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METHODOLOGY FOR BUILDING AND MAINTAINING ENTERPRISE ARCHITECTURES IN SMALL AND MEDIUM ENTERPRISES

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Declaração de Autoria de Trabalho

METHODOLOGY FOR BUILDING AND MAINTAINING ENTERPRISE ARCHITECTURES IN SMALL AND MEDIUM ENTERPRISES

Declaro ser o autor deste trabalho, que é original e inédito. Autores e trabalhos consultados estão devidamente citados no texto e constam da listagem de referências incluída.

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To my partner Claudia Maria,
thank you for your love and support.

In loving memory of Natália de Sousa Gomes,
who taught me the most honorable values in life.

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Table of Contents

List of Tables

List of Figures

List of Acronyms

ADONIS:CE	ADONIS Community Edition
B2B	Business to Business
BPPAM	Business Process and Practice Alignment Methodology
BPD	Business Process Diagram
BPML	Business Process Markup Language
BPMN	Business Process Modeling Notation
CEO	Chief Executive Officer
CIO	Chief Information Officer
CRM	Customer Relationship Management
DoD TRM	Department of Defense Technical Reference Model
DoDAF	Department of Defense Architecture Framework
EA	Enterprise Architecture
EAP	Enterprise Architecture Planning
EDI	Electronic Data Interchange
ERP	Enterprise Resource Planning
FEAF	Federal Enterprise Architecture Framework
IP	Internet Protocol
IS	Information Systems
ISO	International Organization for Standardization
IT	Information Technology
KMS	Knowledge Management Systems
RFID	Radio-frequency Identification
ROI	Return on Investment
SCM	Supply Chain Management
SME	Small and Medium Enterprise
TOGAF	The Open Group Architecture Framework
UML	Unified Modeling Language
VBA	Visual Basic for Applications
XML	Extensible Markup Language

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ABSTRACT

Enterprise architectures are used by companies so that they can understand their structure and dynamics in a more extensive and detailed way, allowing them to reduce costs, increase productivity, promote growth and adapt in a rapidly changing business environment.

In order to not only survive but gain competitive advantage, enterprises need their architectures to be in sync with their business, which means being as faithful and up-to-date as possible.

Current methodologies for developing architectures such as Enterprise Architecture Planning (EAP) are designed for large companies and need to be adapted to be applicable to small and medium enterprises (SMEs). Also EAP develops the business model based in information gathered in interviews and surveys, which means the processes in the model are at an abstraction level that does not reflect the actual actions being performed by individuals. Additionally, current publications in this area don't cover how these models can be maintained in automated ways.

Stemming from these arguments, the main contributions of this research are first, to adapt EAP defining a methodology that can be applied to a SME. Second, to merge EAP with the Business Process and Practice Alignment Methodology (BPPAM) in order to be able to uncover a business process model from actual work practices captured in users' action logs. And third, to develop automated ways of analyzing and relating the model with these action logs in order to ease the maintenance of the business model. This research was developed and validated in a real organizational setting within the purchasing department of a company in the retail industry.

This work concludes with an overview of what was learned; how some problems found could have been prevented; and how the proposed methodology can be improved for future research.

Keywords: enterprise architecture planning, business alignment methodology, enterprise modeling, business processes, work practices, enterprise model maintenance, small and medium enterprises

RESUMO

As arquiteturas empresariais são usadas pelas empresas de forma a compreenderem a sua estrutura e dinâmica de uma forma extensiva e detalhada, o que lhes permite reduzir custos, aumentar a produtividade, promover o crescimento e adaptar-se a um ambiente de negócios em rápida mudança.

Não apenas para sobreviver como também para ganhar vantagem competitiva, as empresas precisam que as suas arquiteturas estejam em sincronia com o seu negócio, o que significa que estas têm de ser tão fiéis e atualizadas quanto possível.

Metodologias atuais para o desenvolvimento de arquiteturas, como o Enterprise Architecture Planning (EAP) são desenvolvidas para grandes empresas e precisam ser adaptadas para ser aplicáveis a pequenas e médias empresas (PMEs). Também, o EAP constrói o modelo de negócio baseado em informações recolhidas em entrevistas e formulários o que significa que os processos no modelo têm um nível de abstração que não reflete as ações que estão na realidade a ser executadas pelos indivíduos. Além disso, as publicações existentes nesta área não cobrem como estes modelos podem ser mantidos de maneira automatizada.

Partindo destes argumentos, as principais contribuições do nosso trabalho são primeiro, adaptar o EAP definindo uma metodologia que pode ser aplicada a uma PME. Em segundo lugar, juntar o EAP com o Business Process and Practice Alignment Methodology (BPPAM) a fim de ser capaz de obter um modelo de processos de negócio a partir de práticas de trabalho reais, capturadas em logs com ações dos utilizadores. E terceiro, desenvolver formas automatizadas de análise e relacionamento do modelo com esses logs de ação, a fim de facilitar a manutenção do modelo de negócio. A nossa investigação foi desenvolvida e validada num cenário organizacional real dentro do departamento de compras de uma empresa no setor de vendas a retalho.

Este trabalho conclui apresentando uma visão geral do que foi aprendido; como alguns problemas encontrados poderiam ter sido evitados; e como a metodologia proposta pode ser melhorada para investigação no futuro.

Palavras-chave: enterprise architecture planning, business alignment methodology, modelos empresariais, processos de negócio, práticas de trabalho, manutenção do modelo da empresa, pequenas e médias empresas

RESUMO ALARGADO

As atividades desenvolvidas pelas companhias de hoje em dia dependem de sistemas de informação cruciais que abrangem vários departamentos ou mesmo toda a empresa. Aplicações como o Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), ou Supply Chain Management (SCM) precisam ter um funcionamento alinhado com a estratégia e processos da empresa para poder suportar as suas operações.

A forma como estes processos se comportam determina a produtividade da empresa e os sistemas de informação podem ajudar a tornar estes processos, e consequentemente as empresas, mais eficientes automatizando parte dos mesmos.

As companhias são compostas por diferentes unidades de negócio, uma grande variedade de processos, ferramentas, estratégias e outras complexidades difíceis de visualizar globalmente mesmo pelos mais experientes.

As arquiteturas empresariais são um plano diretor que simplifica esta complexidade, exprimindo os elementos essenciais da empresa e suas relações em vários níveis de abstração, e que permite uma melhor comunicação e colaboração entre as várias partes.

Estas arquiteturas ajudam a manter o alinhamento entre negócio e sistemas de informação definindo uma plataforma de *standards* tecnológicos que permite às empresas reduzir custos, aumentar a produtividade, promover o crescimento e adaptar-se a um ambiente de negócios em rápida mudança.

Não apenas para sobreviver como também para ganhar vantagem competitiva, as empresas precisam que as suas arquiteturas estejam em sincronia com o seu negócio, o que significa que estas têm de ser tão fiéis e atualizadas quanto possível.

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criado pelo EAP têm um nível de abstração mais alto que pode não refletir as ações que estão na realidade a ser executadas pelos indivíduos. Além disso, as publicações existentes nesta área não cobrem como estes modelos podem ser mantidos, i.e. atualizados, de maneira automatizada.

Partindo destes argumentos, as principais contribuições do nosso trabalho são primeiro, adaptar o EAP definindo uma metodologia que pode ser aplicada a uma PME. Em segundo lugar, juntar o EAP com o Business Process and Practice Alignment Methodology (BPPAM) a fim de ser capaz de obter um modelo de processos de negócio a partir de práticas de trabalho reais, capturadas em logs de ações dos utilizadores. E terceiro, desenvolver formas manuais e automatizadas de análise e relacionamento do modelo de processos com os logs de ação, a fim de facilitar a manutenção do modelo de negócio.

A nossa investigação é desenvolvida e validada num cenário organizacional real dentro do departamento de compras de uma empresa no setor de vendas a retalho.

Em primeiro lugar tentámos descobrir os processos do departamento de compras, seguindo as primeiras fases do EAP, nomeadamente o planning initiation onde se fizeram os preparativos e planeamento para construção do modelo, depois seguiu-se a fase de preliminary business model onde se documentaram a estrutura e funções envolvidas, e finalmente a fase do enterprise survey, onde foram efetuadas entrevistas com os empregados do departamento para coletar mais informação sobre as funções e recursos utilizados e assim completar o modelo de negócio.

De seguida aplicou-se parte da metodologia BPPAM, capturando em logs as ações que os indivíduos executaram ao longo de vários dias. Estes logs foram criados através de formulários digitais parcialmente pré-preenchidos em Microsoft Excel que os indivíduos utilizaram para registar as suas ações.

Estes logs foram então analisados tanto manualmente como através de uma ferramenta que desenvolvemos em C#.NET. Finalmente, tentámos automatizar a relação entre o modelo de processos e os logs (i.e. as práticas de trabalho reais), através do desenvolvimento de outra ferramenta também em C#.NET.

Este trabalho conclui com uma explicação das principais dificuldades encontradas durante a aplicação da nossa metodologia; daquilo que aprendemos; e como alguns desses problemas poderiam ter sido evitados tomando as medidas certas.

Futuramente, e partindo de um conjunto de dados capturados mais extenso que o estudado neste trabalho, o conceito de contextos de ação pessoais poderá ser aplicado de forma a melhorar a qualidade da análise aos dados e assim mais facilmente conseguir distinguir as sequências de ações que existem dentro dos contextos de trabalho dos indivíduos.

Palavras-chave: enterprise architecture planning, business alignment methodology, modelos empresariais, processos de negócio, práticas de trabalho, manutenção do modelo da empresa, pequenas e médias empresas

CHAPTER 1

1. INTRODUCTION

1.1 MOTIVATION

Companies face an ever growing complexity and competition in the business world (Labovitz, et al., 1997). Enterprise architectures exist to manage that complexity and to allow companies to align their business' strategic vision with their information technology, improving departmental collaboration and communication. This enables the company to gain more knowledge about its own business, and to adapt changes in a more agile way while avoiding major obstacles.

Methodologies such as Enterprise Architecture Planning (EAP) are a guide on how these enterprise architectures can be developed (Spewak, et al., 1992). However EAP is generally too extensive to be fully applied on small and medium enterprises (SMEs) and its business process models are too abstract when compared to what happens in actual execution of the business processes. The link between business process models and the processes' actual execution, i.e. work practices, is an important one that hasn't been yet given the needed attention (Zacarias, et al., 2011). Studying this link is crucial for aligning the model with the actual business. Also, automating the translation process between these two perspectives can bring major gains in the architectures' maintenance.

Current publications about enterprise architecture don't encompass how EAP should be adjusted for SMEs neither how the business model can be aligned with actual work practices and maintained over time in any automated ways. This research tries to fill in those gaps.

1.2 MAIN CONTRIBUTIONS

This work studies how small and medium enterprises can adapt the Enterprise Architecture Planning (EAP) methodology and the Business Process and Practice Alignment Methodology (BPPAM) (Zacarias, et al., 2011) in order to improve knowledge about their processes and maintain them aligned with the business. When used correctly, this information can help companies be more agile and adaptable to both internal and

environmental changes thus gaining competitive advantage. EAP is usually applied on large enterprises, but we adapt it and validate it in a real SME; a retail company.

We research how business processes can be uncovered from actual work practices by capturing action logs and analyzing them. This complements the abstract views of processes gathered in interviews and surveys, which are part of EAP's approach.

The capturing of individual's action logs is attempted using prefilled spreadsheet forms, specifically for reducing impact of the capture process in the actions being performed.

Finally, we show how a business model can be exported from a graphical to a textual format, and how model maintenance can be made easier, faster and more reliable by developing automated ways of relating it to the captured action logs. This is opposed to the current maintenance procedures of updating the business forms and model diagrams manually.

1.3 THESIS STATEMENT

In order to stay competitive, companies need to have a strong, accurate and up-to-date knowledge of their business. This can be ultimately achieved by developing an enterprise architecture that is aligned with work practices and that gets updated using automatic means.

1.4 RESEARCH APPROACH

This section defines to which extent we have been able to take advantage of EAP and BPPAM methodologies, and how we applied them in a real working environment. Our study was performed within a retail company which in our work we refer to as "Company X".

1.4.1 SCOPE AND LIMITATIONS

Enterprise architectures (EA) of real world organizations are usually very complex consisting of many components and relationships between them. Also, EA projects are usually long-term and wide-range in scope and involve a team of experienced professionals. In this study we decided to study a relatively small retail company with 250 employees (Company X), and more specifically focus on a single department to be able to complete our research in a reasonable amount of time and within the available resources, i.e. only one person following and adapting the methodology and without involving costs for the company or the university.

As further detailed in chapter 2, we developed work on the first two layers of the Zachman framework (Context and Concepts) (Zachman, 1987), i.e. the ones most concerned with business processes by adapting the first two components of Enterprise Architecture Planning (EAP) methodology, i.e. Planning Initiation and Business Modeling. This methodology was further adapted with the Business Process and Practice Alignment Methodology (BPPAM) from which we focused specifically on its Practice dimension.

We believe the methodology presented in this study is general enough to be applied to other SMEs since it has no particular dependencies on our subject of study, Company X. However, since our work is validated through a case study, such assumption will need to be validated through several case studies in different companies.

1.4.2 METHODOLOGY

Our research started with a literature review of relevant publications related to our research topic including the areas of information systems, business alignment, enterprise architecture methodologies and maintenance issues.

We then designed our methodology for building and maintaining architectures in small and medium enterprises and validated it through a case study in a real company. Afterwards we collected the results produced from applying that methodology and examined our findings by interpreting the obtained data.

Finally we drew conclusions on the implications of our research and prepared a direction for future work.

1.5 THESIS OUTLINE

The remaining of this document is structured as follows. Chapter 2 reviews previous background and related work found in literature, namely in the areas of information systems, business alignment, enterprise architecture methodologies and maintenance issues; Chapter 3 presents the methodology and procedures applied in our research and is divided in four main sections, the planning initiation where the EAP project is prepared, the preliminary business model where a model is created from available documentation about the processes, the enterprise survey where interviews are performed to complete the processes model, and the work practices model section where a model is developed based on information captured from employees in logs and then analyzed and related to the business model.

Chapter 5 is structured similarly to the methodology chapter and reports on the results obtained from applying the procedures. Chapter 6 again follows a similar structure to the methodology and results chapters and sums-up the relevant inferences obtained from analyzing the results and executing the procedures. Chapter 7 summarizes the conclusions we reached from what we learned in this research and how some problems could have been avoided. Chapter 8 suggests how this research can be improved in the future, both by making changes to the methodology and by merging it with other concepts such as personal action contexts.

The appendices provide complementary information. Appendix A introduces the reader to BPMN's basic diagramming elements (White, 2006). Appendix B gives a detailed list of the relation between the functions and their information sources for the purchasing department in Company X. Finally, Appendix C includes two actual form samples (function and information source) obtained during the enterprise survey stage of EAP.

CHAPTER 2

2. LITERATURE REVIEW

In this chapter we used our research topic as a guiding concept to evaluate what has been published about it and what is relevant. We present ideas from the areas of information systems, business alignment, enterprise architecture methodologies and maintenance issues. The contrasting opinions of different authors are taken into account and we explain how these concepts integrate into our research.

2.1 INFORMATION SYSTEMS

Companies' activities nowadays depend on crucial organization-wide information systems such as Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), Supply Chain Management (SCM) or even Knowledge Management Systems (KMS). Other more specific systems support areas such as telecommunications, server administration, project management or human resources among many others. They are a fundamental part of the work and without them companies wouldn't be able to achieve a competitive advantage over their competition and probably wouldn't even survive.

2.1.1 BUSINESS PROCESSES AND INFORMATION SYSTEMS

A business process defines how work is done in a company by stating what activities need to be executed, in what order, under which conditions, and using what resources.

As Laudon further explains, "*Business processes refer to the set of logically related tasks and behaviors that organizations develop over time to produce specific business results and the unique manner in which these activities are organized and coordinated. Developing a new product, generating and fulfilling an order, creating a marketing plan, and hiring an employee are examples of business processes, and the ways organizations accomplish their business processes can be a source of competitive strength.*" (Laudon, et al., 2012).

How business processes behave will determine how the company performs. Information systems can play a big part in making these processes and thus the companies, more efficient by automating parts of the process or by helping redesign them to be more streamlined.

2.1.2 PORTER'S COMPETITIVE FORCES MODEL

One of the most widely used model for understanding how a company can stay ahead of the competition is Michael Porter's competitive forces model (Figure 1).

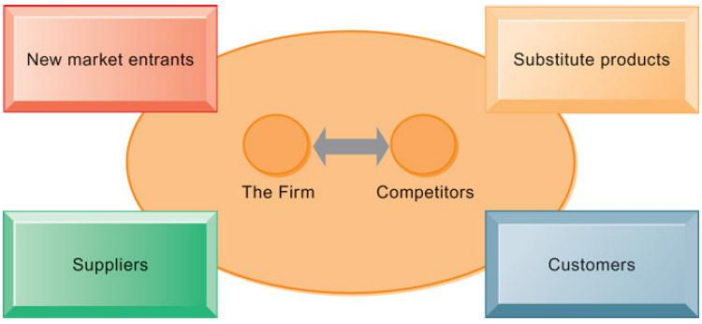


Figure 1. Porter's Competitive Forces Model (Laudon, et al., 2012)

This model takes into account the traditional business competitors and also adds to the equation the influence caused by the environment that Porter lists as: 1) new market entrants, 2) substitute products and services, 3) customers and 4) suppliers. All these factors affect how a company should adapt its strategy to keep competitive. However, this model does not help in telling companies which business unit or department they should focus on to obtain the best results.

2.1.3 THE BUSINESS VALUE CHAIN MODEL

Porter's value chain model illustrated in Figure 2 complements the competitive forces model by showing what the fundamental activities of the business are and where competitive strategies can be best applied (Porter, 1985).

These areas are prime candidates for information systems improvement because it is where they will have the most impact. The model represents the company as a chain of the main business activities that add value to its products or services (primary activities) and a set of activities that support them (support activities).

Primary activities include areas such as inbound logistics (receiving and storing the product), operations (day to day business activities), sales and marketing (selling and advertising the product to the customers), service (maintaining equipment, structures or supporting the customer), and outbound logistics (transportation and distribution of the product). Support activities enable the primary activities to function and are the firm's

infrastructure (administration and management), human resources, technology and procurement (purchasing product or resources).

This detailed view of the business allows focusing strategies after analyzing the business value components. Information systems can be customized to serve specific activities or chains of activities such as CRM or SCM.

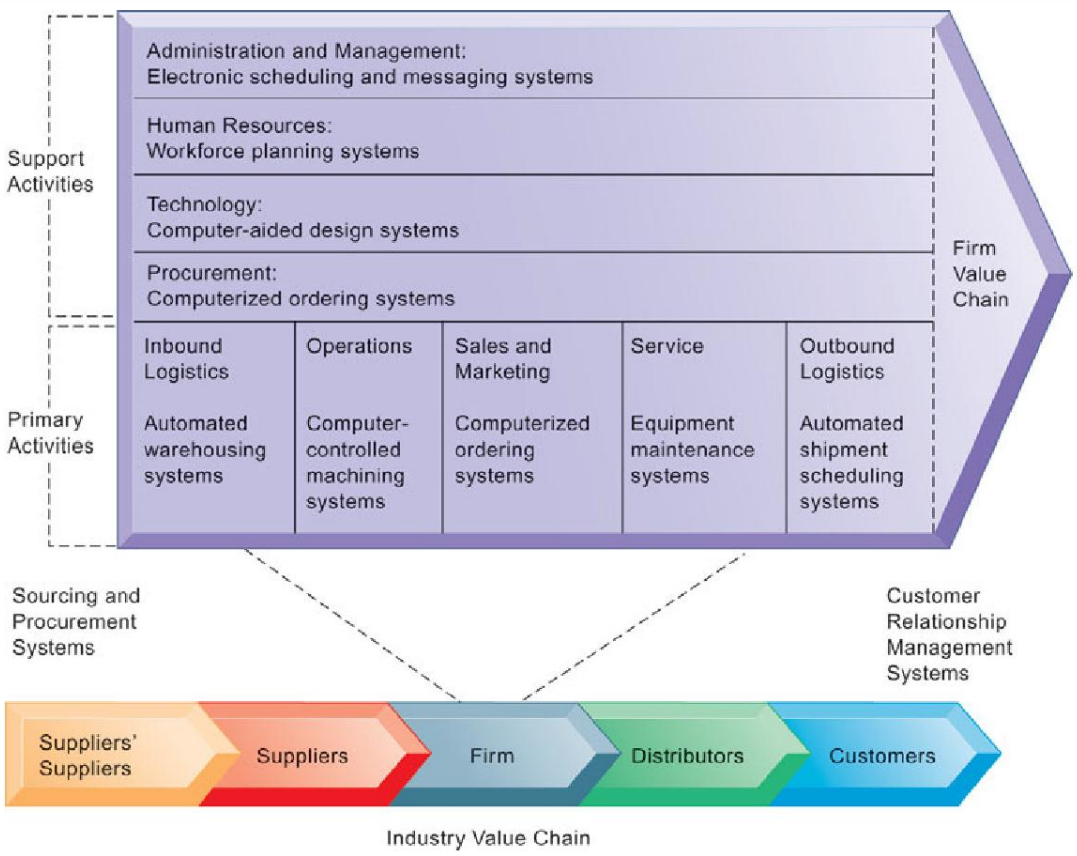


Figure 2. The Value Chain Model (Laudon, et al., 2012)

2.2 BUSINESS ALIGNMENT

In today's highly competitive economy, companies need to keep focused to stay ahead. In 1995 Kmart was pursuing a diversification strategy aimed at acquiring specialty retail companies, while Walmart was focusing on its core discount retail business and improving its buying and distribution systems. This strategy had an impact on Kmart stores which became more disorganized and in need of repair. The customers didn't take long to notice this loss in quality and started taking their business to Walmart (Labovitz, et al., 1997).

If Kmart had kept investing its resources on its most important assets, its stores, it wouldn't have had to endure the loss of their clients. Only by bringing together all the

important elements of the business (employees, customers, and processes) can the company successfully grow in profitability. This is the essence of business alignment.

Alignment is composed of two dimensions, the vertical and the horizontal alignments. Vertical alignment (Figure 3) represents the relation that exists between the company's strategy (at the top) and the employees (at the bottom transforming strategy into actual work practices) and how involved they are in contributing to the strategic decisions as well as how well they understand the strategy.

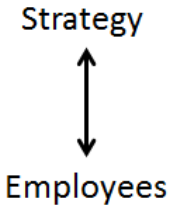


Figure 3. Vertical alignment

Horizontal alignment (Figure 4) is about how well the processes in the company serve the customers' needs and how involved is the customer in influencing the company's business processes.

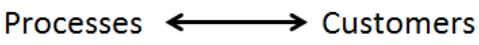


Figure 4. Horizontal alignment

However, even a perfect alignment of each of the axis will not bring success by itself. For achieving business resilience and agility, then both axis need to be aligned together creating a full alignment (Figure 5).

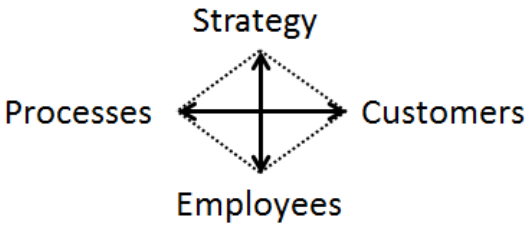


Figure 5. Full alignment

Lack of full alignment can lead to problems such as delivering a great product to the wrong customers, or attaining the right customers but not being able to deliver a product they want or need.

Just as the business elements need to be aligned together, the IT must be aligned with the business to firmly support its operations. Surveys have shown that business executives often express concern about IT not being aligned with the business, disrupting the strategic direction (Malan, et al., 2005). Technology is fundamental to the business and can be used to either keep up with our competitors or to give the company a competitive advantage by implementing capabilities that others don't have.

Enterprise architecture helps to keep the business-IT alignment by laying the foundation of technology standards that will enable productivity improvements, cost reductions and easier systems integration (Malan, et al., 2005).

2.3 ENTERPRISE ARCHITECTURE (EA)

Managers in enterprises need a representation to support them in the decision making process. This ideally should be a model that allows them to see not only the organization's more abstract elements like strategies or goals, but also the lower level operational and support processes details.

Enterprise information systems must be designed in a way that allows subsystems to interact with each other seamlessly. Without a plan or architecture for guiding development, systems in a company will grow organically into a level of complexity that becomes hard to manage and that can hinder a company's operations.

The term "architecture" is a metaphor from the building trade. Builders would not begin construction of a building without the blueprints that provide the details about the work that needs to be done. This is similar to software systems developers in that they need to have the plans that document the software just like blueprints. These plans are the enterprise architecture (Harmon, 2003).

Effective business architectures are developed with the contributions from analysts, senior managers, key users, and other senior staff and they are implemented by a team of experienced IT engineers and architects. For the architecture development to work, the contributors need to know the business very well (Brown, et al., 2009). With so many people involved, this sort of project becomes not only a technological but also a political challenge,

where problems as lack of communication or lack of motivation by some members could bring it to a stop. As noted by DeMarco and Lister in their highly acclaimed book Peopleware (DeMarco, et al., 1999), "*The major problems of our work are not so much technological as sociological in nature*". Other obstacles to enterprise architecture have been identified as fear of losing control over information, vested interests and resistance to change from the people involved in the project (Malan, et al., 2005).

2.3.1 WHAT IS ENTERPRISE ARCHITECTURE

Companies consist of different business units, a great variety of processes, hardware and software tools, strategies and other complexities that are hard to visualize globally even by the most experienced staff.

Enterprise architecture is a master plan that expresses the enterprise's essential elements and that allows better communication and collaboration between the parts (Schekkerman, 2004). It also documents the relationships between those key elements and provides several levels of abstraction or viewpoints.

This holistic view encompasses a lot of information and several views of it. In order to be able to manage it properly the information needs to be organized in some way, and that is the responsibility of frameworks such as Zachman, The Open Group Architecture Framework (TOGAF) or the Federal Enterprise Architecture Framework (FEAF) (Schekkerman, 2004).

Nolan and Mulryan (Nolan, et al., 1987) have compared Enterprise Architecture design to city planning. "*City planners must design in the face of many unknowns, such as future transportation technologies, changing work, living and commuting patterns, and so on […]. As a result of this level of planning, our major cities are able to accommodate new technologies for transportation and communication which remain viable for hundreds of years, and which make a major contribution to each city's brand of urban culture.*"

2.3.2 THE IMPORTANCE OF EA

The growing importance of this area of study is clear by surveys made to CEOs, CIOs and other companies' executives (Schekkerman, 2004). Decision makers need an integrated visibility of all aspects of the company to be able to make sound choices. Failure to do so leads to unsuccessful projects and consequent losses.

Gartner reports that IT project failures in industry and government accounted for $75 billion in losses yearly in 2003 (Schekkerman, 2004).

Enterprises without architectures are forced to make the choice between the risks of making a change which affects other parts of the business, or hesitate on the safe side and abandon the competitive benefits of innovation (Hinkelmann, et al., 2010). Systems' complexity does not add value to a business, and so only well-designed enterprise architectures can enable companies to prosper and allow them to accommodate big changes without major hiccups.

Recent studies on 103 U.S. and European firms found that a 25% reduction in IT costs can be achieved with a strong architecture combined with having information in core processes converted to a digital format (Brown, et al., 2009). Companies like these will also benefit from higher profitability, faster times to market, and higher values from their IT projects (Ross, et al., 2006).

Correct implementations of enterprise architecture leads to less servers and software applications needed, faster adaptability to change, and proactive system management that prevents downtime. Adaptability means companies can perform mergers and acquisitions more easily but also that they can separate again and have their systems working individually if they want.

Many benefits have been pointed out for effective and fully business aligned enterprise architectures, such as creating a common vision of the future shared by both business executives and IT, lowering complexity to improve agility to change, developing a proactive organization capable of meeting customer demands and driving innovation, unifying business processes and information across the enterprise and eliminating duplicate or overlapping technologies thus reducing costs (Schekkerman, 2004).

2.3.3 WHERE EA STANDS IN THE COMPANY

Enterprise architecture must be at the top level of abstraction (Figure 6) where it can relate to both the business and the technology strategies. EA guides the development and implementation of business and information systems relating them to the technology that underlies those systems and enabling them to perform both effectively and efficiently.

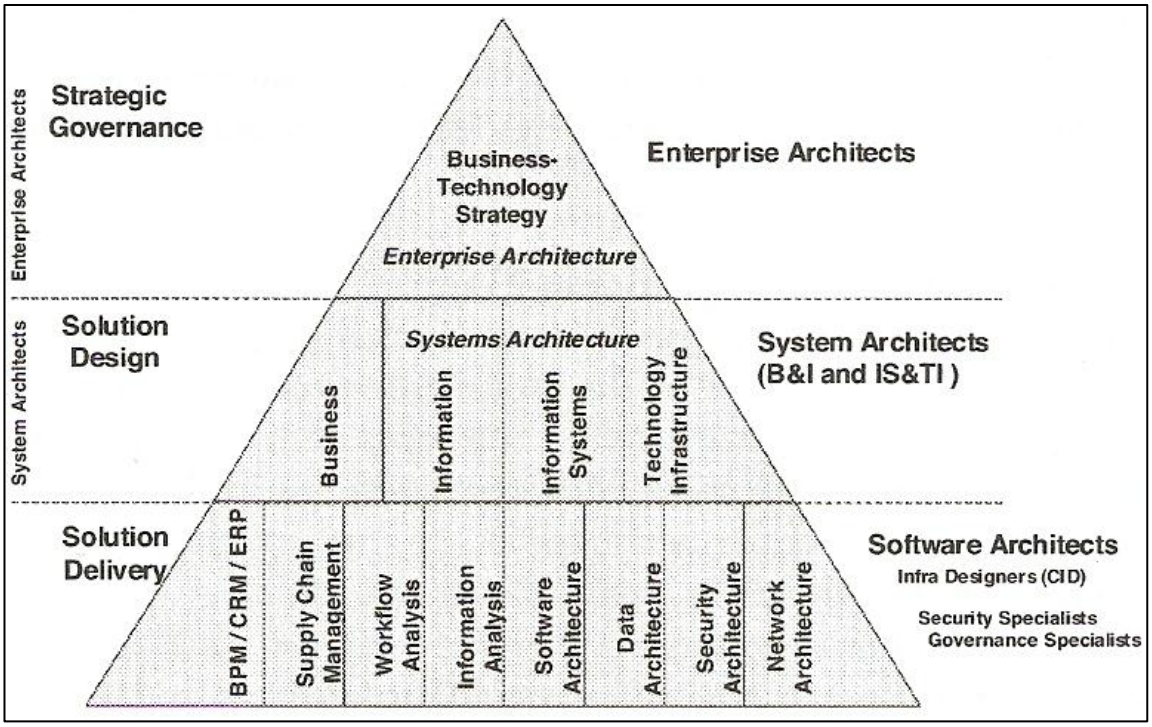


Figure 6. EA's place in companies' abstraction levels (Schekkerman, 2004)

2.3.4 EA STRUCTURE

Gartner identifies three viewpoints for developing an enterprise architecture: 1) business architecture, 2) information architecture, and 3) technology architecture (Brown, et al., 2009). Other authors have attributed different names to these architectures but with the same intention, for instance Steven Spewak (Spewak, et al., 1992) mentions them as data, applications and technology architectures. The data architecture defines the types of data that the business uses and reflects the business architecture, the applications architecture defines what types of application are necessary to work on the business data and can be mapped to Gartner's information architecture, and finally the technology architecture defines the technological systems that are needed to support the business applications. On the other hand Michael Rohloff (Rohloff, 2005) refers to them in that same order as business, application and infrastructure architectures (Figure 7).

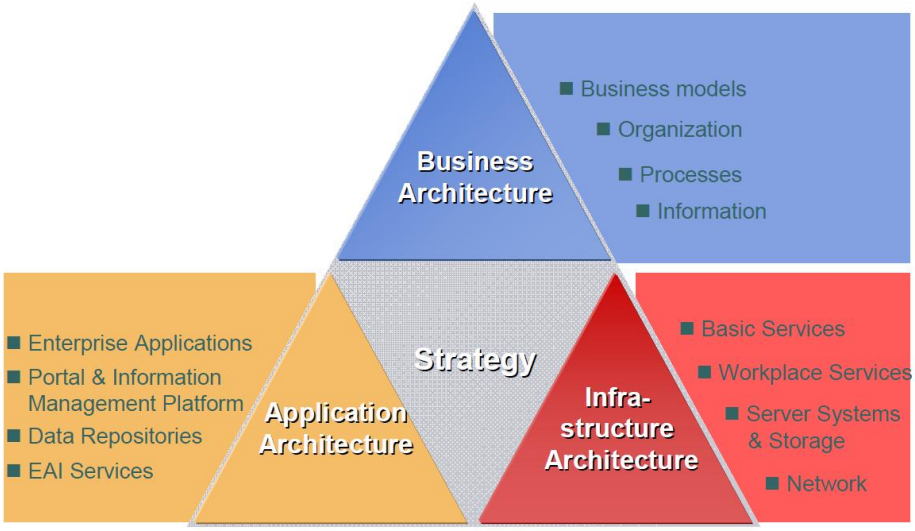


Figure 7. Enterprise architecture framework (Rohloff, 2005)

Business Architecture

For the business model to be developed, we need to understand: 1) who the customers are, 2) if accounts across business units can be consolidated, 3) if the firm's strategic needs are defined, 4) whether the operation processes are documented and 5) what are the company's main concerns, for instance product quality, time to market speed, or keeping the customer informed.

In order for IT managers to be able to create and fine tune an architecture to meet the company's needs, they need to be able to tailor the IT system development to match the business process. This matching is called business alignment which is covered in section 2.2.

The hardest companies to manage are those with decentralized locations, each one with local authority and where each one uses a different system that does not interface with the others. Taking a retail store as an example, this would mean that there's no consistent way to view their clients' information or what products are actually being sold.

