Design a Price Control System in the Purchasing Department of a Clinical Diagnostics Company

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Abstract

This project was developed at a company which is the leader in the Clinical Diagnostics market. This condition was achieved by an aggressive set of acquisitions along the years.

Successfully integrating another company is not always an easy task. This company has been under constant integration processes for the last ten years since every year it acquires several groups of companies. Privileging faster growth, although being beneficial in terms of market share sometimes compromises structure which is key in big companies. The present project was developed within the purchasing department which faces issues derived from how poorly the purchasing databases of the acquired companies have been integrated, originating errors such as duplicate references and uncontrolled prices, both in terms of products and services.

This thesis aimed to, firstly, improve the data quality regarding information that is inserted in the ERP through the purchasing department and secondly, use that data to analyse product prices. Additionally, as the expenditure of the services in telecommunications became also uncontrolled, a model to track its expenditure was developed. For both models, visualisation tools were developed so that the person in charge of controlling these variations can quickly understand the causes for change and act faster.

Regarding the control over product prices, the results cannot be quantified. However, the knowledge gathered about the patterns of products prices gives the purchasing department the business intelligence needed to better conduct future renegotiation processes and hopefully being able to decrease overall costs. Besides, the guidance provided by the visualisation tools towards the most relevant cases improve staff's time allocation for renegotiation actions.

This project also highlights the importance of data for the top management to have their decision-making actions based on real-time information. It demonstrated also that the information, when incorrectly inserted or not inserted at all does not help the analysis in place. Understanding the data and keeping the databases clean and up-to-date can save significant amounts of money and resources to the company as observed with the services segment.

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Resumo

Este projeto foi realizado numa empresa que lidera o mercado dos Diagnósticos Clínicos no território nacional. Ao longo dos anos, a empresa foi tomando uma posição cada vez mais agressiva no mercado ao adquirir vários grupos de peso no mercado nacional, cimentando assim a sua posição de liderança.

Qualquer empresa enfrenta, de uma maneira geral, dificuldades num processo de integração de uma outra empresa, pelo que não constitui um processo trivial. A empresa em questão passou por um processo quase ininterrupto de sucessivas integrações, ao longo da última década. A estrutura base de grandes empresas acaba por se ver muitas das vezes afetada, devido à preferência pelo rápido crescimento. Este último é incentivado pela pretensão de maiores quotas de mercado. O presente projeto foi desenvolvido no departamento de compras. Este enfrenta grandes dificuldades provocadas pela forma pouco estruturada como foram integradas as bases de dados das empresas adquiridas. Isto teve consequências graves, como por exemplo, duplicação de várias referências e preços descontrolados, tanto em produtos físicos como em serviços.

A tese tinha como principais objetivos, primeiro, aprimorar a qualidade dos dados inseridos no ERP através do departamento das compras e, segundo, usar essa informação para analisar o preço dos produtos. Além disso, uma vez que as despesas relacionadas com telecomunicações ficaram também estas descontroladas, um modelo capaz de rastrear ao detalhe estas despesas foi implementado. Para ambos os modelos, as ferramentas visuais foram contruídas, a fim de que as pessoas responsáveis, através deste controlo, fossem capazes de detetar alterações repentinas, entendê-las e corrigi-las o mais rápido possível, quer por sensibilização de comportamentos quer por negociação com fornecedores.

Relativamente ao controlo sobre os preços dos produtos, os resultados não são passíveis de ser quantificados. No entanto, os padrões de variações de preços verificados concedem ao departamento o conhecimento necessário para melhor proceder em futuras renegociações, prevendo-se assim que os custos possam ser reduzidos. Por outro lado, focando a atenção dos responsáveis nos casos mais alarmantes faz com que o tempo despendido relativamente a ações de renegociação seja menor.

Este projeto também salienta a importância que os dados têm para a gestão de topo nas tomadas de decisão. Isto demonstra que, quando a informação é incorretamente introduzida ou nem sequer introduzida no sistema, a análise realizada a jusante vê-se prejudicada. Entender os dados e manter as bases de dados limpas e atualizadas traduz-se em poupanças significativas para a empresa, não só em termos de dinheiro, mas também de recursos. Estas melhorias foram observadas no sistema de controlo de preços direcionado para serviços.

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"Visualization gives you answers to questions you didn't know you had."

Ben Schneiderman

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Acronyms and Symbols

3PL Third-Party Logistics
B2B Business to Business
B2C Business to Consumer
BU Business Unit
CAPEX Capital Expenditures
CRM Customer Relationship Management
ERP Enterprise Resource Planning
FTE Full Time Equivalent
M&A Merger and Acquisition
MLCT Medicina Laboratorial Dr. Carlos Torres
OPEX Operational Expenditures
PO Purchase Order
RFI Request for Information
RFP Request for Price
RFQ Request for Quotation
RPA Robotic Process Automation
SCM Supply Chain Management
SKU Stock Keeping Unit
SLA Service Level Agreement
SRM Supplier Relationship Management
TCO Total Cost of Ownership
TED Telecommunication Equipment Database

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Chapter 1

Introduction

Delivering high-quality service to customers is one of the key concerns in any business sector. Unilabs is the leader in the Clinical Diagnostics domestic market and in terms of private health-related businesses it only cedes rank to the three main private Hospital groups operating in the national panorama. This was achieved by an aggressive set of acquisitions throughout the years. Unilabs was able to merge into one company some of the biggest groups operating in the country. When considering the healthcare sector, quality is the company's highest priority together with quickness, since it is clients' health that is on stake. To comply with these high standards, a supporting structure is indeed needed. To assure quality and low response times, it is essential to have a reliable and knowledgeable procurement department. In other words, a flawless and efficient supply chain is required. Hence, this department is key to get daily operations going by managing deliveries so that no product is missing and the entire business operations are not threatened.

Being in a well established, slow-growing company is sometimes hard. However, in a company which grows by Mergers and Acquisitions (M&A), it gets tougher as the databases inherited from the acquired companies have different reference IDs and prices for the same products. Moreover, the procedures of the purchasing staff in the different companies are generally different, which does not make any easier the task of standardising processes. With this, discrepancies in prices along time exist and are not favourable for the company. Thus, these changes in prices were under the radar of the purchasing director.

This chapter gives an overview of the industry and the company's background. This will allow a more comprehensible view of the problems and suggested solutions presented in the following chapters.

1.1 Unilabs: Global Overview

Unilabs has the M&A mindset in its DNA since its creation through the merger of three Clinical Diagnostic Laboratories in Switzerland in 1987. Until the year 2000, it had progressively hit foreign markets such as Spain, Italy, France and Portugal. In 2007, a game-changing move from

Unilabs happened with the acquisition of the European key player in imaging diagnostic, Caspio - with a strong market presence in important countries like the UK and all four Nordic countries. Along the years, the acquisitions in the countries where the company is a well-established stakeholder did not slow down. With the ambition of becoming a global leader in the diagnostics business, Unilabs converted into a worldwide operator, making investments in South America and the Middle East.

For a company to stay financially healthy while developing this aggressive M&A strategy, it has to manage costs properly, while supporting the organic growth required for a positive performance. This strategy was supported by ongoing investments from APAX Partners, a private equity company, since 2007.

Today, Unilabs is present in 14 different countries, from Peru to the United Arab Emirates providing services of Laboratory Medicine, Medical Imaging and Cellular Pathology, among others. 2019 annual sales exceeded €1 billion, supported by 110 imaging centres and over 250 labs. Unilabs's Mission is "To be at the heart and start of all effective treatment decisions", while its motto is "We give you answers that help give care".

1.2   Unilabs: Portuguese Context

Unilabs Portugal, from now on referred to as Unilabs, started in 2006 with the acquisition of a majority share of the clinic Medicina Laboratorial Dr. Carlos Torres (MLCT), a well-known player in the Clinical Diagnostics market in the North of Portugal. Since entering Portugal, Unilabs has been adding new companies from the healthcare sector to its portfolio almost every year. By acquiring major groups of players in the Clinical Diagnostics market, the corporation rapidly rose to the leader in terms of market share. This M&A strategy brought two distinct but valuable advantages: first, the quickness to gather high shares of the market, and second, the elimination of competitors.

In 2017, Unilabs took a bold move by taking over Base Holding group, the domestic leader in the Integrated Clinical Diagnostics market, offering a panoply of services, including Nuclear Medicine and Gastroenterology. Currently, its national structure accounts for more than 1000 Care Units - the collection site for Clinical Analyses or Medical Imaging related units - and 15 Labs - where all the clinical diagnoses are carried out for the different Business Units (BU). These impressive numbers were also boosted by partnerships made with smaller players in the market.

With the integration of new businesses, Unilabs places now itself among the leaders in the private Health market only surpassed in terms of revenue by the three main groups of Hospitals operating in Portugal, namely Luz Saúde, José de Mello Saúde and Lusíadas. This reflects first the number of operations performed by the entire group in the national context and, secondly geographic scattering.

In terms of the overall Clinical Diagnostics market, Unilabs claims the top position in the national market, with Germano de Sousa and Synlab, taking second and third places, respectively.

However, drilling-down each BU, Unilabs faces more competition since there are still several players specialized in the different technical areas and regionally present. Currently, Unilabs operates in the areas presented in Figure 1.

Figure 1: Unilabs' Business Units

From these, Clinical Analyses and Medical Imaging are the two most significant areas for the company.

In Clinical Analyses, one central laboratory supports part of the network of Care Units, largely located in the north of Portugal. Each type of sample collected in these Care Units is processed by the main laboratory. These day-to-day operations are backed by both the logistics and procurement departments.

In Medical Imaging, which comprises Radiology, Cardiology and Gastroenterology, Unilabs offers medical appointments in Imaging Centres. Sometimes the same unit offers both Clinical Analyses and Medical Imaging. These Medical Imaging units are replenished just like the Clinical Analyses' Care Units.

Next, a more organizational review of the group highlights the department where the project took place as well as the issues addressed.

1.3 Design a Supply Chain at Unilabs

Unilabs has been developing a vast Portfolio regarding Clinical Diagnostics businesses under its hostile market strategy. The businesses that are exclusively controlled by Unilabs fit into the Business to Consumer (B2C) model, whereas the partnerships take the Business to Business (B2B) model since Unilabs, in these cases, is only responsible for picking up the analyses collected by the partners, analysing them and delivering the results, never getting in contact with the final customer. These partners can be hospitals, other clinics or external laboratories.

In the health business, the client's trust is a key issue to the consistent success of companies. To gather the best of both business models, Mergers & Acquisitions were conducted with a fast-growing mindset, while partnerships were also created to get a presence in almost every municipality in the country. Thus, the pool of stakeholders involved has widened as shown in Figure 2.

Figure 2: Unilabs' stakeholders

The Unilabs database contains information about almost 300 suppliers. Partners have been previously mentioned, such as hospitals, private clinics and external laboratories which do not have the required resources internally, end up choosing to outsource the testing steps of the Diagnostics process to Unilabs. The distinction between clients and payers is relevant since it is current practice for patients to either have some sort of insurance relative to medical services or depend on the National Health Service for payment. Hence, while clients are ordinary individuals, the actual payers can be insurance agencies or the government, beyond individuals themselves. The owners represent not only the private equity but also every employee in the company.

Unilabs costs under the management of the Procurement department can be classified into three distinct categories: Goods, Services and those derived from Capital Expenditures (CAPEX), the long-term investments that increase or improve overall infrastructure.

Every department has to look for improvements in terms of costs and asset efficiency, but significant savings can be achieved already in the initial purchasing process, being the focus of the purchasing department.

1.4   Project Context

The project will focus on the Clinical Analyses' BU, of which the structure and operations will be further explained. Regarding infrastructures, Unilabs counts on one main laboratory and warehouse in Porto and several other peripheral labs and warehouses across the country. Every lab has a warehouse supporting it. The logistics cycle for blood analyses, for instance, is the following. In every Care Unit, clients have a sample of their blood taken. Then, members from the logistics staff pick up these samples from every Care Unit once or even twice a day, depending on the dimension of the Care Unit. After the drivers finish their routes, they end up in the main laboratory to deliver the analyses. To leverage this logistic system and to maximize fleet's efficiency, the products that Care Units require and had asked for through the online shop will be conveyed on the way back.

The project was developed within the purchasing team at Unilabs. This team together with the warehouse management team constitutes the Procurement department. The warehouse management team is responsible for purchasing of goods, exclusively those consumed by the main lab, as well as the Care Units under its direct responsibility. This team controls the inventory of the main

warehouse. When some Stock Keeping Unit (SKU) quantity available is low, they shall place an order to the regular supplier. The second team, named purchasing team, is responsible for placing orders to suppliers as well as ensuring they deliver the products directly to Unilabs' peripheral warehouses which then distribute the goods to the labs and Care Units under their direct responsibility. Contracted services and other investments in equipment are directed by the purchasing department too.

One goal the purchasing department has for the short-term is to improve the data quality of the master of products on the ERP. This consists of removing duplicate references, ensuring price consistency and uploading all the commercial information needed regarding suppliers, among other actions. This goal got priority with the new purchasing director. This work needs to be carried out after the aggregation of 80+ different databases from the other companies Unilabs bought along the years. This is a prerequisite for future analyses on more accurate data regarding purchase orders (POs), goods reception and consumption of products.

Price control had not been within the main tasks of the department's staff but became relevant to the purchasing director as the expenses increased. This project aims to map all types of costs the Clinical Analyses related materials and then create a system which alerts the person responsible whenever some significant variations take place in a products' price. The need to supervise the costs associated with services, more specifically in the communications area, also became clear when expenses doubled compared to the same period in the previous year.

1.5   Methodology

The present project will be divided into three distinct phases:

- Define how the creation of new references shall proceed to avoid inserting inaccurate information regarding references details. This is the basis for the next analysis;

- Build a model which can track changes in prices and quantities of the purchased products. Two situations may call up the attention of the purchasing manager to trigger a price renegotiation with suppliers: either the price is constantly rising or the purchased quantity of a specific product is rising and its price remains stable. Visualisation tools shall help the purchasing director to quickly find the price or volume discrepancies for high volume items;

- Build a similar model for the communications area which had a big room for improvement. This would highlight which accounts and the precise service which is consuming additional services and therefore, rising expenditure. This valuable information will be available to the purchasing manager.

Note that the data used in the analysis was transformed so that it did not compromise sensitive information.

To achieve this, the following steps were taken:

1. Understanding the As-Is panorama for the process of creating new internal references, based on the interaction with the individuals who do the inputs into the ERP;

2. Research in terms of academic publications and industry best practices of the areas addressed;

3. Design of potential improvement actions - discussion and analysis with the purchasing staff and approval by the director of both models;

4. Development of the solutions in the course of the project with ongoing adjustments;

1.6   Document Organization

This initial chapter aims to provide a quick overview of the company history and the market it serves, including a brief description regarding the daily operations of the Clinical Analyses' BU and which tasks are under the responsibility of the purchasing department.

The second chapter is a review of the topics of supply chain management, including areas of interest such as price control to help understand what has been done in the past in these areas and to structure the solutions to be developed.

In the third chapter, there is a presentation of how the purchasing department dealt with the issues of interest at the start of the project, highlighting the main problems found.

The solutions are presented in the fourth chapter. Here a more thorough explanation was conducted regarding how models were built.

Lastly, results are shown and discussed to assert how this project has changed purchasing control and management. Some further research and development are suggested to continue with the improvement actions across the entire department.

