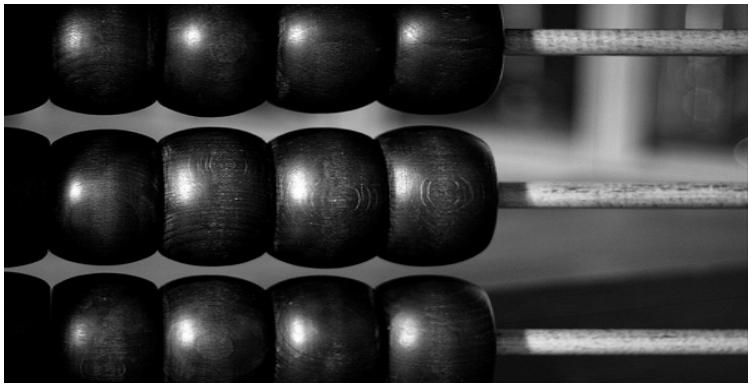
INSTITUTO SUPERIOR TÉCNICO
Universidade Técnica de Lisboa



The Value of ITIL

Pedro Carmo Belo de Oliveira

Dissertação para obtenção do grau de Mestre em
Engenharia Informática e de Computadores

Júri

Presidente:

Orientadores: Professor Doutor Miguel Leitão Bignolas Mira da Silva

Engenheiro Nuno Furtado da Silva

Vogal:

Julho de 2009

Acknowledgements

I'd like to show gratitude to a great deal of people who helped me get ahead of all the obstacles that appeared during the last year.

First and foremost, I offer my sincerest gratitude to my supervisor, Professor Miguel Mira da Silva, who has supported me throughout the development of my thesis with his guidance, vision, encouragement, understanding and knowledge whilst giving me enough room to be creative and express my own ideas.

I would like to thank my co-supervisor, Eng. Nuno Furtado da Silva, for the assistance provided at all levels of this research work and for taking time to guide me and provide me with useful insights. And, I would also like to thank Ana Paula Arsénio for the moral support she gave me in all phases of this research work.

I thank my family for supporting me throughout all my studies at university, and for the love they gave me since I was born. It is to them that I dedicate this work.

Finally, my gratitude goes to all my friends for providing me with cheerful as well as leisure moments, for patiently listening to my endless discussions about everything and nothing, and for the incessant support.

Abstract

As World economy lingers it is increasingly more important to justify any investment so that available corporate funds are spent wisely. However, estimating the value of ITIL investments is not an easy task, which means that most CIOs do not invest in large-scale ITIL projects as much as it would be desirable. Instead, CIOs prefer to embark on *quick win* implementations (e.g. solely implement the incident management process). For this reason, it is necessary to create an ITIL Value Estimator. This estimator is based on an estimation process that quantifies the project's total cost, along with each process' benefits. The outcome of the ITIL Value Estimator is a Monte Carlo simulation whose result provides CIOs with a justification of the value of large-scale ITIL implementations, which can be used to gain the upper hand during the decision-making process.

Keywords

Value of ITIL, estimator, metrics, risk analyses, cost-benefit analysis, KPIs.

Resumo

A crise económica mundial é cada vez mais premente, requerendo uma maior e mais detalhada justificação de qualquer tipo de investimento. No entanto, estimar o ROI de implementações ITIL não é trivial, o que geralmente faz com que a maioria dos CIOs não invistam tanto em ITIL quanto seria desejável. Consequentemente os CIOs tendem assim a optar por "quick wins" (por exemplo, apenas a gestão de incidentes) em vez de implementações ITIL mais abrangentes. Por esta razão, é necessário criar um modelo de avaliação de implementações ITIL que permite quantificar os custos e os benefícios de cada processo. O modelo baseia-se numa análise de sensibilidade, nomeadamente numa simulação de Monte Carlo, cujo resultado final pode ajudar os CIOs a justificarem grandes projectos ITIL aos conselhos de administração.

Palavras-chave

Valor do ITIL, estimador, métricas, análises de risco, análises custo-benefício, KPIs.

Table of Contents

List of Tables

List of Figures

Acronyms and Abbreviations

ITIL	Information Technology Infrastructure Library
IT	Information Technology
IS	Information Systems
CIO	Chief Information Officer
CEO	Chief Executive Officer
CFO	Chief Financial Officer
ROI	Return On Investment
DCF	Discount Cash Flow
NPV	Net Present Value
IRR	Internal Rate of Return
PBP	PayBack Period
EVA	Economic Value Added
KPI	Key Process Indicator
TCO	Total Cost of Ownership
TBO	Total Benefit of Ownership

1. Introduction

"Economy does not lie in sparing money, but in spending it wisely."
- Thomas Henry Huxley

Today's competitive and turbulent economy forces organizations to struggle in order to remain competitive. Organizations can only grow by cutting costs as well as optimizing resources. Having this in mind, a growing number of organizations has become increasingly dependent on IT to manage and grow their businesses [1].

A typical five-leg office chair is a good analogy to understand how organizations are structured these days. Each leg symbolizes a business function within the organization – for example: sales, marketing, manufacturing, product development and human resources. And, representing the chair's spinal column is the IT department which links and integrates the information that drives the business [17], [21].

If all the wheels (business functions) are aligned, as a result of having a common direction (strategy), then all of them will roll towards the same pathway (business goal). However, this wheel synchrony is only possible because the chair's column (IT department) supports the chair (organization) by connecting all the wheels. This simple analogy pictures the fact that organizations are intrinsically dependent on IT.

In the past, this IT dependency meant a growing IT budget, as shown in table 1, despite the fact that there was no evidence if IT investments would bring benefits to the organization [3]. This tendency is still valid nowadays as approximately $500 billion are wasted on IT every year (e.g. failed projects, discarded technology), and the IT investment per employee keeps rising [2], [6]. However, disproportionate budgets are no longer allowed by the executive board, as CIO must justify their IT budget, and must prove that IT projects are indeed necessary for the organization to maintain its competitive level [5], [70].

Table 1. Total Retail IT Spending, 2006-2011 (Millions of Dollars) [35].

Area	2006	2007	2008	2009	2010	2011
IT services	46.529	50.610	54.440	58.681	63.321	68.349
Consulting	3.758	4.099	4.392	4.693	5.000	5.328
IT Management	10.062	10.804	11.537	12.432	13.413	14.524
Development and integration	12.408	13.599	14.654	15.661	16.658	17.729
Process Management	10.831	12.063	13.361	14.925	16.755	18.716
Total	83.588	91.175	98.384	96.392	115.147	124.646

1.1 IT Selection

There are several ways of selecting projects these days, but only three common practices are explained here [18]. In the *first*, the administrative board, without the presence of the CIO, is responsible for analyzing investments, making the CIO a powerless actor in the decision-making process. Typically, administrative boards use a financial perspective. Therefore, it is essential for the CIO to understand key financial concepts so as to create well structured business cases, which is a document that explains why a project should be chosen (see figure 1) [4].

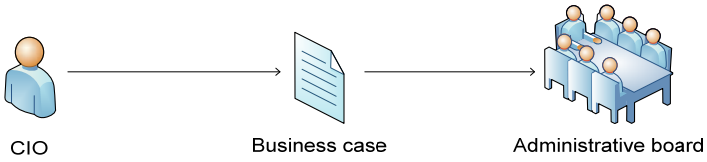


Fig. 1. Project evaluation request.

In the *second*, the CIO is part of the administrative board, and tries to convince his/her peers that his/her IT investment creates value [5]. The CIO may not be the only "technology champion" in the board, as other executives might see technology as a core asset of the business [17]. Even though this seems to be a good option, according to a 2005 research, CIOs are board members in only 8 percent of GLOBAL Fortune 500 firms [19].

The third and last common practice described here is for the CIO to discuss IT investments directly with the CEO. In fact, statistics show that if this is the case, true alignment between business and IT will be reached [18], [24].

Nevertheless, CIOs who have negotiation skills are able to understand the power division in the board, pinpoint who has decision rights and who is accountable in the decision-making process, and then successfully use relationships with key stakeholders to influence their stance [18], [20].

Another essential skill CIOs should have is a broader understanding of the organizations' structure. Organizations are gradually becoming flat instead of having a vertical structure. This transition led to the establishment of horizontal processes in detriment of vertical silos, which made it possible to align IT and business. And, therefore, CIOs should be able to effectively manage the link between IT and business [7].

However, without a coherent framework to manage business processes, organizations are not well prepared to avoid or solve problems related to this transition [7]. Hence, organizations that manage their IT correctly generate returns at least 40% higher than their competitors and, for that reason, it is very important that organizations adopt an IT management framework [3].

1.2 Managing IT with ITIL v3

In this context, ITIL was launched by the UK's Central Computer and Telecommunications Agency with the aim of providing technology-related services in a cost-efficient and reliable manner, by offering a systematic approach to the delivery of quality IT services [7], [8].

In the present day, ITIL v3 consists of a set of guidelines that specify what an IT organization should do based on industry best practices [57]. These guidelines offer advice on the definition, plan, implementation, execution, monitoring and continual improvement of the IT service management. Therefore, it is crucial not to regard ITIL implementations as technological projects but as an organizational change process [16].

Since mid-2007, ITIL v3 became a reality and is now divided into: ITIL v3 Core and ITIL complementary guidance. In fact, ITIL is such a powerful reference in IT management that ISO 20000, which is a complementary international standard, is associated to ITIL [58].

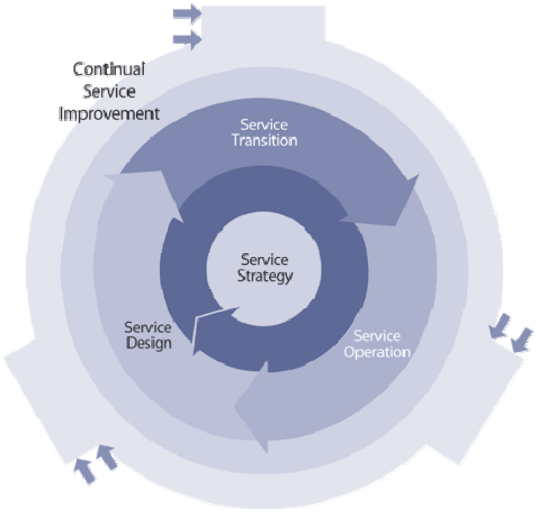


Fig. 2. ITIL v3 core.

ITIL v3 Core is a set of five books: service strategy, service design, service transition, service operation and continual service improvement (see figure 2). Each one provides guidance for an integrated approach. Furthermore, ITIL complementary guidance is a set of publications which are related to a specific industry, type of organization, technology architectures and operating models [9].

To sum up, ITIL investment justification is a non-trivial subject and only by analysing the investment are CIOs able to justify the value of ITIL investments. In this way, the analysis of the investment ends up being the main justification support because it produces numbers that help justifying the ITIL investment, by calculating the benefits as well as the costs. Thus, calculating the value of the investment is part of the investment analysis, and this analysis is absolutely necessary so as to justify the investment.

1.3 Problem Summary

The thesis' problem is the fact that there is no pragmatic methodology for estimating the value of ITIL implementations. As a result, CIOs are not able to prove the value of ITIL projects that would eventually pay off the initial investment.

Therefore, the main objective of this research work is to create a methodology that estimates the value of ITIL implementations. In this way, executives are able to make well informed decisions about

whether to implement ITIL or not, independently of being *quick wins* or large scale ITIL implementations.

If executives are able to see for themselves the ROI inherent to ITIL implementations beforehand, then they might feel more motivated to bring ITIL into their organizations.

1.4 Proposal Summary

In order to build a reliable methodology, an effective process for estimating the ROI of ITIL implementations is to perform a sensitivity analysis.

This thesis' proposal exploits client data so as to quantify the project's total cost as well as the benefits inherent to each process. The benefits quantification is achieved by forecasting the values of each process' KPIs, which will then be used to perform an investment analysis. To end, a Monte Carlo simulation is performed so as to realize the risk of the investment.

By using this estimation process, it is assured that decision-makers have a reliable sensitivity analysis to base their decisions on, and which can be decisive in the go/no-go decision.

All the details are explained in section 4.

1.5 Research Methodology

The chosen research methodology for this research work is the **action research** methodology, which is part of a wider group – the qualitative research methodologies, which involve observation and fieldwork, interviews and questionnaires, and researcher's impressions and notes [49].

Whereas other qualitative research methodologies only focus on studying what the problem is, without acting on the subject-of-study, the same does not happen with action research as the researcher has a problem that needs a solution and, at the same time, he/she studies the whole process in order to expand his/her scientific knowledge [49]. Also, action research is cyclical so that the knowledge accumulated in one cycle can be used in the following cycle (and so on), making this methodology an iterative research approach. Figure 3 pictures the action research methodology.

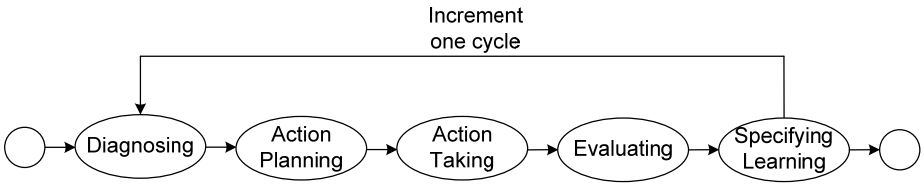


Fig. 3. Action research cycle [49].

In practical terms, by using action research it is assured that all the learning gathered in one cycle, where a solution is proposed and implemented, and its results analyzed and utterly evaluated, is used in the next one so as to improve the solution or to find another type of solution. To put it briefly, action research is a learning process that brings practical results because it makes use of the benefit of hindsight, which further improves the final solution.

1.6 Thesis Structure

The structure of this research work is aligned with the five phases of the action research methodology mentioned in the previous sub-section.

"**Diagnosing**" is represented by **sections 2 (problem) and 3 (related work)**. Section 2 describes the generic problem that this research work addresses and section 3 studies general and IT-oriented investment evaluation methodologies.

"**Action planning**" is represented by **section 4 (proposal)** as it presents an estimation methodology by considering a practitioner-specific context.

"**Action taking**" corresponds to **section 5 (implementation)**. This section describes a prototype that translates the estimation process into practice. Also, an explanation of the evaluation/testing methodology used in the actual implementation of the action is given here. The final step of this phase is to retrieve the results of the action itself.

"**Evaluating**" corresponds to **section 6 (evaluation)** where the results of the previous section are analysed in order to test how well the solution performed.

Finally, "**specifying learning**" is represented by **section 7 (conclusion)** where the lessons learned are specified and the final thesis' conclusion is presented. Since only one action research cycle is carried out in this research work, the solution is not improved any further and the future work (section 7.1) is established.

1.7 Related Publications

During the development of the thesis two papers were accepted at two distinct conferences:

- Conferência Ibérica de Sistemas e Tecnologias de Informação (CISTI) 2009 – "The Value of ITIL" [77].
- Conference on ENTERprise Information Systems (CENTERIS) 2009 – "A Process for Estimating the Value of ITIL Implementations" [78].

2. Problem

Nowadays there are multiple research case studies which support the statement that ITIL brings value [59], [60]. However, CIOs are going through great difficulties so as to justify the value of ITIL implementations to their peers, as there is no pragmatic methodology in their grasp to prove the business value of ITIL implementations.

In a recent survey, 50,5% of the executives interviewed claimed that they did not approve ITIL implementations for their organizations because the business value of these implementations cannot be proven [10]. In fact, this is the second most significant barrier to ITIL adoption; the first is organizational resistance to change (see figure 4). But, as global economy weakens, the gap between these two variables will probably decrease significantly.

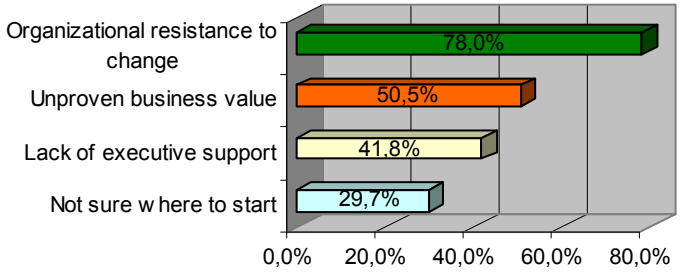


Fig. 4. Most significant barriers to ITIL adoption [10].

Indeed, estimating the value of ITIL implementations is not an easy task because many variables have to be considered [68]. Organizational maturity level, tangible and intangible benefits and costs, organizational complexity, and cultural context are just some of the variables that can be used in the estimation process. Time is also another important aspect to be considered in the investment evaluation process [67].

Since the value of these variables diverges greatly from organization to organization, adding up to the fact that ITIL v3 has 26 different processes, it is very difficult to cluster these values into different groups, and, consequently, derive patterns and re-use estimations.