Enterprise architectures (EA) must be "sold" to the higher management in companies, which most of the times cannot see the benefit of it but only the costs it represents in the short term. This is understandable since EA is a holistic concept for which its exact contributions cannot be calculated. Brown and Yarberry (Brown, et al., 2009) compare EA to a college education where one cannot pinpoint if a specific course or semester contributed X% for the lifetime earnings of a student. Even though we can elicit the potential benefits of EA such as saving costs on servers and software, less man-hours to

maintain interfaces between systems, or reduced system downtime we cannot anticipate the return on investment (ROI) as much as the financial directors in companies would like.

Information Architecture

Business goals cannot be met unless the information the company uses is stored in a secure, modular way, with an efficient database design that can be expanded easily to accommodate more information or more types and structures of information. Moreover, user interfaces must be clean and intuitive so that people using the data can take full advantage of it.

Entering data into the system is also a concern of the information architecture meaning that input methods used (e.g. scanners, keyboard, voice recorders, etc.) and how they are controlled must be planned.

The system must be flexible enough to use its data repositories in a way that enables it to answer to almost all business questions (e.g. which are the best customers, where is money being earned the most, could sales be improved, etc.).

Improving the use of information in an organization is a long term process but the benefits are well worth the effort. As claimed by Toyota in its highly efficient Toyota Production System, managers should base their management decisions on a long term philosophy, even at the expense of short term financial goals (Liker, 2004).

Gartner reports financial improvements for enterprise architecture such as: 1) $3.8 to $7.8 million in annual cost reduction for a university, 2) 25% to 30% reduction in infrastructure costs and 50% reduction in field service calls for a professional services firm, and 3) $3 million in cost reduction for a charity (Brown, et al., 2009).

Technology Architecture

There are currently so many different tools and technologies available in different countries that it is hard to create a standard technology architecture. However, as Brown and Yarberry (Brown, et al., 2009) point out, the important thing is to have two versions of your architecture. One that the business people can understand, written in a non-technical language where the potential financial benefits are stated, and another version with a detailed road map that the technical teams can use to implement the systems.

The architecture should first present the current state of the technology in the organization (also known as the "as-is" state), and proceed to present what it envisions to

implement in the future, the "to-be" state. For organization purposes, the architecture should put together tools and technologies into logical groups, for instance a "to-be" architecture could include groups as the ones in Figure 8.

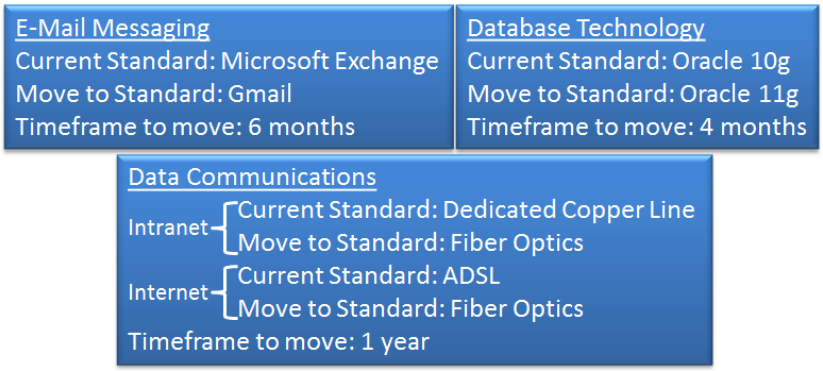


Figure 8. Example logical grouping in technology architecture

2.3.5 EA FRAMEWORKS

The process of creating an architecture of the enterprise produces a large quantity of information about the business and that information needs to be stored in a logical way so that it can be efficiently used and maintained over time.

Frameworks can hold that information in an organized way including models, principles, standards, and design concepts, but they won't by themselves address the issues that EA attempts to solve. As Sasa and Krisper (Sasa, et al., 2011) confirm, frameworks provide little guidance in creating the architectural artifacts themselves.

The chosen framework must be accompanied by a methodology and the tools that support that framework. For instance, while System Architect from Popkin Software supports Zachman, TOGAF and the Department of Defense Architecture Framework (DoDAF) (Schekkerman, 2004), the ARIS suite from IDS Scheer only supports the ARIS framework.

There are many frameworks to choose from. Even though frameworks share the fundamental concepts, most of them are specific to a domain, for instance the governments Federal Enterprise Architecture Framework (FEAF) or the military's Department of Defense Technical Reference Model (DoD TRM) (Schekkerman, 2004). As Figure 9 shows, Zachman is both the first formal framework to be created and also the longest standing framework that has evolved over time and influenced others. The Zachman framework is not designed for a particular domain and so is suitable for use in our study. Figure 9 also

shows that this framework directly influenced and is most closely connected to EAP (Enterprise Architecture Planning) which is the methodology we used in our research and is covered in section 2.4.1.

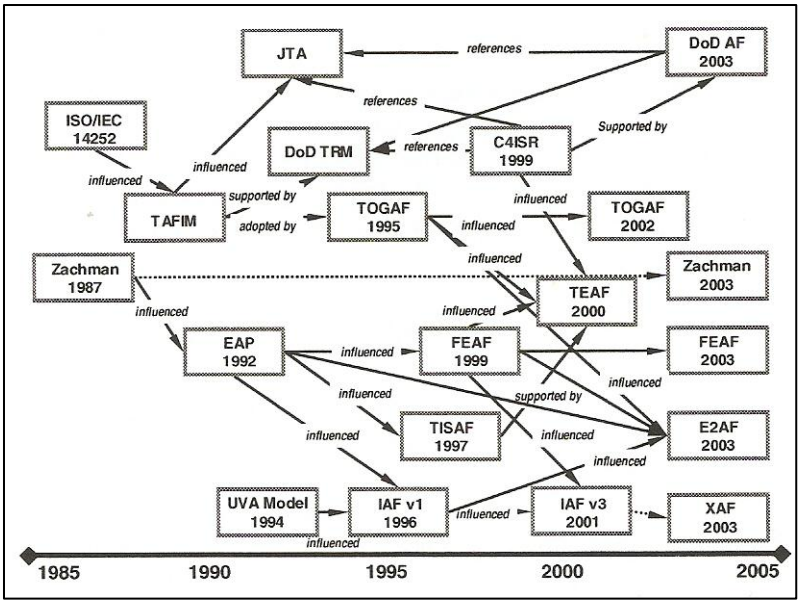


Figure 9. Evolution of enterprise architecture frameworks (Schekkerman, 2004)

2.3.6 THE ZACHMAN FRAMEWORK

Initially published in 1987 in a paper by John Zachman (Zachman, 1987), the Zachman framework is currently at version 3.0 (Figure 10). It describes an organization's information structure from six perspectives: planner, owner, designer, builder, implementer and user.

Each of these perspectives must include enough information to be able to answer to six abstractions, namely: why, how, where, who, when and why. Only then a complete system is modeled. These abstractions exist to reduce the complexity of each perspective's model by compartmenting it. Even though the lower level perspectives depend on the restrictions of the top level ones, the columns have no order. There is no implied order or sequence for the concepts or cells of the framework either.

The perspectives (rows in Figure 10) can be described as follows:

- Context (Planner View): Works as an executive summary of scope and objectives for estimating size, cost and general functionality of the system.
- Concepts (Owner View): Shows business entities, processes and their interactions, i.e. the business model.

- Logic (Designer View): Can be used by system analysts to determine which data elements and software functions represent the business model, i.e. the model of the information system.
- Physics (Builder View): Chooses the tools and technology that can implement the system requirements, i.e. the technology model.
- Components (Implementer View): A detailed description that depicts modules that can be implemented individually in machine language.
- Working System (User View): Actual functioning information system elements.

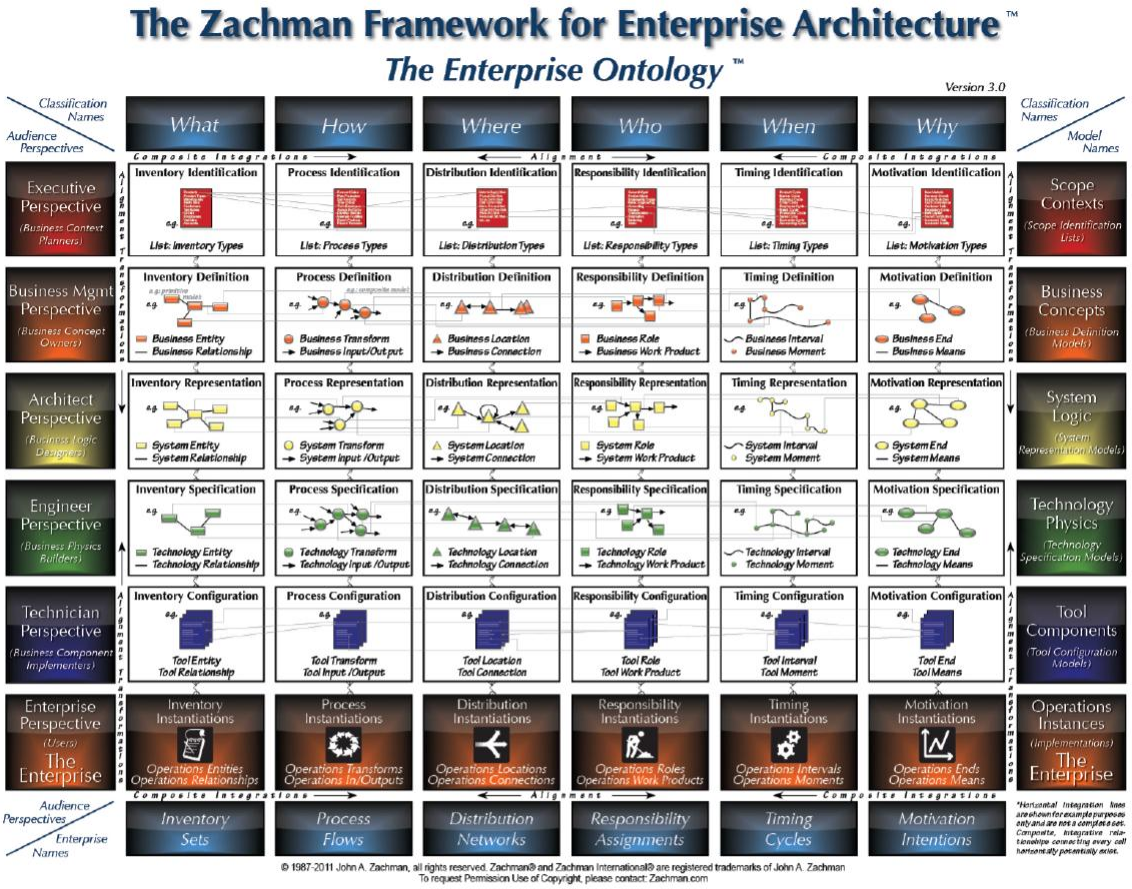


Figure 10. The Zachman Framework v3.0 (Zachman, 2011)

The abstractions (columns in Figure 10) are described as:

- Who: the responsibilities and relations between people in the enterprise.
- When: timing cycles or event relationships.
- Why: the company's motivations, strategy and goals.
- What: the entities involved for that perspective (e.g. employee, supplier, truck).

- How: the functions involved (e.g. business process, software function).
- Where: the locations involved (e.g. store locations).

In this study we have focused on the business processes of the company, meaning the developed models belong to the Context and Concepts perspectives of the framework. In order to be able to complete the research in a reasonable amount of time, we focused on the What, How and Where abstractions (see Figure 11). We also researched how the Concepts layer (processes) can be related to the actual user actions (Working System layer).

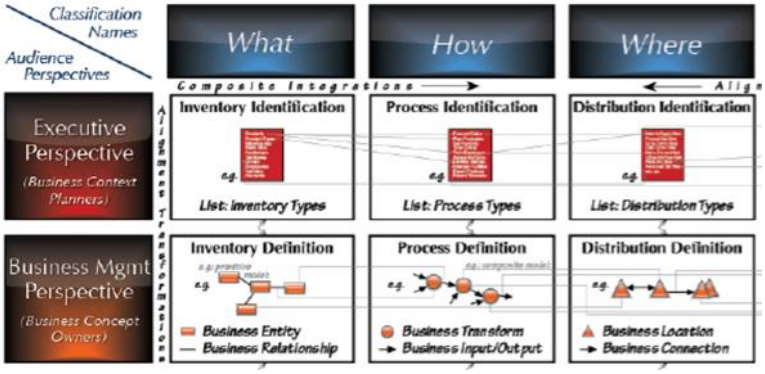


Figure 11. Detail of studied section of the Zachman framework v3.0

The Zachman framework is used to represent an overview of an enterprise architecture and is an approach to describing its elements (see Figure 12). It has become the most popular approach for describing an enterprise architecture (Harmon, 2003).

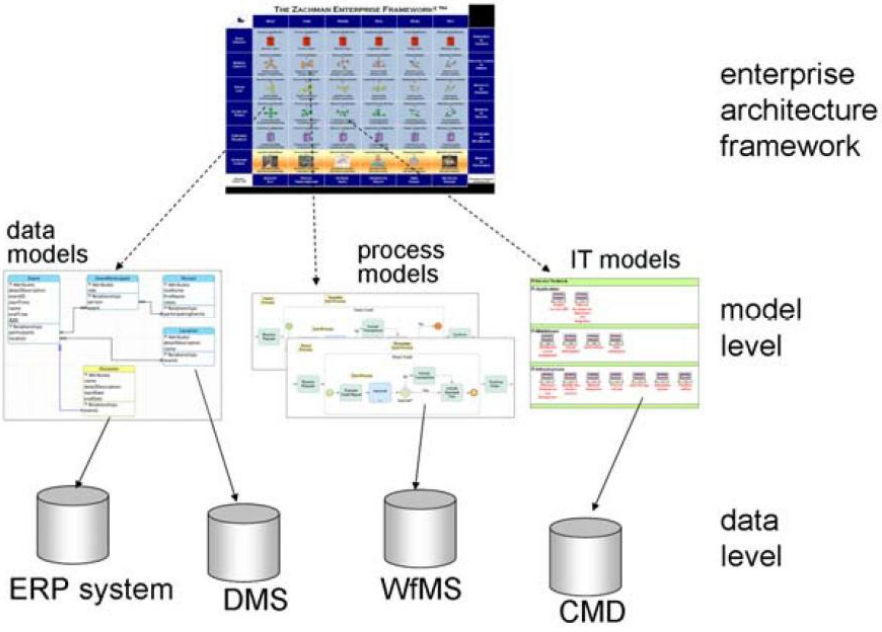


Figure 12. Relation between EA, models and data (Hinkelmann, et al., 2010)

2.3.7 BUSINESS PROCESS MODEL NOTATION (BPMN)

Business process model notation (BPMN) is a specification that provides a graphical notation for expressing business processes in a business process diagram (BPD) (Simpson, 2004). This notation was developed in order to be understandable to all users, from business analysts to technical developers and managers, as well as to allow modeling the complexities in business processes through a simple mechanism. It is also considered the standard business process modeling notation in the business process modeling community (White, 2006).

BPMN is independent of any specific business modeling methodology thus allowing us to use it in our research while following methodologies like EAP or BPPAM (see section 2.4).

There are four main types of elements in BPMN: 1) Flow Objects, 2) Connecting Objects, 3) Swimlanes and 4) Artifacts. A summary of these can be found in Appendix A. An example of a business process diagram is shown in Figure 13 and illustrates several BPMN's basic elements.

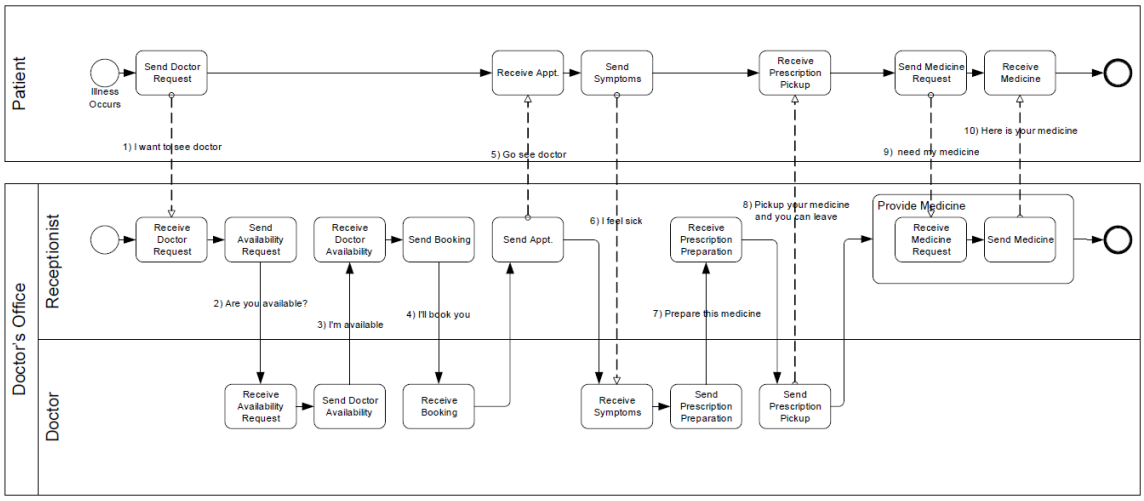


Figure 13. BPMN example: process of patient going to the doctor (White, 2006)

2.3.8 EA TOOLS

There are currently many tools that help analyze, design and develop the enterprise architecture for complex integrated environments. Tools can store in one place all the representations of different elements, i.e. store the model of the enterprise. This is called a repository and is usually a customized database built with this purpose in mind.

Market leaders in this area include ARIS (IDS Scheer), ProVision (Proforma), MEGA Suite (Mega), iGrafx, Enterprise Architect (Sparx Systems), Rational (IBM), and System Architect (Popkin Software) as indicated by (Blechar, 2008) and (Ylimäki, 2004).

The variety of tools provides many options of complexity and each company should choose the one that best fits their needs. They vary enormously depending on what their focus is. Some tools only support creating enterprise architectures while others also include business/IT strategy and software engineering (Schekkerman, 2011).

In our study there wasn't a backing investment from a company, so we needed a tool that could be used for free but that would allow us to design the business processes of a company using the business process modeling notation (BPMN). We found that ADONIS Community Edition (ADONIS:CE) by BOC Group would suit our needs (Harmon, 2010). When compared to ADONIS:CE, the more expensive tools provide more features such as better modeling interface (faster, more intuitive), complete implementation and integration with models and frameworks (Zachman, FEAF, TOGAF), more automated ways of input for populating and developing models. They also provide flexible and extendable platforms that adapt to the company and that can interface with other tools, providing analysis and view manipulation capabilities on the models. Advanced features on the repository are supported such as storage of data in commercial database systems and collaboration of users concurrently on one repository, and finally version control of the model (Sparx Systems, 2010).

Previous research has identified a general list of desirable features to have in enterprise architecture tools (Menefee, et al., 2003): 1) the tool provides framework for modeling and maintenance and is not merely a repository of artifacts, 2) the repository uses database technology to store and manipulate the artifacts, 3) all information, artifacts and concepts in the EA can be interlinked together, 4) information can be easily updated, added or deleted, 5) tool provides the ability to create a web accessible result to present the enterprise, 6) tool provides graphical data like diagrams in addition to textual data, 7) has a powerful and intuitive graphical navigation, and 8) serves as the core source of up-to-date information to support IT management.

However, tool requirements and specifications can be extensively detailed to include topics such as platform compatibility, performance, security, help desk support, training, documentation, simulation, repository management, model validation, modeling language

support, user interface, customization, reporting, and version management among others (Schekkerman, 2011).

The selection of a tool in a company where there's a team of enterprise architects should usually be a carefully planned one. No one single individual should unilaterally select an EA tool risking to alienate other members of the team or choosing a tool that is not adapted to the company's needs. A selection team must be assembled and several tools should be weighted on different criteria (Rudawitz, 2003).

2.3.8.1 SYSTEM ARCHITECT (POPKIN SOFTWARE)

A fully featured but expensive EA tool is Popkin Software's System Architect. This tool supports the Zachman Framework by default in such an integrated way that when the user runs the software, he can click on the cell he wants on a screen showing the framework (Figure 14) and have access to all diagrams and documents stored in it (Harmon, 2003). It also provides a web client that allows advanced editing and publishing features by the modeling team (Castela, 2011).

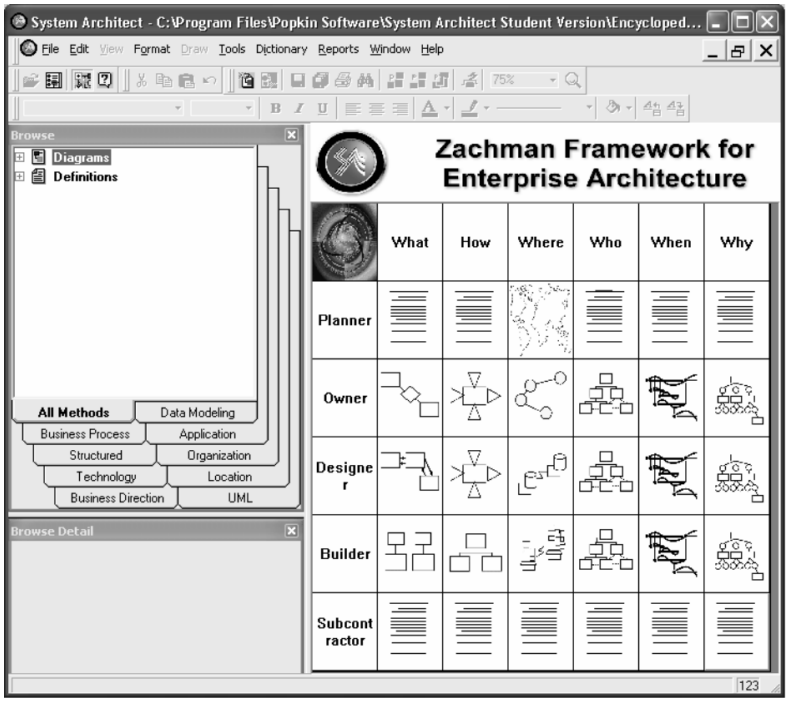


Figure 14. Main System Architect screen (Dologite, et al., 2005)

Figure 15 shows how System Architect (v9.0) supports an enterprise architecture. The user interface allows creating and changing the EA model through business modeling, UML, data

modeling, structured methods and XML design. All of this information is stored in the tool's repository which can then generate many sorts of outputs such as reports, web browsing, XML interfaces or Microsoft Office documents.

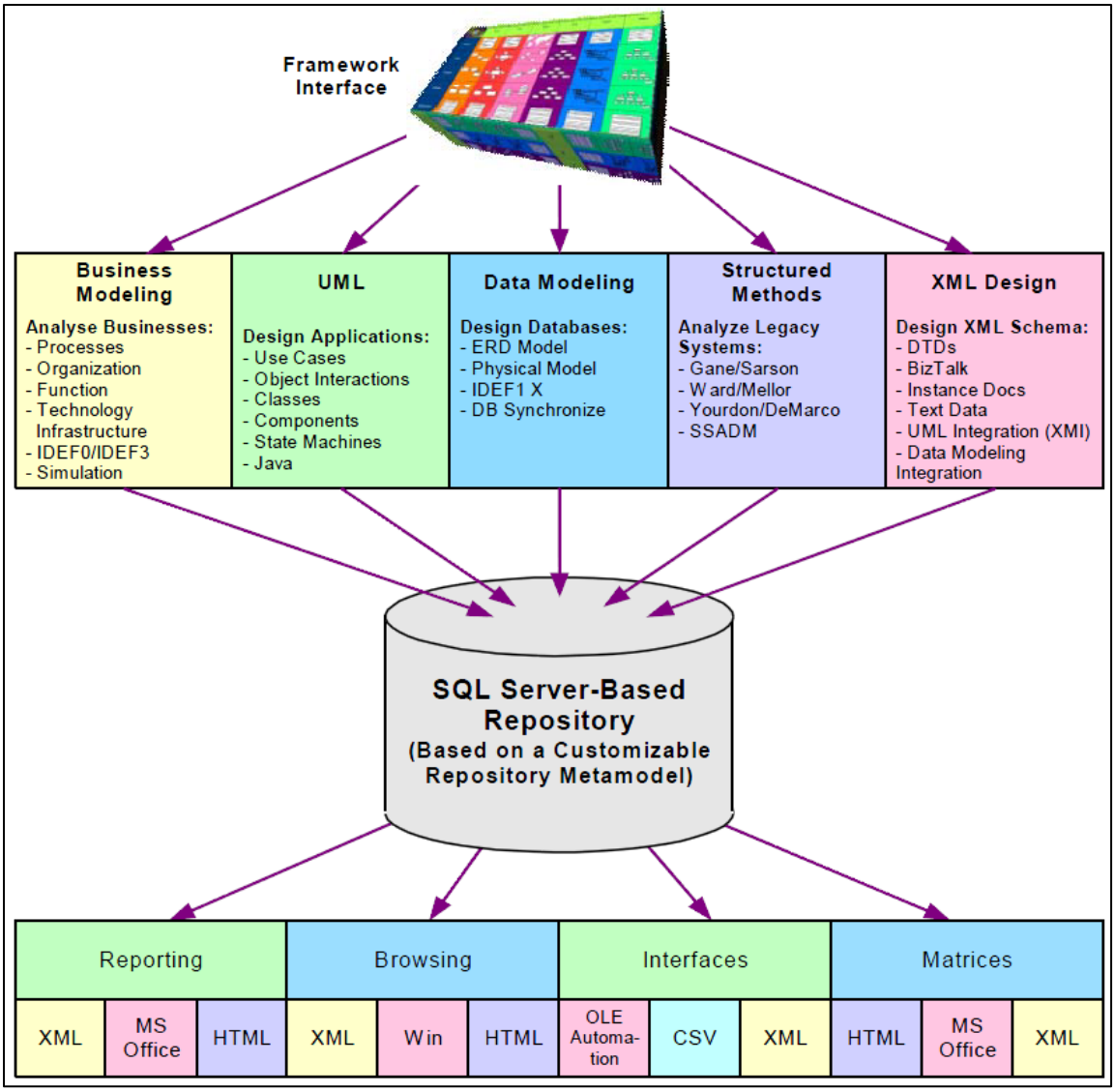


Figure 15. System Architect 9.0 supporting enterprise architecture (Harmon, 2003)

However expensive a tool may be, it is a false statement to say that better tools produce better results. As Spewak (Spewak, et al., 1992) noted, developing enterprise architectures is mostly an interpersonal process and not so much technical, meaning that tools cannot replace human experience or common sense.

2.3.8.2 ADONIS COMMUNITY EDITION (BOC GROUP)

ADONIS:CE whose user interface is illustrated in Figure 16 is a business process and knowledge management toolkit that supports the design and development of business process models (Castela, 2011). It conforms to the BPMN 2.0 standard and also provides features such as analysis and activity costs, simulation of models, evaluation and tracking of key performance indicators as well as importing and exporting the model through languages such as XML and business process markup language (BPML) (BOC Group, 2011). In our research we take advantage of the tools' XML exporting capability to interface with an application we developed.

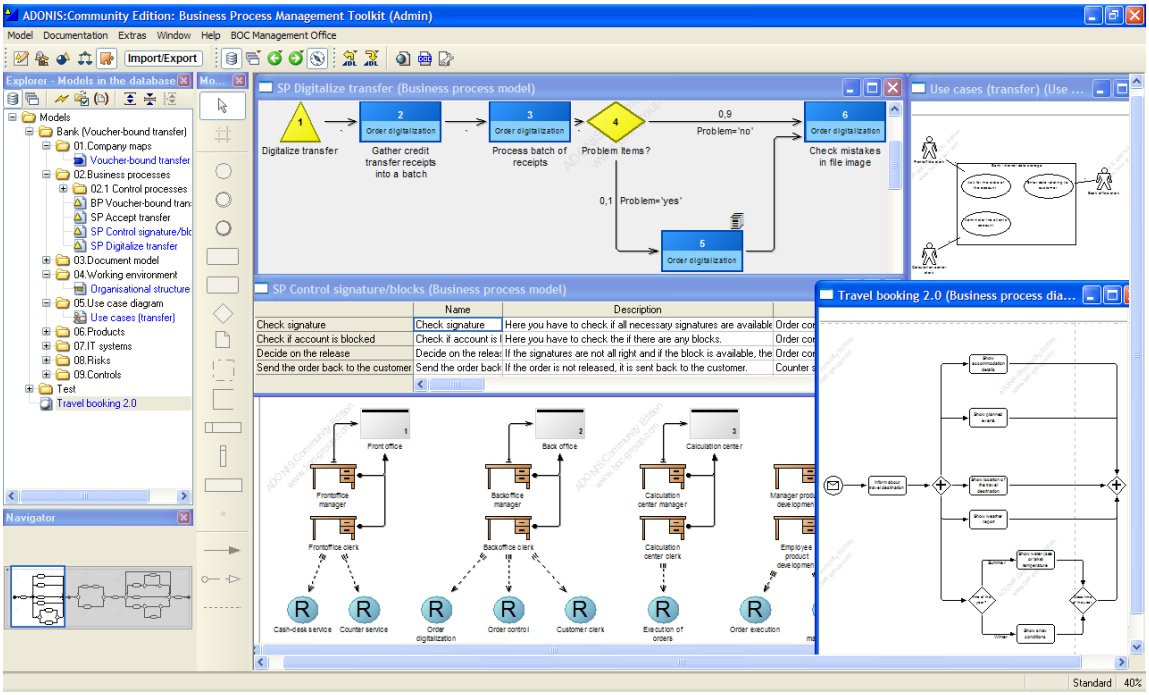


Figure 16. ADONIS:CE modeling component

The commercial edition of ADONIS, which is very similar to the community edition has previously been used successfully as a business process management tool to standardize and support processes at Telefónica, a world leader in the telecommunications sector with over 100 million customers (Harmon, 2010).

2.3.9 EA ALIGNMENT

For an enterprise architecture to be of any value it needs to be up-to-date. We know that many documents in organizations are outdated even before they are finished and published. This is because companies are constantly changing and adapting to its environment.

2.3.9.1 EA ALIGNMENT CYCLE

Companies need to assign the responsibility of maintaining the EA to a team that will keep it aligned to the new goals, strategies or processes. Figure 17 shows how the environment influences the strategy of a company, i.e. the strategy committee along with line managers propose changes to the current architecture. These changes are then consolidated by the business architecture committee who in turn delegates redesigning the business processes and IT infrastructure to the strategy committee and information systems team respectively. The changes are applied in the process and evaluated by top managers. The cycle goes on in an attempt to keep the EA up-to-date with company changes.

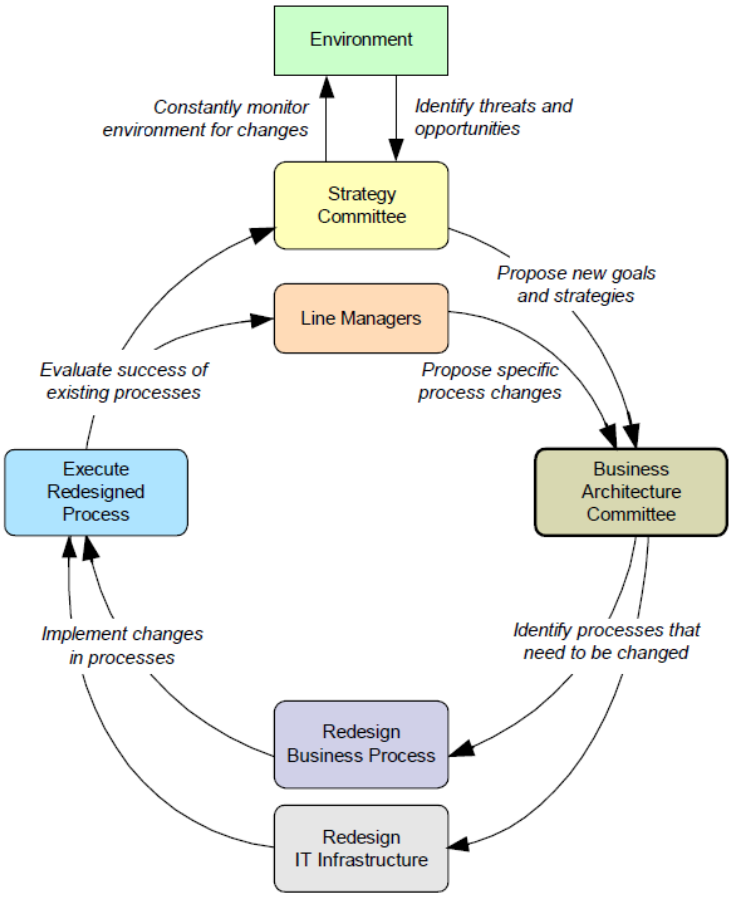


Figure 17. The EA alignment cycle (Harmon, 2003)

2.3.9.2 EA TOOL ASSISTED MAINTENANCE

As several authors agree, the whole enterprise architecture effort will come to nothing if it is not maintained once it's created (Harmon, 2003) (CIO Council, 2010).

EA maintenance can be assisted by such tools as System Architect because these store and organize all diagrams and documents in a logical way that allows both the maintainers and the managers to navigate the information and find what they need.

These tools allow creating, changing and extending the architecture. However they don't provide an automatic means for making or suggesting those changes because they process high level user input instead of capturing data. Also they rely on designed processes and don't attempt to discover the business model from actual day-to-day work practices.

Paul Harmon (Harmon, 2003) suggests that teams should develop a systematic process to generate and store additional documentation and diagrams in an orderly way. Other methods suggest reassessing the enterprise architecture periodically to ensure its alignment with the business (CIO Council, 2010). All these approaches skip over the need to learn what is actually happening at the individual level and don't address the automation issue.

