# Analyzing Cost and Profitability using Process-based ABC

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Thesis to obtain the Master of Science Degree in

**Information Systems and Computer Engineering**

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**May 2013**

# Abstract

Presently there is an ever more increased pressure over organizations to stay efficient and competitive. This is so, not only because of a more and more competitive and global market but also due to a crisis that affected most of the world's economy. This situation leaves organizations with only two options: Increase revenue or reduce cost, but in current conditions only the latter is a valid solution. This makes cost awareness and reduction one of the major concerns today. But, although almost all organizations reckon this need for information and a need to increase their profitability, efficient costing methodologies are out of reach for most small companies which represent more than 90% of the European economy. In this report we present our investigation to solve this problem where we used Design Science Research Methodology as research process. It's result was a method that allows to model and calculate the costs and create templates that reflect an industry allowing to reduce the cost of that same analysis. This proposal was demonstrated in four different industries and evaluated through interviews with experts and potential users.

**Keywords:** Costing, BPMN, TDABC, Modelling, Templates, Business Processes

# Resumo

Actualmente existe uma pressão cada vez maior sobre as organizações para estas serem eficientes e competitivas. Isto deve-se, não só a um mercado global cada vez mais competitivo mas também a uma crise que afectou a economia de grande parte do mundo. Esta situação deixa as organizações com apenas duas alternativas: Aumentar as receitas ou diminuir os custos, mas com as condições actuais apenas a última se apresenta como uma solução válida Isto faz com que a consciência dos custos e a sua redução sejam uma das principais preocupações hoje em dia. Mas, apesar de quase todas as organizações reconhecerem esta necessidade de informação e a necessidade de aumentar a sua rentabilidade, as metodologias de custeio eficientes estão fora do alcance da maioria das pequenas empresas, que representam mais de 90 % da economia Europeia. Neste relatório apresentamos a nossa investigação para resolver este problema em que usámos *Design Science Research Methodology e* cujo resultado foi um método que permite modelar e calcular os custos e criar templates que reflectem uma industria permitindo desta forma reduzir o custo dessa mesma análise. Este método foi demonstrado em 4 indústrias diferentes e avaliado através de entrevistas com especialistas e potenciais utilizadores.

**Palavras-Chave:** Custeio, BPMN, TDABC, Modelação , Templates, Processos de Negócio

# Acknowledgments

My first acknowledgment goes to my supervisors, in particular to Professor Miguel Mira da Silva for all the guidance provided through all phases of this thesis, for all the knowledge shared and for the experiences given.

I would also like to leave a special word to Carlos Mendes for all his effort and for the hours spent helping me, acting like nothing less than a supervisor of this thesis.

I also want to thank all my colleagues in IST and INOV, that shared many hours of work with me, but also many hours of fun.

To my friends, I give them my gratitude, for the extra motivation when needed, but mostly, for the patience that they kept during all these years and that I am sure they'll continue to keep.

I would also like to mention my family, my brothers and grandparents in particular, from whom I picked some parts of my personality.

I would also like to thank my mother, not only for everything she gave me throughout these years, but also for being the best friend anyone can have, both in good and bad times.

Finally I would like to thank my father, Carlos Lourenço for being an example in his professional and personal life that I can only try to equal.

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# List of Acronyms

| | |
|---|---|
| **ABC** | Activity-Based Costing |
| **AIS** | Accounting Information System |
| **BP** | Business Process |
| **BPM** | Business Process Management |
| **DS** | Design Science |
| **DSRM** | Design Science Research Methodology |
| **IS** | Information Systems |
| **MSQF** | Moody and Shanks Quality Framework |
| **RP** | Resource Pool |
| **SME** | Small and Medium Enterprise |
| **TDABC** | Time-Driven Activity Based Costing |

# Chapter 1

# Introduction

Companies have always been competitive entities that try to differentiate between themselves through a variety of factors, one of which is efficiency. This efficiency can be regarding energy, production or cost. The latter, cost-efficiency, although has always been a major concern for organizations has, in the last few years, seen its importance grow due to a global financial crisis. This is even truer for Small and Medium Enterprises (SME's) that due to their size are more exposed to the market conditions. (OECD, 2009).

Organizations from all industries facing this situation started to care more about how the money was spent and where was it spent, and to focus more on those products or services that were more profitable for the organization. (Deloitte, 2011) (VHA, 2012). This information is essential for focusing efforts, making decisions or, in organizations that have these defined, it is essential for Business Process Redesign / Reengineering (Davenport & Short, 1990).

To obtain this cost or profitability information a number of methodologies were developed throughout the years. These methodologies come from the traditional accounting systems that evolved naturally to better take into account the impact of overhead costs on the total cost of products. This was where most methodologies failed (Lambert & Chen, 1996). This increased attention on overhead costs comes from the fact, that the industry has evolved from manufacturing to services (Škoda, 2009), and with this transition, overhead cost has grown from residual to being the majority (Miller & Vollman, 1985).

With these methodologies, it then becomes possible for companies to know where resources are being spent and what is the profitability of their products and services, but there is a catch: These methodologies are too expensive for SMEs, and these form more than 90 percent of the European Economy (European Comission, 2012), since they require time, expertise and software that is out of

reach of these organizations (Hall & McPeak, 2011). On the other hand it has been observed that the results of cost analysis done in organizations inside the same industry were very similar suggesting that some reutilization or standardization could be achieved.

Since organizations have a clear need for cost reduction, and the tools that could provide them the correct guidance are out of their reach, companies have to rely on traditional accounting. This often leads to badly-supported decisions that many times have undesirable results. Managers may for example decide to cease a particular product that appears to be unprofitable when in reality some factor made it the sustainability of the organization, therefore a bad decision related with it could have serious implications in a organization, even its closure.

The research done within this thesis was conducted done using the Design Science Research Methodology (DSRM) (Hevner, March, Park, & Ram, 2004) (Peffers & al, 2008) and structured accordingly . We start by giving a description of DSRM followed by the identification of the problem, the analysis of the context where this research is inserted and the state of the art of costing methodologies as well as modelling languages. We then proceed to define the objectives of a solution and present an artefact that addresses these objectives. This artefact is a method that uses modelling languages, in this case Business Process Modelling and Notation (BPMN) (Object Management Group, 2012) and Time-Driven Activity Based Costing (TDABC) (Kaplan & Anderson, 2007) to take advantage of common processes in organizations belonging to the same industry to make the cost analysis process more affordable. This solution is demonstrated in four situations which results are then evaluated according to previously defined criteria.

## 1.1 Research Methodology

This section describes this research's discipline and the methodology used and the reasons behind the choice.

Design Science (DS) was defined by (Simon, 1996) as being the research and development of things that serve human purposes while Information Systems (IS) a research discipline that applies theories from multiple disciplines to solve problems at the intersection of IT and organizations (Laudon & Laudon, 2012) therefore DS in IS consists on creating things that solve problems on the intersection between IT and organizations. This is the where our research is inserted.

For this reason, we chose to conduct our research using the Design Science Research Methodology (DSRM) (Hevner, March, Park, & Ram, 2004) (Peffers & al, 2008). This methodology incorporates principles, practices and procedures to carry this kind of research and has three objectives: 1) To be consistent with previous research done in the area of Design Science Research; 2) To present a nominal process that the researcher can follow and; 3) To provide a mental model for presenting and evaluating Design Science research in Information Systems.

Regarding the nominal process proposed by this methodology (Figure 1) it provides guidelines for the researcher to conduct the research and how to present it. The mental model provides an accepted common framework for both the researchers as well as for readers and reviewers that will review the research, giving them a common language and context. This common ground helps the author and the reviewers since it avoids the justification of an *ad hoc* research and also contributes for the recognition and evaluation of the results of DS research.

In this dissertation we also used the proposed process to provide its structure, since all research was done using DSRM. The process must produce an artefact that is "relevant to the solution of a heretofore unsolved and important business problem" (Peffers & al, 2008) and consists of six steps in a nominal sequence:

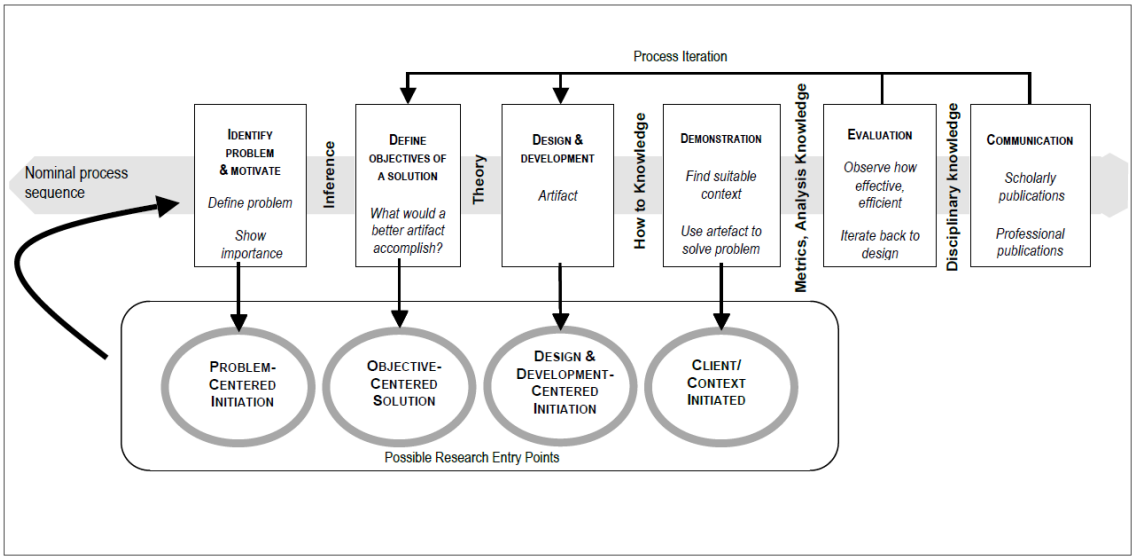


**Figure 1 -** DSRM Process

1) ***Problem identification and motivation***: Consists on defining the specific research problem and justifying why a solution would be valuable. More complex problems should be atomized so that the solution can capture its complexity. Current state and importance of the problem should be included in this section.
2) ***Definition of the objectives for the solution***: In this step problems are transformed into objectives. Not all problems become objectives, since a solution may only intend to partially resolve them since design is an incremental process. These objectives may be quantitative or qualitative. Information on how the current solutions address the problem should be present.
3) ***Design and Development:*** With the objectives defined an artefact is created. An artefact may be a construct, model, method or an instantiation, it can also be a new property of technical, social or informational resources.

4) ***Demonstration:*** To demonstrate the usefulness of the artefact, it is used to solve one or more instances of the identified problem. This can be done through simulation, experimentation or case studies. It should be clear in this step how to use the artefact to solve the problem
5) ***Evaluation:*** Researchers should, in this step, assess how well the artefact solves the problem. This is done by comparing the objectives defined with the actual results obtained in the demonstration step. This comparison can be done through measures, surveys, feedback, simulations among others. If the results are not according to the researchers expectations, they might decide to iterate back to the design and development step. To help us evaluate our research we will be using the strategies for DS evaluation proposed by (Pries-Heje, Baskerville, & Venable, 2004)
6) ***Communication:*** The final step consists of communicating the problem and its importance and how the artefact contributes to a solution. This communication can be done by scholarly publications, workshops, or other means that reach those interested.

This process has four possible entry points or initiations: 1) Problem-centred, in case the research starts from the definition of a problem; 2) Objective-centred, when there is already a set of objectives defined; 3)Design & Development centred if there is already an artefact not formally analysed in the problem domain or; 4) Client/context centred would consist on the evaluation of the performance of a solution that was already applied.

Our investigation was problem-centred initiated since it started with the identification of a problem with the other five steps following in order to complete the full research cycle. Figure 2 shows the DSRM process instantiated for our research in particular, with the results for each step described.

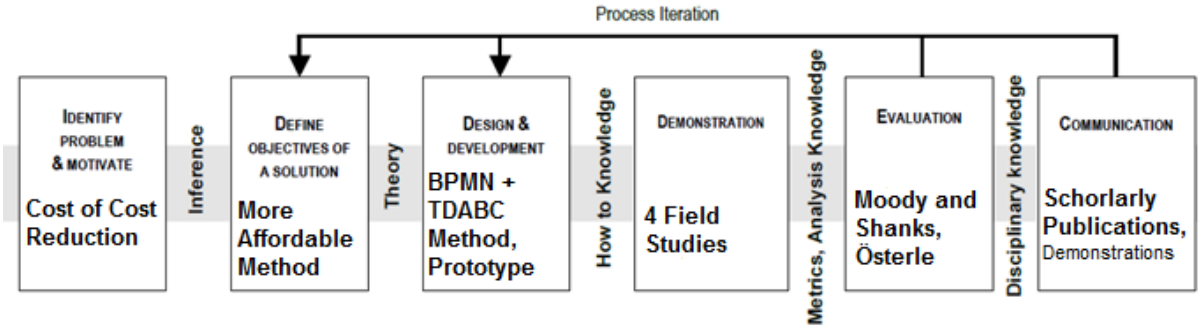


**Figure 2 -** Instantiation of DSRM

This instantiation aims to present a brief summary of how each step of the DSRM was applied to our research, and the results obtained.

## 1.2 Thesis Structure

With the intent of providing a clear presentation of the contents of this research respecting the steps defined in DSRM, we decided to create the structure of this document according to these same steps. Therefore, with some exceptions, the chapters of the report will have a direct relationship to the steps of the proposed nominal process. This relation is expressed in Table 1.

| Chapter | DSRM step |
|---|---|
| Introduction | Problem Identification and Motivation<br>Definition of the Objectives for a Solution |
| Problem | Problem Identification and Motivation<br>Definition of the Objectives for a Solution |
| Related Work | Problem Identification and Motivation |
| Objectives | Definition of the Objectives for a Solution |
| Proposal | Design and Development |
| Demonstration | Demonstration |
| Evaluation | Evaluation |
| Communication | Communication |
| Conclusion | |

**Table 1 -** Mapping between DSRM and Thesis Structure

# Chapter 2

# Problem Statement

This section corresponds to the problem and motivation step of DSRM. We will start by presenting the problem identified which gave rise to this research, and then the motivation that is behind its resolution. Finally we present the research question that was based on the problems defined, summarizes them and was used as the major guideline for the rest of the research.

## 2.1 Problem

Costing has long been a major concern for organizations. Cost efficiency has always been one of the competitive advantages that organizations have tried to achieve. Cost efficiency is what allows organizations to reduce the price of their products or services or increase their profit margins being therefore one of the aspects that brings more advantages to an organization.

But there is the other side of the coin. Although cost efficiency is useful to provide organizations the mechanisms needed to increase their margins and profits, it is not optional and without it organizations cannot thrive. They are currently inserted in an economy that is growing more competitive and are amid a long period of economic uncertainty (OECD, 2009). This uncertainty has on one hand increased many of the costs organization have and, on the other hand, has reduced demand significantly. It has also contributed to the fact that organizations, in particular SMEs, have now more difficulties on obtaining capital (European Comission, 2005). So what we have are organizations with less margin of manoeuvre in prices and an increased pressure in costs.

This drives to a point where companies only have two options: They can increase their revenues (being the main obstacle the reduced demand) or reduce costs (in this case the main obstacle is to know where to reduce them).

In the context of this research, although reckoning that efforts can be made on the side of cost or on the side of revenue, we will focus only on costs. This goes along with a trend that we have observed: organizations in general, are trying to be more efficient and to be more cost-aware instead of simply raising prices since this is less sustainable.

To achieve this goal of cost analysis and reduction, organizations normally resort to Cost Accounting. The issue with traditional cost accounting is that its results have a very large granularity, not giving detailed information and normally is only focused on mandatory state-demanded reports (Hicks, 1999). When it comes to calculating the cost of a product or service, traditional methodologies give inaccurate values, sometimes leading to bad decisions (Lambert & Chen, 1996). They are normally inaccurate because of a wrong distribution of overhead costs that have grown from being minor to being the major slice of costs (Škoda, 2009).

Fortunately there are several methodologies that take this into consideration. But all of them have a catch. They are very complex, require a lot of expertise (Hall & McPeak, 2011) and are normally supported by very expensive software solutions. For large organizations this is bearable, but it closes the access of SMEs to these tools (Hall & McPeak, 2011), when probably these are the ones that most need it since their market is more competitive (Nandan, 2010) and they are more exposed to the effects of an economic crisis (OECD, 2009).

So a paradox is reached: Organizations, in order to survive, need to reduce costs, and to know where to reduce them they need to dramatically increase their costs. This leads us to the main problem of our research:

**Problem: The costs associated to cost analysis make it unaffordable for SMEs.**

To address this problem we propose a solution that results from our observation that organizations within the same industry have very similar business processes. A possible approach would be to take advantage of this overlapping, and doing the analysis only once for each process instead of repeating the same analysis with the same results all over again in each organization.

For this to be possible there would have to exist a way to represent these processes that are common between organizations in the same industry, with a particular emphasis in modelling the costs. The problem is that, although there are many standards related with Business Process Modelling, none of the most used takes cost as a first-class element in the modelling process. This is necessary so there is a representation that is common to all organizations making the obtained models sharable between them, allowing an analysis done by one, applicable by another. This takes us to our first sub-problem (SP1):

**SP1 : Cost is not a first-class citizen in Business Process Modelling**

Finally another problem that we identified was that when efforts were made to do a cost analysis, the analysis was done on a one-time basis and offered more as a project that as a service. This means that only a specific time frame is analyzed and that does not take into account the variations that a organization will have over time. They are also more focused on providing a static report at the end of

the analysis instead of a monitoring tool for organizations to constantly evaluate their processes and re-design them when needed as defined in the business process management cycle. This leads to sub-problem 2.

**SP2 : Cost reduction is offered as a one-time project and never as a service**

With the problems of our research identified we can now move on to finding the motivation behind solving them.

## 2.2 Motivation

This sub-chapter tries to accomplish what is described by (Peffers & al, 2008) as justifying the value of a solution in order to motivate the researcher and the audience of the research to pursue the solution, accept its results and contribute to understand the researchers reasoning.

As expressed previously in the problem section, cost analysis is shifting from an option to organizations that want to improve, for being a must for those that want to survive. This is, from our point of view, the main motivation for companies to do a cost analysis. But as seen in the problem statement, accurate cost analysis methodologies are out of the reach of most SMEs.

Adding to this, less accurate costing methodologies may provide wrong information thus leading to wrong decisions (Lambert & Chen, 1996). We shall now present the advantages of having the right information, and what decisions can managers do with them. This aims to act as an illustration to the motivation for the resolution of this problem.

Normally cost objects (products, services, clients) profits have a distribution according to a variation of the Pareto Rule (or the 80-20 rule). This is called the whale curve of profitability (Kaplan & Narayanan, 2001). What is observed is that the 20 percent most profitable generate 150 percent of the profit, that the following 60 percent are breaking even and then there are 20 percent that destroy that surplus of profit (Kaplan & Narayanan, 2001). This information can be seen graphically in Figure 3.

It becomes clear that, one organization having this information would gain a competitive advantage since it would be able to identify which cost objects are being more prejudicial and then apply corrective measures on them, thus increasing total profit. But for this to be possible the correct information is necessary, otherwise a company could be applying "corrective measures" to an output that is in fact profitable.