Thus, CIOs need a methodology that quantifies the intangible benefits and costs by selecting the metrics that are indispensable for computing the value of ITIL implementations. However, it is traditionally hard to quantify the intangibles using conventional capital-budgeting approaches. Questions like the following one exemplify this difficulty: *how measurable is costumer satisfaction and increased process effectiveness*? [26], [43]. Besides, these benefits and costs take time to be realized, and if they are measured by business financial metrics, any connection with the original ITIL investment may seem tenuous, which might result in the unpleasant questioning of the CIO's position as a good decision-maker and leader [18].

This is why CIOs tend to be short/mid-term thinkers as they want immediate returns, and usually do not like to take risks when it is not clear what the benefits are [18].

Consequently, ITIL projects that immediately fix problematic areas (e.g. incident management systems), commonly known as *quick wins*, that are usually chosen instead of large scale ITIL implementations [69]. This happens because large-scale projects have a much higher degree of complexity associated to them which originates confusion and increases costs [53], [44]. Also, *quick wins* comprise an easier way of showing employees that ITIL works and, therefore, facilitates change that is naturally implicated in ITIL implementation projects [16], [71].

However, even if organizations observe a swift performance improvement after the *quick win* project is put into production, those improvements will not last for ever as organizations are complex adaptive systems [51], [52]. Actually, after some time the problems that were initially solved may eventually come back and new ones might emerge, making the performance decrease yet again. For instance, if someone substitutes a car's engine for a new powerful one without changing any of the other components that are connected to the engine, he/she may end up battering up the engine and the other car pieces as they might not be prepared to work with such a powerful engine.

So, *quick wins* have early returns associated to them but, if the organization does not continue to incrementally implement the rest of the ITIL processes, then things may become even worse than they were [69], [71]. On the other hand, if *quick wins* are completed successfully and the benefits are realized, it is much easier for the CIO to ask support for subsequent larger scale ITIL implementation projects.

Alternatively, CIOs who opt for long term ITIL implementations will experience a larger ROI because large scale ITIL implementations involve more abstract concepts (e.g. organization design) that systematically change the investments where the organization spends its time, which ends up making the ROI proportionally larger as it is a proactive process instead of reactive.

3. Related Work

Currently, there is still limited academic research on appraising the ROI from ITIL implementations [64]. For this reason, ITIL estimation metrics are adapted from different investment analysis approaches which use financial metrics and other non-financial approaches. These two types of investment analysis approaches are discussed in the following sub-sections.

3.1 Investment Analyses

The value of ITIL implementations can be estimated by using general investment analysis techniques because, likewise any investment, ITIL implementations still require an executive decision and financial numbers to support that decision. Thus, ITIL implementations are no different from other investments since they are treated as business decisions subject to the same investment thresholds as every business investment [17].

In this manner, investment analyses provide executives with useful insights when faced with difficult investment decisions, because financial metrics rank investment options against each other according to their economic value and the decision-making process is supplied with valuable information [12], [22]. Another reason to calculate the value of ITIL implementations using financial metrics is due to the fact that finances and accounting practitioners still insist that every investment should be backed by verifiable metrics [25].

In addition, cost benefit analyses estimate the attractiveness of an investment opportunity. However, these types of analyses have long been criticized for its inability to determine the risk and percept the value of investments of strategic nature and, therefore, are the reason for short-term decision-making focus and lack of adequate funds for large-scale IT investments [26]. The “risk paradox” mirrors this reality: “if an organization uses quantitative risk analysis at all, it is usually for routine operational decisions. The largest, most risky decisions get the least amount of proper risk analyses” [42].

The combination of the factors that affect IT projects (e.g. executive support and user involvement [44], [53]) influence negatively the risk analysis of IT investments. Adding up to this is the fact that 80% of executives lack financial skills which would allow them to quantify IT benefits and, therefore, the IT investments are considered even less attractive in the eyes of executives [22], [25].

Financial metrics allow CIOs to determine the financial attractiveness of an investment, possibly comparing its financial attractiveness with other investment possibilities, which are then followed by an analysis that takes financial restrains under consideration [23].

The metrics by which IT is evaluated are divided into cost and benefit analysis and risk analysis. The metrics for cost and benefit analysis include: pay back period, cost benefit analysis, ROI, net present value, internal rate of return et cetera. And the risk analysis metrics include: sensitivity analysis (e.g. gross sensitivity analysis and stress testing), brainstorming, scenario planning, Monte Carlo simulation et cetera [66].

In fact, cost and benefit analyses under risk and uncertainty are the ones that embody the real value behind the estimation process since, without any quantification process concluded beforehand, some of the risk analyses can be valueless. Therefore, risk analyses are generally considered as a valuable extension of the estimation process [65], [72].

Hence, several of the cost and benefit analysis as well as risk analysis metrics are analyzed thoroughly in the following sub-sections.

3.1.1 Cost benefit analyses

Several of the cost and benefit analysis metrics are analyzed thoroughly and, at the end of this sub-section, an overall comparison is given.

Net Present Value

Generally, DCF analyses, which estimate the attractiveness of an investment opportunity, return the net value in terms of today's money, or in other words, the NPV.

If the NPV of an investment is positive and no other investments are under consideration, then the investment should be pursued. Otherwise, it means that the project "destroys" value [14], [50].

One way of calculating the NPV of an investment is by means of the following formula [26]:

1. $$\mathrm{NPV}\ (t) = -C_0 + \sum_{t=1}^{N} \frac{A_t}{(1+r)^t}$$

Legend:

t – Period of time

N – Length of the project

A_t – Cash flow at the end of period *t*

C_0 – Investment at the start of the project (i.e., $t = 0$)

r – Discount rate

A net present value analysis will be better if the worst-case, most-likely-case and best-case scenario are determined. And, it is important to notice that the discount rate and the present value of future cash flows are inversely proportional variables.

The NPV advantages are [13], [50]:

- Simple to calculate.
- Takes into account the time value of money which allows consideration of: cost of capital, interest rates and investment opportunity costs.
- Appropriate for long-term projects.
- By understanding the concept of time value of money, CIOs will probably improve the CFO's judgment about them.

And, the NPV disadvantages are [23], [26], [50], [54]:

- NPV does not state anything about the magnitude of the investment as the return value is expressed as a monetary value.
- Does not take into account risk, flexibility and uncertainty after the investment decision takes place.
- Discount rate percentage can be difficult to calculate.
- The present value of a future sum is not very intuitive at first, but it is intensively used by financial employees.
- It is not conclusive in case of comparison between projects with different durations.

Return on Investment

Calculating the ROI of an investment allows decision makers to catalogue a project according to its expected success. So as to facilitate projects comparison, ROI is expressed as a percentage over a specific period of time [13]. Nevertheless, sometimes ROI can be incorrectly interpreted as a monetary value.

A general formula for ROI is the following:

$$2. \quad \text{ROI} = \frac{\text{Gain from investment - Investment}}{\text{Investment}}$$

Even though the formula above is entirely correct, it is a simple one. It is necessary to have more sophisticated variations of the classical definition of ROI for IT investments [14].

An alternative formula for ROI is to incorporate the TCO methodology which includes all costs, direct and indirect, incurred throughout the life cycle of an asset (e.g. hardware and software acquisition costs and maintenance). On the other hand, TBO, the opposite of TCO, includes all direct and indirect benefits (e.g. sales increase, cost reduction and costumer satisfaction) [15].

It is important to recognize that the TCO increases proportionally to the environment complexity. For example, the TCO will probably be higher in a multinational organization with multiple user types and different time zones, as opposed to a small-size organization with only one type of user [36].

The following formula represents a ROI/TCO approach that takes into account the cost of capital, as well as the TCO/TBO model:

$$3. \quad \text{ROI}(t) = \frac{\sum_{t=0}^{N} \frac{Benefits\ (t)}{(1+i)^t} - \sum_{t=0}^{N} \frac{Costs\ (t)}{(1+i)^t}}{\sum_{t=0}^{N} \frac{Costs\ (t)}{(1+i)^t}}$$

Legend:

t – Period of time

N – Length of the project

i – Weighted average cost of capital

The ROI formula above discounts future costs and benefits so as to express the return on investment in present-day currency terms. If the ROI is over zero percent, then the investment is profitable. Otherwise it is not.

The ROI advantages are [25], [28], [50], [54]:

- Provides finances and accounting practitioners with real cash numbers and it is their “language”.
- Estimating ROI is a good business practice because it is the first step in expectations and change management.
- It is easy to compute and excellent for one-to-one project comparison.
- Takes under consideration the weighted average cost of capital.
- Easy to interpret as ROI is a simple percentage.

And, the ROI disadvantages are [13], [27], [29], [30], [50]:

- ROI numbers do not ensure that IT initiatives are correctly aligned with business strategy.
- The aspects that are not considered in ROI/TCO calculations are the possible intangible benefits of buying a certain item.
- Like NPV, ROI does not state anything about the magnitude of the investment as the return value is a percentage over a certain period of time.
- This approach requires vendors to divulge information they traditionally consider confidential.
- ROI can only compare investments with the same level of risk, and two projects will probably not have an equal risk.
- Even though ROI indicates cash inflows and outflows, it fails to recognize when those cash flows occur.

The ROI should be recalculated over the investment’s life cycle — after approval, during and after implementation and rollout, because organizations must control the investment’s performance, as planned in the business case document, so as to check if the investment is rolling out as initial plan presented in the ROI/TCO calculation at the time of IT investment selection [40]. If the project is not meeting the initial budget, and if it looks as if the pattern of surprisingly high costs is going to continue, then CIOs have to make a decision about whether or not to shut down the project in order to prevent further losses [50].

Maybe the problem with ROI ineffectiveness is that on one side of the coin, CIOs need to have new IT systems implemented fast but without spending too much time calculating the project’s ROI. But, on the other side of the coin, CIOs are aware of the risk of IT investments and demand a precise enough measure that projects the risk, yield, and benefit of a project [31].

Internal Rate of Return

The IRR is the discount rate such that the NPV in a discounted cash flow analysis is zero. IRR is intimately connected to NPV as the profit tax calculated by IRR is the same as the discount tax that is necessary to apply to the benefits so as to the NPV being zero [13], [23].

Essentially, it shows the discount rate below which an investment results in a positive NPV, and therefore should be made, and above which an investment results in a negative NPV, and therefore

avoided. IRR is the 'break even' discount rate, the rate at which the value of cash outflows equals the value of cash inflows.

Usually organizations have a hurdle rate, which is the minimal rate of return that all investments must achieve. If the IRR exceeds the hurdle rate then the investment should be approved.

The following formula is a method of obtaining the IRR of an investment:

$$4. \qquad \text{IRR}\ (t) = \sum_{t=1}^{N} \frac{A_t}{(1 + IRR\ )^t}$$

Legend:

t – Period of time

N – Length of the project

A_t – Cash flow at the end of period t

IRR used to be calculated by trial-and-error which is an excessively lengthy process, but nowadays, with the help of spreadsheet programs (e.g. Excel spreadsheet), the IRR equation can be easily solved.

The IRR advantages are [13], [54]:

- Can be used to point out irregular annual profits of investments.
- It takes into consideration the capital's cost through time.
- Used as a go/no-go investment threshold.
- Based on cash-flows.

And, the IRR disadvantages are [13], [54]:

- Not as easy to compute (Excel uses approximations).
- It offers no magnitude for a project.
- Incorrectly assumes that the cash returned from an investment is reinvested at the same percentage rate.
- Hurdle rate varies from company to company.

PayBack Period

The PBP represents the length of time required for recovering the cost of an investment. Or, in other words, PBP is the time it takes for an investment to become cash flow positive. Moreover, depending on the size of the project the PBP is usually expressed in years or months.

The following equation is how one can calculate the PBP:

$$5. \qquad \text{PBP} = \frac{\text{Total cost of the project}}{\text{Annual cash inflows}}$$

A related number to PBP is the 'break even' point. The break even point represents the point at which costs and revenue are equal.

The PBP advantages are [54]:

- Demonstrates how much time it takes for an investment to become profitable.
- Provides a risk prediction by separating long-term projects from short-term ones.
- Can be a good methodology to pair up with ROI analysis.

And, the PBP disadvantages are [13], [23], [50]:

- Does not provide decision makers with useful information concerning the performance of an investment after the 'break even' point.
- Similarly to the other financial metrics, it suggests no magnitude for a project.
- Does not take into account the time value of money.
- Similarly to ROI, PBP fails to recognize when the cash flows take place.

Economic Value Added

EVA is a financial performance methodology used to calculate the true economic profit of an investment, based on the idea that an investment must cover both the operating and capital costs [32]. At its simplest, EVA looks to measure the effects that an investment will have on share value [13].

EVA is an important measure to IT when an IT investment requires capital expenditures. With IT accounting for more than half of the capital budget in the typical organization, putting the true cost of capital out of the decision-making process can lead to the incorrect decision being made [37].

The following formula depicts a method of obtaining the EVA of an investment:

$$\text{EVA} = \text{NOPAT} - (\text{Cost of Investment} \times \text{Cost of Capital}) \quad (6)$$

Legend:

NOPAT – Net Operating Profit After Taxes

For instance, organization Y just spent €30.000 on an IT investment (without taxes). The financial benefit of this investment (NOPAT) was €4.000, which results in a ROI of 13,3(3)%. Supposing the cost of capital of organization Y is 10%, the EVA is €1.000.

Another alternative is to subtract the cost of capital (10%) to the ROI (13,3(3)%), and multiply the output by the total capital invested (€30.000). This results in an EVA of approximately €1.000.

The EVA advantages are [13], [32], [34], [38], [50]:

- Gives CIOs the incentive to act like shareholders when making investment decisions so as to only invest when there is pure economic profit, simultaneously forcing CIOs to better explain the capital used to obtain the corresponding profit.
- May well be a better metric for organizations which their main asset is intellectual property, goodwill or marketing allure.
- Is a simplistic methodology and it is easy to understand its concept.
- Avoids the trap of focusing on accounting profit, which does not include cost of capital charges.
- Many organizations use EVA as a metric for determining management bonuses.

And, the EVA disadvantages are [13], [32], [34], [38], [37], [54]:

- It is not an ideal metric for organizations that are not publicly traded as it deals with variables like the cost of equity for shareholders, as opposed to debt capital. Also, EVA is assumes that maximizing shareholder value is the first financial objective of every organization.
- Is not suitable for high growth or/and technological organizations for which assets are intangible.
- Because stock prices are not predictable, EVA investment decisions are quite uncertain.
- Obtaining the cost of capital can be difficult as it varies from organization to organization.
- Value calculations are based upon other financial metrics.

Comparison

It is important to compare the five financial metrics that are discussed in this sub-section in terms of their main advantages and disadvantages, so as to identify which situations are more favourable to one financial metric in detriment of the others. The following table corresponds to the outcome of this comparison.

Table 2. Comparison between financial metrics.

Metrics	Advantages	Disadvantages
NPV	• Takes under consideration the discount rate.	• Does not give any indication about the project's magnitude and risk. • Discount rate can be hard to calculate.
ROI	• Perfect for one-to-one project comparison. • Commonly used. • Takes under consideration the cost of capital.	• Does not give any indication about the project's magnitude. • Requires vendors to share "sensible" information. • Can only compare project with the same level of risk. • Does not recognize when the cash flows take place.
IRR	• Identifies investments with irregular profits. • Takes under consideration the discount rate.	• Not easy to compute and understand. • Does not give any indication about the project's magnitude. • Assumes that the cash inflow from an investment is reinvested at the same discount rate. • Hurdle rate varies from company to company.
PBP	• Expresses the time it takes for an investment to reach the 'break even' point. • Separates, in terms of risk, long-term from short-term investments.	• Does not take under consideration the discount rate. • Does not give any indication about the project's magnitude. • No information about the investment performance after the 'breakeven' point. • Does not identify when the cash flows take
EVA	• CIOs analyze investment with shareholder's lens. • Easy to understand. • Simple methodology. • Calculation includes cost of capital charges.	• Cannot be used by organizations that are not publicly traded. • EVA is uncertain. • Cost of capital varies from organization to organization.

In summary, NPV, ROI and IRR should be used if CIOs want to understand how profitable an investment is. Likewise, EVA can also be used but only if the organization is publicly traded and the

share value is an important factor for executives (as it should be). The PBP metric is good to determine how long a project will take until it compensates the initial investment.

3.1.2 Risk analyses

Several of the risk analysis metrics are analyzed thoroughly and, at the end of this sub-section, an overall comparison is provided.

Sensitivity analyses

Two methods which can be used to assess the sensitivity of the expected ROI to changes in the variables entering a cost-benefit analysis are explained here.