Chapter 2

Literature Review

In the present chapter, the theoretical subjects relevant to the project are addressed. First, a more macro view of Supply Chain Management, its history, different strategies and successful examples are described, drilling down to the specific role of Procurement in Multinational companies.

2.1 Supply Chain Management

Many concepts in many areas were once implemented and improved by the military, Logistics is no exception. The first notion of Logistics department inside companies, operationally speaking, is thought to be discussed during WW II. Until then, firms were mainly organized in three different sectors: Marketing – which managed both the distribution channels and customer service; Finance – responsible for supervising the costs and expenses; Production – in charge of purchasing activities and raw materials warehousing. The physical distribution of the products was assigned to neither of the sectors, setting off disagreements that harmed the company's overall efficiency *(Ballou, 2007)*.

For this reason, the notion of Physical distribution was introduced. At the first stage, the entry flow of products was appointed to the purchasing sector, while physical distribution was responsible for the outward flux of cargo. Then, the definition became broader as being the "area responsible for the movement of raw materials and finished products and the development of movement systems." when *Smykay et al. (1961)* claimed that this term, also known as Logistics should embrace not only the outbound but also the inbound flow of goods in the firm.

Some had, in times, discussed the idea that in each transaction along the entire chain, coordination of supply and demand between the entities present in the chain is fundamental. Despite this, the notion of Supply Chain Management (SCM) only appeared decades later. Afterwards, some pillars of SCM were defined by *Lambert et al. (1998)*, namely Customer Relationship Management (CRM), Order Fulfilment, Supplier Relationship Management (SRM), among others.

According to the *Council of Supply Chain Management Professionals (2016)*, the supply chain is simply the network of organizations that makes collective efforts to deliver any type of product to the final consumer. It also tries to define what is, in fact, Supply Chain Management –

"Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers.".

Although this definition considers the various relationships across the whole supply chain, many companies are only able to interact and collaborate with their first-tier suppliers and/or first-tier customers. The reason for this to happen is perhaps the lack of confidence most companies have in sharing what they consider proprietary information with other organizations. Nevertheless, this cooperation has been rising and becoming rather critical since there has been a "shift in the movement and consumption of goods" since businesses tend to enlarge their geographical horizons *(Ballou, 2007)*.

Chopra and Meindl (2013) claim that, for a company to perform better than its competitors, a reliable and efficient supply chain is required. Across the entire value chain, three elements are transferred: information, products and money. They also pointed out that for finished products to be successfully delivered to customers, the process of how these goods need to be conveyed shall be well and simply defined, in a first stage, between companies (B2B) and, at the end of the chain, between companies and final consumers (B2C).

The value generated is defined by *Chopra and Meindl (2013)* as the difference between what the company can monetize from its output and the costs incurred to produce the goods/services sold. Since the objective of every commercial entity is to maximize its margins, that also means grabbing a greater share of value within the supply chain by increasing the value created. Then, it is possible to create more value by either selling the product at a higher price or by diminishing the operating costs. Therefore, this translates the important role of procurement departments in organizations, where actions such as tender and negotiation can bring costs down considerably and consistently.

One fast but perhaps not so effective way to drive costs down is to pressure suppliers by presenting a hostile behaviour. This can transform healthy into harsh relationships, not getting positive results in the medium to long-run. It is also possible to drive costs down by adopting more collaborative actions, sharing information and thoughts with suppliers to improve product availability. All of this takes an outstanding level of communication between supplier and customer to have a relevant impact.

This was the method used by Walmart to achieve impressive financial results. Walmart is implementing SCM for decades now and has been able to do it successfully. It began to diminish the links in the supply chain, thereby having fewer relationships (with suppliers) to manage. They have achieved this by overriding first-tier suppliers, starting to purchase directly from the manufacturer. In doing so, it was possible to eliminate the mark-ups of the intermediaries. Walmart has been in the top of SCM for the last decades due to two main aspects: trust between the business and suppliers and technological innovation applied to different departments and processes, from procurement to logistics *(Chopra and Meindl, 2013)*. Being a big company, Walmart had tremendous buyer bargaining power toward suppliers which also helped in terms of cost reduction. This

is achieved when you purchase great quantities of products from a supplier and it represents a great share of their sales.

On the opposite side, there are companies which have no confidence in their suppliers, that tend to hold harsher relationships with them.

2.2   Risk

In the context of supply chains, risk can be defined as "the potential for realisation of unwanted negative consequences of an event" *(Hathaway, 1991)*. In today's global businesses, the quest for efficiency can become more vulnerable to risk since external factors such as financial instability or new technologies can disrupt the system *(Ghadge et al., 2012)*. *Lee (2002)* categorized 4 different types of supply chains:

- Efficient supply chains

- Risk-hedging supply chains

- Responsive supply chains

- Agile supply chains

The first focus on eliminating non-value-added activities, while using information technology features to link activities so that higher efficiency is reached. These productivity improvements are met by using Lean thinking, for example, streamlining their workflow or automating processes. Regarding Risk-hedging supply chains, to be applied when the supply uncertainty is high, inventory becomes top priority. To mitigate shortages, companies shall consider implementing some policies, for instance, develop a pool of suppliers as backup sources and signing Service-level agreements (SLA) with suppliers, to significantly reduce supply uncertainty, while ensuring simultaneously settled quality standards. Being legally binding, SLAs can be more effective than occasional negotiations with suppliers. In Responsive supply chains, logistics flexibility is key to supply the clients whenever they need. This typically happens in industries like fashion, where the demand is particularly unpredictable. Finally, Agile supply chains try to merge the perks of both Responsive and Risk-hedging supply chains by having the capacity to quickly respond to changes in demand without compromising the supply process.

Bailey et al. (2019) highlights the importance that risk has in global supply chains. The risk element that is known shall be monitored for organizations to minimize supply chain disruptions, while to mitigate the unknown components, the best strategy is to have a risk-aware culture within the company.

Uncontrollable disruptions

As supply shortages happen more frequently than in the past due to factors not controlled by companies, such as impactful strikes, natural disasters or even pandemics, cost-driven supply chains

should perhaps be reconsidered. Are these supply chains ready for emergencies, where reactive and uncoordinated actions are taken instead of being proactive and planned?

Back in 2013, the *Bhatia et al. (2013)* had already surveyed several supply chain managers from all over the world to come up with a list of top catalysers of supply chain resilience. The results were rather interesting since North America and Europe responses highlighted the building of risk management culture as a top priority, while Asia was more concerned with improving information sharing infrastructures across the supply chain, but also improvement of alert and warning systems. Adopting these measures would allow downstream partners to quickly adapt when their n-tier supplier is impacted by disruption, whether climatic or social, among others. More recently, we still have examples of disruptions that expose supply chains vulnerabilities, meaning that actions from most stakeholders are frequently reactive and hardly ever proactive. This might never change since it is difficult to identify and mitigate every single risk their global supply chains face. One can only improve its supply chain resilience after risks are identified *(Fiksel et al., 2014)*.

A risk assessment plan performed by *Alicke et al. (2020)* detailed some policies that companies could adopt to smooth the impact of Covid-19 in its supply chains such as creating transparency with all suppliers present in the supply chain and implement supply network mapping. This helps stakeholders to know precisely which suppliers are affected by a global upheaval such as a pandemic. A common approach is to focus firstly on key components and start from the x top products by revenue, then detail the component suppliers to the raw materials suppliers, ideally. It should contain the info about where the primary supplier site is and, in case there are any other sites capable of producing the same components, their location and the time it takes to begin the shipping from this alternate site. In case companies are too dependent in one single supplier for a certain component, one solution is to search for similar suppliers, especially if the ones currently employed are situated in more vulnerable countries, in terms of disruptions. Having alternative sources reduces the risk. The down point is that perhaps the company will incur in more costs, in the beginning, hoping that the cost savings achieved during future outbreaks will balance the sheet. One alternative that companies might consider is going back to sourcing closely to plants, where, in theory, it is easier to prevent supply shortages and reduce transportation costs *(Choi et al., 2020)*.

2.3   Procurement Process

Khushalani and Woodcock (2018) pictures the role of next-generation procurement in organizations as technological advances were made in recent years, bearing in mind Business Alignment, which is the process of aligning the procurement model with the company's overall goals. The end-to-end "source-to-pay" model is divided into 2 different phases: value capturing (every process until the negotiation is finished) and value sustaining (every process required to ensure the deal is performed accordingly). In the first phase, companies shall benefit from technological

progress in the sense of having access to more infrastructures that support better and faster tenders/Request for Quotation (RFQ) - negotiation where suppliers bid for a set of services/goods. Also in this stage, machine-learning is helpful to support buyers' purchasing decisions by forecasting the expected price for the following period. After choosing the best possible supplier base, it is time to sustain that value. *Chambers and Sutton (2019)* also believe that automation can be implemented through Robotic Process Automation (RPA) systems both for procure-to-invoice and invoice-to-pay processes which are typically very manual. By diminishing the cycle time of these tasks the company can benefit from eventual commercial discounts many suppliers grant to buyers when payment is performed in the transaction moment.

van Weele (2005) suggests global players professionalize their purchasing team and mentions the tasks he considers should be under the management of the procurement department. Regarding the tasks, the most obvious one is the replenishment task which translates in securing the Supply of goods on time from reliable sources. Secondly, Spend Management is important to control if supplies are being acquired at the lowest cost, which in most cases is associated with the lowest price. However, it is recommended to consider instead the Total Cost of Ownership (TCO) (also known as the long-term price of products) as the key driver for decision making since it holds not only the purchase price but also the direct and indirect costs associated to the product's use. Another activity procurement departments should take into account is the risk assessment of suppliers and critical products so buyers do not become too dependent on some specific supplier. The ultimate job is to develop new products in partnership with suppliers. To sustain/ improve market positioning, enterprises must innovate and sometimes they require assistance from suppliers. Hereby, they can both improve these relationships and gain competitive advantage by delivering new products to consumers *(van Weele, 2005)*.

To better understand what policy the company should pursuit with its suppliers, an analysis of its portfolio should be carried out. Kraljic's matrix, presented in Figure 3, differentiates sets of products in 2 dimensions: the complexity of supply market, namely the number of players in the market, and importance of purchasing for the buyer and its financial impact *(Kraljic, 1983)*. This framework enables a simple categorization of products.

- **Strategic products:** usually high-tech tailor-made solutions that have a significant representation in terms of sales for the company. The most suitable strategy for this category is a partnership, creating a long-term commitment.

- **Leverage products:** represent a great share of the volume. However, many suppliers can provide these items at the same quality standards. Therefore, this is where most managers apply cost-cutting actions. For this particular group, the most convenient approach would be competitive bidding, where the goal is to get the best short-term agreement.

- **Bottleneck products:** despite not being so significant in terms of volume or revenue, the number of suppliers for this kind of components is often limited, which translates in supplier dominance in the negotiation. The procedure to conduct for this section is to secure supply with current suppliers by rising inventory levels while mapping further suppliers.

- **Routine products:** these products should be the easier to handle and manage since they do not take a place in the top expenses and can be easily purchased. Nonetheless, procurement managers shall consider this category since it can be a source of cost reduction as well. For this last lot, the proper policy is category management where reducing supplier base and improve operational efficiency can translate in meaningful financial benefits.
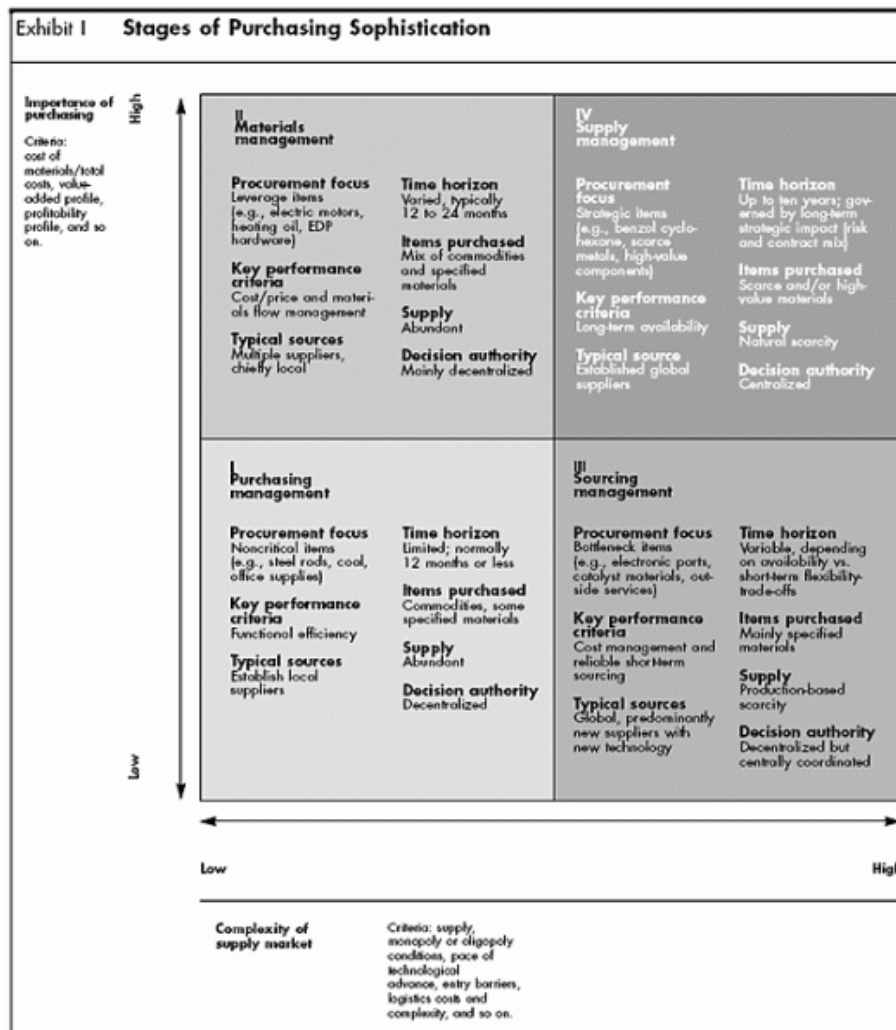
Figure 3: Kraljic Portfolio Matrix. Source: *Kraljic (1983)*

The Kraljic Matrix tries to sum up how the purchasing environment typically behaves depending on both the importance of purchasing for the buyer and the complexity of the supply market. This can help companies to better know how to approach suppliers depending on the context they are facing.

All of the above can only be achieved when supported by a structured logistics department and operations.

2.4   Data Mining in Purchasing

Data mining and more advanced analytics techniques started to be in place in companies long ago. For procurement departments, information is power since knowing better how prices shift, gives the procurement managers a higher buyer's negotiating power and will, therefore, drive prices down. A middle-sized company can generate huge amounts of data only with the purchase orders placed into suppliers. This info is not always used for analysis. These powerful advanced analytics insights can be useful for three different uses: negotiation, vendor segmentation, and yearly planning (Innamorato et al., 2017).

In industry, there are two standard methodologies for analytics implementation: TDSP and CRISP-DM. Here, only the CRISP-DM model will be discussed.

CRISP-DM

CRISP-DM stands for CRoss-Industry Standard Process for Data Mining and it is, as the name suggests, a methodology to conduct data mining projects. It is divided into six distinct stages: business understanding, data understanding, data preparation, modelling, evaluation, and deployment.

