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Public Investment Project Evaluation: Case Study on Municipal Solid Waste Sector in Portugal

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Abstract:
 Over the past 20 years, the Portuguese State has held several public investments that have resulted in significant deviation in cost and deadlines and there is no record of benefits deviation, whose results, critical in terms of public spending, will contribute in a significant way to the burden of current and future generations. To be aware of the real dimension, financial deviation in relevant projects and public works (carried out either by direct administration of the State or in concession regime) in recent years have amounted to more than EUR 4.3 billion, i.e. about 2.5% of Portuguese GDP in 2014.
This research work's core objective is responding to a commonly accepted gap among the Portuguese and which is related to the lack of practical assessment of the causes (ex-ante) and the respective impacts associated with large deviation in public investment projects, when compared to the initial estimates. Based on this diagnosis, which was itself based in four international benchmarks of good practices in project analysis/assessment and public audit, we intend to propose solutions that avoid repeating the same mistakes and failures in future cases (same-type study ones).
For the purpose described above, the case study is the capital investment in Valorsul's Organic Recovery Centre (ORC), in the field sector of urban waste, which seeks to answer the following questions: How and why does Valorsul's ORC project present a high deviation? How could some of the deviation observed in the project have been prevented? How can the project contribute as a learning example for the Portuguese public investment area?
The answer to these questions, which can be adapted to any type of project because the focus is on process management, shows that the factors that explain the reduced project performance are the adoption of non-validated assumptions, the absence of an analysis of sensitivity and risk, the degree of innovation of the project, non-existent or unreliable sources of information and insufficient qualification of the project analysis team.
As for solutions to avoid repeating the same mistakes, one comes up with the urgent need for an entity that is able to previously assess and validate the goodness, the quality and the effective investment return for society and the actual need to implement a culture of sharing lessons learned. The methodology is similar to the "RG3" one, used in this research work, and such assessment and validation is performed in an independent manner.
The question is whether these teachings will be discarded again and we continue to witness project management failures, with harmful effects on our economy and society.
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Keywords: *Investment Project, Analysis and Project Evaluation, Urban Waste, Case Study.*

1. Introduction

Portugal's last two decades have witnessed several cases of significantly faulty public investment (as regards economic rationality inherent to the public management) involving relevant cost and deadline deviation, with significant damage both to the public purse and for the citizens, not to speak of income/benefits deviation, which is also very questionable.

Exemplary of this are the dozens of works launched in recent years. In addition to the public-private partnerships (PPP) – never as spoken of in Portugal as in 2012 and which represent a substantial burden on the public finances and a huge invoice (payable on the part of taxpayers) - there are other specific cases of public works directly managed by the State and with very significant deviations in costs and implementation deadlines. Examples of these deviations are the construction of the Queen Santa Isabel Bridge, the modernisation and restructuring of the Rossio Tunnel, the construction of the Casa da Música, the construction of the Euro 2004 stadiums and the construction of the Centro Cultural deBelém (CCB) (Court of Auditors – Audit Report nº 17/2009 and Audit Report nº 37/2005; SIC- Grande Reportagem, June 9, 2012).

The urban waste treatment/recycling sector of activity, in which the present study's project is integrated, also did not escape the escalating deviation. Among others, for its relevance, emphasis is deserved, in this analysis, by Tratolixo's Central for Anaerobic

Digestion (CAD). Similarly to the public works described in this chapter, the CAD investment project, Tratolixo also recorded significant financial and deadline deviation from estimated values. The contractual and financial situation of the project, in December 2013, is presented in Table 1.

Award Amount	Final Cost	Deviation (%)	Deviation (€)
37.801.467 €	58.440.805 €	55%	20.639.338 €
Deadline		**Deviation**	
Contracted	Real	%	Years
March 2009	August 2012	76,4%	3,5

Table 1: Contractual and financial situation of the project (Tratolixo, 2013).

The burden to taxpayers results from direct compensation paid to the concessionaire, both as financial readjustments (in the case of PPP) and as deviations within forecast costs, relating to Portugal's more lime-lighted public works from recent years (directly managed by the State). To have an idea of the real dimension of the burden to taxpayers, one can put it as follows: 23 projects amount to more than EUR 4.3 billion (i.e. around 2.5% of Portugal's GDP in 2014). It also amounts to more than the cut of EUR 4 billion in State social functions announced in 2012 by the 19th Constitutional Government of Portugal as needed to ensure the sustainability of public finances in the medium term (between 2014 and 2017).

These deviations above EUR 4.3 billion account for heavy additional charges to the State, namely by means of more work, project faults/amendments/omissions, financial readjustments, among others, whose practical effects are reflected in the encumbrance of the final cost of public projects for taxpayers.

Table 2 makes a summary of the overall amount of deviation in costs of major public works, Public-Private Partnerships and road-building sub-concessions previously mentioned.

Table 2: Overall amount of deviation in costs of major public works, Public-Private Partnerships and road-building sub-concessions (Court of Auditors (2005 a 2013); Tratolixo (2013); SIC (2012); Moreno (2010).

Project Designation	Business Sector	Deviation
Motorways (subconcessions)	Road transport	+ 688.700.000 €
Euro 2004 Stadiums	Culture	+ 183.392.973 €
Modernization and Rehabilitation of Rossio Tunel	Rail transport	+ 9.522.810 €
Building of the House of Music	Culture	+ 77.193.368 €
Construction of Palace Square Tunnel	Rail transport	+ 29.139.075 €
Expansion of Sá Carneiro Airport	Air transport	+ 98.760.225 €
Construction of the Bridge Santa Isabel Queen	Road transport	+ 40.977.248 €
Cultural Center of Belém	Culture	+ 184.000.000 €
Metro Sul do Tejo	Rail transport	+ 77.000.000 €
EXPO 98	Culture	+ 300.000.000 €
Granting of the Bridges Vasco Gama and 25 April	Road transport	+ 400.000.000 €
Organic Recovery Plant	Environment	+ 20.639.338 €
Parque Escolar	Education	+ 2.228.000.000 €
Total		+ 4.337.325.037 €

Table 2

One should note that these figures refer only to deviation from capital expenditure estimates not integrating potential deviations of income and benefits in the scope of a social cost-benefit analysis. This is because, in most cases analysed, there was no a priori or subsequent verification of these benefits; would it have taken place, it is likely that the concerned financial deviation would be even more significant (Court of Auditors – Audit Report nº 17/2009, p.8. – Process 07/07).