The gross sensitivity analysis, also called variable-by-variable sensitivity analysis, reveals how sensitive the estimated ROI is to given changes in the considered variable. It is often useful to establish how large a change in a single variable is required to alter the sign of estimated ROI [72], [73].

The stress testing consists of making an analysis of the extremes by calculating the worst/best case scenarios. The baseline ROI is calculated by using expected values for all the variables used. Then, the ROI is recalculated by using, respectively, the smallest and the largest value for each of the variables [72], [73].

Monte Carlo simulation

Several probability and statistics concepts must be clarified before explaining what a Monte Carlo simulation is [73]:

- Variance: the sum of the square of the difference between the value and the mean for all values (the average of all generated outputs).
- Standard deviation: the square root of the variance which gives a measure to the dispersion around the mean of a distribution.
- Skewness: this measure is positive if a distribution has a longer right tail.

This type of risk analysis calculates the chances of success of the investment by using a normal distribution shape with a 95% confidence interval, which means that the probability that a value falls within 2σ (standard deviation) of the mean is 95%, so as to generate several scenarios through a random distribution of values, which belong to the area defined by the normal distribution curve [42], [73].

Furthermore, several variables can be included in the Monte Carlo simulation and correlated with each others. For example, if the correlation between two variables is null then the coefficient is zero, but if there is a perfect level of correlation between two variables then the coefficient is one. Figure 5 represents the level of correlation between two variables.

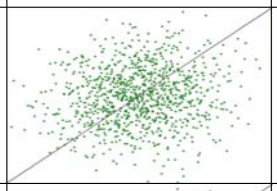
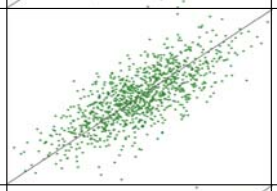
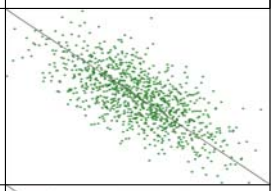
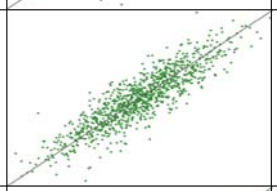
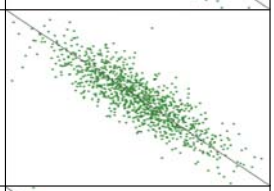
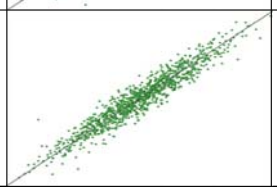
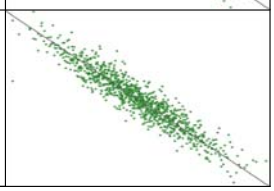
Level of correlation	r	Sample plot	r	Sample plot
None	0.00		-	-
Low	0.71		-0.71	
Medium	0.87		-0.87	
High	0.95		-0.95	

Fig. 5. Graphical representation of correlations [74].

If the level of correlation between two variables is high, independently of being a positive or negative *r*, there is more cohesion between the values assumed by the variables. On the other hand, if there is no correlation between two variables, the values are more dispersed in the Monte Carlo simulation.

Comparison

Performing risk analyses using a Monte Carlo simulation is less limitative than using stress testing or gross sensitivity analysis, because gross sensitivity analysis only changes the values of one variable at a time and stress testing places excessive weight on very unlikely outcomes [73], [74].

3.2 IT Investment Analyses

Since both IS and ITIL regard organizations/systems as people, processes and technology (a slight difference comparing to the Management Information System mantra: “organization, management and technology” [11]), an ITIL implementation can be considered an IS project. Another reason why ITIL and IS are akin is the organizational change that is associated to them, as both of them transform the organizations where they are implemented [11].

As a result, the value of ITIL implementations can be estimated by using IT investment analysis comprehensive approaches because, similarly to any IT investment, ITIL investments can be controlled and measured [33].

Therefore, it is crucial to assess the real business value of ITIL implementations, which means that CIOs have to quantify the tangible benefits (e.g. sales increase, incidents reduction, production increase and workforce reduction), as well as the intangible benefits (e.g. greater insight into the

relationship between users, configuration items and incidents and customer satisfaction). Even though intangible benefits are particularly difficult to quantify and measure, they definitely bring value to the organization, meaning that they must be part of the estimation process mentioned before.

For this reason, new methodologies that go beyond the traditional investment analysis, which are explained in the previous sub-section, are needed instead of focusing only on cost analysis and savings. Hence, focusing on intangible benefits as well [41].

However, the problem lays in the fact that CIOs must quantify these intangibles so as to give evidence that a certain investment will actually realize benefits for their organization. But, this is not an easy task, on the contrary [41], [43].

Nevertheless, some authors defend that it is indeed possible to measure anything or at least to reduce the uncertainty about the value of something, by making assumptions that can help reaching an estimated value, therefore defending that the value of intangibles is not so intangible after all [42], [50].

There are many different approaches and frameworks to manage the value of IT. Nonetheless, only two important approaches for managing IT investments, which represent reliable alternatives to current investment assessment methodologies, are described in the next two topics.

3.2.1 Benefits Management

In order for organizations to incorporate new IT services, significant investments in IT and simultaneous organizational change are required so that the benefits from those investments are actually realized. However, the benefits gained are not always proportional to the scale of the investments and, therefore, organizations are starting to focus on how to facilitate benefits realization [39].

The benefits management approach is one of the available solutions for this problem, because it organizes and manages IS investments so as to actually realize the potential benefits arising from the use of IT. In fact, the benefits management approach goes beyond the aspects of IS evaluation such as financial metrics. Instead, benefits management is a comprehensive process that includes several phases. Indeed, the benefits management approach encloses the beginning and end of project management and surrounds each project (see figure 6) [33].

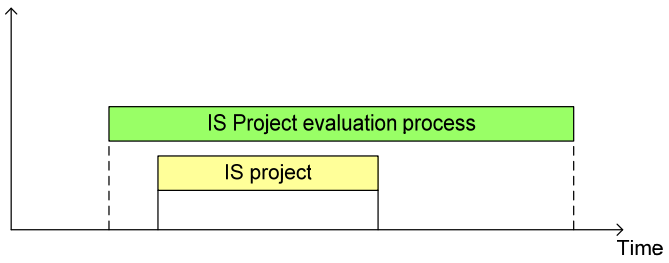


Fig. 6. Benefits management project duration [33].

Essentially, IS evaluation methodologies should be applied at all the phases of the benefits management process in order to realize the benefits [33].

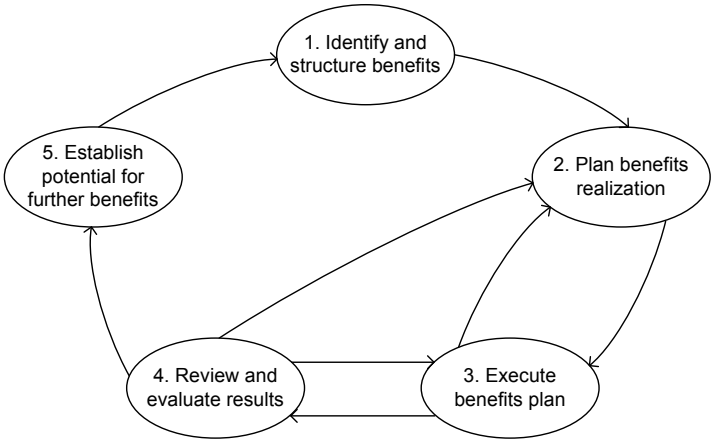


Fig. 7. A process model for benefits management [33].

The benefits management process is divided into five interrelated processes (see figure 7) [33]:

- **Identify and structure benefits**: in this initial phase the links between business drivers, objectives and benefits (tangible or intangible) are established and the dependencies between benefits and changes too.
- **Plan benefits realization**: during this phase ownership over benefits is given to a definite stakeholder, measures are distributed for all benefits (and, in some cases, estimates as well) which means that "many of the improvements can be quantified in advance, and, for some of them, the financial values can be calculated". Also, the business case is prepared and delivered for senior management approval (i.e. go/no-go decision).
- **Execute benefits plan**: this stage is responsible for implementing and monitoring the progress of the project against the activities and deliverables of the benefits plan. It is important to follow a project management approach (e.g. PRINCE2) that focuses on the deliverables.
- **Review and evaluate results**: the fourth phase is responsible for assessing if the objectives and benefits were or not achieved and appropriate actions are taken according to the results of this evaluation.
- **Establish potential for further benefits**: after evaluating the results, an appraisal must occur so as to understand what happened during the project, as well as to check if the benefits were actually realized and ultimately brought value to the business. New improvements to the IS are also suggested in this phase.

The advantages of the benefits management approach are:

- CIOs and executives are able to realize the benefits of a particular IT investment, bringing deep understanding of the business value that IT investments can provoke.
- Having the benefit of hindsight, this approach gives CIOs and executives the opportunity to make consistent and appropriate investment choices.
- If the organization embraces this methodology, the business and IT will become aligned.

And the disadvantages of the benefits management approach are:

- It is a process and has to be used in its full extension so as to be effective.

• Requires an organization to fully adapt to the benefits management process which can cause organizational resistance, and the learning curve is also an issue.

• Many organizations have difficulties to define all the benefits.

• Requires specialists to make this approach fit with the organization.

To put it briefly, the benefits management process enables organizations to avoid benefits 'loss' and increases the number of benefits achieved by IS/IT projects. However, it is hard to change employees' attitude to embrace the benefits management "mindset".

3.2.2 Val IT

The purpose of the Val IT and the benefits management approaches are similar as both were designed to monitor IT investments.

The Val IT is a governance framework that consists of a set of guiding principles that provide CIOs with sufficient know-how to correctly manage IT investments, so as to generate as much value as possible from IT investments [45], [47].

The Val IT framework extends and complements COBIT, which provides a comprehensive control framework for IT governance, by focusing on the investment decision and the realization of benefits parts. On the other hand, COBIT is responsible for the execution part of the IT governance framework [45].

The Val IT framework is divided into three interrelated major processes (see figure 8) [46], [47]:

• **Value Governance**: this process establishes governance, monitoring, and control, by providing linkages between investments and business strategy. Also, Value Governance defines investment portfolio variables such as: risk tolerance and hurdle rates.

• **Portfolio Management**: this process identifies and maintains resource profiles, defines investment thresholds, and is responsible for the evaluation of investments. Also, it manages the overall portfolio, and monitors and reports on portfolio performance.

• **Investment Management**: finally, this process is responsible for identifying business requirements, analyzing alternatives, documenting business cases for programs, assigning ownership, manage programs during their entire life cycle, and monitoring program performance.

Fig. 8. Val IT domains.

The Val IT advantages are [46], [47], [48]:

• Active value management.

• Initiatives evaluation is not too narrow, as Val IT business cases have to be very detailed and continually updated throughout the life cycle of an investment, so as to support the ongoing implementation and execution of a project.

And, the Val IT disadvantages are [46], [47], [48]:

• Despite the availability of guidelines and case studies, few CIOs have adopted Val IT so far.

- Governance practices like reporting are very difficult to implement.
- Val IT requires a mature IT governance framework already in place.

3.3 Conclusion

This section tests against each other all the approaches what are discussed in the previous sections: benefits management and Val IT approaches and financial metrics. It is important to compare them in terms of their foremost advantages and disadvantages. The following table compares the three approaches:

Table 3. Comparison between investment evaluation approaches.

Metrics	Advantages	Disadvantages
Investment Analyses	• Executives value financial metrics. • Compares projects using their economic value as measure. • Easy to calculate. • In turbulent times, organizations give more importance to ROI analyses in order to invest more prudently. So, any project without one is simply waiting for disapproval. • Monte Carlo simulations are usually considered as a valuable extension of cost-benefit analyses.	• Inability to quantify the value of IS projects of strategic nature (difficult to quantify intangible benefits). • A majority of CIOs does not know how to apply these metrics.
Benefits Management	• CIOs are able to realize the benefits of IS investments. • Decision-making will be well-informed after the benefits management approach is accepted extensively. • IT and business become aligned. • Very detailed business cases.	• Creates organizational resistance. • Takes a long time to be effective. • Requires specialists to help with the change management process. • It is ineffective if not used in its full extension. • Not all benefits will be perceived.
Val IT	• Active value management. • Very detailed business cases. • IT and business become aligned. • It is an extension of COBIT.	• Requires a mature IT governance framework to be in operation. • Not widely adopted so far. • Difficult to implement.

Both Val IT and benefits management approaches have a longer learning curve than general investment analyses. However, they have the advantage of being comprehensive processes and realizing both tangible and intangible benefits. Therefore, they can bring more long-term added value to

the organization when comparing to general investment analyses, although organizational resistance can become a tough barrier to overcome.

On the other hand, considering the current financial crisis and, consequently, the IT budget cuts, it is more than ever necessary to economically justify IT investments using financial metrics.

Independent of which approach is chosen, each ITIL process has its own list of tangible and intangible benefits specified in one of the five ITIL v3 books, and in order to assess the value of ITIL implementations these benefits have to be measured, but without forgetting that other variables influence the business value of the investment, for example: current maturity level of each ITIL process and dependencies between ITIL processes as well.

In conclusion, the two topics studied in this section do not constitute a satisfactory solution for the thesis' problem, because they are not prepared to make an accurate estimation of the value of ITIL implementations, as ITIL implementations involve multiple complex variables specific to ITIL which must be regarded. Nonetheless, these two approaches do provide essential insight and background for the conception of the estimation process that is described in the following section.

4. Proposal

After making a bibliographic research about general and IT-specific investment evaluation methodologies, the next logical step is to propose a solution for the thesis' problem that is described thoroughly in section 2.

This section includes a clarification of the context in which the thesis' proposal is built, a short review of the assumptions that have to be considered in order to come up with a well-designed estimation process, two general use cases where the estimation process is used, and a detailed explanation of the estimation process itself.

4.1 Context

Accenture, a multinational consultancy and services firm, has given the necessary physical and logistic support for the completion of this research work.

It is very important to be aware of the fact that Accenture has developed an ITIL maturity assessment tool, and the estimation process, which may be referred to as ITIL Value Estimator, may be integrated into its core.

Moreover, a simpler version of the ITIL Value Estimator could be a potential follow-up since one of Accenture's main goals is to encourage its clients to perform an ITIL maturity assessment (by using the ITIL maturity assessment tool mentioned previously), even though the estimator's accuracy is worse than in the non-simplified version.

Since the ITIL Value Estimator might be integrated in Accenture's portfolio of investment assessment tools, it is applicable to Accenture's clients. Therefore, the "action research" practitioners that have to be considered are typically large-size companies in diverse business areas, whether they are part of the private or public sector.

4.2 Assumptions

Given the context described in the previous sub-section, the following assumptions must be considered when designing the estimation process:

- The ITIL Value Estimator is handled by trained, calibrated and experienced consultants [42].
- The ITIL Value Estimator is supposed to be used during meetings with clients' practitioners which usually take place at the clients' workplace.
- Client data is available.
- Consultants' selection of opportunities is correct, meaning that consultants include in the estimation process only the correct selection of ITIL processes that will be implemented.

It is necessary to understand that the user's calibration has a great influence in the quality of the results produced by the ITIL Value Estimator, as well as the reliability of the client data. Even though these risks can be mitigated, they cannot be fully avoided.

4.3 Use Cases

Using the assumptions described in the previous sub-section, it is helpful to design high-level use cases and explain their respective scenarios so as to further understand in which situations the ITIL Value Estimator is used.

4.3.1 ITIL Maturity Survey Request

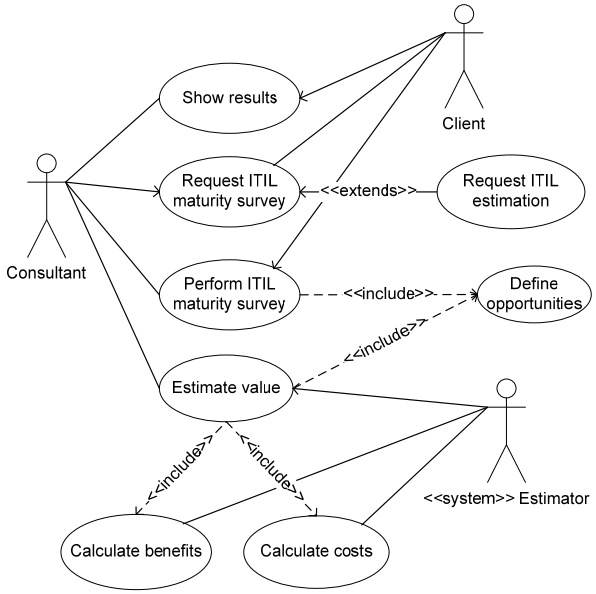


Fig. 9. ITIL maturity survey (including ITIL value estimation) request.