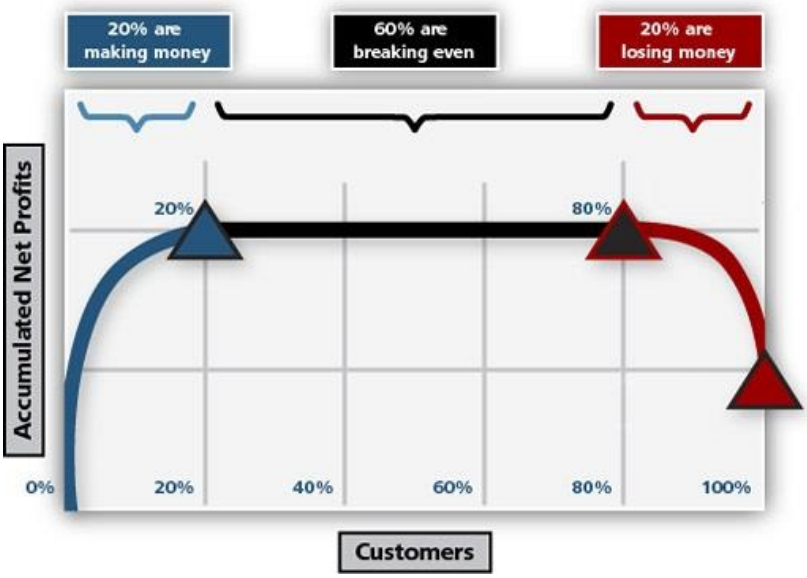


**Figure 3 -** Whale Curve of Profitability

Other than the "efficiency of products", another aspect that one might want to look at is the efficiency of resources. This is to see which are under-performing, which are over-performing and why. For this it is needed to know exactly the consumption of each resource *versus* its capacity.

Another perspective that normally interests managers in what concerns cost is their source. Sometimes managers may even know the costs of their organizations or outputs, but may not know exactly what created them. Costs normally are composed of different components that will slice down the price, resulting on the margin. This is called the profit waterfall. Identifying these components is crucial, and identifying them well so that the correct decision is made. Figure 4 illustrates this.

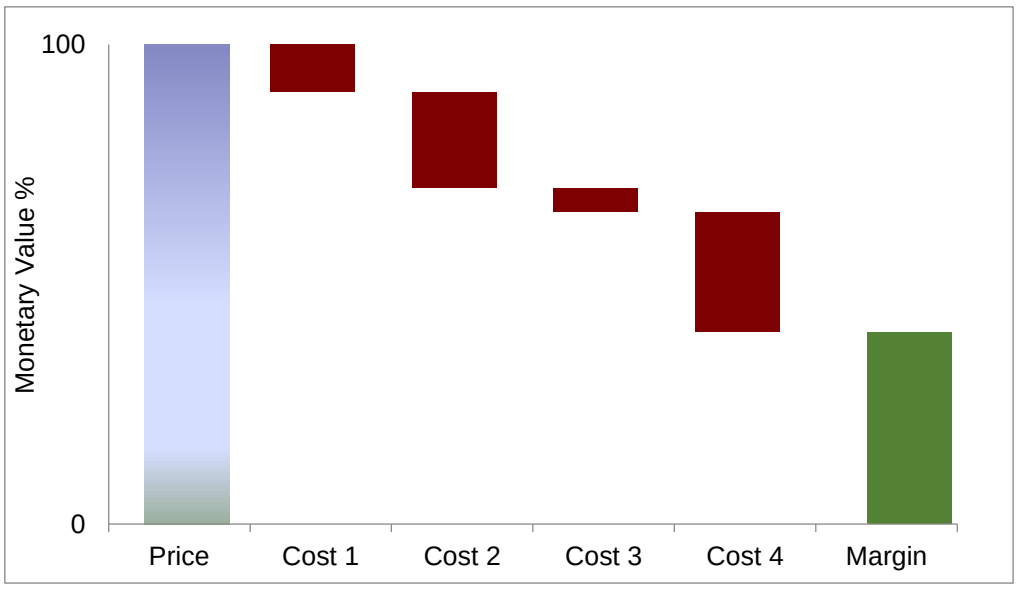


**Figure 4** - Profit Waterfall

In sum, the motivation for this research is that by providing a method for SMEs to clearly identify their costs in a more affordable, easier and less complex manner so that it is accessible for any organization. The method will enable them with some tools hitherto only available to larger organizations, and it could be a positive contribute to their efficiency both regarding outputs but also considering their internal structure.

## 2.3 Research Questions

We propose in this thesis to model and calculate of the costs of organizations using contributions of BPMN and Time-Driven Activity Based Costing with the intent of making the cost analysis more affordable both in capital as in expertise, and easier. It proposes a method that tries to identify all the similarities between organizations inside a particular industry, and with those identified create a template that can be then instantiated to a particular organization.

With this is mind, our research question which will serve as point of departure for our research is:

**RQ : How can BPMN and Time-Driven Activity Based Costing be used together to make cost analysis and modelling more accessible?**

We use the word accessible since we intend to make cost analysis not only more affordable in terms of capital but also less demanding in terms of financial expertise.

Considering this question we believe the main artefacts of our research will be:

- A method to model business processes with particular focus on costs, and that tries to take advantage of the common aspects between organizations
- A prototype to support the method that will assist in the steps of the method and that will allow to offer costing as a service

These contributions were put to practice using several case studies in real organizations in multiple industries and were evaluated according to the principles proposed by (Österle, et al., 2011) and using the Moody and Shanks Quality framework (Moody & Shanks, 2003). These gave us criteria that we, through interviews, used to evaluate both the method and the results in the demonstrations.

## 2.4 Summary

In this chapter we presented the problem statement of this research. This problem was atomized into smaller problems like stated on the DSRM process. We then presented the motivation behind a possible solution, illustrating it with two major contributions of a possible solution. Finally we presented the research question that acted as a guide for the remaining work.

# Chapter 3

# Related Work

In this chapter we will present the context where this research is inserted, an overview of the tools and methods that are available and could contribute to solve the identified problem, other related work like other research done about the subject, and in what aspects it differs from our proposal. After this description we will provide a small section of discussion explaining in detail the reasons behind our choices on the tools to be used.

## 3.1 Thesis Context

In this subchapter we intend to give a brief overview of the context where this research is inserted. To do this we will start by providing an explanation of what are business processes, business process modelling (BPMod), Business process management (BPM), Business Process Standardization (BPS), Business Process Reengineering (BPR), how they are linked together and how they relate to the BPM cycle.

**Business processes** can be defined as a set of one or more linked tasks that are executed in a particular order to realize some goal (Chinosi & Trombetta, 2012). Normally they have inputs/outputs and are executed within the context of an organizational structure, sometimes spanning outside it. **Business Process Management** (BPM) aims to provide governance of the processes of an organization to improve agility and performance. It considers the full cycle since Design to Optimization. It includes methods and tools to support the design, enactment, management and control of business processes (van der Aalst, ter Hofstede, & Weske, 2003). On the other hand **Business Process Modelling** is the definition of manual or automatic aspects of a business process (Chinosi & Trombetta, 2012). Basically it consists on representing the business process with some

notation or standard so that they can be used for analysis, execution among others. **Business Process Standardization** is the effort of capturing the common activities done by organizations or similar and achieving homogenization of these processes within a firm or even multiple firms (Beimborn, Gleisner, Joachim, & Hacketal, 2009). Finally **Business Process Reengineering or Redesign** (BPR) can be defined as a radical redesign of processes in order to obtain improvements in performance (e.g. cost, quality or service) (Ozcelik, 2010) (Davenport & Short, 1990). Figure 5 provides an overview of how all this concepts relate and where these paper is inserted. using as foundation the BPM Cycle.

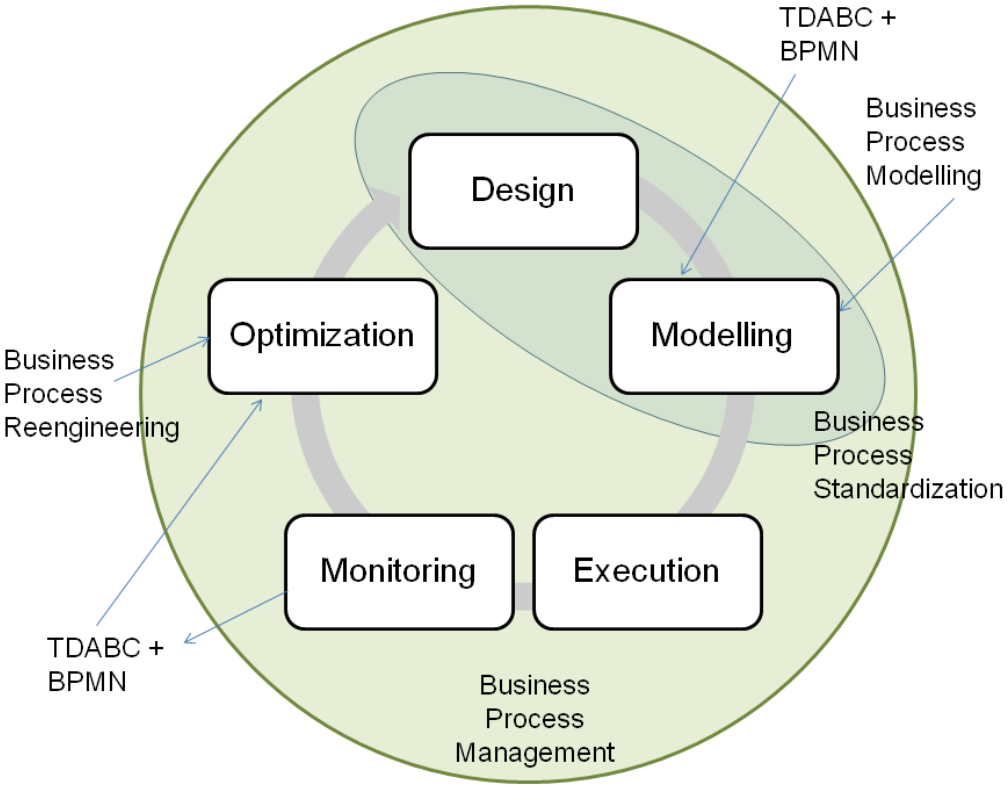


**Figure 5 -** BPM context and cycle

The proposal of this research is a method that is mainly focused in the modelling and monitoring steps of the BPM lifecycle. It is used to model the processes of an industry with special attention to its costs so that it becomes possible after their execution (not related to our method) to monitor those same processes. Our method should then give as output, the costs of the processes which should be useful for their optimization.

This method also takes advantage of, and contributes to, Business Process Standardization, since its goal is to produce templates that capture common processes between organizations.

## 3.2 Modelling Languages

In this section we will make a brief description of some of the modelling languages or notations that were options to use in our research. We will explain their main features and relevant aspects to the research. The choice of the language will be justified in the end of the chapter.

### 3.2.1 DEMO

DEMO stands for Design & Engineering Methodology for Organizations (Dietz, 2006) and is a methodology for representing, (re-)designing and (re-)engineering organizations. It is based on the theory of Enterprise Ontology (EO).

EO is focused on providing an insight into the essence of the operations in organizations. By essence it is meant that this insight is fully independent of the realization and implementation. This level of abstraction tries to represent what is done, and not exactly how it is done. This would allow stakeholders to focus on the essence (more static) and not lose themselves on the detail (more variable).

To achieve this, DEMO presents a set of models that allow to model the business processes in an organization and each of these models is expressed using specific diagram types. In the context of this proposal the most relevant ones would be the Construction Model and the Process Model, that represent the transactions and the processes within the organization respectively.

To create these models there is a nominal process with defined steps that starts with the description of the organization and ends with its representation. DEMO also presents itself as being essential, coherent, consistent, complete, modular and objective and, unlike other methods, leaving no room for creativity of modellers.

### 3.2.2 ArchiMate

ArchiMate is an enterprise architecture modelling language that aims to provide the instruments to support enterprise architects in describing, analysing and visualizing the relationships among business domains in an unambiguous way. One of its objectives, is to describe the construction and operation of business processes, organizational structures, information flows, IT systems and technical infrastructure. The description should not be limited to the concepts but should also describe the relationships between them.

It has its origin in TOGAF (The Open Group, 2011), a standard to develop enterprise architectures and complements it by providing a graphical modelling language.

It differentiates itself from other modelling languages such as Unified Modelling Language (UML) or Business Process Modelling and Notation (BPMN) by having an enterprise scope. On top of this since, as mentioned, one of the goals is to describe a set of concepts each of them in its domain, normally other modelling languages focus on only one domain (for example BPMN is used for business process modelling).

ArchiMate describes Enterprise Architecture in three layers: Business, Application and Technology. Each layer uses the services provided by the lower layers. A service is defined as a unit of essential functionality that a system exposes to its environment and is accessible through interfaces.

Since ArchiMate is more oriented to Enterprise Architecture, it does not provide the level of detail offered by languages used at the design level. For example, ArchiMate provides basic components to represent a Business Process, but has a more limited set than others developed specifically for this purpose. To solve this issue it is possible to have an ArchiMate model linked to one developed in a different language.

### 3.2.3 BPMN

Business Process Model and Notation (BPMN) (Object Management Group, 2012) has become the *de-facto* standard for modelling business processes (Chinosi & Trombetta, 2012) in a graphical way.

BPMN is a graphical notation that aims at providing a notation that is easily understandable for all stakeholders (e.g. analysts, users, developers, audit teams) to represent the steps in a business process. To achieve this it has four categories of elements: flow objects, connecting objects, swim lanes and artefacts. These elements can be used together to form Business Process Diagrams (BPD) as exemplified in Figure 6.

Flow objects are events, activities, or gateways, and are elements that state what is done, in what conditions, and what triggers the events. Connecting Objects indicate the flow between activities, events and gateways. This flow can also define message flow or associations. Swim Lanes work as a graphical separation of roles or departments, allowing to clearly identify in inter-departmental processes, to which department each activity belongs. Finally artefacts are used to provide additional information about process that do not affect the flow.

Although there are a large number of business process modelling available, the fact of being the most widely used and applicable to any kind of organization (Chinosi & Trombetta, 2012), makes BPMN a primary candidate for any research that requires modelling of business processes.

BPMN was also developed with the intent of being possible to be interpreted automatically, which can be valuable when there is an intention of importing Business Process Diagrams (BPD) to an Information System (IS).

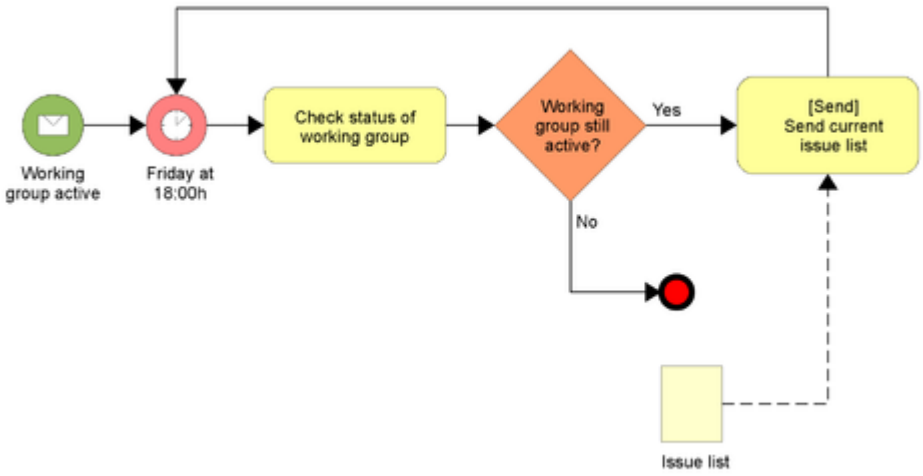


**Figure 6 -** Example of BPMN Business Process Diagram

Recently BPMN 2.0 was released and introduces new notational changes and additions like choreography and conversation diagrams and new events. We will not do a thorough analysis of this new version since its additions bring no additional contribution to our research, except the introduction of the BPMN metamodel which can contribute to the validation of the integrity of a model.

## 3.3 Costing

In this section we will start by providing an overview of what is Cost Accounting and what is it used for. We will then present the main cost concepts necessary to understand this proposal and finally present the most relevant costing methodologies that were analysed. The reason behind our choice in what concerns the costing methodology is presented in the end of the chapter.

### 3.3.1 Cost Accounting and Management

Cost Accounting is the process of collecting and analyzing the costs associated with the activity of an organization and its outputs. The goal of cost accounting is to gather all possible information and then structure it so that it can be used by management to take decisions and to measure performance. Cost Accounting provides the detailed cost information that management needs to control current operations and plan for the future (Vanderbeck, 2013).

Management Accounting on the other hand is the activity developed by accounting and financial professionals to contribute to the design, evaluation of control of business processes in order for them to drive economic value.

Cost Accounting has for many years seen its popularity among organizations drop. This was caused by the intensification of reports demanded by law which made the companies more focused on gathering information required to create these reports (tax accounting), and then evolved to an analysis more focused on ratios and other indicators (financial accounting) (Hicks, 1999). The last two decades and, in particular, the last few years have brought back the analysis on the performance of the outputs of the organization.

There are Information Systems to support Cost Accounting. These are called Cost Accounting Information Systems and are a subset of Accounting Information Systems (AIS). The goal of these is to record transaction data, and to calculate the cost of the outputs of an organization.

### 3.3.2 Cost Concepts

In this sub-chapter we will give a brief description of cost-related concepts since it is important to clearly understand the proposed artefact.

A **cost** is incurred whenever inside an organization a resource is used for some purpose (Blocher, Chen, Cokins, & Lin, 2006). A cost object is any output of the organization (product, service or customer) to which costs are assigned for some management purpose. Costs can be classified according to several aspects, They can be divided by the **nature** (if they are labour, material or expenses), by their **traceability** : direct if can be economically traced to a cost object (e.g. material) or indirect if not (e.g. HR department); by their **behaviour** : fixed if the total cost does not change with volume (e.g. rental) while variable costs are those that are affected by volume (e.g. material).

Often, costs are collected into meaningful groups called cost pools. The assignment of costs to cost pools is called cost allocation and is done according to cost drivers (also known as allocation bases).

In the context of this research it is also important to define the concept of product cost and period cost. Product costs is the cost necessary to complete the product: direct costs, and overheads related to the product. Period Costs are all non-product expenditures of the organization. The sum of these two is called the total cost. In this research we try to apply period costs to product costs, this way distributing total costs by cost outputs.

Figure 7 presents a diagram that tries to summarize these concepts graphically.

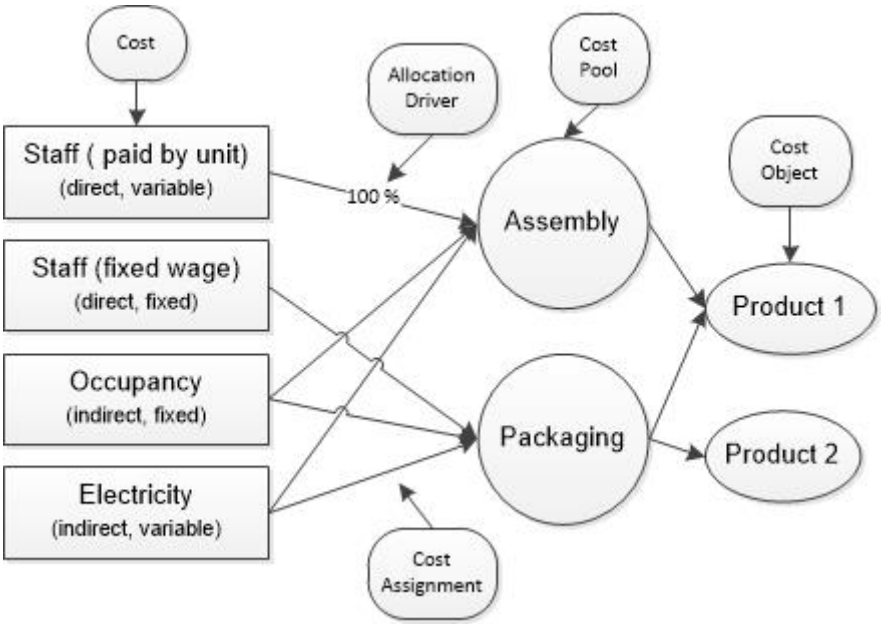


**Figure 7 -** Cost Elements Diagram

### 3.3.3 Activity Based Costing

Activity-Based Costing (ABC) is a methodology that was developed in the early 80's with the intent of presenting a new approach to cost information (Cooper & Kaplan, 1988) that until that point was limited to tax and financial accounting. (Hicks, 1999). It is supported by the basic premise that a company's outputs (its products and services) give rise not only to the functional activities or tasks that produce them (e.g. manufacturing), but also to support activities that are needed by the functional (e.g. IT, Administrative). Both types of activities generate costs that must be reflected on the company's outputs.

