Universidade de Aveiro
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FRANCISCA MIGUEL LUZEIRO ROQUE SALGADO

DEFINIÇÃO DE ESTRATÉGIAS DE COMPRAS QUE VISAM O DESENVOLVIMENTO DE FORNECEDORES NUMA EMPRESA DE CONSTRUÇÃO CIVIL

DEFINING PURCHASING STRATEGIES THAT AIM AN ENHANCED SUPPLIER DEVELOPMENT IN A CONSTRUCTION COMPANY

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Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Engenharia e Gestão Industrial, realizada sob a orientação científica do Doutor José António de Vasconcelos Ferreira, Professor Associado do Departamento de Economia, Gestão, Engenharia Industrial e Turismo da Universidade de Aveiro.

Dedico este trabalho aos meus pais, irmã e avó.

o júri

presidente

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agradecimentos

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palavras-chave

Compras, processo de compras, avaliação de fornecedores, desenvolvimento de fornecedores, construção civil, digitalização.

resumo

O projeto descrito no presente relatório visa estudar a perspetiva dos fornecedores em relação às práticas utilizadas pelas construtoras dentro da cadeia de abastecimento para, posteriormente, dar ênfase às estratégias que dizem respeito ao desenvolvimento de fornecedores.

A indústria da construção civil encontra-se imbuída numa grande complexidade e fragmentação, uma vez que o setor é orientado projeto a projeto. Efetivamente, a indústria emprega uma multiplicidade de fornecedores-chave, consequência de projetos únicos com características específicas que levam à criação de parcerias temporárias. Consequentemente, a generalidade das relações entre fornecedores e construtoras são transacionais, por isso, são criticadas e descritas como sendo adversas.

A crescente competitividade da indústria da construção civil, o crescimento das tecnologias de informação e o aumento dos preços dos materiais pressionaram as empresas a tomar a necessária mudança de métodos de gestão tradicionais pela adoção de estratégias diferenciadas. Assim, as compras desempenham um papel importante uma vez que são uma das atividades principais dentro de uma organização que afeta diretamente o seu desempenho.

Numa primeira fase do projeto, o atual estado do departamento de compras da empresa de construção foi explorado com o suporte do BPMN 2.0. Esta ferramenta facilita a compreensão dos fluxos de informação e o processo de compras em curso. O principal problema identificado foi a ineficiência das relações entre fornecedores e compradores, que levou à oportunidade de implementar relações de longa duração e um alto envolvimento ao longo dos projetos.

De modo a explorar, por parte dos fornecedores, o *status* entre estes e os compradores, foram desenvolvidas várias entrevistas e um questionário. A conclusão retirada desta fase revelou relações desprendidas, falta de fidelização e de confiança. Ao reconhecer os fatores de sucesso que levam a colaborações eficientes entre ambas as partes, bem como as barreiras em parcerias, as necessidades dos fornecedores foram categorizadas baseadas nas suas respostas.

Além disso, para compreender a evolução dos fornecedores no decorrer dos anos, foi utlizada uma ferramenta de Inteligência Artificial da *Microsoft: Power BI*. Este *software* possibilita à empresa a centralização de diversas fontes de dados, assim como uma visualização dinâmica da visão global do progresso do desempenho dos fornecedores. Por outro lado, identifica as áreas que carecem de melhoria.

keywords

Purchasing, purchasing process, supplier evaluation, supplier development, civil construction, digitalization.

abstract

The project described in this report aims to study the suppliers' perspective of contractors' current practices within the construction supply chain to further focus on supplier development strategies.

The construction industry is embedded in an environment of complexity and fragmentation, as the sector is project-driven. This means that the industry comprises a multitude of suppliers, as temporary organizations are created for unique projects due to their specific features. Therefore, it leads to the majority of transactional relationships between buyer-supplier, which are criticized and described as adversarial.

The increasing competitiveness in the construction industry, growth of informational technology, and increasing price of materials, pressure companies to make the necessary shift from traditional management methods to the adoption of differentiating strategies.

Thus, purchasing plays an important role since it is one of the core activities of an organization that directly impacts its performance.

In the first phase of the project, the current state of the purchasing department of the construction company was explored with the support of BPMN 2.0. This tool facilitates the understanding of information flows and the as-is process. The main issue highlighted was the inefficient supplier-buyer relationships, which led to the opportunity of implementing long-term and high-involvement relationships across projects.

To explore the supplier-contractor status from the supplier side, focus group interviews and a survey questionnaire were conducted. The insights taken from this stage revealed loose relationships and mistrust from the suppliers. By acknowledging the success factors that enable efficient dyadic collaborations, and the barriers to partnering, suppliers' needs were categorized based on their responses.

Also, to comprehend suppliers' evolution over the years, a Business Intelligence tool (Power BI) from Microsoft was used. It allowed the company to centralize several purchasing data sources and enabled the visual and dynamic analysis of the overview of suppliers' performance progression and the areas that needed to be improved.

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1. Introduction

This document aims to present the work performed during an 8-month internship at DST, s.a., a construction company based in Portugal.

1.1 Contextualization

This dissertation project is within the scope of the Integrated Bachelor's and Master's degrees in Industrial Engineering and Management at the University of Aveiro. The project was developed during a curricular internship at the Purchasing Department of DST, s.a.

1.2 The project

1.2.1 DST, s.a.'s activity

Based in Braga, DST, s.a. is one of the companies that belongs to DST Group which is currently a reference among the national firms. DST Group develops its activity in engineering and construction, the environment, telecommunications, renewable energies, ventures, and real estate. Following the goal of expanding its portfolio, the company emerged its activity in new sectors, which resulted in the acquisition of several companies, being one of them DST, s.a.

The core activity of DST, s.a. is construction and public works.

1.2.2 Problem background and motivations

The growing complexity and market competitiveness have led to the importance of recognizing the role of strategic purchasing, which becomes vital to the prosperity and success of any business (Andersen & Rask, 2003). Purchasing applied to civil construction failed to keep up with the evolution felt in other sectors such as manufacturing, as it is criticized for low productivity and inefficient processes (Barbosa et al., 2008).

The construction industry is the main economic pillar in most national economies and contributes between 6% and 10% to Gross Domestic Product. In Portugal's economy, the construction industry plays a significant role as it contributes significantly to employment rates and creates investment opportunities (Arantes et al., 2015). However, the

construction industry is a complex and conservative sector that resists change when confronted with the risks associated with projects' demands (Segerstedt & Olofsson, 2010). Among the main industrial sectors, the construction industry is the least integrated due to its high volatile supply chain, especially in a project with a big dimension and long durability. In this case, the number of individual organizations that supply the projects' specifications can reach hundreds (Aloini et al., 2012).

With the growth of the economy, the competition is becoming increasingly visible. Meanwhile, the increasing price of construction materials also brings the construction enterprises enormous pressure. In such an environment, if they want to survive and gain a competitive advantage, it is necessary to change the traditional management methods (Lu, 2010).

The "art" of Purchasing is of the core activities of the construction industry that directly impacts its performance. A construction project consists of purchased goods and services and it can represent 90% of the total cost of a project (Karim et al., 2006). Hence, contractors are highly dependent on their suppliers which leads to the necessity of securing a stable supply chain that will provide an uninterrupted flow of the required materials and services at an acceptable cost.

Many studies conclude that the maturation of the purchasing function, which encompasses supplier development, generates better overall performance and increases profits (Glavee-Geo, 2019). Thus, purchasing strategy, supplier selection and development, and collaboration with suppliers need to be reviewed and restructured.

1.2.3 Project's objectives

Throughout the present project, it is expected that the Purchasing Department of DST, s.a. will develop its function while taking a more strategic view of its business and trying to adapt it to the intrinsic nature of the construction industry.

The project mainly focuses on implementing supplier development activities and analyzing critical elements that harm suppliers' performance and capabilities.

To sum up, this project must accomplish the following objectives:

- Mapping the current Purchasing process and the flow of materials and information for a more effective analysis approach of the organization's external dynamics and internal procedures. This stage is accomplished through the use of BPMN 2.0.

- Acknowledging the current status of supplier-buyer relationships, as well as suppliers' perspectives, to gain insight into the improvement opportunities that can foster greater collaborations and performance.

- Implementing Supply Chain Management practices regarding supplier-buyer relationships to maximize long-term benefits that can help DST, s.a. gain competitive advantage.

- Taking advantage of a Business Intelligence tool to centralize data that will be displayed visually in the form of dashboards. Moreover, the schematized information will give fruitful insights into the organization's business that will provide faster and easier decision-making.

1.2.4 Methodology

Towards the achievement of the previously proposed goals, a methodology must be pursued.

The **first stage** includes discovering the current company's dynamic which involves analyzing its main purchasing procedures and major challenges and problems. This phase defined the cornerstone of the project that better fitted the company's needs and the Industrial Engineering and Management knowledge attained in the 5 years of studying.

The **second stage** concerns the interpretation of a bibliographic review that provided an understanding of the existing research about the purchasing field and construction industry.

Afterwards, at the **third stage**, the "As-Is" purchasing process of DST, s.a. was comprehended and described. This task included direct observation of purchasers' daily routines, meetings with team members for a deeper understanding, process mapping and analysis using BPMN 2.0, and identification of issues and improvement opportunities. Moreover, a prioritized action plan was developed.

The **fourth stage** was focused on supplier development. To understand the supplier's behaviour in construction projects and how it can affect their performance, semi-structured interviews and a survey questionnaire were carried out. After collecting and compiling the information, supplier management activities were developed to strengthen the competitive edge of DST, s.a. To achieve that, conditions for more stable and long-lasting dyadic relationships were promoted.

Finally, the **fifth stage** involves the use of a Microsoft Business Intelligence tool that enables purchasers to optimize their strategies for decision-making.

1.3. Structure of the document

This document is structured in 5 chapters.

The current chapter introduces the reader to the project's theme, as well as the company in which it was developed. Moreover, the methodology used and the expected objectives were also highlighted.

In chapter 2, it is presented a theoretical background of the main concepts related to the dissertation's theme. This section is essential to explain the notions and matters that support the work performed throughout the project.

In chapter 3, the objective is to describe an overview of the current purchasing process of the company and identify issues and improvement opportunities.

In chapter 4, the improvements proposed in chapter 3 are developed and explained.

In chapter 5, the key conclusions and limitations are reviewed. Lastly, future potential work is also briefly discussed.

2. Bibliographic Support

2.1 Supply Chain Management

The term Supply Chain Management (SCM) is a relatively new concept. It was first introduced in the early 1980s and has consequently gained increasing attention as several SCM initiatives have been launched (Chen and Paulraj, 2006). Driven by globalization and brutal competition, supply chains in every industry are moving towards integration (Rogers, 2006). Organizations understand the potential impact supply chain management can have on their success and competitiveness since it manages product flows across multiple enterprises and provides maximum value to their customers (Kaye, 2019). This represents a significant paradigm shift in organizations since they started with individual-managed activities to now practice an integrated set of processes that are both internal and external to the firm (Paulraj et al., 2006).

There are several definitions regarding the perception of Supply Chain Management. Steve LeMay et al. (2015) summarize it as the design and coordination of a network through which individuals and organizations manage the two-way movement and coordination of various flows (information, material goods, and services) to finally make their offerings to the end customer. Lancaster & Reynolds (1998) state that the new approach to SCM all over the network of suppliers, intermediaries, plants and distribution centers, logistic and service providers, and customers, improves communication and informational flow, which converts the supply chain into a more flexible and responsive. Therefore, it generates production improvement and profitability increase.

There is a large set of activities that Supply Chain Management comprises, and Chopra & Meindl (2016) highlight the following key processes within Supply Chain Management: (1) purchasing, (2) manufacturing flow management, (3) order processing, (4) demand planning, (5) inventory control, (6) product development, (7) warehousing/ distribution, (8) outbound transportation, (9) customer service management, and (10) customer relationship management.

In sum, all the integrated areas of SCM are the foundation for an organization's competitive and efficient strategy that allows it to innovate and coordinate the intricate network of business relationships that are required to meet today's demanding needs (Ballou et al., 2000).

2.2 Development of Purchasing

The act of purchasing can be described as one of the oldest basic types of human behaviour (Gelderman, 2003), and it involves the entire process of finding and selecting suppliers, acquiring services or materials through price negotiations, and reaching payment terms (Chiavenato, 2005).

Steele et.al (1985) state that purchase is the process by which a company engages third parties to obtain goods and services necessary to fulfil its business objectives in the most timely and cost-effective way.

On the other hand, Baily et al. (1999) define purchasing activity as a procedure by which companies determine the items to be purchased, identify, and compare available suppliers, negotiate with supply sources, sign contracts, formulate purchase orders, and finally receive and pay for the goods and purchased services.

The role and purpose of purchasing have gained increased recognition in the business context as a vital function in a company (Monczka et al., 2016). Firstly, it was regarded mainly as an administrative activity without a direct contribution to corporates' competitiveness and advantage. Limited on operational tasks and business transactions, purchasing did not focus on understanding the customers' needs, creating enduring collaborations with them, and managing relationships. Before the purchasing revolution, the concept was defined as a decision-making process in which companies establish a necessity of acquiring products and services, evaluating, and selecting alternative suppliers (Webster et al., 1996).

However, due to dramatic changes in the business environment, the role of purchasing shifted from a clerical function into a more strategic function that recognized it as a core activity that impacts the overall performance of a company (Baily, 1990). The trade globalization and development of technology allowed companies to expand their business

and be more innovative. Also, the increasing scarcity of natural materials is rising prices of raw materials, which requires strict monitoring of its evolution due to supply difficulties in some sectors of activity (Carvalho, 2012). Purchasing suffered a boost of needed improvements and it cannot place all emphasis on the cost factor. For companies to increase their efficiency they need to move towards a more collaborative approach with suppliers because they are the critical source of product and process technology. The importance of purchasing increased expressively, being identified as a proactive, strategic, and value-adding business function. It became a core activity and an essential part of the development and success of an organization (Gelderman, 2003).

2.3 Purchasing in construction companies

The construction industry is the least integrated sector among the main industries, due to its complexity and resistance when confronted with the risks associated with construction projects. Also, the supply chain can be extremely complex in the construction sector, particularly in a large project where the number of individual organizations that supply the project could run into hundreds (Zhang & Li, 2011).

Change in the construction industry has been both slow and difficult. External factors such as unpredictability and increasing sophistication of customers' demands have hampered productivity, economies of scale, and reduction of the quality output (Ribeirinho et al., 2020). Thus, purchasing becomes a fundamental function to catalyze change and shape dynamics in the industry to deal with market characteristics and needs.

Purchasing from suppliers contributes to the majority of construction companies' total expenditure (Koskela 2000). Thus, to overcome the volatile economic environment and compete effectively, organizations should adopt an integration strategy and must not remain isolated from their suppliers and other entities in the supply chain (Thakkar et al., 2008).

2.3 Barriers in the construction industry

The construction industry has some specific barriers that hinder its overall performance and innovation.

Barrier 1: cost pressure.

One of the main reasons for failure in the construction industry is the persistent cost pressure due to tight public budgets. Competitive bidding to secure the lowest price led the organizations to be portrayed as price-driven regarding the choice of suppliers. Nevertheless, buyers impose pressure on cost reduction while still demanding continuous improvement in product and service delivery (Macduffie & Helper, 2006). The excessive focus on price as the key driver for supplier selection neglected the dyadic exchange and interfered with the collaboration between the two actors (Ferrer et al., 2010). This created mistrust from suppliers when working with contractors. Relational trust is an essential element that influences suppliers' performance. For companies to prevail in highly competitive environments, relational and sustainable practices must be implemented to resist transactional uncertainty (Casidy & Yan, 2022).