2.4 EA METHODOLOGIES AND MAINTENANCE

Even though Enterprise Architecture Planning (EAP) is widely used and has influenced many other methodologies and frameworks (see Figure 9, page 16) there is no "best" methodology. Some techniques or tools may seem to work better than others, but that is more likely to be affected by the people involved and the work environment than the merits of the techniques themselves. As Spewak reminds us, any methodology is better than none, and that what is important is to pick one that can be completed in a reasonable amount of time and stick to it. Most EAP projects actually fail due to reasons such as: 1) lack of commitment from management, 2) lack of resources (computers, people, etc.), 3) communication problems, 4) unclear project responsibilities, 5) inexperience, and 6) fear of change from users that need to change work habits or managers that are afraid of losing control over information (Spewak, et al., 1992).

2.4.1 ENTERPRISE ARCHITECTURE PLANNING (EAP)

Published in 1992 by Steven Spewak (Spewak, et al., 1992), EAP is "*the process of defining architectures for the use of information in support of the business, and the plan for implementing those*

architectures". This methodology provides guidance in implementing the top two layers of the Zachman framework, i.e. the context or scope (Planner's view) and the business model (Owner's view) described in section 2.3.6.

The methodology consists in defining the steps an enterprise architect has to take to fill in those layers with artifacts that describe the organization as well as how to present the ideas and obtain approval and commitment across the director's board and team members.

EAP's goal is not to design how systems will work but instead to define those systems and create a plan for their implementation. Only after the definition and plan are complete can the design process begin and the implementation plan be followed.

2.4.1.1 EAP STRUCTURE

The EAP methodology is structured in four layers in a "cake" form (see Figure 18) where each block represents a stage in the architecture development process.

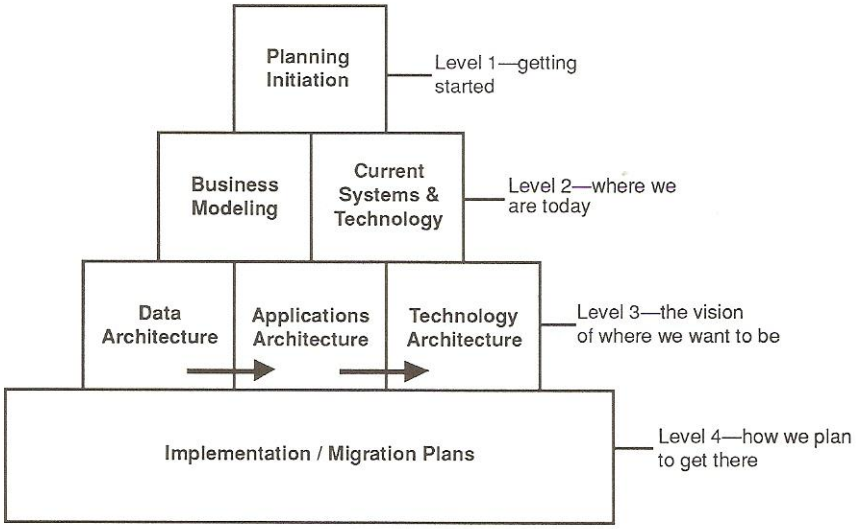


Figure 18. Levels and stages in Enterprise Architecture Planning

The layers or levels in EAP can be described as:

- Level 1 (top): this is the first stage where a team is assembled, a work plan is defined and management approval is sought.
- Level 2: all the information about the company is gathered, documented, an inventory is created for responsibilities, tools, systems, and business units. The "as-is" model of the organization is developed both in terms of the business as well as the technological platforms in use which will provide a baseline for future migration plans.

- Layer 3: plans the future architectures in three modules, namely data, applications and technology.
- Layer 4 (bottom): develops a plan and a time schedule for the implementation of the developed architectures.

The arrows in layer 3 of Figure 18 mean that the data architecture should be defined first followed by applications as opposed to traditional information systems development where technology tends to be defined first and guides the process. Instead, EAP is a data-driven, business oriented approach. This methodology is thoroughly described in Steven Spewak's book *Enterprise Architecture Planning: Developing a Blueprint for Data, Applications and Technology* (Spewak, et al., 1992). In our study, we followed and adapted the relevant chapters from this book.

2.4.1.2 EAP ADVANTAGES

There are many benefits that businesses can expect to get when EAP is implemented successfully. Some of these have been pointed out by Spewak (Spewak, et al., 1992) and Malan (Malan, et al., 2005) including: 1) documentation increases understanding of the business, 2) considers integration of current systems with new, 3) allows for a comprehensive, objective and impartial approach, 4) is a cost-effective, long-term solution that considers rate of return, 5) allows easier accommodation of dynamic business changes, and 6) reduces duplication across projects. EAP provides many of these through improvement of the application portfolio management.

2.4.2 BUSINESS PROCESS AND PRACTICE ALIGNMENT METHODOLOGY (BPPAM)

Methodologies like EAP are very detailed in explaining how to model the business process. However the data they consider is limited to inputs mostly obtained from interviews, forms or company documentation. This way, it fails to address issues such as the constant changes that the processes suffer, and the fact that the actual knowledge about the processes is in people's brains and is ultimately executed by people's actions (Zacarias, et al., 2011).

This means that the actual business processes are probably different from what is documented and can even differ from what people say or think they do (e.g. in interviews).

Previous research has evidentiated the importance of aligning process models with the actual process execution. When compared to the execution perspective, i.e. day-to-day work

practice, the process perspective is not suitable to represent the organization's design. This is because this perspective provides only a static representation of the processes although these change over time (Zacarias, 2008).

These changes in actual execution lead to a misalignment with the designed process model and are commonly caused by the simple fact that individuals develop and evolve their own strategies to perform tasks assigned to them. The implication is that enterprise design models become outdated and the question is how do we build and maintain these models up-to-date and aligned with work practices.

As Marielba Zacarias and Paula Ventura Martins (Zacarias, et al., 2011) point out, recent research has been paying more attention to the repercussions of the business processes' constant changing nature. However, there is a lack of information about how business process models can be maintained over time to keep up with those changes.

2.4.2.1 WHAT IS BPPAM

The BPPAM methodology presented by Marielba Zacarias and Paula Ventura Martins (Zacarias, et al., 2011), allows to develop and improve business process models from work practices, i.e. from the actual patterns of actions that individuals perform during their work time. This is crucial for creating process models from actual work and can be used for keeping the model aligned as well, i.e. maintaining the business model.

The importance of work practice modeling has been acknowledged in (Zacarias, et al., 2011) for: 1) allowing a clearer view on what actions are actually performed by people in business processes, and 2) using that information for improving business processes in a bottom-up "actual-to-abstract" approach.

BPPAM is a multidisciplinary approach with two dimensions, Practice and Process (at the top and bottom respectively in Figure 19).

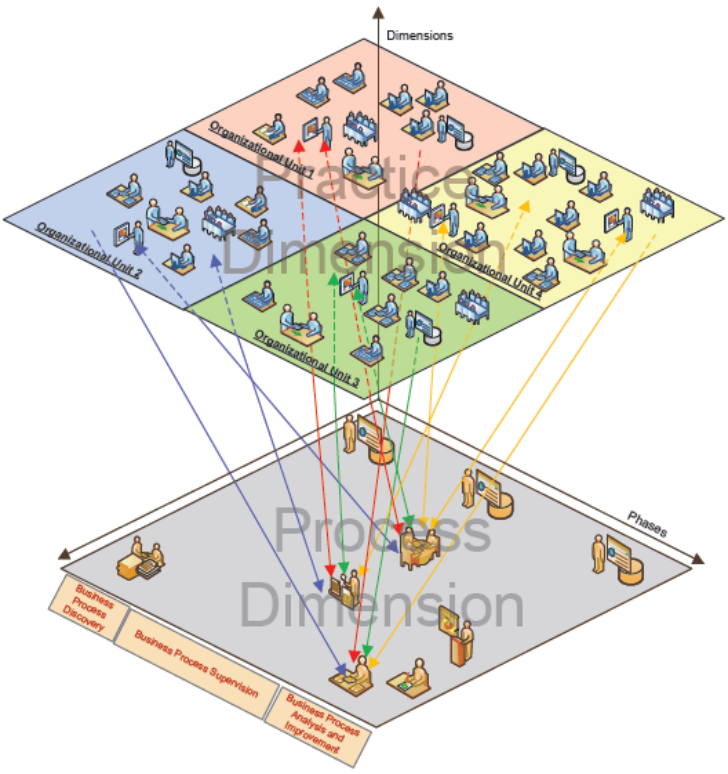


Figure 19. BPPAM overview (Zacarias, et al., 2011)

The Practice dimension works as a source of day-to-day information that feeds into the Process dimension. Then business analysts and architects can review and improve the current processes model based on that information.

The methodology consists of three phases: 1) Business Process Discovery, where processes are initially specified through interviews, surveys and other methods, 2) Business Process Supervision, where the created processes are related and contrasted against day-to-day work practices to make sure both dimensions are aligned, and 3) Business Process Assessment and Improving, which consists of analyzing the differences between the processes and the work practices, and deciding which improvements to make on current processes. In this phase, top managers can decide how current practices will affect the current model.

Building a model from work practices is also addressed in (Zacarias, 2008), where patterns are searched in repositories of manually registered actions, also called the users' or actors' logs. However, even though timestamps in logs' entries make it easier to understand activities' order of execution, errors and inconsistencies introduced by human error make it harder to extract knowledge out of them. In our research, we attempt to automate parts of

the log capturing process and log analysis with a view on improving data quality and maintenance automation.

Also brought up in (Zacarias, 2008) is the concept of context discovery as an important part of the business process discovery phase. Grouping actions in contexts allows distinguishing related tasks from unrelated ones. Contexts can either be personal or interpersonal. Personal contexts are found by analyzing the individual actions, i.e. discovering patterns with techniques such as clustering (Gomes, et al., 2006), grouping actions based on those patterns, uncovering resources commonly used in those patterns (tools, people, etc.) and labeling the patterns. Interpersonal or interaction contexts are a layer on top of personal context discovery where two specific personal contexts of interacting individuals can be related (Maria, 2007).

2.4.2.2 MODEL MAINTENANCE WITH BPPAM

BPPAM's method encompasses the "model revision and evaluation" activity which uses model update proposals based on a technique of annotations created by the business actors.

These annotations are the users' suggestions for corrections that they make when they find that the model is diverging from the actual work practices. Model maintenance by annotations has also been used before by other researchers (Castela, 2011). The annotations mechanism however, is highly dependent on users being able to detect discrepancies between process and practice manually. In this study we take a step in the direction of automating this link between process and practice.

The importance of automation in order to ease and accelerate the capture process has also been acknowledged in other works (Zacarias, 2008).

It is known that it is common practice to archive a business model once it has been created and never change it again, guaranteeing it becomes outdated (Castela, 2011). Changes need to keep going into the model in order to keep it aligned with the organization.

Several reasons have been stated for business models not being updated often enough and include lack of motivation and difficulty in building and changing the model (EMIPA-SIG, 1992). It is relevant to steer in the direction of automating the model maintenance because ultimately an automatic way of updating the model would not require human motivation neither would it be difficult because it would be processed by a computer.

Even though companies are becoming more aware of the need to document the processes and keep them up-to-date, most of the times this happens to meet external requirements such as the quality management systems certification (ISO 9001:2008). Companies should see the need to keep the enterprise architecture aligned internally as a strategy to gain competitive advantage, and understand the benefits of automating that process at least partially.

2.4.3 PROCESS MINING

Process mining is used to analyze event logs from business processes and create the corresponding process model. Advances in automating the creation and maintenance of process models have been made in this area (Rickayzen, et al., 2005).

The idea of process mining and workflow analysis is not new, and was researched by Rakesh Agrawal (Agrawal, et al., 1998). An approach using neural networks was proposed by Cook and Wolf (Cook, et al., 1998), another focusing on concurrent behavior was presented by Will van der Aalst (Aalst, et al., 2004), and tools for hierarchical workflow mining like ProM (Weijters, et al., 2007) were developed to automate this process. Process mining is based on the concept of cases (i.e. process instances). It analyzes event logs, i.e. lists of case-task tuples from workflow management systems such as IBM FlowMark, and generalizes the information into Petri nets to represent all possible executions of the workflows (see Figure 20).

case identifier	activity identifier	performer
case 1	activity A	John
case 2	activity A	John
case 3	activity A	Sue
case 3	activity B	Carol
case 1	activity B	Mike
case 1	activity C	John
case 2	activity C	Pete
case 4	activity A	Sue
case 2	activity B	Carol
case 2	activity D	Pete
case 5	activity A	Sue
case 4	activity C	Carol
case 1	activity D	Pete
case 3	activity C	Sue
case 3	activity D	Pete
case 4	activity B	Sue
case 5	activity E	Clare
case 5	activity D	Clare
case 4	activity D	Pete

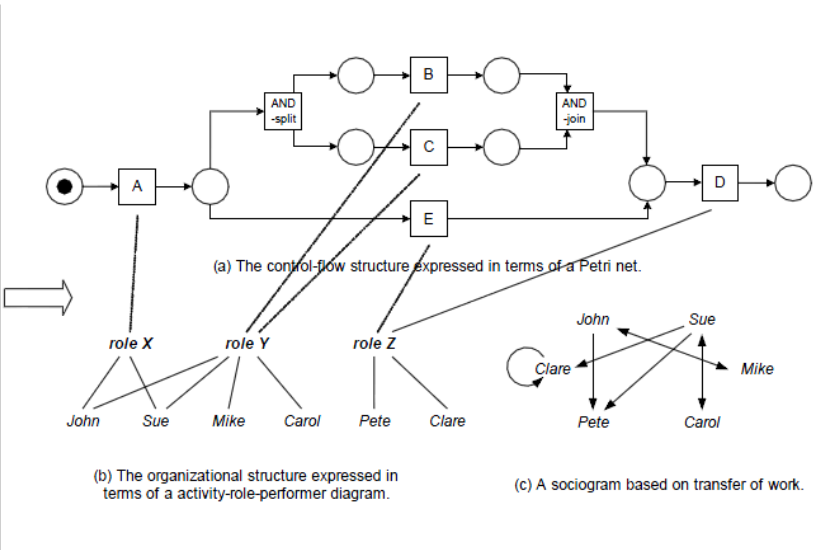


Figure 20. Different models extracted from workflow logs (Rickayzen, et al., 2005)

The main goal of process mining is to expand the utility of current workflow systems and not allowing model creation directly from raw work practice logs. Thus it always requires data to be converted to a common workflow format log (Dongen, et al., 2005). Process mining derives process models from well-structured logs generated automatically by business applications that already include information about process identification (cases) and its associated tasks.

As Marielba Zacarias points out, most authors assume that each actual event has an associated case or process instance in the workflow (Zacarias, 2008). This is a major limitation since actual executed tasks may not exist in the generated workflow logs thus restricting the quality of generated process models. Also, process mining cannot be applied in scenarios where the log data is not available in the workflow format (Ferreira, et al., 2007). In our research, we are interested in studying model discovery from actual execution without involving pre-processed logs from workflow systems.

2.5 CONCLUSION

In this section, we summarize and evaluate the most relevant advantages and disadvantages of the approaches described previously. We also contrast them against each other where appropriate in order to highlight the gaps that our methodology tries to fill in. A summary of these approaches' characteristics can also be found in Table 1.

Porter's competitive forces model which is widely used for understanding how a company can stay ahead of the competition. However, it isn't able to tell companies in which departments they should focus to get the best results.

On the other hand the business value chain model, also from Michael Porter, complements that model by showing what the fundamental activities of the business are where competitive strategies should be applied.

In order to understand how these business activities are interconnected and how they impact on each other, an enterprise architecture that can support managers in the decision making process must be developed. Enterprise architectures however entail a complex set of information artifacts on different levels that needs to be held in an organized way.

An organized way to store information can be provided by enterprise architecture frameworks such as Zachman or DoDAF. However these provide little guidance in creating

the architectural artifacts, and so the chosen framework needs to be accompanied by a methodology and tools to support it.

Zachman is one of the most popular and longest standing frameworks, and it is not limited to a particular domain, thus being suitable for use in a general environment that most companies have. It is also one of the most closely connected frameworks to Enterprise Architecture Planning (EAP).

The EAP methodology is a guide on how to develop architectures that can support information about the company and also on how to implement those architectures. It consists in defining the steps that create the artifacts that the Zachman framework organizes in its two top layers (Context and Concepts perspectives).

As Spewak reminds us, there is no best methodology but there is the need to pick one that can be completed in a reasonable amount of time. EAP is generally too extensive and complex to be fully applied with the usually more limited resources available in SMEs. Our research tries to trim down and adapt the EAP approach in order to place it more within reach of the smaller companies.

Although EAP is very detailed on how to model business processes, it limits its information input to interviews and company documentation. This means it fails to address the business processes' constant changes and to grasp the actual knowledge about the processes. This knowledge exists in people's brains and is executed by people's actions and may not be correct in company documentation or in how people verbally describe their work. Not considering work practices means that EAP can only create abstract views of processes that aren't necessarily aligned with the actual work execution. Also EAP does not offer suggestions on how models can be maintained over time. Our research tries to fill in these gaps adapting the BPPAM work practices approach with EAP.

The BPPAM methodology allows to develop, maintain and improve business process models from work practices, which means the business model is better aligned with actual work. Our methodology takes advantage of this approach by building the model from a repository of user actions, the actors' logs. These actions are usually registered manually by users, but we explore a more intuitive and easier way to register them using a software tool.

Model supervision is performed through the use of annotations in BPPAM, which is highly dependent on users being able to detect discrepancies between process and practice manually. On our proposed methodology, we attempt to both create the model and

supervise its alignment with work practices in a more automated way, by investigating the relation between the registered action logs and the process models.

Approach vs. Feature	Strategy Decision Support	Department Decision Support	Information Storage & Organization	Defines a Methodology	Considers Work Practices	Considers Process Improvement
Porter's Competitive Forces Model	☑					
Porter's Business Value Chain Model		☑				
Enterprise Architecture	☑	☑	☑			
EA Frameworks (eg.Zachman)			☑			
Enterprise Architecture Planning (EAP)				☑		
Business Process & Practice Alignment Methodology (BPPAM)				☑	☑	☑

Table 1. Related work characteristics summary

CHAPTER 3

3. METHODOLOGY

"A designer knows he has achieved perfection not when there is nothing left to add, but when there is nothing left to take away."

-- Antoine de Saint-Exupéry

In this chapter, we start by following the guidelines of EAP's methodology as indicated in Steven Spewak's book Enterprise Architecture Planning (Spewak, et al., 1992). During the process, we trimmed out the parts that aren't applicable to small and medium enterprises.

EAP's adaptation spans across sections 3.1 to 3.3 and covers: 1) the planning initiation stage, which takes advantage of the detailed path this methodology provides including steps such as how to obtain management approval and how to define a work plan, and 2) the development of a business model based on information retrieved from the company's documents and interviews to the employees.

We then adapted the BPPAM methodology as described in sections 3.4 and 3.5 to uncover the practice model by capturing logs of day-to-day actions of the individuals and to improve the business processes.

In section 3.4 the captured logs are analyzed first manually to extract sequences and then a software tool is developed to do this automatically. Finally, another tool is developed to automate the relation between the business model processes (represented in diagrams developed with EAP) and the action sequence logs captured with BPPAM. Section 3.5 describes how process change proposals can be analyzed and discussed in order to develop an improved version of the processes.

A methodology summary identifying the inputs, outputs, roles and source of each of the steps can be found in section 3.6. This information can also be found at the start of each step in the methodology.

3.1 PLANNING INITIATION

Input: -	Role: -
Output: Project work plan; managers support	Source: EAP

Planning is one of the most important phases of any project and especially for the more complex ones. It allows us to anticipate and prevent many of the roadblocks further ahead.

In this section a set of goals is defined, along with the approach and steps that should be taken to achieve them.

3.1.1 DETERMINE SCOPE AND OBJECTIVES FOR EAP

Input: -	Role: -
Output: Project definition	Source: EAP

3.1.1.1 DEFINE THE SCOPE OF THE ENTERPRISE

Input: Company structure	Role: team leader
Output: Scope definition	Source: EAP

Since EAP is to be applied on an enterprise, we must start with defining what the term enterprise encompasses. For a successful EAP, it should generally be applied to the whole or a division of a company that contains all sorts of business functions and departments sharing considerable amounts of information between them. Narrowing the scope too much can lead to architectures that lack detail about other areas of the business. On the other hand, broadening it too much will result in lack of time to gather the company information in enough detail to create a useful architecture.

3.1.1.2 EVALUATE FAVORABLE VERSUS UNFAVORABLE CHARACTERISTICS

Input: Company history/culture	Role: team member
Output: EAP favorability list	Source: EAP

Before we step in a company with the idea of improving it, we need to evaluate if the company is prepared for EAP or if the conditions are not appropriate and could mean overwhelming obstacles down the road. For this reason, at this point we should find out what are the favorable and unfavorable organizational characteristics towards EAP.

3.1.1.3 LIST AND DEFINE EAP OBJECTIVES AND DELIVERABLES

Input: Scope / favorability list	Role: team leader
Output: EAP objectives/deliverables	Source: EAP

The objectives of an EAP project should be written in a simple and concise way. They should convey just enough information that will convince management that the project is worth doing and that benefits to the business outweigh the costs.

3.1.1.4 REVIEW SUCCESS FACTORS AND OBSTACLES AND DEVELOP A STRATEGY FOR THIS INITIATION PHASE

Input: Success factors/obstacles	Role: team leader
Output: Initiation phase strategy	Source: EAP

In general, for a full EAP project to be considered successful, the business model and architectures have to be completed, implemented and maintained over time. However, to be able to reach such goals, we need to define strategies that can overcome the main obstacles, and also define how to take advantage of factors that usually contribute to an EAP project success. Chapter 2 in Steven Spewak's EAP book (Spewak, et al., 1992) lists common obstacles and reasons for success in this type of projects.

3.1.1.5 PUT TOGETHER A PLAN FOR THE REMAINING SIX STEPS IN THE PLANNING INITIATION PHASE

Input: Initiation phase strategy	Role: team leader
Output: Work plan for initiation phase	Source: EAP

The remaining steps in the planning initiation phase are defined below.

- Create a vision
- Adapt a methodology
- Arrange for computer resources
- Assemble the planning team
- Prepare an EAP work plan
- Obtain management approval

3.1.2 CREATE A VISION

Input: -	Role: -
Output: I.S. vision of business future	Source: EAP

3.1.2.1 ASSEMBLE AND READ ALL SOURCES OF MATERIAL ABOUT THE BUSINESS

Input: Background information	Role: team member
Output: Material sources assembled/read	Source: EAP

In this step, we must gather any available documentation about the company, including its structure, processes and procedures, reports and product literature among other relevant documentation we may find.

3.1.2.2 DETERMINE INFLUENTIAL EXECUTIVES' HOT BUTTONS

Input: Background information	Role: team leader
Output: Executives objectives defined	Source: EAP

It is important to understand what objectives the managers have in mind both in the short and long term. By aligning our project with those objectives we make it easier for EAP to be approved and to progress successfully.

3.1.2.3 MAKE REASONABLE PROMISES TO GENERATE ENTHUSIASM AND SUPPORT

Input: Vision statement	Role: presenter
Output: Realistic promises made to executives	Source: EAP

At this point we must generate a level of enthusiasm about EAP and then maintain it over the course of the project. The enthusiasm can be achieved by explaining both managers and other participants that the long term objectives can only be achieved by having a deep understanding of the business, and that this sort of knowledge can be enabled by enterprise architectures. Maintaining the enthusiasm requires a periodic flow of presentations, updates, and progress reports illustrating both the current state of the project and the following steps.

3.1.3 PREPARE AN EAP WORK PLAN

Input: -	Role: -
Output: Project work plan	Source: EAP

3.1.3.1 CONSIDER DIVIDING EAP INTO SUBPROJECTS

Input: Executives support for EAP	Role: team leader
Output: Sub-project division considered	Source: EAP

The main reason why we should consider dividing EAP into subprojects is in order to guarantee commitment of resources. This means that by having separate modules of work we can immediately assign responsibility for each one to different teams. However, be careful when dividing the project because there is a risk of only obtaining management approval for the first phases and then being denied any more resources in the middle of the project. We should only consider this division and approval phase by phase if we can't get approval for the whole project at once.

3.1.3.2 LIST ALL REMAINING PHASES IN THE METHODOLOGY

Input: Project work plan	Role: team leader
Output: List remaining methodology phases	Source: EAP

Based on both EAP and BPPAM, we obtained a general vision of a methodology that was then further adapted and optimized throughout our case study (see Chapter 4). The planning initiation phase is already defined by the steps in the previous sections in this chapter.

- **Preliminary Business Model** (see section 3.2)
- **Enterprise Survey** (see section 3.3)
- **Work Practices Model** (see section 3.4)
- **Business Process Improvement** (see section 3.5)

3.1.3.3 ESTIMATE THE DURATION OF EACH STEP, AND DETERMINE THE START AND COMPLETION DATES CONSIDERING THE RESOURCES ASSIGNED

Input: Methodology phases list	Role: team leader
Output: Phases duration time estimated	Source: EAP

Create a time estimation for the remaining steps in the project and at the same time try to overlap tasks as possible to save time. These estimations should consider just enough time to get the information needed without spending too much time on details that are not a priority. Although presentations and reports may be regarded as lower priority sometimes, we should take time away from the preparation for these as they are some of the most important deliverables of the EAP project.

3.1.3.4 ESTIMATE THE COSTS AND BUDGET IMPACT OF THE PROJECT

Input: Project work plan	Role: team leader
Output: Project costs impact estimated	Source: EAP

The cost estimation should be created considering all steps of the project and the resources they need. Not only we should include costs in terms of money, but also time, human resources involved, equipment such as computers and other material.

3.1.3.5 DISTRIBUTE THE EAP PROJECT WORKBOOK TO TEAM MEMBERS

Input: Project work plan	Role: team leader
Output: Project workbook distributed	Source: EAP

By distributing a workbook to each team member, we allow them to have a place where to organize all the information and documentation they will be gathering during the project. The workbook can be either in digital format or simply a binder working as a filing system.

3.1.4 OBTAIN MANAGEMENT APPROVAL

Input: -	Role: -
Output: Management approval obtained	Source: EAP

3.1.4.1 HAVE AN INFORMAL MEETING WITH BUSINESS EXECUTIVES AND EAP OVERSEERS TO REVIEW THE OBJECTIVES, SCOPE, POTENTIAL BENEFITS, AND FACTORS CRITICAL FOR SUCCESS

Input: Success factors/obstacles	Role: presenter
Output: Executives review objectives/factors	Source: EAP

This is where we get the chance to discuss the project's objectives, benefits, obstacles and how the company culture and attitude can improve its chances of being a success.

3.1.4.2 LISTEN CAREFULLY TO FEEDBACK FROM MANAGEMENT AND DISCUSS THEIR QUESTIONS

Input: Executives feedback	Role: presenter
Output: Executives concerns discussed	Source: EAP

All management questions and uncertainties about the project must be heard and explained at this point. We should try to anticipate as much as possible all sorts of doubts that may arise during presentations, including the more hostile remarks.

3.1.4.3 OBTAIN APPROVAL TO PROCEED WITH THE PROJECT

Input: Project work plan	Role: team leader
Output: Project approval to proceed obtained	Source: EAP

This crucial part of the project is where we get a management's formal confirmation that the company supports the project and will commit the needed resources for following the steps in the project's work plan.

3.1.4.4 PUBLICIZE THE EXPRESSED COMMITMENT OF MANAGEMENT FOR EAP THROUGHOUT THE BUSINESS UNIT WITH AN ANNOUNCEMENT

Input: Executives project approval	Role: team leader

Output: Executives support publicized	Source: EAP

This step makes the rest of the potential EAP participants aware that the project has been approved and that their cooperation and commitment may be required along the stages.

3.1.4.5 HOST A GENERAL EAP ORIENTATION (EXECUTIVE OVERVIEW) FOR THE ENTIRE ENTERPRISE

Input: Executives project approval	Role: presenter
Output: Company EAP orientation performed	Source: EAP

This orientation is geared towards the middle management layer of the company. After having the top management approval and having made the rest of the participants aware of the project, this step is where we obtain the managers and supervisors support and cooperation in more detail for the work plan steps.

3.2 PRELIMINARY BUSINESS MODEL

Input: -	Role: -
Output: Preliminary business model created	Source: EAP

A preliminary business model identifies and relates the business functions and organization units that perform those functions. This section shows how to develop this preliminary stage of the business model, which will then be completed with the information obtained in the Enterprise Survey phase in section 3.3.

3.2.1 DOCUMENT THE ORGANIZATIONAL STRUCTURE

Input: -	Role: -
Output: Organizational structure documented	Source: EAP

In this step we document the structure, individuals, locations and functions of the organization. This will make it easier to find out who we should interview and what data needs to be shared among the company's units.

3.2.1.1 GATHER RECENT ORGANIZATION CHARTS, AND ENTER THE INFORMATION INTO THE TOOLSET

Input: Company documentation	Role: business analyst
Output: Organization charts entered in toolset	Source: EAP

We should get a copy of any available organization charts with information about the departments, positions and people. If there are no charts available, we must create them ourselves. Although it is important to get the details right in these charts, we shouldn't spend too much time in this step, a couple of days should suffice.

3.2.1.2 IDENTIFY BUSINESS LOCATIONS AND RELATE TO ORGANIZATIONAL UNITS

Input: Company documentation	Role: business analyst
Output: Business locations/units identified	Source: EAP

Business locations can be stored in the EAP database in two different ways depending on how the company is structured. The location should be stored as an attribute of an organizational unit if most functions are performed in a single location, or if different business locations have an independent organizational structure. However, if several locations are involved in EAP or if one single organizational structure spreads across different business locations, then the locations must be stored as a separate data structure and not a simple attribute.

3.2.2 IDENTIFY / DEFINE FUNCTIONS

Input: -	Role: -
Output: Business functions identified/defined	Source: EAP

A function can be defined as any set of actions performed in the course of conducting business. It is essentially the same as a process, task or activity with no relevant differences for EAP. Throughout this document, we use the term "function" and "activity" interchangeably.

3.2.2.1 DEFINE THE MAJOR FUNCTIONAL AREAS USING THE "VALUE-ADDED" CONCEPTS OF MICHAEL PORTER

Input: Business functions list	Role: team member
Output: Major functional areas defined	Source: EAP

Using Michael Porter's value chain model is helpful for a company to understand where they must focus to achieve operational excellence. It highlights specific activities in the business where competitive strategies can best be applied.

3.2.2.2 DIVIDE EACH FUNCTIONAL AREA INTO ITS SUB FUNCTIONS BY ASKING THE QUESTION "WHAT IS THE FUNCTION?" OR "WHAT DOES THE ACTIVITY NAME MEAN?"

Input: Major functional areas list	Role: team member
Output: Functional areas divided	Source: EAP (adapted)

After having identified the major functional areas of the company, in this step we define them in terms of what functions exist in those functional areas. Function names should be descriptive especially at greater levels of detail. We should also write a short description of each function in case it doesn't have subfunctions. A function needs no description when it is composed of subfunctions, since these collectively are the function's description.

3.2.2.3 (RE)ARRANGE ALL FUNCTIONS HIERARCHICALLY TO IMPROVE THE BUSINESS MODEL

Input: Functional areas list	Role: team member
Output: Preliminary business model rearranged	Source: EAP

Here we rearrange the business functions hierarchically, having the object of the function at the root. This means that for instance the function "register product" would have "product" in the root and then a branch with the function "register". The product could also have other functions or branches in the hierarchy, e.g. "sell", "buy". The reason behind this rearranging of the functions is so that the functions in the business model are associated with the objects without any order in particular since the order doesn't matter in this case.

3.2.2.4 ENSURE QUALITY OF THE BUSINESS MODEL AND CONTINUE TO MAKE IT BETTER

Input: Preliminary business model	Role: team leader
Output: Measures to ensure model quality	Source: EAP

The less dynamic aspects the business model, the more quality it has. This is because the model should not be susceptible to change, but instead be stable over time. To make the preliminary model stable, we have to keep out volatile variables such as: who performs a function, how, when or where it is performed, its importance, the technology used and the flow of inputs or outputs.

3.2.2.5 ESTABLISH THE STABILITY OF THE BUSINESS MODEL BY CONTINUALLY EVALUATING THE GOODNESS CRITERIA AND BY ASKING HOW THE BUSINESS HAS EVOLVED OVER TIME

Input: Company history	Role: team leader
Output: Business model stability established	Source: EAP

Only by studying the evolution of the business over the years can we attempt to anticipate the path the company may take in the future and its stability. Top management should be asked questions about changes in company strategy that have affected how the company works. If most changes in the past have only affected the details in business functions then it shouldn't affect the general structure of the enterprise and consequently the business model created with EAP should be useful for many years to come. However if there have been profound changes of strategy, that is an alert that in the future the nature of the business can change again and render the business model inappropriate.

3.2.2.6 RELATE THE DETAILED FUNCTIONS TO THE ORGANIZATION UNITS THAT PERFORM THEM, AND PRODUCE A MATRIX REPORT

Input: Business function areas/units	Role: team member
Output: Functions/units matrix report created	Source: EAP

At this point we create a matrix report that indicates the major organizational units and their responsibility towards the company's activities, grouped by functional areas. We must also detail the level of involvement for each of these relations.

3.2.3 DISTRIBUTE THE PRELIMINARY BUSINESS MODEL

Input: -	Role: -
Output: Preliminary business model distributed	Source: EAP

3.2.3.1 COLLECT ALL NOTES AND CHARTS FROM THE PREVIOUS STEP

Input: Preliminary business model	Role: team leader
Output: Charts/notes collected	Source: EAP

In this step all business functions (activities), organization units, and data entities are gathered together and numbered. There is no sequential order implied, but identifying these elements with numbers makes it easier to reference them further ahead and their names can change while the identification number remains the same.

3.2.3.2 PRESENT, FULLY EXPLAIN, AND PROVIDE COPIES OF THE PRELIMINARY BUSINESS MODEL REPORTS TO MANAGEMENT

Input: Preliminary business model	Role: presenter
Output: P.B.Model presented to management	Source: EAP

At this point a meeting should be scheduled with the company's management in which the preliminary business model is presented and explained. This will help maintain enthusiasm in the project and support for the following phases.