ABC can be defined has having three main steps: It starts by collecting information about all functional and support costs, routing them to the activities that made them necessary and then to the outputs that made those same activities necessary. This is represented on Figure 8.

Activities can be defined as actions executed inside the company (e.g. packaging) that have a particular cost rate that comes from the cost of the resources allocated to them. This allocation of resources to activities and then to outputs is done using interviews and estimates, and results on dividing the cost of the resources for the activities using variables like percentage or headcount. Outputs cost is then calculated by choosing which activities were needed to create it and summing their costs. (Blocher, Chen, Cokins, & Lin, 2006) .

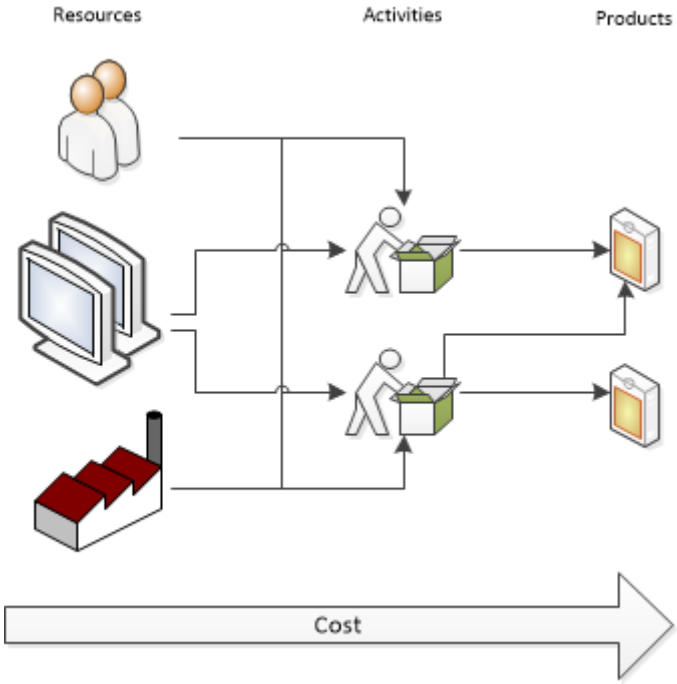


**Figure 8 -** Process of ABC

Unlike traditional costing methodologies that assign overhead costs by volume, meaning that all overhead costs or support activities are distributed by products using some variable/driver that reflects volume like number of hours regardless of the specificities of the product, ABC using activities may differentiate between products, since different products have different activities and therefore different cost rates.

Despite simple in concept, ABC has proven to have some pitfalls: The main are: 1) Since allocations are done based on interviews and estimates their accuracy maybe questioned; 2) Since it is necessary to create an activity for every task performed and specify its cost the model's complexity grows with the number of activities performed and 3) Since these activities may have variable cost (e.g. a hazardous packaging as a different cost from a normal one) and activities have a fixed cost rate, models tend to have many similar activities.

### 3.3.4 Time-Driven Activity Based Costing

Time-Driven Activity Based Costing (TDABC) (Kaplan & Anderson, 2007) is a costing methodology developed to calculate the profitability of products/services with emphasis on allocating overhead costs to these cost outputs. It was created with the intent of addressing some of the issues found when using Activity Based Costing (ABC), like its inaccuracy and the complexity associated with the need to create specific activities to express all conditions.

To address these issues TDABC was created with the objective of being simpler, more flexible, focusing on assigning overhead costs not using a traditional top-down approach but a more accurate one that starts from transactions (bottom-up), and most of all easier and faster to implement and maintain (Kaplan & Anderson, 2007). Also like its name suggests, TDABC is based on the cost of activities (inherited from ABC) unlike traditional methodologies that were normally linked only to the product as a whole, therefore it gives more flexibility and detailed information.

To address simplicity, TDABC only requires values of two parameters: 1) The unit cost of a resource (e.g. IT Department), that can be calculated from the total expenses related to that particular resource divided by its capacity (normally expressed in time) and; 2) The time needed to execute a particular task. With these two values it is possible to calculate the cost of a particular activity simply by multiplying the time taken by the unit cost.

Regarding flexibility, TDABC introduces time-equations to solve the problem of Activity Based Costing (ABC) of each activity reflecting only one factor/condition (Dejnega, 2011). If in the latter there was the need to create a new independent activity for each small variation, in TDABC linear equations are used to model the different times consumed by an activity in each of the conditions it can occur and therefore the different consumption of resources. Taking as an example the packaging of an order that takes longer if the contents are hazardous. In ABC there would be two activities: one for standard packaging and one for hazardous packaging. In TDABC it is possible to express this variation with the following equation:

$$\textbf{Packaging} = (3 + 5 * \psi) * \text{Logistics Department}$$

$$\text{with } \psi = 1 \text{ if hazardous } \vee \ \psi = 0 \text{ otherwise}$$

**Equation 1** - TDABC Time-Equation Example

This equation represents that the time taken by the packaging activity is 3 minutes, or 8 in case it is hazardous. With this time it is possible to calculate the cost by multiplying it by the unit cost of the Logistics Department.

Finally, TDABC also has the advantage of being able to give information about its own accuracy as well as help identifying waste, by comparing the calculated capacity of a given resource vs. the actual used capacity in a given period. If the sum of all the times of a particular resource used in activities is below its capacity, it normally indicates that there is waste or inefficiency. On the other hand if it is above it may indicate over-usage. On both cases the delta between capacity and usage may also indicate errors in the model construction.

### 3.3.5 Other Costing methodologies

There are other costing methodologies like Throughput Accounting (Goldratt, 1999), Lean Accounting (Maskell & Baggaley, 2006), Parametric models among many others. We decided to focus more on Activity-Based methodologies like ABC and TDABC, since our objective is to calculate business process cost and some of these are focused on value (e.g. Lean), others don't try to capture all costs (e.g. Throughput Accounting), and also there is a clear parallel between the activities defined in ABC/TDABC and tasks/Activities in business processes which will make the connection between the diagrams and the costing models easier.

## 3.4 Discussion

In this subchapter we will present what were the modelling language and costing methodologies chosen for the proposed method and the main reasons behind their choices. We will also present other research done on this subject and explain how and why ours differs from it.

### 3.4.1 Modelling Languages

To conduct our research we have decided to use BPMN for several reasons: Firstly, it is considered the *de facto* modelling language, and is the most widely used, secondly its notation is considered quite intuitive since it shares many basic elements with traditional workflows. This goes along with our objectives that are to provide a method that is understandable by all stakeholders. Secondly since it is the most used notation and our effort is to promote reutilization, the probability of a company having its processes modelled in BPMN is higher.

On the other hand DEMO is only focused on the essence of the organization (the ontological layer). Although we recognize the value of this choice, a lot of transactions that will be captured by our method will be lower levels like in the infological layer. Also we believe it would be harder for stakeholders to understand its notation.

Finally ArchiMate provides the tools to model the entire enterprise architecture, and in fact allows to model business processes, but wasn't designed for that purpose, with some authors defending that for this purpose a more domain-specific language would be preferable (Jonkers, Proper, Lankhorst, Quartel, & Iacob, 2011). Also most of our proposal would be limited to the business layer, so ArchiMate would not give added value when compared with BPMN.

### 3.4.2 Costing Methodologies

The first decision made regarding costing methodologies was to go with an activity-based methodology, for the reason stated upon the justification of BPMN as the language to be used: There is a clear parallel between tasks/activities in business processes and activities in costing methodologies. With this criteria the only options become ABC or TDABC.

We decided to use TDABC mainly due to two reasons: 1) Time-Equations allow to keep models simple and contribute to BPMN by expressing not only the cost of the activities but also the total cost of the process, no matter what flow is followed by each transaction since all conditions are expressed in the equation, 2) Time-Driven Activity Based Costing allows to calculate the efficiency of the resources and not only the profitability of the products.

### 3.4.3 Other Research

There have been other proposals to solve the identified problem but with different approaches. In the first place, in our research we had to define which proposals were comparable with ours since if we considered all research related to cost, the approaches would be uncountable. So we defined the context of our research, as that taking advantage of business process modelling and costing methodologies to get the cost of a process.

There is some research work done in this area but it is focused on different aspects. For example (Stelling, Roy, & Tiwari, 2010) uses Activity Based Costing in the design phase of a process to calculate the average cost based on a probabilistic analysis of its flows, while (vom Brocke, Recker, & Mendling, 2010) is more focused on financial and value analysis of the processes and the impact change would have in those same processes. These solutions although related to the identified problem don't solve it since they are more focused on the design phase.

Regarding modelling and monitoring of process costs there has been some research done in the manufacturing industry but these have been more focused in manufacturing than in the services industry. As an example (Agyapong-Kodua, Wahid, & Weston, 2011) gives a good overview of the cost-modelling techniques in manufacturing systems, but most of them are not graphical (which makes them not understandable to all stakeholders) and is mainly focused on prediction and not on monitoring.

All of the research found was not focused in the graphically modelling aspect, and none of them uses TDABC which we believe is the methodology that at the moment better represents process costs. Finally, and most important, none of the found research was made with the aim of increasing reutilization, and therefore driving down cost of cost analysis.

# Chapter 4

# Objectives

This section corresponds to the Objectives Definition step of Design Science Research Methodology (DSRM).

Looking back to the problem we stated that the main issue is that cost analysis is too expensive for many organizations both in human and financial capital, and following the line of thought also concluded that were two sub-problems associated: Modelling techniques normally disregard costs, and costing is normally offered as one time product instead of being offered as a service.

The main objective of this proposal is therefore to present some mechanism that enables organizations, in particular SME's, to solve these problems. This solution can be divided into two parts: the first is based mainly on taking advantage of TDABC's time-equations and some language to model costs, and a second that consists on using the models obtained from this association to create templates that can be developed once and applied to several organizations.

It is also an objective to develop a software prototype, that should support the modelling/template method and that could be the basis for a future solution that automates the application of this method.

What is intended to achieve with the sum of both parts is a method that allows organizations to have a cost calculation and modelling method that is <u>more affordable, understandable, easier to use and less dependent on external consultancy</u> allowing for smaller organizations to conduct a bigger part of the analysis process.

Apart from this main goal there are some other more specific objectives that must be met:

- The method should not be specific to any particular kind of organization.

- This method should not require specialized expertise upon the moment of the application on a organization.
- The results obtained using this method should be reusable when applied inside the same industry.
- The process should be from, the moment a company decides to analyze its costs, to the moment where results are obtained, more affordable than traditional or currently used methods.
- The method should provide results (both the model and the costs) that are easily understandable and that are expressed in a clearly defined notation.
- Models obtained from this method should be easily fed to an Accounting Information System (AIS) that supports TDABC models.

The last point created us the need of developing a prototype where we could test our models. This prototype addresses the main problem of this research as well as sub-problem 2, concerned with offering costing as a service. Some objectives were also defined for the prototype:

- The prototype should be cloud-based
- The prototype should have some way to introduce models
- Integration with financial data should be possible in the prototype

These objectives allowed us to set up a roadmap for the development of both the proposed method ,as well as the prototype that supports it. They were decided based on the problem, the necessities we identified and some principles we believe are essential to any research like Originality and Abstraction.

In the evaluation step each of these objectives will be looked upon and analysed so that we can assess if they were met.

# Chapter 5

# Proposal

This section corresponds to the design and development step of Design Science Research Methodology (DSRM) and its output is an artefact, in this case a model, that aims to solve the identified problems and achieve the objectives defined in previous chapters.

We are going to divide this chapter into two distinct parts as we did in the objectives chapter: First we are going to describe the method that uses BPMN and TDABC to model processes and its costs and that creates templates, and second, we will describe in detail the application that was developed to support these models.

## 5.1 Method

As identified in the problem chapter, costs are not normally treated as first class citizens when it comes to business process modelling. Since our intention with this proposal is to create a mechanism for organizations to reduce costs through re-utilization, it is crucial that there is a way to represent and share cost information between them.

With this in mind we can describe briefly our proposal as being **a method, that models an industry's business processes and costs, and creates a template than can be later instantiated to organizations belonging to that same industry.**

The proposed method is represented in Figure 9 and is composed of two distinct phases.

The first one called **Modelling Phase**, is done only once, and it is where the field or industry is analyzed and where a generic cost model, hereafter called a template is developed. The development of this template is done using an organization that belongs to that same industry. To develop this

template we use BPMN to model the business processes as well as its costs. To represent the costs, and the conditions that change them, associated with the processes and activities modelled in the BPDs, TDABC's time-equations are used. The value indicated for the costs in time-equations will be variables that point to resources since the actual values are only known upon the moment of instantiation. The output of this phase is the industry's template.

The next phase is the **Application Phase**. At this point the resulting template from the previous phase is applied to a specific organization. This consists on its instantiation, where actual costs will be applied to the template, activities that might be missing or in excess are changed, and all the specificities of the organization will be expressed in the final model. This adjustment is necessary since, however similar organizations in the same industry are, each one has particularities, that sometimes are their competitive advantage, and that have different costs associated to them. Once this is completed, managers can then use available transaction data to calculate the costs of the organization.

Finally there is a control and monitoring step that aims to continuously improve the template by providing information about its accuracy upon each instantiation.

Since this method is defined into several distinct steps organized in a nominal process, it has the advantage of assisting the analyst developing the template or the manager instantiating it, by presenting them with a kind of road-map where it is possible to detect some possible errors in advance.

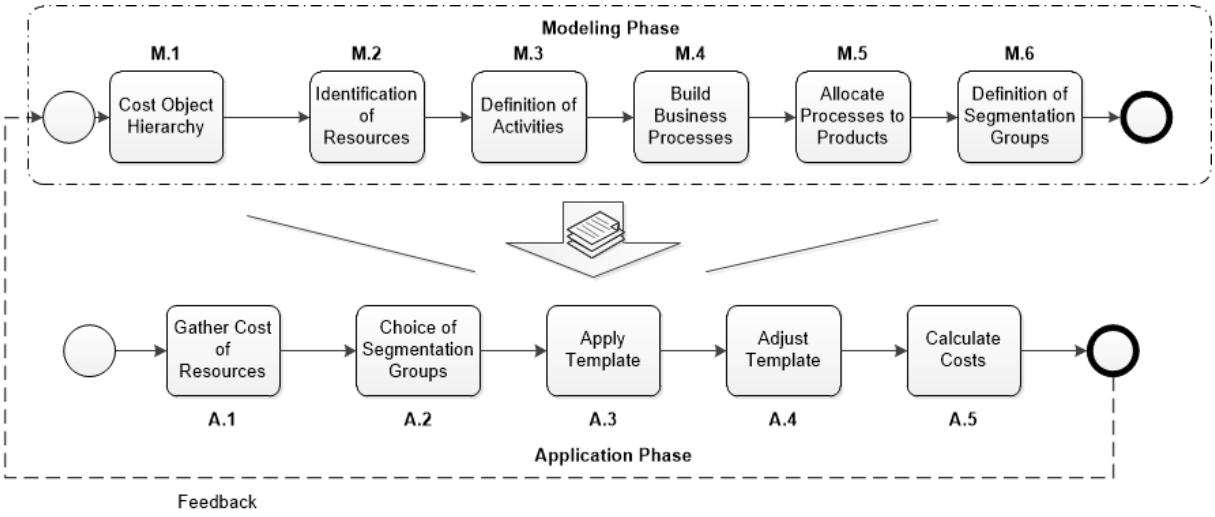


**Figure 9 -** Graphical Representation of the Proposed Method

With an overview of the method, its phases and outputs, we will now present in detail the model, and each step of the execution of both its phases. In each step we will present a description of what is done, the results that should be obtained, and what is the relation between them. We will also provide

when necessary, restrictions and validations, that should be applied to guarantee the correctness of the results.

### 5.1.1 Modelling Phase

The **Modelling Phase** consists in six steps and aims at modelling an industry and creating its costing template.

**M.1. - Cost Object Hierarchy**

The first step in a method concerned with costs and profitability must be to set a target. This target will indicate where the results will reflect, and how they can be organized to help structuring the analysis. Typically this is done by starting at the individual transaction level and then moving up and creating groups according to where the analysis should be focused. For example, transactions can be grouped into orders, that are then grouped by client and so on. An example of a cost object tree is present in Figure 10.

It is important to do this elicitation in the beginning of the analysis since it will define which parts of the organizations will be modelled and therefore which resources, activities and processes will be necessary to analyse. It is also important to know what data will be needed for the aggregation of results once calculating costs.

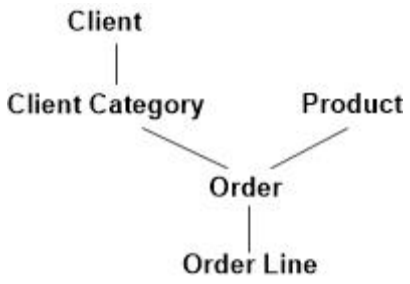


**Figure 10 -** Cost Object Hierarchy Example

**M.2 - Identification of Resources**

Following the cost object hierarchy the analyst should then gather all the resources, both direct and overhead/support, that are related to it and organize them into resource pools. A resource pool (RP) is an aggregation of resources based on some allocation driver, and normally represents a set of resources that work together for some role like for example, a department. In order to assist on the development of the model, we divided this step further into four sub-steps. These steps are illustrated on Figure 11, and their result is represented on Figure 12.

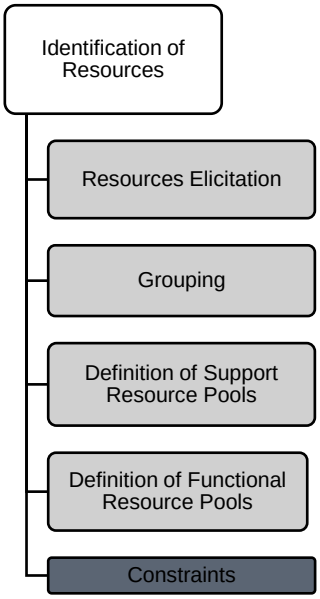


**Figure 11 -** Identification of Resources Step

a. *Resources Elicitation* - This step consists on gathering all the resources needed. This should be done through interviews with a manager or a financial director, and should, when possible, be supported by the values present in the general ledger. It is also necessary in this step to distinguish between which are direct costs (like material) and others, since direct costs are allocated directly to products.

b. *Grouping* - This is an optional step. It consists on considering several resources as being only one. The decision of whether or not to group resources is up to the analyst and it is only based on the level of detail wanted. An example of a group would be to treat all employees as one resource called personnel instead of considering each employee a resource.

c. *Definition of Support Resource Pools* - In this step support RPs are identified. These will be RPs that do not have direct interaction with the outputs of the company, but are necessary for it to work (e.g. Human Resources Department). Resources from the previous steps may be allocated to these support RPs through an allocation driver. Support RPs must be allocated to a Direct RP. The distinction between Support and Functional RPs is necessary to better distribute resources and also to reflect the structure of the organization.

d. *Definition of Functional Resource Pools* - RPs identified in this step are the ones that interact directly with the outputs and will be the ones linked with activities and therefore those that conduct costs to processes. Their costs can come directly from Resources or from Support RPs.