Barrier 2: robust unique designs.

The industry is typically an engineer-to-order supply chain, as each project contains unique features, and changes from one specification to another often occur, due to its complex nature, which leads to the rise of the newness in purchases and lack of standardization (Bildsten, 2016). The increasing complexity of projects also leads to the need for a more qualified workforce, which now faces severe paucity and is a major issue in several markets. Consequently, construction companies face the additional challenge of having to deal with difficulties in finding competent labour. During supplier selection, due to the uniqueness and customization of projects, several suppliers need to be involved and may not have worked together in the past, which complicates the management of collaborations.

Barrier 3: loose relationships.

It is evident that to remain competitive, construction industries must develop a network of solid and effective relationships with suppliers. Despite that, the peculiarities of the industry limit long-term investment and development of partnerships, in opposition to

manufacturing industries that deal with more stable and predictable risks. The above barriers that were mentioned weaken the conservation of relationships. They are characterized as loose with a high level of competition between suppliers and with the low cost incurred to contractors when switching from one supplier to another due to the low level of independence (Benito et al., 1999).

The above factors suggest that the process of purchasing from a construction company faces additional challenges due to its nature. Purchasing decisions for products and services in a construction project represent a large percentage of the total cost of a project. For construction companies, purchasing contributes to as much as 90% of the total cost of a project (Karim et al., 2006). Purchasing decisions are therefore important for the outcome of a project and vital for the prosperity of an organization. Consequently, it can be stated that the success of a project is determined in large part by making the most appropriate purchasing decisions. Thus, it is necessary that contractors make strategic decisions regarding close relationships with their suppliers to ensure the provision of resources and a higher possibility of business growth (Bildsten, 2016).

2.4 Suppliers development

The term “Supplier Development” was first defined as “any effort from buyers in organizations to improve the performance or competency of its suppliers to meet supply needs” (Lau, 2011). Literature of supplier development refers to firms’ intentions to generate and preserve a network of competent suppliers with technical abilities. Before the supplier development plan, purchasers should make an appropriate evaluation of suppliers to further assess their performance. When the previous stage is concluded, buyers proceed to create a strategy that aims at the improvement of suppliers’ materials and service delivery, the quality of their performance, and technical capabilities (Wagner, 2011).

Supplier development starts when an organization first understands its needs. This first stage is usually triggered by weak evaluations of current suppliers which leads to the necessary improvement of current supplier performance to achieve a better position in the market competition (Zimmer et al., 2016).

Hahn et al. (1990) identified the following steps that concern supplier development:

1. The purchasing department recognizes that to compete effectively in the market, it should create and develop a network of competent suppliers.
2. Identify critical and greatest value-added products and suppliers that contribute to a project.
3. Identify performance measures and critical success factors and evaluate and rate suppliers.
4. Formation of a team in the organization that is responsible for the management of the whole collaboration process.
5. Selection of strategic suppliers and the prioritization of areas to be developed.
6. Mutual involvement in the collaboration.
7. Decision on the supplier development areas by both sides.
8. Application of supplier development activities.
9. Measuring and monitoring the development activities' impact on both parties.

2.4.1 Supplier evaluation

Suppliers should be meticulously evaluated by organizations to achieve high status. Supplier evaluation is one of the most important procedures in supply chain management to perceive suppliers' valuable strengths and weaknesses that can become improvement opportunity areas (Noorizadeh, 2021).

The most common supplier development activity to provide suppliers feedback about their performance is an evaluation based on established criteria, and the larger part of companies resort to previous historical evaluations before the cooperation decision. Despite that, not all of them use supplier monitoring on a regular basis. To have a fruitful supplier-buyer relationship, it is important that the previous step is not being neglected to guarantee that both sides' needs are being satisfied to continue effective cooperation (Glavee-Geo, 2019).

For a path of true transformation, companies need to define the factors that lead to the most successful performances, and they must be shared with suppliers. They need to acknowledge the evaluation criteria to fulfil the required parameters and maintain them in the long run to continue the business relationship. By being aware they are delivering a satisfactory performance, suppliers get a boost in their confidence, trust, and motivation (Azadegan, 2011).

Handfield & Bechtel (2002) state that in general sourcing, the top 3 criteria to evaluate suppliers are quality, cost, and trust. Regarding the construction industry, additional tangible and intangible factors should be added and analyzed in the ranking and evaluation of potential suppliers. Despite the growing emphasis on the use of multi-criteria evaluation, the overwhelming majority of tenders are awarded based on unrealistic low prices, which leads to negative consequences in the construction industry that inhibit its growth (Heralova, 2017). Thus, more credence to different factors other than price should be given, such as suppliers' technical expertise, management skills, and collaboration ability (Rogers, 2006).

Regarding construction suppliers, Cengiz et al. (2017), consider several variables that affect the execution of a project, and a multi-criteria approach should be adopted by organizations to reach optimum suppliers. Table 1 shows the main criteria and sub-criteria that affect supplier evaluation.

Table 1 - Evaluation Criteria used in Construction Projects(adapted to (Cengiz et al., 2017)*)*

Main criteria	Sub-criteria
1. Cost	1.1. Total Cost
	1.2. Discount percentage
	1.3. Transportation cost
2. Quality	2.1. Quality management system
3. Delivery	3.1. Type of delivery
	3.2. Delivery speed
4. Schedule	4.1. Expected completion of a project
5. Geographic location	5.1. Geographical distance from the supplier to the site
6. Supplier profile	6.1. Relevant experience
	6.2. Potential project risks mitigation strategies
	6.2. Certificates and references
	6.3. Financial situation
7. Buyer-supplier relations	7.1. Previous problem-solving capabilities
	7.2. Easiness in collaboration
8. Ecological characteristics	8.1. Ecological material and service alternatives
	8.2. Environment-oriented certification
9. Supplier capacity	9.1. Product range
	9.2. Technical expertise
	9.3. Storage capacity
	9.4. Technology
	9.5 Innovation

Organizations must not solely consider the cost attribute, but also variables within the construction industry that are dependent on the projects' specifications. Also, "softer" relationship parameters such as strong leadership, the will to develop and deeply contribute to efficient partnerships, and the desire for continuous improvement should be valued (Cengiz et al., 2017). All the previous attributes affect the global achievement of a

project and considering them will increase suppliers' trust and motivation to maintain or increment the level of performance.

Watts & Hann (1998) mention as well that evaluation criteria must be continuously evaluated and have internal involvement, in this case regarding purchasers and site managers.

2.4.2 Supplier-Buyer Relationships

Supplier Relationship Management (SRM) is a term used by organizations that encourages them to establish and maintain different types of mutually beneficial relationships with their suppliers according to their needs. SRM has a win-win strategy-oriented management philosophy and it aims the optimization of an organization's supply base, the cost reduction of purchasing and the improvement of the overall value proposition (Ma & Yang, 2010).

Supplier Relationship Management should be seen as an investment that requires an iterative process of understanding the company's needs, creation of strategies, constant supplier assessment and developing dynamic approaches to determine the most suitable business relationships. Park et al. (2010) developed an integrated SRM framework that represents what was previously described and is observable in Figure 1.

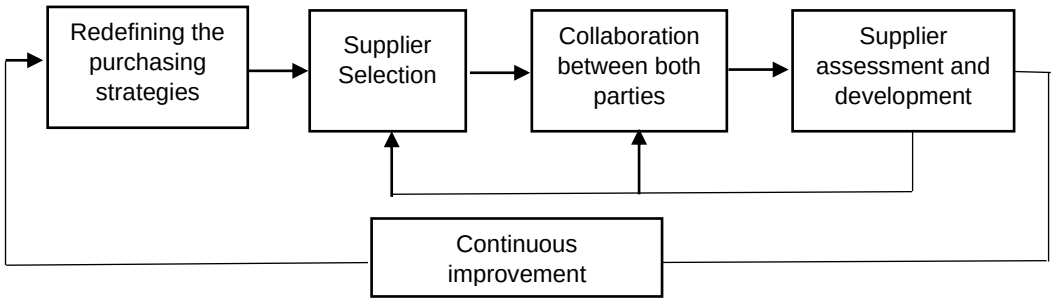

Figure 1 - Integrated SRM framework (adapted to (Park et al., 2010)*)*

In construction companies, the critical role of suppliers in the delivery of successful projects has been reinforced by several studies. Although the growth of supplier development in the manufacturing industry is notorious, the construction industry is not fully taking advantage of the potential of supplier performance enhancement (Osiro et al., 2014). Construction companies are currently dealing with challenges related to the

multitude of suppliers required for projects as well as the not suitable duration of supplier-buyer relationships (Noorizadeh, 2021).

In comparison to Supply Chains in manufacturing, a construction supply chain is more fragmented and comprises a larger number of key participants due to its complexity (Meng, 2010). Consequently, a change in the management of relationships among contractors and suppliers is compulsory. Supplier Development should be considered a strategically important activity for the efficiency and effectiveness of a firm's supply chain (Mol, 2001).

Regarding the nature of relationships, they can be categorized as arms-lengths and partnerships, which depends on the role of suppliers to the company and the level of the relationship (Rogers, 2006).

Arm's length relationship is regarded as a traditional approach that is result-oriented. In the construction industry, it is noticed that there is a strong aversion to collaborative relationships. In opposition, a supplier switching approach is preferred, since purchasers seek alternative choices of suppliers (Haddad, 2017). This type of relationship is defined as having short-term commitments and securing the lowest price is the most important selection criterion (Frödell & Josephson, 2008). It consequently results in the problem escalation of mistrust, ineffective problem solving and win-lose transactions (Arantes et al., 2015). Regarding the short-term result-oriented approach by buyers, Rogers (2006) points out 3 characteristics of arm's length relationships:

- Win-lose transactions between the contractor and the supplier.
- Low degree of supplier-buyer interdependence and asymmetric relationships.
- Historical adversarial relationships.

On the other hand, *partnership relationship* has evolved towards the minimization of the construction industry's fragmentation. On the opposite to the previous type of supplier-buyer relationship, this one is process-oriented, and it pursues supplier development by the reduction of supply base and improvement of suppliers' capabilities (Haddad, 2017). Partnership relationships are based on long-term commitments since suppliers are not involved in specific transactions but extended to more than 1 project (Narus & Anderson, 1991). These partnerships are strategic in nature and they envision closer collaborations

to optimize resources and maximize mutual benefits (Rogers, 2006). This way, there is a higher level of interdependence and no exploitation from a side with greater negotiation power (Gelderman, 2003). In this approach, purchasing has a new role within supplier development to build and maintain new and existing suppliers.

Within an organization, it is crucial to have a team that is responsible for supplier development from its early stages. To leverage effective partnering and strategic alliances, the process needs to include the following activities:

- Focus on Performance. In the initial phase of supplier development, the buying company and the supplier need to develop specific routines that allow an easier engagement of collaborative activities. For example, to improve suppliers' performance, the companies allocate their personnel to the supplier's facilities so that tactic knowledge can be transferred (Grant, 1996). The knowledge transfer activities that improve suppliers' capabilities involve technology, training of supplier personnel, product development and service delivery (Wagner, 2011). To understand if the investments are having the desired results, performance is regularly monitored through indicators and in the end objective and useful feedback is provided (Rogers, 2006).

- Supply Chain Optimization. To maintain strategic partnerships, companies provide the desired continuity of value-adding projects to their suppliers which increases their motivation to meet the organizations' needs (Rogers, 2006).

- Recognition of social factors. Nahapiet & Ghoshal (2009) recognize the inherent value of social factors in the development of business relationships. Relational factors, such as trust, are perceived as the foundation of collaborations. For trust building, both parties cannot have a conflict of interests and they have to move towards co-dependency and collaboration (Yawar & Seuring, 2017). Also, cognitive factors, that consist of shared ambition, vision, and values influence the performance level of suppliers.

2.4.3. Portfolio approach – Kraljic matrix

Several concepts and frameworks have been developed in the field of purchasing which have contributed significantly to sourcing strategies and the development of suppliers (Zimmer et al., 2016). Despite some other suggestions with minor nuances, Kraljic's

matrix has become the portfolio approach with most considerable interest over the years because it acknowledges that not only one purchasing strategy should be applied to all products and services, and it explains how different buyer-supplier relationships can be developed and managed (Gelderman, 2003).

This methodology has been primarily used in manufacturing sectors, but its application in the construction industry is rather unknown or limited since the conditions found in the project-based industry substantially change which requires a further modification approach (Winch, 2006).

The Kraljic matrix is based on two dimensions: the strategic impact (internal) and supply risk (external). Strategic importance can be measured by the importance of the purchase, which can include its cost and profitability to the organization. On the other side, the risk dimension considers factors such as scarce supply, the pace of technological advance, monopoly or oligopoly conditions, and complexity (Ferreira & Kharlamov, 2012). Kraljic (1983) states that the measurement of the previous dimensions requires a regular review, because changes may arise in supply and demand patterns.

Against profit impact and supply risk, purchased products and services are positioned within one of the four categories that can be seen in Figure 2: Leverage items, Strategic items, Non-critical items and, finally, Bottleneck items. The segmentation of the total purchasing model in a systematic way leads to the building of the most suitable supply strategy according to the product and market characteristics.

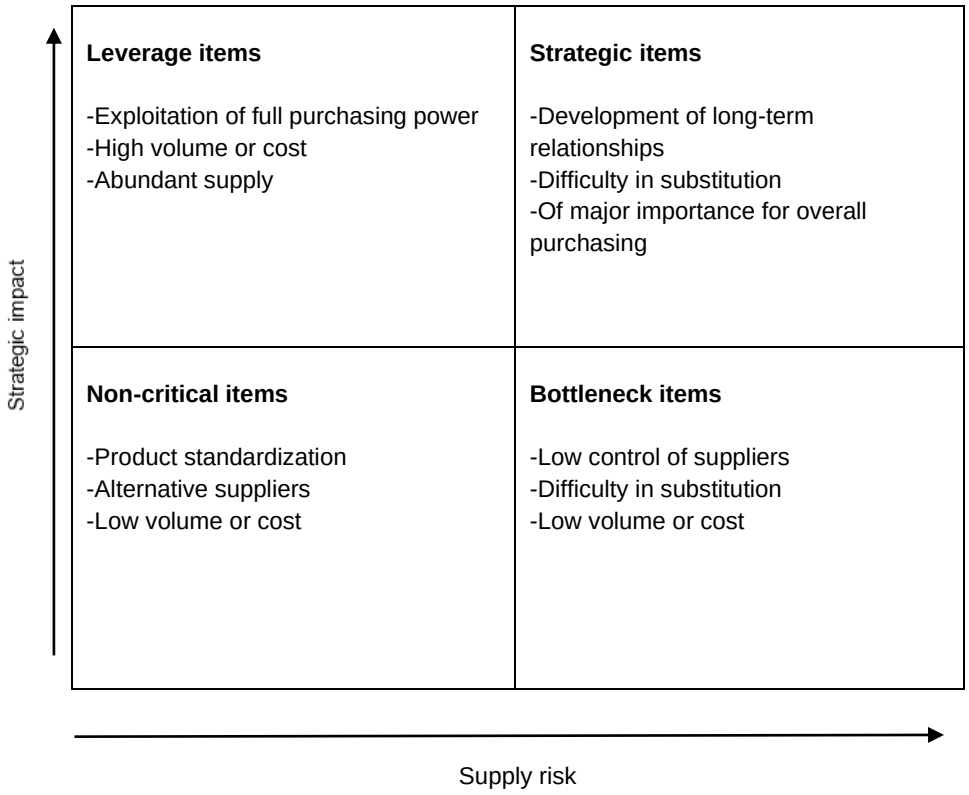

Figure 2 - Kraljic matrix (adapted to Kraljic (1983))

Leverage items category is responsible for a large part of the project' cost which makes them high-valuable for companies. Additionally, the supply risk is low, which makes substituting suppliers easy and at a low cost. Leverage items are characterized by loose supplier-buyer relationships since companies take advantage of their purchasing power, leading to supplier switching being a common practice (Bildsten, 2016).