3.2.3.3 EXPLAIN THE ENTERPRISE SURVEY PHASE AND OBTAIN PERMISSION TO CONTACT PEOPLE FOR INTERVIEWS

Input: Enterprise survey work plan	Role: presenter
Output: Interviewees recommended by manag.	Source: EAP

In order to introduce the following phase to the company, we schedule a meeting with management where we explain how the Enterprise Survey phase works and also ask them for suggestions on who should be interviewed to best describe the company's processes.

3.3 ENTERPRISE SURVEY

Input: -	Role: -
Output: Gather details to complete P.B.Model	Source: EAP

The purpose of this step is to gather more details about the company, conduct interviews, and improve the business model developed in the previous steps. Gathered data includes what information is used to perform a function, when and where the function is performed, how often, and how can the function be improved.

3.3.1 SCHEDULE THE INTERVIEWS

Input: -	Role: -
Output: Interviews schedule created	Source: EAP

3.3.1.1 SELECT THE PEOPLE TO INTERVIEW

Input: Interviewees recommended	Role: team leader
Output: Interviewees selected	Source: EAP

Using the function to organizational unit matrix developed in section 3.2.2.6, we create a list of the people that are directly responsible for each function. All functions at the lowest level

of detail should be covered and one person should be interviewed about it. If there are several people assigned to the same function, there is no need to interview all of them.

3.3.1.2 ARRANGE A MUTUALLY CONVENIENT TIME WITH INTERVIEWEES AND PLAN WHAT TOPICS WILL BE DISCUSSED IN THE INTERVIEWS

Input: Interviews schedule	Role: leader/interviewer
Output: Interviews schedule confirmed	Source: EAP

The interviewers should contact the selected people in order to arrange the interview meetings schedule. We must also prepare a plan of topics to discuss with each people and include it in this schedule.

3.3.1.3 SEND A MEMO CONFIRMING THE INTERVIEW APPOINTMENT AND EXPLAINING THE INTERVIEW PROCESS TO EACH INTERVIEWEE AND THEIR MANAGER

Input: Confirmed interview schedule	Role: leader/interviewer
Output: Confirmation memo sent	Source: EAP

At this point the interviewee should be informed about what topics will be covered, which will help him come prepared with any information or documentation needed. The memo also serves as a reminder of the agreed schedule to the interviewee and a confirmation of commitment of time resources to the manager.

3.3.2 PREPARE FOR THE INTERVIEWS

Input: -	Role: -
Output: Interviews prepared	Source: EAP

3.3.2.1 DECIDE WHAT INFORMATION TO OBTAIN THROUGH THE INTERVIEWS AND, THEREFORE, WHAT QUESTIONS TO ASK

Input: Preliminary business model	Role: leader/interviewer
Output: Interview questions defined	Source: EAP

Interviews should include questions that allow gathering information about what activities are performed and how they are performed; the information used and created during those activities; and suggestions from the interviewees about what could be improved.

3.3.2.2 DESIGN THE FUNCTION DEFINITION AND INFORMATION SOURCE FORMS

Input: Interview questions list	Role: leader/interviewer

Output: Function/Information forms designed	Source: EAP (adapted)

The fields to include in the function definition forms filled in the interviews should be enough to capture the essential information about the functions and information sources they use. A function definition form should include the date, function number, name and the remaining fields as appropriate, for instance: its parent function name, who performs it, whose responsibility it is, where it is performed, what is done and why it is done, the current status of the function (active or inactive), its frequency of execution and how long it usually takes, and how it is performed. The form should always state the name of the interviewee and the author. Apart from these fields, the form can also describe function improvement opportunities suggested by the interviewee, possible function changes and any information sources used.

On the other hand, the information source forms should include the date when it was filled, the function it belongs to, the source name and number. A description should also be present and the information about whether the source was received from or forwarded to someone. It should also state whether a sample of the source was acquired, the quality of the medium it is transmitted in and the status of the source (acceptable or unacceptable). Finally, there should be a note about the accuracy of the source, its currency and volume, its format and once again, the author who filled in the form.

3.3.2.3 ESTABLISH INTERVIEWEE PROFILES AND SPECIFIC QUESTIONS

Input: Interviewees background	Role: leader/interviewer
Output: Responses to questions anticipated	Source: EAP

Each interviewee will have a particular set of responsibilities and from this information we should be able to match his expertise with the right questions in order to make the best of each interview. Try to learn about the person who will be interviewed and to anticipate responses by filling in as much as possible the function definition and information source forms before the interviews.

3.3.3 PERFORM THE INTERVIEWS

Input: -	Role: -
Output: Interviewed performed	Source: EAP

3.3.3.1 PERFORM EACH INTERVIEW AT THE SCHEDULED TIME

Input: Interview schedule	Role: interviewer
Output: Interviews performed	Source: EAP

Remember that punctuality is essential for maintaining a good team image. We must be on time for the interviews or we risk others considering that the project isn't being taken seriously.

3.3.3.2 FILL IN THE FUNCTION DEFINITION FORMS DURING THE INTERVIEW

Input: Information from interview	Role: interviewer
Output: Function definition forms filled	Source: EAP

We shouldn't wait until the end of the interview to fill in the function definition form. As the interview develops, take notes and make a pause every few minutes to summarize and fill in the correspondent part of the form.

3.3.3.3 IDENTIFY THE INFORMATION SOURCES FOR EACH FUNCTION AND FILL IN THE INFORMATION SOURCE FORMS DURING THE INTERVIEW

Input: Information from interview	Role: interviewer
Output: Information source forms filled	Source: EAP

More information sources may be uncovered during the interview than were identified during the preliminary business model phase. So be sure to carry many information source forms to accommodate those details. Like the function definition forms, information source forms should also be filled along the interview and not at the end.

3.3.3.4 OBTAIN A SAMPLE COPY OF EACH INFORMATION SOURCE

Input: Information source forms list	Role: interviewer
Output: Info. source sample copies obtained	Source: EAP

For each information source identified, we should ask for a copy in order to have a real sample of the sources being described, and to add it to our EAP workbook. If the source is a form itself, we should ask for a filled sample so it is more meaningful.

3.3.3.5 AT THE END OF AN INTERVIEW, SUMMARIZE WHAT HAS BEEN WRITTEN, SCHEDULE A FOLLOW-UP SESSION IF NECESSARY, AND CONFIRM COPIES OF SOURCES THAT THE INTERVIEWEE WILL PROVIDE

Input: Information from interview	Role: interviewer
Output: Summary created/interview scheduled	Source: EAP

Besides scheduling the next interview, a review must be made at the end of each meeting to confirm all the information that had been gathered and verify if there were missing fields or forms. After each interview we review the notes that were taken and use them to complete the forms where necessary.

3.3.3.6 SEND THE INTERVIEWEES A COPY OF THE DATA THEY PROVIDED

Input: Interview summary	Role: interviewer
Output: Provided info. copy sent to interviewee	Source: EAP

Sending a copy of the filled forms to the interviewee works as a confirmation of the information they passed to us. If there's any mistake or inconsistency they have the opportunity to confirm the fields and ask us to correct them.

3.3.4 ENTER DATA INTO TOOLSET AND DISTRIBUTE COMPLETE BUSINESS MODEL

Input: -	Role: -
Output: Business model completed	Source: EAP

3.3.4.1 ANALYZE THE ENTERPRISE SURVEY INFORMATION

Input: Enterprise survey data	Role: team leader
Output: Enterprise survey info analyzed	Source: New

In this step, we try to make sense of what was in the forms including how functions are related to the information sources, and what suggestions the interviewees have made to improve the current system.

3.3.4.2 ENTER THE DATA ON THE FORMS INTO THE TOOLSET

Input: Function/Information forms	Role: librarian
Output: Forms data entered into toolset	Source: EAP

After having gathered information in the forms, we enter the data into the toolset, which means the function and information source details should be typed into a database, and that

other reports may be created from the toolset such as diagrams to illustrate the processes, i.e. the description of the functions' activities.

3.3.4.3 THE PLANNING TEAM SHOULD REVIEW ALL FEEDBACK AND CHANGE THE BUSINESS MODEL AS APPROPRIATE

Input: Interviews feedback data	Role: team member
Output: Business model changed as appropriate	Source: EAP

All valuable feedback should be taken into account and the relevant suggested changes applied to the business model.

3.4 WORK PRACTICES MODEL

Input: -	Role: -
Output: Work practices model created	Source: BPPAM (adapted)

In this section we apply the business process supervision phase of BPPAM by capturing day-to-day work practices in logs created by the employees. We then analyze those logs both manually and in a more automated way using a software tool developed by us. Finally we try to relate these logs with the process model developed in the previous sections, both manually and also using a tool we develop as well.

3.4.1 DECIDE WHAT TO CAPTURE IN LOGS

Input: Business model in toolset	Role: business analyst
Output: Data fields to capture defined	Source: New

Both the flow of activities between organizational entities and what information sources get used in activities are stated in the function definition forms. We want to be able to relate the captured logs to a representation of the activities' diagrams. The diagrams display the flow but not what information sources get used. For this reason it is enough for the logs to capture what people are doing, and with whom they are interacting but not what documents or other types of information they are using. We should choose to capture just enough fields for the type of analysis we need do perform. Having fewer fields to fill in the logs will speed up the process and make it easier for the users to register the information needed.

3.4.2 DEVELOP DATA ENTRY TOOL TO ENABLE CAPTURING WORK LOGS

Input: List of data fields to capture	Role: technology analyst

Output: Data entry / log capture tool created	Source: New

In a busy working environment of a real company, it is always a challenge to get the people to type in the activities and other details into the logs during the day. With a view to make it easier for the users to create logs, instead of presenting them with empty spreadsheets to fill in, we develop a software tool that allows them to choose what they are doing at the moment, type in the time when an activity is being started and just press one button to register the activity into the logs and auto-save the file.

3.4.3 CAPTURE LOGS OF WORK PRACTICES

Input: Data entry tool/work practice	Role: operational actor
Output: Work practices logs captured	Source: New (inspired in (Zacarias, 2008))

Here we should define for how long the work practices should be registered in logs (e.g. days, weeks). The total time will depend on the availability from the operational actors and on the type of work performed. We should capture for long enough to have a significant number of entries that allows us to work on that data and extract relevant information. At this point it would make sense to capture logs from those who were interviewed in the Enterprise Survey phase. However other people may capture the logs as long as their work covers processes that can be related to those filled in the function definition forms.

3.4.4 PROCESS THE INFORMATION IN THE LOGS

Input: -	Role: -
Output: Log information processed	Source: New

3.4.4.1 FIRST ANALYSIS TO WHAT WAS CAPTURED IN THE LOGS

Input: Information in logs	Role: data analyst
Output: Logged data analyzed	Source: New

From the captured work practice logs, we create a set of graph reports to illustrate indicators that are relevant to the operational actors and give the reports to them. This helps people to better understand their work from a statistical point of view at the same time it brings more enthusiasm and commitment towards the enterprise architecture project.

3.4.4.2 TIME PRECISION IN RECORDS

Input: Logs data analysis	Role: data analyst

Output: Time precision rules defined	Source: New

Actions captured in the work logs using our data entry tool have two timestamps associated with them: the system time when the user registered the action, and the time field the user filled in when registering the action. In order to be able to get the correct chronological order of events and the actions' approximate duration, in this step we need to establish a set of rules that define how to choose the correct time between the two, from analyzing the existing data.

3.4.4.3 FIND SIMPLE PATTERNS OF ACTION SEQUENCES IN THE LOGS

Input: Information in logs	Role: data analyst
Output: Simple action sequence patterns found	Source: New

This step complements the first analysis to the captured logs and is where the logs are manually reviewed in search for actions that follow one another forming action sequences.

3.4.4.4 TOLERATING INTERRUPTIONS WHEN LOOKING FOR SEQUENCES

Input: Sequence patterns found	Role: data analyst
Output: Interruption toleration analyzed	Source: New

Some actions may occur inside an action sequence in the logs but that may not belong to it. While users are performing a sequence of actions all belonging to a process, they may get interrupted and perform an action from another process, perhaps as a matter of urgency. This sort of situation alters the resulting action sequences depending on the number of interrupting actions, and so we need to analyze the impact this may have on existing sequences in the logs.

3.4.4.5 AUTOMATE THE PROCESS OF FINDING SEQUENCES

Input: Information in logs	Role: technology analyst
Output: Sequence finding tool developed	Source: New

Manually finding and counting all possible sequences, of different lengths, with any number of interruptions, for all days for every person would take a considerable amount of time, so here we develop a software application to do this automatically.

3.4.5 MATCH ACTION SEQUENCES BETWEEN FORMS AND LOGS

Input: -	Role: -
Output: Form/Log action sequences matched	Source: New

In this section a relation between the resulting diagrams from the process model and the results from the captured logs is uncovered. We start by doing this process manually and then analyze how it can be automated by developing a tool.

3.4.5.1 MANUAL RELATION BETWEEN FORMS (DIAGRAMS) AND LOGS

Input: Forms diagrams and logs data	Role: data analyst
Output: Form/log data manually related	Source: New

First we need to make the processes in the diagrams relatable to the logs. For that we can either match activity names in the diagrams with action names in the logs, or add some sort of identifier that will allow us to make a simple text search when comparing.

After associating the logs' activities with the tasks in the process diagrams, we extract all possible sequences with those letters as they appear in the diagrams and then count them. We can also vary the number of tolerated interruptions between actions in the logs to see how that affects the number of occurrences of the sequences.

3.4.5.2 ANALYZE EA TOOL'S ABILITY TO EXPORT DIAGRAMS TO TEXTUAL FORMAT

Input: EA diagramming tool	Role: technology analyst
Output: Tool's textual exporting analyzed	Source: New

In order to be able to automatically relate diagrams with logs, the diagrams need to be in an indexable format and not graphical. We need to be able to search for text, not images. For that purpose, the tool we used to create the diagrams that illustrate the company's processes should have the capability of exporting diagrams to a textual format (e.g. XML) which can later be used for finding the actions in the logs by doing a text search. At this point we must analyze how the exported textual format of the tool represents the diagram and how its elements can be compared to the data fields captured in the work practice logs.

3.4.5.3 AUTOMATE THE RELATION BETWEEN FORMS (DIAGRAMS) AND LOGS

Input: Forms diagrams and logs data	Role: technology analyst
Output: Form/log data relating tool developed	Source: New

At this point we develop a software application to allow us to take advantage of the textual format of the exported processes, by automatically finding action sequences in them and matching with the sequences found in the users' logs.

3.5 BUSINESS PROCESS IMPROVEMENT

Input: -	Role: -
Output: Business process improved	Source: BPPAM

After having uncovered the current business process models from existing documentation (Preliminary Business Model phase), interviews (Enterprise Survey phase) and day-to-day work practices (Work Practices phase), there is the need for maintaining the business processes.

In this section, we show how current processes of a company can be improved following the principles of the Business Process Assessment and Improvement (BPAI) phase of the BPPAM methodology.

3.5.1 PROCESS ASSESSMENT

Input: Process change proposals	Role: business analyst
Output: Proposed changes analyzed	Source: BPPAM

Operational actors review business processes related to their line of work and propose changes. Then the business analyst reviews these suggested changes and compares them against current business processes.

3.5.2 PROCESS IMPROVEMENT

Input: Process key indicators	Role: business analyst
Output: Detailed report supports improvement	Source: BPPAM

In order to correct problems in processes, after analyzing change proposals, the business analyst suggests where adjustments need to be made.

3.5.3 METRICS EVOLUTION ANALYSIS

Input: Collected data / metrics set	Role: business analyst
Output: Metrics evolution analyzed	Source: BPPAM

It is important to keep in mind that over time, the changes being made to the processes can have an impact on how measurements in processes are defined, collected and also how often these are performed. This evolution of indicators must be followed closely through a frequent gathering of daily actions information. The business analyst can use this information to facilitate measurements analysis and their progress over time.

3.5.4 ITERATION FEEDBACK MEETING

Input: Improved version of process	Role: process owner
Output: Process discussed w/ operation actors	Source: BPPAM

At this stage, the improved version of the business process, which includes the adjustments made by the business analyst, is discussed with the operational actors and the process owner. From these meetings, ideas for additional improvement actions can emerge and be integrated in the process improvement.

3.5.5 FINAL FEEDBACK MEETING

Input: Discussed version of process	Role: process owner
Output: Involved actors approve new process	Source: BPPAM

To conclude the development of the new business process version, a final meeting must be held between the business analyst, operational actors and the process owner. In this meeting all improvement topics discussed in previous meetings are validated and a final version of the report holding modifications to the business processes can be released.

3.6 METHODOLOGY SUMMARY

Activity	Input	Output	Role	Source
3.1	-	Project work plan; managers support	-	EAP
3.1.1	-	Project definition	-	EAP
3.1.1.1	Company structure	Scope definition	team leader	EAP
3.1.1.2	Company history/culture	EAP favorability list	team member	EAP
3.1.1.3	Scope / favorability list	EAP objectives/deliverables	team leader	EAP
3.1.1.4	Success factors/obstacles	Initiation phase strategy	team leader	EAP
3.1.1.5	Initiation phase strategy	Work plan for initiation phase	team leader	EAP
3.1.2	-	I.S. vision of business future	-	EAP
3.1.2.1	Background information	Material sources assembled/read	team member	EAP
3.1.2.2	Background information	Executives objectives defined	team leader	EAP
3.1.2.3	Vision statement	Realistic promises made to executives	presenter	EAP
3.1.3	-	Project work plan	-	EAP
3.1.3.1	Executives support for EAP	Sub-project division considered	team leader	EAP
3.1.3.2	Project work plan	List remaining methodology phases	team leader	EAP
3.1.3.3	Methodology phases list	Phases duration time estimated	team leader	EAP
3.1.3.4	Project work plan	Project costs impact estimated	team leader	EAP
3.1.3.5	Project work plan	Project workbook distributed	team leader	EAP
3.1.4	-	Management approval obtained	-	EAP
3.1.4.1	Success factors/obstacles	Executives review objectives/factors	presenter	EAP
3.1.4.2	Executives feedback	Executives concerns discussed	presenter	EAP
3.1.4.3	Project work plan	Project approval to proceed obtained	team leader	EAP
3.1.4.4	Executives project approval	Executives support publicized	team leader	EAP
3.1.4.5	Executives project approval	Company EAP orientation performed	presenter	EAP
3.2	-	Preliminary business model created	-	EAP
3.2.1	-	Organizational structure documented	-	EAP
3.2.1.1	Company documentation	Organization charts entered in toolset	business analyst	EAP
3.2.1.2	Company documentation	Business locations/units identified	business analyst	EAP
3.2.2	-	Business functions identified/defined	-	EAP
3.2.2.1	Business functions list	Major functional areas defined	team member	EAP
3.2.2.2	Major functional areas list	Functional areas divided	team member	EAP
3.2.2.3	Functional areas list	Preliminary business model rearranged	team member	EAP
3.2.2.4	Preliminary business model	Measures to ensure model quality	team leader	EAP
3.2.2.5	Company history	Business model stability established	team leader	EAP
3.2.2.6	Business function areas/units	Functions/units matrix report created	team member	EAP
3.2.3	-	Preliminary business model distributed	-	EAP
3.2.3.1	Preliminary business model	Charts/notes collected	team leader	EAP
3.2.3.2	Preliminary business model	P.B.Model presented to management	presenter	EAP
3.2.3.3	Enterprise survey work plan	Interviewees recommended by manag.	presenter	EAP
3.3	-	Gather details to complete P.B.Model	-	EAP
3.3.1	-	Interviews schedule created	-	EAP
3.3.1.1	Interviewees recommended	Interviewees selected	team leader	EAP
3.3.1.2	Interviews schedule	Interviews schedule confirmed	leader/interviewer	EAP
3.3.1.3	Confirmed interview schedule	Confirmation memo sent	leader/interviewer	EAP
3.3.2	-	Interviews prepared	-	EAP
3.3.2.1	Preliminary business model	Interview questions defined	leader/interviewer	EAP
3.3.2.2	Interview questions list	Function/Information forms designed	leader/interviewer	EAP

3.3.2.3	Interviewees background	Responses to questions anticipated	leader/interviewer	EAP
3.3.3	-	Interviewed performed	-	EAP
3.3.3.1	Interview schedule	Interviews performed	interviewer	EAP
3.3.3.2	Information from interview	Function definition forms filled	interviewer	EAP
3.3.3.3	Information from interview	Information source forms filled	interviewer	EAP
3.3.3.4	Information source forms list	Info. source sample copies obtained	interviewer	EAP
3.3.3.5	Information from interview	Summary created/interview scheduled	interviewer	EAP
3.3.3.6	Interview summary	Provided info. copy sent to interviewee	interviewer	EAP
3.3.4	-	Business model completed	-	EAP
3.3.4.1	Enterprise survey data	Enterprise survey info analyzed	team leader	New
3.3.4.2	Function/Information forms	Forms data entered into toolset	librarian	EAP
3.3.4.3	Interviews feedback data	Business model changed as appropriate	team member	EAP
3.4	-	Work practices model created	-	BPPAM
3.4.1	Business model in toolset	Data fields to capture defined	business analyst	New
3.4.2	List of data fields to capture	Data entry / log capture tool created	technology analyst	New
3.4.3	Data entry tool/work practice	Work practices logs captured	operational actor	New
3.4.4	-	Log information processed	-	New
3.4.4.1	Information in logs	Logged data analyzed	data analyst	New
3.4.4.2	Logs data analysis	Time precision rules defined	data analyst	New
3.4.4.3	Information in logs	Simple action sequence patterns found	data analyst	New
3.4.4.4	Sequence patterns found	Interruption toleration analyzed	data analyst	New
3.4.4.5	Information in logs	Sequence finding tool developed	technology analyst	New
3.4.5	-	Form/Log action sequences matched	-	New
3.4.5.1	Forms diagrams and logs data	Form/log data manually related	data analyst	New
3.4.5.2	EA diagramming tool	Tool's textual exporting analyzed	technology analyst	New
3.4.5.3	Forms diagrams and logs data	Form/log data relating tool developed	technology analyst	New
3.5	-	Business process improved	-	BPPAM
3.5.1	Process change proposals	Proposed changes analyzed	business analyst	BPPAM
3.5.2	Process key indicators	Detailed report supports improvement	business analyst	BPPAM
3.5.3	Collected data / metrics set	Metrics evolution analyzed	business analyst	BPPAM
3.5.4	Improved version of process	Process discussed w/ operation actors	process owner	BPPAM
3.5.5	Discussed version of process	Involved actors approve new process	process owner	BPPAM

Table 2. Summary of steps in our adapted methodology

CHAPTER 4

4. CASE STUDY

In this chapter the methodology presented in chapter 3 is applied in a real organizational setting, i.e. a small retail company. We shall refer to it as "Company X". The "team" for this enterprise architecture project is composed of just one person, apart from the operational actors. This person will be performing the different roles as stated in the methodology summary (see section 3.6).

The titles in this chapter are mapped to the ones in the Results chapter. This means that where sections in this chapter produced a set of results, these can be found in the Results (chapter 5) under the same title.

4.1 PLANNING INITIATION

4.1.1 DETERMINE SCOPE AND OBJECTIVES FOR EAP

4.1.1.1 DEFINE THE SCOPE OF THE ENTERPRISE

Given the scope of this project we will limit the in-depth investigation to the purchasing department while still having a broad but shallow definition of the rest of the company as a whole.

4.1.1.2 EVALUATE FAVORABLE VERSUS UNFAVORABLE CHARACTERISTICS

Table 3 organizes which of Company X's characteristics can help or prevent a successful EAP project.

Favorable	Unfavorable
• Has strategic, long-range business plans. • Existing systems are inadequate. • Need to integrate and share data. • Previous unsuccessful I.S. projects. • Large I.S. project backlog. • Will to design architectures.	• Company is experiencing less profit.

Table 3. Favorable and unfavorable characteristics for EAP

4.1.1.3 LIST AND DEFINE EAP OBJECTIVES AND DELIVERABLES

For Company X the objectives and deliverables were defined as two main points:

- Improve and maintain knowledge about the company's processes and structure
- Present ways to improve processes, making them more efficient

4.1.1.4 REVIEW SUCCESS FACTORS AND OBSTACLES AND DEVELOP A STRATEGY FOR THIS INITIATION PHASE

Table 4 identifies the main EAP obstacles in the company and the corresponding strategies we chose to overcome them.

Obstacles	Corresponding Strategy
• **Acceptance by Top Management**	• Meet with top managers to get approval
• **Commitment of Resources to EAP**	• Present benefits so people are genuinely interested
• **I.S. Dept. don't care about business**	• Focus on understanding actual business needs
• **Multiple depts. responsible for EAP**	• Not applicable in this project
• **Lack of Credibility of Planning Leaders**	• Maintain credibility by being professional
• **Inexperienced EAP; Lack of Training**	• Try to fully understand EAP before applying it
• **People Regard EAP as Threat/Change**	• Present positive impact of EAP in future systems
• **Few or Inadequate Tools**	• EAP depends more on people than tools
• **Expectance of Immediate Results**	• Models are immediately useful (bring knowledge)
• **Fear of Loss of Data Ownership**	• Data is never owned, systems only improve control
• **Substantial Up-Front Cost**	• Not applicable in this project
• **Uncooperative Users**	• Gather commitment from key people for planning

Table 4. Obstacles (left) and strategies (right) to overcome them

Table 5 shows how we are going to take advantage of the success factors that have allowed companies to succeed in EAP.

Success Reasons	Corresponding Strategy
• **Management and User Commitment**	• Share common vision in I.S. and business areas
• **Effective Project Leadership**	• Develop a clear and concise EAP plan easy to follow
• **Balance Scope/Goals/Detail/Time**	• Balance level of detail with resource limitations
• **Qualified Team / Use of Consultants**	• Not applicable (not a team, no consultants)
• **Productive Document/Analysis Tools**	• Choose appropriate tools given available resources
• **Compatible Culture**	• Company X is future and investment oriented
• **Distribute Intermediate Deliverables**	• Allow management to monitor progress of EAP

• **80/20 Principle**	• Focus on vital areas, don't try to cover every detail

Table 5. Success reasons (left) and how to apply them (right)

4.1.1.5 PUT TOGETHER A PLAN FOR THE REMAINING SIX STEPS IN THE PLANNING INITIATION PHASE

The remaining steps in the planning initiation phase have been performed in the following order.

Create a vision

- Investigate background of the enterprise, systems issues and opportunities.
- Define what the project can do to improve the company.

Adapt a methodology

- Customize the general EAP methodology in a way that suits the business needs of Company X and the defined limits for our project.
- EAP methodology provides an outline for the project work plan.

Arrange for computer resources

- Just one laptop computer was used; no more computer resources were needed.

Assemble the planning team

- In our case there was no need to assemble the team since there was only one person doing the planning.

Prepare an EAP work plan

- Given that this project is defining the steps of the EAP methodology that are applicable to Company X, we don't yet have a repeatable process for which we can create a timed schedule including all tasks. However, a general plan of the performed tasks has been gathered in section 4.1.3.2.

Obtain management approval

- Meet with top management, present objectives and obtain approval.

4.1.2 CREATE A VISION

4.1.2.1 ASSEMBLE AND READ ALL SOURCES OF MATERIAL ABOUT THE BUSINESS

Having been responsible for the Information Systems department in Company X for about two and a half years I have gained both technical and management experience. I have

learned about the company in several areas such as budgets and plans, facilities, equipment, retail industry concepts, policies and procedure manuals, products, company culture, processes and system problems. In this project we will be taking advantage of that and any available documentation the company has about the company's structure and processes to develop a business model.

4.1.2.2 DETERMINE INFLUENTIAL EXECUTIVES' HOT BUTTONS

We gathered that in Company X the top management is especially concerned with improving processes by making them more efficient, reducing costs and increasing profit. The guiding principle is that all of these optimizations culminate to provide excellence of service to the customers.

4.1.2.3 MAKE REASONABLE PROMISES TO GENERATE ENTHUSIASM AND SUPPORT

We managed to get enthusiasm from management by presenting them with the possibility of having a clearer view of how the business processes work, particularly in the purchasing department. We always kept a realistic and reasonable approach by making them aware of the limitations of this project since little resources were available when compared to the full blown professional EAP project that a consultancy agency would be able to execute.

4.1.3 PREPARE AN EAP WORK PLAN

4.1.3.1 CONSIDER DIVIDING EAP INTO SUBPROJECTS

This project wasn't divided into subprojects for two reasons:

- It wasn't developed by a team or teams where it would make sense to delegate subprojects to members.
- Generally there is a risk in dividing EAP into subprojects, namely because the management approvals for the subsequent phases may never come, which could lead to failure of the main project.

4.1.3.2 LIST ALL REMAINING PHASES IN THE METHODOLOGY

The phases and steps below are an outline of the applied methodology. The application of the Planning Initiation phase in this case study is already stated by the previous sections in this chapter. In this plan we include steps belonging and further ahead of the EAP

methodology, including BPPAM adaptation and the development of the work practices model.

Preliminary Business Model (see section 4.2)

Week 1:

- Gather all available documentation about the company's structure and functions, namely organograms, process sheets, and function descriptions.

Week 2:

- Analyze gathered information about the company.

Week 3:

- Enter gathered information into the toolset, namely Microsoft Excel and Microsoft Visio; generate tables and charts about the company.

Week 4:

- Schedule meeting with the directors of Company X to explain and obtain comments about the preliminary business model.

Enterprise Survey (see section 4.3)

Week 5:

- Prepare material for meeting with purchasing department.
- Prepare template for sending interview confirmation memo to interviewees.
- Collect and organize all relevant information in documentation about the company's function definition and information sources.

Week 6:

- Send interview confirmation memo to employees Martin and Paula to explain what was to be expected from them in the project, and to schedule the interviews.
- Meeting with buyer Paula: discussion about activities of the purchasing department. Also filled in function definition and some information source forms.

Week 7:

- Second meeting with buyer Paula: discussion about information sources of purchasing department. Filled in more information source forms.

- Meeting with purchasing manager Martin: discussion about activities more under the manager's responsibility. The respective function definition and information source forms were filled in.

Work Practices Model (see section 4.4)

Week 8:

- Stop EAP methodology at current stage and start adapting BPPAM methodology.
- Analyze filled forms.
- Plan what information would be relevant to capture in individual action logs.

Week 9:

- Develop data entry form in Excel to enable capturing of logs from work practices.

Week 10:

- Train and have all four members of the purchasing department use the developed tool to capture at least three full days of work in logs. The capturing schedule was organized to get at least a whole week in total.

Week 11:

- Manually find sequences and patterns of actions in the activity logs captured.

Week 12:

- Develop C# application to automatically find action patterns in the logs.

Week 13:

- Create BPMN diagrams for the processes defined in the function definition forms.

Week 14:

- Manually relate created diagrams from function definition forms with the logs.

Week 15:

- Analyze ADONIS:CE tool's XML format for exported diagrams.
- Prepare BPMN diagrams for allowing automatic textual comparison with the logs.

Week 16:

- Develop C# application to automatically relate diagrams exported to XML with action sequences found in the logs.

Process Improvement (see section 4.5)

Week 17:

- The gathering of process change proposals from the operational actors has been performed during the interviews in the Enterprise Survey phase above. More detail about this phase can be found in its corresponding section.

4.1.3.3 ESTIMATE THE DURATION OF EACH STEP, AND DETERMINE THE START AND COMPLETION DATES CONSIDERING THE RESOURCES ASSIGNED

Based on approximate EAP duration percentages presented by Steven Spewak in his book, and estimating that the total time of the following phases from this point on should take about five months, we can calculate a timed schedule for each step (see Table 6).

Phase	Method.	Duration %	Duration Time (Days)
Preliminary Business Model	EAP	7	11
Enterprise Survey	EAP	23	35
Work Practices Model	BPPAM	70	105

Table 6. Estimated duration per phase in methodology

4.1.3.4 ESTIMATE THE COSTS AND BUDGET IMPACT OF THE PROJECT

The only costs to Company X were mostly the time spent in meetings in the Enterprise Survey phase. No consultants were hired, neither was an employee assigned full time to EAP. No computers or other equipment were bought specifically for this project. Most of the work developed for this project was performed outside working hours of Company X.

4.1.3.5 DISTRIBUTE THE EAP PROJECT WORKBOOK TO TEAM MEMBERS

Although there are no team members to distribute the project workbook to, what is important at this point is to have all relevant documents regarding Company X collected and organized, either digitally or physically into a binder as a filing system.

4.1.4 OBTAIN MANAGEMENT APPROVAL

4.1.4.1 HAVE AN INFORMAL MEETING WITH BUSINESS EXECUTIVES AND EAP OVERSEERS TO REVIEW THE OBJECTIVES, SCOPE, POTENTIAL BENEFITS, AND FACTORS CRITICAL FOR SUCCESS

Before scheduling a meeting with the top managers, i.e. directors and administration, we investigated all information we could about the benefits of EAP. We presented what the

company could gain from this to them, and outlined the phases that would be performed in the project. Not all benefits of EAP could be mentioned because we wouldn't complete or implement the EAP architectures. However, managers are always keen to have the processes in their company studied since it allows learning more about them and sometimes eliminating tasks that aren't as important as once regarded.

4.1.4.2 LISTEN CAREFULLY TO FEEDBACK FROM MANAGEMENT AND DISCUSS THEIR QUESTIONS

In our meetings the feedback we received was positive and any questions were mainly about what resources would be needed and what the project would bring to the company.

4.1.4.3 OBTAIN APPROVAL TO PROCEED WITH THE PROJECT

By the end of the meetings we obtained written approval of the top managers to proceed with the project.

4.1.4.4 PUBLICIZE THE EXPRESSED COMMITMENT OF MANAGEMENT FOR EAP THROUGHOUT THE BUSINESS UNIT WITH AN ANNOUNCEMENT

Since we focused on the purchasing department, one of the directors was responsible for informing that team that we would be performing a project with them and requested their availability for any necessary meetings.