2. Literature Review

From the literature review process was possible to identify four models of best international practices, used in the analysis (ex ante) and evaluation (ex post) of investment projects, namely: the Gateway Review Process (GRP, 2009), inspired by the UK GRP, adopted by the Ministry of Treasury and Finance of Australia; the Guide to Cost Benefit Analysis of Investment Projects (GCBAIP, 2008), published by the European Commission; The Green Book (GB, 2003) - Appraisal and Evaluation in Central Government, published by the Ministry of Finance of the UK and the ROI Methodology Institute (ROII, 2007), a North American-type methodology.

The choice of these models essentially results from the nature and objectives underlying the research project, the information available and the fact that these constitute a reference in the scope of international best practices, in the context of the analysis and assessment of public investment projects. It is so for its accuracy, detail and objectivity, whose systematic integration seems a methodological process more suitable for achieving the objectives of this work.

2.1 Gateway Review Process
Based on the UK Gateway Program, the Gateway Review Process (GRP) was first introduced to Victoria State of Australian in 2003. With over 300 Gateway reviews completed in the last six years, this cost effective process has assisted in the successful delivery of projects, policy and programs in the Australian public sector.
The Gateway Review Process examines projects and programs at key decision points. It aims to provide timely advice to the Senior Responsible Owner (SRO) as the person responsible for a project or program. A review provides the SRO with an independent view on the current progress of the project or program and assurance that it can proceed successfully to the next stage.
The six critical stages of the project lifecycle suggested by GRP is following presented with a resume of purpose of the each review.

- Gateway Review 1 – Strategic Assessment: check outcomes and objectives for the policy or program to confirm they contribute to the overall strategy of the organization; ensure the program or project is supported by users and stakeholders.
- Gateway Review 2 – Business Case: confirm that the business case is robust (i.e. it meets the business need, is affordable and achievable, with appropriate options explored and likely to achieve value for money); confirm potential options have been identified and analyzed and appropriate expert advice has been obtained; ensure the feasibility study has been completed satisfactorily; confirm the market's interest has been measured and appropriate high-level procurement strategies have been considered; ensure there are plans for the next stage, confirm the planning assumptions, and the project team can deliver the next stage.
- Gateway Review 3– Readiness for Market: confirm the objectives and desired outputs of the project are still aligned with the program to which it contributes; check the supplier market capability and track record, or existing supplier's capability and performance, is fully understood.
- Gateway Review 4 – Tender Decision: confirm the business case, including the benefits management plan, after the bid information has been received and assessed; confirm the recommended contract decision is properly executed within a standard, lawful agreement and is likely to deliver the specified outputs and/or outcomes on time and within budget and will provide value-for-money.
- Gateway Review 5 – Readiness for Service: confirm that commissioning plans have been developed, and that they are in line with the organization policy and industry best practice; check the business case remains valid, events and changes do not affect it and the original projected business benefit is likely to be achieved.
- Gateway Review 6 – Benefits evaluation: assess whether the business case for the project was realistic at Gateway 4 - Tender Decision; confirm there remains a business need for the investment; assess whether the benefits anticipated at this stage are being delivered.
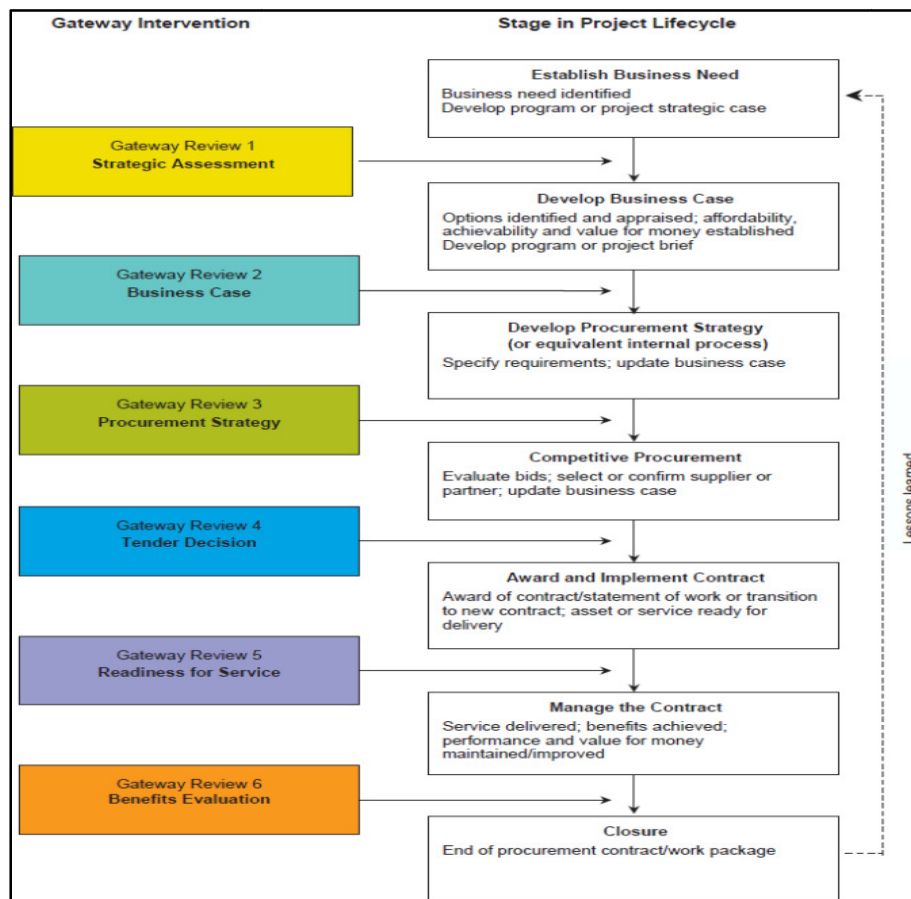

Figure 1: Overview of the Gateway Review Process (2009).

2.2 Guide to Cost Benefit Analysis of Investment Projects

The Guide to Cost Benefit Analysis of Investment Projects (GCBAIP, 2008) is an international benchmark in analysis of project evaluation, published by the European Commission. Cost benefit analysis has been used in Cohesion Policy since 1990´s and has been a requirement since 2000.

The GCBAIP has been written to helpful managing authorities, public administrators and their advisors in the Member States, when they examine project ideas or pre-feasibility studies at an early stage of the project cycle.

Following are listed some examples of questions to be answered by the project manager during the project appraisal process, which integrate six steps, namely:

- Step 1: Context and Project

Are the social, institutional and economic contexts clearly described? Does the project have clearly defined objectives in terms of socio-economic indicators?