The strategic category represents a high impact on the companies' business and high risk. Since products/ services have high value and the supply is scarce, developing long-term supply relationships becomes important for the companies' success. Supplier Relationship Management plays a crucial role in this category and continuity plans and strategic planning are recommended (Monczka et al., 2016).

The lower-right category of the Kraljic matrix concerns bottleneck items which have a low business impact but a high supply risk, since there is not sufficient availability in suppliers which makes substitution unreliable. Purchasers should have control over their suppliers, manage risks regularly and have backup plans.

Finally, the non-critical items have a low impact on profitability and low supply risk and complexity. The relationships with suppliers are short-term based and are not developed.

Besides the advantages of the purchasing portfolio that allow a holistic approach, the Kraljic matrix received some criticism (Gelderman, 2003): implementation difficulties, and lack of precision and subjectivity in the selection of dimensions and weights which leads to incorrect segmentation within the matrix. It is one of the reasons the construction industry is being so conservative in the application of the purchasing model.

2.5 Tools

2.5.1 BPMN

The need for organizations to describe their processes universally, visually, and in a simple way so all users understand their business led to the emergence in 2004 of a notation called BPMN- Business Process Model and Notation.

Therefore, BPMN intends to represent the graphic layout of business processes that occur in mostly all types of organizations. It provides a notation that is easily understandable by all users, that allows them to perceive how processes relate to each other and understand activities' sequences and information. It is important to bear in mind that the graphical representation must be in an agreement with the textual description so that the veracity of the process in question is not compromised (Chinosi & Trombetta, 2012).

Business process modelling can be described as a structured and coherent way of documenting, modelling, analyzing, simulating, and executing an organization's processes, as well as all the resources involved (Häußler et al., 2021). Despite the apparent simplicity inherent in the tool that promotes an easy understanding, it is necessary to note its complexity, due to the diversity of the organization's processes (White, 2004).

Thus, BPMN becomes a beneficial approach in a business context, especially in the domain of Industry 4.0, as decision-making can be made on a lower level of uncertainty, redundant activities become possible to be eliminated, and there is more rational management of resources and communication turns more transparent. All these improvements are due to the use of BPMN which supports a better analysis of the processes that become easier to define (Fernandes, 2021).

2.5.2 Power BI

As businesses grow, it becomes difficult to manage data being generated regularly. It brings the necessity for organizations to create business intelligence systems to develop to great extent tools to remain agile, competitive, and effective. One of the most powerful organizations in the world is Microsoft and it developed a self-service business intelligence tool that several organizations use – Power BI. It can be used to manage all facets of a company, including purchasing, logistics, human resources, and manufacturing processes (Beem, 2020).

Power BI is a good choice for cost-sensitive organizations since it is relativity inexpensive. It is a cloud-based software that has the capability of providing oriented data analysis to any area to monitor business progress and performance dynamically and more quickly. By connecting with data sources to import the convenient data, it has the possibility to transform it in the most desired way and with easily understandable visuals for users. It has the ability to produce fast outcomes and build schemes, relationships, create columns, and create measures (Microsoft, 2021).

Also, since Power BI is a less technical-oriented business tool it becomes user-friendly for beginners due to its simplicity in the language interface, predefined charts, and intuitive graphical designer tools (Howson et al., 2018).

Microsoft is continuously investing in upgrading Power BI's functionalities to become an even better-trusted platform for its users. Some of these investments contain enhancements to augmented reality which leads to new features in machine learning. It is transforming enterprise data into richer personalized dashboards for more efficient decision-making (Howson et al., 2018).

In sum, Microsoft Power BI is one of the most powerful visualization tools that firms can benefit from. Being a collaborative tool, it enables collaboration inside organizations, by promoting information exchange between different departments, and due to its analytical capabilities, it provides trustable reports of business insights that will result in an effective decision support tool.

3. Practical case: defining purchasing strategies that aim an enhanced supplier development at DST, s.a.

This chapter includes the company's presentation and analysis. This section aims to describe the current purchasing practices at DST, s.a. and highlight the improvement opportunities.

3.1 DST Group

DST Group (Domingos da Silva Teixeira) originated from the extraction of aggregates in the 1940s and began as a family business. With the growth and success of the main sectors of construction and public works, the company Domingos da Silva Teixeira e filhos, LDA was formed in 1985. Over the years, the Group suffered a notable growth resulting in the ramification in different business areas, through the acquisition and creation of several companies, that currently encompass six main sectors of activity: engineering and construction, environment, renewable energies, telecommunications, real estate, and ventures.

Currently, DST Group stands in a strong position in the Portuguese market, employing around 1600 workers, and operates under a social responsibility policy based on the development of projects that add value to society. According to the 2021 financial report, the Group presented a turnover of 211 million euros, facing a noticeable growth compared to the previous year. Currently, the Group is aiming for investment and international expansion and operates in 11 countries in multiple sectors, mainly in construction, renewable energies, and the environment, and has its commercial activity in more than 25 countries. The internationalization of the Group continues to be part of its philosophy, as the alliance to the expansion verified by today still shows commercial initiatives and proposals presented in many countries and continents. The plant of DST Group's facilities is shown in Figure 3.

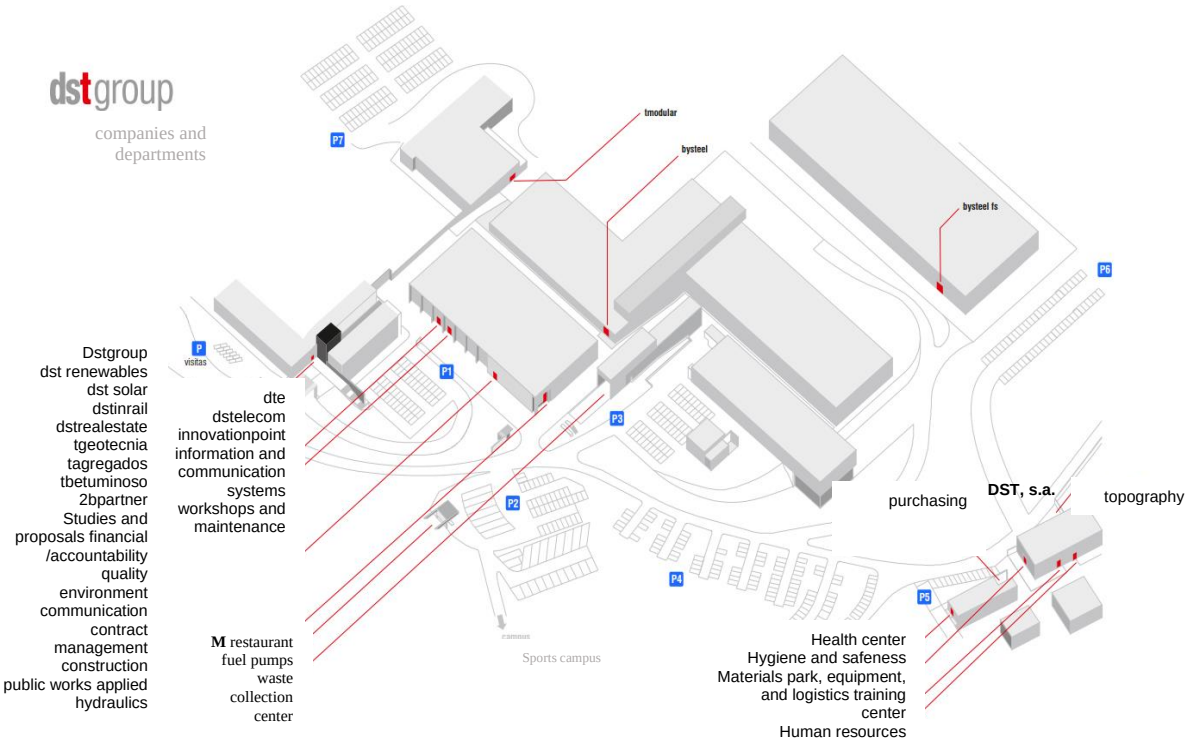

Figure 3 - Plant of DST Group

3.2 DST, S.A.

The project was held in DST, s.a., which is one of the companies that belong to DST Group. The company is one of the pillars of the Group, focusing mainly on construction and public works. It executes different types of construction projects that can be categorized into public buildings (e.g., hospital buildings, sports halls, educational institutions, cultural establishments), residential buildings (e.g., hotels, apartments blocks, terraced houses), commerce and services (e.g., food retail, sports sector, DIY, office), and infrastructure construction (e.g., urban and highway roads, airports, railways, seaports, telecommunications, wind farms, solar farms, hydraulic, environmental, and gas infrastructures). DST, s.a. participates in projects that are selected both by public and private tenders, and the decisive factors are the budget and the expected completion date of the project.

The headquarters of the company is located in Braga, but the biggest representativeness of its projects is in the metropolitan area of Lisbon. Regarding its organization, the

company is divided into departments according to its specific functions, which work individually but symbiotically: Departments of Purchasing, Logistics, Environment, Quality, Safety, Human Resources, and Accounting. Thanks to its installed capacity, DST, s.a. can successfully develop and execute all the civil construction projects that are entrusted, within the demanded deadlines and at competitive prices (DST Group, 2019).

Some of the projects developed by DST, s.a. are shown in Figure 4.

Figure 4 - Examples of construction works of DST, s.a.

3.3 Purchasing Department

As was mentioned previously, the project was held in the purchasing department of DST, s.a. This department is responsible for obtaining all the materials and services necessary to complete projects, at the right time, in the right quantity, and with the right quality. In the early stages of the development of the department, purchasing was not legitimated at the corporate level, was not seen as a supportive part of the organization, and did not have an upside impact on the company's competitive advantage. Throughout the years, the company invested in the purchasing structure and adapted it to the specific conditions and vulnerability of the construction industry to enhance its current position within the construction market. The efforts made culminated in a strongly centralized purchasing organization, where decisions regarding product specifications, supplier selection, and negotiations are made centrally. This results in improved control and management of the

activities, better strategic efficiency, a stronger negotiation position, and a higher standardization of the products purchased. Today, the team is composed of a total of 20 employees: the director of the department, 12 buyers, 2 clerks, 1 administrative technician, and 4 sourcing team members.

The categories within DST, s.a. are characterized as materials, subcontractors, labour, and services. A subcontractor is a supplier that not only delivers material, but also goods. Inside the categories, some segments reflect the multiple and specific needs of projects. A lead buying system is being resorted to, in the pursuit of savings and synergy. Each category has a lead buyer, that is also a purchaser, which is responsible for helping the purchasers that are responsible for their segments. Together, they develop and plan strategies while conducting cost-saving initiatives alongside the sourcing team to achieve the organization's goals and obtain the best cost and quality for goods and services while preserving supplier relationships. Following the lead buyer of each category, each buyer is in charge of identifying and assessing potential suppliers and products and negotiating prices.

Recently, to achieve the goals above and have more control over a fragmented industry, the organization formed a new team designated by sourcing. Its main target is the continuous search for new contacts of suppliers, the creation of support tools for buyers for a quicker and more effective search of suppliers suited to each specific project, and their evaluation. An example of a technological tool that was created and is in continuous improvement is Power BI.

The department's organizational chart can be perceived in Figure 5.

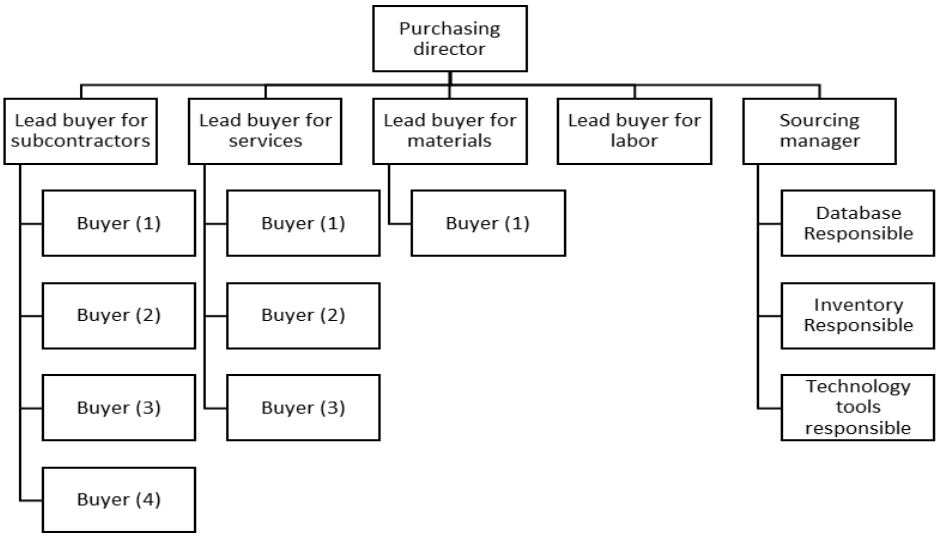

Figure 5 - Organizational chart of the purchasing department

Although it is not included in the organizational chart of the purchasing department, it is important to mention that the purchasers work closely with site managers. The site manager is responsible for coordinating and supervising the work of suppliers, and guaranteeing they are delivering what was assigned on the demanded time and with the required quality. When the company's proposal for the bidding process is accepted, the person that is in charge to control the construction site, the required materials, equipment, and workforce, elaborating the work plan, and controlling project costs is the site manager. This way, there is continuous communication between the manager and the buyers. Every time changes occur within the items required for the construction projects, the site manager must clear that to the buyer, and every decision the purchaser makes needs to be validated by the site manager.

3.4. Purchasing at DST, s.a. – "AS-IS"

In recent years, the company has initiated different tactics and has become more strategy-oriented rather than project-oriented. This helped DST, s.a. to grow into a more refined and mature organization.

Purchases are made from various subcontractors, labour, services, and materials.

The subcontractor category is characterized as being the architectural part of each project and it has various segments, such as electrical installations, AVAC installations, metallic

structures, formwork and steel applications, earthworks, hydraulic, locksmiths, concrete floors, water supply networks, metallic coatings, and drywall.

The labour category comprises bricklaying, curb laying, ceramic laying, plaster, and stonework settlement.

The services category is described as the contribution to the design of the projects, and they carry precast steel services, building information modelling (BIM), waterproofing, topography, waste management, and surveillance.

The materials category consists of everything that the subcontractors do not hand over in their work.

