employee training due to the improvement of productivity. In this case, the amount of hours of training was multiplied with the factors from research and the financial benefit was calculated. Nevertheless, this calculation was not included in the summary due to its uncertainty.	Research and practice proved that suppliers which adhere to sustainability standards offer value to their clients. Since there is a very broad range in the quantification of this benefit, this calculation was not included in the summary.
NET EARNINGS	35.000,00 €	62.500,00 €	Not included

In the figures 2-5, the net benefits are presented in terms of each mediating factor as well as for each sustainability strategy followed. The summary of all net benefits minus the relevant costs for the implementation of the sustainability actions are calculated to € 19,562 million which is a surprisingly high value and consists the 5.5% of the total contractual amount of the examined construction project (14 Regional Airports with budget: € 357 million). As it can been noticed in terms of sustainability strategies the most valuable is the “improved waste management” (82% of total) but also the strategy of “Establish Sustainable Product / Service Presence” (17% of total) offers considerable financial return. In the same line the mediating factor with the higher

financial value is the “Higher Operational Efficiency” (82% of total) from all gathered and after the factor of “Greater Customer Loyalty” (13% of total).

Figure 2 : Total Net Benefits per mediating factor

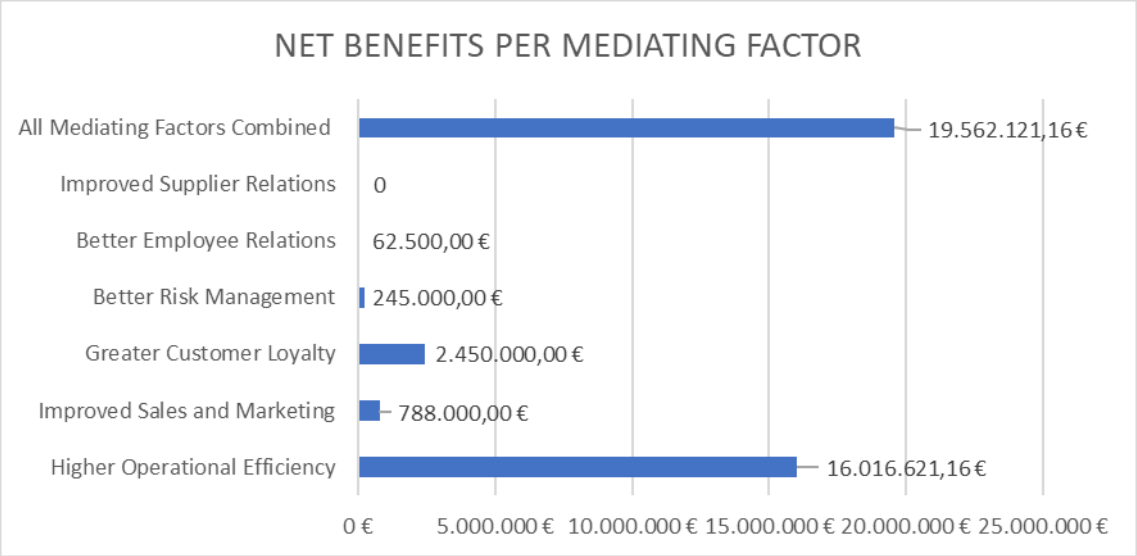


Figure 3 : % Percentage of the value of each mediating factor of total

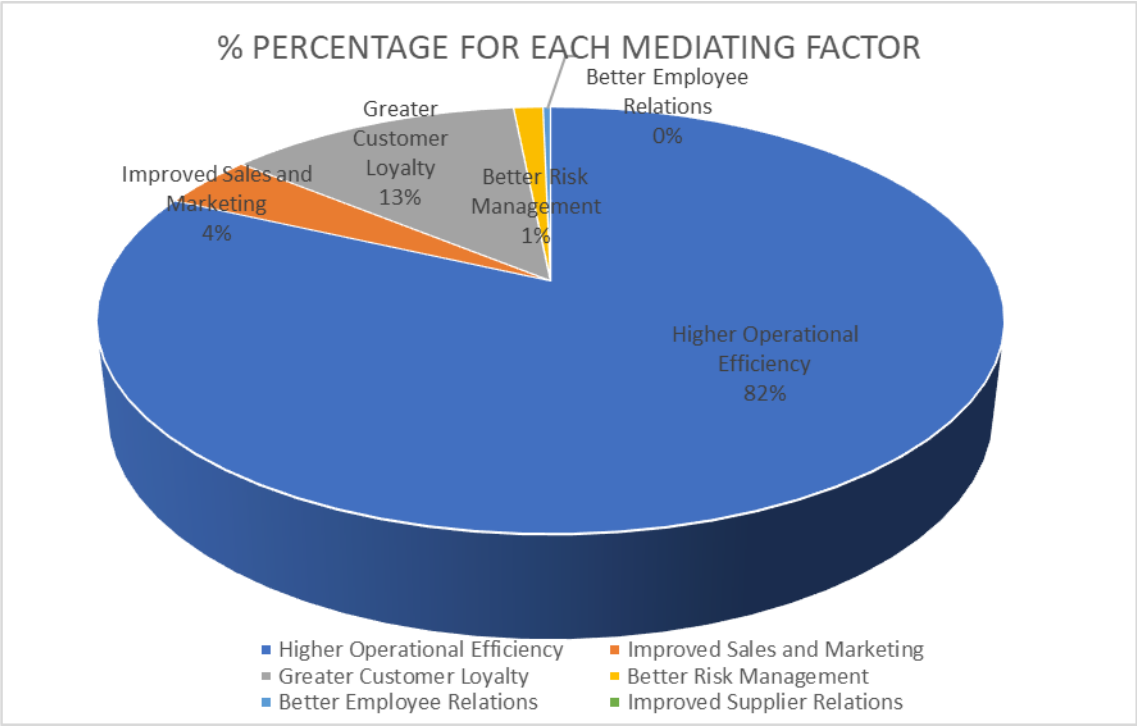


Figure 4 : Total Net Benefits per mediating factor

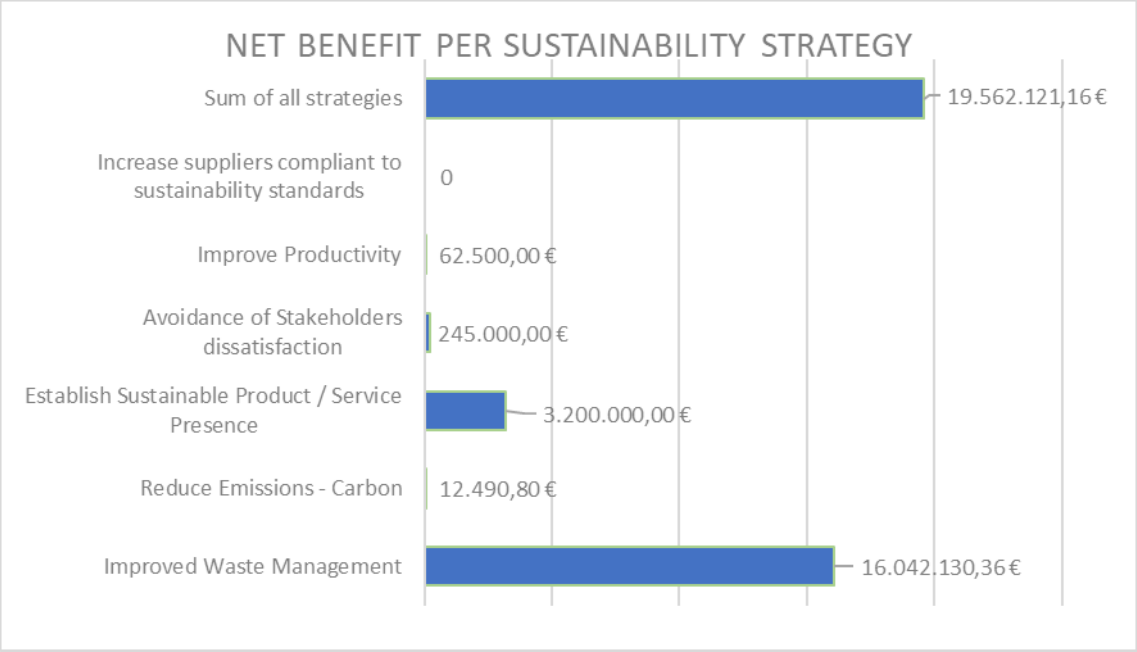
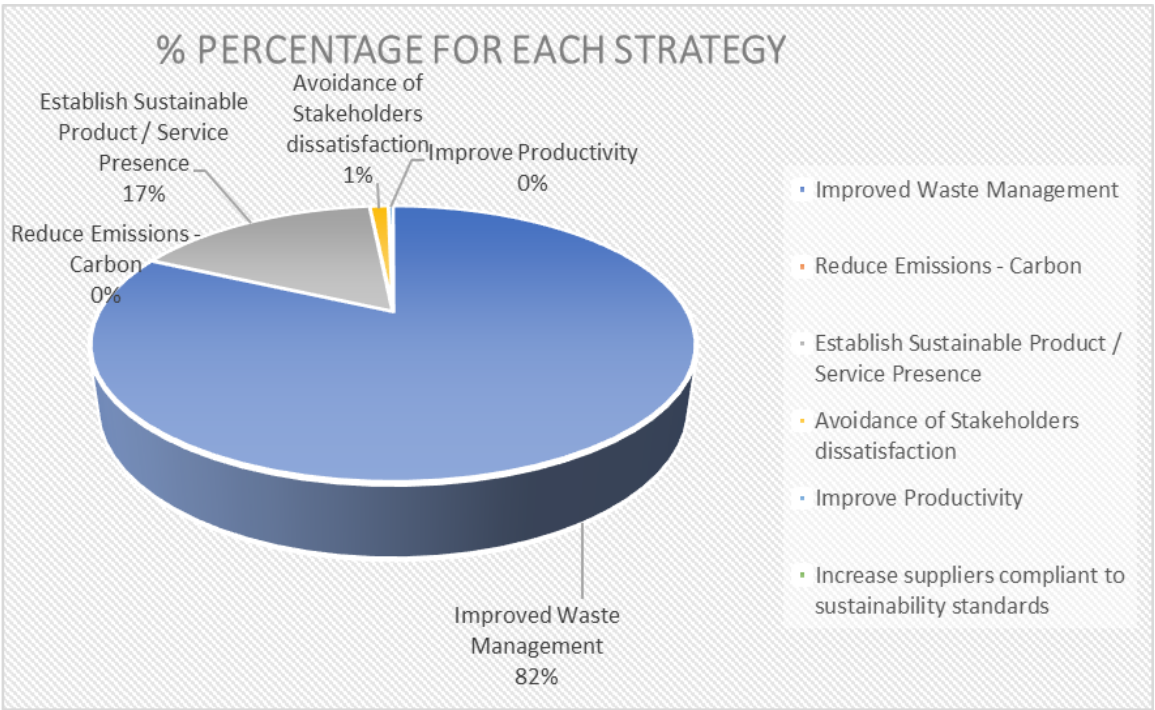