- Step 2: Project Identification

Does the project constitute a clearly identified self-sufficient unit of analysis? Have the network effects been considered? Whose costs and benefits are going to be considered in the economic welfare calculation?

- Step 3: Feasibility and Options Analysis

Does the application dossier contain sufficient evidence of the project's feasibility (from an engineering, institutional, management, implementation and environmental point of view)?

Has the do-nothing scenario ('business as usual') been identified to compare the situations with and without the project?Has the applicant demonstrated that other alternative feasible options have been adequately considered (in terms of do-minimum and a small number of do-something options)?

- Step 4: Financial Analysis

Is the choice of the time horizon consistent with the recommended value? If not, why?

Has the residual value of the investment been calculated? Have the main financial performance indicators been calculated (FNPV(C), FRR(C), FNPV(K), FRR(K)) considering the right cash-flow categories?

- Step 5: Economic Analysis

Have externalities been included in the analysis? Have shadow prices been used to better reflect the social opportunity cost of the resources employed? Have the main economic performance indicators been calculated (Economic Net Present Value (ENPV) Economic Rate of Return (ERR) and Benefit/Cost Ratio (B/C ratio)?

- Step 6: Risk Assessment

Is the choice of the critical variables consistent with the elasticity threshold proposed? Has the sensitivity analysis been carried out variable by variable and possibly using switching values?

What may cause the project to fail? What mitigations may there be for each risk identified? Have risk mitigation measures been identified?

2.3 The Green Book

The Green Book (GB) is a guiding document, published by the UK Government, to help public sector bodies, departments and executive agencies in analytically robust approach to appraisal and evaluation of public investment.

The GB presents the techniques and issues that should be considered when carrying out public project assessments (assessments is the general term used in the GB to refer to both appraisals before decisions are made, and evaluations of decisions once made).

The GB is a best practice guide for all central departments and executive agencies, and covers projects of all types and size. It aims to make the appraisal process throughout government to be more consistent and transparent.

Appraisal and evaluation often form stages of a broad policy cycle that the GB formalise in the acronym ROAMEF (Rationale, Objectives, Appraisal, Monitoring, Evaluation and Feedback). The ROAMEF cycle is presented in Figure 2.
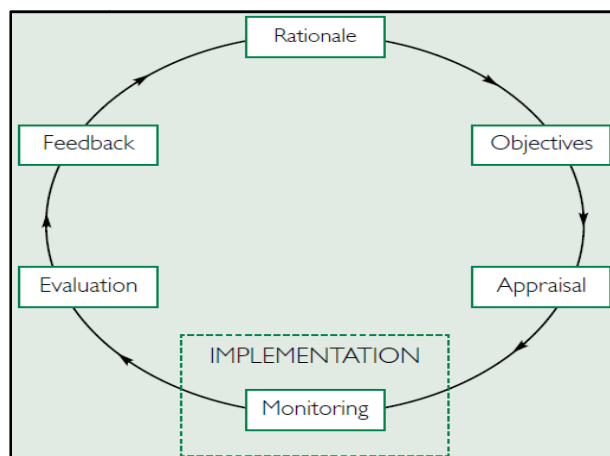

Figure 2: ROAMEF Cycle (The Green Book, 2003).

Following is present a resume of contents concerning the GB stages mentioned above.

- Justifying Action

The first step in the GB process is to carry out an overview to ensure that two pre-requisites are met:

→ Firstly, that there is a clearly identified need; and
→ Secondly, that any proposed intervention is likely to be worth the cost.

This overview must include an analysis of the negative consequences of intervention, as well as the results of not intervening.

- Setting Objectives

The second step is to set out clearly the desired outcomes and objectives of an intervention in order to identify the full range of options that may be available to deliver them. Targets should be set to help progress towards meeting objectives.

- Option Appraisal

The third step is to carry out an option appraisal. This is often the most significant part of the analysis. Initially a wide range of options should be created and reviewed. This helps to set the parameters of an appropriate solution.

- Monitoring

Seeks to check progress against planned targets and can be defined as the formal reporting and evidencing that spend and outputs are successfully delivered and milestones met; and

- Evaluation

Is the assessment of the project effectiveness and efficiency during and after implementation. It seeks to measure outcomes and impacts in order to assess whether the anticipated benefits have been realised.

Risk management of projects is strongly recommended by the GB. Risk management is a structured approach to identifying, assessing and controlling risks that emerge during the course of the project lifecycle. Risk management involves: identifying possible risks in advance and putting mechanisms in place to minimise the likelihood of their materialising with adverse effects; having processes in place to monitor risks, and access to reliable, up-to-date information about risks; the right balance of control in place to mitigate the adverse consequences of the risks, if they should materialise; and, decision-making processes supported by a framework of risk analysis and evaluation.

Finally, according the GB, the results and recommendations from evaluation should be feed into future decision making and evaluation reports and the research that informs them should be placed in the public domain.

2.4 ROI Methodology

The ROI Methodology ™ (ROII, 2007) is a North American-type methodology, whose mission is to help managers to assess the contribution of each decision to create wealth, value and corporate sustainability, by applying the main business techniques in the evaluation of investment projects.

This methodology is a compilation of practices, techniques, procedures and rules used in the business, with the particularity of being applied either in a public or private logic.

Know capture and estimating tangible and intangible benefits, know how to perform cost and benefits estimates, know how to analyze scenarios and build a decision package are goals to be accomplished by ROII in the analysis of investment projects, which is based on 8 steps or processes.

Below are presented the intended goals for each steps of the ROII framework.

1. Know to assess which investments create greater wealth for the organization;
2. Know what the best configuration of an initiative to enhance its benefits;
3. Know capture and estimating tangible and intangible benefits;
4. Know perform cost estimates and schedule of the project;
5. Know to assess whether the initiative is economically interesting for the organization;
6. Know to assess how much the organization is prepared for the change;
7. Know how to analyze scenarios and build a decision package;
8. Know measure the benefits over the life cycle.

The ROII gives emphasis to the part of capturing quantitative economic value in each investment, such as, emphasis on economic benefits. To achieve the ROII goal, the methodology presents the techniques and issues that should be considered when carrying out economic benefits analysis of projects. These tools and techniques, such as, Focus Groups, Expert Opinion, Literature Searches, can help managers carrying out appraisals which focus clearly on quantified results and impacts of the project implementation (Pereira, L. 2014).