4.1.4.5 HOST A GENERAL EAP ORIENTATION (EXECUTIVE OVERVIEW) FOR THE ENTIRE ENTERPRISE

Hosting an orientation for the entire enterprise wasn't necessary given the scope of this project. We scheduled a meeting with all members in the purchasing department to introduce them to EAP, the project and how their collaboration would be necessary in the near future.

4.2 PRELIMINARY BUSINESS MODEL

4.2.1 DOCUMENT THE ORGANIZATIONAL STRUCTURE

4.2.1.1 GATHER RECENT ORGANIZATION CHARTS, AND ENTER THE INFORMATION INTO THE TOOLSET

Company X has several locations, and although the structure varies slightly between their stores, those differences are irrelevant to our study. The company's organograms were merged and simplified to achieve a generalized version. The purchasing department, which is the one we will be studying in more detail, stands in the head office location under the operations director responsibility and has four employees: Martin the department manager, and the buyers Paula, Barry and Helen. The resulting organogram can be found in Figure 40 (page 91) under the results chapter.

4.2.1.2 IDENTIFY BUSINESS LOCATIONS AND RELATE TO ORGANIZATIONAL UNITS

Company X is divided in three different locations A, B and C. Location A is where the head office is, including the main warehouse, while locations B and C are stores that include common supermarket sections under a store manager and a smaller warehouse each. The relation between organizational units and business locations is represented by groupings illustrated in Figure 40 (page 91) under the results chapter.

4.2.2 IDENTIFY / DEFINE FUNCTIONS

The activities that compose the functional area of our object of study, i.e. the purchasing department are listed along with other functional areas in section 4.2.2.2.

4.2.2.1 DEFINE THE MAJOR FUNCTIONAL AREAS USING THE "VALUE-ADDED" CONCEPTS OF MICHAEL PORTER

Company X's major functional areas are logistics, operations, sales & marketing and customer service. These activities are supported by: 1) the administration which is the top management, 2) finance and accounting, 3) administrative services (secretarial/clerical activities), 4) quality and auditing controls for maintaining standards and enforcing procedures that allow the company to earn accreditation through certificates, 5) human resources, 6) information systems & technology, and 7) the purchasing department which is responsible for buying goods for refilling stock. The procurement department is responsible for finding new products that may interest the clients. Company X's instantiation of Porter's value chain model can be found in Figure 41 (page 92) in the results chapter.

4.2.2.2 DIVIDE EACH FUNCTIONAL AREA INTO ITS SUB FUNCTIONS BY ASKING THE QUESTION "WHAT IS THE FUNCTION?" OR "WHAT DOES THE ACTIVITY NAME MEAN?"

For the purpose of this study, we have adapted this step and show here only a partial list of the activities performed by the company covering the most relevant areas. The following activities exist:

Financial Direction

- Issuance of credit notes
- Issuance of debit notes
- Introduction of bills
- Processing payments
- Processing contract rappels (volume discount)
- Budget planning
- Personnel planning

Operations Direction

- Labeling of products
- Transferring products between stores
- Creating production orders
- Handling customer interaction (returns, complaints, etc.)
- Marketing planning
- Selling

Logistics Direction

- Reporting on receiving goods
- Product control when receiving
- Warehouse receiving
- Outbound load transportation

There are also processes that traverse several departments in the company, for example:

- Store events planning (procurement, purchasing, marketing, store manager, etc.)
- Internal auditing (quality department and audited departments)
- Store inventory (store sections, operations, warehouse)

The Purchasing department, which is under the operations direction, includes the following activities. Note that since this department is the focus of our study, these activities will be further detailed in the following sections of this document.

Purchasing Department

- Purchases planning
- Purchasing
- Supplier evaluation
- Negotiate contract
- Expenditure and consumables management
- Subcontracting management
- Store events and shelves planning
- Supplier price tables handling

4.2.2.3 (RE)ARRANGE ALL FUNCTIONS HIERARCHICALLY TO IMPROVE THE BUSINESS MODEL

The activities mentioned in the previous step were further decomposed in: 1) the object of the action, and 2) the actions themselves (verbs). The application of this concept resulted in Table 10 (page 92) that can be found in the results chapter.

4.2.2.4 ENSURE QUALITY OF THE BUSINESS MODEL AND CONTINUE TO MAKE IT BETTER

In order to keep the preliminary model stable, we kept out of the model variables that are most likely to change over time, for instance: the names of the actors in the purchasing department, how specific actions are performed (e.g. "send email" is more stable than "send email using Microsoft Outlook®), and the place where the actions are performed (e.g. "call supplier" is more stable than "call supplier from meeting room").

4.2.2.5 ESTABLISH THE STABILITY OF THE BUSINESS MODEL BY CONTINUALLY EVALUATING THE GOODNESS CRITERIA AND BY ASKING HOW THE BUSINESS HAS EVOLVED OVER TIME

The nature of the business of Company X has stayed the same for many years. Given this stability in the past we can assume that it should remain the same in the future. This means that for the business model to need to change, the nature of the business would need to change drastically. Therefore the current preliminary business model is considered to be stable and aligned with the business nature.

4.2.2.6 RELATE THE DETAILED FUNCTIONS TO THE ORGANIZATION UNITS THAT PERFORM THEM, AND PRODUCE A MATRIX REPORT

The resulting matrix can be found in Table 11 (page 93) in the results chapter.

4.2.3 DISTRIBUTE THE PRELIMINARY BUSINESS MODEL

4.2.3.1 COLLECT ALL NOTES AND CHARTS FROM THE PREVIOUS STEP

The resulting numbering can be found in Table 12 (page 94) in the results chapter.

4.2.3.2 PRESENT, FULLY EXPLAIN, AND PROVIDE COPIES OF THE PRELIMINARY BUSINESS MODEL REPORTS TO MANAGEMENT

The model was deemed correct by the directors and complete within the decided scope and aligned with the company's available documentation.

4.2.3.3 EXPLAIN THE ENTERPRISE SURVEY PHASE AND OBTAIN PERMISSION TO CONTACT PEOPLE FOR INTERVIEWS

In this step we asked for and obtained permission to interview people in the purchasing department from the operations director.

4.3 ENTERPRISE SURVEY

From this point on in this case study we focus on the purchasing department only. This is because from here on we start performing interviews to operational actors and in the next section capturing logs from them. This would not be feasible to perform on the whole company due to time and team size constraints in this project.

4.3.1 SCHEDULE THE INTERVIEWS

4.3.1.1 SELECT THE PEOPLE TO INTERVIEW

In order to cover the activities in the purchasing department, we chose to interview the department's manager Martin and one of the buyers, Paula.

4.3.1.2 ARRANGE A MUTUALLY CONVENIENT TIME WITH INTERVIEWEES AND PLAN WHAT TOPICS WILL BE DISCUSSED IN THE INTERVIEWS

We contacted the purchasing manager and buyers and discussed with them a time and place for the interviews. The activities that candidates were interviewed about are numbered on Table 12 (page 94) and included: [21] Purchases planning; [22] Purchasing; [23] Supplier evaluation; [24] Negotiate contract; [25] Expenditure and consumables management; [26] Subcontracting management; [27] Store events planning; [28] Handle supplier price tables

The scheduling for the arranged interviews is shown in Table 7.

Date	Time	Name	Dept/Title
22 June	11:30-13:00	Paula	Buyer
26 June	11:00-13:00	Martin	Purchasing Mgr.
27 June	11:30-13:00	Paula	Buyer

Table 7. Interviews schedule (enterprise survey)

4.3.1.3 SEND A MEMO CONFIRMING THE INTERVIEW APPOINTMENT AND EXPLAINING THE INTERVIEW PROCESS TO EACH INTERVIEWEE AND THEIR MANAGER

Given the size of the company and the small number of interviewees, the sample interview confirmation memo presented by Steven Spewak in his book (Spewak, et al., 1992) is too formal and extensive. Knowing that in a busy work environment nobody wants to spend time reading more than they need to, we wrote a shorter and more to the point email, and further confirmations were made informally by telephone and in person. Figure 21 shows the memo e-mail that was sent to the interviewees in the purchasing department.

Subject: Enterprise Architecture Planning Study (EAP)

I'm currently studying your department with the goal to make it easier and faster for you do manage and execute your day-to-day tasks. The improvement of any sort of work processes is only possible after we understand how they actually work. To achieve this, I need you to help me better understand your department's processes.

The information I'll be gathering will include:

- The activities you work on; The information you use or generate during these activities; What you think could be improved.

Your help will consist of:

- A couple of meetings that may last around an hour and a half each; Creating a log of your daily tasks during a set period of time (to be defined).

I'll be calling you individually to schedule the meetings.

Figure 21. Interview memo sent to purchasing department members

4.3.2 PREPARE FOR THE INTERVIEWS

4.3.2.1 DECIDE WHAT INFORMATION TO OBTAIN THROUGH THE INTERVIEWS AND, THEREFORE, WHAT QUESTIONS TO ASK

The information we want to obtain is how processes are performed in the purchasing department of Company X, what information sources they use (e.g. supplier forms, product details) and also what the purchasing manager and buyers have in mind in order to improve the current processes. The specific questions or information to obtain are stated in the forms created in step 4.3.2.2.

4.3.2.2 DESIGN THE FUNCTION DEFINITION AND INFORMATION SOURCE FORMS

Based on the sample function definition and information source forms that can be found in Spewak's EAP book (Spewak, et al., 1992) adaptations were created to use in the interviews.

These can be found in Figure 22 and Figure 23 respectively. The function definition form starts with a field to register the date when the form was filled in, and it contains all the information about the function, namely its number and name; who performs it and where it takes place; a short description; why it exists (purpose); how it is performed (decisions); how often it is executed (frequency); and how long it takes (duration).

The form also allows us to register suggestions for improving the function, which information sources it uses, and finally who was the interviewee. Each information source is

also collected into a form, which includes the date of the interview; the source identification number; the number of the function to whom it belongs; its name and short description; from who the information comes and to whom it is forwarded; whether a sample of the source has been collected; the medium used (e.g. paper); the accuracy of the information in the source; whether the formatting of the information is considered good; and just as the function definition form, the name of the interviewee.

Function Definition Form

DATE: _____
FUNCTION NO.: _____
FUNCTION NAME: _____
PERFORMED BY: _____
LOCATION(s): _____
DESCRIPTION: _____
PURPOSE: _____
DECISIONS: _____
FREQUENCY: _____
DURATION: _____
FUNCTION IMPROVEMENT OPPORTUNITIES: _____
INFORMATION USED: _____
INTERVIEWEE: _____

Figure 22. Function definition form (adapted for Company X)

Information Source Form

DATE: _____
SOURCE NO.: _____
FOR FUNCTION NO.: _____
SOURCE NAME: _____
DESCRIPTION: _____
RECEIVED FROM: _____
FORWARDED TO: _____
SAMPLE ACQUIRED: _____
MEDIUM: _____
ACCURACY: _____
FORMAT: _____
INTERVIEWEE: _____

Figure 23. Information source form (adapted for Company X)

4.3.2.3 ESTABLISH INTERVIEWEE PROFILES AND SPECIFIC QUESTIONS

Before the interviews we tried to fill in the function and information source forms as much as possible to give us a head start and to make the interviews more productive. The information we filled in was extracted from company documentation gathered in the preliminary business model phase (section 4.2). We also spoke informally to the interviewees before the meetings to get a grasp of what they knew and how we could take advantage of their knowledge. The questions made in the interviews were divided among the purchasing manager and one buyer; in part simply for load balancing but also because some activities are only performed by the purchasing manager so only he knows about them. The association between the interviewees and the forms they helped us fill in can be found in Table 8 (Table 7's schedule but with column showing filled form numbers).

Date	Time	Name	Dept/Title	Activity/Info. Source no.
22 June	11:30-13:00	Paula	Buyer	21,22,24,27,28
26 June	11:00-13:00	Martin	Purchasing Mgr.	21,23,25,26,78,79,80,85,89,90, 91,92,93,94,95,96,97,98,104
27 June	11:30-13:00	Paula	Buyer	81,82,83,84,86,87,88, 99,100,101,102,103

Table 8. Interviewees who filled function and information source forms

4.3.3 PERFORM THE INTERVIEWS

4.3.3.1 PERFORM EACH INTERVIEW AT THE SCHEDULED TIME

Trying to perform the interviews at the scheduled times was actually harder than expected given the busy state that the purchasing department was in. We were forced to postpone the meeting with the purchasing manager twice, and once with the buyer. After some persistence it paid off and we managed to perform the necessary interviews.

4.3.3.2 FILL IN THE FUNCTION DEFINITION FORMS DURING THE INTERVIEW

Using a quiet office room and after placing all related documents on a desk, questions were made to the interviewees while at the same time the answers were written into the forms. Only one person was interviewed at a time.

4.3.3.3 IDENTIFY THE INFORMATION SOURCES FOR EACH FUNCTION AND FILL IN THE INFORMATION SOURCE FORMS DURING THE INTERVIEW

We identified most of the information sources before the meetings from existing documentation so we were able to prepare ourselves by pre-filling these forms to save time in the interview. The procedure for asking questions and filling these forms was similar to the one used for function definition forms. These information source names and identifying numbers can be found in Table 12 (page 94) and their associations to functions are detailed in Appendix B. Samples of the actual filled forms are available in Appendix C.

4.3.3.4 OBTAIN A SAMPLE COPY OF EACH INFORMATION SOURCE

A sample was obtained for most of the information sources in the purchasing department although not all could be disclosed. For the samples we did gather, we indicated that in the respective field in the information source form (Sample Acquired). Copies of digital sources were provided by the interviewees during the interview but paper sources were reviewed after by visiting the locations where documents were stored.

4.3.3.5 AT THE END OF AN INTERVIEW, SUMMARIZE WHAT HAS BEEN WRITTEN, SCHEDULE A FOLLOW-UP SESSION IF NECESSARY, AND CONFIRM COPIES OF SOURCES THAT THE INTERVIEWEE WILL PROVIDE

At the end of each interview we developed all notes taken on the forms by filling in any incomplete fields, and confirmed availability of the interviewee for a following interview as needed. Copies of information sources where mostly digital and so were copied from the company network during the interviews instead of at the end.

4.3.3.6 SEND THE INTERVIEWEES A COPY OF THE DATA THEY PROVIDED

A copy of the filled function definition forms and information source forms were sent to both the purchasing manager and the interviewed buyer.

4.3.4 ENTER DATA INTO TOOLSET AND DISTRIBUTE COMPLETE BUSINESS MODEL

4.3.4.1 ANALYZE THE ENTERPRISE SURVEY INFORMATION

In order to better understand the information in the forms, we developed a relation between the functions and the respective information sources. This can be found in Table 20 of Appendix B.

4.3.4.2 ENTER THE DATA ON THE FORMS INTO THE TOOLSET

After reviewing the data in the forms, particularly the "Decisions" field that explains the steps in each activity, the tool ADONIS:CE v2.0 was used to create the BPMN diagrams that represented those activities (see Figure 42 to Figure 45, pages 96 and 97).

4.3.4.3 THE PLANNING TEAM SHOULD REVIEW ALL FEEDBACK AND CHANGE THE BUSINESS MODEL AS APPROPRIATE

Although comments and suggestions were solicited to the directors' board, there was no relevant feedback to make changes to the model.

4.4 WORK PRACTICES MODEL

4.4.1 DECIDE WHAT TO CAPTURE IN LOGS

For each row in the logs we decided to capture five fields: 1) the date of the event, 2) the time, 3) what is the activity, 4) who sent the information that the user is working with, and 5) who will the user send the information to after it has been processed.

4.4.2 DEVELOP DATA ENTRY TOOL TO ENABLE CAPTURING WORK LOGS

The developed tool is a Microsoft® Excel 2010 form (shown in Figure 24) where users can:

- Choose or type in the date and time of the activity
- Choose the activity being performed
- Choose or type in more details about the activity (Figure 25)
- Choose who the information is being received from or sent to (Figure 26)
- Register the activity into the logs by pressing the "Add" button

The list of activities the user can choose from in the application was provided by the purchasing manager and is, as he described himself "all sorts of things we do along the day here in the department".

Besides being able to register activities, the tool informs users about the last entry added so they have the notion if they are adding something that has already been added (Figure 27). If an activity is added by mistake or contains details that are wrong, the user can press the "Delete last entry" button on the form. This button does not actually delete the row internally but instead makes a mark on it so we can still see the entries when analyzing the logs (this marking will show up in the column "Delete/Wrong", see Figure 28).

The form was developed using ActiveX controls, of which the option boxes were pre-filled with data coming from a hidden spreadsheet in the document. The actual log, i.e. the database was also a hidden spreadsheet that the user never gets to see and thus is not tampered with. The code controlling the events in the form was developed in Visual Basic for Applications (VBA) and special attention was paid in improving user experience in the interface. For instance, the option boxes expand automatically when the user clicks on any part of it (and not just the "expand" button); the time and date are automatically fetched from the system time and filled in when the user opens the spreadsheet; the "Detail" option box contents change according to the "Activity" that the user has selected (Figure 25). Also, the form isn't scrollable so the user can't scroll it out of view of the window and the cells are protected so they can neither be edited nor selected.

The date and time are updated in the form controls only when the spreadsheet is opened or when the user manually overrides them by typing in these fields. When the user clicks to add an activity entry, we not only save that information, but also the operating system's current date and time. This way we will always know exactly when the activity was added and also when the user wanted it to be registered. So effectively, there are nine captured fields in the logs per row (Figure 28).

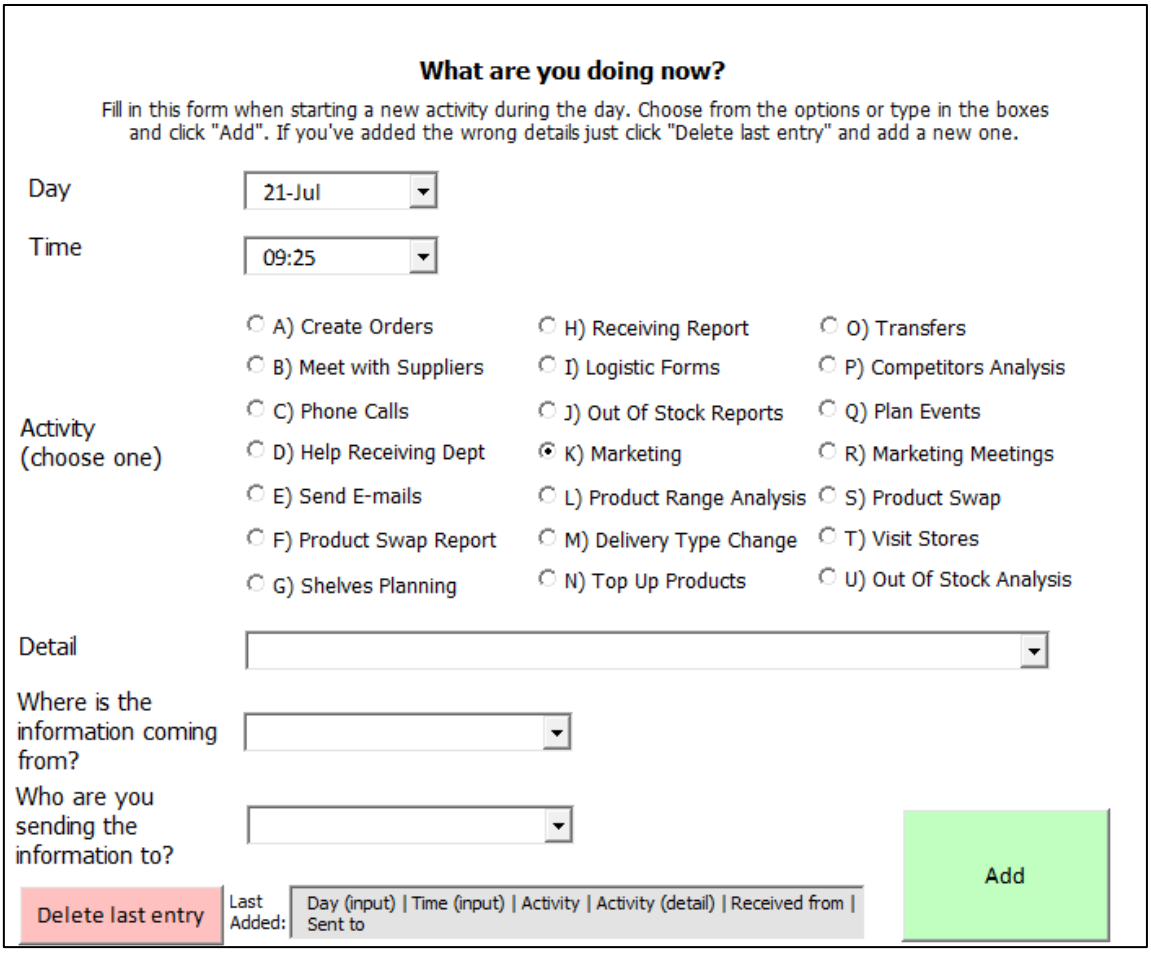


Figure 24. Data entry tool for capturing purchasing department user logs

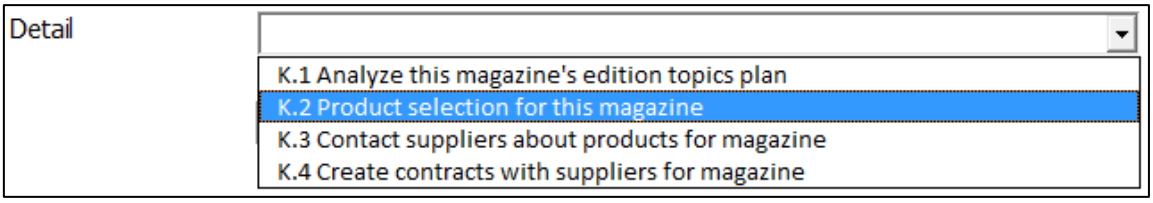


Figure 25. (Tool detail) Expanded detail option box for activity "K) Marketing"

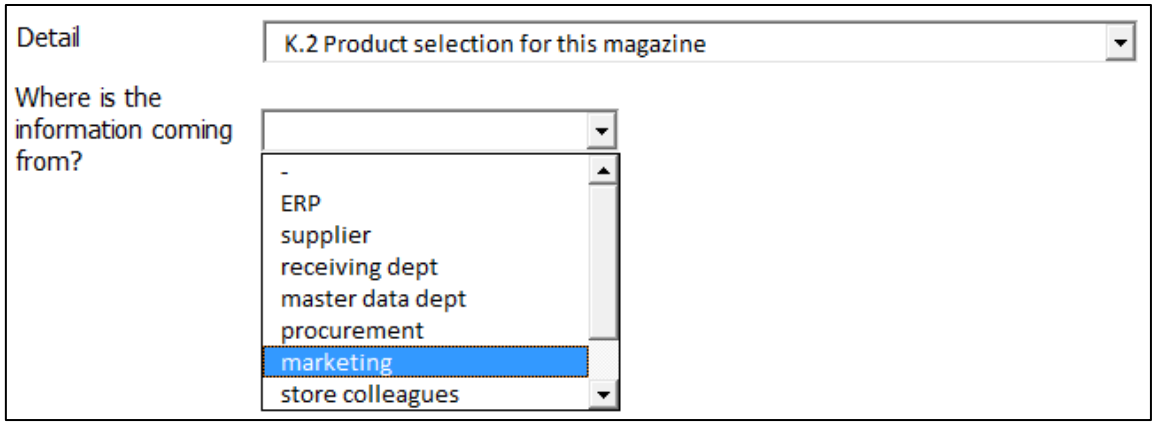


Figure 26. (Tool detail) Expanded option box for choosing source of information

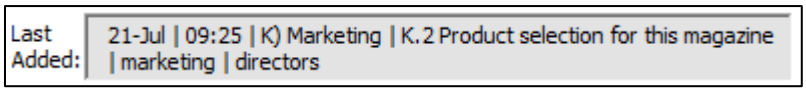


Figure 27. (Tool detail) Sample of "Last Added" record

Day (input)	Day (system)	Time (input)	Time (system)	Activity	Activity (detail)	Received from	Sent to	Delete/Wrong

Figure 28. Fields captured in the logs

4.4.3 CAPTURE LOGS OF WORK PRACTICES

In order to be able to capture activities for an entire week, different days for capturing logs were assigned to each member of the purchasing team. Barry and Helen, both buyers, started registering their activities on a Monday morning and continued for three days until Wednesday evening. Martin (manager) and Paula (buyer) registered from Wednesday morning until Friday evening. However, since Paula was out most of the day on Thursday, she was asked to do more logging which she did on the following Monday and Tuesday.

4.4.4 PROCESS THE INFORMATION IN THE LOGS

4.4.4.1 FIRST ANALYSIS TO WHAT WAS CAPTURED IN THE LOGS

In order to better understand what had been captured in the logs (see sample in Figure 54, page 111), a report was created for each of the purchasing team members identifying what activities they had performed per day (Figure 55, page 111) and who they had interacted with either by receiving information (Figure 56, page 112) or sending information to (Figure 57, page 112). These reports were then sent to the team so that they could better understand how their time is being spent.

4.4.4.2 TIME PRECISION IN RECORDS

Since the field "Time (input)" in the logs (Figure 28) was only updated when opening the tool or when a record was added, and also knowing that the users could type in another time of their choice, it was necessary to create a logic to choose the correct time that each activity belongs to (whether it is the input time or the system time). The following scenarios were possible:

- **Input time is earlier than system time**: either the user didn't update the time when he/she added the record (A), or the user changed it to a previous time on purpose (B).
  A. We know the user didn't update the input time if it is the same as the system time registered on the previous record. In that case, the correct time to consider for the current record is the system time.
  B. If the input time for a record is before the system time of the previous added record then we know the user typed in the input time for the current record and thus it should be the considered time, not the system one.
- **Input time is equal or later to the system time**: this can only happen if the user changed the input time on purpose, to anticipate an activity that he/she was going to perform afterwards. In this case, the input time should be considered for the current record.
- **For the first record of any given day**: we always consider the later time between input and system time since there are no previous records for comparison.

As for the "Day (input)" field, the adopted rule was to always consider the day typed in as the correct day (and not the system date) allowing the users to add records for previous days if necessary. In these cases the time that is considered is the input time as well and not the system's. Following the rules defined above, the actual times for each action were calculated, and the time columns were replaced in the log files (Figure 29).

Day(input)	Actual time	Activity	Activity (detail)	Received from	Sent to
18-Jul	08:34	E) Enviar E-mail's	E.1.8 Ciclos/ Promocionais	ERP	fornecedor
18-Jul	08:49	E) Enviar E-mail's	E.2.5 Envio de informação s/ produtos/ acções	ERP	colegas lojas
18-Jul	08:53	C) Atender Telefone	C.2 Colegas das lojas	colegas lojas	colegas lojas
18-Jul	09:25	P) Análise de Folhetos	P.2 Comparar os preços com os do sistema	outros	outros
18-Jul	10:05	B) Receber Fornecedores	B.1 Negociar acções/ descontos/ promoções	ERP	fornecedor
18-Jul	11:51	C) Atender Telefone	C.1 Fornecedores	fornecedor	fornecedor

Figure 29. Format of logs after correct day and time calculation (Martin's log sample)

4.4.4.3 FIND SIMPLE PATTERNS OF ACTION SEQUENCES IN THE LOGS

It was possible to extract meaningful information from the logs by finding sequences of activities (or actions) in each day for each person. Firstly and before further analyzing the logs, they were ordered by day and time, and consecutive duplicate entries (rows) were removed. These duplicate entries were removed since two equal actions following each other can be treated as a single action when searching for sequences.

Then we looked for sequences of actions in the logs and counted how many times they occurred for each of the users.

4.4.4.4 TOLERATING INTERRUPTIONS WHEN LOOKING FOR SEQUENCES

Let's imagine there is an action sequence <A><E> that represents a process that users in the purchasing department keep coming back to every once in a while. They may get interrupted sometimes and in between those actions they may squeeze in one or two actions that they needed to do urgently from another process. The interrupting actions can be represented with question marks `<?>`, and the number of interrupting actions can be called the interruption length. For a sequence of two actions with an interruption of length one, we would have `<A><?><E>`, and the same sequence with an interruption of two would be represented as `<A><?><?><E>`.

So what happens when we look up sequences of three or more actions? The process is very similar, but we need to be more careful in the way we interleave the interruptions with the actions. In order to correctly count the occurrences of the interrupted sequences, we need to follow a "binary count" pattern (see Figure 30), where "a" represents an action in our sequence, "1" represents an interruption of any length, and "0" represents no interruption.

```
a 0 a 0 a
a 0 a 1 a
a 1 a 0 a
a 1 a 1 a
```

Figure 30. Sample interruption patterns (sequence length = 3)

Counting the number of occurrences for each sequence must then be complemented by summing up the results for all days captured in the logs. This way the total number of ocurrences for that sequence in the logs can be obtained for a person.

4.4.4.5 AUTOMATE THE PROCESS OF FINDING SEQUENCES

We developed this tool for finding sequences automatically in the logs using Microsoft Visual C# 2010 Express.

On the top part of the application's user interface (see Figure 31), there are two fields that allow the user to configure the number of actions in the sequences to look for and the maximum number of actions allowed per interruption. A maximum interruption length of "0" means no interruptions at all, but "2" means that there may exist interruptions between the actions and that they can be of one or two actions in length. Clicking on the "Open File…" button will display a file browser dialog (Figure 32) that allows to choose the file with the logs to analyze. As long as the file has the correct column format as Figure 29 shows, the application will then analyze and output the results on the main output text panel (Figure 33).

The application that was developed processes the Microsoft Excel file and generates results in five steps:

Step 1. Create Day objects

The application reads the file and creates one day object for each day that has captured logs.

Step 2. Find all sequences in file

For each Day object, it recursively finds all possible action sequences of the specified length and stores them in memory. It then removes duplicate entries of sequences in each day.

Step 3. Generate interruption patterns

Calculates all possible action interruption combinations for a specific action sequence length and interruption length (see example in Figure 30). Also calculates the "interrupted sequences" to look for, by interleaving the interruption pattern with the actual sequences.

Step 4. Count action sequence occurrences per day

For all sequences of actions found (both normal and interrupted versions), it counts how many times they appear for each day.

Step 5. Count total action sequence occurrences

Finally the application sums up the totals for all days and displays them per action sequence.