The client requests the consultant to perform an ITIL maturity survey as well as an additional ITIL value estimation. The consultant attends the request and performs an ITIL maturity survey, which includes defining the opportunities for this particular client (i.e. which ITIL processes should be implemented). Then, the consultant triggers the estimation process by inputting the client data into the ITIL Value Estimator. As a result, the benefits and costs for the given set of opportunities are calculated by the ITIL Value Estimator. In the end, the consultant presents the final results to the client.

4.3.2 ITIL Value Estimation Request

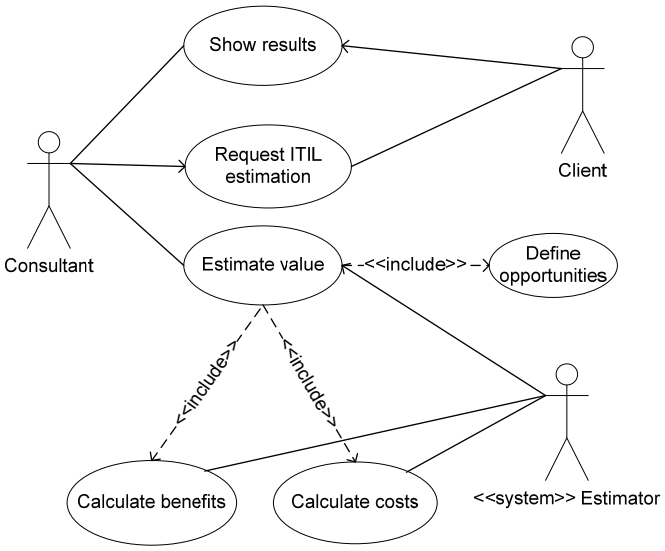


Fig. 10. ITIL value estimation request.

The client requests an ITIL value estimation to the consultant, who promptly replies affirmatively. Then, the consultant defines what the opportunities are and triggers the ITIL Value Estimator by inputting the corresponding client data. After that, the ITIL Value Estimator reacts and computes the benefits and costs of the investment, which are then presented to the client by the consultant.

4.4 Estimation Process Overview

In order to perform a cost benefit analysis, three actions should be included in the estimation process: determine the tangible and intangible benefits in addition to the project's costs, which embody the tangibility return of an investment [55], and determine the NPV. Subsequently, an additional sensitivity analysis should be included as the previous variables are not deterministic and, therefore, are subjected to risks and uncertainty [65], [72]. Even though managers and executives tend to be risk averse, they should be concerned about variability and include risk and uncertainty in cost benefit analyses [72]. Therefore, a sensitivity analysis, which assesses how the deviation of the output of the model can be apportioned to different causes of variation in the input variables that enter the cost benefit analysis, has to be included in the estimation process.

In this research work, these steps are used with an exception. Instead of only determining the NPV, the calculation of the ROI, PBP and IRR is also included in the cost benefit analysis because they can be easily interpreted and are common financial metrics used by managers, as it is explained in section 3. On the other hand, the EVA, which is described in sub-section 3.1.1, is not included in the estimation process as it takes the "net operating profits after taxes" as input, which is a difficult variable to assess in the context of this research work. Also, the sensitivity analysis is performed over the ROI instead of the NPV because managers tend to value more this financial metric.

These insights are used to build a proposal which is an estimation process constituted by several sequential steps, which are further described in section 4.5.

4.5 Estimation Process Description

The business process modelling notation (BPMN) was used in order to describe the estimation process. Figure 11 represents the estimation process.

The following points explain each activity and sub-process in more detail.

- **Choose the processes**: the start event leads to the first activity of the process which is performed by the consultant. In this activity, the consultant determines which ITIL processes will be implemented. If a maturity survey occurs beforehand, the opportunities selection will be a lot more accurate because the consultant has more precise information about each ITIL process's maturity. Nevertheless, as it is made clear by the "ITIL value estimation request" use case (see 4.3.2) the ITIL maturity survey artefact is an optional input.
- **Choose the project's risk level**: the consultant chooses the project's risk level based on a risk analysis, which impacts greatly the benefits quantification process and investment analysis further ahead. The higher the risk is, the lower the benefits will be, and the investment is influenced as well, i.e. the higher the risk is, the higher the value of the investment will be. So, there is a downward revision of the benefits and an upward revision of the investment value, which is done on ad-hoc basis, for instance: by decreasing 10% of the benefits and increasing 10% of the value of the investment [72].
- **Input general client data**: the consultant inputs general client data, for example: the organisation's revenue, number of employees and working hours per year.
- **Quantify benefits**: "prior to implementing any process improvement initiative, processes should be measured and if possible assigned a monetary value" [64]. Therefore, in this sub-process the benefits are quantified by analyzing the general client data gathered in the previous activity, as well as data specific to each process, for example: the total number of incidents, estimated average time lost in an incident per employee, etc. This sub-process is further explained in 4.5.1.
- **Compute total benefits**: the benefits are automatically quantified by the ITIL Value Estimator through the analysis of the data that is inserted in the "quantify benefits" sub-process.
- **More processes?**: this gateway consists of a decision-making point. If at least one process, from the ones that were chosen in the first activity of the estimation process, has not been processed yet, then the next phase is to analyze the next process on the waiting list. Otherwise, the next phase is to quantify the project's costs.
- **Quantify costs**: after all the processes have been analysed, the project's costs have to be quantified, which include assessing the monetary value of some of the following costs: hardware, software, training, IT consultants, and internal IT staff labour [64]. Accenture possesses efficient tools to do this, which means that there is no reason to focus on quantifying the costs of the investment. This sub-process is further explained in 4.5.2.
- **Perform investment analysis**: using the data gathered in the previous two activities, a financial analysis is made in order to assess the NPV, PBP and IRR of the investment, which are further explained in 3.1.1. These values constitute the investment analysis report depicted as the output artefact of this activity.

• **Select number of trials to run**: in this activity the consultant selects how many scenarios will be used to perform a Monte Carlo simulation.

• **Correlate variables**: because some variables are correlated to others, i.e. “the state of one variable gives us the information about the likely occurrence of another” [74], it is important not to ignore the correlations that exist between variables. Therefore, the consultant has to define the correlation coefficients between all the variables that enter the sensitivity analysis.

• **Perform Monte Carlo simulation**: to finalize the estimation process, a Monte Carlo simulation on the project’s ROI is performed. However, discovering the estimated ROI by using the expected values for the project’s benefits and costs is generally incorrect because of non-linearity between the variables (i.e. they are correlated). In order for the ITIL Value Estimator to be more precise and, therefore, more reliable, it is important to perform a Monte Carlo simulation since it is mathematically correct if the chosen distributions for the variables are correct. According to the “central limit theorem”, since the ROI results from the sum of several variables, there are strong arguments for choosing a normal distribution.

The chance that the investment will compensate is calculated by counting the number of scenarios in which the user-defined breakeven line is reached. This activity is comparable to the certainty revenue which is one of the characteristics of an investment [55].

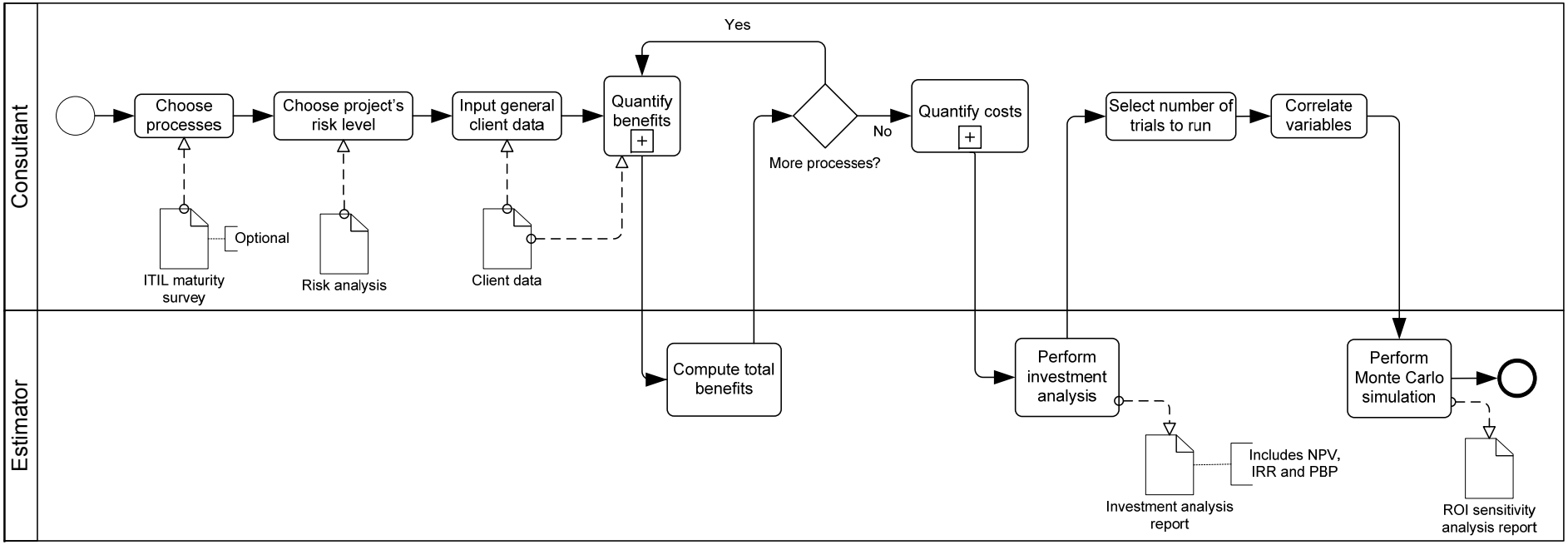


Fig. 11. ITIL value estimation process.

4.5.1 Benefits quantification process

This sub-process is constituted by four activities as it is illustrated in figure 12.

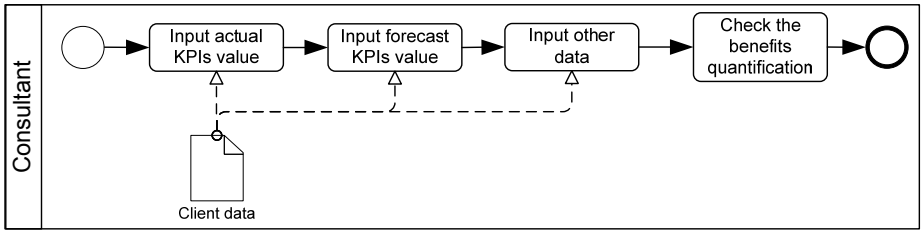


Fig. 12. Benefits quantification sub-process.

The first activity is for the consultant to input the actual KPIs value into the ITIL Value Estimator as well as the forecast values considered to be more adequate by the consultant. Finally, other data besides the KPIs is inserted in the necessary fields and the logic behind the benefits quantification has to be checked by the consultant.

4.5.2 Costs quantification process

This sub-process, pictured in figure 13, requires the consultant to define the discount rate and the percentage of operating costs that come from the investment over the years and the value of the investment, so as to determine the project's costs.

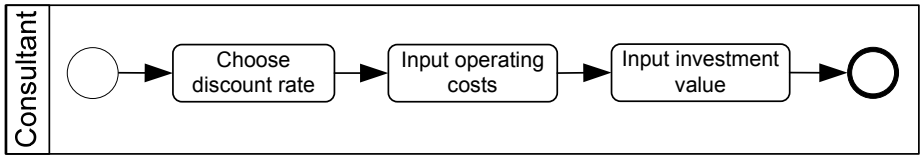


Fig. 13. Cost quantification sub-process.

4.5.3 Structure

Figure 14 zooms in part of the ITIL Value Estimator's structure which is relevant to further understand the estimation process' built-in logic.

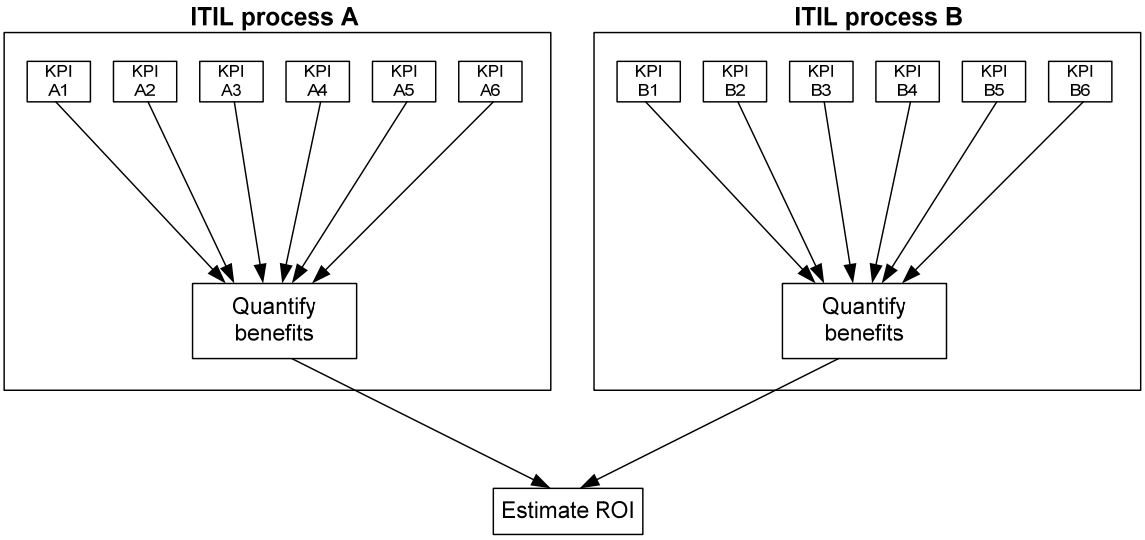


Fig. 14. Estimator's structure in more detail.

The KPIs are related to each other in the sense that they contribute to the calculation the benefits of the process they belong to, and the benefits quantification of all processes considered are then consolidated into a final ROI estimation.

5. Implementation

This section describes the employment of a prototype which supports the estimation process that is described in the previous section.

Some details concerning the prototype and its evaluation methodology, which is used to simulate the prototype's behaviour against simulated and real data, are explained so that the value of ITIL can be assessed.

Finally, the prototype's outcomes are used in order to further evaluate the estimation process in the next section.

The following sub-sections go through each one of these topics.

5.1 Prototype

It is important to mention that the prototype is not tailored to a specific organization; instead, it can be applied to any organization as the estimation process is independent of the organizational context.

The technology that was used to implement the proposed model is Excel™ 2003 in order to address all the requirements specified in 5.1.1, more specifically those concerning data input and results retrieval speediness, portability and changeability.

5.1.1 Requirements

In order to guarantee that the prototype is a successful endeavour, the following requirements must be satisfied:

- The estimator's outcome should be as **accurate** as possible.
- The collection of metrics, which are part of the benefits quantification sub-process, should be as **complete** as possible.
- All the calculations should be **correct** and **valid**.
- It should be **easy to use and to input client data** which is essential to trigger the estimation process.
- All calculations should be **configurable** so as to be adapted to each client's specificities.
- The estimator should be **modifiable** so as to include new ITIL processes or/and new metrics.
- The prototype should be **portable** as it is supposed to be used during meetings with clients which usually take place at the clients' headquarters.

Thus, if the previous requirements are met, the quality of the prototype is expected to be guaranteed.

5.1.2 Architecture

According to [76], the module view-type is commonly used to document the principal units of implementation of a system according to the pre-defined requirements. As figure 15 implies, the

prototype's architecture contains three layers: the presentation layer, the application logic layer and the addIns layer.

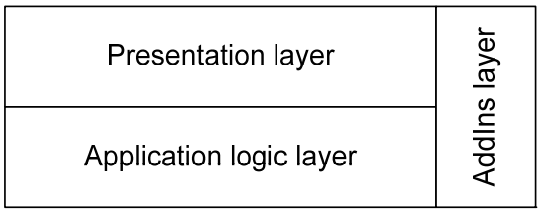


Fig. 15. Architecture layered overview.

Presentation Layer

Figure 16 depicts the use relations that exist between the different modules of the presentation layer.

The data input control module is responsible for controlling the user's input, and the data validation module depends on the data input control module as it can only validate cells that the user has access to. These two modules exist so as to prevent Excel formulas and macros from not working just because the input data is not in the correct format.

The data collection module uses the data input control module so as to realize which cells are accessible to the user. At last, the data generation module uses the data collection module because it needs collected data in order to produce other information/data.