Business Understanding concerns understanding the business objectives, assessing the current situation in terms of information needs, determine the data mining project goals and build up a project plan. It is the definition of the current status and what it is intended to achieve with the project. Next, there is a need to Understand Data. To do this, collecting an initial sample of data is needed so that one can describe and explore the data collectable and verify data quality. After understanding the data, it is time for Data Preparation. Here, all the data transformation and selection occur so that the Model can be built. If necessary for further analysis, new data attributes can be also constructed from existing attributes. In the Modelling part, one needs to develop a model which will process the data and send out results at the end. After getting these results, Evaluation process must be conducted to verify how good the model is for the available data and how well it serves the intended goal. If there are still some adjustments to make, the model will be fixed until the results are the desired ones. After going through all these steps, it is time for Deployment (Shearer, 2000). These steps are summed up in Figure 4.
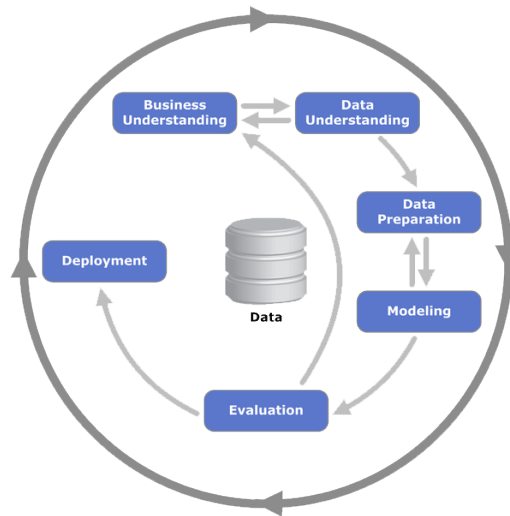
Figure 4: Phases of CRISP-DM Process Model for Data Mining. Source: *Shearer (2000)*

Data Visualisation

As the amounts of data increase along the years and companies want to understand what data can say about the market and its players, easy identification through the visualisation of relevant information becomes one of the chosen tools to simplify and accelerate the comprehension of data by the managers. Berinato (2016) suggests that the different purposes of visualisation can simply be mapped on a scatter where one axis concern the nature and purpose of the visualisation - either it is conceptual or data-driven - and the other axis expresses how one can define what is shown - it can be more declarative or more of an exploratory kind. Then, the four types of visualisation communication, which are Idea Illustration, Everyday DataViz, Idea Generation and Visual Discovery, are distributed in the scatter as shown in Figure 5.

Figure 5: Types of visual communication. Source: *Berinato (2016)*

Chapter 3

Current Situation

This chapter intends to describe first how the purchasing team, where this project was carried, works and how it is integrated with the Procurement department. For context, first, a description is added of how th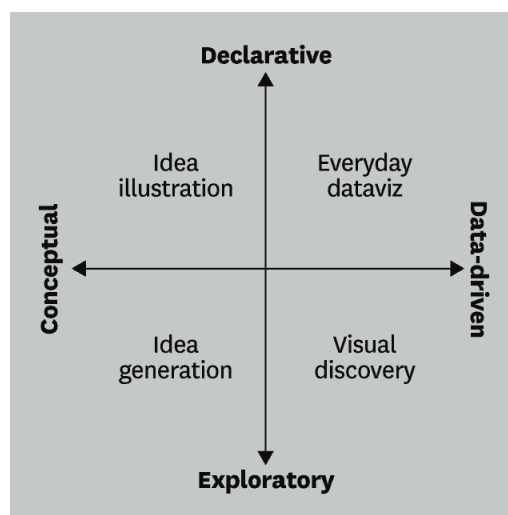e daily operations are carried out in the BU in question, Clinical Analyses. It also explains how information flows are conducted and thereby illustrates how poorly the ERP is sometimes fed with information. In the end, an analysis regarding why a price control system is needed is also carried out. It also points out the importance to introduce a control system for services, namely telecommunications.

3.1   The Clinical Analyses BU

Unilabs has expanded its Business Portfolio quickly in the last few years, acquiring some important players in the Portuguese Clinical Diagnostics panorama. Along with this massive increment of human resources, came the tough task of integrating several systems from distinct areas, such as veterinary, cardiology and genetics, into one single structured unit.

One key challenge this M&A strategy has brought is standardisation. The lack of standardisation is notorious in the procurement department since every single one of the acquired companies had its suppliers and its ways to relate and negotiate with them. With this immense pool of stakeholders, it is much more laborious to control every purchase, which cannot happen in any industry, otherwise, quality of products and services will be affected, which will lastly impact clients.

One stakeholder which has tremendous power in the procurement process is the technical staff as they are the ones who decide, on many occasions, which equipment and reagents will be used to perform the analyses. It is rather difficult to change a product the technical staff are accustomed to, leaving a narrower space where the purchasing team can work in achieving cost savings and synergies. Every product purchased is requested by the different infrastructures of the group to fulfil their operational needs.

In terms of infrastructures, the Clinical Analyses BU is supported by three different types of facilities: Laboratories, Warehouses and Care Units.

- Laboratories: 1 main lab located in central Porto plus 6 other peripheral labs distributed across the country. The main lab is considered as such since it can process greater amounts of tests when compared to all the other labs. Also, it is the only lab processing particular analyses, more specialised ones which are usually more costly but also infrequent. The peripheral labs process high volumes of standard analyses and when the more specialized ones are requested, these are redirected to the main lab;

- Care Units: close to 1000 Care Units spread across the country, a great share owned by Unilabs, the remaining account for partnerships such as small private clinics which cannot process the analyses in-house and outsource the testing to Unilabs. In both cases, Unilabs is responsible for picking up the samples collected by the clinic daily, test them and deliver the results;

- Warehouses: 7 warehouses located next to each lab. Its inventory is used both to replenish the lab adjacent to each warehouse as well as the whole network of Care Units whose samples are delivered directly to that lab.

3.2   Procurement

The department responsible for the procurement activities in Portugal accounts for a total of twelve Full-Time Equivalent (FTE) - workers. In big numbers, the entire procurement department members handle all the order placement related both to (OPEX) goods and services + CAPEX. Last year, concerning only the Clinical Analyses BU, the total number of orders placed to suppliers was over 15 000, around 63% representing goods and the remaining 37% services + CAPEX.

Within the entire operations network, the procurement tasks focus more on the Inbound Logistics part, where the following tasks take place. Afterwards, there is a need to create a new internal reference for each new item. Next and when needed, an order is placed to suppliers. When the product arrives at Unilabs warehouses, reception and check-in are performed and the products are taken to their usual locations, although the location may be altered sometimes due to space restrictions.

In terms of goods, the purchasing team accounts for the following tasks:

1. Negotiation with suppliers;

2. Creation of new internal references;

3. Modification of existing internal references;

4. Attend peripheral warehouses needs;

5. **Placing orders to suppliers;**

6. Handling complaints about products which do not meet the agreed requirements;

Apart from these tasks which are related to replenishment, this team is in charge of monthly inventory valuation for the whole group among other occasional projects which have in mind the improvement of processes within the department.

The warehouse management staff takes control of the following tasks:

1. Stock management;

2. **Placing orders into suppliers;**

3. Reception of products according to the POs;

4. Store the items in their usual location;

Here one observes that there is one task, order placement, which is shared by both teams. The clarification of how they differ from each other will be presented next.

Concerning the national purchasing for Clinical Analyses, the team is responsible for the replenishment of every product that every lab and Care Unit require for their daily operations. However, there is a little distinction of roles. The warehouse management staff can only order routine products for the main warehouse – which replenishes the main lab and around 600 Care Units which are distributed along the northern and central region of Portugal. The purchasing staff take care of the replenishment of the remaining storage facilities – which supply the peripheral labs and their Care Units, almost 400 in total, spread along the rest of the country. The latter is also in charge of ordering, for instance, occasional and strategic products such as top-notch machinery to perform innovative analyses in the lab, when these are not arranged by the central purchasing globally.

Figure 6 presents the differentiation between the tasks of warehouse management and purchasing staff in terms of replenishment for the different stakeholders, in this case, Unilabs' internal clients, which are their laboratories and care units. Despite suppliers delivering goods directly to every warehouse, internal logistics are responsible for conveying the materials from the warehouses towards the Care Units facilities as illustrated before. This highlights how important is the Logistics role for the replenishment process to run smoothly.

Figure 6: Replenishment: Warehouse Management vs. Purchasing tasks

Concerning the products consumed by all these facilities, from the reagents used to calibrate machines that carry out diagnostics of blood samples in the labs, to the uniforms wore by the medical staff at the Care Units, each of these minor goods are purchased and managed by the purchasing team.

This team guarantees high quality products and services to meet the demands of all the Care Units, struggling at the same time to reduce the amount of references in the Bill of Materials. Keeping the number of internal references low is not always easy. Regarding the categories of products purchased, these are divided into four main groups: Goods, Services, CAPEX, CAPEX IT as demonstrated in Figure 7.

Figure 7: Categorisation of existent products and services

3.3   Control of Expenditures

With competition increasing globally, the healthcare business is no exception. Even though Unilabs is among the biggest private companies operating in the Portuguese health sector, it still faces competition. This forces the company to drive prices down to grab higher market share while coping to maintain its competitive advantage. If not monitored properly, expenses associated with the purchase of materials and contracted services can easily increase and drive the company to an unhealthy economic situation.

One important source of expenses is the cost of purchased products and services, as for any other enterprise. These have a great impact on the company's balance sheet. Being a services company in the Diagnostics business, the products bought are the raw materials used by the company to add value but only assist the work of both the human resources and machinery assets. As the value-added in the service is not related with the products used but with the expertise of the human resources and the advanced technology in place for testing the analyses, the goal of any business with this frame is to drive down the costs associated with purchasing activities as much as possible.

Monitoring these costs is the first step for the purchasing team to be aware of which products should be renegotiated in terms of prices whether because their price had been rising for some time or because the total purchased volume is growing and the price remains stable. However, it will be noticeable how unmethodical this was done before the project. Next, several situations will be exhibited where errors in the system make difficult the task of analysing the shifts in products' prices.

One reason why this control has not been done before is due to the low credibility of the data which is in the system regarding references details. It is also associated with the high flexibility of the ERP in the data input process. Thus, there is no process which defines how the information flow between departments and with suppliers must be done to secure that all the info is gathered and correctly inserted into the system.

The data input is associated with the creation of new internal references, which derive from the replenishment process. This process considers three distinct situations. In the first case, the product is new, the basic information regarding the product, such as designation is requested to the supplier so that this info can be associated with the reference in the ERP. In the second case, the product is not new but the entity in the system is not the desired one since the supplier is now selling the product in different quantities, meaning extra references will have to be created. In the third situation, it is a regular product with a reference already introduced in the system. The latter is the process which has usually less communication between supplier and buyer as both previously know the terms of the deal. This project will deal with the first two cases in more depth as they are the ones which require new inputs into the ERP system.

When looking at the data, some inconsistencies stood out. First and perhaps the most notorious was the existence of POs placed into suppliers without any price on it. The only situation where this is not done by mistake is when the supplier charges for their services in terms of quantity

of tests with a "correct" result. This means that they offer all the goods needed for the analyses and then charge only for the tests with a clear result, in other words, inconclusive tests are not accounted on these expenses since they need to be checked again. Apart from this, it could happen either because there was no pricing list inserted in the ERP system or the purchasing member did not include the price as shown in Figure 8.

Encomenda	Data_enc	Artigo	Designaca	Purchased Quant	Un_stock	Qtt_compr	Un_compr	Preco	Total
601	20/03/2019	100023	Product A	5,0	EMB	500	UN	€ 22,18	€ 111
818	02/04/2019	100023	Product A	5,0	UN	500	UN	€ 22,18	€ 111
945	16/04/2019	100023	Product A	3,0	UN	300	UN	€ 0,00	€ 0
982	26/04/2019	100023	Product A	1,0	UN	100	UN	€ 0,00	€ 0
1159	14/05/2019	100023	Product A	5,0	UN	500	UN	€ 22,18	€ 111
1158	14/05/2019	100023	Product A	5,0	UN	500	UN	€ 22,18	€ 111
1503	11/06/2019	100023	Product A	5,0	UN	500	UN	€ 22,18	€ 111
1937	23/07/2019	100023	Product A	10,0	UN	1000	UN	€ 22,18	€ 222
2210	13/08/2019	100023	Product A	5,0	UN	500	UN	€ 0,00	€ 0
2215	13/08/2019	100023	Product A	4,0	UN	400	UN	€ 0,00	€ 0
2239	14/08/2019	100023	Product A	5,0	UN	500	UN	€ 22,18	€ 111

Figure 8: Example of Purchase Order sent out without a price on products

One implication of these inconsistencies was that suppliers could charge whatever price they pleased since the purchasing staff sometimes did not have the information regarding the product's price. Another common error was using the same product reference but with altered information such as description and prices. There were cases where even in the same PO, the price for the same reference was different from each other. Figure 9 highlights these situations.

Encomenda	Data_enc	Artigo	Designaca	Purchased Quant	Un_stock	Qtt_compr	Un_compr	Preco	Total
1101	08/04/2019	100198	Product G	60,0	CX	60	CX	€ 40,71	€ 2 443
1101	08/04/2019	100199	Product F	10,0	CX	10	CX	€ 32,63	€ 326
1101	08/04/2019	100199	Product F	49,0	CX	49	CX	€ 32,63	€ 1 599
1118	22/04/2019	100199	Product G	20,0	CX	20	CX	€ 40,71	€ 814
1118	22/04/2019	100198	Product F	45,0	CX	13500	CX	€ 32,63	€ 1 468
1118	22/04/2019	100199	Product G	5,0	CX	5	CX	€ 40,71	€ 204
1118	22/04/2019	100199	Product G	10,0	CX	10	CX	€ 40,71	€ 407
1118	22/04/2019	100198	Product F	10,0	CX	3000	CX	€ 32,63	€ 326
1118	22/04/2019	100199	Product G	10,0	CX	10	CX	€ 40,71	€ 407

Figure 9: Reference with more than one ID

Sometimes the same product appears more than once in the same PO because the order can be split into different deliveries. However, different prices for the same reference must not happen even when deliveries are done in distinct days since the products are under the same contracted price on the PO. Nevertheless, there were still cases where this happens as Figure 10 illustrates.

Encomenda	Data_enc	Artigo	Designaca	Purchased Quant	Un_stock	Qtt_compr	Un_compr	Preco	Total
1356	28/05/2019	100875	Product J	2,0	UN	2	UN	€ 238,24	€ 476
1356	28/05/2019	100875	Product J	2,0	UN	2	UN	€ 234,73	€ 469

Figure 10: References with different prices in the same PO

To quantify the frequency of these errors, Table 1 presents the summarised information regarding the Clinical Analyses. All the data displayed is from 2019 yearly records of POs placed into suppliers.

Table 1: Errors occurrence

	Attribute	Total number of occurrences
General	Purchase Orders (PO)	16 076
	Rejected PO	404
	Different references	3 171
Errors	PO without price	916
	References with several ID	274
	References with different prices in the same PO	36

3.4 Information Flow

With the multitude of businesses currently in the portfolio of Unilabs and workload associated with the replenishment activities regarding the high number of sites across the country, the focus was rather on running the daily business instead of standardising the master of products. The only change which was being made was the normalisation of the reference codes which were different for each company acquired by the group. A good step into a more standardised coding concept, however, by itself, this does not solve the problems associated with the lack of data or divergence of data uploaded into the system. This provokes, on the one hand, delays in the replenishment process as the orders placed to suppliers asked for a specific quantity is perhaps lower than the minimum order quantity demanded by the supplier. On the other hand, the divergence of data in the system regarding prices for the same product with duplicate references results in price variations which were not supposed to happen. These price variations can also happen due to an increase in prices from the suppliers.