3.4.1 Suppliers' availability

An important factor for the purchasing and supply strategy of the organization is that suppliers should guarantee low costs. DST, s.a. is known among its competitors for demanding the lowest prices. Another point of interest is the dependence on suppliers which is often a topic in daily meetings with the team. Throughout the years the construction industry has become heavily reliant on subcontractors and suppliers and DST, s.a. reflects that. Although points of view diverge, the organization opts to have a wider range of suppliers, resulting in a project-based short-term partnering. DST, s.a. is currently lowering costs and purposing quicker delivery times. This results in very attractive bids to clients and consequently, the company wins more construction projects. Also, some aspects included in competitive markets are the flexibility in the substitution of suppliers, and tenacious price negotiations. Since project specifications changes can occur in such a volatile industry, the company does not want to risk being dependent on a single supplier, since it turns the switching cost of a supplier relatively high, and in severe situations could result in the rupture of the supply chain.

Table 1 shows the business volume for 2021 for all segments and the ABC analysis. With the use of Pareto's Law, it was possible to verify that 21% of the segments represent 80% of the total purchase volume, 29% of the segments represent 15% of the total purchase volume and 50% of the segments represent only 5% of the total volume of purchases. This analysis is important since it accounts for the total cost of purchases in each segment. Class A segments mean that their suppliers are key contributors to the company's profitability. Given this fact, the company should spend extra attention on these important suppliers and close relationships with them should be cultivated.

Table 2 - Summary of the ABC classification of the segments (2021)

Class	% Of segments	% Of the volume of purchases	The volume of purchases (euros)	Nº of segments
A	20, 90%	79,88%	107 341 548,08 €	28
B	29,10%	15,13%	20 329 952,85 €	39
C	50,00%	5,00%	6 713 097,31 €	67
Total	100,00%	100,00%	134 384 598,24 €	134

In Figure 6 it is possible to observe the distribution of the company's suppliers across Portugal. It is possible to conclude that the highest density of suppliers is located in the Lisbon metropolitan area, followed by the northern zone between Braga and Porto. This reflects that the interior of the country suffers from great inequality in opposition to the borderland. An explanation for the absence of uniformity in the number of suppliers in the country is the fact that in opposition to urban areas, rural locations struggle to recruit younger workers who are not encouraged or exposed from an early age to vocational education related to the construction industry. DST, s.a. faces severe challenges when they have to execute projects in the interior of Portugal due to the lack of suppliers or qualified workforce in that area.

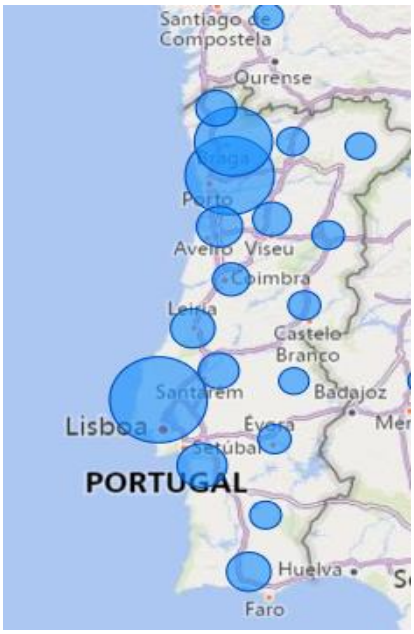

Figure 6 - Distribution of the company's suppliers across mainland Portugal in 2021

The map below in Figure 7 shows the location of the projects the company incurred in 2021. It is possible to verify that they are distributed mostly in the metropolitan area of Lisbon and the north of Portugal. Contrary to the concentration of building development in urban centers, citizens that live in rural areas travel significant distances to reach facilities located in the main centers of the population.

The projects that have a more remote location usually represent more difficulties in the supply, as the number of suppliers is significantly lower in these geographical areas.

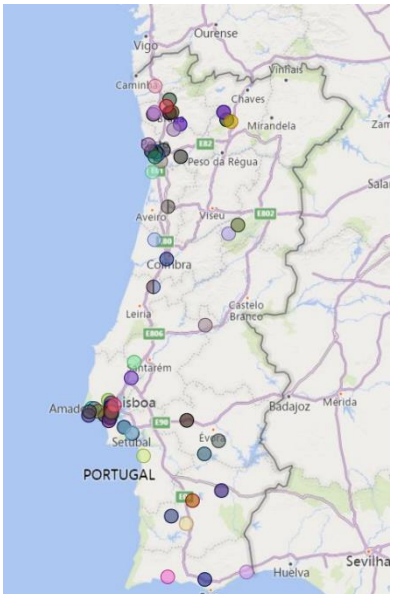

Figure 7 - Distribution of the company's concluded projects across mainland Portugal in 2021

3.4.2 Supply savings

In 2019, after the assessment of that year, it was realized that the targets of savings of the total purchasing volume were far from being accomplished. Lead buyers were not organized to maximize purchasing goals, and crucial components such as spend analysis and development of strategies were missing.

As a consequence, at the beginning of 2020, the sourcing team was founded with the main goal of cost savings in all aspects. The new strategic group withdrew emphasis on the price and acted in the sense of suppressing the difficulties that are felt in the more remote areas and critical segments. One of its main targets is the continuous search for new contacts from suppliers as it provides a safety net if a supplier runs into difficulties. Since 2020, the number of suppliers in the company's database has grown significantly.

The strategic sourcing processes occur continuously over the year since the team is always working on upgrading data visualization, so the buyers spend less time on the analysis of the current database and construction market. In parallel, other strategic sourcing processes occur when a buyer is notified of a new project that involves critical segments. Thus, buyers and sourcing members work alongside to develop risk mitigation plans.

When a new supplier is selected for a certain work, a total cost perspective is used throughout the entire supply chain of the organization to calculate cost savings. That saving is calculated by the difference between the value of the budget closed with that new supplier and with the best one that was not chosen and that already existed in the company's database.

From 2019 to 2020, the company registered a growth of supplier contacts of 184% from 2020 to 2021, and there was a 367% growth in new suppliers of DST, s.a. compared to 2020.

Figure 6 shows the growth of savings accomplished in the years 2019, 2020, and 2021.

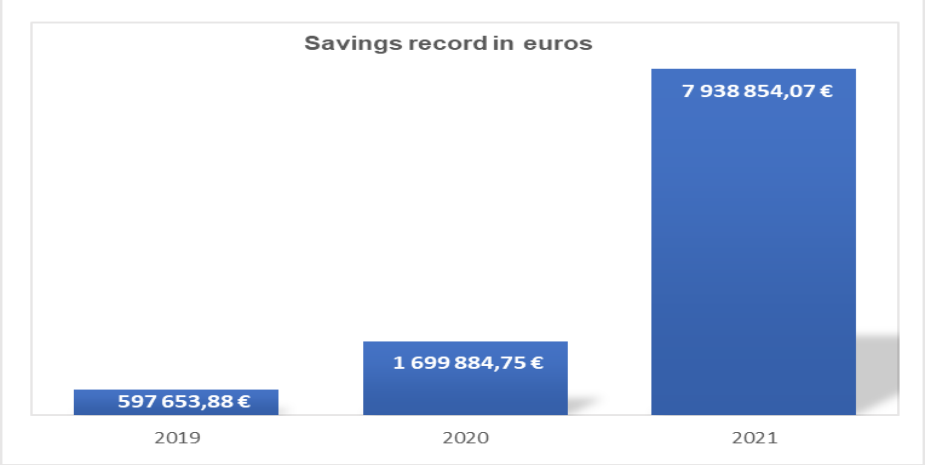

Figure 8 - Savings record in 2019, 2020 and 2021

3.4.3 Process of hiring suppliers

The purchasing process starts when DST, s.a. is selected in the bidding process which generates the need for multiple subcontractors and material supplies.

The procedure starts with a request from the site manager, via email, with all the requirements for the project's execution, which includes articles to buy or subcontractors to hire, the budget available for the project, and the respective closing dates.

The buyer then creates an Excel document called "provisioning map" where the processes and their status will be registered. After planning the business, the supplier selection process starts.

The buyer analyses if the project requires a critical segment, which means that there are few suppliers in the department's database and it contributes to a large cost of the project. If it is one of the most critical segments, the buyer will notify the sourcing team to start working in the field. This activity is called "task force", designed to solve major problems and create new opportunities.

Thus, the sourcing team starts the process of looking for new supplier contacts and then provides the buyer with proposals for new contacts. Finally, the buyer launches a contest for suppliers, via email, which begins by questioning their interest in working with DST on a certain work. The stage that was previously described can be seen in Figure 9, which is represented by BPMN 2.0.

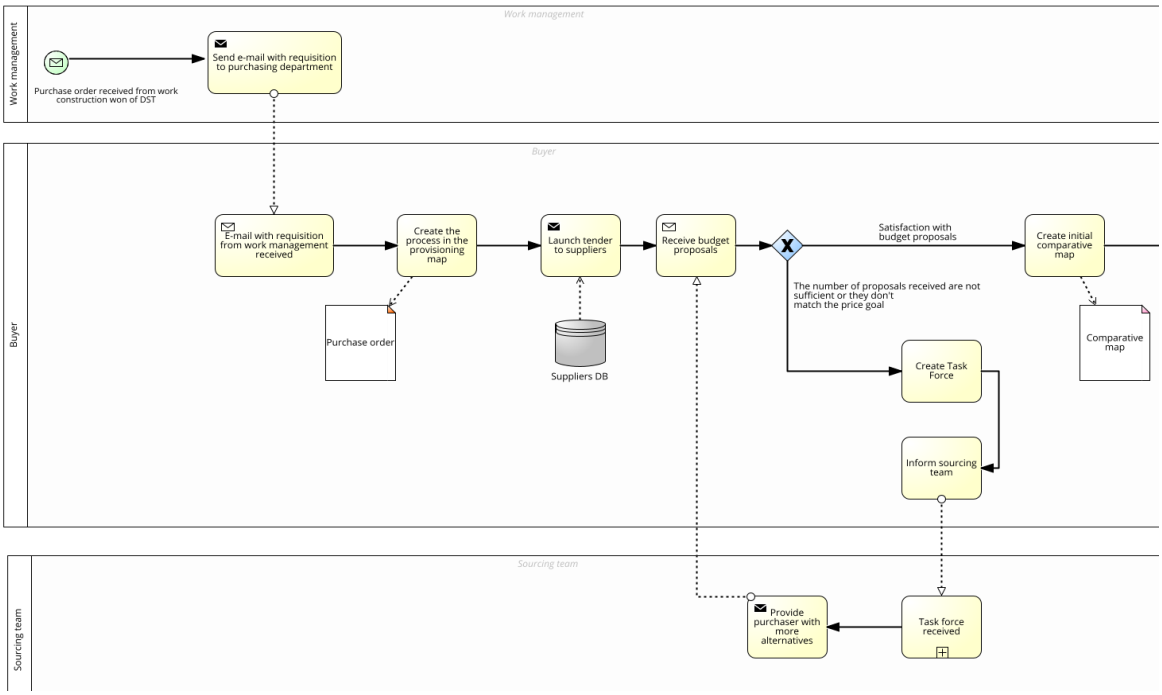

Figure 9 - First stage of hiring suppliers

Then, the buyer updates an Excel document named "comparative map", where the prices quoted by the various suppliers that were approached are filled. Then, the site manager reviews the document and validates financial requirements, payment terms, and whether the price, terms, and quality are fulfilled for the purchase in question. The document with the updated and validated proposals is named "final map".

If the requirements are not met, the buyer negotiates a proposal review with the supplier and if successful, the proposal is updated. At this stage, the buyer will decide the best adjudication option according to established criteria.

Then, the process is sent to the client and waits for the conceived approval. When the approval is established, the site manager creates a subcontract requisition that will serve as a basis for the supplier's contract. If the value awarded is below 10000 euros, the buyer sends a validation request to the production director; if the value is superior, it will also be directed to the board chairman. Figure 10 represents the previous description.

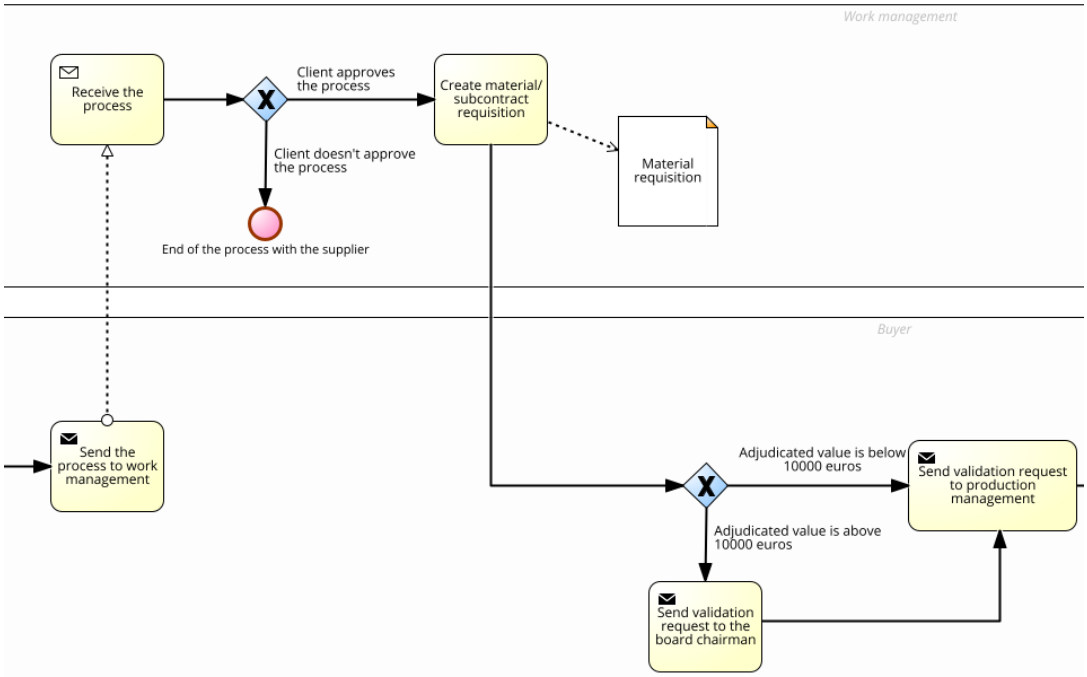

Figure 10 - Second stage of hiring suppliers

Finally, the contract with the supplier is formalized in case of the supplier acceptance of the contractual term conditions.

Then, the sourcing team will verify if the adjudicated supplier has previously worked for the company or not. If it is a new contact, they will register the information of the saving in the system.

When the work with the subcontractor is finalized, its performance will be subjected to evaluation. For DST, s.a. to remain ahead in today's competitive and globalized era, it needs to work with efficient suppliers, therefore a strong evaluation needs to be done to select the right construction suppliers to minimize the risk of purchasing. The final procedures of the hiring supplier process are followed in Figure 11.