3. Research Questions and Methodology

3.1. Research Questions

Research questions are as follows:

- 1st Question: Why does Valorsul'sOrganic Recovery Centre (ORC) project present a high deviation when it comes to benefits and costs, compared to the initial estimate?
- 2nd Question: How could some of the deviation observed in the ORC project have prevented?
- 3rd Question: How can Valorsul's ORC project contribute as a learning process to the Portuguese public investment?

The first question raised, regarded as of the utmost relevance, corresponds to the whole process' "issue approach", as it allows us to identify the main causes behind the low performance of the project.

The second research-related question corresponds to the "issue-solving approach", that is: approaching a solution liable to eliminate or rectify the very faults having determined high divergence from project estimate.

The third question will be answered based on the information collected about the causes boosting deviation in public investment projects, by putting forward to a specific government body (one which is empowered prevention-wise as regards evaluation of public projects) a set of measures resulting from the lessons learned from the investigation process. The answer will correspond to the research work's "educational approach".

3.2. Research Methodology

The present work focuses on the reason why Valorsul's ORC project presents a high benefit/cost deviation from the initial estimate, how you could have prevented some of the deviations observed in the ORC project and how it may contribute as a learning example for Portuguese public investment.

The type of questions raised determines the method of research. A case study is recommended whenever it comes to an empirical research of a contemporary phenomenon in its real context, whenever the borders between the phenomenon and its context are not evident, whenever you ask such questions as "how" and "why" and whenever resorting to multiple sources of evidence. It then appears that, in the face of the problem identified and the qualitative nature of the information required, the single case study is a good option as the research method used in this study.

The present research meets the four conditions set by Yin (2009) which justify the choice of the researcher regarding the case study method. Specifically: the phenomenon in question is contemporary; investigating issues are how and why; the investigator took on the role of visitor, not having any control either over the phenomenon under study or on the behaviour of those involved - in the role of visitor, the investigator visits the company and collects data through interviews, documents and observation. However, the researcher is not directly involved in the matter under investigation (Ryan *et* al., 2002; Scapens, 2004); usage is made of various sources of evidence (interviews, observation, documents).

3.2.1. Evidence Collection and Analysis

Evidence for a case study may come from six different sources: documents, interviews, direct observation, participant observation, physical objects and databases. To be able to answer the research questions, usage was made in this work of the following sources of evidence:

- Interviews: Researcher adopted semi-structured interviews. The interviews [carried out to four parties involved in the project and a national expert in the field of urban waste management, who was also involved in the project as a service provider] aimed (I) to deepen and clarify the decisions leading up to the development of the project and (II) to receive comments on its outcome. The four participants in the project selected for interviews were the following: the external consultant, the project's coordinating director, the current manager in charge of the ORC and a unit's operating technician.
- Interviews with Stakeholders: as shareholders, suppliers of raw material and customers, we interviewed the heads of City Councils in charge of urban waste management, namely, the local City Council councillors.
- Documents: In addition to the interviews, the researcher uses other data sources to collect the evidence, specifically the collection of documents and observation. The investigators collected information on Valorsul and the ORC project from a number of documents considered essential for research development, namely: the Concession Agreement; Operating Plan for Management Integrated of Municipal Solid Waste; the Economic and Financial Study of the ORC Project; Tender documents for the Construction and Supply the ORC; Bases and Technical Conditions of the Project; monthly Reports of Exploitation of the ORC; Rehabilitation Study of the ORC.
- Direct Observation: In addition to the interviews and documentation collection, the researcher turned to direct observation as a data source for collection of evidence. Several visits were carried out to ORC facilities, where (I) in situ observation of how equipment was running and (II) rating of the waste treatment process were possible. We also took the opportunity to hold some informal interviews with unit officials, some notes having been taken.

3.3. Research Methodology for Valorsul's ORC project

The development of this research is anchored in the theoretical foundations and empirical evidence sustaining the four models of international assessment of investment projects which have been referenced and which were presented in chapter 2.

As they are conveniently formatted for the analysis and evaluation of public investment projects, ROII, GRP, GCBAIP and GB models are to be used as a reference and as the case study's support base theory. From the bases of the four models, a unique procedural model ("RG3[1] ") was developed, which captures the best practices and techniques received by each one of them in the context of the analysis and assessment of projects. We then chose as outputs eight prospects on which they are based. This aims at achieving the main goal of this work: getting answers to specific targeted questions regarding public investment project deviation and simultaneously establish a set of instructive recommendations, which are to be considered when responding to questions viewed as decisive in the process of economic analysis of projects.

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1 (RG3) - Acronym that means the combination of the ROI Methodology, the Gateway Review Process, the Guide to Cost Benefit Analysis of Investment Projects and the Green Book.

Figure 3 shows a representative scheme of the four-model integration that explains the creation of the "RG3" procedural methodology.
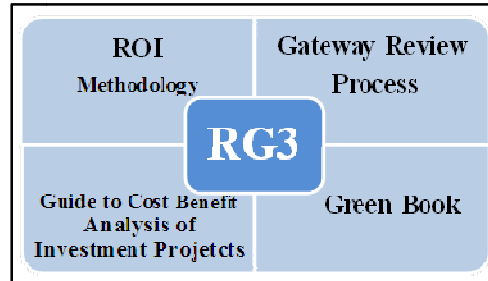

Figure 3:RG3 Model

The application of the RG3 model consists, briefly, in the following steps:

Performing the analysis and discussion of the results obtained from the work carried out by the researcher out of data obtained in the various documents consulted, information gathered from interviews carried out and studies that gave origin to the investment decision - then, compare these to the RG3 procedural model; assessing the alignment and consistency of the studies regarding the guiding principles, the goals set for the project and the good assessment practices; checking the level of rigor and exemption regarding the assumptions, sources of information, collection process and methodologies adopted in the framework of the evaluation process; diagnose what has been the basis of the deviation that has jeopardised the estimated results.