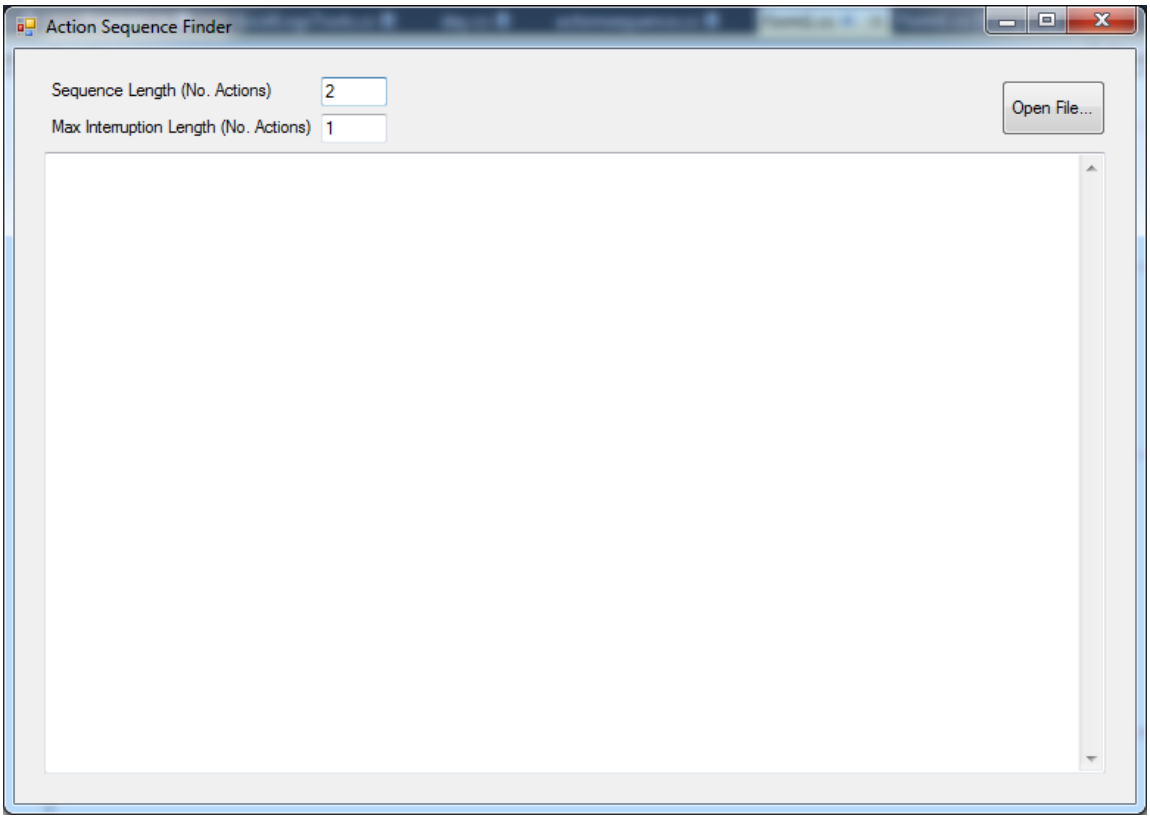


Figure 31. Action Sequence Finder application

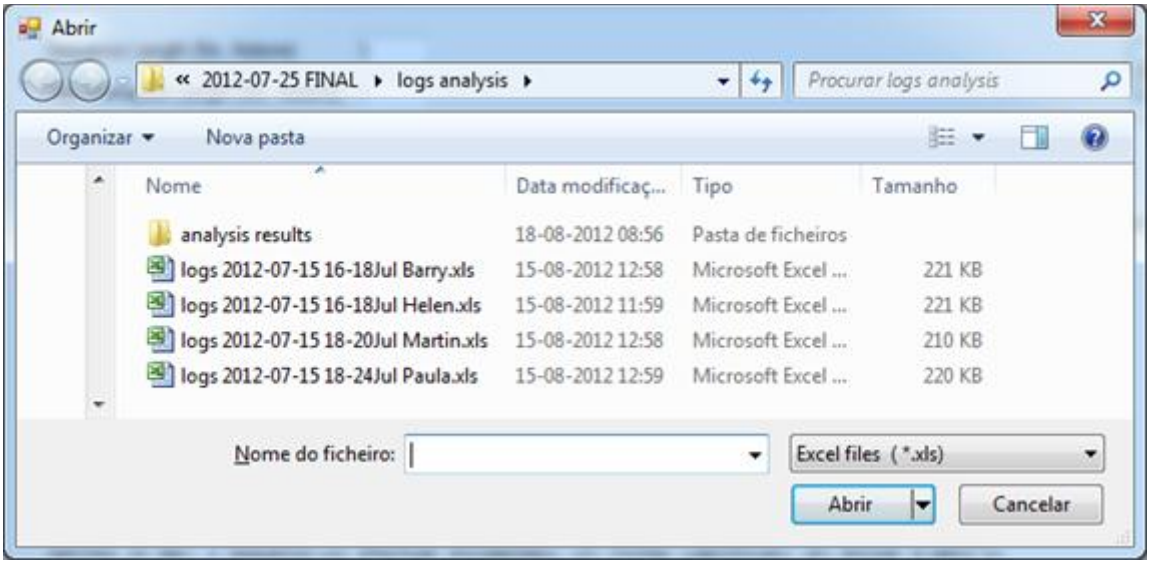


Figure 32. Action Sequence Finder - file browser dialog

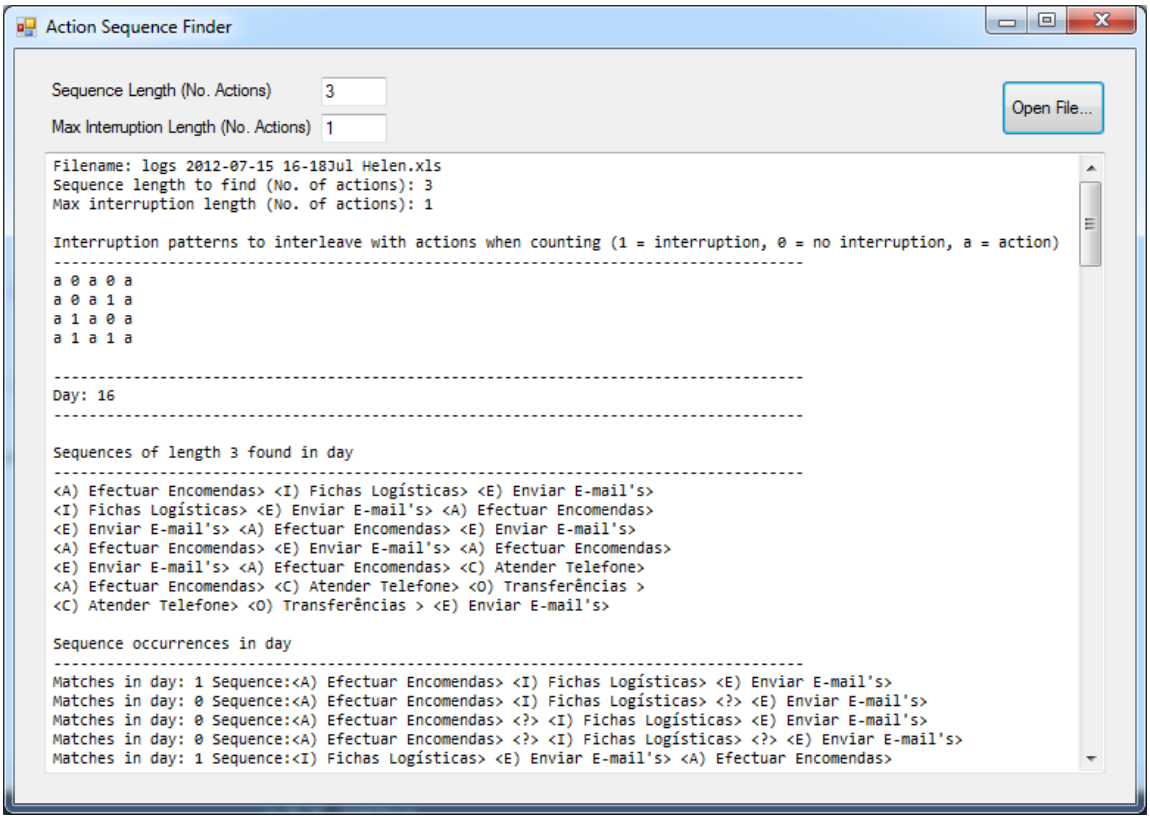


Figure 33. Sequences analyzed in Helen's logs: Seq.Length = 3, Int.Length = 1

4.4.5 MATCH ACTION SEQUENCES BETWEEN FORMS AND LOGS

4.4.5.1 MANUAL RELATION BETWEEN FORMS (DIAGRAMS) AND LOGS

First, it was necessary to make the diagrams relatable to the logs. To achieve this, tasks in the diagrams were named after the letters identifying the activities captured in the logs (see Activity options in Figure 24, page 77). For instance, the task "Receive Price Tables" in the "Handle Supplier Price Tables" process (Figure 45, page 97), can be associated to activity "I) Fichas Logísticas" ("Logistics Forms") in the logs because the price tables are part of what Company X calls the products' logistic information.

After associating the logs' activities with the tasks in the process diagrams, all possible sequences with those letters were extracted as they appeared in the diagrams and then counted. We also made changes to the number of tolerated interruptions between actions in the logs to see if those sequences appeared more often.

4.4.5.2 ANALYZE EA TOOL'S ABILITY TO EXPORT DIAGRAMS TO TEXTUAL FORMAT

Even though the quantity of diagrams and sequences in this study is small enough to be related manually, a more automated method can be created.

Using the tool ADONIS Community Edition v2.0 we can export all processes to XML format, allowing us to compare them textually with the actions in the logs. Figure 34 shows how the elements that are in the diagrams (example of the purchasing process in Figure 42, page 96) are exported in the XML. For instance, the element <MODEL> shows the diagram's name in the "name" attribute. The start event, tasks, gateways, pools and lanes are represented as <INSTANCE> elements specifying the respective name, id and class. Subsequent connections between elements and whether the objects are inside specific pools or lanes are identified by the <CONNECTOR> elements, respectively by the "Subsequent" and "Is inside" classes.

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE ADOXML SYSTEM "adoxml31.dtd">
<ADOXML <...> >
 - <MODELS>
    - <MODEL <...> modeltype="Business process diagram (BPMN 2.0)" name="Purchasing" id="mod.16010">
       + <MODELATTRIBUTES>
       + <INSTANCE name="Daily Purchasing" id="obj.16868" class="Start Event">
       + <INSTANCE name="Create Order" id="obj.16935" class="Task">
       + <INSTANCE name="Should make new order?" id="obj.16892" class="Exclusive Gateway">
       + <INSTANCE name="Company X" id="obj.19096" class="Pool">
       + <INSTANCE name="Buyer" id="obj.19449" class="Lane">
       + <CONNECTOR id="con.16889" class="Subsequent">
       + <CONNECTOR id="con.16972" class="Is inside">
        <...>
```

Figure 34. Sample XML for purchasing process (ADONIS:CE)

Each element holds more information if we expand it, for example a <CONNECTOR> will tell us the object where it starts <FROM> and where it stops <TO> (Figure 35). With this information we know which task comes after another and therefore the sequence.

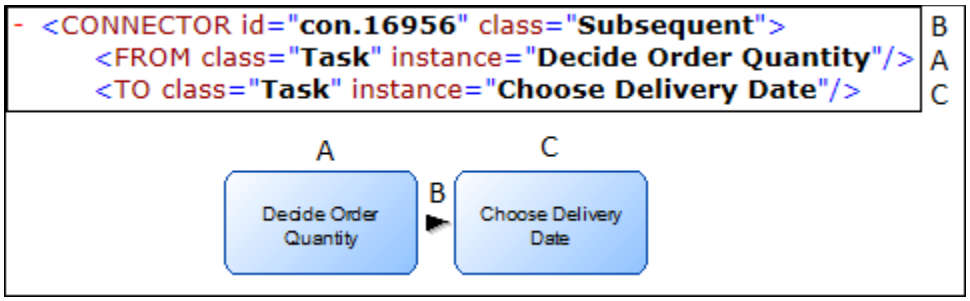


Figure 35. Example of "Subsequent" connector in ADONIS:CE XML

We can also tell who is performing the tasks from the <CONNECTOR> of class "Is inside". The example in Figure 36 shows a task "Create Order" that is in the lane of the buyer, and thus is executed by him/her.

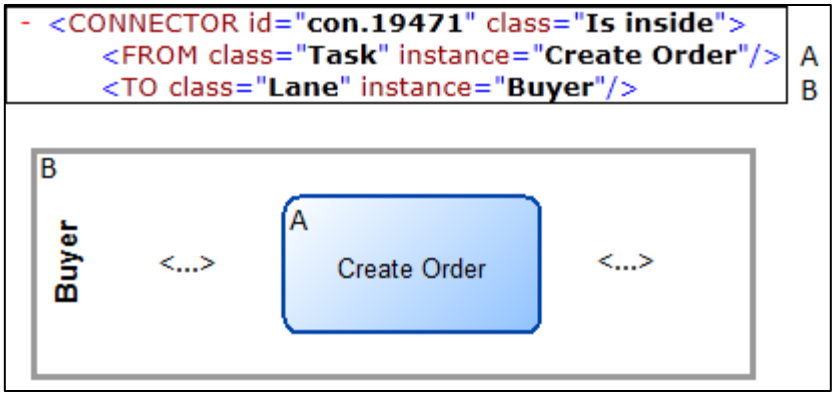


Figure 36. Example of "Is inside" connector in ADONIS:CE XML

By programming an application, this sort of XML format can be compared to the action sequences extracted from the captured logs.

4.4.5.3 AUTOMATE THE RELATION BETWEEN FORMS (DIAGRAMS) AND LOGS

In order to take advantage of the XML files that ADONIS:CE can generate for each diagram, a C# application was developed to process those files and automatically find action sequences in them that match the sequences found in the users' logs.

As mentioned in section 4.4.5.2, tasks are identified by <INSTANCE> elements in the XML. Those elements hold the name of the task in the diagram, but we also know from Table 13 (page 101) that they don't always have the same names as the actions in the logs. Because of this, and for the application to be able to recognize a specific action match when it sees it in the diagrams, the first step is to manually associate the actions' identifiers to the names of the corresponding tasks in the XML. This basically means writing the log's action identifier in front of the corresponding task name in the XML so the application can pick it up.

There are however cases where more than one log action identifier can be associated to a single task in the diagram. One example of this is the "Create Order" task in the Purchasing diagram which can either be associated with action "A) Efectuar Encomendas (purchase)" or with action "N) Reforçar Produtos (restock from supplier)". A straightforward way to

process these cases is by creating an alternative version of the diagram, where the different identifiers are used accordingly (see Figure 37).

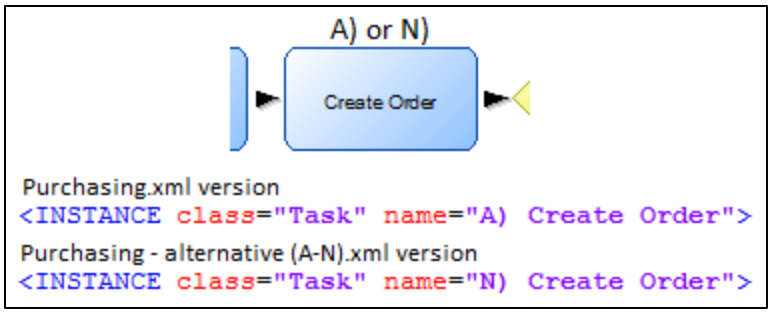


Figure 37. Example of task that can be action A or N and respective XML versions

The application that was developed for automating the diagrams and logs relation has a user interface with four input fields and four main output panels (see Figure 38). The user can choose in which actors the application should focus on by typing them into the "Actors Performing Actions" field (e.g. Buyer, Purchasing Manager). This is used to make sure the application is comparing the actions to the tasks in the correct lane of the diagram. The field "Pool To Analyze" works as a filter and the application uses it to remove unnecessary pools and the elements in those pools. In the other two fields we can set the paths where the application will get the files with log results for the actor and where it can find the XML files of the diagrams.

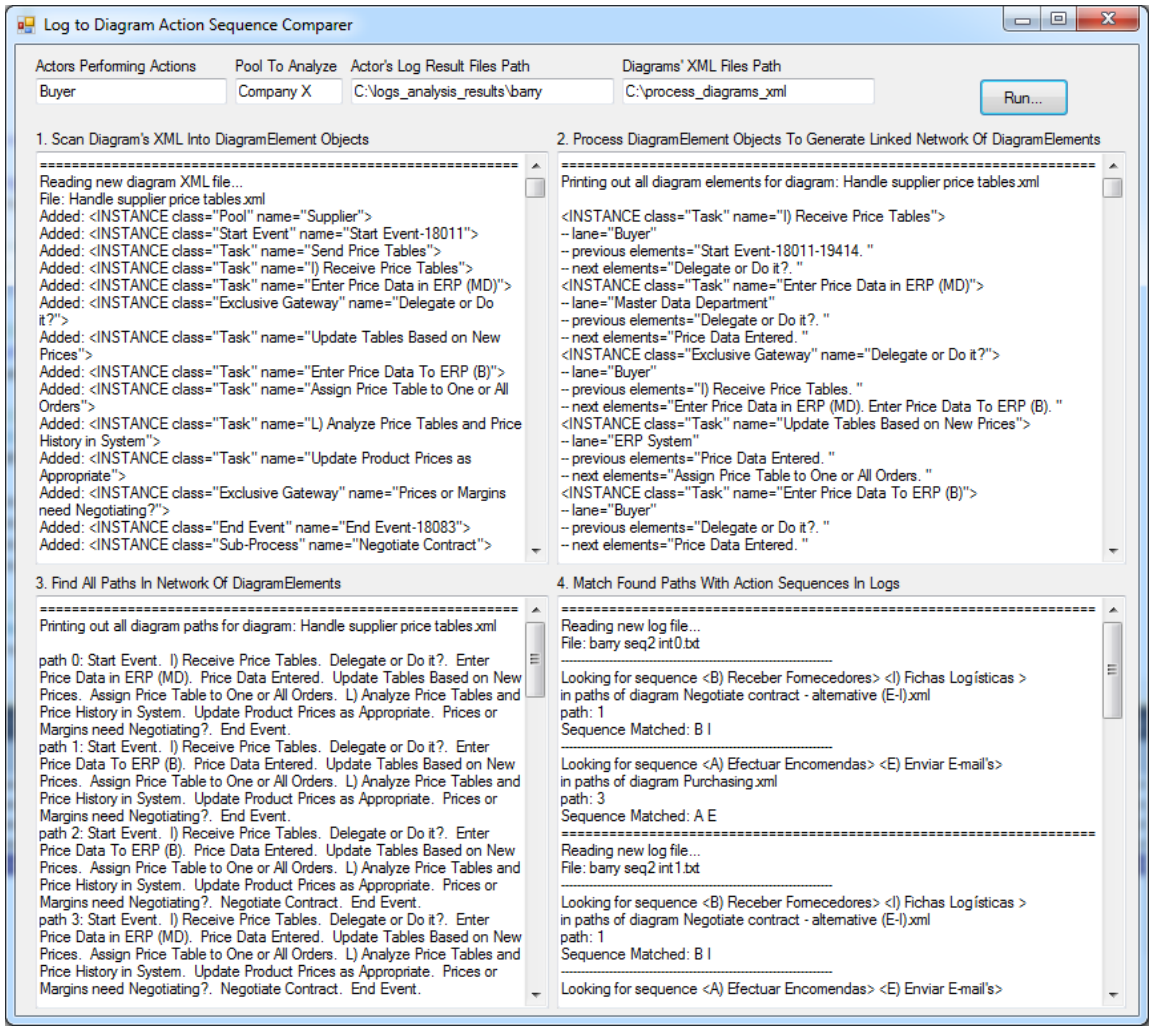


Figure 38. Action sequence model XML and Logs Comparer application

The application processes the logs and generates the comparison results in four steps (the four output text panels in the application's user interface, left to right, top to bottom):

Step 1. Scan diagrams XML into DiagramElement objects

In this step each XML file for all diagrams is processed from top to bottom, using the .NET class XmlTextReader to get all elements and attributes and then the application creates custom DiagramElement objects to hold the relevant information about each element (e.g. type, name, class, and lane). The number of stored attributes depends on the type of element, so for example an <INSTANCE> element will store less fields than a <CONNECTOR> element which besides all attributes in the former, also has to store

where the connection is coming from and where it is connecting to. The accepted format for XML in our application is ADONIS ADOXML v3.1.

Step 2. Process DiagramElement objects to generate a linked network

Here some cleaning is done, namely pools and lanes are deleted (they're redundant since their contents can be extrapolated from the <CONNECTOR> links). Message flows are also deleted since they connect different pools and we're only interested in analyzing Company X's pool. For the same reason, all elements that belong to other pools are also deleted (start events, tasks, connectors, etc.).

Then the <CONNECTOR> links are processed by: 1) storing the lane name directly inside the DiagramElement objects instead of indirectly in a <CONNECTOR>, and 2) storing inside each <INSTANCE> object the references to the previous and to the next DiagramElements; this way they can be navigated without the need to consult the <CONNECTOR> objects. Once processed, these connector entries are deleted.

Step 3. Find all paths in network of DiagramElements

The application starts by finding the start event (there's only one at this point since the others were deleted along with the other pools). Then the application traverses the paths recursively in a "left-first" order, i.e. starting on the start event, for each "next" element in the path, it will calculate possible paths until all paths are found. Figure 39 shows a diagram with two examples of different paths the application can find.

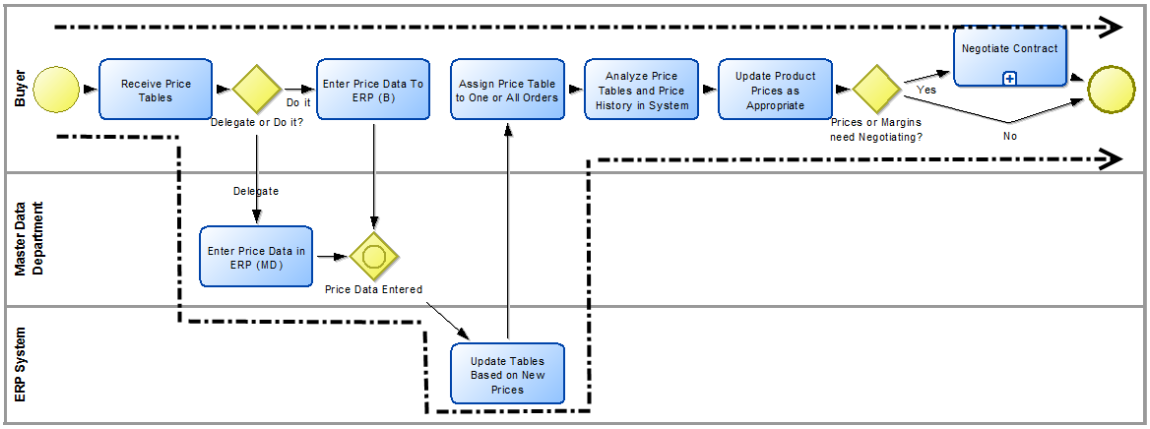


Figure 39. Detail of Handle Supplier Price Tables (sample paths in dotted lines)

Step 4. Match found paths with action sequences in logs

Finally the application opens the log text files for the actor, scrolls to the section where the totals of sequences found are listed, i.e. line "Total sequence occurrences (all days)" and tries to find those sequences one by one in the paths generated in Step 3. In order to be correctly analyzed, the log files need to be in the same format as shown in section 5.4.1.3.

4.5 BUSINESS PROCESS IMPROVEMENT

Change proposals have been gathered from the operational actors into function definition forms during the interviews in the Enterprise Survey stage. However, due to time constraints, we transport the application of these improvements suggested by the purchasing manager and the buyers into future research work.

CHAPTER 4

5. RESULTS

In this chapter we present the data produced from the research procedures applied in the methodology. We abstain from making assumptions or conclusions about the data, as that will be presented in the next chapter. The results are organized by following a section structure and titling similar to the methodology chapter. This way the reader can relate the results to the right methodology stage although direct references are occasionally used where appropriate. Not all methodology sections are represented in this chapter, only the ones that produced results.

5.1 PLANNING INITIATION

5.1.1 PREPARE AN EAP WORK PLAN

5.1.1.1 ESTIMATE THE DURATION OF EACH STEP, AND DETERMINE THE START AND COMPLETION DATES CONSIDERING THE RESOURCES ASSIGNED

After completing our methodology, it was possible to track how much time had actually been spent in each phase. Applying the methodology took four months in total instead of the five that were initially estimated. Table 9 shows a comparison between the estimated times in section 4.1.3.3 and the actual time for each of the phases.

Phase	Estimated Duration %	Actual Duration %	Estimated Time (Days)	Actual Time (Days)
Preliminary Business Model	7	20 [+13]	11	24 [+13]
Enterprise Survey	23	15 [-8]	35	18 [-17]
Work Practices Model	70	65 [-5]	105	78 [-27]

Table 9. Estimated vs. actual duration per phase in methodology (difference in "[ ]")

5.2 PRELIMINARY BUSINESS MODEL

5.2.1 DOCUMENT THE ORGANIZATIONAL STRUCTURE

5.2.1.1 GATHER RECENT ORGANIZATION CHARTS, AND ENTER THE INFORMATION INTO THE TOOLSET

Figure 40 shows a summarized version of the organograms gathered for Company X, and was developed with Microsoft Visio.

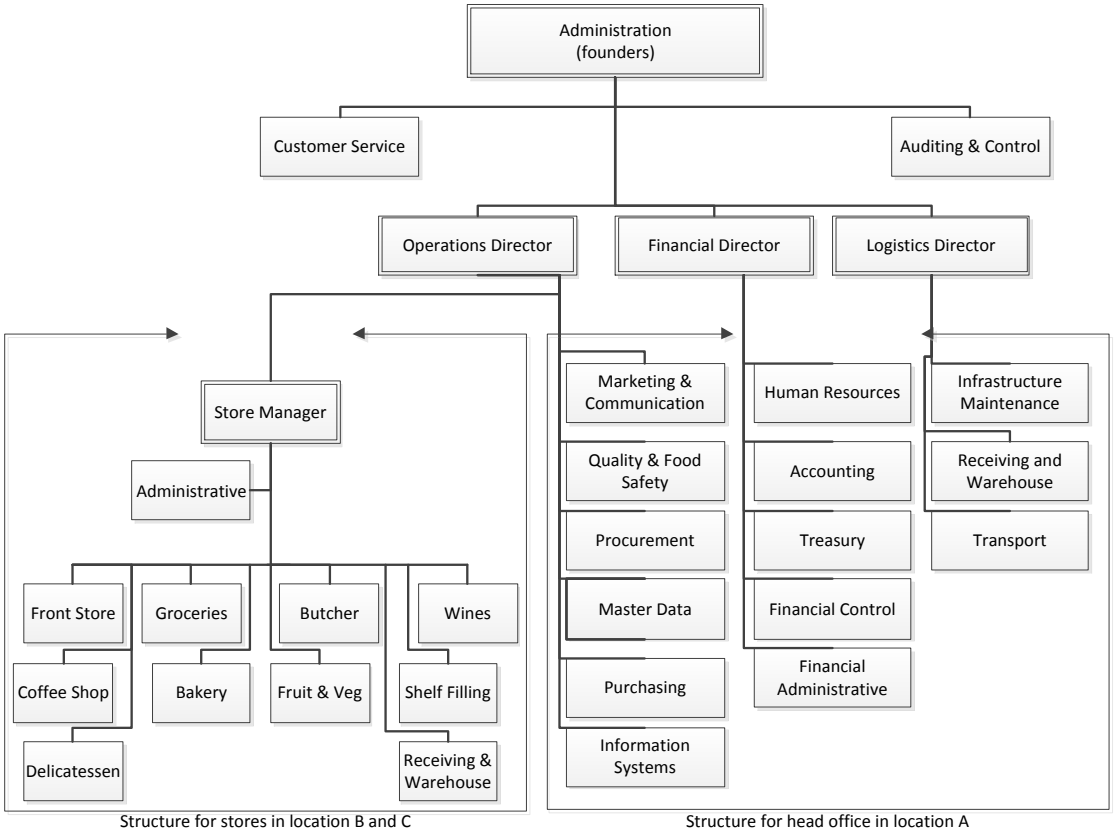


Figure 40. Organogram of Company X for its three locations (Visio)

5.2.2 IDENTIFY / DEFINE FUNCTIONS

5.2.2.1 DEFINE THE MAJOR FUNCTIONAL AREAS USING THE "VALUE-ADDED" CONCEPTS OF MICHAEL PORTER

Figure 41 shows how Company X's primary and support activities can be mapped to Porter's value chain model.

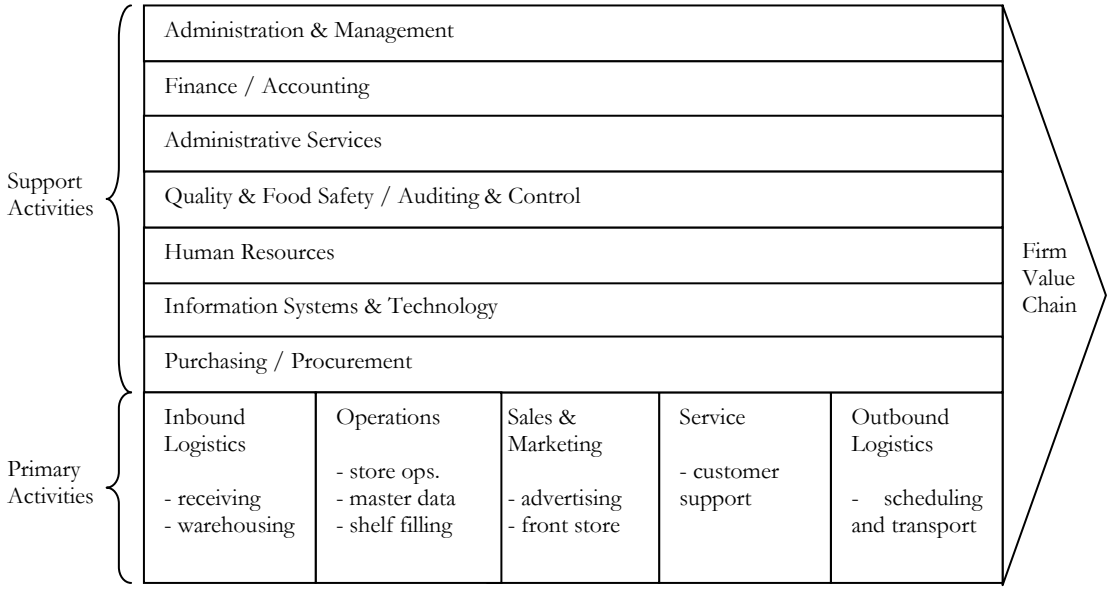


Figure 41. The Value Chain Model for Company X

5.2.2.2 (RE)ARRANGE ALL FUNCTIONS HIERARCHICALLY TO IMPROVE THE BUSINESS MODEL

Table 10 shows the result of grouping actions in the departments' activities by the objects of those actions.

Bills	**Personnel**	**Purchase**
- Introduction	- Planning	- Making
Budget	**Processes**	- Negotiating
- Planning	- Internal auditing	- Planning
Contract Rappels	**Production Orders**	**Store**
- Processing	- Creating	- Inventory
Customer	**Products**	**Store Events**
- Handle interaction	- Control when receiving	- Planning
Debit & Credit Notes	- Labeling	**Shelves**
- Issuance	- Outbound transportation	- Planning
Expenditure & Consumables	- Reporting on receiving	**Supplier**
- Management	- Transferring	- Evaluating
Payments	- Warehouse receiving	- Price table analysis
- Processing		**Subcontracting**
		- Management

Table 10. Indented structure list with decomposition of activities by object

5.2.2.3 RELATE THE DETAILED FUNCTIONS TO THE ORGANIZATION UNITS THAT PERFORM THEM, AND PRODUCE A MATRIX REPORT

Table 11 shows a matrix report relating organization unit and function for the main areas in Company X.

Function / Organization	Finance						Operations						Logistics				Mixed			Purchasing						
	Issuance of debit/credit notes	Introduction of bills	Processing payments	Processing contract rappels	Budget planning	Personnel planning	Labeling of products	Transferring products	Creating production orders	Handle customer interaction	Marketing planning	Selling	Reporting on receiving	Product control when receiving	Warehouse receiving	Outbound load transportation	Store events/shelves planning	Internal auditing	Store inventory	Purchases planning	Purchasing	Supplier evaluation	Negotiation	Expend./Consum. management	Subcontracting management	Supplier price tables analysis
Financial Director	X	X	X	X	X	X					\	\														
Operations Director					X		X	X	X	X	X	X					X	X	X							
Logistics Director					\								\	\	\	\										
I.T. & Systems Manager					\												\		X							
Marketing Manager					\						X						X									
Purchasing Manager					\									\			X			X	X	X	X	X	X	X
Accounting Manager	X	X	\	X	\																					
Treasury Manager	X	X	\		\																					
Finance Control Manager					X																					
HR Manager						X																				
Master Data Manager							X							\			\		\							X
Store Section Managers								X	X								X									
Quality Manager									X	X				\				X	X							
Store Manager										X		X					X		X							
Receiving Manager													X		X											
Warehouse Manager													\	X	X	X										
Auditing Manager																		X	X							
Administrative Manager																			X							
Buyers																				X	X	X	X	\	\	X

X Major responsibility and decision maker X Major involvement \ Some involvement

Table 11. Relation of business functions to organization units

5.2.3 DISTRIBUTE THE PRELIMINARY BUSINESS MODEL

Table 12 shows a listing that numerically identifies all activities, information sources for the purchasing department, organization units, and data entities in Company X.

N.	Activity	N.	Organization Unit	N.	Data Entity
1	Issuance of credit notes	**29**	Administration	**61**	Debit notes
2	Issuance of debit notes	**30**	Customer service	**62**	Credit notes
3	Introduction of bills	**31**	Auditing & control	**63**	Bills
4	Processing payments	**32**	Operations director	**64**	Payments
5	Processing contract rappels	**33**	Financial director	**65**	Contract rappels
6	Budget planning	**34**	Logistics director	**66**	Customer
7	Personnel planning	**35**	Store manager	**67**	Processes
8	Labeling of products	**36**	Administrative	**68**	Products
9	Transferring products	**37**	Front store	**69**	Production orders
10	Creating production orders	**38**	Coffee shop	**70**	Store
11	Handle customer interaction	**39**	Delicatessen	**71**	Store events
12	Marketing planning	**40**	Groceries	**72**	Purchase
13	Selling	**41**	Bakery	**73**	Supplier
14	Reporting on receiving	**42**	Butcher	**74**	Expenditure & Consumables
15	Product control (receiving)	**43**	Fruit & Veg	**75**	Subcontracting
16	Warehouse receiving	**44**	Wines	**76**	Budget
17	Outbound transportation	**45**	Shelf filling	**77**	Personnel
18	Store events/shelves planning	**46**	Receiving & warehouse		
19	Internal auditing	**47**	Marketing & communic.		
20	Store inventory	**48**	Quality & food safety		
21	Purchases planning	**49**	Procurement		
22	Purchasing	**50**	Master data		
23	Supplier evaluation	**51**	Purchasing		
24	Negotiate contract	**52**	Information systems		
25	Expenditure management	**53**	Human resources		
26	Subcontracting management	**54**	Accounting		
27	Store events planning	**55**	Treasury		
28	Handle supplier price tables	**56**	Financial control		
		57	Financial administrative		
		58	Infrastructure maintenan.		
		59	Receiving & warehouse		
		60	Transport		
N.	**Information Source**	**N.**	**Information Source**		
78	Sales history	**92**	Supplier evaluation		
79	Annual sales plan	**93**	Supplier eval. notification		
80	Monthly sales report	**94**	Strategic decisions		
81	Products stock report	**95**	Company goals		
82	Sales objectives	**96**	Expenses plan history		
83	Supplier delivery conditions	**97**	Expenses plan		
84	Product details form	**98**	Subcontractor contract		
85	Supplier contract details	**99**	Store aisles blueprint		
86	Warehouse receiving report	**100**	Store events plan		
87	Scheduled order	**101**	Store shelves plan		
88	Supplier formal complaint	**102**	Supplier price tables		
89	Current suppliers/products	**103**	Product price history		
90	Supplier details form	**104**	Standard stock		
91	Supplier certificate/licenses				

Table 12. Numbering of EAP elements

5.3 ENTERPRISE SURVEY

5.3.1 ENTER DATA INTO TOOLSET AND DISTRIBUTE COMPLETE BUSINESS MODEL

5.3.1.1 ANALYZE THE ENTERPRISE SURVEY INFORMATION

The information gathered in interviews shows that the most common information source, i.e. the one that is used in most functions is "Supplier contract/commercial details" (85). On the other hand, the function that uses the most information sources is "Purchasing" (22). Appendix B shows the relation between all functions and information sources whilst Appendix C shows an actual sample of a filled function form and information source form.
As for the interviewees' suggestions for improvements, the following points were gathered:

- The ERP system should allow customizing the margin percentage for each month of the year. Currently the user can only set one margin value for the entire year which introduces errors in the system when compared to the actual negotiation.
- The purchasing process is too manual. The user has to visit each product's details in the ERP system to be able to create a purchase order for up to 200 products per supplier. In the current system there is an attempt to automate orders through a Supply Chain Management module but it doesn't function properly.
- The ERP system does not have a way to clearly show the user any previous negotiations made with the suppliers.
- When creating the expenses plan, the master data department should register all consumable products into the ERP system, so that purchases for those products are created and controlled in the system, not manually as they are now.
- Communication and timing could be improved between the purchasing department and the store sections managers when creating the shelves plans for the store.
- Price tables should be sent by suppliers to Company X in the previous month to when the product is to be first ordered so that the master data department can enter all the details into the ERP system. Ideally these tables would be sent electronically and the data would be updated automatically in the ERP system.

5.3.1.2 ENTER THE DATA ON THE FORMS INTO THE TOOLSET

In this section the four more relevant diagrams from the ten developed for the purchasing department are displayed. In these examples, the purchasing process is represented by two

diagrams, Figure 42 and Figure 43. The Negotiate Contract process is shown in Figure 44 and the Handle Supplier Price Tables process in Figure 45.

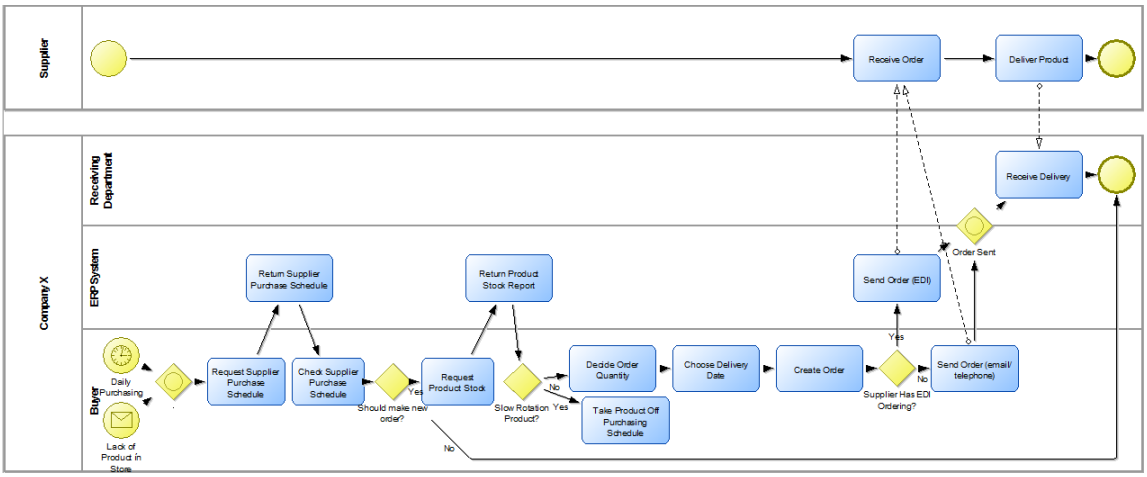


Figure 42. Diagram of Purchasing process

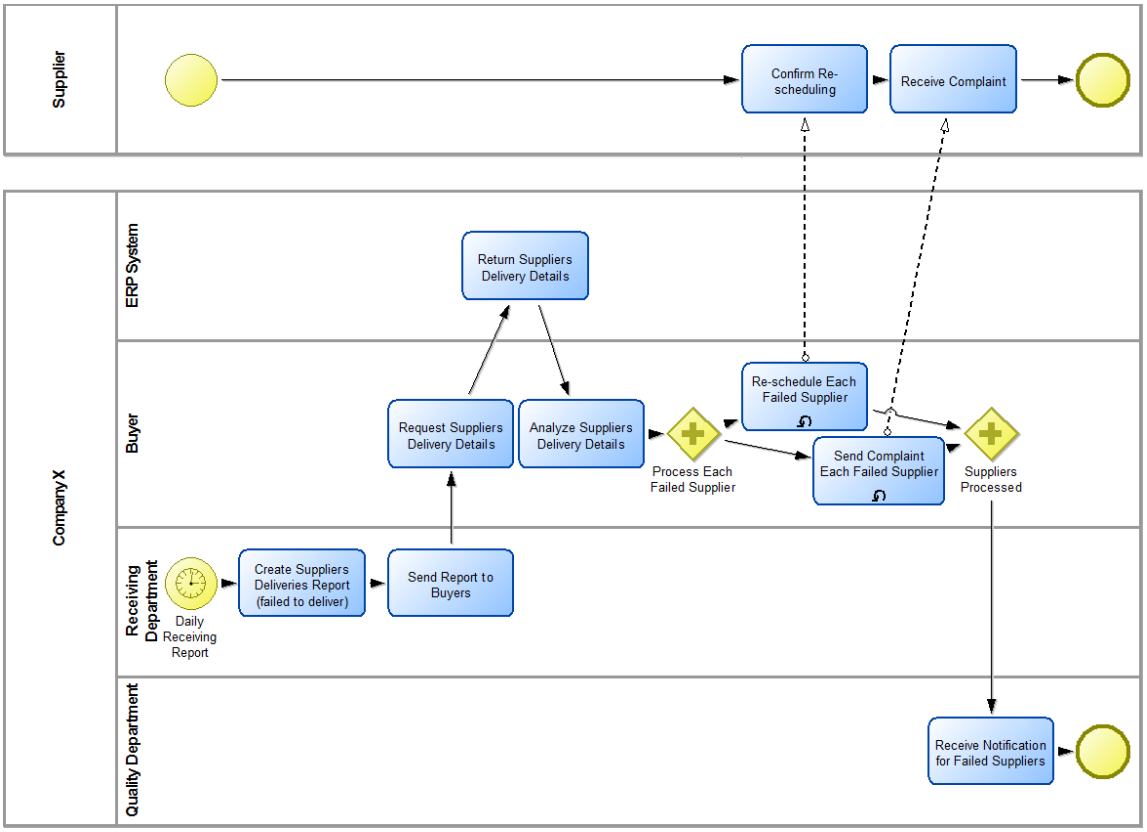


Figure 43. Diagram of Purchasing (Delivery Control) process

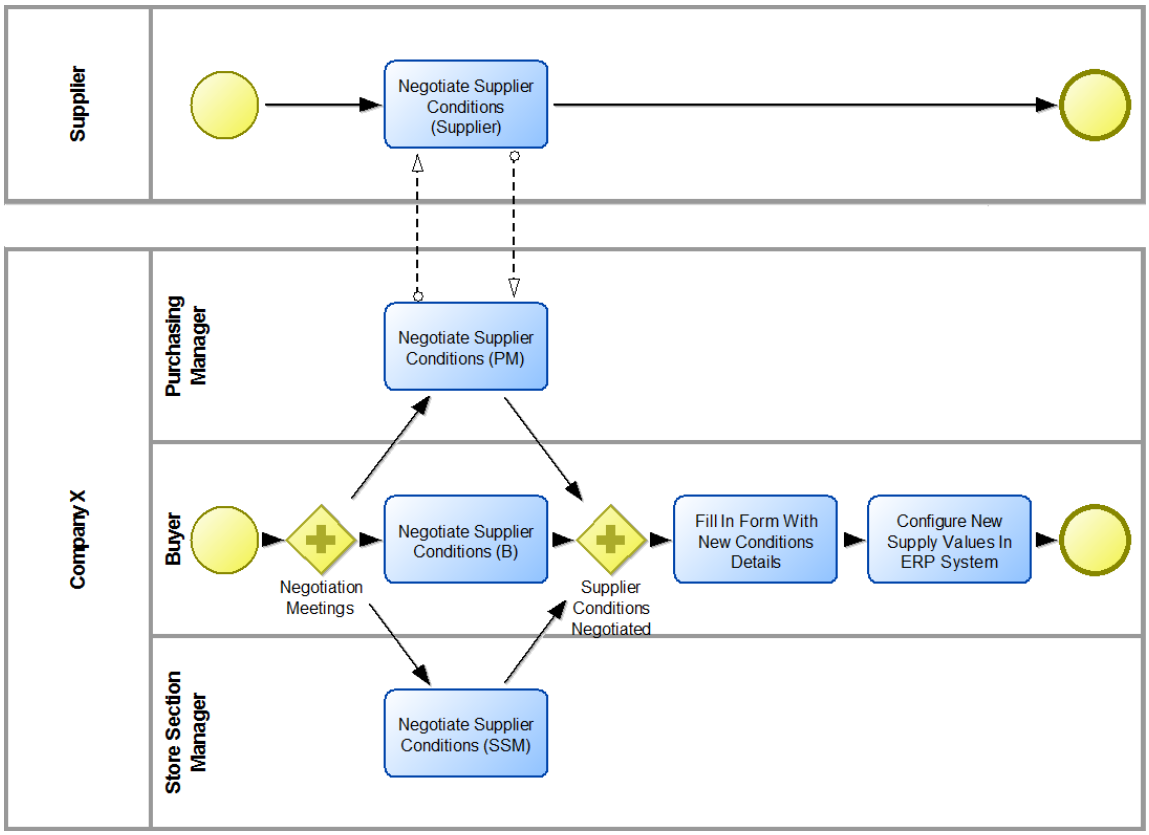


Figure 44. Diagram of Negotiate Contract process

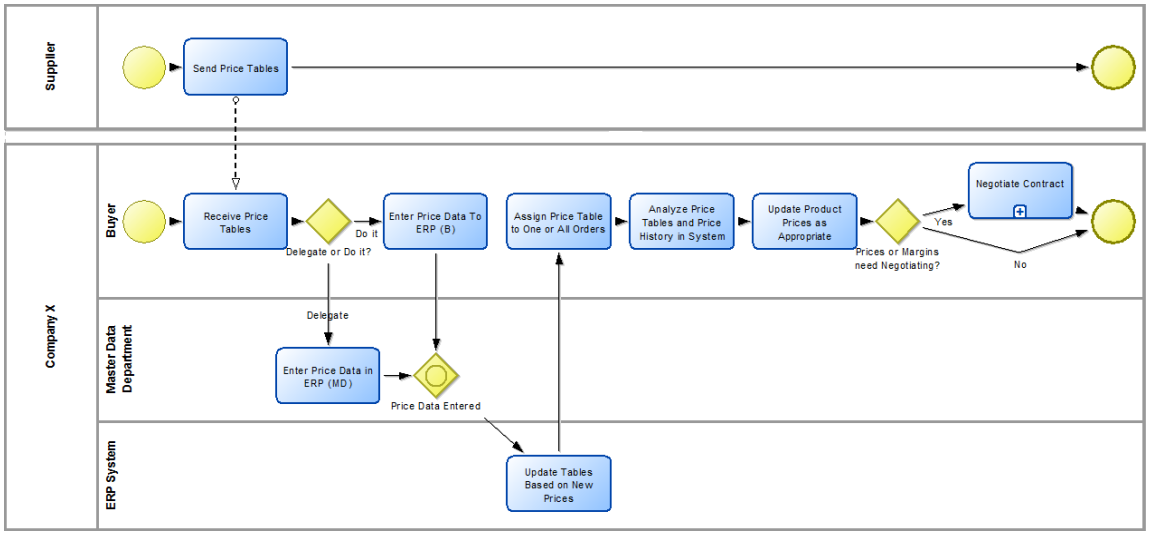


Figure 45. Diagram of Handle Supplier Price Tables process

5.4 WORK PRACTICES MODEL

5.4.1 PROCESS THE INFORMATION IN THE LOGS

5.4.1.1 FIND SIMPLE PATTERNS OF ACTION SEQUENCES IN THE LOGS

Before analyzing the logs, they were ordered by day and time, and duplicate entries were removed. For instance, in Figure 46 from 11:32 two repeated entries of activity "A" appear, so the second was removed. For this analysis' purpose, doing the same activity twice can be considered to be doing that same activity, only for a longer period of time.

Let's take Helen's logs for the 16th of July (Figure 46) as an example. First we started by finding all sequences of two actions that existed, starting from the top (remember we removed the duplicate "A" action). The resulting sequences were: `<A><I>, <I><E>, <E><A>, <A><E>, <E><A>, <A><C>, <C><O>, <O><E>.` Then, we counted how many times each sequence happened on that day: `<A><I> = 1, <I><E> = 1, <E><A> = 2, <A><E> = 1, <A><C> = 1, <C><O> = 1, <O><E> = 1.`

Day(input)	Actual time	Activity	Activity (detail)	Received from	Sent to
16-Jul	09:26	A) Purchase	A.6 Schedule	ERP	supplier
16-Jul	10:06	I) Logistics Forms	I.1 Filling in	supplier	master data
16-Jul	10:07	E) Send E-mails	E.1.7 Logistics forms	master data	supplier
16-Jul	10:25	A) Purchase	A.6 Schedule	ERP	supplier
16-Jul	11:31	E) Send E-mails	E.2.3 Transfer between stores	ERP	store colleagues
16-Jul	11:32	A) Efectuar Encomendas	A.6 Schedule	ERP	supplier
16-Jul	13:33	A) Efectuar Encomendas	A.6 Schedule	ERP	supplier
16-Jul	12:30	C) Phone Call	C.4 Receiving	receiving	ERP
16-Jul	12:30	O) Transfers	O.1 Identify product transfer need	receiving	ERP
16-Jul	12:30	E) Send E-mails	E.4 Receiving	ERP	receiving

Figure 46. Helen's logs for the 16th of July

5.4.1.2 TOLERATING INTERRUPTIONS WHEN LOOKING FOR SEQUENCES

The sequence that happened the most in Helen's log for the 16th of July was `<E><A>` (see Figure 46), with two occurrences during the day. However let's count how many times each sequence occurs in Helen's day, if we allow an interruption of one action in between the actions of the current sequence:

`<A><?><I> = 0, <I><?><E> = 0, <E><?><A> = 0, <A><?><E> = 1,`
`<A><?><C> = 0, <C><?><O> = 0, <O><?><E> = 0`

We see that <E><A> is no longer the most common sequence. In fact it doesn't occur when interruptions of one action are tolerated.

The only sequence that was still found when tolerating one interruption was <A><E>, and the match was <A><I><E>, with <I> being the interrupting action.

If we extend the length of the interruption to two we find the following occurrences:

<A><?><?><I> = 0, <I><?><?><E> = 1, <E><?><?><A> = 1, <A><?><?><E> = 1,
<A><?><?><C> = 1, <C><?><?><O> = 0, <O><?><?><E> = 0

And if we extend the length of the sequence to three and also allow interruptions of one action, we get the following sequences of three:

<A><I><E>,<I><E><A>,<E><A><E>,<A><E><A>,<E><A><C>,<A><C><O>,<C><O><E>

And the following occurrences for interrupted sequences:

<A><I><E> = 1, <A><I><?><E> = 0, <A><?><I><E> = 0, <A><?><I><?><E> = 0
<I><E><A> = 1, <I><E><?><A> = 0, <I><?><E><A> = 0, <I><?><E><?><A> = 0
<E><A><E> = 1, <E><A><?><E> = 0, <E><?><A><E> = 0, <E><?><A><?><E> = 0
<A><E><A> = 1, <A><E><?><A> = 0, <A><?><E><A> = 1, <A><?><E><?><A> = 0
<E><A><C> = 1, <E><A><?><C> = 0, <E><?><A><C> = 0, <E><?><A><?><C> = 0
<A><C><O> = 1, <A><C><?><O> = 0, <A><?><C><O> = 0, <A><?><C><?><O> = 0
<C><O><E> = 1, <C><O><?><E> = 0, <C><?><O><E> = 0, <C><?><O><?><E> = 0

5.4.1.3 AUTOMATE THE PROCESS OF FINDING SEQUENCES

The following is a sample output produced by our sequence finder tool after analyzing Helen's logs, and being configured to find sequences of two actions with up to one interruption. The output starts by showing the action sequences that were found with the chosen length. Then it counts how many times they exist in the logs for each day. It also accounts for ocurrences of those sequences including interruptions in case the user chose to include so. Finally it summarizes the sequences total occurrences for all days.