Figure 5 : % Percentage of each strategy's value to the total



5.2 DISCUSION

From the previous paragraph it can been easily acknowledged that in our case and the construction project under review, the mediating factor of operational efficiency was the one with the most important monetized impact on the project. After that, the factor of greater customer loyalty wielded the second highest benefit in terms of net earnings and after the mediating factors of improved sales and marketing, better risk management and better employee's relations are following. Nevertheless, an different analysis could reveal and quantify the impact of sustainability strategies on the firm's supply chain (suppliers and subcontractors), by searching for data in the micro-level (in each small firm who participated) and eventually calculate increased net earnings from the sustainability actions considerably. In addition, media coverage factor was not analyzed at all, but taking into consideration that the project success was highly advertised and officially opened by Greek Prime Minister and was broadcasted live from all major Greek media, it is more than sure that the impact of this factor on the firm's brand image and recognizability was considerable. From the analysis, seems that employee relations factor does not create large earnings, but this is in fact a wrong interpretation, since the difficulty to measure intangible benefits of the higher productivity and retention rate did not allow us to fully investigate the factor in depth as the more straight forward measurable actions of the waste management absorbed most of our efforts. We strongly believe that the confident and impowered people of this project with their skills, enthusiasm and ethics were the ones who accomplish the project success in every aspect (completion time, quality of works and sustainability practices). In addition, it is universally accepted that a firm's value consist nowadays more on the intangible assets (skilled workforce, intellectual property to name a few) than on the tangible ones although according to the current financial reporting standards this fact cannot be fully reported.

Finally, we would like to highlight that during the construction period (2017-2020) the construction sector in Greece was not in a very good shape macroeconomically, since the sector was still recovering from the sovereign debt crisis of the country with limited major public and private projects running. Under different macroeconomic climate, the benefits of the improved sales and marketing could have yielded a multiple of the calculated one as more construction projects would have been contracts signed.

5.3 ROSI METHODOLOGY IN CONSTRUCTION SECTOR

The results of the research in this thesis confirm the hypothesis that by using sustainability practices in construction projects, companies can be benefitted through Operational Efficiencies, Customer Loyalty, Employee Relations, Sales and Marketing, Risk Management, Supplier Relations. In addition, the results of this thesis are in the same line with the literature review, apparel case, beef case, automobile case where sustainability strategies and practices drive firms to considerable net earnings and cost savings. Instinctively, in the beginning of this work we were confident that the results

would be positive but realistically we did not expect the net benefits to reach the 5.5% of the project budget. For construction projects of this scale this percentage is enormous, while alarming for the construction sector.

One of the aims of this thesis, was to give guidance to industry professionals to introduce them with the ROSI methodology and to present them solid evidence that sustainability practices will be beneficial for their organizations and people. One of the advantages of the ROSI methodology is that it can be used in various industries and practices as its 9 mediating factors cover and monetize all range of possible benefits tangibles and intangibles. In addition, when the professionals of construction sector will start to calculate and monetize the results of their practices, they will then realize the value of even small innovations, methods and techniques which will introduce and inevitable will bring to organizations the atmosphere of creativity, belonging and purpose for the firm the employees, the community and the environment. This scope might seem very ambitious, but we are strongly confident that there is no other time left for the construction industry to change towards more sustainable practices, there is no reason to delay more and there is no cost associated with that, but on the contrary only solid financial and societal benefits.

Finally, after being in the sector for almost 20 years and knowing that the mentality of the people of the industry is never to stay idle but to work hard and to be ahead of plan, we are sure that all professionals are more than willing to discover and decide themselves which sustainability practices fit to them and their organization, implement them and after publish them, instead of waiting for regulators to enforce them with practices that might not suit them so much. This is the time for the industry, transformation to more sustainable construction and operation should be the sector's next big step globally.

6. CONCLUSIONS AND RECOMMENDATIONS

Conclusively, in this thesis the question if sustainability practices are offering firms financial benefits was answered positively and by applying the ROSI methodology we quantified and monetized those benefits calculating the net earnings for each of those practices. In particular, the sector under investigation was the construction, where sustainability actions are so much needed as it is one of the most environmental damaging sectors. For our analysis we compared two construction projects, one executed without any solid sustainability practices and the second with special attention in the sustainability issues. By applying the ROSI methodology for the theoretical approach as well the excel spreadsheets published by the NYU STERN CSB we were able to calculate and monetize the net earnings from 6 mediating factors, higher operational efficiency, customer loyalty, sales and marketing, employee relations, supplier relations and better risk management. The results were astonishing as a net benefit of € 19.562 million was calculated which comprise the 5,5% of the construction project's value. The higher operational efficiency mediating factor was the most beneficial (€ 16.061 million), after greater customer loyalty (€ 2.45 million),

improved sales and marketing (€ 0.78 million), better risk management (€ 0.245 million) and finally better employee relations (€ 0.062 million).