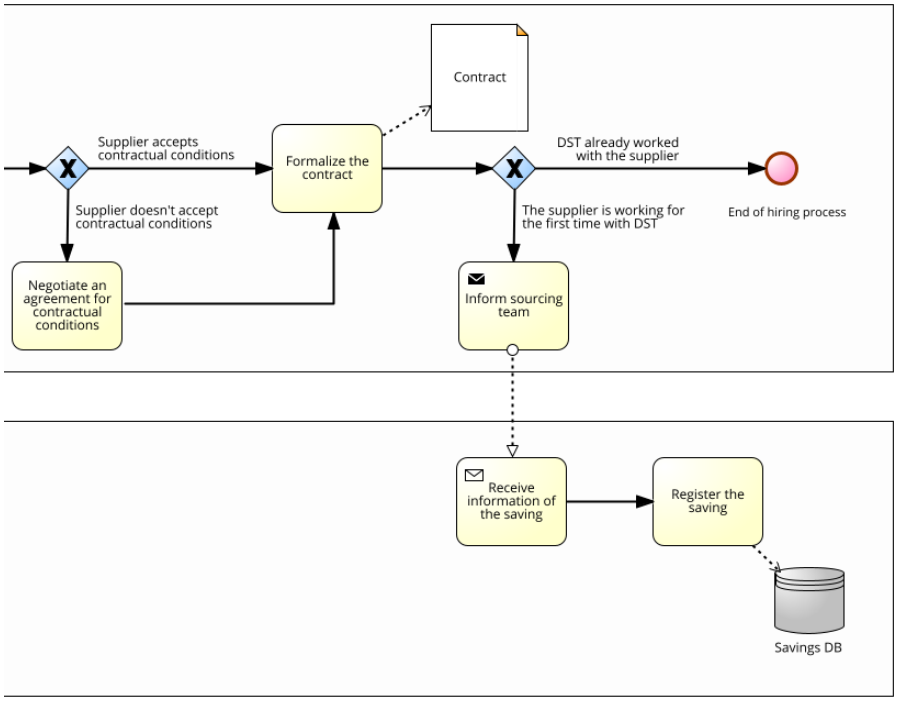

Figure 11 - Final stage of hiring suppliers

3.4.4 Suppliers' evaluation and development

In the recent past, DST, s.a. has initiated different programs to strengthen its ongoing position within the construction markets. One example is the ongoing supplier evaluation the sourcing team is responsible for. This new strategy is due to the perception that sometimes the price pressure on suppliers causes many unpredicted problems in the projects. It was studied that approximately 50% of quality problems in the industry are due to inadequate selection of suppliers (Monczka et al., 2016). After recognizing the importance of cooperation within a supply chain that generates benefits such as quality improvement, productivity, ability skills, and maximization of the objectives, DST, s.a. made efforts in that sense.

The supplier evaluation system is an operation that has been subject to changes and enhancements to better adapt to the reality of the company. It is important to note that DST s.a. has always conceived the suppliers' evaluation program as a phase that precedes supplier development. It is a tool to acknowledge the performance of suppliers in previous projects and share that information with them. It is not a penalizing process, instead, it is a procedure that aims for continuous improvement.

The site managers play a significant part in this initiative because after each project they give feedback on suppliers' performance. Since the site managers work closely with suppliers and accompany them in the tasks they were assigned, they can give a detailed overview of their performance. When a project is concluded, the sourcing team receives the feedback description from the site manager and they become now responsible for making the suppliers' evaluation.

The company divides 12 evaluation variables into 6 main categories: technical capacity, fulfilment of deadlines, compliance with environmental rules, compliance with safety rules, human relations, and negotiating ability. Table 3 presents the variables that are adopted in the supplier evaluation.

Table 3 - Supplier evaluation criteria

Technical capability:
Quality of work
Equipment used
Preparation/ Training of the workers
Presentation on technical solutions
Quality of materials
Compliance with the agreed-upon timetables:
Work plan completion vs expected date
Compliance with environmental rules
Environmental management systems
Compliance with safety rules:
Security rules
Legal documentation
Alcohol detected in workers
Human relations:
Schedule availability and exact time
Negotiating ability:
Collaboration in the negotiation process

After assigning the score to each parameter, a global rating is calculated. The final rating is divided into A (excellent), B (desirable), C (should improve), D (possible to be soon excluded), and E(excluded).

The suppliers who obtain a D rating are excluded within a short period if they do not immediately implement appropriate corrective actions for the problems that were faced in the project. It is important to highlight that suppliers' evaluation is fundamental for the success of supplier development since it includes the members that better fulfil the company's needs. With the ranking implementation, the buyers are allowed to have knowledge of the evaluation of the suppliers of their database and make their decisions based on higher quality, since they give priority to suppliers that own A and B classifications.

Figure 12 shows the suppliers' evaluations in the years 2020 and 2021.

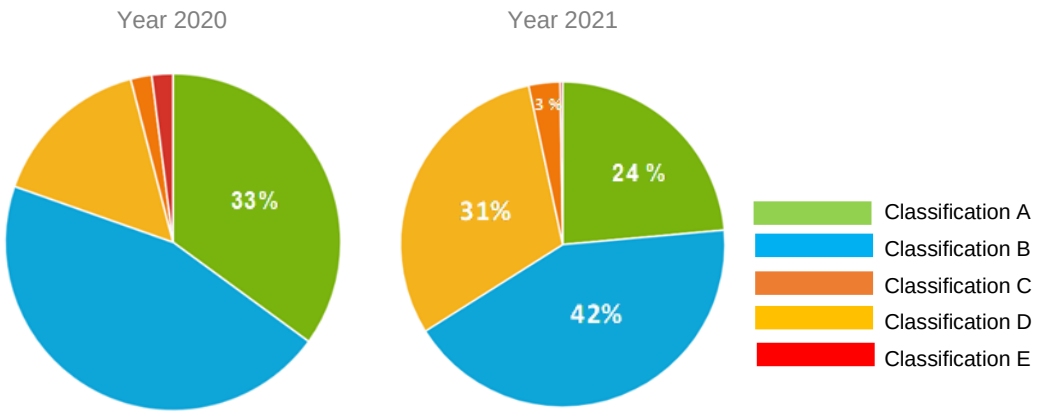

Figure 12 – Suppliers' evaluation in ranking in the years 2020 and 2021

The upper right graph shows that most subcontractors obtained a B rating in the year 2021 and the E rating is almost null, representing a percentage of only 0,26%, which meets the company's goals. The objective of the department is to have a bigger representation of the A and B classifications.

Although the year 2021 appears to be forward-looking in the distribution of classifications, it is shown in Figure 12 that the evolution of the ranking of subcontractors from 2020 to

2021 had a negative progression in classification A, which harms the purchasing department's ambition. After a discussion with the team, an explanation for this cause was absent or unclear.

3.4.5 Purchasing strategy

In the year 2020, an investigation on how the purchasing department could apply the Kraljic Model in DST, s.a. was followed. The Kraljic Model, developed for the implementation of a purchasing portfolio model, classifies products and services according to 2 dimensions: profit impact, and supply risk. In this case, the company's segments were assessed, which were measured in the risk parameter by negotiation power, location of the project, ease of switching suppliers, and timelines.

After scoring the 2 dimensions for each segment, the portfolio matrix was constructed, as can be seen in Figure 13.

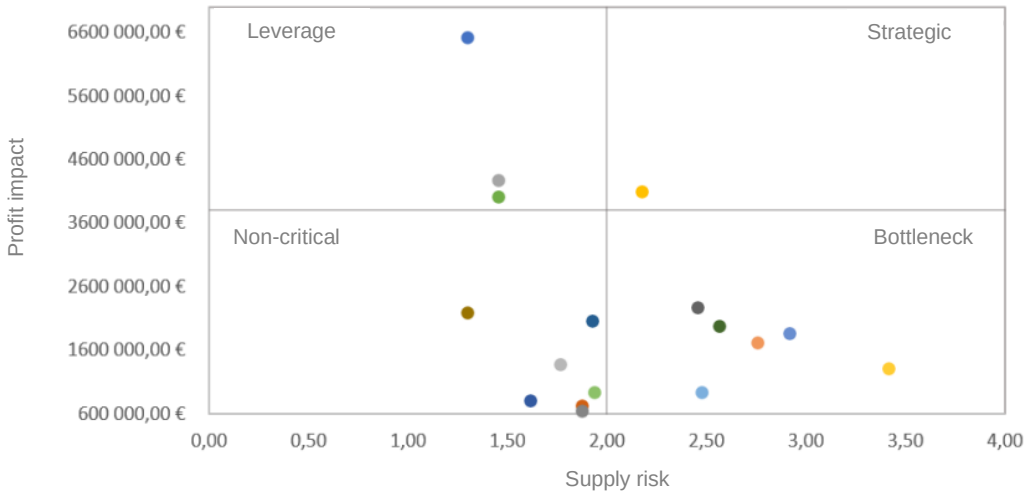

Figure 13 - Purchasing portfolio matrix of DST, s.a.

This tool applied to the purchasing department aimed to develop a support model for the formulation of different purchasing strategies for the multiple segments required in construction projects.

After discussing with the purchasing team about the improvement strategy, it was perceived that it did not have the positive outcome expected. Although the Kraljic Matrix is

very recognized and has been widely used in various industries, it still does not have a remarkable presence in the studied industry.

Firstly, purchasers admitted that they did not have a proactive attitude towards the analysis of the portfolio model and did not use it to make strategic decisions. Also, the needed yearly update of the segments' classification did not happen because purchasers stated that they did not find the required time to make a continuous study about the risk inherent in the supply market.

The purchasing director of DST, s.a. discussed that the Kraljic Matrix did not have enough accuracy to be systematically used for decisions that demand a strategic change according to the segments' position in the model. Within the team there was an overall agreement that it was difficult to classify the supply risk of each segment because there is a significant variation in each project:

- *Project type*.
  The company executes different types of construction projects, being the main ones public and residential buildings, infrastructure construction, and related to the area of commerce and services. As a result of the freedom of choice that customers have in choosing the specific requirements they desire in a certain project, the variability of project types increases. Due to the different circumstances and specifications that projects demand, for one building design, the supply market may be available, but for another one, the purchasers may find it difficult to find an appropriate supplier that has the technical capacities to perform different specifications.

- *Project location.*
  This factor also contributes to the overall difficulty to give a score to the supply risk of a segment. For the evaluation of project location risk, purchasers analyze the suppliers that can respond to a customer's demand. For example, during the development of the most suited matrix for DST, s.a., this risk was calculated according to the distribution of subcontractors of each segment across the country. If the suppliers of a segment were only concentrated in a few areas, it would be considered a risk for the projects' execution. Due to the complexity of the industry, the previous analysis cannot be so linear. Several suppliers have a robust transportation system that allows them to perform even in remote areas. During

the negotiation between both parties, suppliers can reach an agreement with DST, s.a. that does not increase the costs for the contractor in transportation. Besides that, construction site conditions also influence the supply risk, once poor soil conditions, weather changes, and dependence on construction approvals can influence the projects' delivery. They should be parameters to be also considered in the assessment but are not possible in a global approach.

- *Number of suppliers.*
  The ease of switching suppliers is dependent on the size, type, and location of a project, which influence the number of suppliers that are capable to satisfy all demands of DST, s.a. Specific characteristics of a project inhibit the supply market availability due to required expertise. Also, the absence of long-term strategic relationships that the company has with its suppliers increases the uncertainty of relying on the contractor.

All the above factors restricted the management of all purchasing situations and the consequent non-use of the Kraljic Matrix in the purchasing department of DST, s.a. A different approach could have been more successful, as categorizing all segments with the same criteria is not ideal. The strategic category, which is critical for organization's business, gives the knowledge of the areas that need strategic partnerships, which would be valuable for greater supplier development.

3.5 Improvement opportunities

After analyzing the current situation of the department through the available purchasing data and supplier performance that was systematically gathered from previous projects, the next step was investigating feedback and problems identified, through participatory observations, detailed discussions, and formal and informal interviews. Given the changing nature of the construction industry, it was necessary to conduct a longitudinal data-oriented approach that took a substantial part in the 8-month project developed in the company. The access to the department's database and the collaboration of the members were considered crucial in the puzzle-solving analysis of the status of the purchasing department.

The problems identified by the purchasing department that have a direct negative effect on the organization's performance are discussed below.

- Despite the supplier evaluation system with several criteria that are taken into account, the purchasers' focus is mainly based on the price, rather than on trust-building, managerial skills, and quality delivered in the work.

- The company pressures site managers to select suppliers with the lowest prices. Since the selection of suppliers from purchasers needs approval from the site manager, many times the decision of the most suitable subcontractor for a project is turned down. Therefore, the period of supplier selection suffers a delay since site managers usually object to the purchasers' decisions.

- DST, s.a. reinforces purchasers to prioritize companies that belong to DST Group. Over the years, the mother company suffered a significant expansion and acquired:
    - *Tmodular*, whose activity is centered on wood transformation.
    - *Tgeotecnia*, which is responsible for the conception and execution of geotechnical engineering works.
    - *Tagregados*, that specializes in rock mass blasting.
    - *Tbetão*, which is responsible for the design, development, production, and marketing of all kinds of concrete.
    - *Tbetuminoso*, that operates in route communication and owns teams that are responsible for the application of bituminous mixtures and granular layers.
    - *Dte*, that focuses its activity on the installation of infrastructure and electromechanical equipment.
    - *Bysteel*, which today has a remarkable presence in the construction of super infrastructures in steel.
    - *Dstinrail*, that is specialized in rail infrastructures.

  When the purchasing department gets notified of a new project, the buyers launch the contest to the subcontractors and suppliers that specialize in the demanded area, and usually, a company of the Group is included. If this company is interested in working on the available project, the purchaser is ought to accept its offer. Consequently, it is difficult to maintain a good relationship with usual suppliers because they know they will lose an opportunity in case of competing with one of the companies of DST Group.

- No personal meetings with suppliers are arranged during negotiations, which could be beneficial for an easier and faster agreement that would serve both interests. In some cases, in-person meetings result in greater deals and better relationships between the entities.

- There is not a team within the department that is dedicated to the suppliers' continuous improvements and buyers have a limited time to study the market and think of new strategies to upgrade the purchasing efficiency.

- Communication between the site manager and the purchasers is frequently not clear. Sometimes the projects' needs that are expressed to the purchasers, for instance, budget value, quantities required and closing dates are missing or incorrect.

- The department is facing several situations of supply difficulties, related to the challenge of finding suppliers with quality services within the required prices and deadlines. The segments that face the most difficulties in supply are the ones related to reinforced concrete, carpentry, and labour.

    - A massive shortage of skilled labour in the construction industry is affecting the projects' kickoff and success. The number of qualified candidates for employment opportunities is insufficient for the demand, which often makes the contractors hire less suitable candidates and further suffer the loss of quality and higher costs.
    - In carpentry, most of the suppliers do not accept the low prices that DST, s.a. requires. Also, projects that represent less value of adjudication, and the location of the project are usually factors that restrain them to work in a certain area, especially in a remote one.
    - The reinforced concrete segment, which is widely required in construction projects, faces a few number of suppliers in the market with availability or interest to work with the contractor, and unlike other contractors that guarantee continuity of projects, DST s.a. adopts a strategy of increasing the supplier options to always have alternative choices in case of emergency or complications with the current suppliers.

3.6. Action Plan

After evaluating the problems, improvement opportunities for the purchasing department were thought of. It is unequivocal that communication between the site managers and purchasers needs to be revised and improved to have a smoother supplier selection process. Also, a strategy that concerns the companies of DST Group should be thought of, to avoid conflict with subcontractors. The aspects that are a priority in the company concern:

1. Improvement of supplier development. The company needs to find a balance between increasing the supplier database to avoid supply chain rupture and considering a collaborative partnership that is regarded as a pivotal factor in the success of a project. The construction companies' suppliers are responsible for assuring a large part of the quality of the finished products, so supplier development efforts are recommended to be made. An interesting area to investigate is related to the supplier side to acknowledge their perception of the relationships with the purchasing companies and how it affects their performance. Thus, suppliers' expectations about this theme will be raised.