There is no procedure or method which explains how a reference should be created and which fields in the ERP system are mandatory to fill and even more important, what measures can be taken to transform the system into a fool-proof one so that no errors are committed during the creation of a new reference. Within the ongoing recoding process, every member of the purchasing team who needs to place an order referring to an existing product which has the previous code format must create a new reference and the ID of the product reference is sequentially generated in the new format. However, all the commercial data such as minimum order quantities, multiples and even prices are not verified or updated during this process. After this, the staff member can place the intended order to the supplier. The POs are often rejected by the supplier due to errors respecting quantities or the description of the product when it is not the one used by the supplier.

There is also no process in place regarding the information flow when there is a possibility of starting to purchase a new product, therefore a new internal reference is needed. New products are adopted for various reasons, the most common ones being:

- Current supplier stops the production of the product;

- Current supplier changes the product (technically or commercially);

- New equipment and methods require new products;

- New products in the market demonstrate better performance.

Although not written down, the process performed subconsciously is often one of the following two.

Alternative A: Usually, the directors of the technical areas keep close relationships with suppliers since they are the ones present in the workplace when maintenance actions or training events take place. So, when the need for a new product emerges, the directors get in touch directly with some suppliers to discuss alternatives for the product in need. Here, more technical information regarding the product is transferred from the supplier to the technical area's staff. Typically the supplier provides the product datasheet - where the physical characteristics of the product are reported. Besides, in terms of tests or reagents, it is common to provide studies where the requested products were tested, with this the buyer has a more realistic view regarding the product's performance.

After all the options are examined and one is chosen with medical supervisors approval, the technical area's director notifies the purchasing department of their intent of introducing a new product. If not asked before or given by the supplier, the purchasing staff have to request from the supplier a quote for the product. When in possession of this information, the purchasing staff compare the price with the product currently in use and calculate the impact of this change in terms of costs. After this is done, it is discussed with the person who requested the change in the technical area if the variation in expenditure is compensated in theory by the change in performance and then a decision is taken, always with the approval of the purchasing director.

1. Request for technical information
2. Supplier delivers product datasheet
3. Technical area informs purchasing about the interest in a new product
4. Purchasing asks for a budget
5. Supplier answers to the RFQ
6. Decide based on a cost-benefit analysis
7. New reference created and order placed

Figure 11: Alternative A: information flow
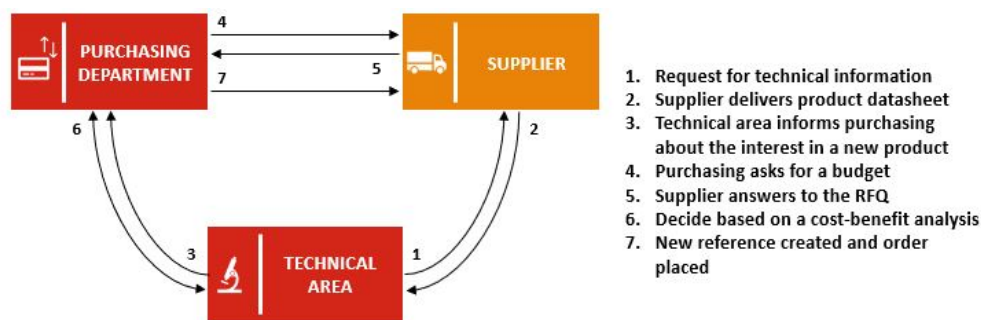
Alternative B: When the demand for a new product arises and the directors of the technical areas have no idea of whom to contact to get a substitute for the product currently used, they ask the purchasing department for help in the market search task. Usually, this division is capable of finding a handful of suppliers who can potentially provide a product that can substitute the one

in use. After having a shortlist of possibilities, the purchasing staff asks for a quote and, in some cases, for technical information, in most cases, only the product datasheet. Thereafter, when in possession of this information, the purchasing team shares the technical data with the person who sought the substitution, while evaluating the budget and the resultant impact of this change in total expenditure. The change is sometimes discussed together with both the purchasing staff and the technical area until a consensus is reached. After both sides agree, the new reference is created and the PO is placed with the chosen supplier.
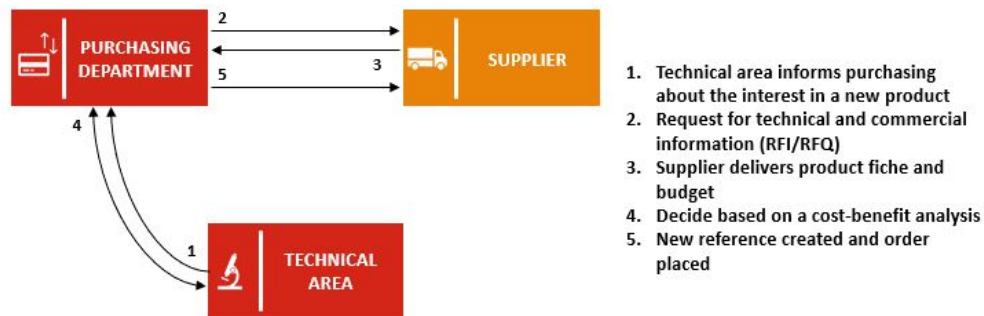

Figure 12: Alternative B: information flow

Next, the current problems regarding the information flow in place and the external environment around them will be drawn with practical examples for each of them.

1. **Lack of accountability** of managers whether on the purchasing side or on the technical side: without these validation points, no one is held accountable for the success or failure of the task, in this case, the substitution for a new product. For the time being, managers do not even have to send an email confirming the need to substitute the product, leaving an unknown gap in the accountability of every substitution;

2. **Lack of standard** regarding the actual information flows: this makes the task of purchasing staff more difficult as it will be shown in the next bullet;

3. **Disorganisation** shown: having more than one point of contact with suppliers, in this case, different departments keeping contact with suppliers is unsatisfactory because, in the first place, it clearly demonstrates the lack of communication and organisation inside the company and secondly, the supplier can take advantage of these situations.

One important step in the information flow process is the actual input of data into the ERP system when creating a new internal reference. Since the ERP integrates the core tasks of the business such as order placement, pricing and consumption of products, among others, it is rather important to feed the system with good data, otherwise, the results are poor and more problems will eventually arise.

The next section presents how the ERP is designed for the creation of new references and also several examples of how data is improperly inserted will be displayed.

3.5   ERP

Having several people, which come from different businesses inside the main company, from different realities and, more importantly, having no procedure to guide them, it becomes harder to get consistency in the data inserted by different people into the same software. This inconsistency in data is magnified by the "openness" of the system - the system flexibility which allows the user to insert any type of character in every field. Even though seen as flexibility for the user, the complete freedom the users' experience in the moment of entering new data results in difficulties in the data processing stage afterwards. Although there is no procedure written down of how one should fill each domain with correct data during the reference creation phase, there are some fields which are seen to be essential and therefore mandatory to be filled by the user.

The fields that every purchasing staff member needs to fill out in the database are scattered into three different tabs, namely the Main Registry, Information and Financial. Now the fields will be categorised as mandatory or non-mandatory. Regarding the mandatory fields, a more thorough analysis of how the mandatory domains are currently completed will be conducted, whereas regarding the non-mandatory ones it will be argued if they should be considered mandatory or if at least there should be given indications to fill out whenever possible those areas.

Mandatory Domains

In the Main Registry window, as the name states, there are some of the principal information about the product. **Designation:** the technical name of the product, usually the same name as suppliers exhibit in quotes. **Family:** refers to the category of products the reference fits in. It is chosen between the available and pre-determined options. There is one other field that is directly linked with Family, leaving the user unable to determine its value, which is **Type of Good**, characterising the good as being a commodity, for instance. **Minimum and Maximum Stocks** are also mandatory to fill. However, these are seldom filled with correct numbers since the purchasing team has no idea about these quantities. There is one checkbox field which is **Mandatory Due Date** which is relevant for chemical products for example. One already pre-determined field is the **Analytical Hub** whose options are specified by central Unilabs. These options concern the specific area where the costs shall be allocated, for example, X-Ray, Ultrasound, among others. The last domains present in the Main window refer to the presentation (both the look and numeric quantity) of the product in two distinct forms: in which quantity is the product purchased and stocked. For these, it can be inserted the type of package of the product - tests, bottles, etc. Then, quantitatively, a **Conversion Factor** refers to the relationship among both. The **Conversion Factor Units-Entity** represents the number of entities - tags - that will be created for each stock unit and consequently attached to each stock unit. The latter relates to the usual quantities consumed. For example, one secondary box of masks delivered by a supplier has 2000 masks inside. However, inside the secondary box, there are 40 primary boxes with 50 masks each. As the consumption of this item is generally performed one primary box at a time, the entity created should be for each minor box.

Hence, the Conversion Factor would be 2000, while the Conversion Factor Units-Entity would be 40. Therefore, 40 different tags would be printed and attached to the box.

Regarding the remaining windows, there are some other fields which are compulsory to fill. In the Information window, these are the **Brand** which specifies the manufacturer of the product and **Technical Area** which indicates the division of the department where the product is consumed. In the Financial window, **List Price**, the price associated with each purchased unit without taxes that the supplier charges for its product, is the sole information required.

Table 2: Mandatory fields in the creation of new references

Field Designation	Description
Designation	Technical name of the product
Family	Categorisation of product concerning its technical nature of use
Type of Good	Categorisation of product concerning its nature of use
Minimum and Maximum Stocks	Limits of inventory levels accepted for each SKU
Mandatory Due Date	Y/N options - relevant for chemical and perishable items
Analytical Hub	Categorisation of product concerning its nature of expenditure
Conversion Factor	Quantity of items each stock unit (box) has inside
Conversion Factor Units-Entity	Quantity of entities (tags) created for each stock unit
Brand	Name of the manufacturer
Technical Area	Place (inside the company) where the product is used
List Price	Actual supplier's price (without taxes)

Other Useful Domains

Apart from the data that is already required to be inserted into the system while creating new references, there is still some information which could be useful downstream in terms of inventory analysis and order planning. In the Main window, fields like **Minimum Order Quantity** and **Multiples** are key for placing correct orders to suppliers. In the Information tab, both **General Location** - designation of the pretended warehouse - and **Line and Rack** - specifies the coordinates where products are located. To estimate the shelf area that the product will occupy, one needs to predict its consumption with the help of the technical areas. In the Description area, the **Technical Info** domain is rarely used and when used, it is for other purposes, to alert for the existence of the same product in other presentation units (Conversion Factor), consequently different internal references. Fields like **Lead Time** and **Discounts** are located in the Integration area. This can be of important use, one for the order planning and the other for simplification of order placement, respectively. Despite this, currently, these fields are rarely filled.

Table 3: Other important fields in the creation of new references

Field Designation	Description
Minimum Order Quantity	Lowest quantity accepted by the supplier in an order
Multiples	Ordered quantity must be multiple of this number
General Location	Designation of the warehouse where the product will be stored
Line and Rack	Exact location of product inside the warehouse
Technical Info	Product datasheets
Lead Time	Number of days the supplier typically takes to deliver the product
Discounts	Percentage of the discount made by the supplier

Regardless of the existence of certain fool-proof actions, such as mandatory fields, looking to the examples aforementioned, there is clear evidence that they are not enough to preserve the authenticity of the information in the system. Perhaps, these errors happen due to the non-existence of a formalised procedure to follow when the creation of a new internal reference is needed. Adding to this, with the acquisition of several companies, people within the purchasing team coming from different companies were used to do things their way, so in Unilabs' reality, they continue to follow their method.

In the designation field, both the technical name of the product and the supplier's reference is often inserted together, even though there is a specific field for the latter. Staff claims that afterwards, it is easier to find the reference if it is the same as the one shown in the supplier's quote. However, the software allows you to search both by name and by supplier reference. Relatively to the commercial information that is missing for most products in use, this creates the same problems addressed in the process of renewing internal reference codes.

Much of the information that is incorrectly uploaded or sometimes not even included, is not in the purchasing staff possession most of the times. Despite knowing things such as the pricing and supplier's reference ID and name, they do not know where the product shall be stored inside the warehouse, for instance. This highlights the lack of collaboration between departments in the creation of the new references and no process is "binding" them. There is also a lack of description for each field saying what kind of information should be included.

The absence of this relevant data has its known problems downstream in the process when orders are placed into suppliers with wrong information. This results in extra and unnecessary contact between buyer and suppliers to fix the errors that would not exist if the data was already correct in the system. Trying to cope with all of these issues, a collaborative solution will be presented in Chapter 4.

Despite Technical staff being more often the ones who request for changes in terms of goods and, consequently, the creation of new internal references, there are still other triggers. It would be interesting to analyse more deeply how the purchasing can play an important role in this matter.

The need to introduce new products in the system by the purchasing members may arise when the price of specific products is not appealing, in the sense that either it has been consistently increasing for the past years or it has remained unchanged while the volume of purchases has been

growing. This should trigger a renegotiation of prices with the current supplier while a market search is carried out to understand what other alternatives exist in the market.

Today, the only actions done towards prices renegotiation with suppliers are not more than a simple request for a suppliers' lowest possible price. Moreover, the only tool managers currently use to look for possible price reductions is the total purchase volume by the supplier, even though this might not show which suppliers are constantly raising their prices. With the current conjecture, there is not a tool which alerts when the price of a specific product shift .

Hence, to correctly analyse price variations, first, a process in place is needed to better collect essential data as inputs for the ERP. Also, a few modifications in the system might be handy to make it more of an error-proof system. With the information properly inserted, it is possible to track price variations in the designed price control system. This lack of visibility regarding expenditure, both in terms of total volume and variation, is present not only in goods but it also spreads into services.

3.6   Services Cost Monitoring

Unilabs concentrates a substantial share of expenditure on services. Services are divided into the categories shown in Figure 13. Among these, there are services which are more related to the business, meaning that they change according to the development and growth of the company, such as Energy or Specialized Services, whereas the rest are more associated with workers' spending. The latter includes the Other Services segment which had expenses of over three million euros in 2019. Being the second most costly category of services and being dependent on workers usage, it is worth looking for improvement and cost reduction.

Figure 13: Categorisation of Services' Expenditure

Within the Other Services, all the sub-segments were graphically plotted according to both the expenditure and monthly average percentual variation. This will indicate which services have a greater positive increase in monthly expenditure and at the same time, among these, which ones are more relevant in terms of total expenditure. This metric results from the division of monthly average variation by monthly average expenditure.