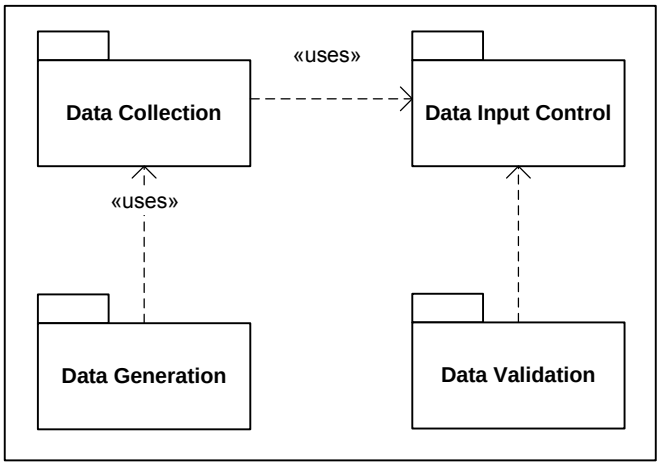


Fig. 16. Presentation layer.

Business Logic Layer

The business logic layer is represented by four interrelated modules as pictured in figure 17.

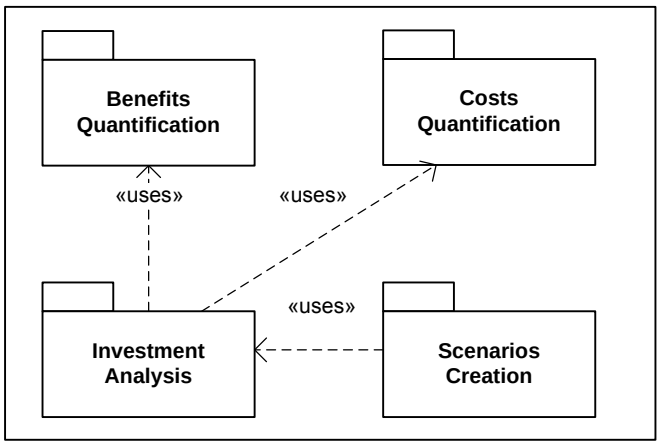


Fig. 17. Application logic layer.

The benefits and costs quantification modules are both used by the investment analysis module as it is necessary to identify the monetary value of the project's benefits and costs before the investment analysis takes place. In turn, the scenarios creation module, which is responsible for executing the Monte Carlo simulation, uses the investment analysis module because it needs its output information.

As it is possible to observe in figure 18, the modules of the application logic layer use the data generation and collection modules, which are included in the presentation layer, because it is necessary to present the results generated by the application logic layer's modules.

Both the scenarios creation and data generation modules use the analysis toolpak addIn as they need it to run the Monte Carlo simulation and create histograms and other type of information. It could be the case that an addIn software is sufficiently powerful to replace the scenarios creation module, for example: Palisade's @Risk [79] and Oracle's Crystal Ball [80] addIns for Excel are powerful tools that allow the user to make detailed Monte Carlo simulations.

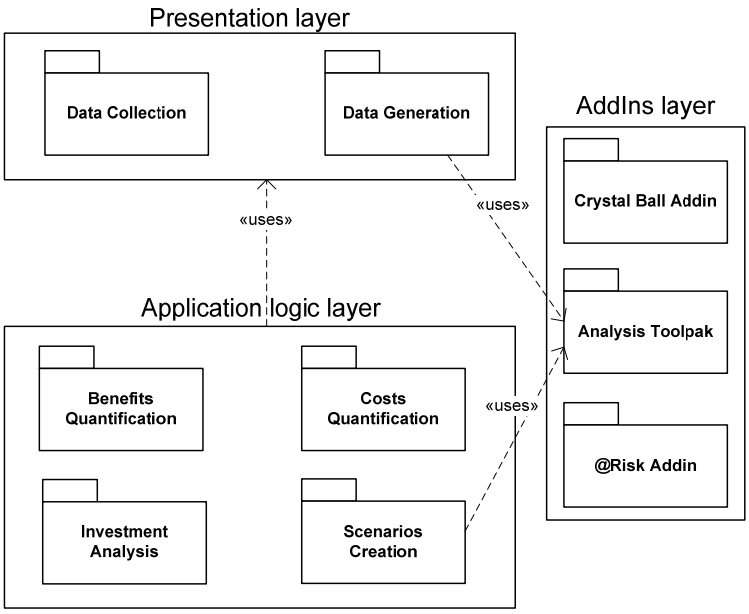


Fig. 18. Use relations between layers.

5.1.3 Development Process

Only one action research cycle was completed in this research work. However, several sub-cycles occurred between the action planning phase and action taking phase. This innovative adaptation of the action research cycle is pictured in figure 19, and the estimator's implementation phase is included in the action taking phase.

The prototype's construction evolved at the same time as the development of the estimation process did, which was the result of several interactions (i.e. meetings) with practitioners, insights from ITIL experts, and contributions that were introduced as a consequence of further scientific investigation.

Therefore, the action research cycle was adapted and transformed into a more "agile" one.

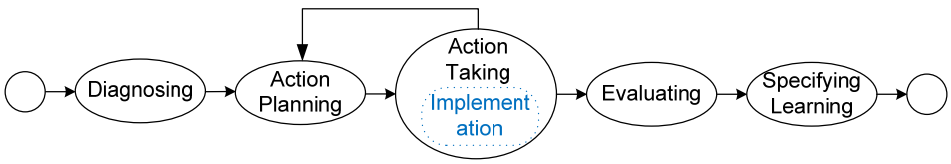


Fig. 19. Modified "action research" cycle.

Having in mind the sub-cycle depicted in figure 19, three main iterations took place between the action planning and action taking phases:

1. In the **first iteration** the KPIs forecast values were automatically estimated, which created a complex problem that was detected by an ITIL expert: the way the forecast values of the KPIs were estimated depended on so many variables (e.g. maturity, business area, size of the organization, etc) that the

2. In the **second iteration**, the "garbage in, garbage out" problem detected was solved by forcing the user to predict the forecast values of the KPIs. In this iteration, the investment analysis module was included into the estimation process, which means that the NPV, IRR and PBP started to be calculated. The risk factor was also introduced into the estimation process, which ultimately influenced the investment analysis activity in an ad-hoc form: a downward revision of the benefits implies an upward revision of the costs, and vice-versa.

3. In the **third iteration**, the scenarios creation module was substituted by the Crystal ball addIn, which facilitated the retrieval of graphics and tables containing important information regarding the outcome of the Monte Carlo simulation. Finally, correlations between benefits and costs and amongst benefits were added to the estimation process.

5.1.4 Graphical Interface

The presentation sheet of the ITIL Value Estimator is shown on figure 20.

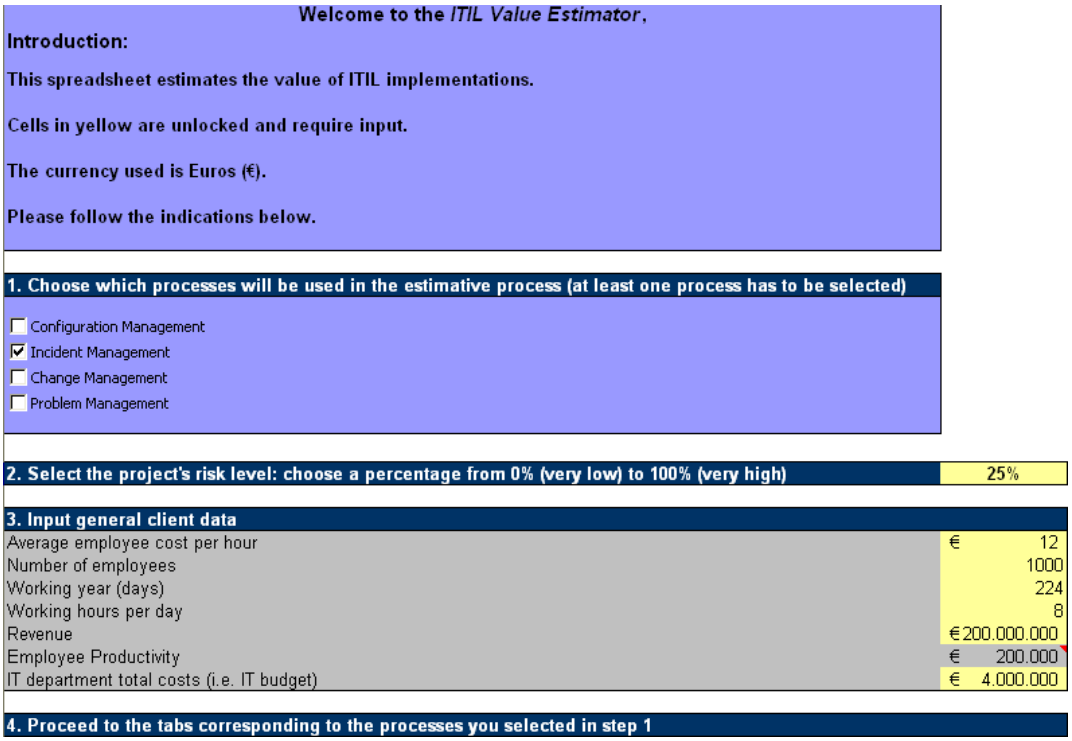


Fig. 20. Snapshot of the ITIL Value Estimator presentation sheet.

Figures 21 and 22 represent the "Incident management" tab where the consultant must input data.

5. Insert the KPIs' actual and forecast values		
KPIs		
Efficiency (internal)	As-is (actual)	To-be (forecast)
Percentage of incidents resolved without breaching one SLA	0%	80%
Percentage of incidents re-assigned	70%	20%
Percentage of incidents incorrectly categorized	100%	59%
Percentage of calls 1st line support bypassed	50%	3%
Percentage of proactively solved incidents	0%	3%
Incident management process maturity	1	2
Effectiveness (external)		
Number of incidents	20000	11200
Percentage of incidents resolved by 1st line support	65%	80%
Average call time with no escalation (minutes)	5	3
Percentage of incidents incorrectly assigned	35%	15%
Average time for 2nd level support to respond (minutes)	60	30
Average time to resolve incidents (minutes)	80	40
Percentage of calls that are service requests	50%	80%
Percentage of incidents solved rightly the first time	70%	97%
Customer satisfaction	3	5

Fig. 21. KPIs list overview.

In figure 21, the consultant has to input the actual values of the KPIs relative to the incident management process as well as the future <values they will assume. The forecast values should be discussed with experts and practitioner so as to reach the best estimation possible.

Figure 22 represents the benefits quantification sub-process. It is important to notice that several assumptions are made in this step.

BENEFITS QUANTIFICATION		
Efficiency		
Percentage of incidents resolved without breaching one SLA		
Percentage of incidents resolved without breaching one SLA (as-is)		0%
Percentage of incidents resolved without breaching one SLA (to-be)		80%
Number of incidents resolved without breaching one SLA (as-is)		0
Number of incidents resolved without breaching one SLA (to-be)		8960
Average cost of breaching one SLA	€	100
Total gains	€	**896.000**
Percentage of incidents re-assigned		
Percentage of incidents incorrectly categorized		
Percentage of calls 1st line support bypassed		
Percentage of proactively solved incidents		
Incident management process maturity		
Effectiveness		
Number of incidents		
Number of incidents (as-is)		20000
Number of incidents (to-be)		11200
Percentage of level 5 incidents (as-is)		30%
Percentage of level 4 incidents (as-is)		25%
Percentage of level 3 incidents (as-is)		20%
Percentage of level 2 incidents (as-is)		15%
Percentage of level 1 incidents (as-is)		10%
Percentage of level 5 incidents (to-be)		20%
Percentage of level 4 incidents (to-be)		20%
Percentage of level 3 incidents (to-be)		15%
Percentage of level 2 incidents (to-be)		20%
Percentage of level 1 incidents (to-be)		25%
Average cost of a level 5 incident	€	600
Average cost of a level 4 incident	€	300
Average cost of a level 3 incident	€	100
Average cost of a level 2 incident	€	50
Average cost of a level 1 incident	€	20
Incidents cost as-is	€	5.690.000
Incidents cost to-be	€	2.352.000
Total savings	€	**3.338.000**
Percentage of incidents resolved by 1st Line Support		
Average call time with no escalation (minutes)		
Percentage of incidents incorrectly assigned		
Average time for 2nd level support to respond (minutes)		
Average time to resolve incidents (minutes)		
Percentage of calls that are service requests		
Percentage of incidents solved rightly the first time		
Customer satisfaction		
TOTAL	€	**4.554.604**

Fig. 22. Incident management process' benefits quantification.

Figure 23 illustrates the investment analysis sheet.

7. Insert the discount rate, the investment, and the % of operating costs from the investment

Discount rate	10%
Investment	€ 68.000
Operating costs (% of the original investment)	20%

	Setup	Year 1	Year 2	Year 3
Benefits	€ -	€ 1.138.651	€ 1.138.651	€ 1.138.651
Incident Mngm.	€ -	€ 1.138.651	€ 1.138.651	€ 1.138.651
Investment	€ 85.000	€ -	€ -	€ -
Operating Costs	€ -	€ 17.000	€ 17.000	€ 17.000
Net Annual Benefits	€ (85.000)	€ 1.121.651	€ 1.121.651	€ 1.121.651
Cumulative Benefits	€ (85.000)	€ 1.036.651	€ 2.158.302	€ 3.279.953
NPV	€ 2.704.380			
IRR	1319%			
PBP (years)	0,12			

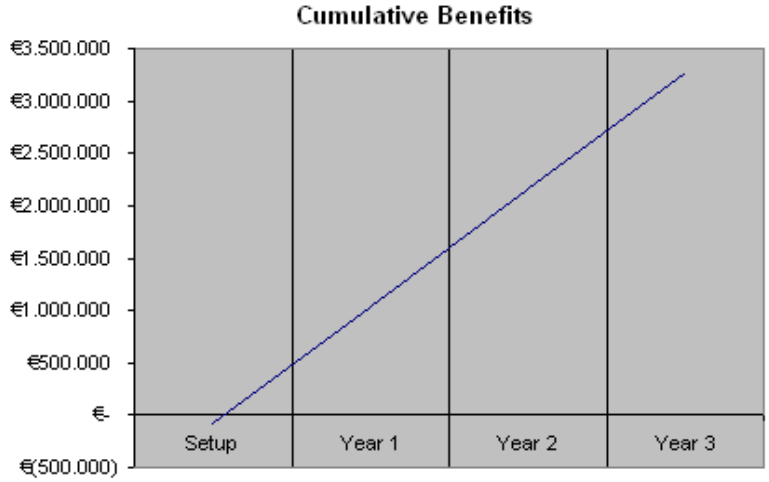


Fig. 23. Investment analysis sheet.

At last, figure 24 shows the results of the Monte Carlo simulation results. The Monte Carlo results are achieved by using the Crystal Ball addIn mentioned earlier.

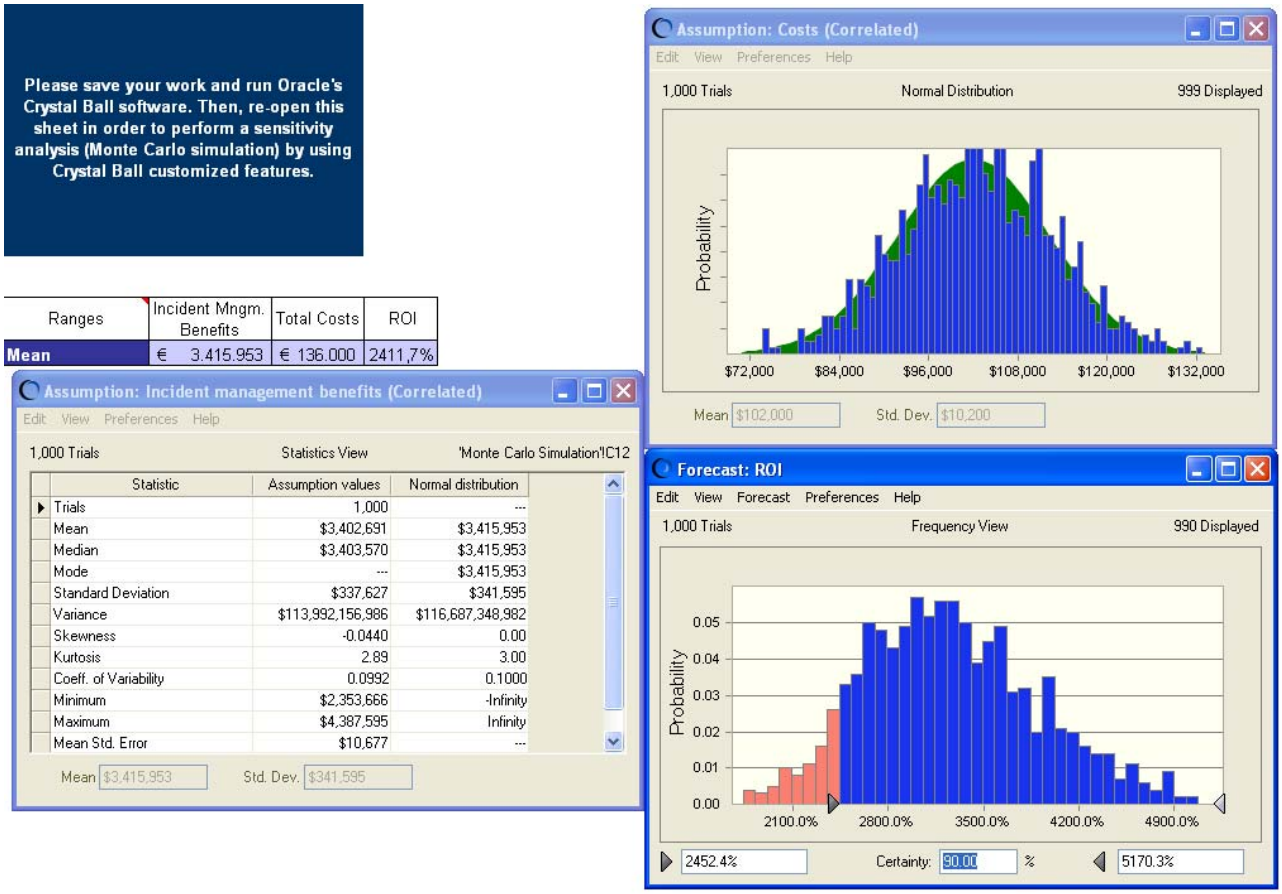


Fig. 24. Monte Carlo simulation.