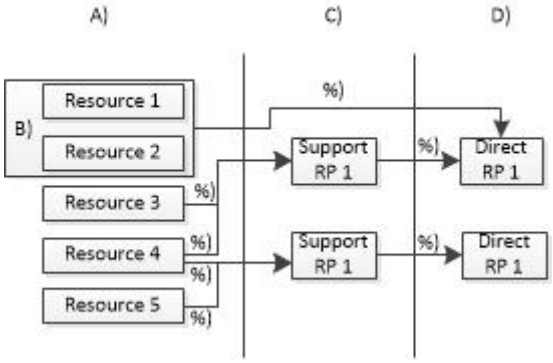


**Figure 12 -** Identification of Resources

Functional RPs do not allocate their cost forward to products with static drivers like the allocations done up to this point. For each output its cost is calculated based on its time consumption. This way of allocation is one of the corner stones of the TDABC method and it will be the link to time-equations. This is what will allow to accurately and dynamically calculate costs of activities, as well as the efficiency of these RPs. Since time-equations are based on time, only the resources used will appear on the product with the remaining being considered waste. The unit cost is calculated according to Equation 2 where cost is the total cost allocated to that Functional RP, and capacity is the total time available from those resources (e.g. the sum of all employees/machines allocated to that RP). This capacity will also be used later in the method to calculate the waste/efficiency of each Functional RP.

$$\text{Unit Cost} = \frac{\text{Total Cost}}{\text{Capacity}}$$

**Equation 2** - Calculation of Unit Cost

e. *Constraints* - There are some constraints that have to be considered to assure the correctness of the model. Some of these are shown graphically in Figure 13, in particular those concerning the relations between elements. These are:

- Regarding Figure 12 the total amount of the allocations going through each vertical line must always be the same and equal to the sum of all non-direct resources. If this value isn't the same it means that there are incomplete allocations, meaning lost costs.
- Resources and Support RPs cannot be allocated directly to activities, to products or to the cost object hierarchy (once again direct materials as an exception).

- Each activity may only have one Functional RP
- Each resource may only belong to a group
- Direct materials are allocated directly to the transaction unit level in the cost object hierarchy

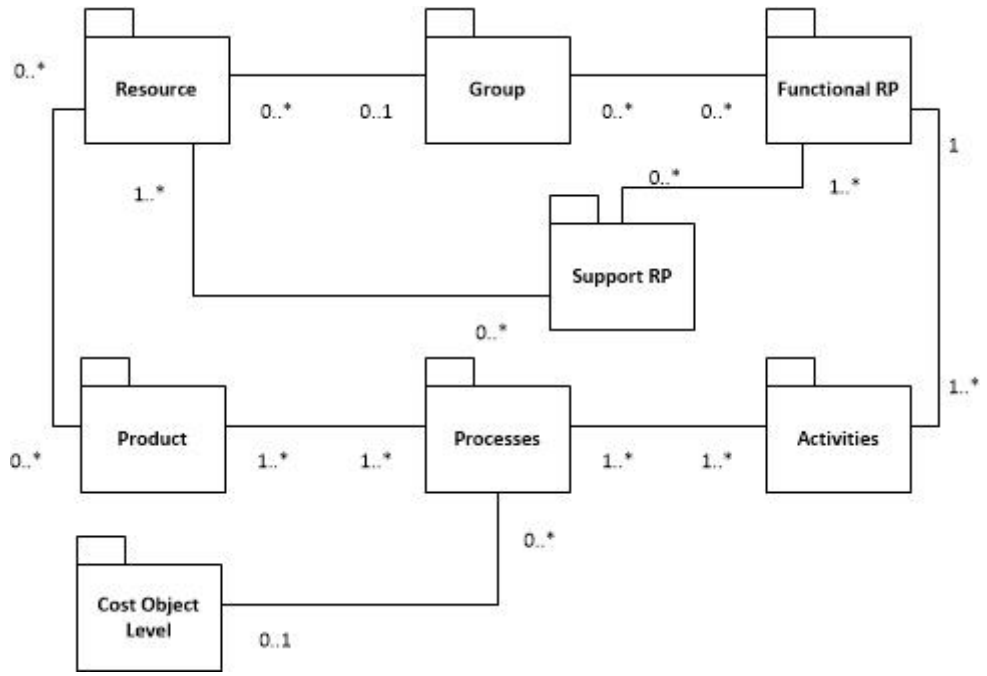


**Figure 13 -** Model of the Resource Elements.

**M.3. - Definition of Activities**

With the Resource Pools defined, the activities that are executed by organizations inside an industry must be identified, and linked to the cost object hierarchy.

a. *Identification of activities* - For each identified activity, the consumption of resources must be modelled. For this purpose we use the contribution of BPMN, extending it so that it uses TDABC's time-equations, to associate the resources and their costs to activities. This association is done using text-annotations. It was decided to use text-annotations instead of adding new attributes, since these are graphical which helps in understanding the model for those not familiar with BPMN. Regarding the importation of models, the information on text-annotations is also a part of the XML file that represents a BPD.

   Each activity must be linked through the time-equation with one, and one only, Functional RP. The amount of time in the time-equation will reflect the usage that an activity will have from its Functional RP. An example of an activity modelled using BPMN and TDABC can be seen in Figure 14.

b. *Linkage to Cost Object Hierarchy* - Activities will be what allocates costs to the outputs of the organization and what will allow monitoring of the efficiency of the organization in its several departments. The allocation of these costs is normally allocated directed at the transaction unit level (what was produced), but in some cases they have to be directed to an higher level in the hierarchy (e.g. processing an order affects several transaction units) and then distributed to the lower levels. This distribution of costs from activities has to be expressed in this step.

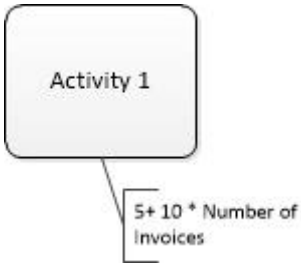


**Figure 14 -** Example of Activity with Time-Equation

To explain the time-equations in Figure 14 we can see that "Activity 1" consumes 5 units of a functional RP assigned to it, plus 10 minutes for each invoice.

**M.4. - Construction of Business Processes**

Since the method's goal is to maximize reutilization, the same activity can be used in several processes. This way there is no need to create for two different processes, two different activities, which in reality would be the same. A clear example of this situation would be the process payment activity that is present in many business processes, but with exactly the same execution and cost. With this approach the creation of a business process consists on selecting the activities that compose it, and specifying the conditions when they occur and their order, although the latter has no reflection on costs.

With the process defined, costs of the process result of the sum of the time-equations of all activities. The result of this step is exemplified in

Figure **15**.

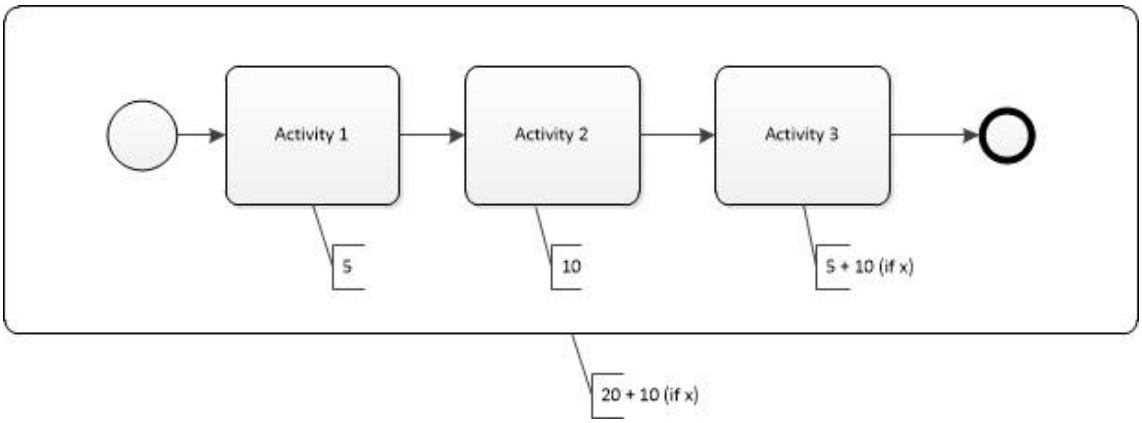

**Figure 15 -** Example of Business Process with Time-Equations

### M.5. - Allocation Processes to Products

The cost of products/services is the final goal of the calculation. In this step of the modelling phase, for each product, the processes that contribute for its creation (or contribute with costs in some other way) must be allocated to it. Once again the cost of a product will result from the sum of the costs of the processes that contribute to it plus direct materials. This is not the same as the allocation done previously to the cost object hierarchy, since two processes maybe linked to a level (e.g. order) but each one only contribute with costs when a specific product is concerned.

Before moving to the last step of this phase it is important to show how the several steps are linked together in order to form the industry's template. This is shown graphically in Figure 16 where the cost object hierarchy is excluded to promote the simplicity of the diagram.

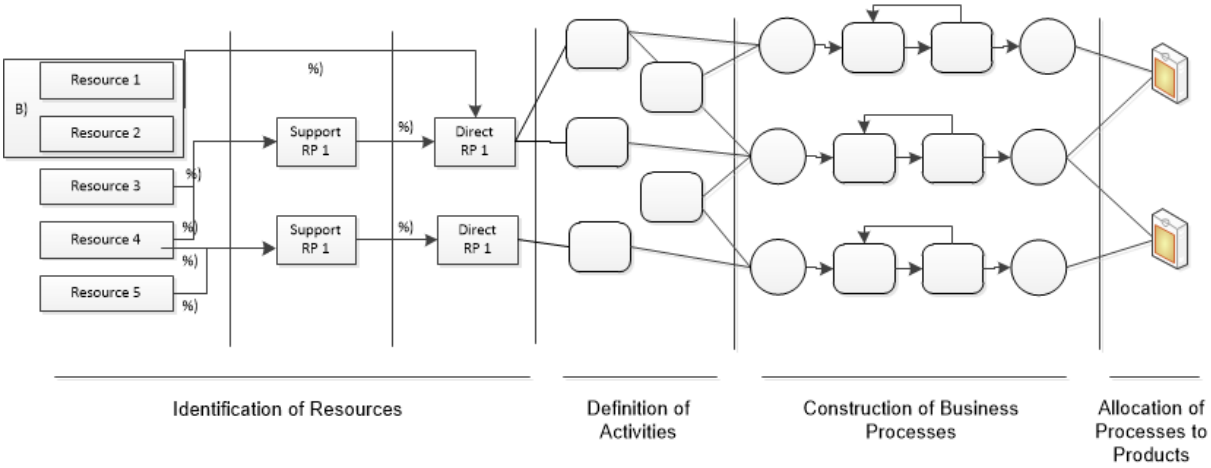


**Figure 16 -** Graphical Representation of Modelling Phase

### M.6. - Definition of segmentation groups

Finally to conclude the modelling phase, some levels of common variation can be expressed inside the template. This comes from the fact that inside some industry there is sometimes some segmentation that is based on a number of variables. These can be geographical, regarding size or equipment among others. By taking advantage of this segmentation it is possible to create packages that close the gap between the generality of the template and the specificity of the organization thus making the next phase faster. This packages may include different time-equations, activities, processes, or any other of the aspects covered in the modelling phase. This can be seen as a sub-template inside the template. An example where this could be useful would be a package for pharmacies that possess dispensing robots.

## Summary

The modelling phase has as its output a generic model that represents the costs, activities/processes and allocations for an industry called a template. This template is done only once and can be later used as input for the application phase where it is instantiated for a specific organization in order to calculate its costs and profitability. After instantiation some adjustment may also be necessary.

## 5.1.2 Application Phase

The **Application phase** consists on adjusting and instantiating the template obtained from the previous phase. This is achieved by five steps:

**A.1 - Resource Cost Gathering**

The resource structure obtained from the previous phase represents, the resources of the organization, how costs are allocated to support and functional RPs and then to products and levels of aggregation. To apply the template to a specific organization, it is necessary to gather the missing information. This is: the total cost of each resource and the practical capacity for each of the identified Functional RPs, so that it is possible to calculate the unit cost for each one. These costs will then reflect on the activities through the previously defined time-equations, and therefore in processes and products.

**A.2. - Segmentation variables choice**

At this point it is necessary to choose the correct segment of the template. This is done by choosing the segmentation packages that better reflect the reality of the organization. An organization may choose more than of the packages defined earlier, since each of them may reflect a specific feature and an organization may have both. For example a pharmacy may apply the package for automatic dispensing and the package for online sales. This ,as already mentioned, closes down the distance between the template and the reality of the organization.

**A.3. - Application of template**

With all the resources gathered and the segmentation packages added, the model needs to be instantiated to the analyzed organization. This means replacing all the variables defined in the model by the actual values of the organization. These variables will be the total cost of the resources, the practical capacity of each functional RP and the unit cost of each Functional RP that is calculated using these two values. With this value calculated the cost rate is also applied to the activities linked with the corresponding Functional RP.

### A.4 - Adjustment of Template

Obviously not all organizations, even if they belong to the same industry, are exactly the same. Some resources may have different costs (*situation* covered by step 1 of this phase), the set of activities may not be an exact match, processes may be different, allocation percentages can be different and the cost object hierarchy may not be exactly the same.

Segmentation packages try to reduce this delta between the template and the organization but nevertheless, there has to be some mechanism to take care of these differences. This step achieves exactly this goal. In this step the manager applying the template has to look at the model, if possible following the steps defined in the modelling phase, in order to find missing/not-needed elements in the model if there are any

One could argue why is this step done after the application. We made this option since we believe that, if the manager has to first assume that the template is complete before adding changes and therefore calculating the asked values, the identification of gaps in the template becomes easier. If the user would just look at the model and try to find differences it would be more difficult than, if at some point during the application, a value did not make sense and therefore raised focus to adjustment.

### A.5. Calculation of costs

In the final step of the method, with the model instantiated and adjusted, the calculation of costs for products is done using the calculations defined by the TDABC methodology. They consist basically in calculating the total time consumed at the points defined in the cost object hierarchy. With times gathered, the cost is obtained by multiplying them by the unit cost of the corresponding functional RP. An example of this operation is presented in the next subsection to illustrate TDABC calculation

To calculate the times, the method receives as input data from transactions which is used to decide the conditions expressed in the time-equations defined in the modelling phase .These define the variations of the usage of resources in the activities/processes.

With costs calculated there are some more values that have to be given. Waste/efficiency will be calculated by dividing the time consumed in each Functional RP by its practical capacity, profitability for each of the levels of the hierarchy will be calculated by Equation 3 and the total cost of the organization is obtained by summing the costs of all transactions.

$$Profitability = \frac{Profit}{Cost} * 100 \qquad Profit = Sales - Cost$$

**Equation 3 -** Calculation of Profitability

Finally, although not depicted as an independent step, there is a component of control, that aims to continuously improve the quality of the template. Upon each application the manager applying the template can give feedback in order to improve the generic model. For example, if while instantiating a template, a process or an activity is missing, the user should verify if it is in fact specific to his organization. If it is not specific, it should be added to the template, thus making it more accurate. Another option is to create another segmentation package if the manager believes that there will be more organizations in the same situation.

From the values obtained with the method, a wide course of action can be taken other than calculating profitability of products and analyzing the efficiency of resources. On top of this information, decisions can be made like investment or divestment on a product using what-if analysis. Although it is interesting, our research is concerned only on the generation of data (cost analysis). The decisions that can be taken over this data are out of the scope.

This method, apart from the contributions to business process modelling and re-engineering/ re-design, takes advantage of the concept of business process standardization. This is so because as organizations tend to standardize processes between them this would make it easier for the template while being generic to have a higher accuracy. It also can contribute for organizations, in particular small ones, by helping them standardize their processes working in more similar ways, obviously not losing their particular competitive advantages.

## Calculation Example

Let us assume that we have an organization that has been analysed and it was reached the conclusion it had two Functional RPs and each receive half the organization's costs. Table 2 presents this data and shows the unit cost for each RP.

| Functional RP | Allocated Cost (€) | Capacity(min) | Total Cost (€/m) |
|---|---|---|---|
| **RP1** | 400 | 200 | 2 |
| **RP2** | 4000 | 1000 | 4 |

**Table 2** - Example Unit Cost Calculation

Let's assume that there only exists one process, with two activities: Packaging and Delivering. The Packaging activity takes 10 minutes, or 15 if hazardous while the Delivering activity takes 20 minutes.

If we had 10 transactions, where two were hazardous, we would have a total time given by the following multiplications.

| | |
|---|---|
| 8 * Normal Packaging (10) | = 80 min |
| 2 * Hazardous Packaging (15) | = 30 min |
| | 110 min |
| 10 * Delivery (20) | = 200 min |
| **Total Time** | **= 310 min** |

Table 3 gives the total cost and time distributed by the activities.

| Activity | Func RP (Unit Cost) | Total Time (m) | Total Cost (€) |
|---|---|---|---|
| **Packaging** | RP1 ( 2 €/m) | 110 | 220 |
| **Delivering** | RP2 ( 4 €/m) | 200 | 800 |

**Table 3** - Example of Cost Calculation

This gives a total cost for this period of 1020€. it is also possible to do the calculations for only one transaction, by using only it's time and not the total. From this information we can also see that there was an efficiency of 55% in RP1 and 20% in RP2. This is obtained by dividing the time used by the activities, by the capacity of the RP.

In a situation where there were direct costs, these could be added to the cost of the product, after the costs of activities (that represent overhead) had been calculated.

### Summary

The application phase is used to instantiate the templates modelled in the first phase. This instantiation consists on applying the actual values of the organization and adjusting the model to its specificities. After this instantiation is complete, the models can be used to calculate the costs, as illustrate on the calculation example.

## 5.2 Prototype

Although our proposal is more focused on providing a method to model and calculate costs of organizations, in particular for SME's, that is affordable and doesn't require specific cost accounting expertise, we have found that by itself it did not achieve all the objectives of our solution. Other than this, we also found that the volume of data in each demonstration made it not feasible to process all data manually or using spreadsheets.

Regarding the objectives that weren't met, fully or partially by the method, these were: 1) those related with users not needing to have expertise; 2) the objective related to the cost of the analysis and; 3) the aspect mentioned in the problem of cost analysis typically being provided as a one-time product instead of a service that could be linked with the Business Process Re-engineering cycle.

Regarding the first issue, we believe that a user with absolutely no expertise on cost-accounting, even considering that he would have the template as a starting point, could not run the model without any kind of assistance. We believe the prototype will provide this assistance by offering a friendly user-interface, and because of course it runs the model on behalf of the user. This also takes us to the second issue. If without a tool to support the user, he/she would not be able to use the model from the template, and would eventually have the need to resort to someone with the expertise which would increase costs dramatically, which would go against the objective of this research.

Regarding the last issue mentioned, we must provide a way for the method to be offered as a continuous service integrated with the BPM cycle. This is not feasible if it is required to have one individual of the company to be constantly updating the model and manually running it with new data. A prototype would allow for this to happen with almost no human intervention particularly through data integration.

Finally, the main objective of the method is to promote the reutilization of the generated model. Although this would be possible to do without any IT-related tool, the dissemination of a model would be much easier using the Internet.

Now that we have provided the motivation for the development of the prototype by presenting the main issues it should address, we will now make a description of it by explain its main characteristic and features. We will not present a very technical-oriented exhibit since once again we state that the prototype is not the core of our proposal.

After the explanation of the features we will also present the limitations as well as future developments planned for the prototype.

### 6.2.1 Features

- **Usage of templates**

  This feature is the core of the developed prototype. This application supports the templates that result of our proposed method. Not only does it support the application phase where the model is instantiated to a particular organization but, it also supports the modelling phase making it possible to develop the template inside the application.

  To aid the user in this task the application is itself designed and developed according to the steps of both phases of the method, guiding the user through the several steps starting from the importing of resources and allocating them to Support and Functional RPs, passing by the definition of the activities and their time-equations (explained in more detail in the next bullet),

and ending in the definition of processes and allocation to products.

This wizard-like structure will allow users with little or no expertise, to apply the developed templates, or in the limit, creating a template themselves.

Although not fully implemented at this point, the prototype was designed to support two roles (analyst and manager). These roles change the application according to whom is using it. If the user is an analyst the application is focused on the development of templates. If the user is a manager the application offers the set of available templates and provides the tools for their instantiation, adjustment and calculation of costs.

- **Edition of Business Processes**

One of the main issues reported by users of AISs, in particular those that provide support for TDABC models, is the difficulty in modelling the processes and building the time-equations associated with the activities performed. In small time-equations like the ones presented in the method's examples, this is not a real issue, but when the number of conditions tends to grow, the complexity of the equation increases as well.