Figure 14 emphasises the pattern of spending in terms of telecommunications since early 2019. Among the services which show a positive increase in terms of costs, the one with the highest variation is the Representation Costs. These are not so relevant if one looks to the expenditure axis. On the other side, there is Real Estate, which comprises rents and rentals. It is the highest segment in terms of total expenditure as Unilabs' infrastructures are almost always leased and not owned by the company. Despite being the most costly service, its variation is not as high as the one from telecommunications. Also, rents typically tend to relate more to the business than to individual spending, being more difficult to cut costs in the short term. This leaves communications as the section with considerable change in monthly spend and high impact on a company's Profit and Loss statement (P&L). Therefore, this is the section chosen to initiate control over services costs. Next, a brief description will be presented so that it becomes clearer why these cost control initiatives are needed.
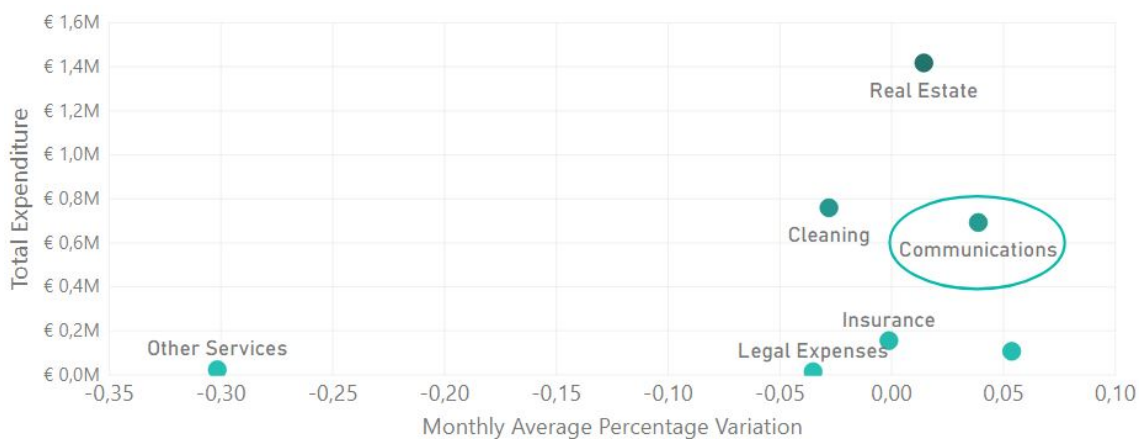

Figure 14: Mapping Other Services according to Percentual Variation and Expenditure

Moreover, telecommunications have become a great concern in the department since the total expenditure had been rising for the last months, more than normal, even considering the acquisitions Unilabs had done in the same period. These had not been thoroughly analysed until recently since its payment was done automatically.

Almost until the end of 2019, telecommunication expenses were in charge of the IT department. After that, its responsibility changed to the purchasing department which knew barely anything concerning these services and its suppliers. At the beginning of the project, the telecom panorama was dissociated and decentralised.

Dissociated since the contracted services from every company within the Unilabs group were spread among the three main suppliers of telecommunications in Portugal: Supplier A representing 77% of total expenses, next Supplier B with a total of 20% and lastly, Supplier C with the remaining 3%.

Decentralised since some companies from the group still had its services and invoices checked by their accountants, not passing through the scrutiny of the purchasing department. At this time, the payment was automatic and without any approval. This means that even if the purchasing staff

found some discrepancies in the invoice, the actions taken would be slow and it would be difficult to detect every anomaly since the only monitoring in place was being done through the scanned invoices. These disparities happened to a certain extent due to the absence of limitations in the contracted services: in other words, ceilings did not exist.

It is important to note that the integration of services into one unique supplier might be tricky for two reasons. First, the predominant supplier, in this case, Supplier A does not possess optimal infrastructures for telecommunications in every location of the country, therefore, some remote places where Unilabs' Care Units are placed can not be supplied by Supplier A. Secondly, the acquired businesses often had signed contracts with the corresponding supplier for a while. This means Unilabs is not able to switch suppliers overnight.

Moreover, data can be collected from the invoices and also, some suppliers have the option of downloading the invoice electronically which helps on data transformation and finally, monitoring. Top management was suspicious of abusive billing and uncontrolled spending from employees which contributed also for this topic to be tested in terms of cost control and monitoring in services.

Although Supplier A provided, for some companies within the Unilabs group, the invoices from the last six months in their online platform, this data was not analysed. One example of the invoices, which can be downloaded in a CSV format, is presented in Figure 15.

```
"Detalhe Movimentos"
"Movimentos";"Quadro";"Conta";"Conta/Número";"Plano Tarifário";"Descritivo";"Valor sem IVA"
"Movimentos";"Serviços adicionais";"4.1311.12.10.100000";"93xxxxxx7";"Plano Corporate";"Subscrição semanal MB Phone";0,441
"Movimentos";"Serviços adicionais";"4.1311.12.10.100000";"93xxxxxx7";"Plano Corporate";"Subscrição semanal MB Phone";0,441
"Movimentos";"Serviços adicionais";"4.1311.12.10.100000";"93xxxxxx7";"Plano Corporate";"Subscrição semanal MB Phone";0,441
"Movimentos";"Serviços adicionais";"4.1311.12.10.100000";"93xxxxxx7";"Plano Corporate";"Subscrição semanal MB Phone";0,441
"Movimentos";"CRÉDITOS/DÉBITOS E DESCONTOS";"4.1311.12.10.100000";"91xxxxxx9";"Plano Corporate";"D_Correção Mensalidades Dados";15,000
"Movimentos";"CRÉDITOS/DÉBITOS E DESCONTOS";"4.1311.12.10.100000";"91xxxxxx8";"Plano Corporate";"D_ROA 500MB SUIÇA 1+1 ADHOC";50,000
"Movimentos";"CRÉDITOS/DÉBITOS E DESCONTOS";"4.1311.12.11.100000";"93xxxxxx0";"Kanguru 4G 50 Corp";"Desconto Assinaturas 20%";-3,000
"Movimentos";"CRÉDITOS/DÉBITOS E DESCONTOS";"4.1311.12.11.100000";"93xxxxxx2";"Kanguru 4G 50 Corp";"Desconto Assinaturas 20%";-3,000
"Movimentos";"CRÉDITOS/DÉBITOS E DESCONTOS";"4.1311.12.11.100000";"93xxxxxx7";"Kanguru 4G 50 Corp";"Desconto Assinaturas 20%";-3,000
"Movimentos";"CRÉDITOS/DÉBITOS E DESCONTOS";"4.1311.12.11.100000";"93xxxxxx8";"Kanguru 4G 50 Corp";"Desconto Assinaturas 20%";-3,000
"Movimentos";"CRÉDITOS/DÉBITOS E DESCONTOS";"4.1311.12.11.100000";"93xxxxxx2";"Kanguru 4G 50 Corp";"Desconto Assinaturas 20%";-3,000
"Movimentos";"CRÉDITOS/DÉBITOS E DESCONTOS";"4.1311.12.11.100000";"93xxxxxx1";"Kanguru 4G 50 Corp";"Desconto Assinaturas 20%";-3,000
"Movimentos";"CRÉDITOS/DÉBITOS E DESCONTOS";"4.1311.12.11.100000";"93xxxxxx7";"Kanguru Corp 7.2";"Desconto Assinaturas 20%";-3,000
"Movimentos";"CRÉDITOS/DÉBITOS E DESCONTOS";"4.1311.12.11.100000";"93xxxxxx0";"Kanguru Corp 7.2";"Desconto Assinaturas 20%";-3,000
```

Figure 15: Invoice available on CSV document

This structure makes the analysis more difficult. Apart from these, no data was in an electronic format since all the remainder invoices were only available in the document management platform in the form of scanned PDF's.

There was a lack of knowledge regarding this area that did contribute to the unawareness of what could be the source for consecutive and significant increases in costs. The complexity of the invoices as well as the variety of services offered by the suppliers also contributed to the difficult understanding of the invoices. These contributed to a certain extent to the lack of monitoring regarding communications.

The main problems related to the telecommunications area were identified as follows.

1. **Invoice format** did not help the managers to quickly work with the information given by the suppliers as the data was not electronically available;

2. **Outdated tracking of services and equipment** distributed across the various companies. It becomes difficult to match the equipment to the user to track individual spending in terms

of extra services such as data usage. This is relevant since one reason for the high variation in telecom spending is attributed to this extra individual expenditure;

3. **No process for returning equipment** in place for workers who recently had left the company. This means Unilabs was paying for services from ex-collaborators just because it would not be communicated to the supplier that a specific account could be cancelled or transferred to the individual's account;

Chapter 4

Improvement Initiatives

4.1 Information Flow

All the aforementioned issues originated from the same root cause, which is the absence of a defined process for creating new internal references. Creating one would ensure that the consistency of data would be kept in the future and therefore it was the first focus of this work. A tool where every procedure, inside the major process of creating new references, is mapped and the flows of information transferred between technical departments and the purchasing department are visible.

First, it is important to identify the players which may demonstrate an interest in creating new references. This is highly linked with which teams own information that is necessary to insert into the ERP system. This stage has had some iterations. At first, only the technical and purchasing staff were thought to be of interest. Afterwards, to gather all the info needed to furnish the master of products with the expected data, apart from the purchasing and technical, also the accounting, warehouse and inventory management staffs were considered to be essential parts of the process in terms of inputs and knowledge sharing.

Secondly, validation points are required so that employees are held accountable for their decision-making. In this case, both the purchasing and technical area's directors need to approve the requests for the creation of new references. The staff members responsible for providing the information relative to the product will also need to be identified. This action aims to effectively correct possible mistakes and these are not repeated thereafter. Along with deciding when to perform these validation actions, it is also necessary to choose who is held accountable for them.

Next, several alternatives, commonly used to show how processes are carried on in practice, were evaluated considering the actual situation. The options taken into consideration were: Responsibility matrixes, namely RACI, Flowcharts and Swimlanes. RACI matrixes are typically used for processes which involve several players, need a significant level of detail regarding actions and usually, these players have different roles. On the other hand, Flowcharts, being more graphical, have the advantage of clearly define processes and add decision-making blocks. But its disadvantage results from the fact that it is not capable to map inter-department activities/flows, which in this case is important. Swimlanes combine two features of both, clear and more visual

flow of processes while being able to capture inter-department actions. Since interactions among departments are required and process visible, a swimlane chart was selected to map the processes regarding the creation of new internal references: from the need to upload into the ERP system.

The final stage was the creation and design of the swimlane itself. To do this, there was a need to choose how interactions between departments ought to be conducted. From communication, through validation steps until the collection of product's information required for the creation of a new reference, all of these tools had to be chosen.

The final design of the swimlane is described as follows (Figure 16). The trigger of this process is the appearance of a new need for the technical department. As the focus of the project is concerning the Clinical Analysis and the technical departments for this Business Unit can be the different departments inside a lab, the need for a new product can be caused by several reasons. For instance, the product currently in place is not performing as expected and the technical staff considers a substitution or suppliers introduce new techniques and methodologies that require different products in the process and, therefore when these new techniques are adopted, new references shall be created and new products bought. Additional reasons for creating new references can be, the supplier ceases to produce the product the lab is currently using and will begin to produce a new one or simply because the package is now different and the amount of units supplied in each primary unit is different from what it used to be.

The first validation point should be right after the need is identified by the technical staff. It comprises both the technical staff who is seeking to add a new product and his director. Here, a discussion about the relevance of this new product in technical terms, such as performance shall be held. If the manager does not agree with the introduction of a new product, the process ends right away. Otherwise, a form with information regarding the product in need must be electronically filed, approved, and sent to the purchasing department, so that the next step, sourcing, can be performed. A draft of this form can be found on the Appendix B.1 and contains information regarding the causes which justify the need for a new reference, as well as the name of the product and suppliers which might be able to supply this new product.

During the market search, apart from the common info requested to the suppliers, such as price, designation, supplier's reference, among others, all the suppliers have to state the minimum order quantity; multiples of units to be ordered; discounts. Additionally, if requested by the technical area, studies regarding product performance shall be asked as well.

Next, the purchasing staff will do a simple cost-benefit analysis where the price and performance of the different products will be compared with the currently used product. This will be presented to the Technical Department's Director and discussed whether the found alternatives are better than the one in use. If the decision is that the change of product does not represent a significant improvement, another question shall be asked, which is: Are there any other suppliers in the market that may supply these products? If so, another market search should be performed, and the process repeated. On the other hand, if there are no other known suppliers in the market, the process ends. If adding the new product to current activities bring benefits to the technical process and is economically interesting, and, in the end, both the Department and Purchasing Directors

validate the introduction of a new reference, the process goes forward.

It is time for purchasing staff to add the info of the new product in the online platform, which will be presented next, and notify both the warehouse and inventory management teams so that they can add the information which they are responsible for. After all the information is collected, the purchasing staff can successfully create a reference in the ERP system.
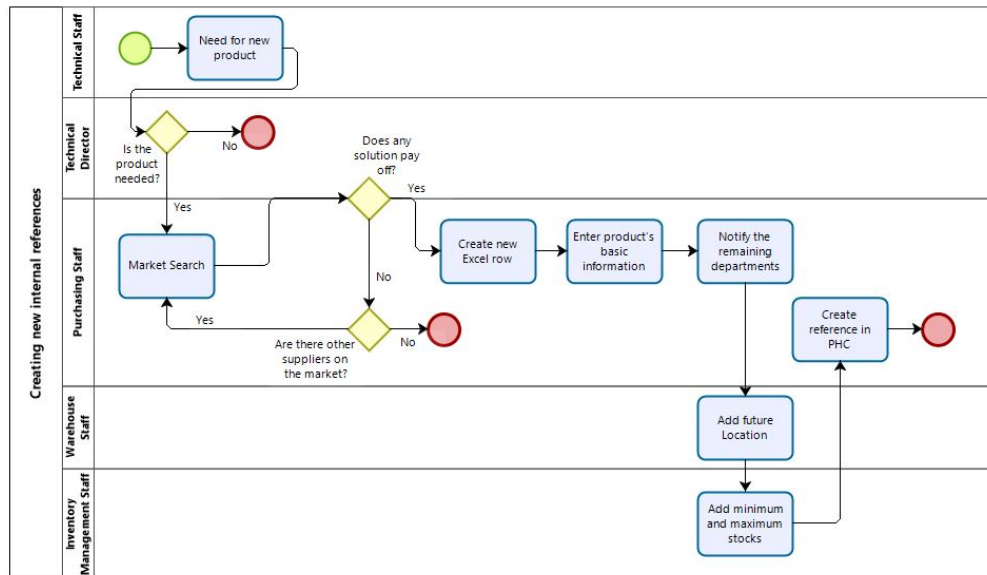

Figure 16: Technical Trigger Swimlane

With these actions and tools used, several improvements are expected such as:

- **Swimlane:** standardise the entire process of creation of new references which was, in the past, performed *ad hoc*;

- **Approvals:** hold accountable the participants in the process for their decision-making. At the end, more reasoned and correct decisions are awaited;

- **Online platform:** simplify and improve the transmission of data in a more transparent way. With this, the ERP is expected to be fed with more accurate and reliable information. Along with this, time spent to rectify orders is expected to lower close to zero.

4.2 Materials Price Monitoring

This section aims to explore the potential of cost reduction in negotiation, more specifically on the physical goods of daily consumption. It also points out what the purchasing staff can expect to achieve in terms of cost reduction. Typically, price negotiation relative to existing references comes to the managers' minds when one of the following things happen in a specific product:

- **Price is consistently rising** for a certain time;

- **Purchased Volume** (quantity-wise) is steadily increasing while price remains unaltered.

There are certainly other reasons which should trigger renegotiation, namely the decrease in commodities' prices and the supplier leaves the product's price unchanged. For instance, paper pulp price decreasing and the price of products such as stationery rising which makes no sense. Despite not being treated in this project, this trigger will be addressed in the future work section.