5.1.5 AddIns Required

There are several Monte Carlo addIns available for Excel which simplify the generation of graphics and comprehensible tables.

Unless a more comprehensive Monte Carlo addIn for Excel, such as Crystal Ball, is utilized, the "Analysis ToolPak" addin is absolutely necessary since without it the Monte Carlo simulation cannot be executed.

5.1.6 Benefits Quantification Synopsis

Quantifying the benefits of one or several processes is one of the most important activities included in the estimation process. For this reason, the KPIs used in the estimation process are defined in [62] and reviewed by certified consultants and/or ITIL experts. Finally, the KPIs' values are automatically added to the total monetary value of the process.

As in any estimation, there are always compromises and assumptions that must be considered, for instance: the percentage of time that affects the employee productivity can vary from KPI to KPI, which means that it takes a skilled expert (together with the practitioner's assistance) to determine what the correct values should be.

The quantification of the value of each KPI is the result of human reasoning. This means that the prototype must be prepared to accept modifications to the benefits quantification sub-process, in order to be easily adapted to the user's raison d'être.

Finally, the logic of the benefits quantification sub-process can always be challenged because it is hard to give each KPI a monetary value, despite the fact that they still can bring value to the process under analysis, as ITIL can be a business need, for instance: clients can demand suppliers to have ITIL best practices embedded into their organization, or the IT department can be pressured to support efficiently and effectively the launch of new products in order to keep the organization competitive [75]. These examples support the statement that an improvement in the ITIL maturity of one or more processes or the savings gained from improved KPI values, which are typically hard to quantify, bring value to the bottom-line of the organization and, therefore, must be considered.

5.2 Evaluation Methodology

The evaluation mechanisms for the prototype, which are applied during the "action taking" phase, are explained next. Furthermore, the evaluation methods by which prototype's requirements are evaluated are clarified as well.

5.2.1 Evaluation methodology for one process

The evaluation methodology varies according to two distinct situations: when only one process is considered for the estimation process or when multiple processes are considered.

Several questions have to be answered in order to evaluate one process:

- Which metrics are the most relevant during the benefits quantification sub-process?
- Is the logic of the KPIs challenged by the practitioner or ITIL experts?
- Until what point is risk consequential?
- Do the correlations between variables affect the result? How?

5.2.2 Evaluation methodology for multiple processes

The main difference to 5.2.1 is the fact that correlations between the processes' benefits have to be contemplated when multiple processes are considered.

Indeed, the evaluation methodology for several processes is focused on the consequences that derive from the dependencies that exist between processes and, consequently, the benefits adjacent to the correlation coefficients attached to these dependencies.

5.2.3 Requirements evaluation

Besides making distinctions between evaluation methodologies for one or several processes, it is necessary to evaluate the prototype so as to verify it against the proposed requirements (see section 5.1.1).

Effectiveness

The effectiveness of the estimation process' outcome is tested by using a hybrid form of the back-testing technique, which offers perception regarding how successful the estimator's outcome has performed in the past [61]. Indeed, it is a hybrid form of back-testing because the back-testing technique is adapted to the thesis' context, despite being a widely known strategy used for market trend forecasting purposes [61].

In order to determine the **real value** of one or more processes it is necessary to retrieve reliable data directly from historical data and introduce it into the prototype, in order to perform the investment analysis as well as the Monte Carlo simulation.

The **estimated value** of one or more processes is calculated by introducing input data regarding the forecast values of the KPIs and other data, which were determined by the practitioner.

So, in this way it is possible to compare the estimator's effectiveness in a past project by comparing that project's real value and estimated value.

Completeness

The fact that the KPIs included in the prototype are published in trustworthy ITIL and IT Service Management sources which contain KPIs' listings [62], [63], along with the same KPIs being verified by ITIL experts as well as the practitioner, makes the estimation process a more complete one.

Correctness

The accuracy of the estimator's outcome gives an indication whether the estimator's logic is more or less correct. Nevertheless, the correctness of the prototype is verified and improved theoretically and as a result of meetings with ITIL experts and practitioners.

Usability

The estimator's usability is evaluated through the observation of consultants completing several tasks, in order to measure how well they perform the tasks (e.g. time it takes to complete a ITIL value estimation for three processes).

This requirement cannot be fully evaluated in the context of this thesis since the prototype is not to be used by Accenture's consultants without further testing. However, some comments and insights received from Accenture's consultants as well as ITIL experts can be used to improve the estimator's usability.

Configurability

The estimator's configurability is evaluated through the observation of users completing several tasks with different data, i.e. estimating the value of ITIL implementations for organizations in different contexts.

This requirement can be tested during meetings with client's practitioners and/or ITIL experts, where the KPIs are actively challenged and modified accordingly.

Modifiability

One interesting property of the prototype's structure is that cohesion is always kept between the different KPIs as they are related to each other, and belong to the same ITIL process. However, because this cohesion is associated with the coupling of the benefits quantification outcomes, which result from all the ITIL processes that are considered for a given project, the prototype is easily modifiable [56]. This property can be deduced from figure 14.

Portability

Portability is already guaranteed due to the fact that the prototype was developed in Excel, which means that the tool is easy to "carry" and to install as Accenture's clients usually have Excel software installed in their own offices.

To sum up, it is necessary to evaluate only five out of the seven requirements described here as the modifiability aspect is theoretically guaranteed, and the portability aspect is assured because the prototype was built using Excel.

5.3 Action

In order to evaluate the situation described in 5.2.1, a simulation using real KPIs' data was performed in a state/public organization – Turismo de Portugal (TdP), which implemented the incident management process for a period of one year.

Moreover, the situation described in 5.2.2 was simulated for several processes so as to evaluate the value of the correlations that exist between them.

This section is dedicated to presenting the variables and assumptions that were used to simulate these two distinct situations.

5.3.1 Common data

The data shown in table 4 was supplied by TdP or derived from variables that were collected from reliable sources.

The average employee cost per hour was calculated by using the following formula:

7. $$AvgEmpCost\ Hour = \frac{CountryEmp\ Cost}{(CountryNum\ Emp \times AvgWorkDay\ sYear \times AvgWorkHou\ rsDay)}$$

Legend:

AvgEmpCostHour – Average employee cost per hour

CountryEmpCost – Total country employee costs

CountryNumEmp – Total country number of employees

AvgWorkDaysYear – Average working days per year

AvgWorkHoursDay – Average working hours per day

The CountryEmpCost and CountryNumEmp were both retrieved from Portugal's INE [81]. The revenue of TdP complies with the Portuguese national standards [82] for an organization with more than one thousand employees, and the IT department budget was defined as 2% according to TdP's practitioner.

Finally, quantifying the average employee productivity is typically done by measuring the employees' performance, which can be captured by analysing productivity metrics. But, in order for this to happen, comprehensive methodologies usually have to be applied and that is not the case at TdP. So, after reaching a compromise with the practitioner, the employee productivity was defined as the total revenue divided by the number of employees.

Table 4. TdP's general data.

Average employee cost per hour	€ 12
Number of employees	1000
Working year (days)	224
Working hours per day	8
Revenue	€ 200.000.000
Employee Productivity	€ 200.000
IT department total costs (i.e. IT budget)	€ 4.000.000

5.3.2 Data used in the incident management process simulation

Because of the "agile" interaction with TdP's practitioner, some errors in the benefits quantification process were detected and new ways of quantifying the benefits, which forced several modifications to the KPIs' logic itself, were also proposed.

Those variables for which it was not possible to give a real value were used in order to realize the estimated value of the incident management process. The same applies to the variables for which no estimated value was available.

Table 5 includes the KPI's values concerning TdP's incident management process and the time span is year-wise.

Table 5. KPIs' values.

Efficiency	**As-Was**	**Estimated value**	**Real value**
Percentage of incidents resolved without breaching one SLA	0%	N/A	80%
Percentage of incidents resolved within target time by priority	0%	80%	N/A
Percentage of incidents re-assigned	70%	20%	20%
Percentage of incidents incorrectly categorized [1]	100%	20%	59%
Percentage of calls 1st line support bypassed	50%	10%	3%
Percentage of proactively solved incidents	0%	0%	3%
Incident management process maturity	1	3	2
Effectiveness			
Number of incidents	20000	11200 [2]	9856
Percentage of incidents resolved by 1st line support	65%	70%	80%
Average call time with no escalation (minutes)	5	4	3
Percentage of incidents incorrectly assigned	35%	20%	15%
Average time for 2nd level support to respond (minutes)	60	30	30
Average time to resolve incidents (minutes)	80	70	40
Percentage of calls that are service requests	50%	60%	80%
Percentage of incidents solved rightly the first time	70%	90%	97%
Customer satisfaction	3	4	5
[1] This KPI was not computed as it takes no time to re-categorize one incident (see table 6).			
[2] It is not used to assess the value of this particular KPI.			

Finally, table 6 includes several values for other variables that are also needed to quantify the benefits of the incident management process.

Table 6. Other variables' values.

	As-Was	Estimated value	Real value
Average cost of breaching one SLA	N/A	N/A	€ 100
Average time to re-assign one incident (minutes)	N/A	10	10
Average time to re-categorize one incident (minutes)	N/A	0	0
Percentage of time that impacts employee productivity	N/A	5%	5%
Number of calls	N/A	28000	49280
Number of calls with no escalation	N/A	10000	39424
Number of calls with escalation	N/A	18000	9856
Average time to resolve one incident at 2nd line of support	N/A	120	300
Probability of proactively solved incidents being reported by client	N/A	10%	10%
Percentage of level 5 incidents	30% [1]	20%	N/A
Percentage of level 4 incidents	25% [1]	20%	N/A
Percentage of level 3 incidents	20% [1]	15%	N/A
Percentage of level 2 incidents	15% [1]	20%	N/A
Percentage of level 1 incidents	10% [1]	25%	N/A
Average cost of a level 5 incident	€ 600 [2]	€ 600 [2]	N/A
Average cost of a level 4 incident	€ 300 [2]	€ 300 [2]	N/A
Average cost of a level 3 incident	€ 100 [2]	€ 100 [2]	N/A
Average cost of a level 2 incident	€ 50 [2]	€ 50 [2]	N/A
Average cost of a level 1 incident	€ 20 [2]	€ 20 [2]	N/A
[1] Estimated As-Was			
[2] These values were established in a meeting with an ITIL expert and the TdP's practitioner			

In both simulations, the project's risk was considered to be 25% (100% is a project that will definitely fail and 0% is a risk-free project), the discount rate was defined as 10%, the investment was 68.000€ and, finally, the operating costs were considered as 20% of the investment.

5.3.3 Data used in the simulation with multiple processes

This simulation is a theoretical exercise because no data regarding the metrics of other processes is available, as TdP opted for *quick wins* instead of investing in a large scale ITIL implementation.

So, the correlations that exist between processes must be investigated so as to understand if the ROI is indeed proportionally larger in large scale ITIL implementations, comparing to *quick wins*.

In order to evaluate the correlations that exist between processes, the following tests were performed:

- With correlations that exist between the processes and between processes and investment costs.

• Without any correlations.

Four processes were considered and each one creates € 100.000 of benefits and the project's overall investment is € 500.000, which means that the ROI mean value is -20%.

The purpose of this simulation is to realize if the correlations that exist between processes pay off the superior project's investment costs or not.

5.4 Results

The two situations (described in 5.2.1 and 5.2.2) were simulated and the results are carefully explained in the following sub-sections.

5.4.1 Incident management process simulation

The incident management process simulation results are sub-divided into estimated and realized (i.e. the real value), according to the data division presented in 5.3.2.

Simulation with estimated data

The result of the investment analysis, which uses the estimated values scrutinized in 5.3.2, is shown in table 7.

Table 7. Investment analysis.

	Setup	Year 1	Year 2	Year 3
Benefits	€ 0	€ 2.909.842	-	-
Incident Management	€ 0	€ 2.909.842	-	-
Investment	€ 85.000	€ 0	-	-
Operating Costs	€ 0	€ 17.000	-	-
Net Annual Benefits	€ (85.000)	€ 2.892.842	-	-
Cumulative Benefits	€ (85.000)	€ 2.807.842	-	-
NPV	**€ 2.544.856**			
IRR	**3303%**			
PBP (years)	**0,04**			

And, figure 25 further complements this analysis by presenting a graph with the cumulative benefits.

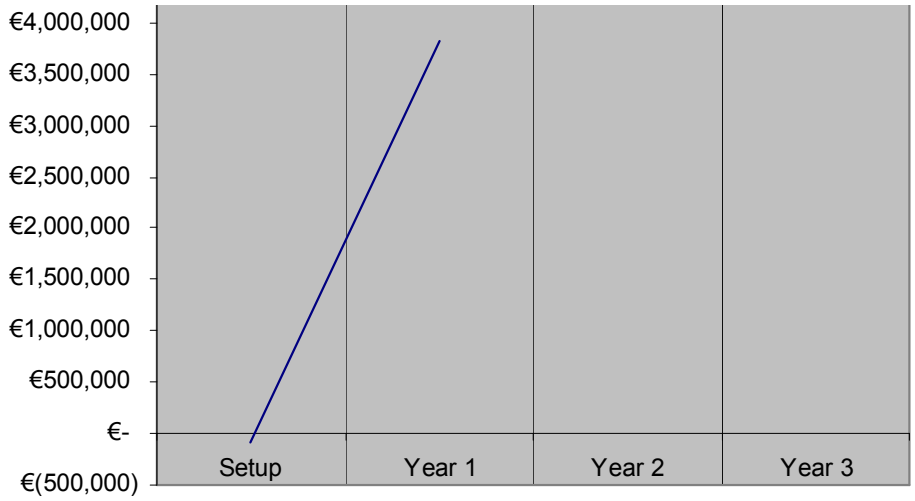


Fig. 25. Cumulative benefits.

Table 8 provides an answer to the question “which metrics are the most relevant during the benefits quantification sub-process?” mentioned in 5.2.1.

Table 8. Percentages from total benefits.

Efficiency		**% from total benefits**
1	Percentage of incidents resolved without breaching one SLA	N/A
2	Percentage of incidents resolved within target time by priority	0,00%
3	Percentage of incidents re-assigned	0,13%
4	Percentage of incidents incorrectly categorized	0,00%
5	Percentage of calls 1st line support bypassed	3,22%
6	Percentage of proactively solved incidents	0,00%
7	Incident management process maturity	1,03%
Effectiveness		
8	Number of incidents	93,31%
9	Percentage of incidents resolved by 1st line support	0,16%
10	Average call time with no escalation (minutes)	0,02%
11	Percentage of incidents incorrectly assigned	0,04%
12	Average time for 2nd level support to respond (minutes)	1,29%
13	Average time to resolve incidents (minutes)	0,27%
14	Percentage of calls that are service requests	0,47%
15	Percentage of incidents solved rightly the first time	0,02%
16	Customer satisfaction	0,03%
Total		100,00%

The “number of incidents” KPI (KPI number 8) has a devastating influence over the benefits quantification outcome. Some of the other KPIs are irrelevant, but those KPIs whose percentages are linearly dependent on the “percentage of time that impacts employee productivity” (e.g. KPIs 5 and 12), could have more impact on the final result if the “percentage of time that impacts employee productivity” was set to a higher value.