Figure 4 shows the reference framework for the model framework that resulted from the integration of four international models (ROII).
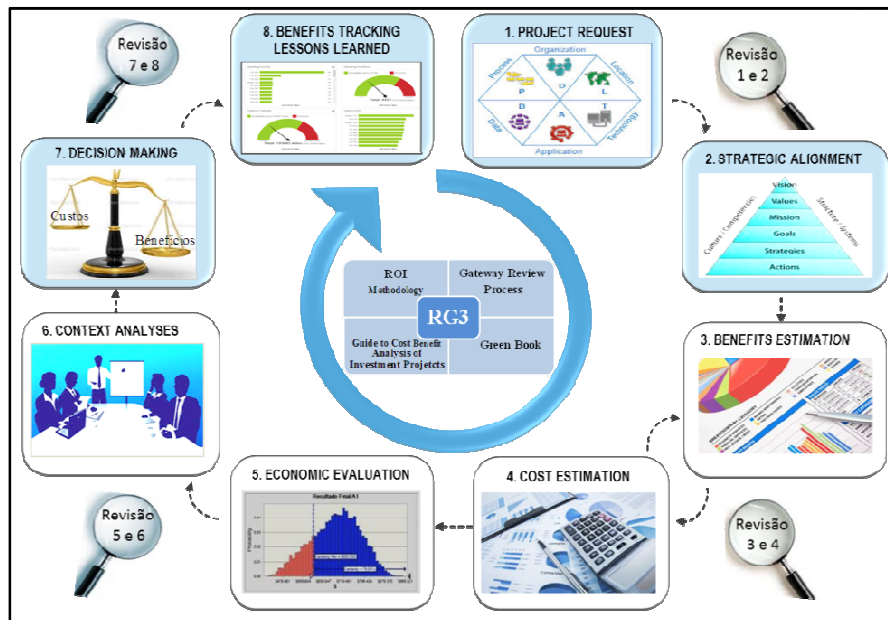

Figure 4: RG3 Framework (Preparation by the author from ROII; GRP; GCBAIP; GB; Pereira, L.2014).

As mentioned before, from the bases of the four models, a unique procedural model ("RG3") was developed, which captures the best practices and techniques received by each one of them. We then chose as outputs, eight prospects/phases on which they are based, as shown in Figure 4.

As an example, we proceed to present phases 1 and 3 of the RG3 procedural model, whose design and development will serve as a basis for assessing the performance of Valorsul's ORC investment project.

- Phase 1: Project Request

This phase of an essentially qualitative approach is used to define the need, the problem or the opportunity detected, justifying it and framing it in the organization, in order to ensure maximum understanding, to avoid subsequent amendments and inaccuracies.

The questions, inputs, techniques and outputs related to the project request stage are shown in Table 3 in parallel with the recommendations that project managers should take into account when grounding the answers to the questions put forward.

RG3: Phase 1 - PROJECT REQUEST				
Questions	Inputs	Techniques and tools	Outputs	Recommendations
1 - What problem the project intends to solve? 2 - What solutions have been identified to solve the problem? 3 - What justified the choice by a recovery facility of organic matter? 4 - What are the alternatives identified for the recovery of organic matter? 5 - What is the alternative that was selected and what was the basis of this choice? 6 - What are the critical factors of the project? 7 - What are the main benefits of the project? 8 - What are the impacts of this project does not take place? 9 - How and what criteria governed the selection of the project team? 10 - The decision to move to the next phase (strategic alignment) was previously validated by a monitoring Committee?	• Strategic Plan • Market Demand • Client Request • Innovation Initiative • Enterprise Reports • Enterprise Risk	• POLDAT • ZACHMAN • Expert Judgement • Enterprise Architecture • Elevator Pitch	• Project Request Form	See page 11

Table 3: Questions, inputs, techniques, outputs and recommendations

- Phase 3: Benefits Estimation

The phase 3 corresponds to the estimate of project benefits while aiming at a quantitative assessment of benefit impact, whether project-wise or as far as the overall results of the company are concerned. This phase is particularly important as it helps define all following stages until reaching (or not) the decision to move forward with the implementation of the project.
Table 4 presents the issues, inputs, techniques, outputs and the recommendations related to this phase.

RG3: Phase 3 - BENEFIT ESTIMATE				
Questions	Inputs	Techniques and tools	Outputs	Recommendations
1 - What is the methodology used to estimate the benefits of the project? 2 - What are the qualitative benefits expected with the implementation of the project? 3 - The sensitivity analysis of the benefits of the project was carried out? What are the techniques used? 4 - The quality of the process has been validated by an independent body? And what were the results?	• Project Request Form • Strategic Alignment • Historical Data • Market Reports • Enterprise Environment	• Data Collection Plan • Parametric Analysis • Sensitive Analysis • Focus Group • Pareto Analysis	• Benefits Estimation • Confidence Analysis	See page 12

Table 4: Questions, inputs, techniques, outputs and recommendations

4. Presentation of Case Study
The ORC is located in the parish of S. Brás, in the municipality of Amadora, occupying an area of 3 ha. Organic waste started being received at the ORC in February 2005 and it is prepared to receive the separated organic residues from restaurants, canteens, markets and other large producers of organic waste.

4.1. Centre's Technical Features
Through treatment processes by anaerobic digestion (AD) - treatment in a confined, oxygen-free environment - the ORC produces "green" electricity resulting from burning biogas produced in the technological process of anaerobic digestion, also producing an organic compound (without chemical additives) which can be used as fertilizer in agriculture. The processing unit, at an early stage, is designed to reach a nominal capacity of 40,000 tons / year. However, most of the equipment has been designed for a second stage, getting a processing capacity of 60,000 tons / year of biodegradable municipal waste. The ORC is built to generate between 8 and 12 GWh (per year) of electricity from renewable sources and 14,700 (tons / year) compound for agriculture, resulting from the treatment process of biodegradable municipal waste.

4.2. Estimated Benefits vs. real Benefits of the project
The comparison between the total benefits foreseen in the economic study, since the start of the Central in 2005 until now, and the real benefits generated by the ORC`s project is presented in Table 5.
Table 5: Estimated benefits vs. real benefits (Authors' elaboration based on data from the project feasibility study and ORC`s financial/activity reports, and reformulated in accordance with the operational changes meantime performed)

Estimate					Unit: euro	Real				Unit: euro
Year	Energy	Compost	Tariff	Subsidies	Total	Energy	Compost	Tariff	Subsidies	Total
2005	342.021	213.385	944.109	589.578	2.089.093	0	0	0	584.318	**584.318**
2006	569.028	383.076	1.658.999	589.578	**3.200.681**	0	0	0	517.425	**517.425**
2007	583.393	391.057	1.700.499	589.578	**3.264.527**	413.179	0	0	613.790	**1.026.969**
2008	598.157	399.038	1.742.996	589.578	**3.329.769**	476.405	0	0	427.129	**903.534**
2009	612.922	407.018	1.786.491	589.578	**3.396.009**	309.073	0	0	1.386.001	**1.695.074**
2010	628.484	414.999	1.831.184	474.855	**3.349.522**	792.809	0	0	308.866	**1.101.675**
2011	644.047	430.961	1.876.873	379.086	**3.330.966**	999.974	0	0	299.974	**1.299.948**
2012	660.008	438.941	1.923.960	379.086	**3.401.995**	983.170	0	0	316.130	**1.299.300**
2013	676.768	454.903	1.972.044	479.344	**3.583.058**	880.792	458	0	274.094	**1.155.344**
Total	5.314.828	3.533.378	15.437.155	4.660.260	**28.945.621**	4.855.402	458	0	4.727.727	**9.583.587**

Table 5

Table 5 shows that, regarding the value of the estimated benefits in the economic study (EUR 28.9 million), the total benefits until now (EUR 9.58 million) showed a deviation of 67% (over EUR 19.4 million). This is due to the fact there has been no revenue from tariff application to municipalities for the treatment of organic waste, nor relevant income from the sale of compost (only 458 euros in 2013), because the quality of compost produced is not high enough to allow its utilisation as fertilizer for agriculture.