2. Improvement of the analysis of suppliers' progression. The ranking program is not being analyzed and the most qualified workers have been lost from one year to the other, which is drawing back the company's results. This is due to the absence of a tool that immediately helps purchasers in the decision-making process. The purchasing department has an excessive number of files that are decentralized which leads to the difficulty of knowing where to search for data.

Despite the efforts made throughout the years to facilitate the purchasers' work, such as the creation of the sourcing team that helps them in the most critical segments, and the adoption of new technological platforms, like Power BI, there is still a major struggle in fulfilling the supply demands. This way, it was agreed that supplier development should be the cornerstone of the project.

4. Implementation of the action plan

In this chapter, a discussion will be held about how the suppliers of DST, s.a. perceive the construction industry, the challenges they face, and how the dynamic with the purchasing departments affects their performance in projects. To achieve that, firstly the critical segments will be defined, and a survey will be elaborated and shared with the suppliers of those segments. Lastly, an investigation of the supplier development in the platform ranking will be conducted, and a business intelligence tool will be implemented.

Within this chapter, relevant information will be gathered and investigated to answer the following questions:

1) What are the critical factors perceived by suppliers that affect their performance in construction projects?

2) What efforts and changes can DST, s.a. do to improve supplier-buyer relationships?

3) How can the development of suppliers be analyzed?

Firstly, to respond to the raised questions, the target suppliers will be defined. Then, interviews will be made with the selected suppliers, and a survey will be conducted. When all the data is gathered, for the first time in the purchasing department, the factors that suppliers mostly consider in the decision of working with a construction company will be exposed. With the collected information, improvements will be suggested to upgrade the supplier-buyer relationship.

Finally, a deepened analysis of the evolution of suppliers will be made, as the current goals of the purchasing department are not being achieved.

At the end of the chapter, with the new findings and improvement proposals, it is foreseen to have made a positive impact on the purchasing department, so the company develops an enhanced supply base to lever the competitive advantage.

4.1. Improvement of the relationships with suppliers

This section aims to identify and interpret the suppliers' perspective on their relationships with purchasers and site managers, and to receive their insight about what leads them to

accept working with DST, s.a., and about the key driving factors that maximize their performance in projects.

Since suppliers affect and determine a large part of a project's success and they are responsible for the highest percentage of turnover of the company, it is necessary to understand how efficient cooperation with suppliers can increase their core competency and enable DST, s.a. to become more competitive.

4.1.1 Suppliers selection

The construction industry is very diverse unlike other ones and specifications and needs change over different demands. As such, many segments are very volatile because of the low stability that they present over the years.

First, it is necessary to set the focus on the segments within the construction area that will be addressed. The core of the project is the critical segments that do not suffer fluctuations over the years and represent the largest monetary value in purchasing, as well as supply risk due to the market's availability.

To identify the critical segments, firstly an ABC analysis of the purchased volume in 2021 of the segments will be made, to realize the segments that represent 80% of the total value that was adjudicated.

Table 4 shows the class A segments that contributed the most to the company's profit in 2021.

Table 4 - *Class A segments in purchasing volume (2021)*

Class A segments	**Adjudicated volume (euros)**
sub_electric installations	13 063 412,9 €
sub_avac instalations	10 012 411,3 €
sub_ formwork / concrete application	5 938 161,4 €
sub_ metallic structures	5 669 746,2 €
sub_hidraulic	4 987 266,4 €
sub_earthworks / earth movement	4 841 740,8 €
mat_iron profiles	4 587 963,2 €
sub_croncrete pavements	3 880 659,1 €
mat_ready-mixed concrete	3 752 526,5 €
lab_ per hour	3 734 274,4 €
sub_steel application	2 910 538,8 €
sub_ metallic coatings	2 586 571,2 €
sub_hydromechanics	2 455 568,0 €
sub_ landscaping	2 309 533,6 €
mat_aggregate	2 119 358,2 €
sub_ aluminium locksmiths	2 025 041,8 €
sub_light metalwork	1 950 620,6 €
mat_light/heavy concrete artefacts	1 888 323,4 €
Sub_prefabricated concrete substructures	1 820 431,1 €
sub_plasterboard	1 659 439,7 €
sub_metal retainers	1 550 015,1 €
mat_pipe	1 370 197,6 €
sub_accustic barriers	1 336 698,6 €
sub_general carpentry	1 196 426,1 €
sub_bituminous pavement	1 079 650,2 €
serv_ precast steel	1 053 883,5 €

After the previous analysis, the next step consists of the analysis of the segments that represent the biggest risk in the supply chain. This could be due to factors such as localization, absence of a market, price competition, and relationship status.

As was mentioned in the previous chapter, after a discussion will all the purchasers, the segments that over time faced the highest risk of supply were labour, carpentry, and reinforced concrete, regardless of the variables that characterize a project.

Since all these 3 segments (labour per hour, general carpentry, and formwork/ concrete application) represent the highest percentage of financial transactions and risk in the supply chain, they will be the subject of this chapter.

After selecting the segments that are part of this action plan, it was necessary to decide the suppliers within the whole range that would be included in the program.

According to Rungtusanatham et al. (2003), units of analysis refer to who or what is being investigated, which could be an individual, a workgroup, a project, a function, a company, or a group of companies. The project's sample of investigation matters the suppliers that act for the most significant contribution to the company's success. They concern the critical segments that are evaluated with A and B classifications since they represent the suppliers with the most added value to DST, s.a. and at the same time, they are preferred suppliers that perform accordingly to the demanded requirements in technical capability, human relations, negotiation skills, compliance with the agreed-upon timetables, environmental rules, and safety rules. The group consisted of 22 suppliers.

4.1.2 Inquiry of suppliers' insights

For each segment, the chosen methods were interviews and a questionnaire destinated for the suppliers to understand the correlation between a contractor's attitude, in this case, DST, s.a., and a suppliers' behaviour and performance before and during construction projects.

It is important to highlight that the first stage of this process had the plan of raising suppliers' overall considerations and problems to then elaborate the survey. Although the interviews are a first step to collecting enough information and should be addressed to a smaller number of respondents, in this case the opposite happened. There were more suppliers included in the interviews than in the survey. The reason for not having fewer interviewees was because it was advised from the department to include all those suppliers. After all, conditions were met to acquire more valuable insights. Thus, it was chosen to follow the teams' advice and opted not to decrease the number of suppliers to be interviewed.

4.1.2.1 Semi-structured Interviews

Interviews were chosen as the first method of data collection and ten subcontractors were interviewed per each of the three critical segments, which made a total of 30 interviewees.

This data collection method aimed to measure the variables that affected the suppliers' motivation of working with DST, s.a. and its competitors within the construction market, to then elaborate the survey that is going to be approached in the following subchapter.

The suppliers were interviewed by phone calls, and the instrument used was a semi-structured script, which accordingly to Gilbert (1979), consists of a set of questions previously planned that conduct an informal conversation. This type of interview reinforces the specificity of each case and the need to deepen the investigated information.

Regarding the selection of the interviewees, the choice was not made on a random basis. As previously mentioned, the buyers responsible for each critical segment recommended the suppliers with a vaster specialized knowledge in the construction field, and that had a more significant negative or positive impact on the collaboration with the contractor company in the past.

The interview script held the following questions:

1) What are the factors that lead you to accept working with a contractor for a construction project?

2) How was your experience with DST, s.a., as the contractor company?

3) Which are the desired factors to improve the relationship with DST, s.a.?

All the interviews lasted between 30-40 minutes and the duration of this phase was 4 weeks since it was not easy to reach suppliers due to their availability, and when the interviews concluded, the purchasing team wanted to be part of the analysis process which made it also difficult to schedule some meetings.

The interviews served as a pilot study that aimed to the reliability and the validity of the survey, and when they concluded, they were discussed with the purchasing director, the head of the sourcing team, and the buyers responsible for each segment.

According to the fruitful discussions that were held with the suppliers, it was clear that all the collected answers had the same line of thought, which led to the same survey for all the targeted suppliers.

4.1.2.2 Survey

The second phase of data collection was the elaboration of a survey, after filtering and analyzing the gathered responses in the interviews and summarizing the findings.

The questionnaire survey sought the suppliers of the segments labour per hour, general carpentry, and formwork/ concrete application that were evaluated with the best classifications, being excellent and desirable. During the selection stage, purchasers should prioritize high-value suppliers that not only offer the lowest price but can also deliver construction quality. Therefore, to reduce the risk of non-supplier availability in the market it is necessary to have novel purchasing strategies that will be introduced.

The sample consisted of 22 subcontractors and the survey included 7 qualitative questions and 1 quantitative question. Also, to have an easier analysis of the collected data from the survey, closed questions were preferred. The multiple selections of possible answers were drawn from the interviews addressed to the suppliers.

The time limit set to receive the answers from the selected suppliers was 3 weeks and the goal was achieved, with a response rate of 22 / 22 = 100%. Most of the targeted group had to be alerted before the deadline. The purchasers took a fundamental part in this achievement since they reached the suppliers and asked them to fill and submit the survey.

The questions elaborated for the survey are followed.

1.) Name of the company

2.) TIN (tax identification number)

3.) Rank in ascending order the importance level of the following topics when working with a contractor.
- Compliance with the agreed-upon payment.
- A good relationship with the site manager.
- Financial stability of the company.
- Continuity of transactions.

4.) Is it possible to identify 2 unfavourable aspects that DST, s.a. should improve? If so, which ones?

5.) In such a competitive market, in what aspects do DST's competitors prevail?

6.) Regarding DST's purchasing department, assign a score to the following topics, from 1 to 4, with the latter being the best possible score.
- Relationship with the purchaser.
- Feedback on the response to the submitted budget.
- The deadline that is given for the budget submission.
- Contractual continuity for new projects.

7.) How could DST help your company improve its services?
    - Performing audits.
    - Training (e.g., marketing area, leadership and performance, technology skills and programs)
    - Possibility of taking advantage of DST's benefits (e.g., fuel discount, education, health, and well-being)
    - Incentives for younger people to join the construction industry.

8.) What is the estimated percentage of turnover for which DST was responsible in the previous year?

    - < 25%
    - 25-50%
    - 50-75%
    - > 75%

4.1.3 Interpretation of the collected data

After obtaining the responses given by suppliers, the proceeded stage consisted of the analysis of the received feedback.

Question: Rank in ascending order the importance level of the following topics when working with a contractor.

This question aimed to identify the prioritized criteria by the suppliers when they are faced with the decision of working with a contractor. The response rates to the topic are illustrated in Figure 14.

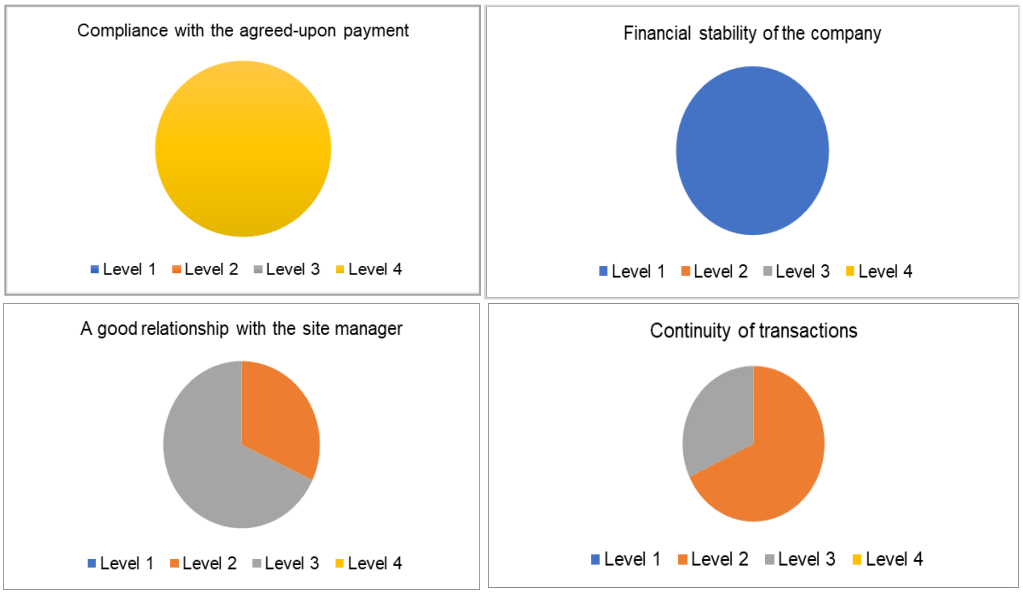

Figure 14 - Responses to the question "Rank in ascending order the importance level of the following topics when working with a contractor".

- "Compliance with the agreed-upon payment": with unanimity, all the respondents ranked this factor with the highest importance level. This means that paying suppliers on time makes the contractor an attractive company to do business with. Payment practices can be the decisive factor for a good supplier-buyer relationship. Late payment to suppliers can be severely harmful to their economy as a whole and cause supply chain disruption.

- "A good relationship with the site manager": 68% of respondents ranked this factor as the second most valued. The site manager is the person that works the closest with suppliers. Thus, efficient and fluent communication is mandatory between both parties. Sometimes, site managers do not immediately communicate and exchange information with the suppliers about changes in project specifications which causes unpredicted events and delays in the conclusion of the work. Many times, the suppliers get penalized in added costs for unfair practices from the site managers which leads to a trust decrease.

- "Continuity of transactions": suppliers wish to have a higher chance of having more opportunities to work on bigger projects which result in business expansion. This aspect is considered to have the third most critical role in the decision of a collaboration and development of partnerships. Despite that, due to the fragmented and complex nature of the construction industry, it becomes difficult to provide opportunities to suppliers to continue working with the same contractor in future projects. Construction buildings with unique features and diverse specifications have a very limited degree of repeatability and standardization, which means a supplier may not be specialized to perform a certain job for a future project.

- "Financial stability of the company": with unanimity, suppliers pointed this factor as the fourth most important among the previous ones. Despite the low importance, suppliers must be ensured that the agreed payment will be fulfiled.

Question: Is it possible to identify 2 unfavourable aspects that DST, s.a. should improve? If so, which ones?

After analyzing the collected answers, the aspects that revealed negative insights about DST, s.a. that led to improvement opportunities were:

- Price pressure: suppliers face persistent cost pressure for price reductions because of tight public budgets. Although the company has various criteria for supplier selection, the purchasers appear to be in a conundrum since they are still mainly price-driven when they face the responsibility of choosing suppliers. Since DST, s.a. deals with competitive bidding, there is organizational pressure on the

purchasing department from top management to secure the lowest price. This action forces sometimes the purchasers to select suppliers they never worked with before, that could fail on quality delivered but are willing to accept the price demanded from DST, s.a., in opposition to working with a supplier that has a good evaluation from the company. This creates mistrust and conflicts with the suppliers, hindering the two entities to build long-term relationships.