Normally AISs ask the user to manually insert the time-equations. Apart from the fore mentioned complexity associated with the definition, this is also error prone.

To solve this issue we created an editor of time-equations that tries to resemble a typical spreadsheet. Each component of the time-equation would correspond to a line where the user chooses the resource (from a list of options), the condition (from a list of options) and gives the time associated to each component. There is also an editor for the list of resources and conditions. This way the only possible error is the precision of the coefficient associated with each condition. A screenshot of this feature is on Figure 17.

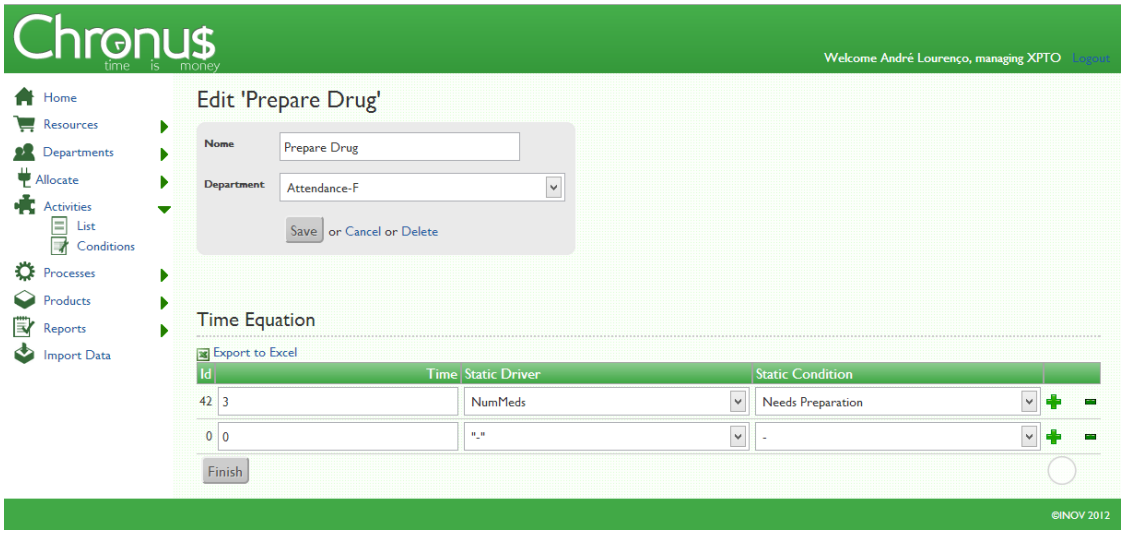


**Figure 17 - Screenshot of Time-Equations Edition**

Regarding the modelling, although not graphical, the application has forms where all the information about an activity is gathered, and then presents a list to the user with the activities that can form a process, so that they can be chosen to form one. Figure 18 shows a screenshot of a Business Process activity selection.

This is one more contribution, we believe, to make the TDABC models executed by someone not familiar with TDABC or AISs.

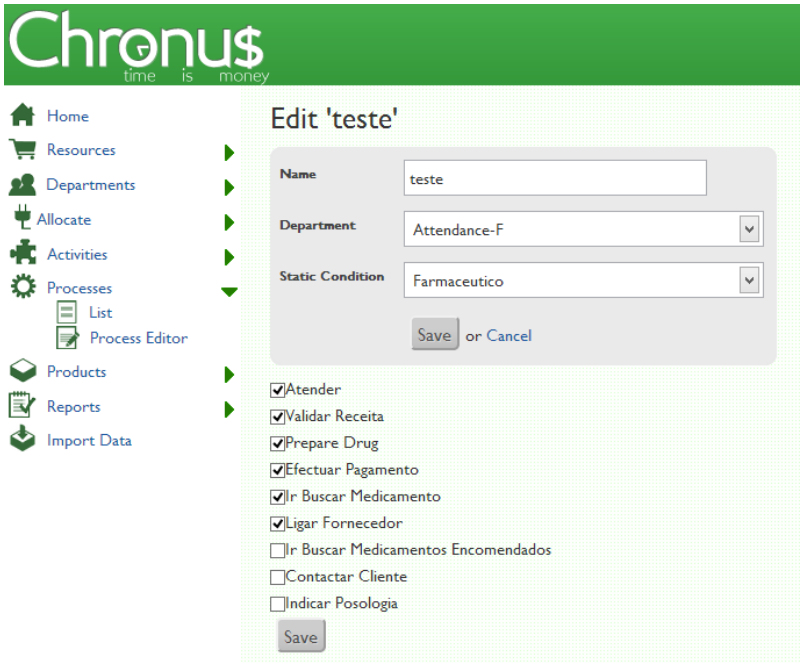


**Figure 18 -** Screenshot of Construction of Business Processes

- **Data visualization**

We believe that one of the most appealing features in any analysis tool is the way data can be visualized. Our prototype presents not only the numerical values representing the costs of the transactions but also presents them in a more appealing way by using graphics and charts. This highlights points of concern for managers like unprofitable products, processes or clients and then allowing to drill-down obtaining more detail. Among these graphs are included the whale graph presented in the problem, as well as efficiency charts for each department.

Another visual information aspect we covered was offering the possibility of the user to see the impact of each component that contributes with cost on the profitability.

Figure 19 gives an example of data visualization.

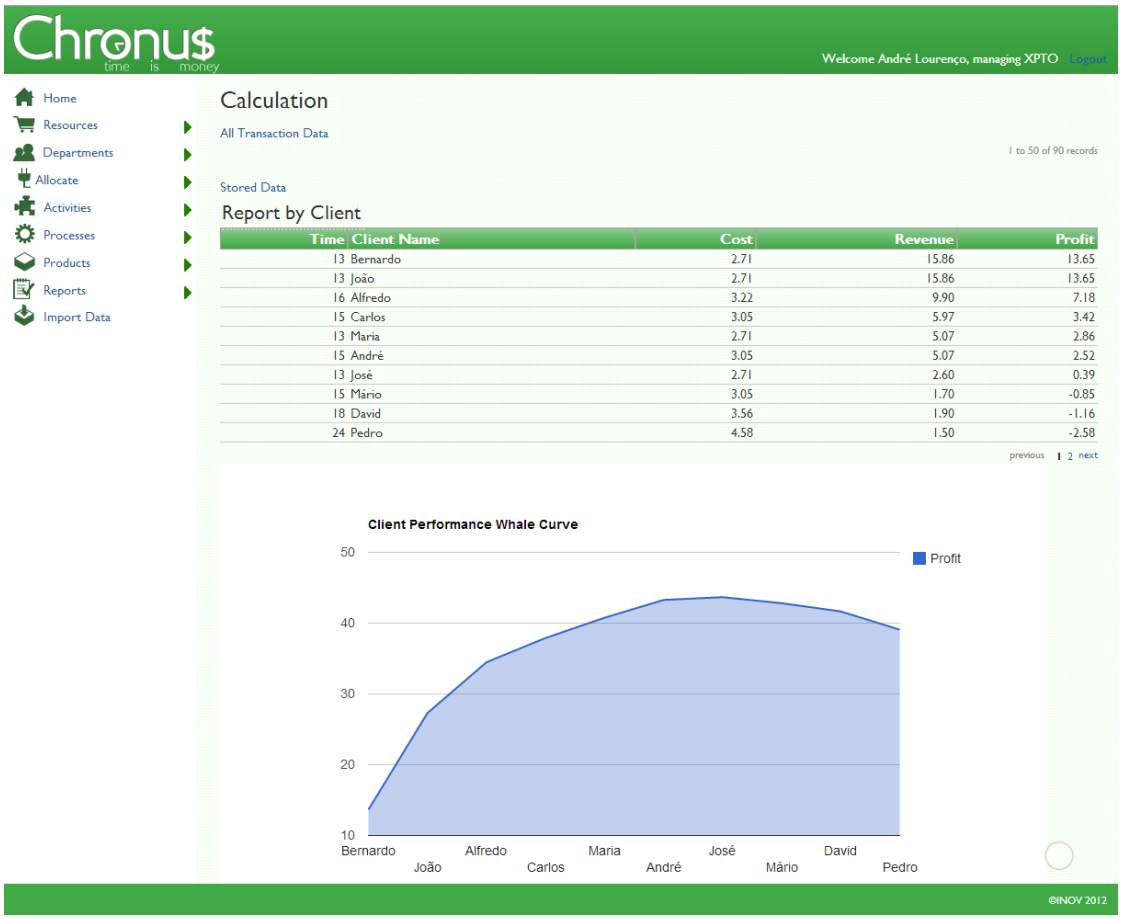


**Figure 19 -** Screenshot of Data Visualization

- What-if Analysis

Another feature possible with the use of TDABC is the ability to do what-if analysis. This is done by changing variables of the model representing the new conditions, and using the solution to evaluate the effect it would have on the rest of the model. An example of this would be to evaluate the effect of changing a process or an activity and see the repercussions it would have on client or product profitability based on past transactions. This helps diminish the risk taken when making decisions regarding introduction of products, changing processes, etc. and it is useful for BPR.

- Integration with data

  This feature has as its objective to make the prototype as simple as possible to the user. This consists on providing the user with a template spreadsheet with the format expected by the application, so that all the information regarding costs, transactions, clients, among others can be uploaded to the application. This prevents the user from having to insert by hand all the data.

### 5.2.2 Use-case Scenario

Figure 20 presents a simple workflow that represents how the solution works and represents the following scenario: Alice has a pharmacy and decides to do a cost analysis, so she goes to the Chronus website and sees that there is already a template for pharmacies done by Bob a health consultant **a)**, so she applies it **b)**, and sees that there is an activity done by her pharmacy not present in the template. To solve this, she adds it to the model using the BPMN editor adjusting the model **c)**. Then she chooses the appropriate module for her ERP and indicates the source of the data **d)**. Finally she is able to run the model **e)**, using the resource costs and capacities fed by the ERP as well as all the transactions for a specific period of time. She can then use those results to do some benchmarking or to try and identify points where she can improve **f)**.

### 5.2.3 Limitations

Being this a prototype and although most of the functionalities are already developed it still has some limitations. These are: allowing only one template to be instantiated at a time and requiring that, each time the user wants to do analysis, the calculations are done again. Finally there are some static elements that in the future would have to be done dynamically like the conditions that at the present moment are defined in build time.

Even with these limitations we received very positive feedback from some organizations that saw the prototype, and the National Pharmacies Association asked to run a pilot with a set of their associates.

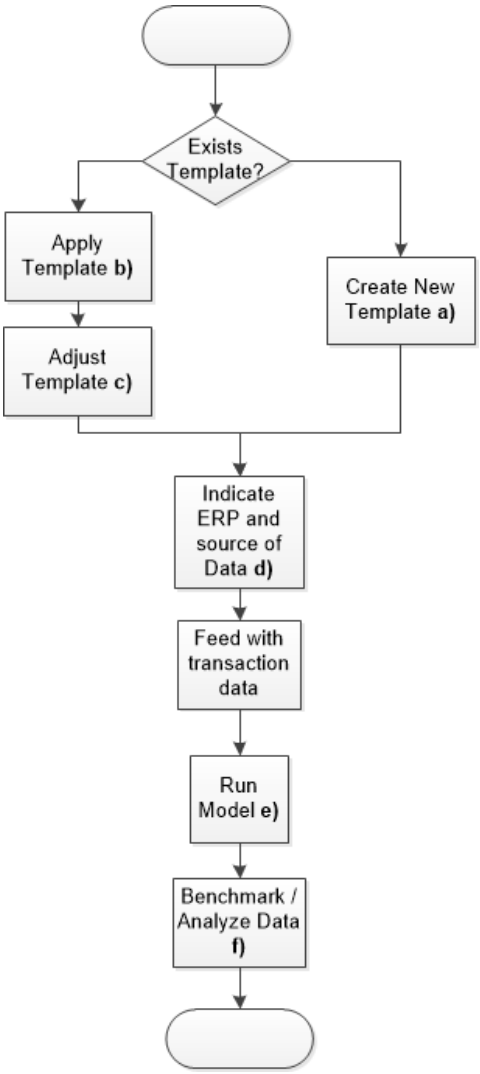


**Figure 20 - Use Case Scenario of the prototype**

### 5.2.4 Future developments

In order to make the tool easier to use some future developments would be interesting. These include integration with ERPs so that there is no need for the user to feed the resource and transaction data to the tool using spreadsheets. Graphical edition of processes where it would be possible for the user to graphically edit a BPMN model, or import one and then define the costs for its activities.

## 5.3 Summary

This chapter presented the proposal to solve the problem of this research. This proposal consists on a method that allows to model the business processes, with special attention to costs, of an industry and then instantiate the obtained models (templates) to particular organizations. This aims to reduce the cost and the complexity of costing analysis for sets of organizations that have similar processes.

Regarding complexity, this method is presented in very clear steps so that some user without specific expertise can follow them and we also provided a prototype made specifically to assist the user when following this process.

This prototype was described through its main functionalities. It was also presented its limitations as well as future developments that would contribute to its value.

# Chapter 6

# Demonstration

With the intent of presenting how the proposed artefact was used in order to solve the problem we now present the demonstrations we conducted, how they were carried, why they were chosen and the results obtained in each of them.

This chapter corresponds to the demonstration step of DSRM and the way we chose to demonstrate our proposal was through several field studies. Since one of the objectives is to show that the artefact is abstract and not specific we decided to do all demonstrations in different industries. These industries were: Pharmacies, Hospitals, Road Transportation and Ambulance transportation.

For each demonstration we approached an organization of a different industry and proposed to develop a template. Once this template was done it was instantiated using real or simulated data and validated with experts of each industry to guarantee that it was applicable to several organization belonging to their industry.

All the templates were developed to reflect only one of the organization's business processes and not the totality of the organization. This was done by choice since we believe modelling more business processes within the same industry would not bring additional value to the demonstrations and it was preferable to develop templates for more industries than developing a more extensive one that would limit us to only to one industry.

We will start each demonstration by presenting its motivation. In some case this was given by the managers, in others it was more related to what we wanted to achieve. The first reflection of this motivation was in all cases expressed in the cost object hierarchy.

In all the field studies emphasis was given to the modelling phase. This is so due to the fact that, for this research, it is more important to model the costs of each industry, than to know the actual specific

costs of each organization. Also, the modelling phase is the most innovative factor, and there were also some difficulties on obtaining data of organizations so it would be possible to instantiate the models with real values.

All templates were done using as starting point an organization, except for the third field study where we did the template without using a specific organization, but with consultants with large experience in the road transportation area. This has brought interesting insight to aspects that had to be taken into consideration so that the template could fit all organizations.

We will do a more thorough and descriptive explanation of the first field study, so that all concepts become clear. We will then try to simplify the exhibition of the remaining cases.

## 6.1 1st Field Study - Pharmacy

This was the first field study undertaken in this research. At the time we tried to choose an industry where the advantages of our method could be most evident. We reached the conclusion that pharmacies were a good industry since:

- Pharmacies normally are small organizations and their budgets do not allow them to execute a complete costing project.
- It is a field where most of the processes are very well-defined which we were able to confirm.
- They belong to the Health segment, which is an area where costs are constantly rising and have become a serious concern around the world (Dias, Mendes, & Mira da Silva, 2012). Also there has been some research related with TDABC done in this segment (Kaplan & Porter, 2011).
- Considering the Portuguese case, pharmacies are struggling and cost reduction is becoming a must. (Antão & Grenha, 2012).
- Finally, since it is a heavily regulated industry and most of the processes are common between them, the template should need less adjustment upon the time of its application.

With the industry chosen we approached a pharmacy, proposed to create a template of a process of their organization and then calculate the costs in a pre-determined period using the developed prototype.

After creating the template, this was instantiated and then validated in a second pharmacy in order to assess it was applicable to a different organization.

The business process chosen was the attendance service since it was the one with most variation, the most visible one and the one easier to explain to someone not familiar with the proceedings inside a

pharmacy. Although the template was limited to one process all the resources and departments of pharmacies had to be modelled since they were somehow related to this process.

According to our method the first step consists on assessing what were the targets of the cost analysis in this industry. The second step consisted on gathering resources, distributing them into Support and Functional Resource Pools. To obtain information for each of these steps, we conducted a series of interviews(three, one hour each) to gather the cost object hierarchy (Figure 21), the resources, RPs and allocations (**steps 1 and 2 of the modelling phase**) . This is represented in Figure 22

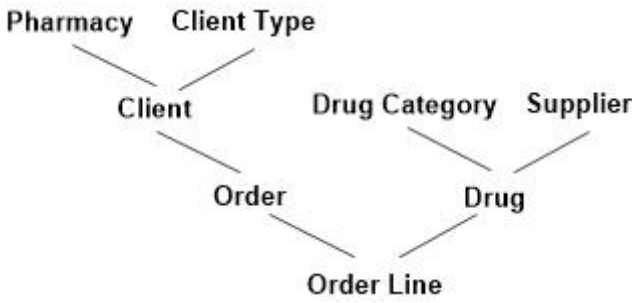


**Figure 21 -** Pharmacy Cost Object Hierarchy

This hierarchy makes it obvious that the main areas where information were necessary was related to the order (and the client that made it), and to the drug. This last concern was related to new government regulations that stated the margin of each drug.

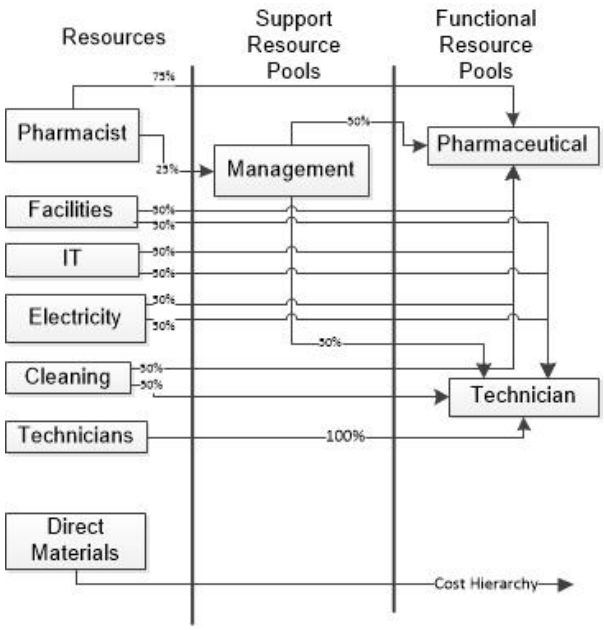


**Figure 22 -** Pharmacy Resource Pool Definition

The activities that are executed were elicited according to the third **step of the method** and are expressed in Table 4. Since both the Functional RPs execute the same activities, we omitted this information from the table.

| Activity |
| --- |
| Receive Request |
| Fetch Drug |
| Order From Supplier |
| Indicate Dosage |
| Perform Payment |
| Get Ordered Drugs |
| Contact Client |

**Table 4 -** Pharmacy's Activities

With the activities defined we then proceeded to model the attendance service business process. This process is shown in Figure 23 and corresponds to **step four of the modelling phase**. The information in the text annotations linked to the activities are time-equations that represent costs associated with the activity (this cost doesn't correspond to the actual cost since at this point this is a template).