4.3 Estimated costs vs. actual costs of the project
The comparison between the total operating costs foreseen in the economic study and the real operating costs of the project is presented in Table 6.
Table 6: Estimated costs vs. real costs of the project (Authors' elaboration based on data from the project feasibility study and ORC`s financial/activity reports, and reformulated in accordance with the operational changes meantime performed)

Estimate					Unit: euro	Real				Unit: euro
Year	Personal	External Services	Amortization	Interest Other	Total Costs	Personal	External Services	Amortization	Interest Other	Total Costs
2005	182.709	972.804	1.242.503	317.734	**2.715.750**	648.890	676.442	2.621.007	139.361	**4.085.700**
2006	281.471	1.547.268	1.242.503	298.281	**3.369.523**	1.059.822	1.042.655	2.140.533	131.029	**4.374.039**
2007	288.055	1.549.463	1.242.503	279.825	**3.359.847**	1.137.396	1.433.974	2.038.289	135.821	**4.745.480**
2008	295.737	1.841.908	1.242.503	285.312	**3.665.460**	1.212.583	1.879.824	2.116.676	120.813	**5.329.896**
2009	302.870	2.128.866	1.242.503	285.312	**3.959.550**	1.207.032	1.950.212	2.547.096	109.502	**5.813.842**
2010	310.551	998.043	819.025	285.312	**2.412.930**	1.272.728	1.675.961	1.171.452	133.676	**4.253.817**
2011	318.232	1.024.928	819.025	285.312	**2.447.497**	1.104.372	1.292.596	1.139.088	101.670	**3.637.726**
2012	326.463	1.049.619	819.025	285.312	**2.480.418**	981.222	1.439.101	1.136.558	83.541	**3.640.422**
2013	334.144	1.075.955	749.193	285.312	**2.444.604**	1.130.793	1.406.956	1.137.238	61.561	**3.736.548**
Total	2.640.232	12.188.853	9.418.784	2.607.711	**26.855.580**	9.754.838	12.797.721	16.047.937	1.016.974	**39.617.470**

Table 6

Table 6 shows that the greater deviation are regarding to, respectively, personnel costs (+ 269%, over EUR 7.1 million than the values foreseen in the economic study) and concerning depreciations (+70%, which corresponds to a deviation ofEUR 6.6 million).
Regarding the value of the estimated costs foreseen in the economic study(EUR 26.8 million) and the real costs (EUR 39.6 million) showed a deviation of 47.5% (over EUR 12.7 million).

5. Model Application and Discussion of Results
The application of the RG3 model complies with the following aspects:
1. Performing the analysis and discussion of the results based on the work carried out by the researcher from the data obtained in the various documents and studies that led to the decision to move forward with the investment in the ORC;
2. Confronting them with the practices resulting from the symbiosis of four international models for evaluating projects, which gave rise to the procedural RG3 model proposed here;
3. Diagnose, from the calculated results, what formed the basis of the very deviation that questioned the guiding principles of the project, as well as the estimated results. This assessment is performed by the researcher and by a set of project stakeholders through the interviewing method;
4. Proposing solutions based on the model proposed, so that similar situations do not happen again in the future, as far as same-typology projects are concerned. These solutions have resulted from the interviews and the research carried out in the field of best international practices of analysis and evaluation of projects.

The findings are obtained by: analysing the documentation and interviews conducted with key managers and stakeholders in evaluation, implementation and operation of the project; conducting observations; analysing documents related to project feasibility

studies; analyzing Valorsul's financial/activity reports; analysing the ORC operation reports; looking; analysing the project's supporting data and consulting international reports related to the subject under investigation, such as the case of "Final Report to the European Commision - Economic Analysis of Options for Managing Biodegradable Municipal Waste (2002)".

In the following paragraphs, a response is given to research issues that based in the steps, techniques and tools of the RG3 procedural model developed in 8 phases:

5.1. Question 1 - Why does Valorsul's Organic Recovery Centre (ORC) project present a high deviation when it comes to benefits and costs, compared to the initial estimate?

The case study showed that the management of the analysis process regarding the ORC project's economic viability recorded a number of serious shortcomings, which contributed to the standard deviation of 67% and 47.5%, respectively, in terms of benefits and costs, given the initial estimate.

Regarding the first research question, which corresponds to the process' "issue approach", here are the main conclusions:

- Phase 1: Project Request
-    In terms of analysis of alternatives, the studies performed only identified the processes of classic composting and anaerobic digestion. No assessment was performed of the co-anaerobic digestion of organic waste. This is because international evidence shows that, in terms of treatment of organic waste, the process of anaerobic co-digestion was the most widely used at the time of making the decision to implement the project.
-    The internal project team has proved little-experienced in analysing projects the nature and size of this one, including the external consultant, whose experience (at date of study completion) was essentially in the field of assessment of projects concerned with waste incineration (and not treatment facilities and urban waste organic recovery).
- Phase 2: Strategic Alignment
-    The evidence shows the absence of reasoning with regard to the guiding principles of ORC design/construction, which were, for the most part, indicative of the great potential of the project. The absence of reasoning with regard to the guiding principles of ORC design/construction constitutes an important gap in the process of developing the feasibility study for a project, seriously compromising the results expected from such a project's implementation.
- Phase 3: Benefits Estimation
-    In the phase of estimating the benefits, the methodology used for calculation of them presents relevant shortcomings and gaps, since a consistent and rigorous analysis of the competitive environment was not performed, specifically, regarding market study (suppliers; competition; prices of competing products).
-    The assumptions, the criteria and the projections that support the benefits have not been rigorous, in the sense that they present serious shortcomings when it comes to the indication of sources.
-    The projections of the benefits were only based on a very optimistic scenario and no sensitivity / risk analysis was carried out to the benefits generated by the project.
- Phase 4: Cost Estimation
-    As for cost estimation, adopted sources of information failed to be presented and there was no indication as to the ORCs that served as a basis for defining the calculation assumptions for the core scenario as a referential framework for an economic and financial analysis of the project.
-    The context of the project analysis involved risks arising from the fact that a choice had been made of an innovative-type investment – one that focused on recent technologies, which were still in the implementation phase in various countries of the European Union. These risks were not analysed nor weighted.
-    There was also a lack of rigor and prudence, in the framework of the cost-estimation process, whose projections underestimated the spending in operation and capital investment.
- Phase 5: Economic Evaluation
-    It is a very serious fault that the projection as to the useful life of the project points to 20 years, on the one hand, while, on the other hand, no project sensitivity/risk analysis has taken place, at such a crucial stage in the process of economic analysis of it.
- Phase 6: Context Analyses