- Absence of continuity of transactions: the answers collected from the survey declare that there is a lack of commitment from DST, s.a. regarding the continuity of projects given to its suppliers. Many times, to convince them to lower the price, DST, s.a. gives false forecasts about future projects that can include the suppliers' collaboration. Although the previous statement was affirmed, that they would have continuity of transactions or more advantagous projects, priority to those suppliers is not given in the stage of supplier selection because the companies of DST Group are first considered. Also, instead of awarding projects that interest suppliers the most, they are many times awarded with ones that represent low turnover. Once again, trust and commitment are interfering with dyadic relationship success.

Question: In such a competitive market, in what aspects do DST's competitors prevail?

The suppliers' responses showed that the aspects that represent weaknesses in DST, s.a. are the strengths of its competitors. While dealing with the competition, the suppliers mentioned that they did not suffer as much cost pressure while still requiring the same high service. Also, some suppliers claimed to have solid partnerships with other contractors that were willing to cultivate mutually beneficial relationships. This translates the opportunity of transaction continuity, in opposition to what happens with DST, s.a. Also, some of the collected answers were related to the payment conditions, which showed that other contractors pay their suppliers in a shorter period. As previously discussed, suppliers value payment terms the most, so DST, s.a. should be remarkable for not failing that.

Question: Regarding the purchasing department, rank in ascending order the importance level of the following topics when working with it.

- Relationship with the purchaser: from the suppliers' perspective, this factor has a predominant agreement with the assignment of level 2. This score is due to the fact that suppliers mostly work with site managers on the projects they are assigned, and purchasers take a less significant part in the influence of their performance and satisfaction with the work.

- Feedback on the response to the submitted budget: 95% of the respondents pointed out an importance level of 4. Many times, when the suppliers' submitted budget does not meet the price goals of the organization, the purchaser takes a long-time giving feedback to those suppliers or they do not give them feedback, leaving them at standstill. This results in a prolonged process of the supplier selection stage, due to the phase-in and phasing-out times. The lack of communication and transparency from the purchasers' side creates a feeling of mistrust and unprofessionalism.

- The deadline that is given for the budget submission: 91% of the respondents selected this factor with the highest importance level. The commercial team, which is responsible for managing the schedules and durations of the multiple projects, often has a delay in the communication when providing information about the beginning and closure of the projects. Consequently, the purchasing department faces the obligation of pressuring suppliers to send their proposals within a very short period. Once construction projects are characterized by their high complexity and particular features, suppliers are not confronted with an effortless assignment of elaborating a quick proposal.

- Contractual continuity for new projects: 14% of the respondents pointed out an importance level of 3 and 77% of them selected a level of 4. As it was mentioned in this chapter, if there is continuity for future projects, the suppliers' overall turnover will increase, which is one of the most appealing opportunities and motivations when getting awarded projects. Also, there will be a higher intensity of cooperation between the contractor and supplier which will deepen the strength of

the relationship. Continuity for future projects enables the possibility of the suppliers' business expansion and the creation of mutual benefits for both parties.

The importance levels related to the previous four factors can be seen in Figure 15.

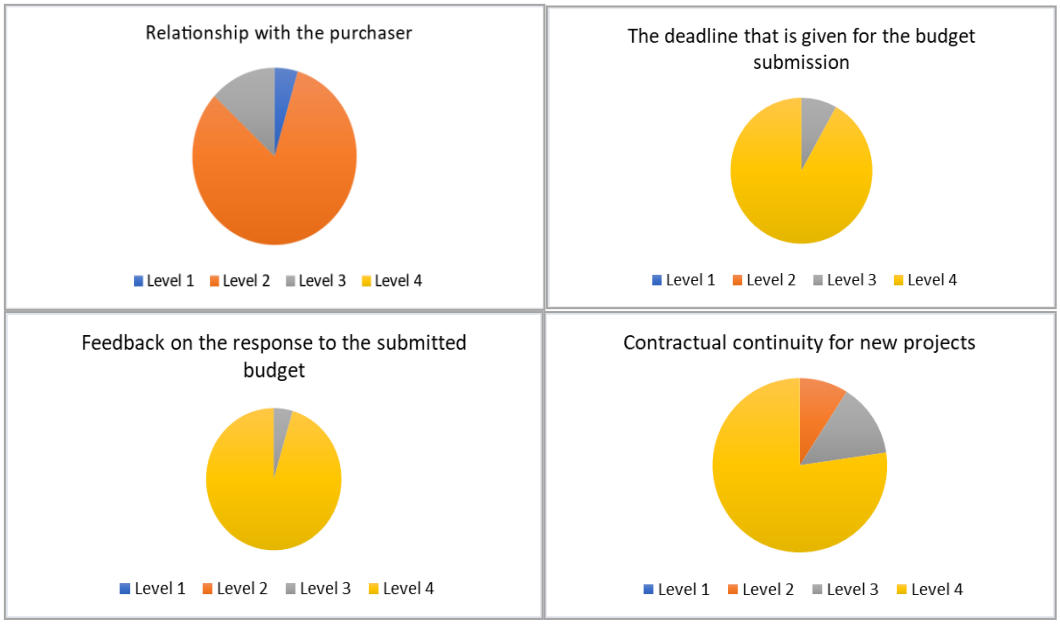

Figure 15 - Responses to the question " Regarding the purchasing department, rank in ascending order the importance level of the following topics when working with it"

Question: How could DST help your company improve its services?

After summarizing the collected answers, the findings shown in Figure 16 concluded that suppliers value the existence of additional benefits, the possibility of audits and trainings, and incentives to increase workforce employment.

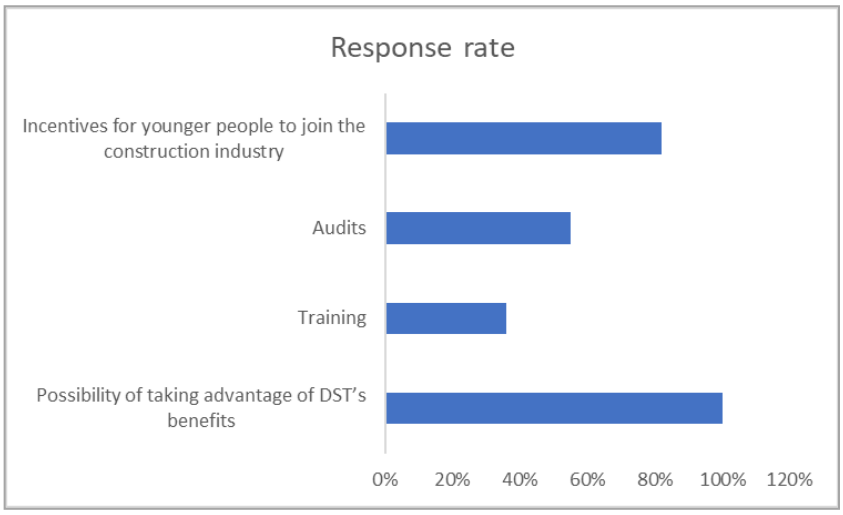

Figure 16 - Responses to the question " How could DST help your company improve its services?"

- Possibility of taking advantage of DST's benefits. All the respondents agreed that this action would be favoruable for their performance. DST, s.a. has a program with benefits for its employees, which includes offers and discounts in the areas of health and wellness, transportation, and education. By sharing this structure of incentives that would provide its suppliers with tangible and intagible benefits, a strong partnership with commitment could happen, making negotiations between both entities easier.

- Training. Regarding this opportunity, 36% of the respondents revealed their interest in receiving training from the contractor. Due to the complexity of the construction industry, suppliers must have the product knowledge to deliver the best possible performance. The development of training programs would build up suppliers' technical knowledge and skills. Thus, the contractor would benefit in terms of competitive advantage. Also, training in other areas related to technology seems to be interesting from the suppliers' perspective to increase efficiency in the processes.

- Audits. With a percentage of 55%, suppliers consider that having someone responsible from DST, s.a. performing audits in their spaces could result in the improvement of their services. Audits are one of the best practices for efficient,

safe, and transparent projects. They are an effective way to examine the quality of supplied parts and they minimize risks in the occurrence of problems that would result in the penalization of the supplier. Also, it improves communication and collaboration between both parties.

- Incentives for younger people to join the construction industry. Currently, the industry is facing a significant shortage of skilled workers in multiple markets and forecasts indicate that it will remain so. This explains that 82% of the respondents agree that being present in young people's education that are ready to start their careers could incentive them to enter the industry and control the scarcity of skilled labour. Offering bigger and more competitive wages could be a strategy to encourage current and future employees. Also, it is important to intervene in education and stimulate practical courses with better and safer conditions.

Question: What is the estimated percentage of turnover for which DST was responsible in the previous year?

To understand the negotiation power that DST, s.a. can have over their suppliers, the percentage of turnover that DST, s.a. was responsible for in their business was requested. Figure 17 represents the distribution of the suppliers' turnover.

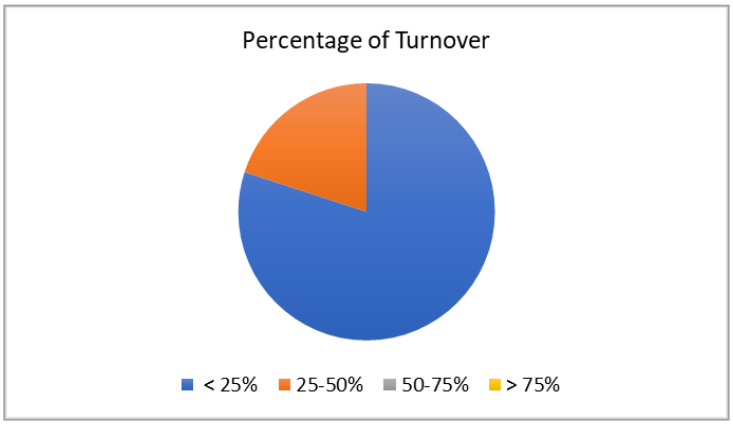

Figure 17 - Responses to the question " What is the estimated percentage of turnover for which DST was responsible in the previous year?"

From the findings of the above question, it was shown that 80% of the respondents had less than 25% of a turnover due to DST, s.a. and 20% of the suppliers had between 25% and 50% of a turnover due to the contractor.

The previous percentages demonstrate that DST, s.a. represent a low revenue-sharing in its suppliers, which reveals that they prefer working with the company's competitors. Thus, it results in a reduction in the negotiation success rate. The reason for that can be linked to the fact that the company has a strategy of increasing the outsourcing database to be less dependent on suppliers and being able to easily switch to another one with lower costs. DST, s.a. opts not to choose a supplier that had a history with the company in previous projects, which leads to a limited volume of purchases to a single supplier.

4.1.4 Considerations

After analyzing the suppliers' side on aspects such as the current relationship that they have with different departments of DST, s.a., and the factors that stimulate and inhibit their motivation and performance, an adaption of the Maslow Hierarchy to suppliers was made.

Abraham Maslow's theory named "Hierarchy of Needs" is described as a theory for human motivation and it proposes that humans have five levels of needs displayed in a pyramid and before they may progress from one level to the other, they must fulfil firstly certain basic needs to then proceed to the peak of the hierarchy. As the lower levels of needs are satisfied, the motivation to achieve a higher level increases.

To improve the performance factors that are critical for a successful project and achieve further competitive advantage, an awareness of the suppliers hierarchy needs is presented in Figure 18.

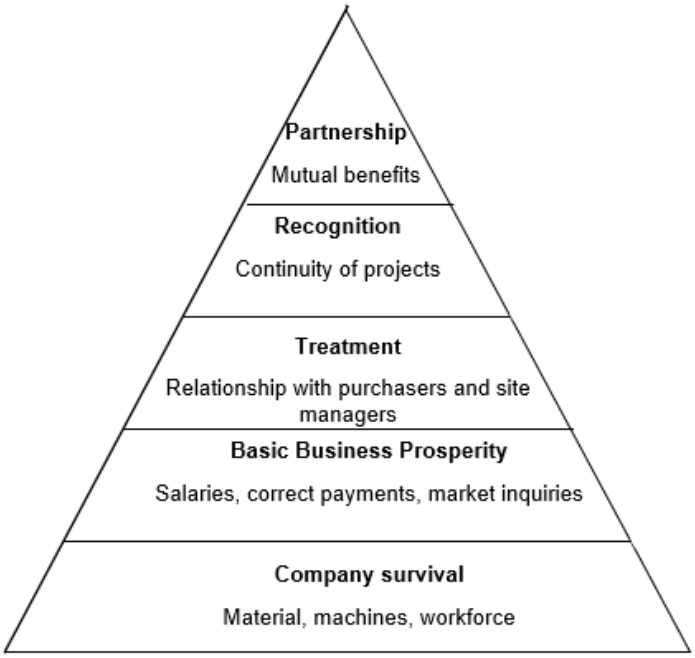

Figure 18 - Suppliers' hierarchy of needs

In order to reach the top of the pyramid, companies must first satisfy their basic needs. That means that for suppliers to survive and prevail in the construction industry competition, they need to have available material or/ and services that contractors require. For that, suppliers need materials for their production line and a qualified workforce, to be ready to customize project specifications in any time and that that tend to change significantly in the industry.

Once the first level is conquered, the basic business prosperity needs arise. It consists of the opportunity for suppliers of being consulted by contractors and be awarded in projects that create a fair pricing program that allow them to generate enough profit. For suppliers to expand their business and improve their services, all the mentioned factors are crucial.

In addition, to reach a higher level of the hierarchy of needs, suppliers expect to be treated respectfully by contractors. This means that the purchasing department and site managers, that work closely with them, play a significant role in this stage. During the negotiation phase, purchasers cannot stand an attitude of self-interest orientation to the maximization of the company's own goals and profits. In the supplier selection process to execute a certain project, an approach of cooperation and the creation of win-win benefits

must happen. Also, the experience with site managers in the field can be a decisive factor in trust-buildingng.

Following the satisfaction of the previous needs, new ones motivate the performance of suppliers that are portrayed in the recognition they receive. When the previous relationship variables such as trust, social bonds, and cooperation are accomplished, the suppliers desire a new level of needs characterized as “recognition”. This level, positioned as being more strategic, reflects the ambition of suppliers to be awarded more construction projects, after proving they are competent in the accomplishment of the required performance. If a contractor allows continuity of projects and more longevity in the history of shared business, a supplier will more easily accept agreement terms and cooperate more efficiently.

Finally, the top of the hierarchy can be accomplished. At the most ambitious level, suppliers seek partnerships with companies. These high-involvement relationships surpass single project transactions and transcend mutual agreements that result in compensations for both parties. The contractors invest in the suppliers’ weaker and needed areas, and in return they deliver top-quality performance for a lower price and availability to mitigate supply chain rupture, which is so feared in the construction industry. Summing up, the higher level named “partnerships” consists of the exchange of benefit packages, and the arrangement of periodical meetings to understand and discuss if necessities and interests from both sides are being met. Also, core suppliers’ innovation capabilities are developed.

After the interviews and survey of suppliers and therefore perceiving the motivating factors that improve their performance, the construction of the hierarchy needs of suppliers was able to be made. It is a tool for the purchasing department of DST, s.a. to improve the development of suppliers for the generation of growth and gain of competitive advantage.

4.1.5 Improvement actions

After receiving the suppliers’ insights in various areas, DST, s.a. recognized that supplier development and management are strategically vital for the minimization of project discontinuity and risk of supply chain rupture, and on the other hand, maximization of distinct advantage and overall success of the company.