```
Filename: logs 2012-07-15 16-18Jul Helen.xls
Sequence length to find (No. of actions): 2
Max interruption length (No. of actions): 1

Interruption patterns to interleave with actions (1 = interruption, 0 = no int., a = action)
--------------------------------------------------------------------------------
a 0 a
a 1 a

--------------------------------------------------------------------------------
Day: 16
--------------------------------------------------------------------------------
Sequences of length 2 found in day
--------------------------------------------------------------------------------
<A) Efectuar Encomendas> <I) Fichas Logísticas>
<I) Fichas Logísticas>   <E) Enviar E-mails>
<E) Enviar E-mails>      <A) Efectuar Encomendas>
<A) Efectuar Encomendas> <E) Enviar E-mails>
```

```
<A) Efectuar Encomendas> <C) Atender Telefone>
<C) Atender Telefone>    <O) Transferências>
<O) Transferências>      <E) Enviar E-mails>

Sequence occurrences in day (considering up to one interruption)
-------------------------------------------------------------------------------
Matches in day: 1 Sequence:<A) Efectuar Encomendas>     <I) Fichas Logísticas>
Matches in day: 0 Sequence:<A) Efectuar Encomendas> <?> <I) Fichas Logísticas>
Matches in day: 1 Sequence:<I) Fichas Logísticas>       <E) Enviar E-mails>
Matches in day: 0 Sequence:<I) Fichas Logísticas>   <?> <E) Enviar E-mails>
Matches in day: 2 Sequence:<E) Enviar E-mails>          <A) Efectuar Encomendas>
Matches in day: 0 Sequence:<E) Enviar E-mails>      <?> <A) Efectuar Encomendas>
Matches in day: 1 Sequence:<A) Efectuar Encomendas>     <E) Enviar E-mails>
Matches in day: 1 Sequence:<A) Efectuar Encomendas> <?> <E) Enviar E-mails>
Matches in day: 1 Sequence:<A) Efectuar Encomendas>     <C) Atender Telefone>
Matches in day: 0 Sequence:<A) Efectuar Encomendas> <?> <C) Atender Telefone>
Matches in day: 1 Sequence:<C) Atender Telefone>        <O) Transferências>
Matches in day: 0 Sequence:<C) Atender Telefone>    <?> <O) Transferências>
Matches in day: 1 Sequence:<O) Transferências>          <E) Enviar E-mails>
Matches in day: 0 Sequence:<O) Transferências>      <?> <E) Enviar E-mails>

Total sequence occurrences per day (considering with and without interruptions)
-------------------------------------------------------------------------------
Day: 16
Total Matches: 1 Sequence: <A) Efectuar Encomendas> <I) Fichas Logísticas>
Total Matches: 1 Sequence: <I) Fichas Logísticas>   <E) Enviar E-mails>
Total Matches: 2 Sequence: <E) Enviar E-mails>      <A) Efectuar Encomendas>
Total Matches: 2 Sequence: <A) Efectuar Encomendas> <E) Enviar E-mails>
Total Matches: 1 Sequence: <A) Efectuar Encomendas> <C) Atender Telefone>
Total Matches: 1 Sequence: <C) Atender Telefone>    <O) Transferências>
Total Matches: 1 Sequence: <O) Transferências>      <E) Enviar E-mails>

-------------------------------------------------------------------------------
Day: 17 (… omitted in this sample …)
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
Day: 18 (… omitted in this sample …)
-------------------------------------------------------------------------------