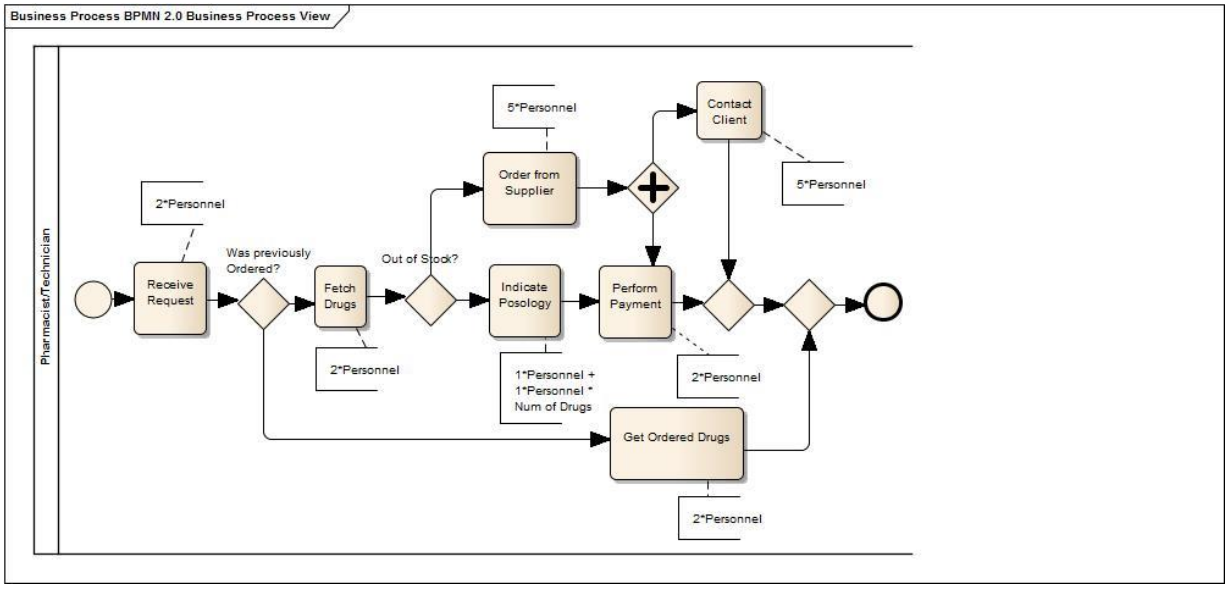


**Figure 23 -** Attendance Service Business Process

In this BPD we used the keyword personnel in the time-equations to show that it can be executed by a pharmacist or by a technician. This information could be left out since, the swim lane already gives this information, but we chose to keep it in this case to make the diagram easier to read.

Since this is the first demonstration we will describe a segment of the attendance service process to explain the notation. The process starts by an employee receiving a request for a drug (that costs 2 units of personnel). In case it is available, the technician will fetch the drugs (that costs 1 unit of personnel, plus 1 minute for each medicine that doesn't need preparation, or plus 3 if they do need).

Finally since all products receive costs from this process the allocation is trivial (**step 5 of the modelling phase**). **Step 6** was not executed at this point, since the only segmentation variable we obtained was the use of drug-dispenser robots, but the pharmacies we contacted did not have this feature so it was not possible to capture its cost.

The result of these steps was a template for a Pharmacy attendance service that can be later applied to other similar organizations with only minor modifications to the time-equations or to the activities, and easily imported by software to calculate the costs.

To demonstrate the application phase we calculated the unit cost of each resource (**step 1 of the application phase**) of the pharmacy where we developed the template represented in Table 5.

| **Resource** | **Resource cost data** | | |
|---|---|---|---|
| | ***Cost (€)*** | ***Capacity (min)*** | ***Unit Cost (€ / min)*** |
| Pharmacists | 2000 | 1000 | 2 |
| Technicians | 3000 | 1000 | 3 |
| IT infrastr. | 5000 | 1000 | 5 |
| Cleaning | 1000 | 1000 | 1 |
| Rental | 1000 | 1000 | 1 |
| Electricity | 1500 | 1000 | 1.5 |

**Table 5 -** Pharmacy's Resource Cost Data

These resources and their costs were then allocated into the defined Resource Pools (Table 6) using the drivers defined in the modelling phase.

| Resource Pool | Resource pool data | | |
|---|---|---|---|
| | ***Cost (€)*** | ***Capacity (min)*** | ***Unit Cost (€ / min)*** |
| Pharmacists | 5350 | 1000 | 5,35 |
| Technicians | 6350 | 1000 | 6,35 |

**Table 6 -** Pharmacy's Functional Resource Pool Data

It is also important to mention that the values on tables I and II are not real and are here just for illustration purposes. We did use real values but cannot present them due to confidentiality.

With these values we applied the template (**step 3 of the application phase**). Since the template was made based on this pharmacy, the second and fourth steps that consist on adjustment and selection of segmentation were not necessary so we proceeded to step 5 and calculated the costs.

To calculate the pharmacy's costs we modelled the process in our prototype and fed it with transaction data of one month.

In our opinion actual cost results are not the most relevant output of our demonstration, but as an example, we got an average cost of each attendance of 1,36€. This cost includes not only the direct costs of personnel but also all overhead costs. We also calculated the whale curve for simulated customers. Figure 24 is a screenshot of this analysis.

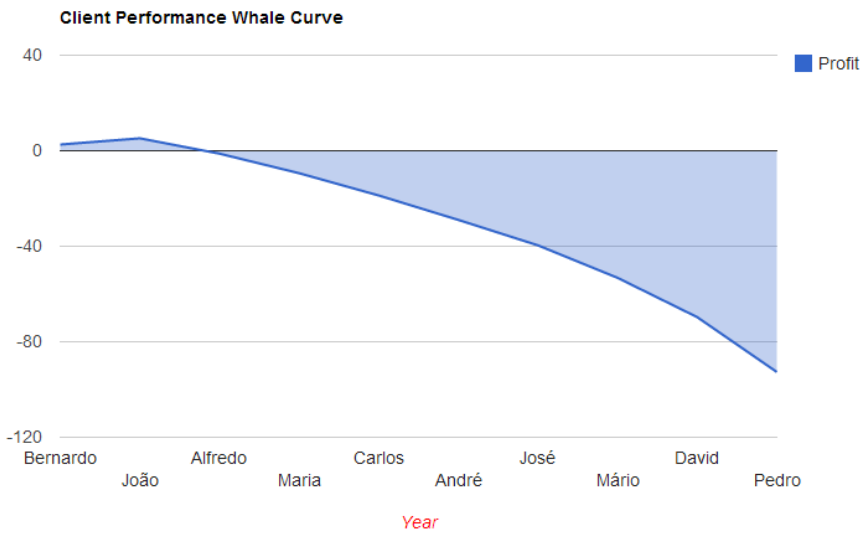


**Figure 24 -** Screenshot of Pharmacy Customer Whale Curve

Finally we proceeded to validate this template in a second pharmacy, only for evaluation of the template, to assess its accuracy and applicability in a different organization inside the same industry and to know which changes would be needed . This pharmacy had a bigger structure than the first one, with more employees and bigger facilities. Regarding location it is the same. The template was shown to the technical director that agreed that the resources were exactly the same with possibly different values, as was the process, except for one activity that was missing to deal with queue management tickets. The remaining activities were found to be the same with the same time-equation meaning that the template represented already most of this pharmacies attendance process.

This field-study allowed us to create a template of an industry and then apply it to two different organization belonging to it. It also allowed us to test the prototype and helped us validate if our method worked in practice.

## 6.2 2nd Field Study - Emergency Department

The second field study consisted on modelling a part of the urgencies service of an hospital in order to know its costs. This field study follows the path started with the first one, since it remains in the healthcare segment, that has, as mentioned, been going through difficulties.

It was the intent of the director of this emergency department to know the exact cost of the process that concerned the treatment of asthma diagnosed patients, and to be able to compare the costs when the treatment was executed by different teams.

So in this case, there is an interesting aspect: we will model a template that would be possible to apply to different hospitals, but also to different teams inside the same hospital.

This field study was done through several interviews with the director of urgencies of a Portuguese public hospital

The target of the analysis is presented on the cost object hierarchy in Figure 25 (**step 1 of the modelling phase**). It is possible to see that the objectives of team monitoring of the director are achieved by the central branch.

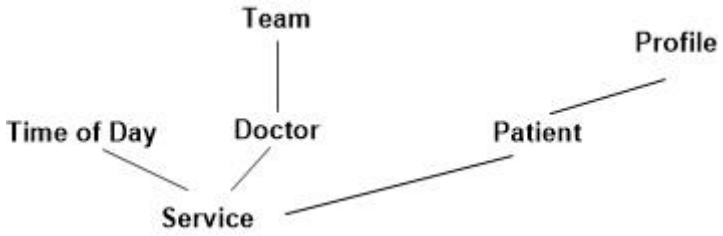


**Figure 25 -** Emergency Cost Object Hierarchy

Since the target process was a very limited one, and since there wasn't any information available about structure costs like occupancy or electricity we were only able to work with direct costs and personnel costs. All other would be speculated without any basis. The Resource Pools obtained are present in Figure 26 (**step 2 of the modelling phase**).

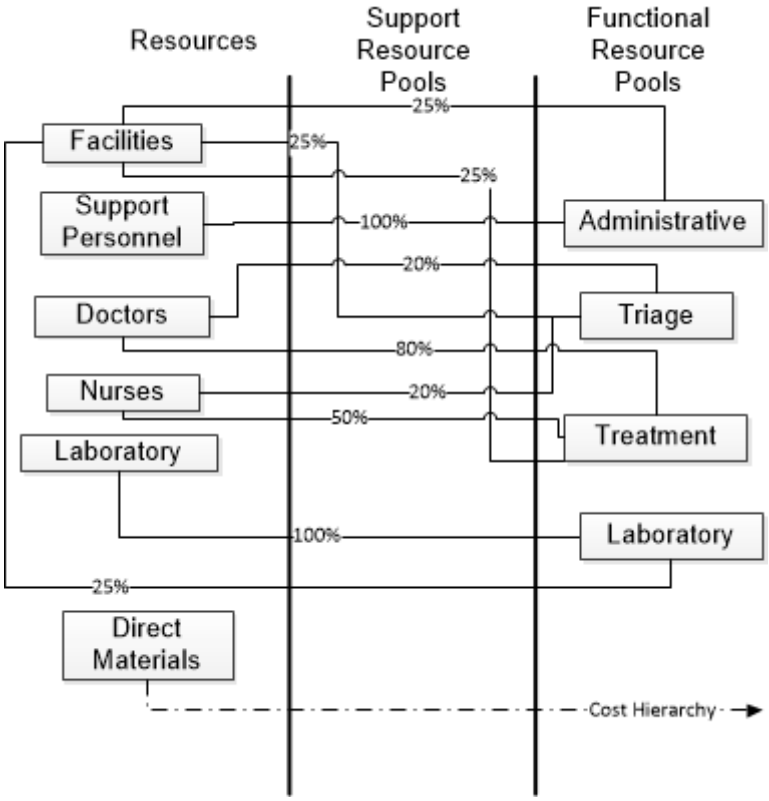


**Figure 26 -** Emergency Department Resources

The next step of the method is to gather all the activities executed. Those are expressed in Table 7 together with the corresponding functional Resource Pool. (**step 3 of the modelling phase**)

| Activity | Functional RP |
|---|---|
| Registry | Administrative |
| Release Processing | Administrative |
| Define Colour | Triage |
| Examination | Treatment |
| Administration of Medication | Treatment |
| Complementary Exams | Treatment |
| Analysis Request | Treatment |
| Evaluation | Treatment |
| Issue Release | Treatment |
| Analysis | Laboratory |

**Table 7 -** Emergency Process Activities

With these activities we were then able to model the complete process (**step 4 of the modelling phase**) as well as the corresponding time-equations. The process is shown in Figure 27. The time-equations still have to be validated by each department.

Regarding **steps 5 and 6** we did not define any segmentation groups, being this an optional step, and the allocation in this case is done directly to the patient. We then asked the IT department of the hospital for a sample of 40 episodes to do the application phase, but at the time of the delivery of this report we are still waiting, therefore we did not proceed to the application phase.

Although the method was not completed, from its first phase resulted a template that can be later applied in this hospital, or other, by feeding transaction data.

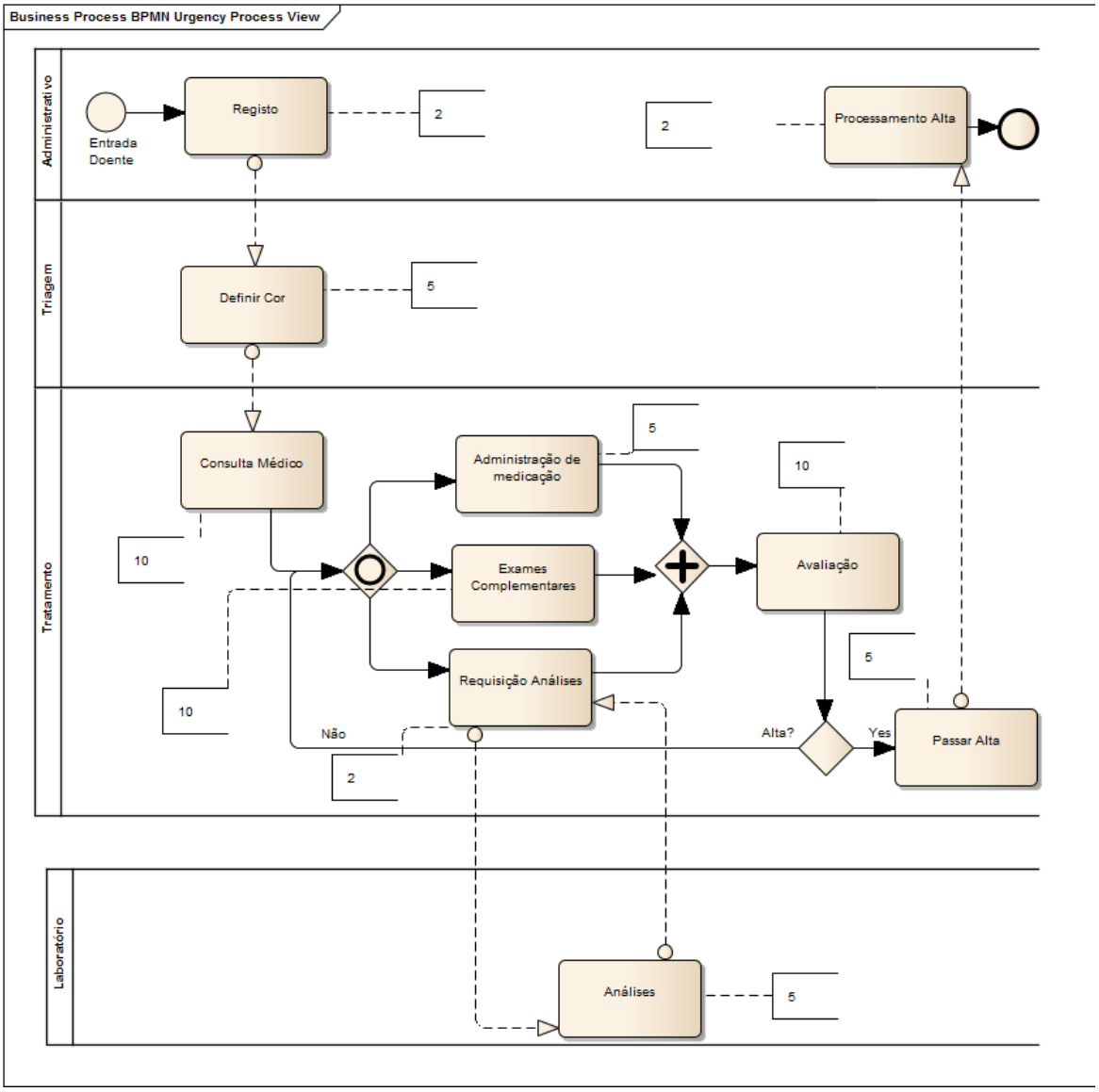


**Figure 27 -** Emergency Service Process

## 6.3 3rd Field Study - Public transportation

In this third field study we were approached by a road transportation consulting company specialized in ticketing services to participate in a project that had the intent of improving efficiency of its clients both regarding costs and energy. In this project participated at least two different companies which made it a good candidate for our method since we could develop a template and see if it would match both companies structures.

An interesting aspect of this industry is a factor already mentioned in the problem chapter. Some industries can only improve their profit margin by increasing their efficiency in terms of cost, due to

being incapacitated to change prices of their products/services. In the case of road transportation this is so, due to government regulations. The government sets the price of tickets for all road transportation companies, and in turn offers compensatory remunerations. This means that the competitive advantage of any road transport company in Portugal lies in how well costs are managed.

The results presented in this sub-chapter result from the steps defined by our method and were done using information obtained on three meetings with two consultants.

In the first meeting it was decided that the first step of this project should be to clearly define its scope and exactly what were the values expected. In the case of our method this would mean defining the cost object hierarch as defined by **step 1 of the modelling phase**.

It was decided that we should only focus at first on the main process of road transportation that is, transport and that the goal would be to get values of cost and profitability for service, bus route, passenger and passenger per kilometre per hour (the main metric in this industry). Then these should be aggregated into groups like type of bus (brand, type, capacity), network and so on. These dimensions are graphically expressed in Figure 28.

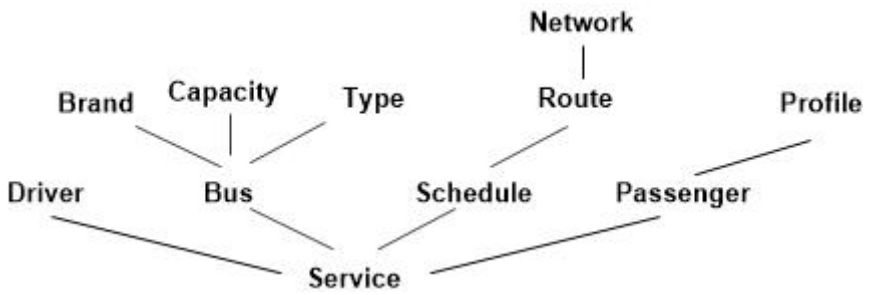


**Figure 28 -** Road Transportation Cost Object Hierarchy

With the target defined we then proceeded to assess which were the resources (**step 2 of the modelling phase)** that were somehow related with the transportation of people process. Although we did not have access to all the data, in what concerns resources we were able to find that the biggest slice in terms of absolute value is composed of: fuel, drivers, mechanics, infrastructure and vehicles. There were other costs identified but with less impact on the overall cost of the process/organization.

These resources and their allocations to support and functional Resource Pools are expressed in Figure 29. It is important to mention that the percentages in the diagram result from the feedback from the interviews and might not be entirely accurate.

Regarding the division between passenger inspection and operational inspection, we were informed that in some companies the same human resources are used to do both these tasks, but in some cases the passenger inspection is done by an outsourced entity. To cover both cases this division is

done which can mean that in some situations normal and passenger inspection become the same resource.

The same situation applies to "Driving" and "Parking". In some organizations they are executed by the same Resource Pool, in others by a different one. So by keeping them apart it's possible to cover both situations (In the case where they are executed by the same department what will happen is that both departments use the same resources and have the same capacities. If a manager desires so, he can merge them in the application phase and change the time-equations).

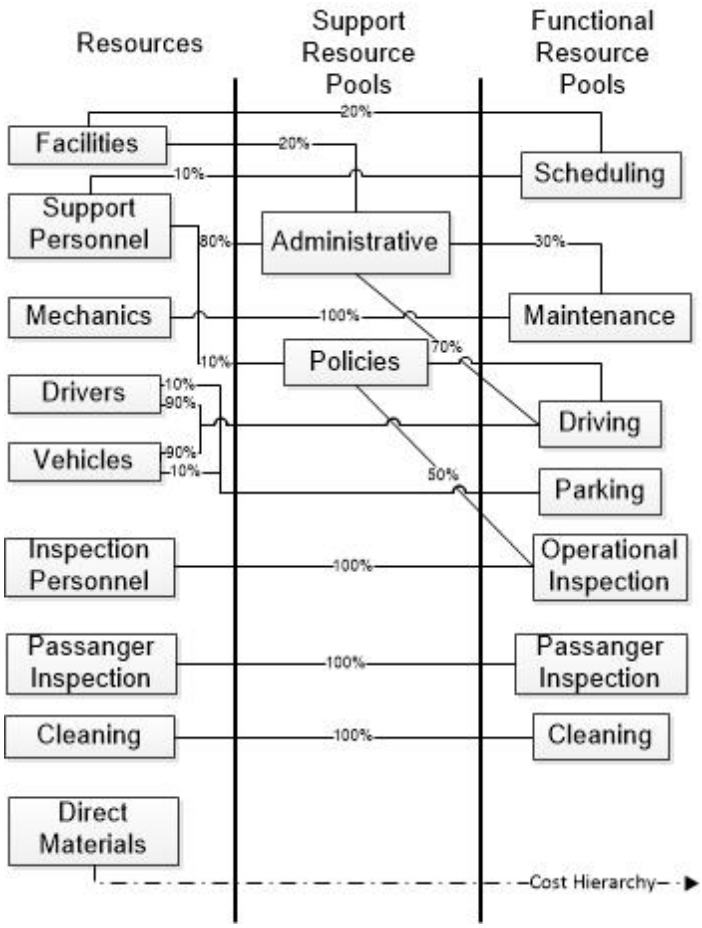


**Figure 29** - Road Transportation Resources

We can also see from the previous diagram that direct materials are not assigned to any resource pool. This is due to the fact that they are allocated directly to the transaction according to information about their consumption meaning, that there is no need for a time-equation to model them.