At this stage, there is no record of relevant failures that might have contributed to any project deviation.

- Phase 7: Decision Making
-    It is a serious failure of the decision making process that decision-makers have approved project implementation based on a single optimistic scenario, while no analysis of sensitivity and risk was required from the project analysis team.
- Phase 8: Benefits Tracking
-    Despite the efforts shown to minimize the negative impact of operating expenses, it is noted that the measures and solutions (found so far) to minimize costs to adequate and sustainable levels (for example, sharing facilities and services of multi-municipal systems in order to optimize and streamline existing investments) did not achieve the desired results.

5.2. Question 2: How could some of the deviation observed in the ORC project have prevented?
Regarding the second research question that corresponds to the "issue-solving approach", that is, the solution approach to the failures that led to the high deviation of the project, the conclusions are as follows:
- Phase 1: Project Request
- It is absolutely necessary to make an accurate and thorough analysis of the existing alternatives, for it is very important to conduct benchmarking in terms of the international market: research reports on success stories; evidence collection with credible sources on the potential of the technology; assessment of the durability and reliability of the equipment; analysis of the costs, income and investment related to the same typology projects.
- The risks and the critical factors that affect project performance in terms of success or failure must be immediately identified in the initial assessment phase of the project – Project Request - and prioritized in order to justify, or not, the need to continue with the further analysis.
- The impacts of a project that does not materialize is considered a critical factor that should always be analysed in any evaluation process of investment projects, becoming vital to quantify this impact and the analysis of its evolution in face of a potential problem worsening in question.
- The scenario of not doing anything "business as usual" should always be formulated and / or identified, in order to evaluate and compare the situations with and without the project. The justification of the need to carry out a project, from the conviction of its viability, must clearly state the consequences and the effects of doing nothing.
- The RG3 model recommends as well that the selection of the team responsible for examining the investment project be carried out based on objective and transparent criteria. The latter should allow choosing people with a high degree of demonstrated experience in the business sector and in similar projects, with valences proven in area of finance, management, engineering, among others, and that are free from potential interest conflicts.
- Projects should be subject to assessment in key moments of decision, in particular before making the decision to move to the next phase of project evaluation by providing useful advice, in each of these critical stages, to those responsible for project evaluation. This review should be performed by independent, free and impartial experts (university professors, top managers, auditors from Portuguese Court of auditors and representatives of regulatory bodies), with technical skills, proven in the field of investment projects evaluation, which use their experience to review progress, risk and project success probability.
- Phase 2: Strategic Alignment
- The objectives of a project should be formulated in terms of a specific goal to be achieved, establishing a clear link with project operational aspects.
- In industrial projects, it is considered a critical point of success resorting to technologies sufficiently developed, tested, reliable and available in the market.
- Phase 3: Benefits Estimation
- The rigor and impartiality of information sources should be considered as critical success factors in the field of estimating the benefits along with definition and justification of adopted assumptions. A project's benefits estimate, in order to be accurate and reliable, is a lengthy process, although a critical one, to properly scale investment amount.
- Given the estimated benefits of a project are the anchor to a critical variables set, i.e. those variables whose changes, positive or negative, exhibit a high impact on project economic performance, such as, for example, in case of benefits estimate, the demand data (population, specific consumption, market size, market share, the quantities sold) and revenues price (fees, product selling price), it proves decisive, at this stage, to conduct a benefits sensitivity analysis.
- To understand the processes and techniques used in project developing, this should always include in each stage a methodologies subchapter, assumptions and data sources. This aims at specifying methods used to achieve presented results, how the results were obtained and analysed with the objective that project recipients can also clearly understand and evaluate if results are reliable.
- Phase 4: Cost Estimation
- The processes of technological obsolescence or systems non-functionality are critical factors that affect project performance and exponentially enhance the project's future costs. Therefore, the question related to equipment obsolescence is an aspect that should be analysed in detail in operating costs and investment estimating process.
- In order to ensure process credibility, those responsible for investment project analysis (and in this case cost estimate) must clearly identify and explain the fundamentals that underpin the conclusions and describe the assumptions underlying the analysis, the consulted sources of information as well as specifying in detail uncertainties and risks associated with obtained results.
- Whereas estimated project costs are, like the estimated benefits, a critical variables set anchor, i.e. those variables whose changes, positive or negative, exhibit a high impact on the project economic performance, such as, for example, data relating to equipment cost, the personnel expenses and equipment maintenance and upkeep expenses proves to be decisive at this stage, to undertake a cost sensitivity analysis.
- Phase 5: Economic Evaluation
- Given Phase 5 has an underlying relatively-automated process (since data are pre-set and provided that conditions are credible and exempt, estimation processes have been accurate and queried information sources are trusted), this phase passes almost exclusively by an interpretation analytic branch of investment profitability or performance indicators, measured by Internal Rate of Return (IRR), by net Present Value (NPV) and by the Payback Period, which support decision making on project completion or rejection.

- Following economic benefits determination, the need to establish heights/maximum investment ceiling is considered absolutely critical, without which project implementation does not make any sense.

- Another critical success factor of a project should include the required development of a procedure which includes an analysis and evaluation of risks associated with a project. This process should identify risks that may negatively affect project objectives achievement, quantifying and managing them through a systematic and dynamic process.

- More important than the simple project cash flows analysis procedure should be assessing the quality, independence and credibility of information sources, collection process as well as the respective assumptions, which must be completely free and properly validated in order to ensure indicators robustness.