Table 9. Risk influence.

Financial metrics	Risk		
	25%	50%	75%
NPV	€ 2.544.856	€ 1.642.995	€ 741.134
IRR	3303%	1782%	695%
PBP (years)	0,04	0,06	0,15

The risk influences greatly the financial metrics included in the financial analysis. When the risk increases from 25% to 75%, there is a 343% and 475% decrease in the NPV and IRR values, respectively. Conversely, the PBP increases 375% when the risk increased 50%.

Figure 26 illustrates the frequency of a ROI Monte Carlo simulation with 10.000 trials.

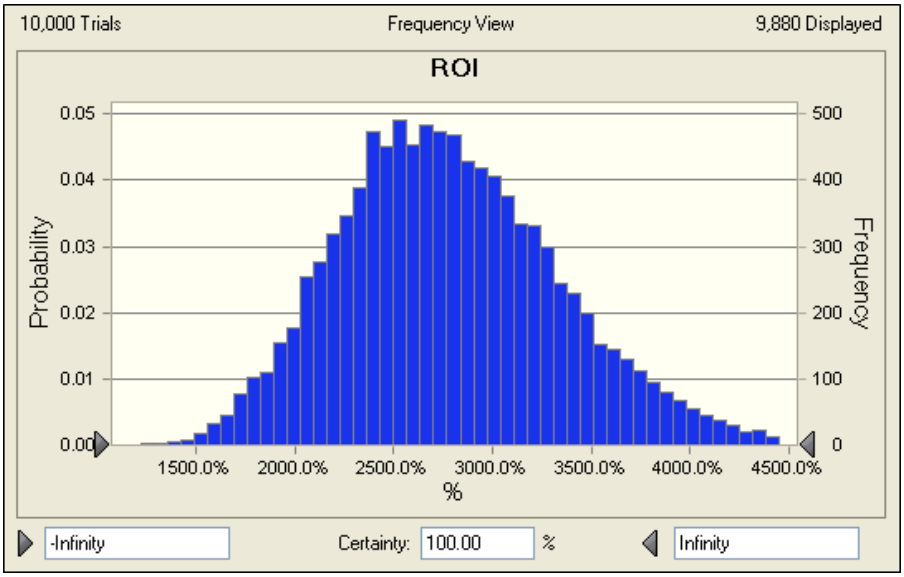


Fig. 26. ROI Monte Carlo simulation frequency.

Table 10 shows that a higher level of a negative correlation between variables is associated to higher values of variance, standard deviation and skewness. This means that the trials tend to be more dispersed if there are negative correlations between the variables considered.

All variables that enter a Monte Carlo simulation assume random values within the normal distribution curve assigned to the variable. The fact that the state of the project’s investment cost

variable supplies information relative to the likely occurrence of the variable regarding the benefits of the process creates a correlation between these two variables.

So, it is necessary to negatively correlate the processes together with the investment's costs even though there exists an indirect dependency between these two variables, as they are both dependent on the project's risk in a ad-hoc way. Even so, the case scenarios created by a Monte Carlo simulation have to take under consideration the fact that when the investment's costs are higher, the benefits arising from that investment are negatively influenced, and vice-versa.

Table 10. Correlations effect on the ROI Monte Carlo simulation.

Level of correlation	Variance	Standard deviation	Skewness
High (-0,95)	3404 %	583 %	0,6543
Medium (-0,87)	3399 %	583 %	0,6228
Low (-0,75)	3038 %	551 %	0,5944
None (0)	1661 %	408 %	0,4617

Simulation with real data

The result of the investment analysis, which uses the real values listed in the previous sub-section, is pictured in table 11.

Table 11. Investment analysis.

	Setup	Year 1	Year 2	Year 3
Benefits	€ 0	€ 1.205.064	-	-
Incident Management	€ 0	€ 1.205.064	-	-
Investment	€ 85.000	€ 0	-	-
Operating Costs	€ 0	€ 17.000	-	-
Net Annual Benefits	€ (85.000)	€ 1.188.064	-	-
Cumulative Benefits	€ (85.000)	€ 1.103.064	-	-
NPV	**€ 995.058**			
IRR	**1298%**			
PBP (years)	**0,08**			

Figure 27 further complements the investment analysis by presenting a graph that shows the investment's cumulative benefits.

Fig. 27. Cumulative benefits.

The benefits realized in the simulation with real data proved to be less than expected when compared to the simulation with estimated data, due to the fact that the impact of the KPI "number of incidents" is extremely decisive as it is not taken into consideration in the simulation with real data.

Table 12. Percentages from total benefits.

Efficiency		**% from total benefits**
1	Percentage of incidents resolved without breaching one SLA	49,07%
2	Percentage of incidents resolved within target time by priority	N/A
3	Percentage of incidents re-assigned	0,29%
4	Percentage of incidents incorrectly categorized	0,00%
5	Percentage of calls 1st line support bypassed	40,22%
6	Percentage of proactively solved incidents	0,01%
7	Incident management process maturity	1,24%
Effectiveness		
8	Number of incidents	N/A
9	Percentage of incidents resolved by 1st line support	1,03%
10	Average call time with no escalation (minutes)	0,46%
11	Percentage of incidents incorrectly assigned	0,11%
12	Average time for 2nd level support to respond (minutes)	1,71%
13	Average time to resolve incidents (minutes)	2,28%
14	Percentage of calls that are service requests	3,42%
15	Percentage of incidents solved rightly the first time	0,03%
16	Customer satisfaction	0,12%
Total		100,00%

From table 12 it is possible to observe that KPIs 1 and 5 totalize almost 90% of the total benefits. Likewise to what happens in the simulation with estimated data, there are also several irrelevant KPIs. However, some KPIs (e.g. KPIs 9, 12, 13 and 14) are linearly dependent on the "percentage of time that impacts employee productivity", which could easily have more impact on the benefits quantification if this percentage increased.

KPI "number of incidents" unleveraged the results of both simulations. In fact, the estimated value for this KPI is the outcome of a meeting with ITIL experts and TdP's practitioner which challenged the benefits quantification. Hence, this KPI is included only in the benefits quantification of the simulation with estimated data because no real data was available at the time.

Table 13. Risk influence.

Financial metrics	Risk		
	25%	50%	75%
NPV	€ 995.058	€ 609.796	€224.534
IRR	1298%	668%	218%
PBP (years)	0,08	0,15	0,36

Similar results to those drawn from table 9 can be deduced from table 13. Consequently, risk influences greatly the investment analysis in both simulations.

The following figure depicts the frequency of a Monte Carlo simulation with 10.000 trials.

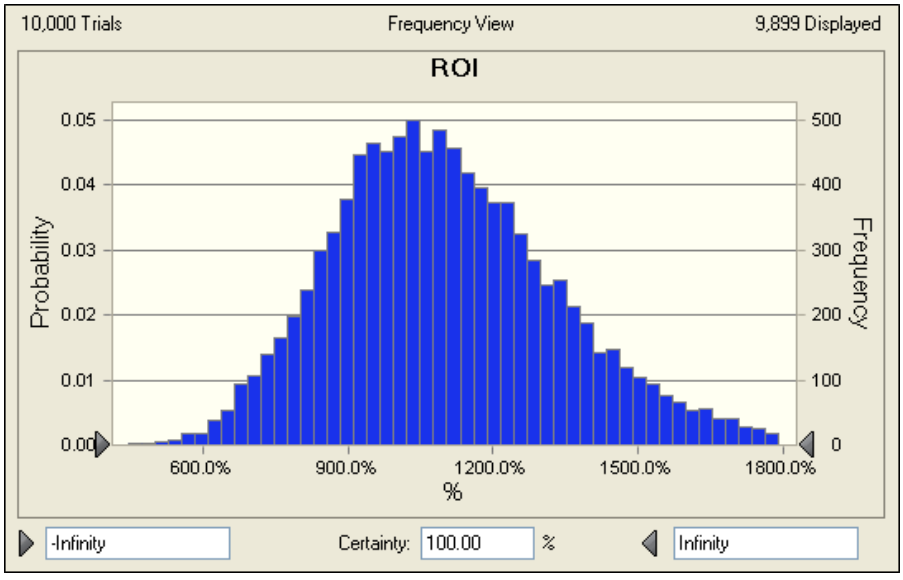


Fig. 28. ROI Monte Carlo simulation frequency.

By comparing figure 28 and 26, i.e. the ROI Monte Carlo frequency of both simulations, it is possible to retain that both have a "bell shape" curve since they apply a normal distribution curve. However, the ROI Monte Carlo simulation with real data is displaced more to the left as the mean value of the normal

distribution is considerably lower than the one of the simulation with estimated data. Due to this fact, the minimum and maximum values of the ROI Monte Carlo simulation with real data are also lower than those observed in the ROI Monte Carlo simulation with estimated data.

Also, the values included in table 14 act in accordance with the levels of correlation observed in the table 10, which means that the outcome scenarios tend to be more dispersed when there exist negative correlations between the variables used in the Monte Carlo simulation.

Table 14. Correlations effect on the ROI Monte Carlo simulation.

Level of correlation	Variance	Standard deviation	Skewness
High (-0,95)	593%	243%	0,647
Medium (-0,87)	568%	238%	0,5256
Low (-0,75)	504%	225%	0,5623
None (0)	298%	173%	0,4588

5.4.2 Simulation with multiple processes

The results of the simulation with multiple processes are described next. Figure 29 depicts the ROI Monte Carlo simulation frequency result for the situation where correlations are not included, which is already mentioned in 5.3.3.

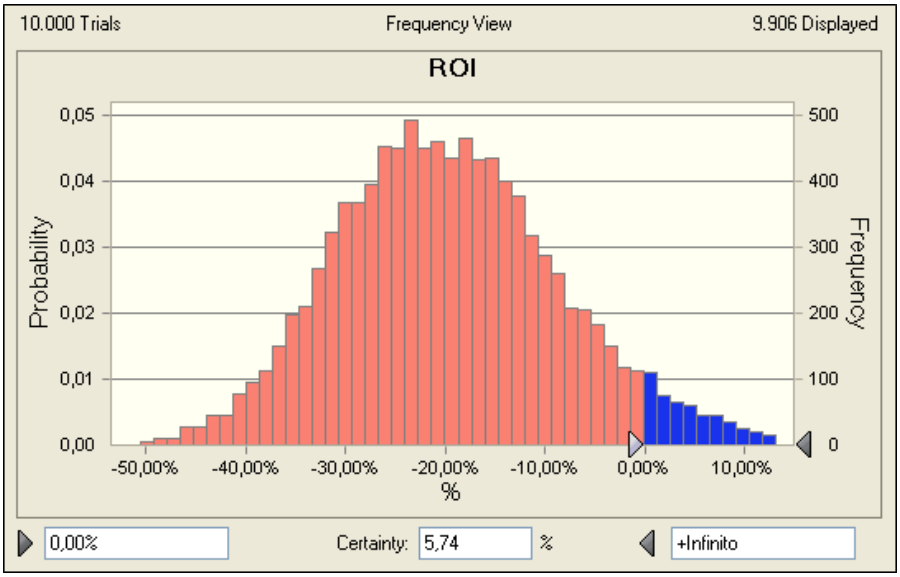


Fig. 29. ROI Monte Carlo simulation frequency without correlations.

Figure 30 represents the ROI Monte Carlo simulation frequency result for the situation where correlations are included.

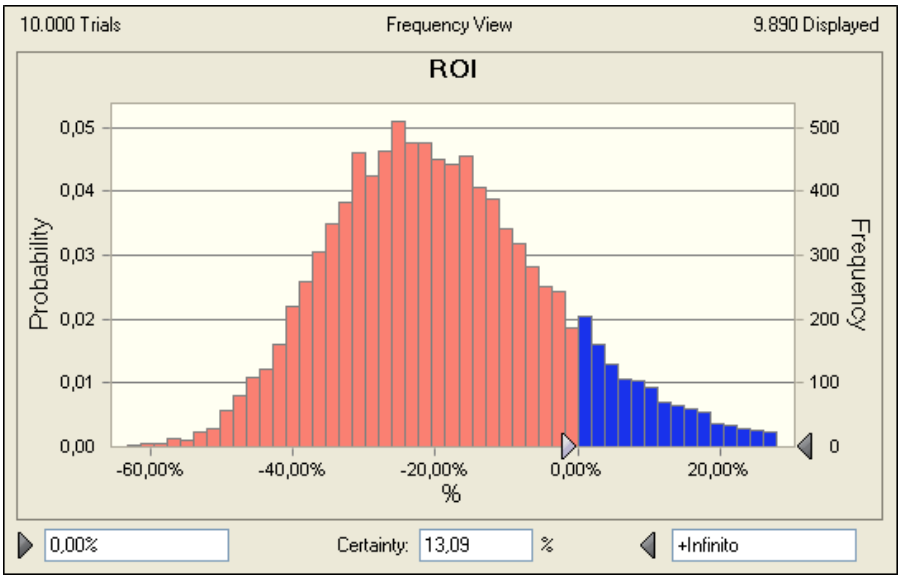


Fig. 30. ROI Monte Carlo simulation frequency with correlations.

The first observation that can be drawn from the two figures above is that there are more positive ROI scenarios in the Monte Carlo simulation with correlations than in the one without correlations. The following table provides data that is necessary to further understand the previous result.

Table 15. Correlations influence.

Statistic	With correlations	Without correlations
Mean	-18,49%	-19,36%
Median	-20,22%	-20,12%
Standard Deviation	16,34%	11,61%
Variance	2,67%	1,35%
Skewness	0,6402	0,4541
Minimum	-65,68%	-53,94%
Maximum	63,89%	36,82%

Table 15 clearly shows that the main reason for having such different results with and without correlations resembles in the fact that the standard deviation, variance and skewness are higher in the simulation with correlations than in the one without, which then causes the trials to be more dispersed in the simulation with correlations.

So, having correlations amongst processes and between the processes and the investment's costs do affect the results of the ROI Monte Carlo simulation, as they widen the distribution's tail as it is possible to observe in figure 30.

5.4.3 Requirements results

In terms of requirements, the effectiveness is tested by the incident management process simulation according to the specifications that are defined in 5.2.3.

The completeness and correctness of the prototype was improved over the time as it was challenged by both the TdP's practitioner as well as ITIL experts, which ultimately resulted in the modification of the prototype itself.

Finally, in terms of usability and configurability, the users were familiarized with Excel technology and, therefore, it was easier to utilize and configure the prototype.

6. Evaluation

This section is dedicated to evaluating how successful the action was so as to test out how well the proposed estimation process performed in stipulating what action to take.

The next two sub-sections discuss the results obtained in 5.4.1 and 5.4.2, correspondingly. In the end, an evaluation of the requirements is performed and, at last, a re-factorized estimation process is proposed.

6.1 Incident Management Process Simulation

The simple fact that different KPIs were utilized in the two simulations influenced greatly the effectiveness of the estimator itself.

As a consequence, different quantification logics were applied in both simulations, for instance: some KPIs are based on the employee productivity whilst others are based on the cost per incident, which is calculated by dividing the IT total costs by the total number of incidents in a period of one year. On the other hand, the employee productivity is the result of the division of the revenue by the total number of employees.

Using different forms of quantification isn't necessarily incorrect. On the contrary, it makes the estimator more correct as both forms are valid and should be taken under consideration, since the cost per incident is focused on cost reduction and the employee productivity is driven towards productivity gains.

Also, in view of the fact that the risk's influence over the investment analyses is enormous, it is important that the risk analysis is performed carefully and with the help of risk experts.

As a final note, it is important to acknowledge that the data obtained from TdP is not absolutely precise and, it would be more enriching to the estimator's evaluation to test it with several organizations in different business areas.

6.2 Simulation with Multiple Processes

When the correlations amongst processes are considered in order to perform a Monte Carlo simulation, there are higher chances of more positive ROI outputs being generated as a consequence.

To prove this statement, the expected loss ratio of the simulation without correlations is 7,35% higher than the one of the simulation with correlations, meaning that there are more 7,35% case scenarios with a positive ROI in the simulation that considers correlations. This result cannot be expected in situations where correlations amid processes are not considered at all.

The Monte Carlo simulation of the implementation of several processes could have an expected loss ration higher than 50%, but the fact that the benefits of each process positively influence the benefits of

all the other processes decreases the expected loss ratio or, in other words, increases the number of positive scenarios.