Since there was no space and time to include it in this thesis, we consider as a next step which is extremely interesting and innovative, Impact Weight Accounting to be combined with the ROSI methodology. Tensie Whelan, George Serafeim et. Al. (2021) combined the ROSI framework of NYU Stern with the Impact Weight Accounting from Harvard University, and the publication was extremely interesting as those 2 different approaches were merged to calculate the benefits of sustainability practices (is very impressive that two top Universities with the top teams of researchers in the field of sustainability have connected their methodologies and practices and published together). Impact Weight Accounting is a very promising and innovative approach which measures and quantifies the impact of sustainability practices using a lot of data and monetize this impact in the various fields which are not directly connected but are affected and this is the main difference with the ROSI methodology. Unfortunately, those data are difficult to be found in countries like Greece but are widely available in US, UK, Japan, Canada and Australia. Nevertheless, we are strongly recommending researchers and professionals to continue research on the sustainability actions quantification and try to apply both approaches in the construction or any other sector.

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Appendix

Table A1 : ROSI CSB methodology, full calculation of financial impact

Total net benefits for operational efficiencies			
Net benefit	**Methodology or example**	**Unit**	**Data**
Total gross benefits	Sum benefits totals from 1, 2, 3, 4, 5, 6	EUROS	16.875.068 €
Total cost and investments	Sum fields 0.1, 0.2 (at the bottom)	EUROS	979.938 €
Total net benefits	**Subtract field above from field two above**	EUROS	**15.895.130 €**
ROSI	**Return of Sustainability Investment**	**%**	**1622%**

Decreases in waste generation			
Total benefit	**Methodology or example**	**Unit**	**Data**
Total cost avoided	**Sum fields 2.1, 2.2, 2.3**	**EUROS**	**16.875.068 €**

Cost Structure			
COGS		EUROS	**15.545.000 €**
Total Annual Manufacturing Waste Weight - base case		Tonnes	285.420

Cost avoided of traditional waste disposal	**Methodology or example**	**Unit**	**Data**
Total weight of construction waste produced - base case SOILS	Using available data sources, input the average quantity of waste generated per unit of production, before the sustainable initiative was implemented	Tonnes	32.220
Percent reduction in construction waste from more efficient manufacturing		%	7%
Total weight of construction waste produced - after	Using available data sources, input the average quantity of waste generated per unit of production, after the sustainable initiative was	Tonnes	10.615

	implemented		
Total sale - base case ΕΡΓΟ ΤΡΙΠΟΛΗΣ	Annual production volume before sustainable approach was implemented	€	7.960.022,00
Total sale - after ΕΡΓΟ FRAPORT	Annual production volume after sustainable approach was implemented	€	357.000.000,00
Cost of waste disposal	Drawing data from available sources (i.e., waste disposal bills), include the total cost of waste disposal	€ / tonne	8,50 €
Per € sale cost of waste disposal - base case	Calculated	cost (€) / sales (€)	0,03441 €
Per € sale cost of waste disposal - after		cost (€) / sales (€)	0,00025 €
Per € sale waste disposal savings		cost (€) / sales (€)	0,03415 €
Cost avoided	**Multiply the per unit savings by the total production volume**	**EUROS**	**12.192.601,61781 €**