To find these patterns quickly and noticeably, the existing data regarding purchases shall be examined. This was done according to the following steps:

1. **Collect** the data from the ERP relatively to what has been entering the main warehouse since the beginning of 2019. This was the period chosen since, before this, the dimension of the group could not be compared to the one in place today as the latter significant acquisitions were made at the end of 2018;

2. **Understand** the data: identify situations where there exist differences in prices (for no apparent reason) when compared with the remaining orders. Other similar situations were also encountered;

3. **Prepare** the data to be used in the analysis. After identifying all the odd situations, it was time to transform and leave aside info which does not contribute to the analysis. For example, POs with null price are not going to be taken into consideration;

4. **Modelling** the data;

5. **Build** a dashboard which will highlight both variations in products' price and purchased volume.

Relatively to data gathering, all the info regarding materials expenses was extracted directly from the ERP for the year of 2019 until the beginning of 2020. After looking at the data, as proved with the examples of discrepancies in the previous chapter, the ERP is perhaps more flexible than desired since its openness jeopardizes information quality in the system downstream. Without this being fixed, it becomes difficult for any system to identify patterns in products' price variability. Despite these issues, there was still data in the ERP which can be worked with.

So for the noisy data not to be included in the analysis, some were left apart. First, the references with null price were discarded. Secondly, as stated before, there was going on a renovation of products' references in terms of its description so that they would become standardised. These references are created sequentially and characterized by having 6 digits starting from in the reference "100000". All the references which did not follow this structure were left out of the analysis since many of these were inherited from one of the acquired companies and were not currently in use.

After these procedures, the data could be treated and the system model. It became necessary to develop a tool that helps the purchasing team members to easily identify products where the price should be renegotiated due to the reasons initially considered.

The models were divided into price and quantity variation by product. Afterwards, it was discussed whether it would be interesting having the same analysis by supplier. The latter was only done using quantity variation since the average price could not be compared across time since products are not all bought with the same frequency. Next, the analysis conducted by product is presented.

Regarding price, its variation was measured annually as the purchasing team members claimed that the price increases typically happen at the beginning of the year.

To reach the measure of price increase, a measure of the year on year change was used, which compares the average price of the product registered in the year in question with the previous one. To track product references with the highest variations from 2019 to 2020 and the greater volumes of purchased products (€), a scatter plot exhibited in Figure 17 was built. To only display the most important cases, it was asked to present only products whose total purchased volume was over 2.000€ and the Price Annual Variation higher than zero. With these constraints, the search is narrowed down, simplifying the task of the manager.
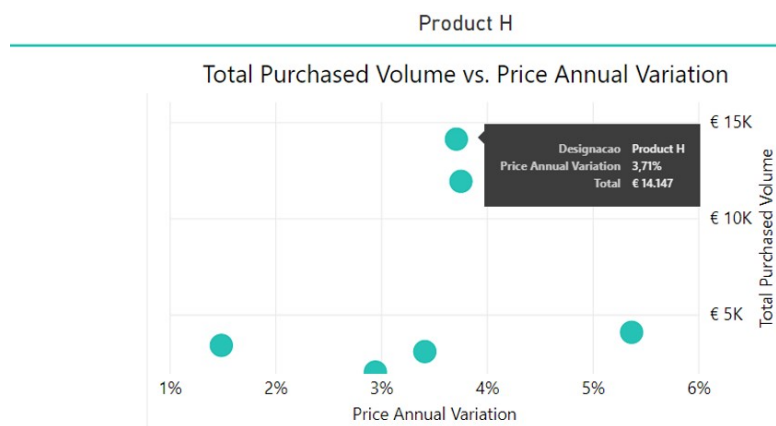

Figure 17: Scatter of products according to Price Variation and Total Purchased Volume

Now, it becomes clear that this product, "Product H" have been affected by price increases and will impact significantly the total expenses since it is one product with a significant volume of purchases monetarily. To get a better view of the price pattern across the last months, one line chart is also developed to detect when these shifts in price occurred. This chart is illustrating in Figure 18 the example of "Product H" price variation.
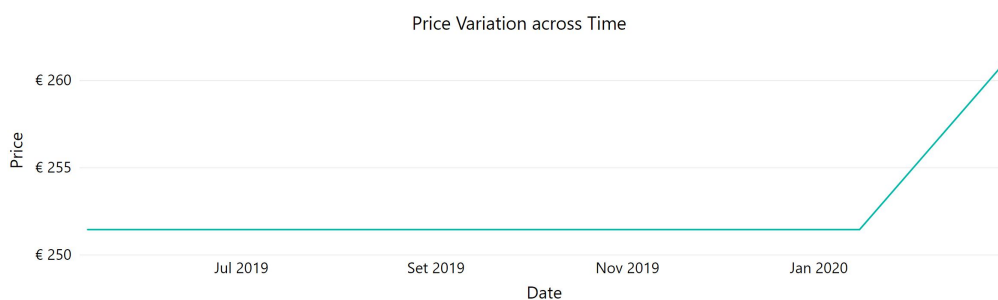

Figure 18: Product H Price evolution

This is a good example of a product which would surely draw the manager's attention as it presents a small variation in price, but it accounts for a substantial amount of volume purchased.

With the given data, it was possible to track examples where the tool would be useful as demonstrated with "Product H". The variation of "Product H" price was verified in practice since the supplier notified the purchasing department, at the end of 2019, that the prices of some products, including "Product H" would be raised close to 4%. Although these changes were previously informed by the supplier, some others might not follow the same path. It illustrates the level of information that the visualisation tool can bring to the purchasing manager. It gives a complete overview of how material costs are evolving across time.

The other trigger to ask for closer analysis is the steadiness of prices in products which had been consumed in greater quantities, which normally tends to give a higher negotiation power for the buyer.

To compare the evolution of quantity, first, the period to compare was in need to be defined. Using yearly variations would be rather difficult to track changes in purchases, whereas monthly would be too sensitive to changes as not every product is purchased monthly and would not portray useful patterns of variation. Quantity variations are tracked quarterly as it was discussed with the team to be the best option.

These variations are comparing consecutive quarters as the purpose of this analysis is to track situations where, across time, the purchasing department is ordering more products and product price remains stable. This pattern, when observed over several quarters, should draw the attention of the manager for a coming negotiation. The data which reliably represents the current situation for the company in terms of purchased products restricted the analysis for the period after the beginning of 2019. With this restriction, it would be difficult to set comparisons among homologous quarters, even though this would be a more rigorous approach.

To track these variations, one simple linear regression was first designed. After getting the equation relative to the total quantity variation, the next step was to extract the slope of the line - quantity slope. This is one way to express, in numbers, the fluctuation of numeric variables. A positive slope means that the quantity tends to increase across time, whereas a negative slope will show the opposite trend. The linear regression was performed with the ultimate goal of obtaining the slope which would help to understand whether the variation was positive or negative. There was no intention of predicting future prices with this model, only to detect past trends of price evolution.

One way to achieve cost reduction is trying to renegotiate products with a great purchased volume since a small reduction of price will translate in considerable savings. Sometimes with agreements involving rappel actions, meaning the buyer will get discounts based on the yearly purchased quantity. This is currently done just for a handful of products but could potentially be done for many others with the ambition of reducing costs in high-volume products. A scatter plot with both the total purchased volume since the beginning of 2019 and the quantity slope was built. Now, products with high quantity increase over time and considerable expenses show up as cases which may be interesting to renegotiate. The scatter chart is shown in Figure 19. Some filters were

added so that only the most relevant cases would show up in the analysis. Products with a total purchased volume over 50.000€ were displayed. Moreover, just positive total volume slopes were presented as well since the purpose of this analysis was to verify if any products were bought in more quantities and the prices remained steady.
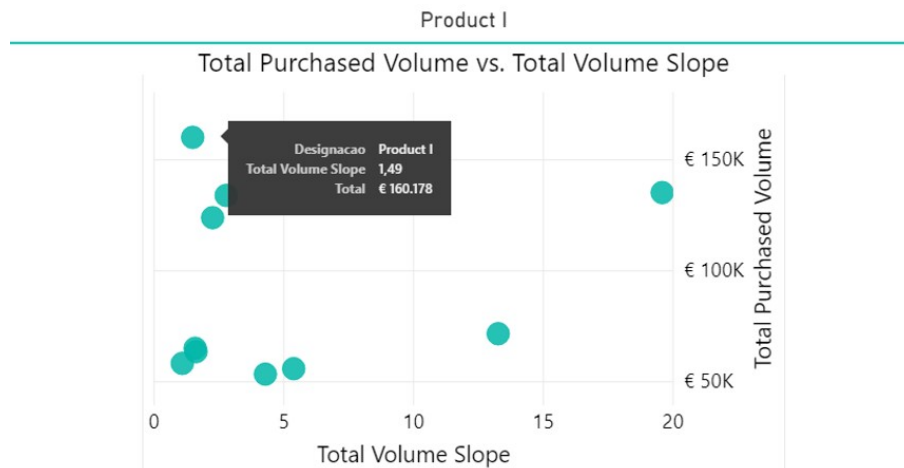

Figure 19: Scatter of products according to Volume Variation and Total Purchased Volume

Positive variations in terms of quantities purchased are presented in the graph. The ones which matter the most are the ones which represent more in terms of costs, namely "Product I". In Figure 20 it is possible to understand how these expenses are increasing over time.
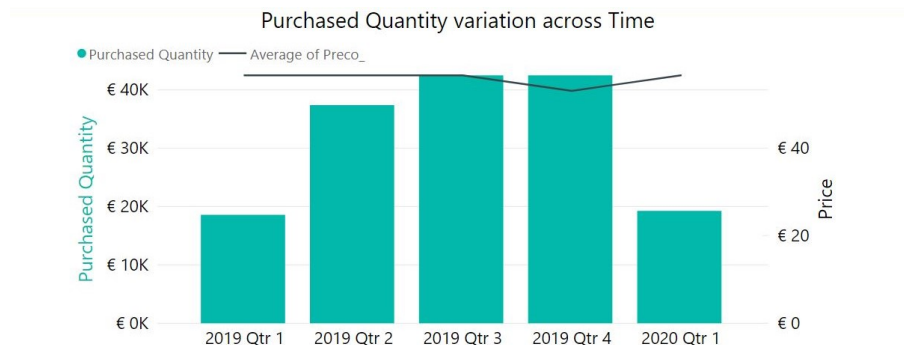

Figure 20: Product I Volume evolution

The volumes purchased in the last quarter are not following the pattern since the available data at the time of the analysis did not contemplate the entire first quarter of 2020. Even though, the increase in quantities purchased is clear. This can help the purchasing staff to know which products should be renegotiated.

For the purchasing manager to be able to see the big picture, an additional analysis, similar to the previous one, was conducted by supplier. First, the scatter presented in Figure 21 will show which suppliers had a positive variation in terms of total volume purchased while also giving the

information regarding the total amount purchased so that the manager can prioritise its renegotiation actions. In cases where the expenditure with the supplier is considered valuable, the discount granted by the supplier due to the renegotiation can bring a notable saving.
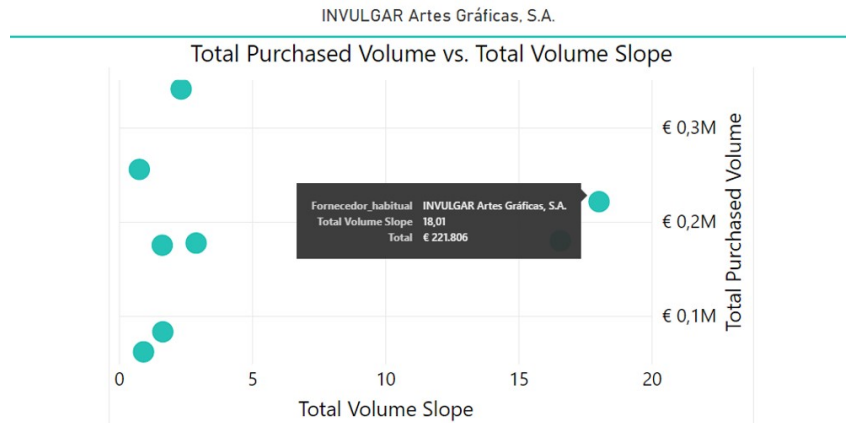

Figure 21: Scatter of suppliers according to Volume Variation and Total Purchased Volume

Take Invulgar as an example, it sells office supplies and stationery. Its total volume had been drastically rising. This increased can be observed in Figure 22.
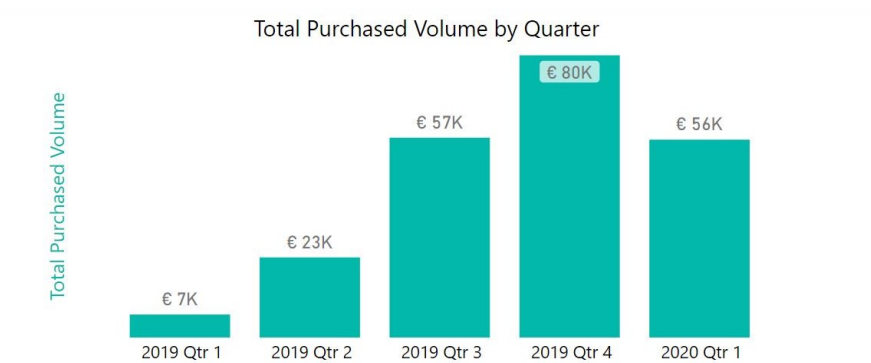

Figure 22: Invulgar Volume evolution

Although not the best method to track all the different patterns that both quantities and prices can have, it is a good start to control the costs of materials. Consequently, it is expected that renegotiation with suppliers can be done more regularly which will translate in cost reductions to the group. Getting discounts from suppliers, such as Invulgar, for its products can easily translate in a cost-saving of over 10.000€ after one year, considering a plausible 5% discount. Extrapolating this to other suppliers whose products have been purchased in more quantities, it is expected to achieve a considerable amount in cost reduction. Price variations like "Product H" example are common due to ordinary inflation. Here it is more difficult to quantify the improvements.

As initially mentioned, not only materials price are lacking the monitoring needed in a company that Unilabs already possesses. This absence of control is also noted on services. Next, another model and visualisation tools will be presented.

4.3   Services Price Monitoring

This section will demonstrate how the increase in costs in the telecommunications area can be partially managed. First, the model was prepared and built and then the visualisation tool was developed to fit the requirements of the purchasing director.

A new database regarding telecommunication services, more precisely mobile phones, was developed from an outdated database, named Telecommunication Equipment Database (TED). The intention was to map all the mobile phone numbers appearing in every invoice from the three different suppliers with some of the following information: **number**; **name** of the user; **role**, **area** and **BU** under which the user is working; **supplier account** to which the service is associated; **Unilabs company** within the group which the supplier account is associated with; **service description**; **total cost**; **supplier**; **type** as being mobile phone, internet, etc. Information regarding name, role, area and BU was gathered with the help of BUs directors and with the people accountable for every Unilabs company when needed. The latter helped both to make the right match between every mobile phone and its user and to map which mobile phones services could be either cancelled or asked for portability. These were either service concerning workers' relatives (since one of the companies used to pay for their workers' close relatives communications bills as a bonus for employees) or they belong to ex-workers. This happens frequently since employees with their private number linked to the company's accounts, whenever they leave the company, no one is accountable for asking the supplier for phone number portability. This was achieved by following these steps:

1. Gather all the data provided by the suppliers. Part of it had already been asked at the end of 2019 by the purchasing manager;

2. Match this information with the outdated database;

3. Ask both the BU directors and responsible personnel from every company for help in identifying services that could be cancelled. Any service where the user was not found was immediately cancelled.