With resources identified and allocated, the next step was to identify activities performed in the organization that may apply to the process being analysed (**step 3 of the modelling phase)**. These activities and the resource pools that execute them are described in Table 8.

The information concerned with resources from step 2 and the activities from step 3 was then used to model the Business Process of People Transportation (**step 4 of the modelling phase)**. The process here represented is the result of two iterations since after presenting the first model we reached the conclusion that some departments and activities were missing (Inspection and Parking). These made us update all models (in this report we only present the last version of each model). The process modelled with BPMN and TDABC's time-equations is represented in Figure 30.

It is important to mention that the values in the time-equations are estimates and still require validation and further adjustment.

| Activity | Functional RP |
|---|---|
| Short-term Scheduling | Administrative |
| Long-Term Scheduling | Administrative |
| Operational Inspection | Inspection |
| Passenger Inspection | Inspection |
| Maintenance | Maintenance |
| Parking | Parking |
| Driving | Driving |

**Table 8 -** Road Transportation Activities

Regarding segmentation variables **(step 5 of the modelling phase)**, we identified the two already mentioned. In some cases the inspection is done by only one functional resource pool .An organization instantiating this template has to choose one of the possible resource structures (we only present one for the sake of simplicity).

Finally regarding allocation to products (**step 6 of the modelling phase)**, we only considered one product therefore the allocation is trivial.

This case although it didn't reach the application phase, since until the date of the delivery of this report we didn't have access to transactional data, it allowed us to do a template of an industry with different characteristics from the others. The most relevant one is that this industry unlike the previous analysed has a bigger component of direct cost than overhead costs. This presented some variation at the level of time-equations since most of the costs go directly to the transaction, and unlike other industries it's not only one material or product that goes to the transaction. In this case we have to consider fuel, tires, etc. An approach to this problem would be to make an estimate and convert in time the usage of direct resources but this way we would lose accuracy.

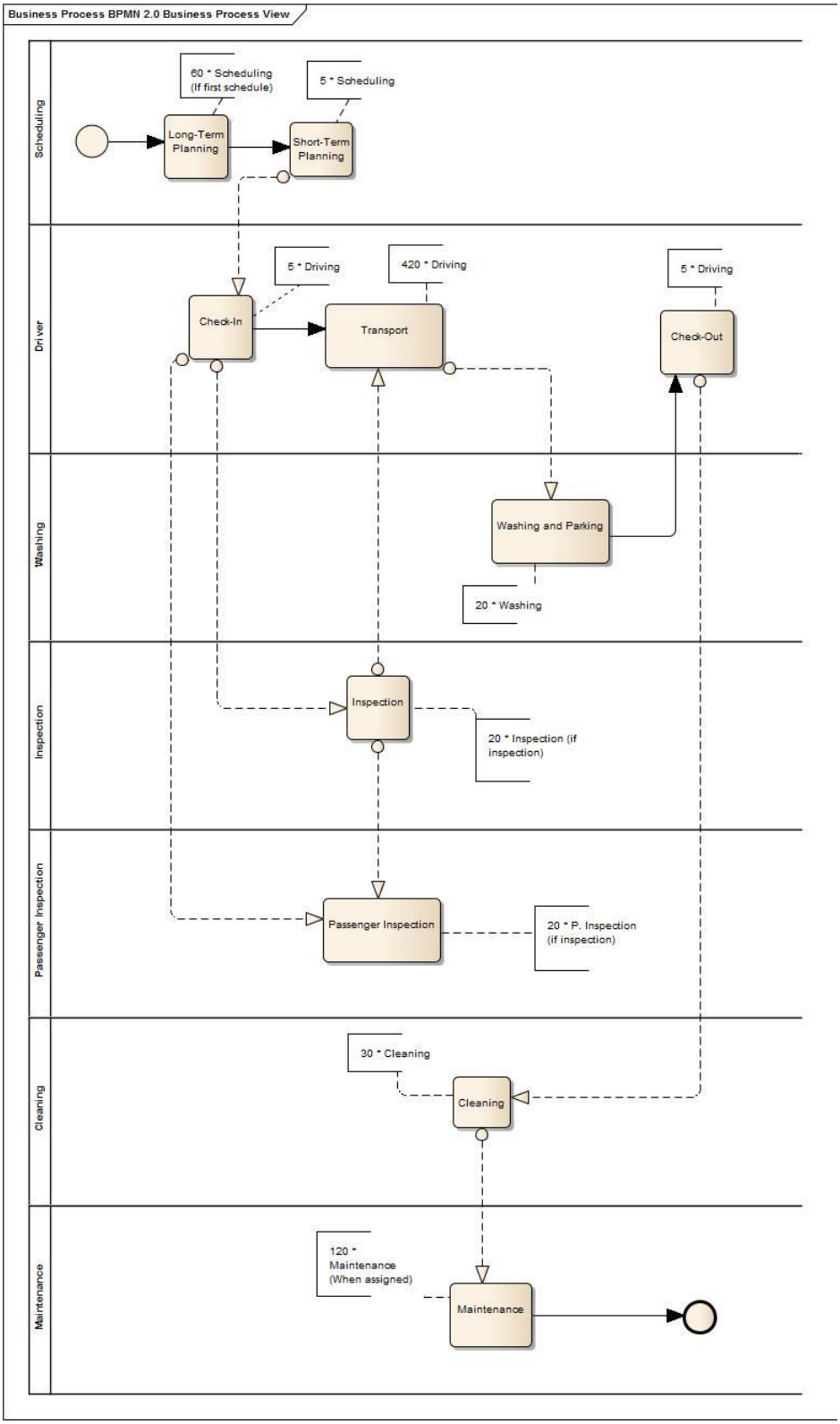


**Figure 30 -** Road Transportation Main Process

Another consideration that we must do, and that results from the feedback obtained, is that even if we are only modelling the costs of one process, we should model an high-level model of the organization. This advice arise when we were presenting the BPD and the consultants that weren't familiar with time-equations argued that an activity with residual costs like inspection shouldn't appear next to the transport activity even if it belonged to the process. After some discussion we reached the conclusion that this was due to the difficulty of people understanding why some important activities in terms of cost are not represented (due to not contributing to the cost of a specific process and assuming they are forgotten). The example on this case was the ticket sale activity, that has no influence on this process but it is the second biggest activity. Therefore our solution was to present an high-level analysis of the organization to give context and show why only some activities were considered. We do not present any of these models here since they have no direct contribution to our proposal.

## 6.4 4th Field Study - Private Ambulance Company

The last field study consisted on creating the template for the patient transportation process. We chose to do this demonstration since it was in the health segment and in some way could give continuity to our first two demonstrations. It is also a process with a lot of mandatory and compliance activities resulting in increased overhead. In this field study we will focus more on the results and the differences since the process was followed in a quite similar way as in the previous field-studies.

Another particular aspect of this demonstration is that this company was implementing ISO9001 (International Standards Organization, 2008) which requires all processes to be modelled, so in this case we already had a basis from where to start. Although helpful, since they gave the discussion a basis to start with, we observed that models to capture costs are much more complex than those existent just to model the behaviour of the organization (at least those required for ISO9001).

Using our method we started by inquiring the manager of the company which were the main perspectives from which they would like to analyse costs. After some discussion it became clear that in this client  the transaction level unit is one transport/service, and that further aggregation must be done from this point. The result is the cost object hierarchy presented in Figure 31 **(step 1 of the modelling phase)**.

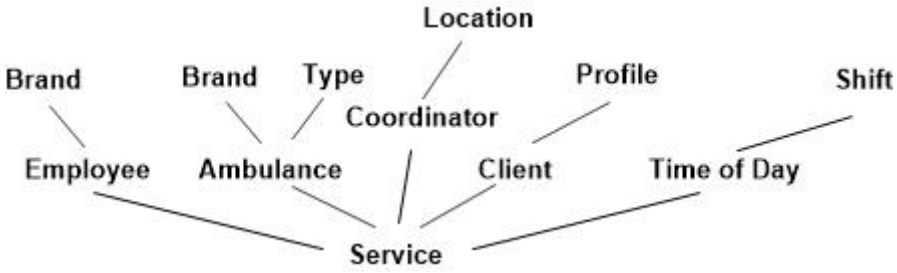


**Figure 31 -** Ambulance Cost Object Hierarchy

This hierarchy will give information later in the process like, for example, what information is needed to differentiate between multiple cost dimensions. If we for instance want to analyse different ambulances then we'll need information in the transaction data about what ambulance did the transport.

With the cost object hierarchy defined we then proceeded to model the resources of the organization **(step 2 of the modelling phase)**. In this field study it was quite simple since we had access to the general ledger, and identified only one support department. This resulted on the cost structure presented on Figure 32 where we can see the main resources in terms of cost. Others were left out because whether they were irrelevant, or not enough information was available.

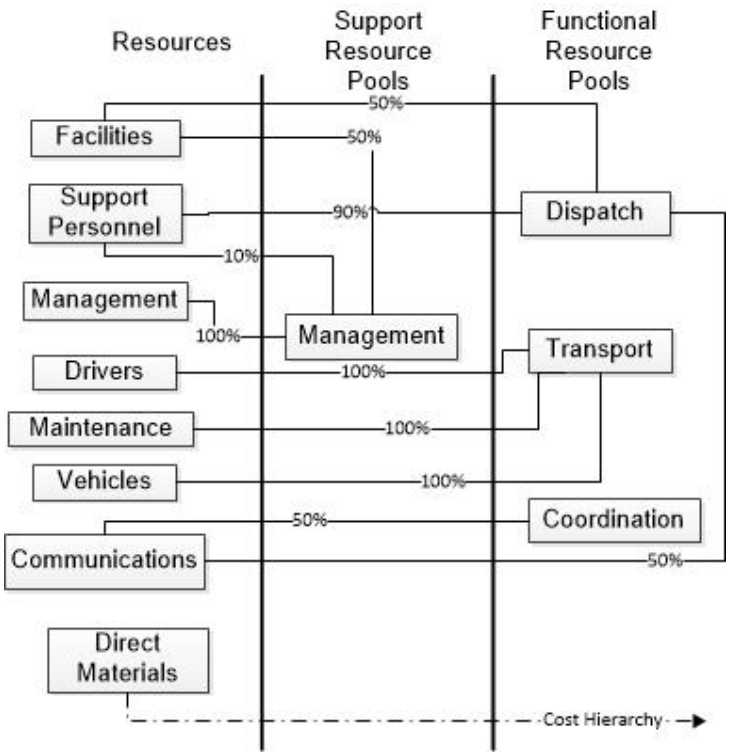


**Figure 32 -** Ambulance Company's Cost Structure

With all the costs gathered and distributed to the point of functional RPs we then identified all the activities relevant to the patient transportation service, their corresponding functional RPs and their time-equations **(step 3 of the modelling phase)**. This information is present on Table 9, except for time-equations that are on Figure 33.

| Activity | Func. RP | | Activity | Func. RP |
|---|---|---|---|---|
| Receive Call | Dispatch | | Check-Out | Coordinator |
| Verify Availability | Dispatch | | Planning | Coordinator |
| Confirm Transport | Dispatch | | Fill Papers Check-In | Crew |
| Assign Service | Dispatch | | Fill Service Form | Crew |
| Schedule | Dispatch | | Transport | Crew |
| Process Documents | Dispatch | | Fill Service Form Out | Crew |
| Assign Service | Coordinator | | Fill Paper Check-Out | Crew |
| Receive End Service | Coordinator | | Wash | Crew |

**Table 9 -** Ambulance Company's Activities

These activities were then grouped into a business process modelled in BPMN where the costs (time-equations), functional RP (using the swim-lanes) and activities are represented. **(step 4 of the modelling phase)** In this BPD, unlike in the others, we chose to omit the RP in the time-equation since it is already represented by the swim-lane. Both notations are correct, the advantage is that ,although redundant, by representing in the time-equations may be clearer for some stakeholders.

The result of this field-study was a template applicable to this particular organization, and given the feedback, to any organization belonging to this industry in Portugal. We did some simulations with the model, in order to test its application phase but these were the made-up data since we did not have access to the data of the transactions until this moment.

This field-study also allowed us to observe that in organizations with quality management processes that require that they have their processes already modelled, the work needed is reduced and the communication with managers is simplified since they already have some knowledge regarding processes.

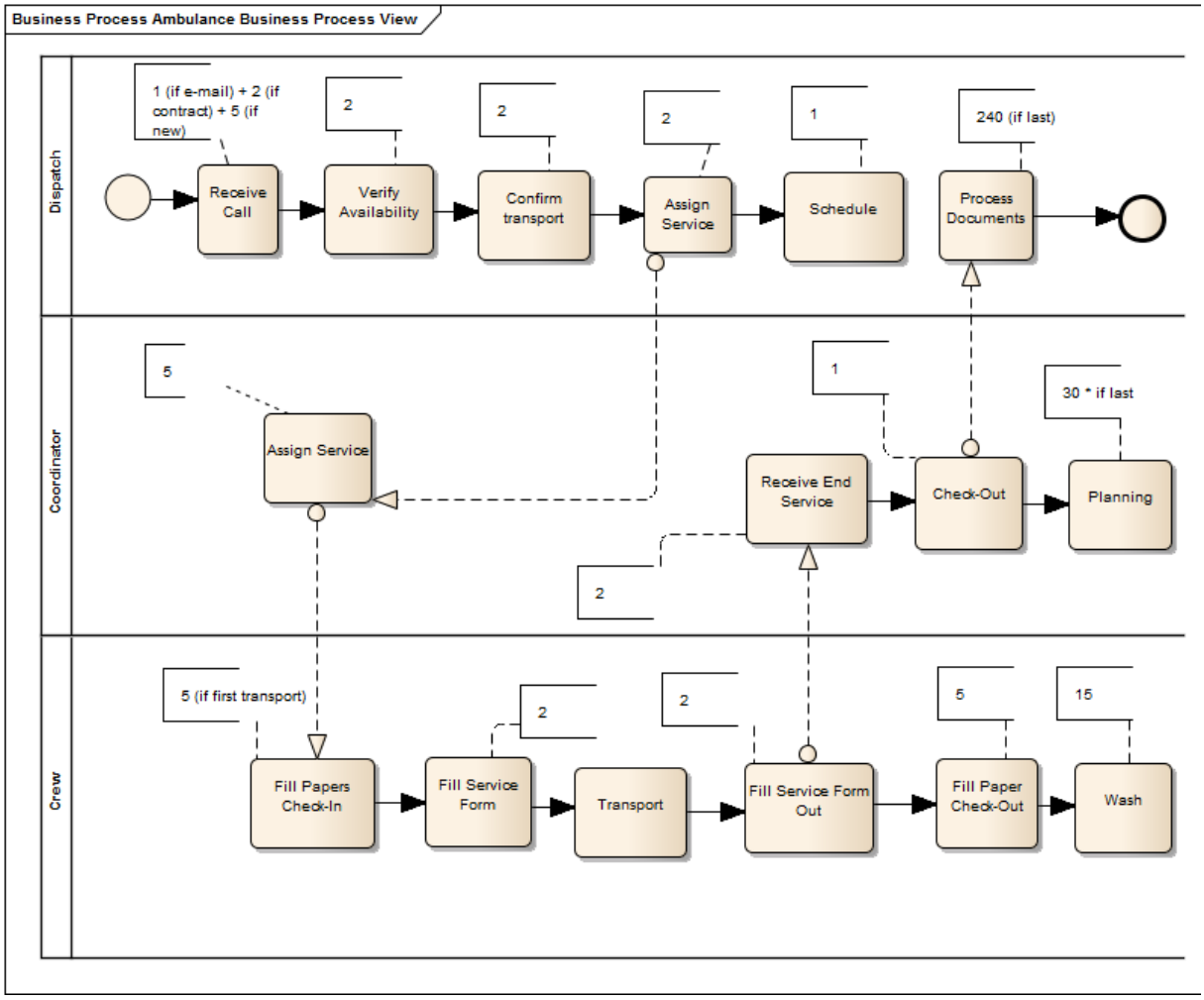


**Figure 33 -** Patient Transportation Process

## 6.5 Summary

These four field studies allowed us to apply in practice the proposed artefact and, in one case, also allowed us to test the prototype and provide actual data. In this sub-chapter we intend to provide the main aspects to consider in the set of the four field-studies and also the main lessons learned.

The most relevant aspect was that we were able to follow each step of the method and obtain a template for an industry in each case. We were also able to obtain some variations from organization to organization and build the model taking that into consideration. As mentioned we focused more on the modelling phase since our goal was not to provide actual cost data but to create templates that could be evaluated and applied in the future.

There was one particular aspect that we weren't able to test although we did model it. This was segmentation packages.

Regarding lessons learned, there are several aspects that at the point of the proposal we didn't consider to be relevant and in some cases we hadn't seen any relation, but proved to be essential. One of these cases was terminology. Different organizations have different names for the same things. At first this would result in two different models that would represent exactly the same thing, so we have learned that this is a very important aspect to take into consideration. Another aspect that is important is to try to limit the scope of the first analysis and then move to other processes. If during an analysis one tries to model everything at first, it becomes quite easy to lose the lot.

We also observed that the last field studies went better than the first ones. This was expected since as we were doing more demonstrations we were improving our method, and some pitfalls became expected. One example was the elicitation of activities, that we learned quickly that managers tend to miss some activities in the first iteration.

The final lesson we have learned is that cost analysis and their detail are very dependent on the data available. Many organizations can tell that a transaction will be more expensive if some condition occurs, but the data that tells if this condition occurred or not is not stored in any system. This makes it impossible for an analysis to be done taking this into account. This was most visible in the case of the pharmacies. We believe that facing this, one of the outputs of this method can be exactly proposing systems that would provide more data and therefore better results.

# Chapter 7

# Evaluation

This chapter corresponds to the evaluation step of DSRM.

The evaluation of our research was done accordingly to the strategies for Design Science Research Evaluation and using the Moody and Shanks Framework and the four principles proposed by (Österle, et al., 2011). To evaluate our artefact we did several field studies and collected feedback from experts and potential users through interviews.

We chose to do only one evaluation contemplating all the demonstrations instead of one for each, since we were more interested in evaluating how the characteristics of the method itself, and not so much on the quality of the specific models, although these are important as well and were validated with the interviewees.

In this chapter we will begin by providing a brief description of the framework proposed by (Pries-Heje, Baskerville, & Venable, 2004) that aims at offering a strategic view of the evaluation. The use of this framework requires the definition of criteria for evaluation. For this purpose we chose to use the four principles proposed by (Österle, et al., 2011) and the Moody and Shanks Quality Framework. With the background defined, we will then present the results of the interviews done, and the results we obtained for the criteria defined.

Since the main goal in evaluation is to measure it's quality, in the context of this evaluation it was defined as offering what the stakeholders pretend, and what solves their problem.