Cost avoided of traditional waste disposal	**Methodology or example**	**Unit**	**Data**
Total weight of construction waste produced - base case CDW	Using available data sources, input the average quantity of waste generated per unit of production, before the sustainable initiative was implemented	Tonnes	840
Percent reduction in construction waste from more efficient manufacturing		%	
Total weight of construction waste produced - after	Using available data sources, input the average quantity of waste generated per unit of production, after the sustainable initiative was implemented	Tonnes	12.781

Total sale - base case ΕΡΓΟ ΤΡΙΠΟΛΗΣ	Annual production volume before sustainable approach was implemented	€	7.960.022,00
Total sale - after ΕΡΓΟ FRAPORT	Annual production volume after sustainable approach was implemented	€	357.000.000,00
Cost of waste disposal	Drawing data from available sources (i.e., waste disposal bills), include the total cost of waste disposal	€ / tonne	10,50 €
Per € sale cost of waste disposal - base case	Calculated	cost (€) / sales (€)	0,00111 €
Per € sale cost of waste disposal - after		cost (€) / sales (€)	0,00038 €
Per € sale waste disposal savings		cost (€) / sales (€)	0,00073 €
Cost avoided	**Multiply the per unit savings by the total production volume**	**EUROS**	**261.368,75848 €**

Cost avoided from using recovered materials	Methodology or example	Unit	Data
Total construction waste SOILS- base case		TON	44.327
% construction waste SOILS recovered and reused in construction - base case		%	28,4%
Weight of waste recovered and reused in construction - base case		TON	12.600
Annual improvement in incorporating recovered material into new construction		%	8,0%
% construction waste recovered and reuse in construction - after		%	97,6%
Weight of waste recovered and reused in production SOILS - after		TONS	448.110

Weighted Average Unit Price of Comparable Virgin Materials		€ / tonne	7,00
Cost avoided	**Multiply the value of the virgin raw materials replaced by the volume of waste recovered and reused**	**€**	**3.048.570,00**

Cost avoided from using recovered materials	**Methodology or example**	**Unit**	**Data**
Total construction waste CDW- base case		TON	840
% construction waste CDW recovered and reused in construction - base case		%	0,0%
Weight of waste recovered and reused in construction - base case		TON	-
Annual improvement in incorporating recovered material into new construction		%	
% construction waste CDW recovered and reuse in construction - after		%	92,9%
Weight of waste recovered and reused in production CDW - after		TONS	166.816
Weighted Average Unit Price of Comparable Virgin Materials		€ / tonne	8,00
Cost avoided	**Multiply the value of the virgin raw materials replaced by the volume of waste recovered and reused**	**€**	**1.334.528,00**

Relevant cost and investments

Cost of sustainability initiative	**Methodology or example**	**Unit**	**Data**
Operating expenses	Any typical cost for the sustainability initiative, e.g. alternative materials (cost differential * volume).	EUROS	325.000 €

Cost of time to implement initiative	Value of time (daily wage * days) for all employees implementing	EUROS	642.588 €
Any other variable cost not covered above		EUROS	12.350 €
Total cost	**Sum of fields above**	EUROS	**979.938 €**

Recovery and reuse / recycling of end-of-life product			
Total benefit	**Methodology or example**	**Unit**	**Data**
Total benefit	**Sum fields 2.1, 2.2, 2.3**	**$**	**38.000 €**

Revenue from recycling of products at end-of-life	**Methodology or example**	**Unit**	**Data**
% of Total End-of-Life Product Weight that is Recovered and Recycled - base case		%	0%
Amount of End-of-Life Product that is Recovered and Recycled - base case		tonnes	0,0
Annual increase in proportion of end-of-life product weight that is recovered and recycled		%	
% of Total End-of-Life Product Weight Recovered and Reused - new		%	
Amount of End-of-Life Product that is Recovered and Recycled - new		tonnes	190
Average unit price of recovered and recycled materials sold		EUROS / tonne	200 €
Process Savings from Using Recovered Components			
Total Benefit	**Multiply revenues earned from recycling end of life product, by weight of recovered end of life product that is recycled**	**EUROS**	**38.000,00 €**