When neither the directors nor the people accountable for the companies knew the origin of a number, the quickest way found to proceed and get the info needed was to dial them directly. The name, position within the company, area and location of work would be asked so that one could find a match to the group company and BU.

The construction of this structured database was needed due to the considerable number of services which were charged to Unilabs and were not used by current employees of the company. Doing only this helped to reduce costs considerably. The results of this action will be displayed at the end.

To detect additional cost quickly, the existing data regarding telecom services shall be examined. The only information available electronically was provided by Supplier A, so this more quantitative analysis will be focused on Supplier A expenses. This was done according to the following steps:

1. **Collect** the existing data from the online client area provided by Supplier A;

2. **Understand** the data: what were the increases origins;

3. **Prepare** the data and identify categories of services, with the help of the suppliers, to map the most important variable sources of costs;

4. **Modelling** the data;

5. **Build** a dashboard which highlights important surpluses in mobile phone's extraordinary spending.

Regarding data collection, as previously said, the supplier provided all the data regarding invoices, online. However, the person with access to the platform did not possess all the invoices connected to its profile. The supplier was asked to provide for aggregation of services associated with companies within the Unilabs group, which unfortunately was not accomplished within the time frame of this project. Consequently, the dashboard will only present the data regarding the information available for analysis during the project.

The expenditure is divided into two different segments: monthly fees, which are fixed costs but depend on the number of services contracted, and additional expenses, which are related to extra services used when the contracted service packages are exceeded. These are distinguished in the invoices.

Supplier A invoices are divided into three tables: the first presenting basic information about the invoice and a sum up of the expenses; one which presents all the spending regarding normal monthly utilization of equipment and contracted services, denominated monthly fees, and the agreed discounts for every type of service, from TV and internet to telephones, cell phones and mobile internet pens; the last table showing info regarding additional spending, denominated additional expenses, which includes extra services, namely national and international communications, extra data usage inside the nation and roaming, both communications and data usage.

These tables provided the following info: the account, the number which defines the services (for cell phones it is the cell phone number itself), date of the invoice, the service tariff and description as well as the amount each service is charged for. For the additional communication's table, there is extra info since every additional service is discriminated by date, time and quantity of either byte (data usage) or minutes and messages (communications) used.

Initially, to understand how the different accounts were evolving in terms of expenditure, a simple chart with the total expenditure associated with Supplier A for the last 6 months was created. The result is shown in Figure 23.
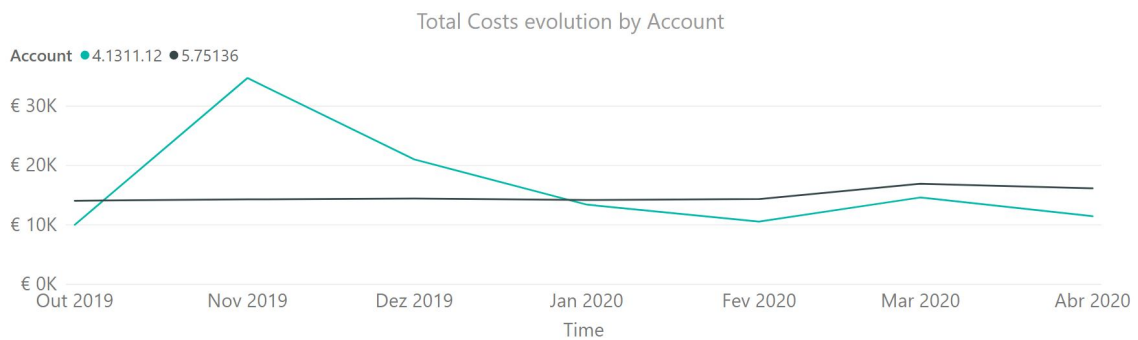
Figure 23: Total Supplier A' telecommunications costs

Observing the plot, it is easily noticeable that while one of the accounts is almost always steady, except for the last 2 months, the other is always changing. To understand why this was happening, two other charts, exhibited in Figure 24, were developed to see how both "fixed" - monthly equipment fees - and "variable" - extra costs associated with additional communications, such as data usage and phone calls - costs were changing in the same period.
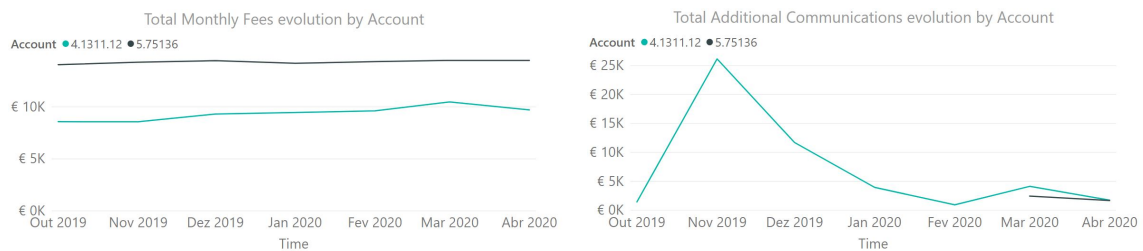

Figure 24: Evolution of monthly fees and extra expenditure

With this analysis, it becomes clearer that the cause for successive variations and an overall increase in telecommunications billing is due to this unsupervised usage of resources. To help the purchasing manager, a simple model, which was fed up with the information coming from Supplier A's electronic invoices, was created. To easily detect these abrupt shifts in costs, some visuals were also added. These will be explored soon.

After analysing the available data, it was time to create tables with summarized information regarding the spending for each service by date, so that the evolution of expenditure could be analysed. Afterwards, plots and tables were built to complete the dashboard.

It was decided by the top management that, from now on, regarding data usage, ceilings are defined by the value of the contracted service.

Top management intended to cancel the possibility of using services which are not previously contracted but Supplier A claimed this was not possible to do, which leaves on the table the option of monitoring and warn the employees when they surpass the limit of contracted services.

With this purpose, relevant data from the last month's invoice is displayed in a dashboard where the additional expenses are the ones highlighted. With this visualisation tool, the purchasing

member in charge of monitoring the telecommunications area will be capable of quickly detect numbers with extraordinary spending. Next, it will be explained how the dashboard was designed.

To analyse how many accounts should be presented at the same time on the plot of accounts with the most expenditure, a Pareto Analysis was performed. It was gathered, before having access to the electronic invoices, the information regarding every account associated with supplier A and ranked the accounts by total expenditure. The top 8 accounts totalled 80% of the total expenses, being the most important accounts for the analysis. This can be observed in Figure 25.
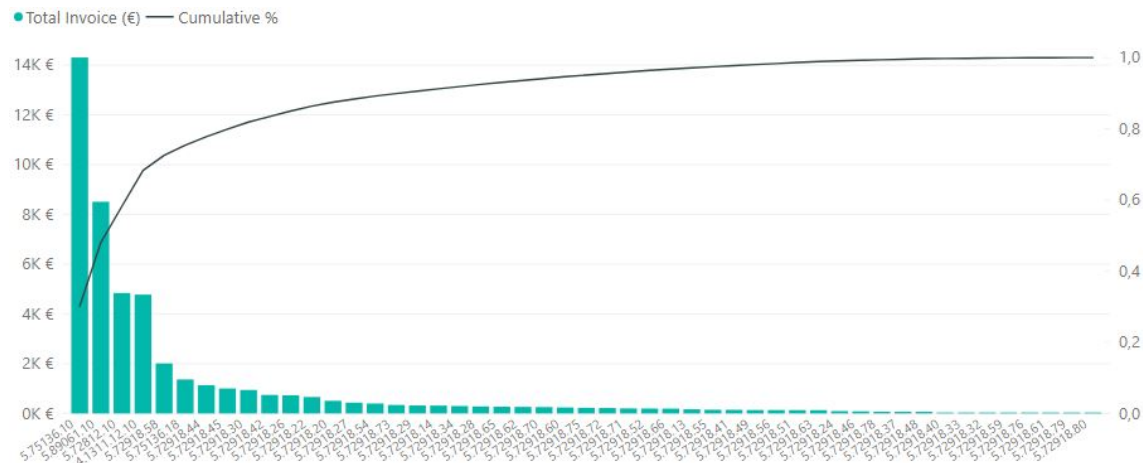

Figure 25: Pareto Analysis regarding Supplier A expenditure

Regarding the Total Comms Expenditure, this is calculated taking into account the ceiling defined by the mobile data contracted service. This measure subtracts the ceiling defined for every service to the total amount charged to the number. For instance, a number with a contracted service of 2GB of mobile data is charged X€ in total monthly. So, the Total Comms Expenditure equals the total amount charged to the number minus the theoretical value (X€), resulting in the surplus. This surplus is what the purchasing manager wants to know so that alerts can be automatically sent to the individuals who have exceeded the defined ceiling.

The dashboard can be found in Figure 26.

Figure 26: Dashboard to control additional expenses

This tool also comprises an area where every additional charged service is detailed by mobile phone number which helps the purchasing manager to understand the origin of every extraordinary

expenditure. It also exhibits the evolution of expenses incurred by a specific number over time, as it can be observed in Figure 27.
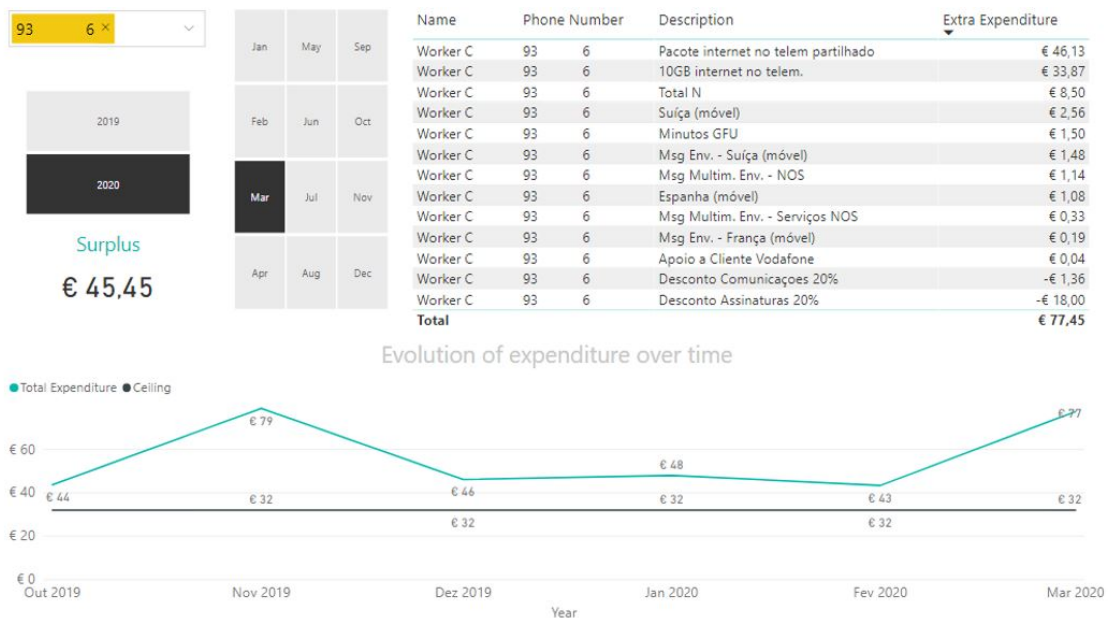

Figure 27: Dashboard with drill down over expenditure

With these actions and tools developed, it is expected to achieve the listed enhancements:

- **TED:** updating outdated databases is sometimes needed. Harder than updating once is keeping it always updated. For this, the purchasing department will need the help of the human resources department. The info collected from the database was used in the dashboard to match the mobile phone numbers to their users and therefore show instantly who are the users with most additional spending;

- **Additional communications dashboard:** with this tool, it is expected that the extra costs are better and easily monitored. With this, automatic messages can be sent to the users exceeding their ceilings. As a result, it is expected that the workers will become more aware of this extra expenditure and ultimately, try to reduce as much as possible, these additional expenses. The data import is done simply by downloading the CSV files to a specific folder. This process needs to be carried out at the beginning of every month, after the invoices being sent out.

Even though not being possible to address all the issues that may contribute to better control of costs, in this case, both products prices and contracted services tariffs, the actions mentioned along this chapter helped the company to achieve some improvement. Regarding other actions that might be helpful to take in the future, these will be considered in Chapter 5.

Both of these visualisations tools are expected to be under surveillance for the future. The individuals in charge for doing this monitoring and also the time span of which the tools shall be used is displayed in Table 4.

Table 4: Monitoring schedule

	Person in charge	**Monitoring frequency**
Services Price Control	Purchasing Director	Monthly
Materials Price Control	Purchasing Director	Quarterly
TED	Purchasing Director	Every Semester

Chapter 5

Conclusion

The entire project of improving data quality and developing price control systems is of major importance to the company both for products and services.

Regarding data quality, with a better way to generate new references in the ERP being adopted by the purchasing department, even with two different teams ordering goods from suppliers, errors will not happen so frequently due to duplicate references and subsequent analysis would be rather fruitful.

Nowadays, the focus on cost-cutting is more common in companies along the supply chain due both to high competition and pressure from the final customer to lower prices. This became more explicit with the Covid-19 outbreak when most companies saw its income drastically reduced and had to adapt and try to reduce every cost which was not crucial for the operations of the company. The focus on these superfluous costs brought significant improvement for Unilabs.

Properly monitoring over costs will make it possible to save significant amounts of money and resources to the company. Therefore, there is value on data and on the analyses carried out with that data. Having a profound knowledge about the company's data, especially when talking about the purchasing department is a synonym of higher bargaining power towards suppliers. This know-how is important in negotiation actions where sustainable cost reduction is the buyer's main goal.

On the other hand, the analysis conducted towards telecommunications expenditure was important for the company as after visualising the information gathered and track excessive billing regarding some specific mobile phone numbers, it triggered the scheduling of a meeting with the top management of Supplier A to clarify the conditions of the contract and the reasons behind this excessive billing. The purpose of the meeting is extended to the standardisation of communication services across all the companies of the group.

Results

As the adoption of the new workflow for creating new references could not take place during the period of the project, improvements regarding the reduction of mistakes made during the insertion

of data in the ERP could not be reported. However, the results obtained within the course of the project can be divided between the construction of the database (TED) and the visualisation tool.

Regarding TED, almost 900 services related to mobile phones were analysed. Figure 28 shows the improvement regarding the total number of services deactivated.
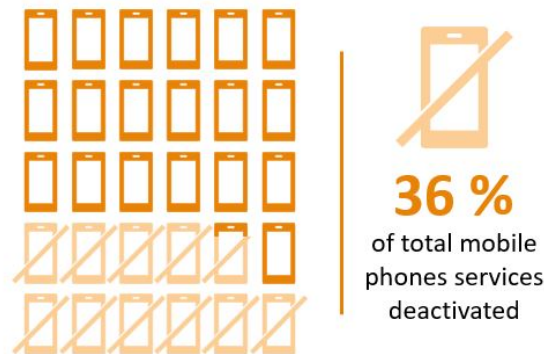

Figure 28: Infographic: total number of Mobile Phone services deactivated

Inside the document where the linkage between phone number and employee is defined, it was found several numbers were from ex-workers or relatives of workers. This resulted in the deactivation of 325 services concerning mobile phone services, translating in a reduction of 2.500€ monthly.