- Phase 6: Context Analyses

- Before taking the decision to proceed with project implementation, a road show should be held to present project to stakeholders, including respective analysis and the results obtained by the project evaluation team. The goal is to gather and collect stakeholders' opinions on the analysis carried out to project, in order to re-evaluate and correct any weaknesses that were identified during auditions to the whole of entities interested in the project.

- Phase 7: Decision Making

- The investment decision is an irreversible decision that involves risks associated with increasingly higher amounts. Thus, by its importance and the irreversibility, it represents, in a way that, after investment starts, cancelling it always involves heavy losses, it is recommended that studies supporting these decisions must be robust and consistent in technical and economical point of view.

- When a certain investment option involves a high risk, it is recommended that it always be given the possibility to postpone the decision, allowing project analysts to be provided with more time to deepen and investigate other alternatives to achieve objectives, or even to abandon investment.

- In addition to impediments resulting from interest conflicts, those responsible for the projects analysis and evaluation should always declare any relationship with the project's object. Be it either the interested party or other parties, likely to raise doubts about performance, fairness as well as declare that expressed views were given, in a completely unbiased and impartial manner, i.e., without being subject to any higher orders, pressures or instructions.

- Phase 8: Benefits Tracking

- The clearance of causes underlying divergence in terms of estimated benefits and costs is an important project management activity, which should be taken forward to identify factors that boosted the deviations and assess its relevance, but above all, aimed at implementing preventive and corrective measures and managers accountability.

5.3. Question 3: How can Valorsul's ORC project contribute as a learning process to the Portuguese public investment?
The third and final research question corresponds to research work "educational approach", whose conclusions are set out below:

- 1st Lesson - Preventive entity

The first and perhaps the most important lesson, on the researcher point of view, to be drawn from analysis to ORC project evaluation process, is based on the urgent need for creation of a preventive entity with responsibility to assess (*ex-ante*) the technical and economic analysis process of public investment projects.

- 2nd Lesson – Post-evaluation projects assessment

The second lesson relates to the importance of conducting evaluations (ex post) of public investment projects to enable analysis and comparison of actual results with project initial estimates.

This ex-post evaluation should be performed by recognized competence and independence consultants (university professors, auditors from Portuguese Court of Auditors, senior management and the industry regulator) and include all stages of the economic analysis of the project.

- 3rd Lesson - Post-evaluation projects' assessment model

Disclosure and mandatory implementation of an evaluation model for public works investment cost/benefit (like, for example, the one which was approved by the French Government, in November 2008, referred to as "Évaluation des Grands Projects Publics - diagnostique et propositions" also constitutes a remarkable measure.

- 4th Lesson - Sharing lessons learned

There is no formal, systematic and regular Portuguese practice of collection and public review of relevant reference cases for sharing and further improvement of public investment works projects' evaluation, similarly to what happens in many countries (e.g. US portal usaspending.gov). This has led to unknowing flaws and deficiencies previously occurred, many with cross-cutting nature, which, if they had been subjected to appropriate treatment, would have not repeated in future cases, same mistakes and failures.

- 5th Lesson - Public officials assessment based on projects' performance

The fifth lesson is related to the importance of assessing public officials involved in the analysis and decision to implement projects / investments, depending on project performance.

This assessment, which public managers must be submitted to, shall be performed by recognized competence and independence consultants (university professors and auditors from Portuguese Court of Auditors) and classification, which shall be included as a mandatory rule in these managers' professional curriculum, will be selective in future projects and public functions.

6. Conclusion

From this research work, it was found that there is a strong scientific research deficit, whose focus is analysing the quality of the project-evaluation process related to public investments in general and to the urban waste sector in particular, with special emphasis on issues concerning independence, impartiality, rigor of process and underlying sources.

This situation is particularly relevant in Portugal, after two decades of public investment with huge budget gaps - and after that period, few or no lessons learned, which indicates that we are on the verge of repeating the phenomenon (Pinho & Vilares, 2009; Court of Auditors, 2012).

Indeed, never in Portugal a thorough study was carried out on how a procedural model, which combines the best practices, may at an early stage of an investment project evaluation calculate with accuracy the success probability of the project. On the other hand, how can it demonstrate that evaluation of performance of subsequent investments can contribute to the maximization of results, and provide useful data for future decisions on similar nature of studied investments.

It was based on this detected gap that the researcher, using a single case study, sought to validate or refute these assumptions and, simultaneously, develop the existing theory by developing a process model.

It was also concluded that the causes of observed deviations cannot be considered as inevitabilities of the process, but rather as serious flaws that occurred in the areas of assessment of investment, planning, execution and project control, putting into question the good practices that should guide decisions rationality on public investment and fundamental principles of public funds' good management.

6.1. Theoretical Contribution

In theory, this research has contributed to a theory of analysis and evaluation of public investment projects and to improve the knowledge about the causes of project deviation, solutions that must be observed to solve them or even eliminate them.

6.2. Practical Contribution

This work originated two practical contributions to those responsible for the analysis and evaluation of public investment projects; these contributions are summarized hereafter:

From the identification of best practices, techniques and tools of analysis and assessment of investment projects, on an international level, the first practical contribution expected from this research is to bring together the strengths of each one of them and integrate them in a single and a systematic procedural model, called "RG3".

The second practical contribution that can be expected from this research is about recommending the agents who exercise public functions (public auditor, decision maker and project evaluator) a paradigm shift. This latter will take into account the lessons drawn from this research as well as the findings based on an analysis of the factors and causes that affect project performance and their opposition to the RG3 procedural model here developed, which may then have a major contribution in correcting these distortions.

6.3. Limitations

The present study used the single case study method of investigation. The researcher took this option because he wanted to develop a detailed and holistic understanding, one rich in details, descriptions and explanations about the practices and methods that were the basis of the architecture of the ORC project.

However, this line of research made it impossible to compare the results with other studies that could possibly have been used in same-activity companies, if the option had been for conducting a multiple case study.

Therefore, the results obtained in the study cannot be generalized (Ryan *et* al., 2002; Yin, 2009) and there is a need to replicate it in other companies or projects, so that they can draw conclusions about its potential of general application. It should be noted, however, that this does not remove appropriateness and relevance to the three formulated research questions and the respective answers given under this thesis.

6.4. Future Research

Given that research is a continuous act, which is never ended, and that much can be discovered in the field of analysis, the opportunities for future investigations derive from the process of research carried out in this work and the limitations that were set out in the previous point.

Taking into consideration the limitations referenced, it would be important to replicate this study in other public undertakings (the same sector of activity, or not), which rely on valuation analyses of investment projects that generate cost-associated benefits.

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