## 7.1 Design Science Research Evaluation Framework

Evaluation is considered as being one of the most crucial steps in the Design Science Research of Information Systems. It is considered so, because it is what verifies the contribution of the solution for the identified problem and its utility, quality and efficacy (Hevner, March, Park, & Ram, 2004). It is also a part of the rigor that must be applied to this kind of research (Hevner, March, Park, & Ram, 2004). According to (March & Smith, 1995) evaluation regards the development of criteria and the assessment of the artefact's performance in comparison to the criteria. The author also defends that the researcher should not only mention if it worked, but also how and why did it work.

(Hevner, March, Park, & Ram, 2004) proposed along with the guidelines for Design Science Research, that five kinds of evaluation methods are possible in this context: Observational, Analytical, Experimental, Testing and Descriptive. Although this division of evaluation paths is defined, not much more guidance was provided on how to accomplish them.

In order to fill this gap and taking into account prior research done in the area of DSR evaluation (Pries-Heje, Baskerville, & Venable, 2004) proposed a framework to help design science researchers build strategies for evaluation and to achieved improved rigor in DSR.

This framework consists on distinguishing evaluation in two dimensions. The first dimension is related to the form of the evaluation, that can be artificial or naturalistic. Artificial evaluation evaluates a solution in a contrived and non-realistic way (e.g. simulations, laboratory experiments, mathematical proofs). Naturalistic evaluation consists on evaluating the performance of a solution within its real environments which relates to the three realities defined by (Sun & Kantor, 2006): real users, real systems and real problems and takes into account human behaviour.

The second dimension is concerned with the moment in time of the evaluation. This evaluation can be done ex-ante, meaning that the evaluation takes place before the artefact is developed, meaning that it is not absolutely necessary to construct an artefact to evaluate a theory, or ex-post meaning the evaluation is conducted with the artefact already developed.

Finally the artefact can be a process or a product. Figure 34 resumes the two dimensions presenting the combinations possible.

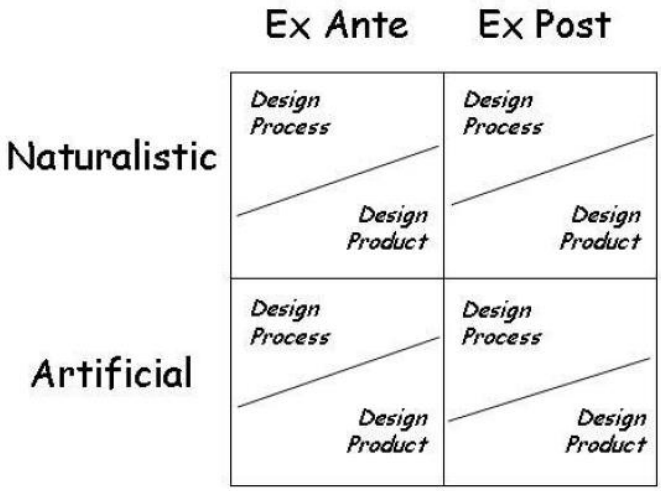


**Figure 34 -** DSRM Evaluation Strategies

The framework then proposes a strategy to evaluate the artefact that is based on three questions:

- When does evaluation take place?
- What is actually evaluated?
- How is it evaluated

The answer to these questions allows the researcher to know in which quadrant the research is.

In the case of our research in particular, our evaluation is inserted on the quadrant presented in Table 10, since it was done after the development (ex-post), it was naturalistic since we chose to use field studies as the base for the evaluation, and what was evaluated was the proposed method.

The framework also states that a process and criteria must be defined. In our case, as we already mentioned, we chose interviews as the process and the four principles of Österle and MSQF as criteria.

| | Ex Ante | Ex Post |
|---|---|---|
| **Naturalistic** | | P: Interviews to experts and potential users<br>C: Österle and MSQF principles |
| **Artificial** | | |

**Table 10 -** DSRM Evaluation Strategy Instantiation

## 7.2 Moody and Shanks Quality Framework

The Moody and Shanks Quality Framework is the result of research on how to evaluate and improve the quality of data models from the perspective of the multiple stakeholders. Although our artefact is not a data model but a method which has as its result a model we believe that the criteria defined fits well in this research and will allow us to assess its quality, and it has already been used for this purpose by other authors.

The criteria and their meaning are:

- **Completeness** - Refers to whether the data model contains all information that is required.
- **Integrity** - Refers to whether the data model defines all business rules that apply.
- **Flexibility** - Measures the ease with which the model can cope with business or external change.
- **Understandability** - Measures the ease with which the concepts in the model can be understood.
- **Correctness -** Refers to whether the model conforms to rules and conventions.
- **Simplicity -** Refers to whether the model contains the minimum number of entities needed for the model (in this case we adapted this to be the measure of how easy it is for the user to use the method);
- **Integration -** Refers to the consistency of the model with the rest of the organization.
- **Implementability -** Measures the ease with each the model can be implemented according to defined constraints.

## 7.3 Four principles of Österle et. al.

These principles result from a memorandum written by ten authors and subscribed by another 111 full professors with the intent to set a way to characterize design-oriented IS research and distinguish it from solutions from practitioners or commercial providers. In sum it tries to provide a contribution to the rigor of research. These principles are:

- **Abstraction**: Each artefact must be applicable to a class of problems (not specific).
- **Originality**: Each artefact must substantially contribute to the advancement of the body of knowledge.
- **Justification**: Each artefact must be justified in a comprehensible manner and must allow for its validation.
- **Benefit**: Each artefact must yield benefit either immediately or in the future - for the respective stakeholder groups.

## 7.4 Feedback from the Interviews

In this sub-chapter we will present the conclusions obtained from our interviews. We will start by describing their structure and the profiles of the interviewees and then present the results and present our view of the evaluation facing the objectives defined.

For the evaluation we collected the opinions of experts and potential users of the artefact. These interviews were semi-structured with the durations of 40 minutes each approximately. In these interviews we looked to assess the fulfilment of each criteria of Moody and Shanks and Österle, and to assess if in fact the artefact is more affordable and easier to use comparing to other methods available.

We chose the interviewees so that we could reach multiple industries and we tried to include both sides of the process, this is, the side of the organization and the side of consultants/cost analysts and cost specialists. The interviewees were:

- A member of the board of a Portuguese consulting company
- The director of the urgencies of a public hospital
- The IT director of another public hospital
- The owners of two pharmacies
- A professor specialized in costs
- Three cost consultants
- The coordinator of a task-force of the Portuguese Association of Pharmacies
- A professor of health management
- A manager from an Ambulance Company

We will not present the detailed result for each interview but the conclusions we have drawn from the sum of the interviews. The received feedback was positive and showed that the goals of the proposal are achieved by the method.

The main ideas from these interviews confirmed our initial beliefs that in fact organizations inside the same field share many processes and that therefore this method can be a contribution for more affordable and easier costing analysis This is achieved by modelling the industry only once and then instantiate as needed. Regarding the ease of use all interviewees acknowledged that if the template could be "selected" from a software and they would only have to give the data, most managers possessed the knowledge to do the application without external help.

Some recommendations were also made, as the aspect of introducing segmentation variables to make the instantiation easier and with less need for adjustment. This observation was already taken into account in our proposal.

There were also some misgivings. The main one was the fact that managers stated that two organizations inside the same industry, were not the same and so the template could never fit all. Faced with this situation we explained that was the purpose of the adjustment step. Interviewees stated that with this step it should be possible to adapt the template to different realities.

Another misgiving was related to how easy it would be to make these changes. To address this concern we suggested that the use of the prototype would guide the user, and the interviewees agreed but stated that the prototype should be user-friendly and wizard-like.

Regarding the criteria defined we will now present the conclusion drawn not only from the interviews, but our analysis on the method based on the definition of these same criteria.

## 7.5 Results of the evaluation

In this sub-chapter we give the detailed results for each of the criterion.

The results of MSQF were:

- **Completeness**: The model obtained is complete since all activities were normally present in the template and those that were not, could be added in the application phase using the adjustment step.
- **Integrity**: Is highly dependent on the interviews. There is no business rule or other constraint that prevents errors defining the activities or time-equations of the model since it relies on interviews and observations. An interviewee suggested to use the BPMN templates together with DEMO to address this.
- **Flexibility**: The ability of reflecting changes is achieved by the use of time-equations and the inclusion of the adjustment step on the method.

- **Understandability**: Interviewees in general found the models obtained easy to understand since their notation is close to traditional workflows but asked for a better explanation of the time-equations. It was suggested by an interviewee to have an example of a time-equation with a description in each model.
- **Correctness**: Same as integrity. It's fully dependent on interviews, except for the resources definition where constraints were defined.
- **Simplicity**: According to the practitioners the method is simple to follow, and what we verified is that it is simple to apply the template and reflect changes. The prototype was recognized to contribute to this aspect.
- **Integration**: The model is consistent with the rest of the organization for the sole reason it represents the organization.
- **Implementability**: Implementability is solely dependent on the information available. The basic information needed for the models must be registered as enforced by law, but for more in-depth analysis other information is needed. It was observed that sometimes this information exists, but it is not available through an IT system.

The four principles of Österle are also met. These are:

- **Originality**: None of the interviewees had knowledge of any research or product similar to the proposed artefact, and none similar was found in the related work.
- **Abstraction** – Our view on abstraction of this method is that it should meet at two levels: (1) it should be able to be applied to any industry, (2) in the end of the modelling phase the result is a template for all organizations in an industry and not only a specific one. All the interviewees agreed that it was the case.
- **Justification:** The artefact is supported by the related work, by the its theoretical background (BPMN + TDABC), by the representation of the model as well as all its constraints with each step described both textually and graphically. This result was not obtained from interviews.
- **Benefit**: According to the interviewees, at least in the industries consulted, there would be valuable benefit, since it would provide an easier, more affordable and faster to implement costing methodologies and doing cost analyses. This was also confirmed by the results obtained from our demonstrations, where in some cases we were able to provide insight to an organization using the proposed method.

## 7.5 Objectives Evaluation

Regarding the objectives we defined, we believe that they were all achieved as did our interviewees since **1)** the method is not specific to an kind of organization (we applied it to four different industries); **2)** our interviewees, particularly potential users (that had no expertise in accounting) said they could understand and use the models; **3)** The models were re-usable as proven by its validation in two different pharmacies with minor changes; **4)** the Method is less expensive due to the multiple instantiation of templates (also confirmed with interviewees); **5)** Potential users stated that the models are easily understandable (except for time-equations) and; **6)** The models were applied inside the prototype proving they can be used in an AIS.

Regarding the objectives specific to the prototype they were achieved since the prototype is cloud-based, was used to import models and financial data was imported in field studies using spreadsheets.

## 7.6 Discussion

In this chapter we described the evaluation strategy we followed. This strategy states that a process and a criteria and process must be defined. As process for evaluation we decided to do interviews with experts and potential users of this solution. As criteria, we used the Moody & Shanks Quality Framework and the four principles proposed by Österle.

In our interviews we looked to find the answers to those criteria and to see if our solution achieved the intended purpose. The feedback was positive as it was expressed, and most criteria were met.

We then proceeded to do an evaluation, based on all the information gathered from the interviews and demonstrations, we picked the objectives defined for this solution, and evaluated if they were indeed fulfilled.

# Chapter 8

# Communication

Communication is the last step of the DSRM and consists on communicating to the proper audience the artefact and its contributions. In order to do so we decided to do this through two channels : demonstrations to practitioners, experts and potential users and by submission of scholarly publications.

Regarding the first the audience was composed by the elements already identified in the evaluation. These included managers of several industries, professors, owners of small companies, health consultants, doctors, transport consultants and also cost consultants. This communication sometimes resulted in further evaluation since by communicating our method we were sometimes approached with suggestions.

In what concerns scholarly publications we submitted three research papers to three international conferences. These were:

- Fernandes, J. , Vieira, C. , Lourenço, A. et. al.(2012) Using Serious Games to Teach Business Process Modelling and Simulation ,Conference on Modelling, Simulation & Visualization Methods (MSV 2012), Las Vegas, Nevada, USA **(Accepted)**
- Lourenço, A., & Mira da Silva, M. (2013). Chronus: A cloud-based solution for affordable cost analysis offered as a service. Nineteenth Americas Conference on Information Systems. Chicago, Illinois, USA. **(Accepted)**
- Lourenço, A., & Mira da Silva, M. (2013) Business Process Cost Templates, 17th IEEE Enterprise Computing Conference (EDOC), Vancouver, Canada **(Under Revision)**

The first paper was solely related to the modelling phase and was written in an early stage of this research, and done together with other research relating serious games. Our contribution was how our

way to model costs could help managers learn more about business processes. The modelling phase has changed substantially since this publication.

The second publication regarded the prototype, it's current state and possible future developments. It was also focused on the concept of costing and a service, and how a cloud platform could help achieve this.

The final publication tried to summarize all our investigation, taking into account both the method and the prototype.

Both in the second and third publications the pharmacy field-study was used as demonstration.

We also submitted two other full-papers that although not accepted brought us feedback from the reviewers that was taken into consideration for the following papers.

Although not scholarly, several presentations of the method were done to experts in the area, collaborations with cost consultants working with TDABC were done, and demonstrations to potential users. Regarding the latter we would like to emphasize the interest shown by the Portuguese Pharmacy Association, that gave good feedback of the prototype and has proposed a pilot using the method in the prototype with several of its associates.

# Chapter 9

# Conclusion

Cost analysis and reduction was, is and will always be a major concern of organizations around the world. This has been accentuated in late years due to economic uncertainty, and also due to an increased competition that is becoming ever more global. It is vital to assess an organization's performance, to identify points of improvement and to increase efficiency. The issue is that not all cost analysis produce the desired effects, and those that do, are out of the reach of the large majority of the economy.

Our research was conducted using DSRM that provided us with a nominal process and a mental model to carry it through. We started by identifying the problem and then analysed the methods available to us both in what concerned costs and in what concerned modelling of business processes. From this analysis we made the choice of developing our artefact using BPMN and TDABC.

This artefact is a method composed of two phases. The first phase allows to create templates of an industry that aim to represent all the common aspects of organizations belonging to it like resources, activities and processes. The second phase is used to instantiate a template to a particular organization, by using the actual values of the organization and by adjusting it to its specificities.

As a complement to this method we developed a cloud-based prototype, that has as its main objectives to provide this method as a service, to reduce the level of expertise needed to create/instantiate the method and finally to allow the templates to be shared easily.

To assess the usefulness of our method we demonstrated it in four different industries, three of them belonging to the health segment. We focused more on the modelling phase of the method and created for each of these industries a template and in some cases we instantiated them to specific organizations.

Following these demonstrations we evaluated the proposal using for that purpose the criteria defined in the Moody & Shanks Quality Framework and the four principles proposed by Österle. With the criteria defined, we conducted interviews with experts and potential users. The feedback obtained was taken into account to improve the proposal.

Finally we communicated the method and our results to the proper audiences through demonstrations and by scholarly publications to internationally recognized conferences.

In the next subchapters we will detail our conclusions by presenting which were the lessons learned during this research, the limitations we identified, future work related to the context of this research that we believe would bring extra value and finally, which are the main contributions of this proposal.

## 9.1 Lessons Learned

There were several aspects raised during this research that are interesting to mention. Some resulted from the related work and the design phase, others resulted from the experience obtained during the demonstration and evaluation phases.

Regarding the lessons learned during the related work research and design phases we observed that there is already a clear effort to model processes cost and cost in general but there is a gap that exists between all stakeholders in the process. Inside an organization we have managers that just want information that they can understand, then we have those related with business process management that model and monitor business processes inside the organization, accountants that are calculating costs but without any relation to the business processes, and then IT that have to provide the data needed. What we observed is that there is no common link between them.

Regarding lessons learned from the demonstration, these were rather practical. In the first place the accuracy given to cost analysis is highly dependent on the data available. It is possible to model how each condition has an influence on costs, but it is only possible to evaluate them if they were somehow recorded. So the lesson learned here was not to start from only modelling and asking the data, but having a notion of what is available in advance to model according to the possibilities. To help dealing with these problems ERP's and CRM's could be used, but we found cases where these were available and the information was not introduced. Finally we observed that many organizations are not very keen on providing their data since they are afraid of leaks to their rivals.

Another aspect was that during interviews, interviewees had a clear tendency to simplify and forget some of the steps of the process they were explaining since these were already usual and obvious to them . A useful exercise was to ask the interviewees to put themselves in the role they were explaining and present step by step what was done. Also related to this is that when interviewing employees and asked them about the time some activity took, they tended always to over-estimate this value as a protection.

## 9.2 Limitations

The limitations associated with our proposal are directly related to the demonstrations done and the industries considered.

At this point we cannot state definitively that this template is applicable to every industry, with organizations of every size, since we only did demonstrations in four industries and in organizations of small size, but the feedback collected gave us strong indications that it might be possible to apply to others. We also only analysed one process in each industry, and all the organizations analyzed had the characteristic of having a simple structure without many support Resource Pools.

Regarding more technical details we observed, in particular during the third and fourth demonstrations, that some organizations, even if they are service organizations, have a lot of different direct costs. The problem with these direct costs is that, for them to be modelled using time-equations, they would have to be distributed to resource pools resulting in a loss of accuracy.

There are other limitations but are more related to the prototype, since it was only developed as a proof-of-concept, and to evaluate our demonstrations.

## 9.3 Main Contributions

We believe our proposal brings a valuable contribution in the context of cost modelling, reduction and analysis. We also believe that our method presents an answer to the research question we raised since on one hand, by using business process modelling languages together with costing methodologies, it is able to join two pieces of information normally kept apart. This symbiosis, on the other hand, opens the door for sharing this information which allows to capture common aspects of organizations belonging to an industry. This results on a template that allows to dramatically reduce the total effort of carrying a cost analysis since it can be distributed by all the companies that use the template.

The proposed method provides a nominal process of how to achieve this template. We believe that these well-defined steps will also act as a guideline for both analysts and managers. Regarding the latter, the proposed method reduces the demands of financial expertise, making it easier for SMEs to conduct a cost analysis using only indoor resources.

It is also important to mention the contribution of the prototype that although not at the core of this research, was vital to execute the step of calculation properly and because we believe it complements the method by contributing to the ease of use, and by allowing a better distribution of the models and therefore open the opportunity of offering cost analysis as a service.

The method and the results obtained from the demonstration were also evaluated by both users and experts. Their feedback was highly appreciated and resulted in several changes in the method and

generally it went accordingly to our best expectations: The method would be more affordable than those available today, it would be easier and it is innovative, making it a valuable contribution.

Regarding the area of business process management It will contribute on one hand to business process standardization by promoting the re-utilization of processes, and on the other hand it contributes to Business Process Re-engineering since it provides SME's with a tool to continuously monitor and re-design their processes.

## 9.4 Future Work

Regarding future steps we believe that they go through applying the templates obtained from our demonstrations to more organizations to verify if they really reflect the industries, developing templates of more industries and finally try that these templates capture more than one business process.

Another aspect that could be positive would be to see if this method would be applicable to larger organizations with an increased complexity and to evaluate the impact of moving across borders to see the differences or similarities between templates in different countries, since all the templates we created were in Portugal.

In what concerns the limitation regarding the modelling of direct costs, it would be valuable to find a way to model direct costs using a variation of time-equations. An option would be creating an activity having a time-equation that would represent the usage of direct-materials exactly, but for this to be accurate the time-equation should be able to have more than one resource allocated to it, which goes against the rules of TDABC.

Regarding the modelling phase of our method we believe it would be interesting to see if it would be possible to use another modelling language or notation like DEMO or ArchiMate to model the costs of an organization. This would allow an easier application of the method in organizations with processes defined with different modelling languages. There is already some research work being done around this subject.

We also believe that this concept of costing as a service could be further developed, starting with the implementation of a complete software tool based on the prototype resulting from this research, and then evaluate its applicability by promoting a pilot where the analysis would be done by the managers themselves.

Finally, and also related to the prototype, research could be done around the further integration of a cloud-based service with other information systems like CRMs and ERPs in order to assess how it could be possible to provide real time information to managers related to costs, and also provide real-time information about the profitability of an operation before it is made. Some of this was considered on our paper accepted in Americas Conference on Information Systems (Lourenço & Mira da Silva, 2013).

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