On the other hand, to understand the potential of the dashboard, with the identification of mobile phone users which had used extra services, it is possible to estimate how much could be saved in terms of additional services. For the past 6 months, the total expenditure was of about 31.000€, being attributed to a total of 109 different mobile phones which were using more than the services contracted. Monthly, it represents an average of 5.200€ in extra expenses - being the minimum around 1.000€ and the maximum slightly under 13.000€. This extra spending constitutes over a quarter of the total amount paid for the supplier's bills. Trying to reduce drastically these costs, Supplier A was asked to present a quote for bigger data usage packages. Then, contracts regarding numbers with a justifiable consistent high spending would be changed to reduce the probability of incurring in additional spending.

Further Development

On the short term, there are some actions which are needed to be taken. First, every month a message containing the monthly expenditure regarding each individual will be sent so that employees become more aware of their additional expenses. This will not be difficult as there is a similar action taking place in the logistics department regarding fuel and tolls spending. This is expected to raise awareness among employees who might use additional services even without noticing, and this can translate in representative savings for the company.

This analysis must be extended to the other categories of expenses inside telecommunications services, such as telephones - pretty much the same approach took with the mobile phones area -, internet connections and TV packages.

As it will be difficult to have only one supplier in the communications segment because of the location of some remote Care Units controlled by Unilabs, electronic invoices shall be asked to the other two suppliers so that this information can be joined in the analysis currently in place for Supplier A.

Raising awareness towards the importance of data quality in the purchasing department will be key for the future as the useful analysis is only accomplished when models are fed with good data. Transforming the ERP into a more robust system will be key for the desired outcome too.

On the medium to long term, these control measures must be extended to other BUs with products price control and also to other kinds of services which have information available for analysis. Moreover, the payment process must change into one with approval steps and not an automatic payment as it is done nowadays. This can be based on a monthly average of expenditure, calculated with the data within the model, for each account and it would only be paid automatically if the total cost would be lower than the monthly average plus a defined tolerance, to preserve occasional additional consumption to take place which is normal in these services. The bills which exceed this ceiling would be sent for approval, instead of being automatically paid. On the data gathering process, there is the desire to implement scrapping techniques which automatically download the desired documents from the internet. It is also able to organise them in a specific folder so that the data input is rather simple.

Bibliography

Alicke, K., Azcue, X., and Barriball, E. (2020). Supply-chain recovery in coronavirus times—plan for now and the future. [https://www.mckinsey.com/business-functions/operations/our-insights/supply-chain-recovery-in-coronavirus-times-plan-for-now-and-the-future.

Bailey, T., Barriball, E., Dey, A., and Sankur, A. (2019). A practical approach to supply-chain risk management. [https://www.mckinsey.com/business-functions/operations/our-insights/a-practical-approach-to-supply-chain-risk-management.

Ballou, R. (2007). The evolution and future of logistics and supply chain management. *European Business Review*, 19(4):332–348.

Berinato, S. (2016). Visualizations that really work. [https://hbr.org/2016/06/visualizations-that-really-work.

Bhatia, G., Lane, C., and Wain, A. (2013). Building resilience in supply chains. [https://www.weforum.org/reports/building-resilience-supply-chains.

Chambers, K. and Sutton, G. (2019). Procurement innovations helping cfos cope with mounting cost pressure. [https://www2.deloitte.com/content/dam/Deloitte/us/Documents/finance/procurement-operating-model.pdf.

Choi, T., Rogers, D., and Vakil, B. (2020). Coronavirus is a wake-up call for supply chain management. [https://hbr.org/2020/03/coronavirus-is-a-wake-up-call-for-supply-chain-management.

Chopra, S. and Meindl, P. (2013). *Supply chain management: strategy, planning, and operation*. Pearson, 5th edition.

Council of Supply Chain Management Professionals (2016). Cscmp supply chain management definitions and glossary. [https://cscmp.org/CSCMP/Academia/SCM_Definitions_and_Glossary_of_Terms/CSCMP/Educate/SCM_Definitions_and_Glossary_of_Terms.aspx?hkey=60879588-f65f-4ab5-8c4b-6878815ef921.

Fiksel, J., Polyviou, M., Croxton, K., and Pettit, T. (2014). From risk to resilience: Learning to deal with disruption. [https://sloanreview.mit.edu/article/from-risk-to-resilience-learning-to-deal-with-disruption/.

Ghadge, A., Dani, S., and Kalawsky, R. (2012). Supply chain risk management: Present and future scope. *The International Journal of Logistics Management*, 23(3):313–339.

Hathaway, S. (1991). The application of risk assessment methods in making veterinary public health and animal health decisions. *Rev Sci Tech*, 10(1):215–231.

Innamorato, T., Prilepok, M., and Schillinger, I. (2017). The era of advanced analytics in procurement has begun. [`https://www.mckinsey.com/business-functions/operations/our-insights/the-era-of-advanced-analytics-in-procurement-has-begun`.

Khushalani, S. and Woodcock, E. (2018). A next-generation operating model for source-to-pay. [`https://www.mckinsey.com/business-functions/operations/our-insights/a-next-generation-operating-model-for-source-to-pay`.

Kraljic, P. (1983). Purchasing must become supply management. [`https://www.abaspro.com.ar/wp-content/uploads/2019/05/Kraljic.pdf`.

Lambert, D., Cooper, M., and Pagh, J. (1998). Supply chain management: Implementation issues and research opportunities. *The International Journal of Logistics Management*, 9(2):1–20.

Lee, H. (2002). Aligning supply chain strategies with product uncertainties. *California Management Review*, 44(3):105–119.

Shearer, C. (2000). The crisp-dm model: The new blueprint for data mining. *Journal of Data Warehousing*, 5(4):13–22.

Smykay, E., Bowersox, D., and Mossman, F. (1961). *Physical Distribution Management*. Macmillan.

van Weele, A. (2005). *Purchasing Supply Chain Management: Analysis, Strategy, Planning and Practice*. Thomson Learning.
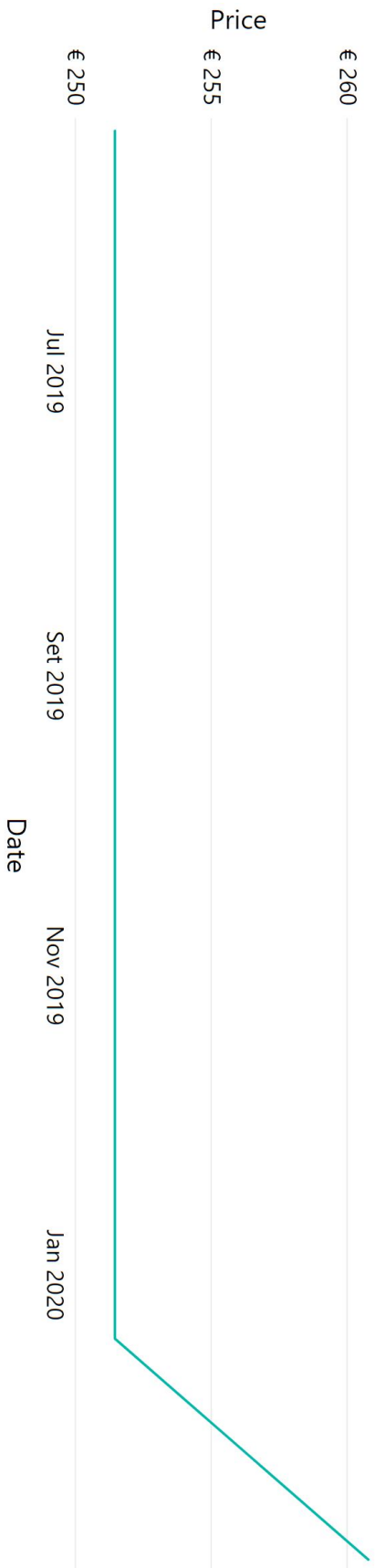
Appendix A

Monitoring Dashboards

A.1 Dashboard to control Price Variation: Example Product H

A.2 Dashboard to control Volume Variation: Example Product I

A.3 Dashboard to control Volume Variation: Example Supplier In-vulgar

Product H

Price Variation across Time

Reference Name		Product H	
		2019	2020
Purchased Quantity (€)		€ 10.561	€ 3.586
Price Annual Variation			3,71%
Average of Price		€ 251,46	€ 260,78

Total Purchased Volume vs. Price Annual Variation

Product I

Purchased Quantity variation across Time

Total Purchased Volume vs. Total Volume Slope

| Year | | | | | 2020 |
Reference Name	2019 Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1
Product I					
Purchased Quantity (€)	€ 18.578	€ 37.382	€ 42.480	€ 42.480	€ 19.258
Volume Quarterly Variation		101,22%	13,64%	0,00%	-54,67%
Average of Price	€ 56,64	€ 56,64	€ 56,64	€ 56,64	€ 56,64	€ 53,10
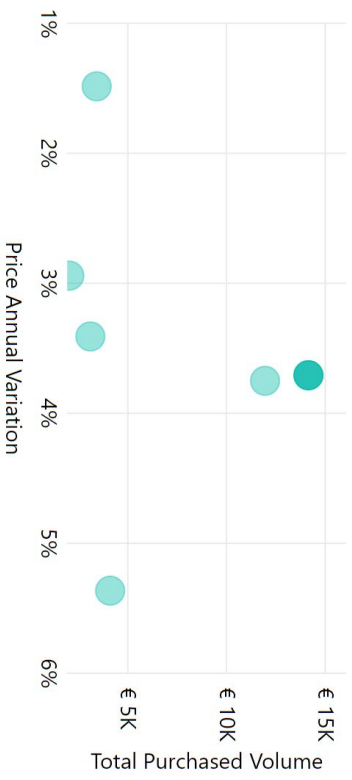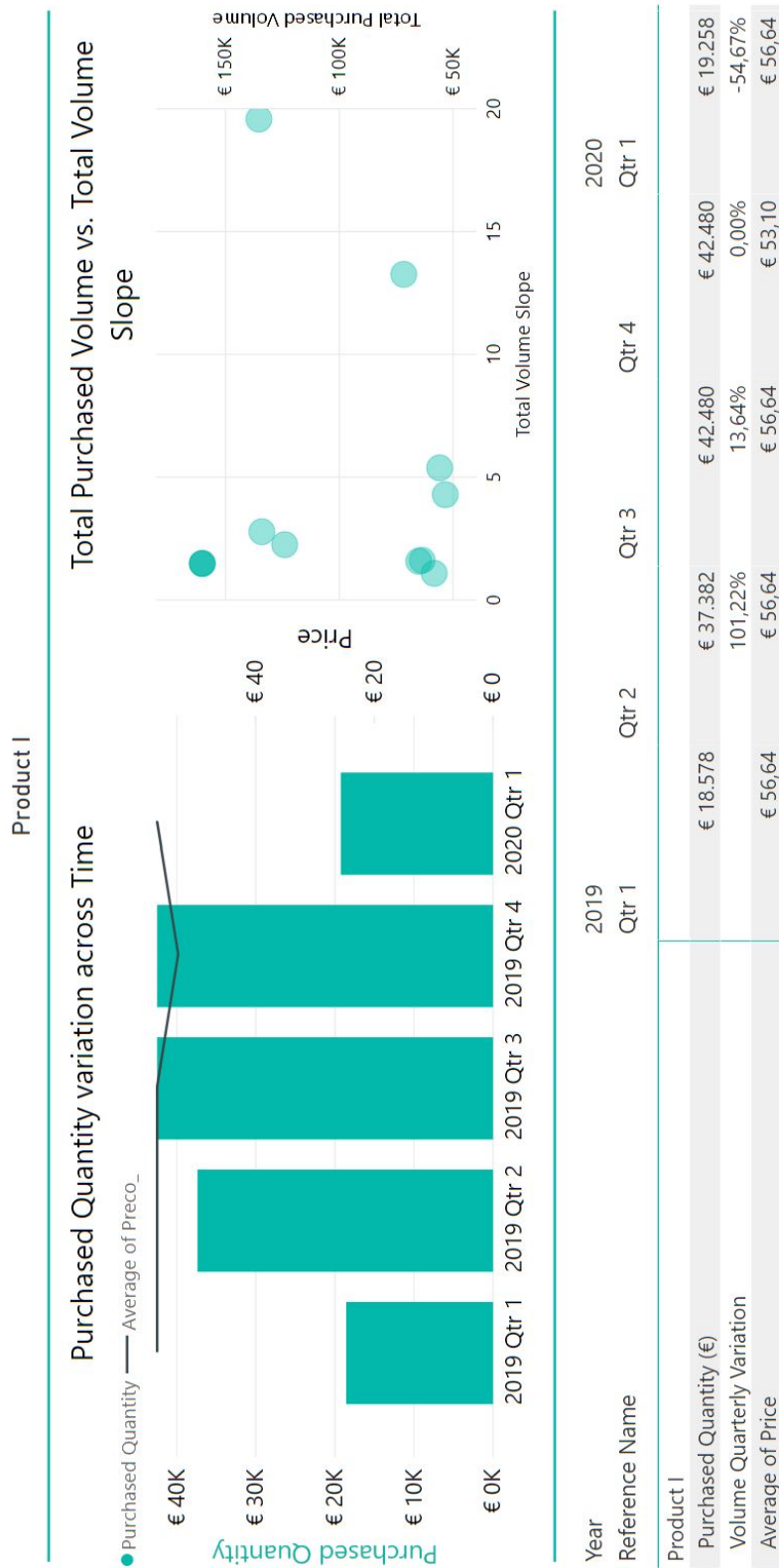
Total Purchased Volume

Total Purchased Volume by Year and Quarter

INVULGAR Artes Gráficas, S.A.

2019 Qtr 1	2019 Qtr 2	2019 Qtr 3	2019 Qtr 4	2020 Qtr 1
€ 7K	€ 23K	€ 57K	€ 80K	€ 56K
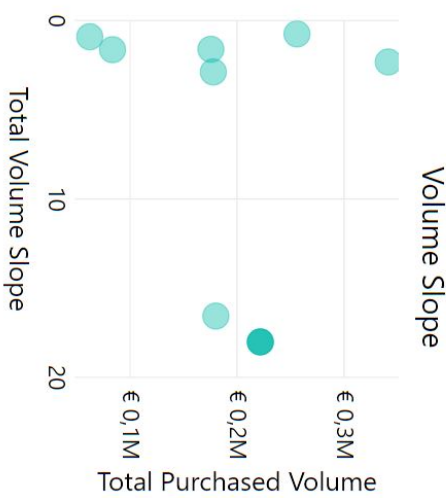
Year		2019				2020
Supplier		Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1
INVULGAR Artes Gráficas, S.A.						
Purchased Quantity (€)		€ 6.505	€ 22.690	€ 56.604	€ 79.955	€ 56.053
Volume Quarterly Variation			248,83%	149,46%	41,25%	-29,89%

Total Purchased Volume vs. Total Volume Slope

Total Volume Slope

0   10   20

Total Purchased Volume

€ 0,1M   € 0,2M   € 0,3M

Total Purchased Volume

€ 221.806

# of Orders   # of Products

94   **55**

Appendix B

Information Flow

B.1 Example of form to create a new product reference

Unilabs — Request for introducing new product

Requestor: [   ]   Date: [   ] / [   ] / [   ]

Technical Product Designation: [   ]

Potential Suppliers: [   ]

Expected Annually Consumption: [   ]

Business Unit: [   ]

Department: [   ]

Technical Area: [   ]

Cause for need: [▼]

In case of substitution, write the internal reference of the substituted product [   ]

Expected advantages in economic/performance/safety terms with the use of the new product:
_____
_____
_____
_____
_____
_____