Even though the correlations might not pay off the superior project's investment costs, it is important to consider them in the estimation process as some potential generated outputs are not neglected and, therefore, the client can be elucidated about the potential of large scale ITIL investments.

So, the benefits generated by a single process are considerably less due to the fact that the positive correlations between processes are not included in the Monte Carlo simulation.

6.3 Requirements Evaluation

Excel proved to be valuable as it allowed the prototype to be easily modified and configured.

In terms of effectiveness, the fact that different KPIs are used in both the incident management process simulations (with estimated and real values) influences the prototype's effectiveness.

Finally, the cyclical process of interaction with the client is a cooperative and useful method to tackle the prototype's completeness and correctness concern.

6.4 Estimation Process Re-factorization

Taking into account the results' evaluation that is performed in the previous sub-sections, the parts in yellow of figure 31 represent the modifications that were made to the estimative process proposed in section 4.

This re-factorization consists of two main changes:

- Due to the fact that multiple interactions with the client must occur so as to improve the benefits quantification logic, this sub-process becomes cyclical.
- In case of a large scale ITIL implementation, i.e. a project with multiple processes, the dependencies between these should be checked in order to correlate the processes and this is the reason for placing a gateway after the "select the number of trials" activity. In case of being a single-process ITIL implementation, only the benefits of that process and the project's investment costs have to be correlated.

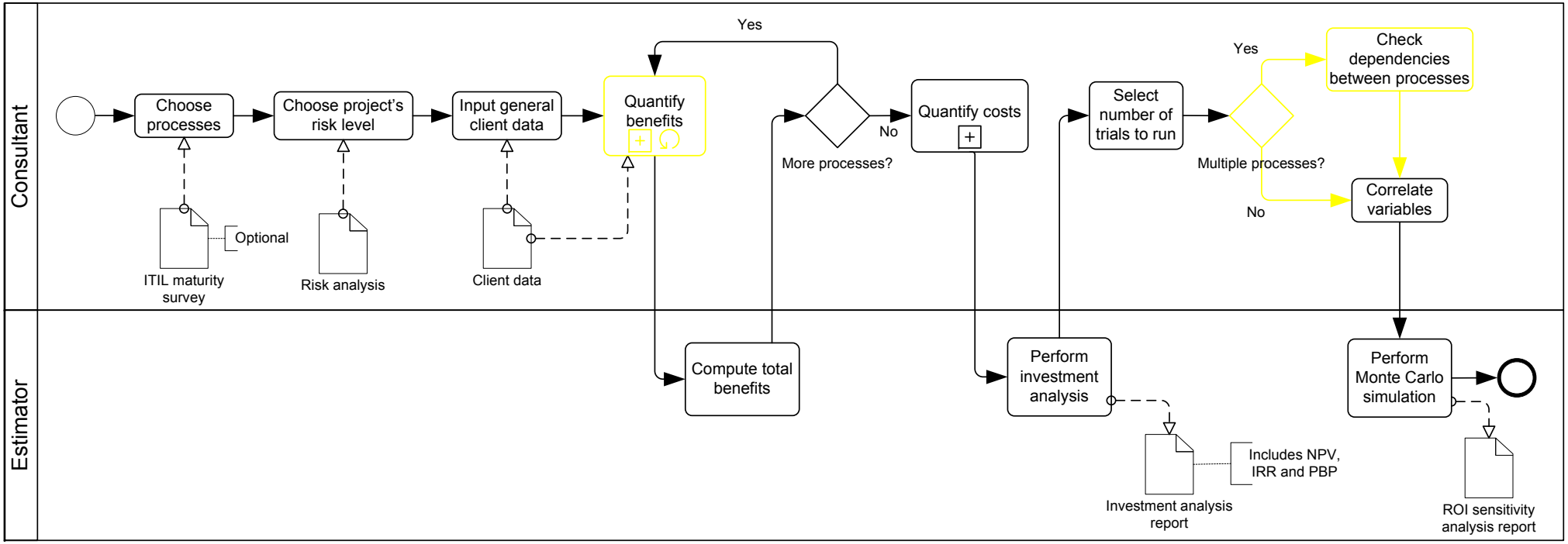


Fig. 31. Re-factorized version of the ITIL value estimation process.

7. Conclusion

The value of ITIL is a much discussed subject these days as reducing IT costs, increasing IT performance and, at the same time, improving business performance through IT-business alignment are vital for any organization. Essentially, the importance of assessing the value of ITIL implementations rests in the fact that by doing so, senior executives are provided with crucial information which will help them in the projects' selection decision-making process.

The related work provided enough insight to create an estimation process for assessing the value of ITIL implementations. An important acumen to be added is that ITIL investments impact dramatically the business processes' efficiency as well as the business goals' effectiveness. For this reason, the estimation process incorporates into its logic the investments' impact, plus the tangible and intangible benefits quantification as well as project's investment costs and, lastly, the risk assessment of the investment which is the ultimate outcome of the estimation process.

The estimation process was tested with data retrieved from a project that consisted of implementing the incidents management process in a state organization. The main results were that only a few KPIs have a great impact on the final benefits quantification and the project's risk has a great influence over the investment analysis and the ROI Monte Carlo simulation.

Furthermore, a theoretical exercise was performed so as to evaluate how the interconnections between processes affect the overall project's ROI. The results were revealing as the project's mean ROI can be negative but, given the fact that those processes are interconnected and interdependent, the benefits are heightened, which ends up making the investment more attractive.

As a final point, it's not only important to estimate the value of ITIL implementations, it is also critical to realize the improvement benefits through measurement and reporting tools. Therefore, a measurement framework and metrics are required in order to reach IT-business alignment and realize the benefits [75]. The problem lies in the ITIL project's planning phase because the metrics, which should be measured and compared during the project's life cycle, are typically not defined and, therefore, the real value of ITIL investments is hard to realize.

7.1 Future Work

The focus of this research work was to propose a model for solving the particular problem of estimating the value of ITIL implementations, whether it is *quick wins* or large scale ITIL implementations. However, there is some future work that could be done.

Knowing that ITIL processes depend on each others, specifying the correlation coefficients between two processes is a way to include those dependencies into the estimation process, and these correlation coefficients can be derived from statistical analyses of past data or be suggested by experts [72].

In fact, those correlations can be defined by comparing two experimental data sets, which are derived from the level of dependency that exist between processes, by using several mathematical methodologies such as the Pearson's correlation coefficient, or by associating the Pearson's correlation coefficient with the rank order coefficient [74].

Another topic that needs further research is when a major operational change takes place in the IT function, for instance, when the IT department adopts a charge-back methodology for the incident management process, meaning that the IT department charges a certain amount of money per incident according to the incident's complexity and urgency. This change implies that a new KPI has to be created and quantified, but there is no way to compare the as-is with the to-be situation because the KPI is not considered in the benefits quantification before the charge-back adoption takes place. So, it is necessary to further study how these changes, whatever their range is, impact the value of ITIL implementations and, specially, what is the best way to compare the as-is with the to-be situation.

References

1. Selig, G.: IT Governance – An Integrated Framework and Roadmap: How to Plan, Deploy and Sustain for Competitive Advantage. CA (2006).

2. Feld, C., Stoddard, D.: Getting IT Right. Harvard Business Review (2004).

3. Ross, J., Weill, P.:Six IT Decision Your IT People Shouldn't Make. Harvard Business Review (2002).

4. O'Leary, J.: Learn to Speak the Language of ROI. Harvard Management Update (2002).

5. Lepore, D., Rockart, J., Earl, M., Thomas, T., McAteer, P., Elton, J.: Are CIOs Obsolete? Harvard Business Review (2000).

6. McAfee, A.: Mastering the Three Worlds of Information Technology. Harvard Business Review (2006).

7. Bon, J., Jong, A., Kolthof, A., Pieper, M., Tjassing, R., Veen, A., Verheijen, T.: ITSM Library – Foundations of IT Service Management Based on ITIL V3. Van Haren Publishing (2007).

8. Nieves, M.: IT Infrastructure Library (ITIL) version 3 – Driving business growth through IT. Accenture (2007).

9. Taylor, S., Iqbal, M., Nieves, M.: ITIL Service Strategy. The Stationary Office (2006).

10. Developing the Business Value of ITIL 2006 Survey Results. Evergreen (2006).

11. Laudon, K., Laudon, J.: Management Information Systems: Managing the Digital Firm, 10th edition. Prentice Hall (2005).

12. Jalonen, E.: Portfolio Decision Making in Innovation Management. Helsinki University of Technology (2007).

13. McCready, S.: TCO, NPV, EVA, IRR, ROI, Getting the terms right. CIOview (2005).

14. Verhoef, C.: Quantifying the value of IT investments. Free University of Amsterdam (2004).

15. Heilala, J., Montonen, J., Helin, K.: Selecting the right system - assembly system comparison with total cost of ownership methodology. Emerald Groups Publishing Limited (2007).

16. Silva, M., Martins, J.: IT Governance. FCA (2008).

17. The Business Value of IT. Harvard Business Review (1999).

18. Broadbent, M., Kitzis, E.: The New CIO Leader. Harvard Business School Press (2004).

19. A missing Competency: Boardroom IT-Deficit. Burson-Marsteller (2005).

20. Bruijn, H., Heuvelhof, E.: Management in Networks: On multi-actor decision making. Routledge (2008).

21. Wyatt-Haines, R.: Align IT – Business impact through IT. John Wiley & Sons (2007).

22. Dos Santos, B.: Information Technology Investments: Characteristics, Choices, Market Risk and Value, Kluwer Academic Publishers (2003).

23. Gama, N.: O *Business Value* dos Investimentos em Sistemas de Informação. Instituto Superior Técnico (2006).

24. Cecere, M., Liddell, H.: Where Should The CIO Report? Forrester (2005).

25. Dekleva, S.: Justifying Investments in IT. Journal of Information Technology Management (2005).

26. Dos Santos, B.: Justifying Investments in New Information Technologies. Journal of Management Information Systems (1991).

27. Varguese, J.: ROI is not a formula, it is a Responsibility. Journal of Business Strategy (2003).

28. McMahon, E.: What Technology ROI Looks Like and Where to Find It? Canadian HR Reporter (2004).

29. Hurkens, K., Wynstra, F.: The concept 'Total Value of Ownership': A case study approach. Erasmus University of Rotterdam (2006).

30. Duncan, N.: Capturing Flexibility of Information Technology Infrastructure: A Study of Resource Characteristics and Their Measure. Journal of Management Information Systems (1995).

31. Mogollon, M., Raisinghani, M.: Measuring ROI in E-Commerce Applications: Analysis to Action, Chapter VIII. Information Systems Management (2003).

32. Grant, J.: Foundations of Economic Value Added. Wiley Finance (2003).

33. Ward, J., Daniel, E.: Benefits Management, Delivering Value from IS & IT investments. Wiley Series (2005).

34. Ehrbar, A.: EVA: The Real Key to Creating Wealth. John Wiley & Sons (1998).

35. Forecast: Retail IT Spending, Worldwide, 2006-2011. Gartner (2008).

36. Mieritz, L., Kirwin B.: Defining Gartner Total Cost of Ownership. Gartner (2005).

37. Symons, C.: Add EVA to IT Investment Analysis. Forrester (2005).

38. Buytendijk, F., Rayner, N.: A Starter's Guide to CPM Methodologies. Gartner (2002).

39. Päivärinta, T., Dertz, W., Flak, L.: Issues of Adopting Benefits Management Practices of IT Investments in Municipalities: A Delphi Study in Norway. In: Proceedings of the 40th Hawaii International Conference on System Sciences (2007).

40. Eisenfeld, B., Kolsky, E., Grigg, J.: Don't Confuse CRM benefits with ROI. Gartner (2003).

41. Violino, B.: Return on Investment. Information Week (1997).

42. Hubbard, D.: How to Measure Anything: Finding the Value of "Intangibles" in Business. John Wiley & Sons, Inc (2007).

43. Silva, M., Gama, N.: Activos Intangíveis dos Sistemas de Informação. Instituto Superior Técnico (2006).

44. Denker, A.: The Challenge of Large IT Projects. In: Proceedings of World Academy of Science, Engineering and Technology Volume 9 (2005).

45. Getting Started with Value Management. IT Governance Institute (2008).

46. Val IT Framework 2.0. IT Governance Institute (2008).

47. Symons, C.: From IT Governance to Value Delivery. Forrester (2007).

48. Peters, A.: EA Adds a Fourth Pillar to IT Value Management. Forrester (2008).

49. Lee, A.: Information Systems Action Research, Chapter 3. Springer (2007).

50. Finance for managers. Harvard Business School Publishing Corporation (2002).

51. Egyedi, T., Vrancken, J., Ubacht, J.: Inverse Infrastructures: Coordination in Self-Organizing Systems. TUDelft (2007).

52. Bünger, M.: The Santa Fe Institute: An Innovation Broker. Forrester (2005).

53. The Chaos Report. The Standish Group International, Inc (1995).

54. Silvius, A.: Does ROI Matter? Insights into the True Business Value of IT. The Electronic Journal Information Systems Evaluation Volume 9 Issue 2 (2006).

55. Silvius, A.: The Business Value of IT: A Conceptual Model for Selecting Valuation Methods. Communications of the IIMA Volume 8 Issue 3 (2008).

56. Bass, L., Clements, P., Kazman, R.: Software Architecture in Practice (2nd edition). Addison Wesley (2003).

57. Banerjee, P.: Best of Everything: ITIL, CMMI & Six Sigma. In: SEPG (2008).

58. ISO 20000 and ITIL, http://20000.fwtk.org/20000-itil.htm (accessed on the 15th of October of 2008).

59. Determining the Return on Investment from Deploying Integrated IT Service Management. IDC (2006).

60. The Information Technology Infrastructure Library Improves Infrastructure Investment. Gartner (2006).

61. Mendelsohn, L.: Trend Forecasting With Technical Analysis. Marketplace Books (2000).

62. Brooks, P.: Metrics for IT Service Management. Van Haren Publishing (2006).

63. Steinberg, R.: Measuring ITIL. Trafford Publishing (2006).

64. Tiong, C., Cater-Steel, A., Tan, W.: Measuring Return on Investment from Implementing ITIL – A Review of the Literature. Information Science Publishing (2008).

65. Anandarajan, A., Wen, J.: Evaluation of Information Technology Investment. Management Decision, Volume 37, Number 4 (1999).

66. Ballantine, J., Stray, S.: Information Systems and Other Capital Investments: evaluation practices compared. Logistics Information Management (1999).

67. Repenning, N., Sterman, J.: Nobody ever gets credit for fixing problems that never happened: creating and sustaining process improvement. California Management Review (2001).

68. Seddon, P., Graeser, V., Willcocks, L.: Measuring Organizational IS Effectiveness: an overview and update of senior management perspectives. SIGMISDatabase (2002).

69. Fry, M.: Essential ITIL: What you need to succeed. CA (2008).

70. Kersnar, J.: ROI: The Age of Reason. CFO.com http://www.cfo.com/article.cfm/3005624/c_3036068 (accessed on the 13th of January of 2009).

71. Hochstein, A., Tamm, G., Brenner, W.: Service-Oriented IT Management: Benefit, Cost and Success Factors. University of St. Gallen (2005).

72. Stæhr, K.: Risk and Uncertainty in Cost Benefit Analysis. Institute for Miljøvurdering (2006).

73. Ross, S.: Introduction to Probability and Statistics for Engineers and Scientists. Elsevier Academic Press (2004).

74. Rodger, C., Jason, P.: Uncertainty & Risk Analysis. PriceWaterHouseCoopers (1999).

75. Smith, D.: Implementing Metrics for IT Service Management. Van Haren Publishing (2008).

76. Clements, P., Bachmann, F., Bass, L., Garlan, D., Ivers, J., Little, R., Nord, R., Stafford, J.: Documenting Software Architectures: Views and Beyond. Addison Wesley (2002).

77. Oliveira, P., Silva, M., Furtado, N.: The Value of ITIL. Conferência Ibérica de Sistemas e Tecnologias de Informação, Póvoa de Varzim, Portugal (2009).

78. Oliveira, P., Silva, M., Furtado, N.: A Process for Estimating the Value of ITIL Implementations. Conference on ENTERprise Information Systems, Ofir, Portugal (2009).

79. Palisade's @Risk, http://www.palisade.com/risk (accessed on the 14th of June of 2009).

80. Oracle's Crystal Ball, http://www.oracle.com/technology/products/bi/crystalball/index.html (accessed on the 14th of June of 2009).

81. Instituto Nacional de Estatística, http://www.ine.pt (accessed on the 10th of March of 2009).

82. Instituto de Apoio às Pequenas e Médias Empresas e à Inovação, http://www.iapmei.pt/ (accessed on the 10th of March of 2009).