Total sequence ocurrences (all days with and w/out interruptions – 16th to 18th)
-------------------------------------------------------------------------------
Total Matches: 1 Sequence: <A) Efectuar Encomendas>  <I) Fichas Logísticas>
Total Matches: 1 Sequence: <I) Fichas Logísticas>    <E) Enviar E-mails>
Total Matches: 4 Sequence: <E) Enviar E-mails>       <A) Efectuar Encomendas>
Total Matches: 5 Sequence: <A) Efectuar Encomendas>  <E) Enviar E-mails>
Total Matches: 3 Sequence: <A) Efectuar Encomendas>  <C) Atender Telefone>
Total Matches: 1 Sequence: <C) Atender Telefone>     <O) Transferências>
Total Matches: 1 Sequence: <O) Transferências>       <E) Enviar E-mails>
Total Matches: 2 Sequence: <E) Enviar E-mails>       <I) Fichas Logísticas>
Total Matches: 1 Sequence: <I) Fichas Logísticas>    <C) Atender Telefone>
Total Matches: 2 Sequence: <C) Atender Telefone>     <A) Efectuar Encomendas>
Total Matches: 2 Sequence: <E) Enviar E-mails>       <C) Atender Telefone>
Total Matches: 2 Sequence: <C) Atender Telefone>     <E) Enviar E-mails>
Total Matches: 2 Sequence: <E) Enviar E-mails>       <B) Receber Fornecedores>
Total Matches: 1 Sequence: <B) Receber Fornecedores> <I) Fichas Logísticas>
Total Matches: 1 Sequence: <I) Fichas Logísticas>    <N) Reforçar Produtos>
Total Matches: 1 Sequence: <N) Reforçar Produtos>    <E) Enviar E-mails>
Total Matches: 1 Sequence: <B) Receber Fornecedores> <A) Efectuar Encomendas>
```

5.4.2 MATCH ACTION SEQUENCES BETWEEN FORMS AND LOGS

5.4.2.1 MANUAL RELATION BETWEEN FORMS (DIAGRAMS) AND LOGS

Of the ten diagrams representing the purchasing department processes, we found matching tasks and sequences with the logs in four of them. These were "Purchasing" (Figure 42),

"Purchasing (delivery control)" (Figure 43), "Negotiate Contract" (Figure 44) and "Handle Supplier Price Tables" (Figure 45). Table 13 shows the match we found and defined between tasks in the process diagrams and the activities captured in the logs.

Task in Process Diagram	Associated Activity in Log
Negotiate Supplier Conditions	B) Receber Fornecedores (meet w/ suppliers)
Fill In Form With New Conditions Details	I) Fichas Logísticas (logistics forms)
Analyze Suppliers Delivery Details	H) Relatório Recebimento (receiving report)
Re-schedule Each Failed Supplier	A) Efectuar Encomendas (purchase)
Create Order	A) Efectuar Encomendas (purchase)
Send Order (e-mail/telephone)	E) Enviar E-mails (send e-mails)
Create Order	N) Reforçar Produtos (reinforce stocks)
Request Product Stock	I) Fichas Logísticas (logistics forms)
Receive Price Tables	I) Fichas Logísticas (logistics forms)
Analyze Price Tables and Product History	L) Análise de Cardex (product listing analysis)

Table 13. Manual association between process tasks and activities in logs

Tasks in the diagrams that matched activities in the logs and formed a sequence were then looked up in the logs and resulted in the findings illustrated in Table 14, Table 15, Table 16 and Table 17. Section 5.4.1.3 shows an example of the processed data in the logs where each sequence occurrences were counted.

Sequence	Barry	Helen	Martin	Paula
<B><I>	3	1	0	0

Table 14. Count of sequence matches in logs per user (Negotiate Contract)

Sequence	Barry	Helen	Martin	Paula
<A><E>	1	3	0	3
<N><E>	0	1	0	0
<I><L>	0	0	1	0

Table 15. Count of sequence matches in logs per user (Purchasing)

Sequence	Barry	Helen	Martin	Paula
<H><A>	0	0	0	1

Table 16. Count of sequence matches in logs per user (Purchasing/Delivery Control)

Sequence	Barry	Helen	Martin	Paula
<I><L>	0	0	1	0

Table 17. Count of sequence matches in logs per user (Handle Supplier Price Tables)

All matching sequences between the diagrams in the model and the logs have only two actions. That is how far the similarity between the diagrams and the logs goes. Longer sequences of the activities in the logs could not be matched in the diagrams.

Even though we cannot find longer sequences, we have a way of increasing the number of matches per sequence. Changing the number of tolerated interruptions in the action sequence had an impact on the number of found matches for most sequences (see section 4.4.4.4 for more information about interruptions).

Sequence/ User	0 inter.	1 inter.	2 inter.	3 inter.	4 inter.
<B><I>/Barry	3	4	5	7	7
<B><I>/Helen	1	1	1	1	1
<H><A>/Paula	1	1	2	2	2
<A><E>/Barry	1	1	2	2	3
<A><E>/Helen	3	5	6	7	10
<A><E>/Paula	3	3	4	4	5
<N><E>/Helen	1	1	1	1	1
<I><L>/Martin	1	1	1	1	1

Table 18. Count of sequence matches per user (w/ tolerated interruptions)

The results found in Table 18 and further illustrated in Figure 47 show that generally the more interruptions we allow interleaving the sequences, the more times we will find them in the logs. This is normal because this counting is cumulative between interrupted and non-interrupted sequences and as the actions get repeated throughout the day, the more likely it is to find a match. In order to understand if these interruptions are in fact part of the process or really just exceptions in the sequence it would help to analyze the context of the actions found. This could be performed by using context discovery techniques presented by Marielba Zacarias (Zacarias, 2008) but is beyond the scope of this study and is thus considered future work.

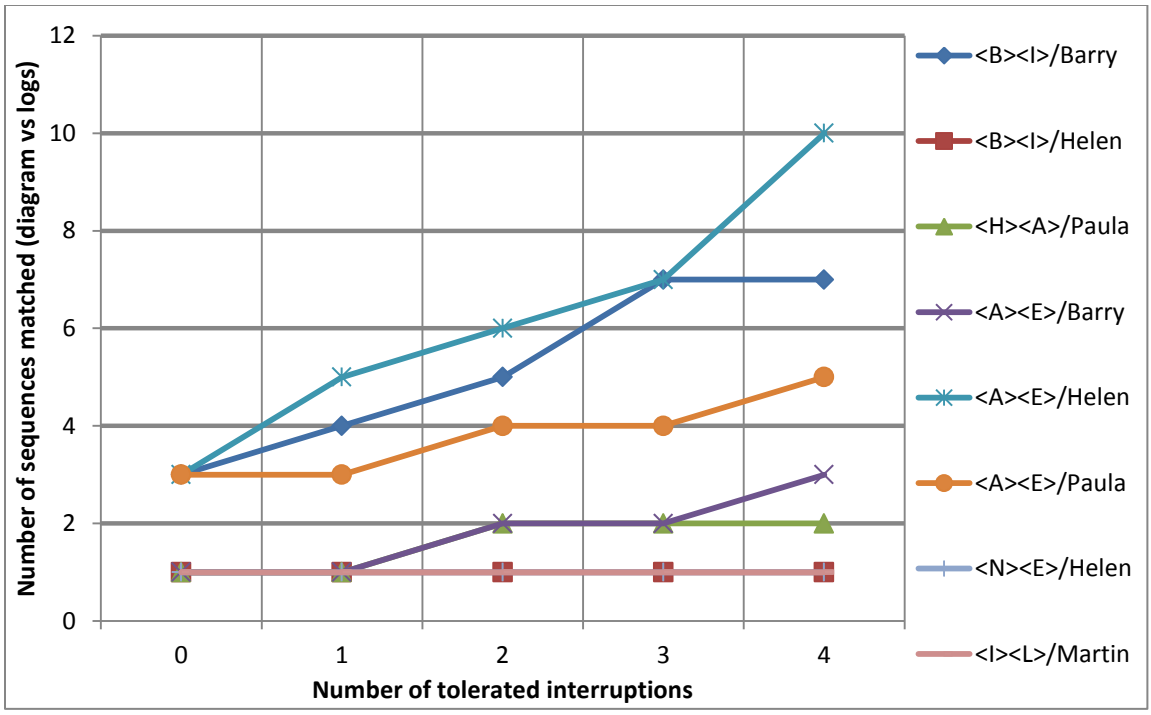


Figure 47. Graph showing proportional increase (sequence match vs interruptions)

5.4.2.2 AUTOMATE THE RELATION BETWEEN FORMS (DIAGRAMS) AND LOGS

The results obtained in an automated way are the same as the ones obtained manually in section 5.4.2.1. This is expected, after all the objective of automating the process was not to find different results, but instead to make it easier to find the results. In this context easier means saving time and work, thus reducing the probability of human error.

For instance, let's take the matches obtained manually between the logs and the Purchasing diagram (Figure 42). When we run the application for each user and count the matching sequences for that specific diagram, we get the output illustrated in Figure 48 through to Figure 51. In summary these figures show that both Barry's and Paula's action sequence <A><E> was found in the Purchasing diagram on path number 3. Helen's <A><E> sequence was found on path number 3 as well, but besides that, the application also found the <N><E> sequence match for her. Finally the application found Martin's sequence <I><L> on path number 0. The sequences found in the diagram for each user are the same as the ones shown in Table 15.

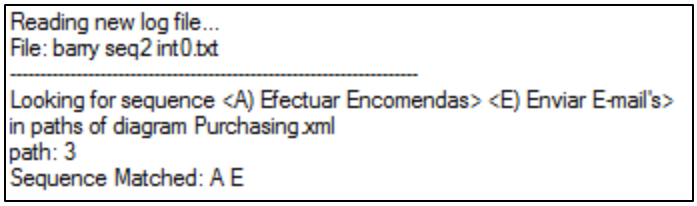


Figure 48. Automated finding of Barry's sequences in purchasing diagram (sample)

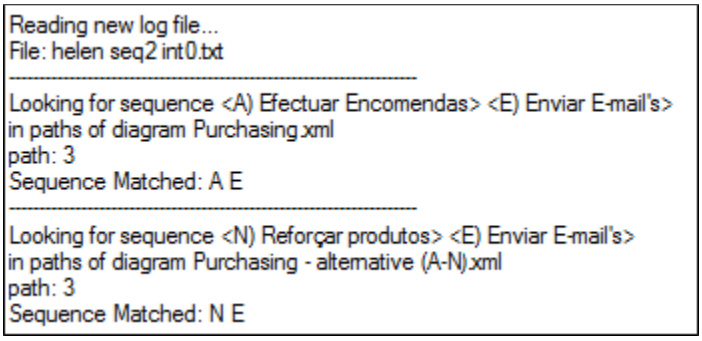


Figure 49. Automated finding of Helen's sequences in purchasing diagram (sample)

Figure 50. Automated finding of Martin's sequences in purchasing diagram (sample)

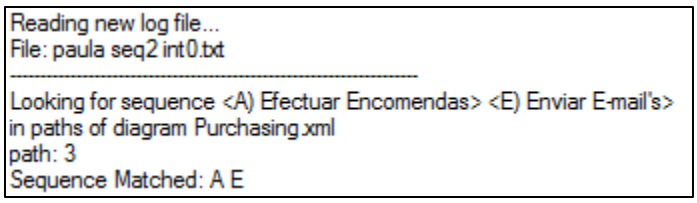


Figure 51. Automated finding of Paula's sequences in purchasing diagram (sample)

The paths where the action sequences were found in the diagrams were generated by the application as well. In the results above, sequences were found on paths 0 and 3 of the Purchasing diagram. Figure 52 and Figure 53 show and identify all paths found for that diagram as they appear in the output of the program. Each new path starts with the number identifying it (e.g. "path 0") and inside the path, each task is separated with a full stop symbol ".". BPMN elements with empty names (e.g. converging gateways) appear only as a full stop in the path. To start the paths, we just searched for the start event in the XML and navigated the diagrams from there.

Printing out all diagram paths for diagram: Purchasing.xml

path 0: Daily Purchasing. . Request Supplier Purchase Schedule. Return Supplier Purchase Schedule. Check Supplier Purchase Schedule. Should make new order?. I) Request Product Stock. Return Product Stock Report. L) Slow Rotation Product?. Take Product Off Purchasing Schedule.
path 1: Daily Purchasing. . Request Supplier Purchase Schedule. Return Supplier Purchase Schedule. Check Supplier Purchase Schedule. Should make new order?. End Event.
path 2: Daily Purchasing. . Request Supplier Purchase Schedule. Return Supplier Purchase Schedule. Check Supplier Purchase Schedule. Should make new order?. I) Request Product Stock. Return Product Stock Report. L) Slow Rotation Product?. Decide Order Quantity. Choose Delivery Date. A) Create Order. Supplier Has EDI Ordering?. Send Order (EDI). Order Sent. Receive Delivery. End Event.
path 3: Daily Purchasing. . Request Supplier Purchase Schedule. Return Supplier Purchase Schedule. Check Supplier Purchase Schedule. Should make new order?. I) Request Product Stock. Return Product Stock Report. L) Slow Rotation Product?. Decide Order Quantity. Choose Delivery Date. A) Create Order. Supplier Has EDI Ordering?. E) Send Order (email/telephone). Order Sent. Receive Delivery. End Event.

Figure 52. Paths identified for purchasing diagram (purchasing.xml)

Printing out all diagram paths for diagram: Purchasing - alternative (A-N).xml

path 0: Daily Purchasing. . Request Supplier Purchase Schedule. Return Supplier Purchase Schedule. Check Supplier Purchase Schedule. Should make new order?. I) Request Product Stock. Return Product Stock Report. L) Slow Rotation Product?. Take Product Off Purchasing Schedule.
path 1: Daily Purchasing. . Request Supplier Purchase Schedule. Return Supplier Purchase Schedule. Check Supplier Purchase Schedule. Should make new order?. End Event.
path 2: Daily Purchasing. . Request Supplier Purchase Schedule. Return Supplier Purchase Schedule. Check Supplier Purchase Schedule. Should make new order?. I) Request Product Stock. Return Product Stock Report. L) Slow Rotation Product?. Decide Order Quantity. Choose Delivery Date. N) Create Order. Supplier Has EDI Ordering?. Send Order (EDI). Order Sent. Receive Delivery. End Event.
path 3: Daily Purchasing. . Request Supplier Purchase Schedule. Return Supplier Purchase Schedule. Check Supplier Purchase Schedule. Should make new order?. I) Request Product Stock. Return Product Stock Report. L) Slow Rotation Product?. Decide Order Quantity. Choose Delivery Date. N) Create Order. Supplier Has EDI Ordering?. E) Send Order (email/telephone). Order Sent. Receive Delivery. End Event.

Figure 53. Paths identified for purchasing diag. (purchasing - alternative (A-N).xml)

CHAPTER 5

6. DISCUSSION

In this chapter we examine our findings, interpret the data and try to understand what went wrong and how we could improve based on what was learned. Again we opted to follow a section structure similar to the one in the methodology and results chapters, making it easier for the reader to understand the context of the discussions and which methods or results they are related to.

6.1 PLANNING INITIATION

6.1.1 DETERMINE SCOPE AND OBJECTIVES FOR EAP

6.1.1.1 DEFINE THE SCOPE OF ENTERPRISE

Although not completely unexpected, in retrospective we now understand how focusing on the purchasing department made it harder to get a complete view of that department. Even without studying a whole company, the analysis of other departments could have helped us in understanding this single department through the capture of interactions with others.

6.1.1.2 EVALUATE FAVORABLE VERSUS UNFAVORABLE CHARACTERISTICS

Based on the results in Table 3 (page 58), Company X appears to be a good candidate for developing an EAP project, having plenty more favorable characteristics than unfavorable ones.

6.1.2 PREPARE AN EAP WORK PLAN

6.1.2.1 ESTIMATE THE DURATION OF EACH STEP, AND DETERMINE THE START AND COMPLETION DATES CONSIDERING THE RESOURCES ASSIGNED

The actual time it took to complete the methodology after the planning initiation stage was substantially different from the time we had estimated, as seen in Table 9 (page 90). It's interesting to understand why some phases took proportionally more time than expected. For instance, the preliminary business model phase took more 13% of time than the estimated while the enterprise survey took less 8%. We believe these two phases counter balanced because we invested more time in finding and gathering documentation of

Company X to create a preliminary business model (PBM), and consequently we had to spend less time in interviews (enterprise survey). Another reason why the PBM took more time when it should have taken less than the enterprise survey is because while we gathered documentation that covered the whole company, when making the interviews we only focused on one department.

6.1.2.2 ESTIMATE THE COSTS AND BUDGET IMPACT OF THE PROJECT

Although we proved that we can apply our methodology at a low cost to companies (see section 4.1.3.4), it is also true that if we wanted to study more departments at the same time the amount of work necessary would certainly require the formation of a team instead of a single individual. Also, the more departments involved the more data that would need to be entered into the toolset and analyzed. With this increase in complexity, tools for organizing enterprise architecture artifacts become more of a necessity and represent a cost as well.

6.2 PRELIMINARY BUSINESS MODEL

6.2.1 IDENTIFY / DEFINE FUNCTIONS

6.2.1.1 DEFINE THE MAJOR FUNCTIONAL AREAS USING THE "VALUE-ADDED" CONCEPTS OF MICHAEL PORTER

Company X's functional areas fitted perfectly into Porter's generalist model of the value-added chain (see Figure 41, page 92). Although we couldn't take much advantage of this model as we were studying a single department, this fitting assured us that the purchasing department was indeed one of the functional areas where the company should focus to improve service and product value.

6.2.1.2 (RE)ARRANGE ALL FUNCTIONS HIERARCHICALLY TO IMPROVE THE BUSINESS MODEL

As shown in Table 10 (page 92), grouping actions by object allows us to understand the main things around which activities revolve. The object "products" is the one with the most related actions (labeling, transferring, reporting, controlling, receiving, and transporting). What this means is that by improving these processes around this object, the company will be able to add value to the products in its value chain. On the other hand, the object "store

events" doesn't attract so much attention or activities, thus meaning that it isn't regarded as important as the products.

6.2.1.3 RELATE THE DETAILED FUNCTIONS TO THE ORGANIZATION UNITS THAT PERFORM THEM, AND PRODUCE A MATRIX REPORT

It became clear from the information in Table 11 (page 93) that in Company X different directors use different delegation strategies. For instance, the financial director has major responsibility and involvement in almost all financial functions, but on the other hand the logistics director delegates a lot more to his subordinates, in this case the warehouse managers. As for the purchasing functional area, it's the purchasing manager that holds major responsibility and decision making for most activities in the department, with the exception of actual purchasing and negotiating where his subordinates, i.e. the buyers, are allowed to make decisions. The table also showed that the function of budget planning is the one that involves most organizational units across the company.

6.2.2 DISTRIBUTE THE PRELIMINARY BUSINESS MODEL

Identifying all EAP elements with numbers as shown in Table 12 (page 94) was of paramount importance to be able to organize and track those elements along this study and refer back to them when needed. Numbering them also gave us a better notion of the quantity of elements with which we were actually working with.

6.3 ENTERPRISE SURVEY

6.3.1 PERFORM THE INTERVIEWS

6.3.1.1 PERFORM EACH INTERVIEW AT THE SCHEDULED TIME

Looking back on the timing of the interviews, we must understand that being Company X a seasonal retail business, it tends to be the busiest during summer. The dates we scheduled the interviews for kept dropping off the interviewees' priorities list and a lot of persistence was needed to actually go through with the interviews. If we had had the chance of choosing another season of the year, it would have helped this scheduling to go smoother.

6.3.1.2 FILL IN THE FUNCTION DEFINITION FORMS DURING THE INTERVIEW

When filling in the forms in the interviews, I found that for some questions I only needed to take a couple of notes to work as a reminder while for other more complex answers I had to make a small pause to write down the whole answer. To speed up gathering information in the interviews, we believe using a voice recorder would have helped because we could mostly just make the questions and save some writing time in the interview.

6.3.1.3 OBTAIN A SAMPLE COPY OF EACH INFORMATION SOURCE

The gathered samples were useful to understand how the information sources were used and what they were in essence.

6.3.1.4 AT THE END OF AN INTERVIEW, SUMMARIZE WHAT HAS BEEN WRITTEN, SCHEDULE A FOLLOW-UP SESSION IF NECESSARY, AND CONFIRM COPIES OF SOURCES THAT THE INTERVIEWEE WILL PROVIDE

What helped us in this step was that we already had the function and information source forms partially filled in digital format already so it was easier to add information to them without having to start from scratch. Only the interviewees' answers and notes were handwritten during the interview and then processed afterwards. We decided not to use the laptop to type in the answers during the meetings as we felt using a pen would give us more freedom if drawings were needed, and speed also. Short handwritten notes are usually faster to write or cross than formatted text on the computer.

6.3.2 ENTER DATA INTO TOOLSET AND DISTRIBUTE COMPLETE BUSINESS MODEL

6.3.2.1 ANALYZE THE ENTERPRISE SURVEY INFORMATION

Our results show that the most used information source is "Supplier contract/commercial details" (85) and the function using most sources is "Purchasing" (22). This means that if we want to maximize the benefits from an optimization effort, one should start by focusing on improving the purchasing process and the format and accuracy in this information source.
As for the suggested improvements by the interviewees, it's clear that most issues revolve around the ERP system. Either by implementing more features, fixing the bugs or replacing the ERP system altogether, that should be a focal point in improving the purchasing department processes.

6.3.2.2 ENTER THE DATA ON THE FORMS INTO THE TOOLSET

We came to realize that some of the activities captured in the forms during the interviews with the purchasing department were actually macro activities that included more than one activity and thus could be divided in two processes. For that reason, from the eight documented processes in the purchasing department, ten BPMN diagrams were created. An example of such division happened for the Purchasing process, which we divided into two separate diagrams: 1) the actual creation and sending of the order to the supplier (Figure 42, page 96), and 2) controlling that the purchased products were correctly delivered (Figure 43, page 96). The Negotiate Contract process (Figure 44, page 97) depicts meetings of several people not only between Company X and the supplier, but also among employees inside the company itself. The Handle Supplier Price Tables process (Figure 45, page 97) shows an example of delegation when the Buyer decides whether he will enter the price data into the ERP or let the master data department do it. It also includes the Negotiate Contract sub-process that is executed in case the prices need negotiating with the supplier.

6.4 WORK PRACTICES MODEL

6.4.1 CAPTURE LOGS OF WORK PRACTICES

The form we developed in Excel to capture the logs was easy enough to use that we could present it to the purchasing department users on the same morning they would start using it. That is exactly what we did and it went well as they started capturing logs immediately.

On a daily basis we went to check if they were experiencing any problems with the tool or if there was something they didn't understand. This was important to maintain a level of importance to what we had asked them to do, and also to act as a reminder.

From the feedback we got, the impact of capturing the logs didn't conflict too badly with their work since they didn't have to think too much about what they were doing, only choose from a list. Each activity only took them a couple of seconds to log.

6.4.2 PROCESS THE INFORMATION IN THE LOGS

6.4.2.1 FIRST ANALYSIS TO WHAT WAS CAPTURED IN THE LOGS

During a period of three days of logs captured, Barry added 47 records to his list (15.6 per day), Helen added 32 records (10.6 per day) and Martin added 49 (16.3 per day).

Interestingly enough, Paula scored the lowest even after asking her to record for more time in a total of approximately four days. She added 34 records (8.5 per day).

A sample log obtained from Martin is shown in Figure 54. His full log was analyzed for creating a report of: his activity distribution along the days (Figure 55); who he received information from (Figure 56); and who he sent information to (Figure 57).

Day(input)	Day(system)	Time(input)	Time(system)	Activity	Activity (detail)	Received from	Sent to
18-Jul	18-Jul	08:33	08:34	E) Send E-mails	E.1.8 Cycles/Promotionals	ERP	supplier
18-Jul	18-Jul	08:34	08:49	E) Send E-mails	E.2.5 Information/products/store events	ERP	store colleagues
18-Jul	18-Jul	08:49	08:53	C) Phone Call	C.2 Store colleagues	store colleagues	store colleagues
18-Jul	18-Jul	08:53	09:25	P) Brochure Analysis	P.2 Compare to prices in system	others	others
18-Jul	18-Jul	09:25	10:05	B) Meet w/ Suppliers	B.1 Negotiate actions/discounts/promotions	ERP	supplier
18-Jul	18-Jul	11:49	11:51	C) Phone Call	C.1 Suppliers	supplier	supplier

Figure 54. Sample of log captured by Martin

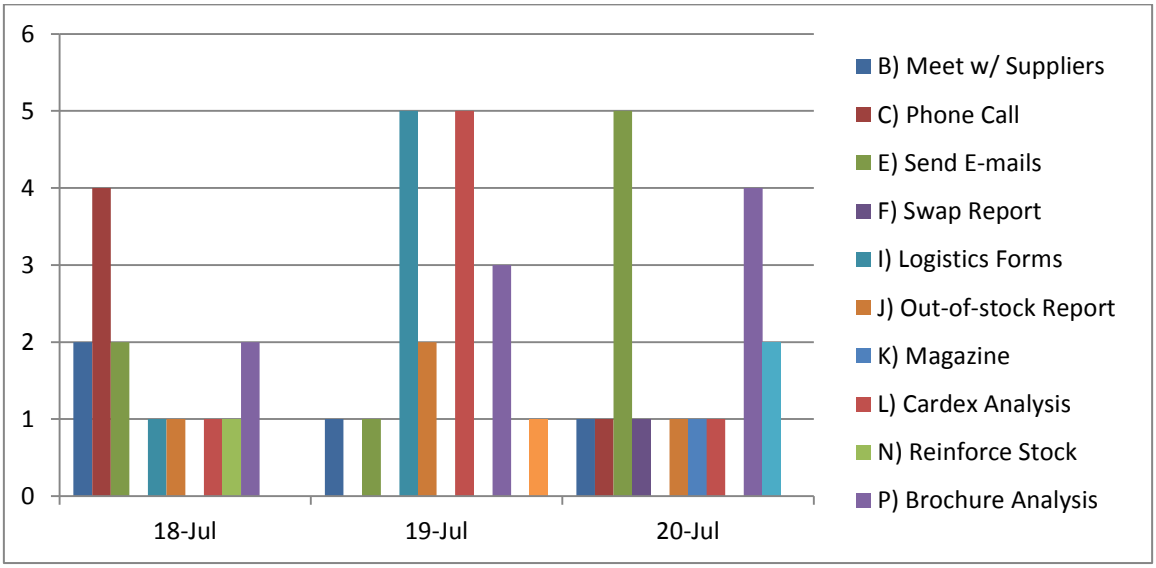


Figure 55. Activity distribution per day (Martin's log sample)

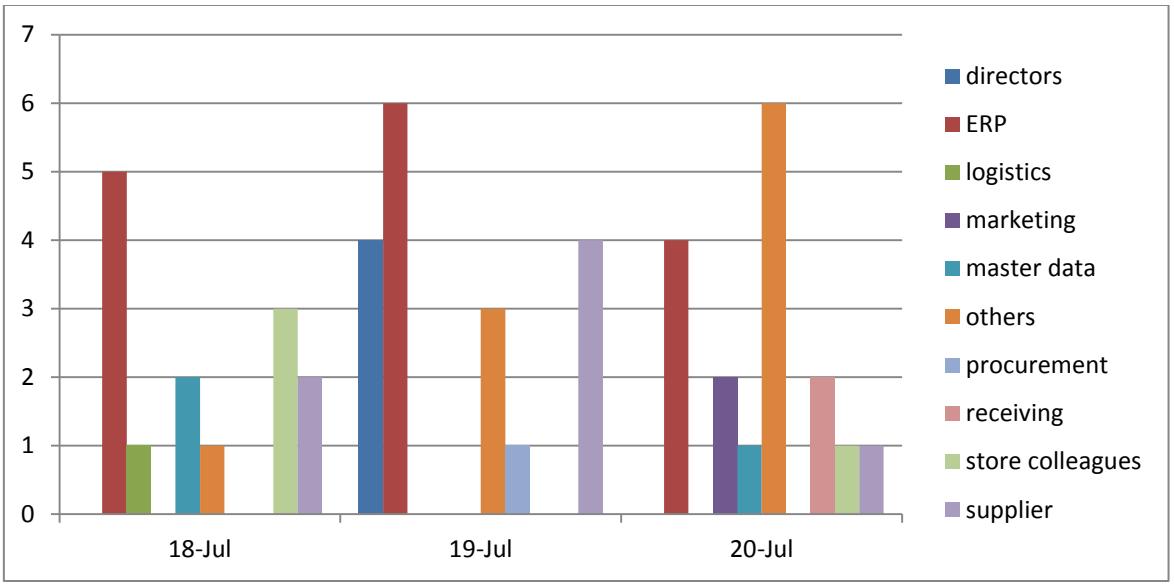


Figure 56. Entities that the user received information from (Martin's log sample)

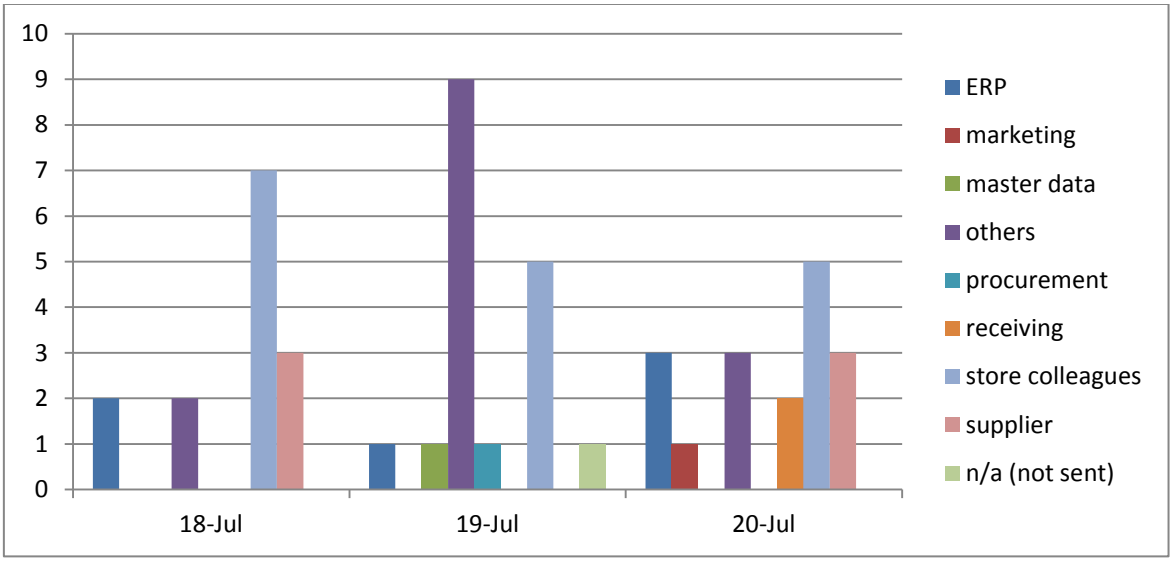


Figure 57. Entities that the user sent information to (Martin's log sample)

6.4.2.2 FIND SIMPLE PATTERNS OF ACTION SEQUENCES IN THE LOGS

Even though we captured several fields in each activity entry, we did not use all of them for this analysis. We used the day and time information to determine the order by which the activities were performed. The actual task performed was given by the activity column. The "activity (detail)" column acts as a specialization of the activity that at this point would only add noise to the comparison results. Even though this column would be important if we were trying to find action contexts, for the purpose of this study and the relatively small

sample of logs, it was more appropriate to compare them to the process diagrams' tasks keeping only the generalized part of the action (the "activity" column). The columns "received from" and "sent to" were useful to understand with whom the users are interacting more as illustrated in Figure 56 and Figure 57. However, these two columns do not bring us useful information when looking for sequences of actions since in this instance we are only studying the purchasing department's logs. Even if we tried to follow the action flow across to other departments in the diagrams, this information wouldn't exist in the logs in order to be compared with.

6.4.2.3 TOLERATING INTERRUPTIONS WHEN LOOKING FOR SEQUENCES

We can infer that allowing two interrupting actions when looking for sequences of two actions is obviously adding too much noise in the sequence and most likely we won't find anything of interest. However, when looking for sequences of three, four or more actions, adjusting the number of interrupting actions tolerated when looking up the sequence can work as a way to fine-tune the search results.

We don't know for sure if the actions interleaving the sequences are actually interruptions or not as they could just represent another process. But if a sequence happens many times, chances are that if we can still find that pattern of actions when tolerating a couple of interruptions in between, we will still be talking about the same sequence and probably the same process as without interruptions.

6.4.3 MATCH ACTION SEQUENCES BETWEEN FORMS AND LOGS

6.4.3.1 MANUAL RELATION BETWEEN FORMS (DIAGRAMS) AND LOGS

The fact that sequences longer than two actions in the logs could not be matched when we searched in the model diagrams' tasks proves that the documented processes (where the model was mostly created from) are very different from the tasks people actually perform every day. Another reason for only having found matches for sequences of two actions is that we would need to capture more data, namely the work logs for every department that interacts with the purchasing department. This way we would be able to find sequences that in the diagrams cross the lanes between the responsibilities of several departments. We have to keep in mind that the logs were captured only inside one department. The diagrams tasks show a wider view of the processes crossing the departments but are small in number, while

the logs show many more possible sequences of actions (possible processes) but specifically about the purchasing department (apart from knowing where the information was received from and sent to). This makes relating them more difficult.

Also for this relation we are looking to find sequences throughout each day, but not sequences that cross several days. We use the "day" as the time measure that gets repeated and assume that the processes start and finish each day. Most of the processes we are looking for work that way, for instance, making a purchase, controlling product delivery, negotiating with the supplier or handling supplier tables usually only take a few hours and most times less than that as noted in the function definition forms. However, some documented processes such as budget planning are executed once a year and may take up to a month to be completed.

6.4.3.2 AUTOMATE THE RELATION BETWEEN FORMS (DIAGRAMS) AND LOGS

When we started developing an automated way of relating the diagrams with the logs, the reader might have noticed that one of the first steps was to manually associate the actions' identifiers in the logs to the names of the corresponding tasks in the XML files (textual representation of the diagrams).

This was done so that the tool could automatically match the actions and the tasks in the model using a simple text comparison. This manual step could have been eliminated if the company had a standard beforehand that defined an identifier to be used universally for each task. That way, each task would have a single identification when expressed in the process diagrams, as well as when captured in logs.

When looking up the action paths in a diagram, as one might expect, as the application navigates through all the paths it finds the same path elements several times, with small differences caused by the different ways the paths can follow at gateways in the diagram. We are aware that this could cause a degree of repetition in the results when counting the number of occurrences that each sequence occurs in the diagrams. However, for this application we're not interested in counting how many times a specific sequence of actions comes up, that analysis has been done with the logs in section 4.4.4.3. What we want is to prove that there is a relation between logs and diagrams and that it can be analyzed automatically.

CHAPTER 6

7. CONCLUSIONS

In this study we have proposed a methodology that can be used for defining enterprise architectures for small and medium enterprises. We also attempted to push back the difficulty barrier of enterprise architectures maintenance by developing automation tools.

As a basis for our approach, we followed and adapted the Enterprise Architecture Planning (EAP) methodology with the Business Process and Practice Alignment Methodology (BPPAM) and introduced new activities. We started by developing a business model about our subject of study, Company X, following EAP. Then we captured logs from individuals' real work practices in the purchasing department of the company. We analyzed those logs manually to look for sequences of actions, and then developed a tool that could automate that work. The last stage involved finding and examining the link that existed between the business model and the logs, again first manually, and then through a tool we developed to automate this.

In sections 4.1 to 4.3 where EAP was followed, we experienced how that methodology is designed for a larger scale than small and medium enterprises. The adaptation we developed was a considerable downsizing from the original plan, and encompassed taking off the more corporative bureaucratic steps as well as those that depended on a large EAP team.

In section 4.3.3 where the interviews were performed and section 4.4.3 where the work logs were captured, we were taught just how hard it is for working people to invest some of their time for studies like EAP. However, the less time you obtain from the subjects, the less data you have to go on which forces the researcher to make more assumptions and generalize based on a smaller sample. Understandably, people are busy and enterprise architecture is not regarded as a top priority in their line of service. There's a delicate balance one must strike between making them understand the importance of EAP, and "forcing your entrance" a bit by making their management place EAP as a priority in their vision.

In section 4.4.4.3 when looking for action sequences in the captured work logs, we discovered how having focused our study on a single department's logs had a negative impact in finding the complete department's modeled processes. The main issue was that as

the processes crossed responsibilities to other departments we weren't able to follow the execution path to them and back because they weren't represented in the logs.

In section 4.4.5 where the business model tasks were related with the captured logs, it became apparent how important it is to use the same level of granularity in activities of both approaches. For instance, the purchasing process in the model could either represent a single macro activity in the logs (e.g. purchasing), or several actions (e.g. check stock, create order, and send order). Choosing either way renders different results.

Still the same section proved that there is a big gap between the company's process documentation and the actual work being performed by the employees. Documentation available tended to be incomplete and outdated. Since EAP makes use of those documents to create part of the business model, the model's tasks ended up not being as relatable to the captured logs as it was initially expected.

This section also showed how the lack of a process identification standard will undermine attempts to completely automate the architectures maintenance. Because processes are not identified sharing a single standard, some parts of the comparison between the business model tasks and the captured logs actions cannot be automated. That is why we had to manually add an identifier to each activity thus making possible an automatic textual comparison between similar activities of the two approaches.

We believe this research is a step further in improving the automation of enterprise architectures maintenance. The ultimate automation would make it easier for companies to develop and maintain architectures up-to-date making these more valuable to the business as a whole, while saving time and other costs that currently plague companies. It would give management current and detailed knowledge about their company's processes, enabling them to make informed decisions and take more calculated risks. This sort of efficiency is the goal for companies who endeavor to obtain a competitive advantage over other companies in their field.

CHAPTER 7

8. FUTURE WORK

Basing on changes proposed by the operational actors during the interviews in the Enterprise Survey phase, in the future we can start by applying the business process improvement phase described in this methodology.

With regards to improving the methodology, an important and interesting problem for future work is using the concept of personal action contexts (Zacarias, 2008) as units of analysis in order to improve the identification of action sequences in data from the individuals' activity logs.

A good example that illustrates how contexts can help was found in our study when automating the relation between diagrams and logs. We found that the activity "Create Order" in the diagrams could actually have two different meanings depending on the context. An order could either be created for a completely new product, but on the other hand its intent could be for resupplying stock of existing products.

Another case of the same nature happens with the activity of sending email, which could for instance be part of a sequence where the user is contacting a supplier, but it could as well be directed to a client, which represents a different context and probably a different action sequence.

Different actions with similar names like these make it harder to identify action sequences correctly, unless we group actions in contexts beforehand. In this case, it is the purpose or intention of the user that allows us to identify and classify to which context the actions belong to. Also, seemingly unrelated actions can be found to be part of a single action sequence after performing a context analysis and taking into account relations that emerge from the use of the same resources such as the same tools, documents or people between actions.

A deeper analysis and a more complete business process model could be extracted if more data were gathered in a future study. Capturing logs during more days would allow finding patterns in data and also enable the application of action contexts.

Although our work focused on a department, by analyzing more departments we would have the opportunity to follow action sequences in the logs that fall outside the range of a single department and consequently build a more complete process model.

The capturing of individual action logs can be optimized to be the less obtrusive. By integrating IP phone systems, e-mail and application servers, programs can be developed to track phone calls including time spent and people involved, email communications with suppliers, clients or others and time spent using application modules, e.g. create order, receive goods, or invoicing.

Currently it is not possible to log every action automatically, for instance the time spent physically talking to someone. However, let's consider that in a not too distant future everyone will carry their personal identification digitally in their mobile phones. Technologies such as these combined with radio-frequency identification (RFID) would allow a company to track who entered the office and for how long they stayed, e.g. knowing that a representative of supplier X came to a meeting in one of the purchasing department offices.

Our study on the process model discovery was a step in the direction of automating both the creation and maintenance of models based on captured work practices. However we have focused on the individual's work, i.e. on a single person at a time logging their actions. We believe that there's potential in studying action logs from a multi-user perspective and that collaborative tools can be developed to allow capturing the interacting actions between individuals.

APPENDIX A

A. BPMN BASIC ELEMENTS

There are four basic component categories in business process model notation and these include the elements illustrated in Table 19.

Name (Category)	Description	Graphic Notation
Event (Flow)	Represented by circles with open centers; is usually a cause (trigger) or has an impact (result) on the process flow. There are three types of events: Start, Intermediate and End (pictured to the right respectively).	
Activity (Flow)	Represented by a round-corner rectangle, is the work performed in the process. There are two types of activities: Task and Sub-Process (compound activity) (pictured to the right respectively).	
Gateway (Flow)	Represented by a diamond shape, controls the decisions, divergence and convergence of the flow paths. Control behavior is defined by symbols inside the shape.	
Sequence Flow (Connector)	Represented by a solid line and arrowhead. Defines order of flow objects execution.	
Message Flow (Connector)	Represented by a dashed line with open arrowhead. Indicates messages sent or received between two separate business entities (e.g. two different organizations).	
Association (Connector)	Represented by a dotted line with a line arrowhead. Associates flow objects with BPMN artifacts that usually represent the inputs and outputs of activities.	
Pool (Swimlane)	Used for containing and partitioning sets of activities between different participants (e.g. two separate companies).	
Lane (Swimlane)	Used as a sub-partition of a pool to organize activities of different units of the same business entity.	

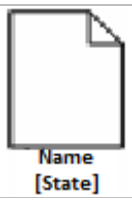
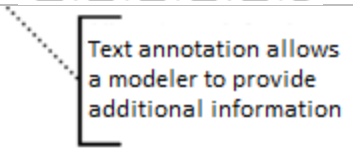
Data Object (Artifact)	Represents the input and output data units of activities.	
Group (Artifact)	Represented by a rounded corner and dashed line rectangle. Used simply for documentation or analysis grouping purposes.	
Annotation (Artifact)	Used for providing additional text information on any element of the diagram.	

Table 19. Basic BPMN elements (some graphics from (White, 2006))

Activities in pools are considered self-contained processes (see Figure 58). Only message flows can cross different pools but they may not be used between lanes. On the other hand, sequence flows can only be used between lanes in a pool and not between pools. Message and sequence flows connect to flow objects directly and not to swimlane containers. Collaborative flow (i.e. between pools) involves business to business (B2B) processes and contrasts with internal processes (i.e. between lanes) which occur inside a single participant.

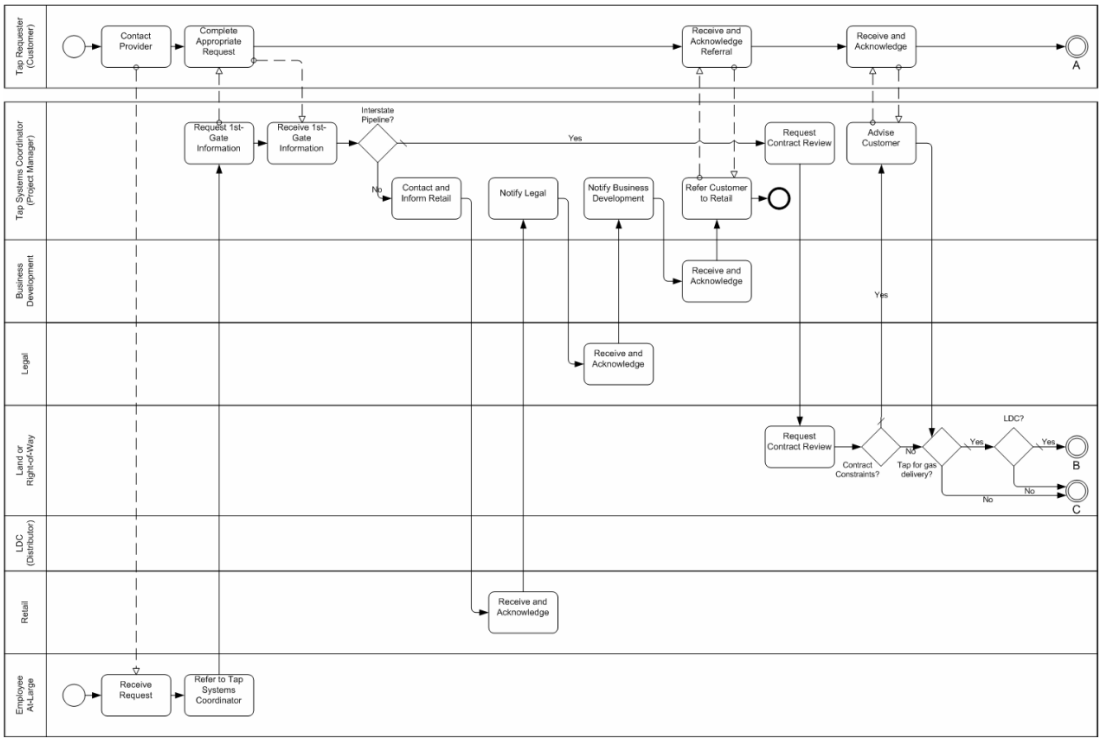


Figure 58. Low level (detailed) business process diagram example

APPENDIX B

B. PURCHASING DEPARTMENT – FUNCTION VS. INFORMATION SOURCES

Information Source	Info Source No.	Function No.	In/Out
Sales history	78	21	i
Annual sales plan	79	21	o
Monthly sales report	80	21	o
Company goals	95	21	i
Sales history	78	22	i
Annual sales plan	79	22	i
Products stock report	81	22	i
Sales objectives	82	22	i
Supplier delivery conditions	83	22	i
Product details form	84	22	i
Supplier contract/commercial details	85	22	i
Warehouse receiving report	86	22	i
Scheduled order	87	22	o
Supplier formal complaint	88	22	o
Standard stock	104	22	i
Supplier contract/commercial details	85	23	o
Current suppliers/products report	89	23	i
Supplier details form	90	23	i
Supplier certificate/licenses	91	23	i
Supplier evaluation	92	23	o
Supplier evaluation notification	93	23	o
Supplier contract/commercial details	85	24	o
Supplier evaluation	92	24	i
Strategic decisions	94	25	i
Company goals	95	25	i
Expenses plan history	96	25	i
Expenses plan	97	25	o
Supplier evaluation	92	26	i
Subcontractor contract	98	26	o
Sales history	78	27	i
Store aisles blueprint	99	27	i
Store events plan	100	27	o
Store shelves plan	101	27	o
Supplier contract/commercial details	85	28	i/o
Supplier price tables	102	28	i
Product price changes history	103	28	i

Table 20. Information source and respective functions in purchasing department

APPENDIX C

C. FILLED FUNCTION AND INFORMATION SOURCE FORMS (SAMPLE)

DATE: 22-06-12 Function Definition Form
FUNCTION NO.: 22
FUNCTION NAME: Purchasing / Purchasing delivery control
PERFORMED BY: Buyers
LOCATION(s): Head Office
DESCRIPTION: Periodically purchase the products.
PURPOSE: Maintain stock of products in store/warehouse, and adjust according to sales.
DECISIONS: 1) Daily, the buyer checks the ERP system to find when he needs to create the next order. Alternatively, he checks his schedule and may decide to order a product when lack of a product is detected physically in store. 2) To decide the quantity he needs to purchase, the buyer considers: sales objectives, current season, market tendencies, existing stock, events that may affect sales, frequency and delivery dates of suppliers, commercial conditions, perishability, etc. 3) When choosing delivery dates from the supplier, the buyer should keep in mind how to optimize logistics and receiving process, namely the number of deliveries per day and their size. 4) During the purchase process, the buyer analyses if products have slow rotation and removes them from the purchasing list. 5) The order is then sent to the supplier by fax, e-mail, or EDI. 6) A delivery control report is made daily by the receiving department to check pending orders and failed deliveries. That information is sent to the buyer and is also available in the ERP. 7) Suppliers that failed to deliver are contacted by the buyer to reschedule. When rescheduling, the buyer also sends a written complaint to the supplier and notifies the quality department.
FREQUENCY: 40 times per week (6 to 10 times per weekday)
DURATION: 5 to 60 min
FUNCTION IMPROVEMENT OPPORTUNITIES: ERP system could be improved to optimize purchasing process, allowing to create an order of several products at the same time without having to enter into the details panel of each product.
INFORMATION USED: Standard Stock (in), Annual sales plan (in), Products stock report (in), Sales objectives (in), Supplier delivery conditions (in), Product details form (in), Supplier contract/commercial details (in), Sales history (in), Warehouse receiving report (in), Scheduled order (out), Supplier formal complaint (out)
INTERVIEWEE: Paula

DATE: 27-06-12 Information Source Form
SOURCE NO.: 84
FOR FUNCTION NO.: 22
SOURCE NAME: Product details form
DESCRIPTION: Form describing a product, filled by supplier with help from buyers.
RECEIVED FROM: Supplier
FORWARDED TO: Warehouse Manager, Master Data Manager
SAMPLE ACQUIRED: Yes
MEDIUM: Spreadsheet
ACCURACY: Not good. Suppliers make mistakes when filling in form / miss some fields.
FORMAT: Good
INTERVIEWEE: Paula

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