Within the period of improvement suggestions and discussion with the purchasing team, the organization was aware that DST, s.a. could not guarantee to its suppliers when they

would be adjudicated with a project and the number of times that would happen. Since the contractor must give contractual preference to the companies of DST Group, and the construction industry is highly volatile, direct measures were not applied in the pursuit of project continuity.

To balance the previous impossibility, an action to compensate the suppliers' highest ambitions was implemented. A program, named Group T, that consists of shared incentives with DST's suppliers was developed. The suppliers that benefit from it are the ones that had the most outstanding performance in past construction projects for the company. The benefits are the following:

- Fuel discount of 17 cents per litre, in *Galp*'s gas station.
- 10% of cost reduction in several pharmacies.
- Multiple discounts in hotels located in Portugal.
- Weekly psychology appointments with zero costs.

By having the previous robust benefits packages, the suppliers get a higher boost of motivation to continue working for DST, s.a., and a mutually beneficial relationship between both parties can be established. In the negotiation process that entails project assignments, suppliers can more easily accept the lower price demanded from the contractor with consequent lower monetary compensation, but since they can take advantage of the benefits program to meet their individual needs, it is quicker and less complicated to reach into an agreement.

The benefits program that will entail the greatest suppliers of the critical segments will start at the beginning of 2023 when all the evaluations of the suppliers in the previous year will be included and summarized.

4.2. Supplier Evolution

4.2.1. Revision of the evaluation criteria

The current subchapter has the purpose of answering the question “How can the development of suppliers be analyzed?”

During the study of the state of the purchasing department of DST, s.a., it was analyzed that there was a decrease from 2020 to 2021 of 9% of the suppliers classified as excellent in their performance, which made a total loss of 260 suppliers.

When the purchasers were questioned about this problem, many of them did not know this reduction occurred or the cause that originated it. This reveals that although DST, s.a. invested and adopted a practice of supplier evaluation, there is no data-driven method that shows supplier development across the years, more precisely about performance development. This generates an opportunity to achieve a more fruitful supplier-buyer relationship and further prosperity for the company, and for that, a tracking approach to supplier development should be made.

To get straight to the essence of the problem of the current chapter, an investigation of the historical interaction between some of the suppliers and the purchasers was conducted. During the analysis of some projects that DST s.a. was responsible for, it was noticed that in the stage of launching the contests of the projects via email to the suppliers, many of them that had the best evaluation in previous works were not reached.

When approaching the purchasers about this situation, they mentioned that their strategy several times is contacting suppliers they never worked with before to expand the volume of suppliers within the database, to minimize the high-cost risk that is to be dependent on suppliers, and in the case of an unforeseen situation having the chance to switch to another supplier.

One reason for the decrease in the number of suppliers with an A classification was clarified, but it leaves an option of a supplier having evolved to a lower classification.

4.2.2 Tool for suppliers’ evolution visualization

Since DST, s.a. is responsible for hundreds of projects in a year, and there are multiple databases, and no automatic processes of analyzing and visualizing the evolution of the performance of suppliers exists, the platform Power BI will be used.

Power BI is a business analytics software that provides dynamic interactions of visualizations of various reports. To gain knowledge about this platform and the ability to maximize its advantages, a deep individual study was made alongside the internship in the construction company.

The process began by transforming raw data from excel databases of the suppliers' evaluations of 2020 and 2021, to information that was important to the analysis. By choosing the appropriate parameters that matter to the process of supplier evolution analysis and for decision making, it was possible to attain the ambitioned dashboard, which is designed for presenting a real-time status on key performance indicators and other metrics. It is essential to have a dashboard with clear visualization with the focused points for the organization, without overloading information that could prejudice decision-making. The dashboard that was designed to gather insights about subcontractors' evolution from the years 2020 to 2021 is shown in Figure 19.

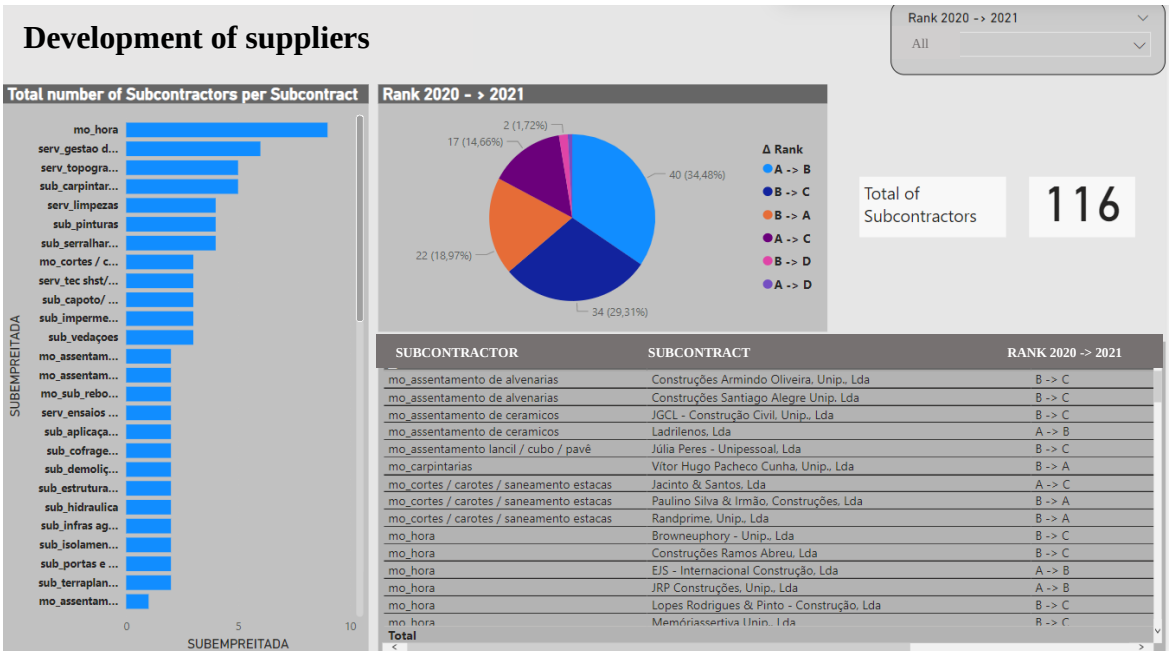

Figure 19 - Dashboard of Power BI that shows the development of subcontractors from 2020 to 2021

The above dashboard provides a slicer, which is represented by the total number of subcontractors that transitioned from one level to a higher or lower one and is dependent on the filter selected. As Figure 19 shows, 116 subcontractors lowered their overall classification and 58 of them lowered from level A. Also, a table that is detailed-focused

was selected to be displayed in the dashboard, allowing users to search for specific information.

A horizontal bar was selected too, with the goal of understanding the ranking of segments that transitioned a level. A pie chart was selected to easily visualize information regarding the evolution of the subcontractors' evaluation from 2020 to 2021. When hovering on different filters, a different subtitle and a total percentage of each changeover in evaluation will be shown in brackets. An example of this dynamic visualization can be perceived in Figure 20.

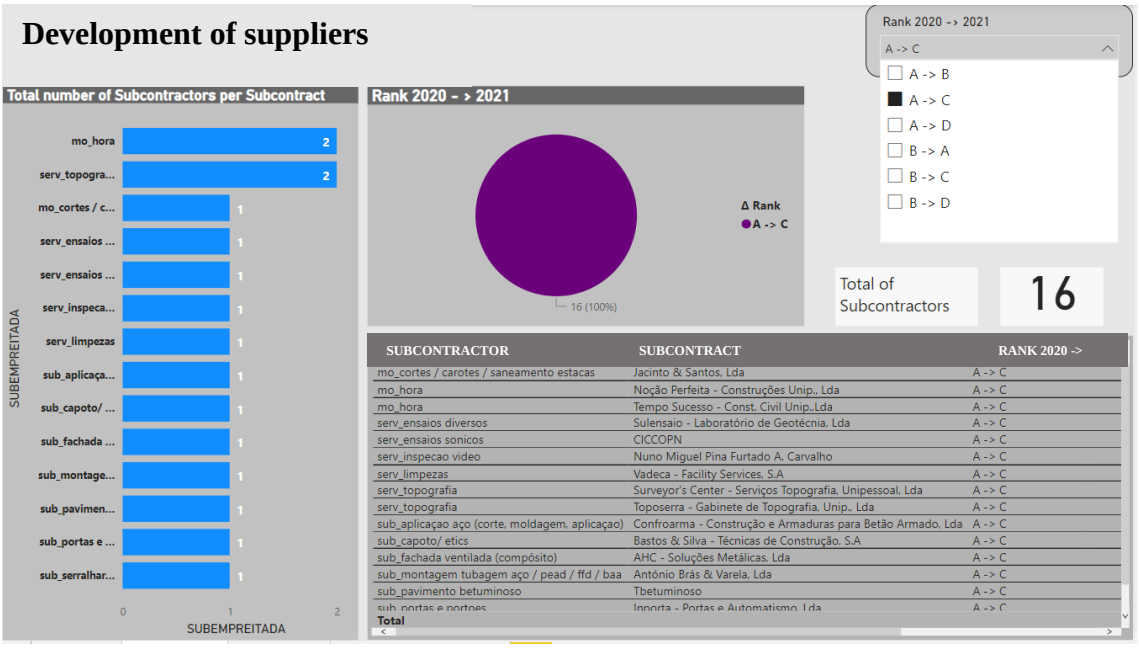

Figure 20 - Dashboard with the filter selection of the transition from level A to level C

As the dashboard shows, when selecting a different filter, all the information displayed in the different data features changed.

To understand what may have caused the undesired transformations, several discussions with site managers that evaluated the subcontractors were held. Most of the problems were due to the lowest score on a certain evaluation parameter, which made the classification lower. The rest of the issues were due to incorrect evaluations from the site managers, which were then corrected. This new information shows that supplier performance is evaluated subjectively. A subcontractor can have done several projects

during a year, and each is conditioned by the site manager that was supervising it, the project type, and size, which results in often unfair evaluations.

4.2.3 Considerations

By understanding the potentialities of Power BI, it was confirmed that it is a valuable visualizing tool for the purchasing department to monitor the company's business performance and interact with data.

It was possible to create different dashboards to visualize the subcontractors, per segment and classification, and understand their evolution.

One of the goals of DST, s.a. is to have within the ranking platform a higher representation of subcontractors with classification A. To understand if the company is accomplishing the goals that were defined and to perceive how the company is evolving it is important to play a reactive approach with the tools the company possesses. The purchasing department besides seeing the results should analyze them in order to understand the possible areas that can be improved.

For the segments that have a strategy of creating solid collaborations and partnerships with the suppliers, the informative dashboards are a valuable tool that facilitate the purchasers in making the most suitable decision for a certain project.

Before using Power BI features, the purchasers rarely took into consideration the classifications of the suppliers they worked with before since it was difficult and time-consuming to manage all the existent data.

Concerning the suppliers' development, it is also essential to know how the supplies are evolving. With the resource of Power BI dashboards, it is possible to see the path suppliers are taking. If the evolution is not favourable, a meeting between top management and suppliers should be held to discuss the provided evaluation, progress and performance. It is an opportunity for strengthening the relationship between both sides and a possibility of finding an optimal solution to help suppliers to maximize their channels and resources to contribute to the success of DST's projects.

Also, it is important to regularly reinforce to site managers the importance of evaluating suppliers with the highest possible level of awareness and as soon as a project ends, to reduce possible biases and enhance the reliability of scores given to different parameters.

5. Conclusion

This final chapter intends to outline conclusions about the developed work, its main contributions to the company, as well as some difficulties that were felt in the course of the 8-month internship in DST, s.a. This chapter will also present suggestions for future research.

5.1. Final Considerations

The construction industry is an important driving force of a country's economy, as it contributes greatly to the growth of a nation. However, it presents slow responsiveness to changing needs and innovation development. More than ever, to remain competitive, companies must establish a two-way, mutually win-win relationship between the organization and its suppliers. These collaborative and relationship-building activities are targeted at the most strategic and critical supply partners that deliver great added value to the firm (Deloitte, 2015). This leads to an opportunity to closely examine the current practices and identify and develop improvements to enable the company of becoming more competitive.

To support this project, several fields were researched and integrated. The main focus areas were on **Construction Industry**, **Purchasing**, and **Supplier Development**.

Different tools and methodologies were used: **BPMN** was a valuable tool that enabled the identification, understanding and clarification of the as-is purchasing process. Since the project also encompassed the need for data centralization and easier visualization of business development, Microsoft's **Power BI** tool was used.

The bibliographic review provided the awareness that the construction industry is highly fragmented and is a conservative sector characterized by poor performance and low profits. A large contribution to its failure was the deficient management and coordination of suppliers in the Construction Supply Chain. Through the investigation of new angles of various aspects of the supplier-buyer relationship, it was possible to conduct the project with the required knowledge to apply improvements.

Thus, the focus of the project was to analyze possibilities to develop purchasing strategies to improve the collaboration between contractors and suppliers for a further transformation into high-involvement relationships.

The main goal was achieved: obtaining suppliers' insights about the strengths and weaknesses of past projects' collaborations and an overview of the motivation factors that lead to better performance. The majority of the respondents argued that the biggest strengths of a possible partnership were relationship continuity across projects and the engagement of a mutual benefits package. The last element was accomplished, as DST, s.a. and its best suppliers will engage in high-involvement relationships based on trust, social bonds, learning culture, and information and resources sharing over a long period. By providing preferential treatment to its suppliers, DST, s.a. will retain the most capable suppliers in the market and will gain competitive advantage.

Also, another objective was the information about suppliers' performance evolution. Over the years, suppliers were being evaluated but it was made yearly and a progress analysis was not being made. To fix that issue, the Power BI tool was used. The possibility of centralizing data allows the company to analyze suppliers' performance, progress and notice the parameters that need to be improved.

DST, s.a. is now one step closer to acting against the construction industry's unstable market and developing risk mitigation plans, as well as improving both efficiency and effectiveness by extending traditional functional activities that are mainly cost-driven.

5.2 Future Research

The developed solutions were, in every stage, discussed and validated by the purchasing team of the company. Nevertheless, there were some limitations during the internship. The covid pandemic and the Ukraine-Russia war had negative impacts on the company's construction projects. To survive the supply crisis, DST, s.a. had to take fast strategic actions that demanded extra time from the employees. Thus, the required validation of the improvement solutions that were shared with the team was left on stand-by for a longer period than what was foreseen. Therefore, the whole development process was slower than expected which did not allow further development of the improvement solutions.

For future work in the purchasing department, it is recommended to assemble an internal team that is responsible for preserving and following up on changes regarding supplier development. Key Performance Indicators for the development of high-status suppliers should be defined to monitor suppliers' performance and understand if the goals from both sides are being met.

Additionally, to foster supplier integration, an interesting approach could be applying the Kraljic Matrix differently. In the past, all the segments were evaluated and categorized, which was not the most suitable decision for the company. Instead, it is suggested to categorize the segments by applying the Kraljic Matrix according to the different project types of DST, s.a. This way, it would be easier to classify the segments and further make purchasing decisions. The segments classified as strategic would reveal the suppliers of major importance and consequently thrive supplier development.

Finally, the Power BI dashboard that was created has the potential to be improved: new features and information regarding other parameters may be also incorporated. The Power BI tool should always reflect the company's strategies and be aligned with the changes that the business suffers.

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