Development of a Purchasing Portfolio Model for the Health Sector: A Case Study of a Central Hospital

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Keywords: Purchasing Portfolio, Kraljic Portfolio Matrix, Analytic Hierarchy Process, Health Sector.

Abstract: Over the years, the purchasing area has taken on an essential role in the management of companies in all activity sectors. In the health sector, purchasing medicines is highly important considering the amounts involved, the impact on the service quality, and the wide variety of purchased products. This research work combined action research with a case study and aims to apply to a Central Hospital a Purchasing Portfolio Model based on the Kraljic Purchasing Matrix (KPM). The KPM allows for the classification of different classes of medicines in accordance with their impact on profits and supply risk dimensions, making it possible to define differentiated purchasing strategies. This application used the Analytical Hierarchical Process (AHP) tool for criteria prioritization and used direct measurement for criterion rating. By applying the model to a Central Hospital, this study seeks to increase the areas of applicability of purchasing portfolio models. Moreover, the results confirmed the model's value in defining medicine purchasing strategy at the Central Hospital and also gave rise to guidelines for applying the model.

1 INTRODUCTION

In recent years in Portugal, the health sector has evolved, in both the public and private sectors, through the implementation of a set of structural reforms, the reinforcement of the health care network, and a process of modernization and digital transformation (Ministério da Saúde, 2018). In 2018 total health expenditure (public and private) represented about 9.1% of the Portuguese Gross Domestic Product, with the general public spending about 4.4%. These values demonstrate the importance of the health sector in the Portuguese economy.

The hospital procurement of medicines involves a wide range of financial resources and time. It carries certain risks, especially in terms of storage, as most handled products are fragile and must not be defective when they are used. Furthermore, given the large quantity and variety of products and services that have to be purchased, not all medicines should be managed and purchased in the same way. According to Medeiros & Ferreira (2018), the purchase portfolio can be an excellent tool for strategic management hospital purchases.

The most recognized and commonly used Purchasing Portfolio Model (PPM) was introduced by Kraljic (1983). This model is considered an important advance in purchasing area development and considers a matrix that classifies product item classes into four categories: non-critical, bottleneck, leverage, and strategic; and according to two dimensions – profit impact, and supply risk. This matrix allows for the definition of purchasing strategies according to the characteristics of each product item class (Gelderman, 2003). A set of criteria must be defined for each of the Kraljic Purchasing Matrix (KPM) dimensions and be weighted using the Analytic Hierarchy Process (AHP) tool. The Kraljic matrix has already been applied in several areas. However, in the literature the number of reported applications in the health sector is limited.

This paper is organized as follows: firstly, the portfolio approach based on the Kraljic model is presented; secondly, the research method is described, then, thirdly, the selected case study is summarily described; fourthly, the PPM is developed with the help of the AHP for criteria prioritization;

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Arantes, A. and Alhais, A.
Development of a Purchasing Portfolio Model for the Health Sector: A Case Study of a Central Hospital.
DOI: 10.5220/0010225903290337
In *Proceedings of the 10th International Conference on Operations Research and Enterprise Systems (ICORES 2021)*, pages 329-337
ISBN: 978-989-758-485-5

fifthly, there is a report on the results obtained and discussion thereof; and finally, in the conclusions, the main findings and implications are presented.

2 LITERATURE REVIEW

The healthcare supply chain is a complex and fragmented process, and management thereof encompasses managing suppliers, procuring resources, and delivering goods and services to providers and patients. Moreover, the customer service level of the healthcare supply chain is of paramount importance, given the direct impact it has on the health and safety of the patients (Uthayakumar & Priyan, 2013).

Hospitals have many different departments provide healthcare services, requiring a wide range of products (and services) that the procurement area seeks to provide, including consumables such as medicines, and permanent material, such as medical equipment (Almeida & Lourenço, 2009). Medicines constitute the highest costs in running a hospital; they usually account for between 40% and 60% of the public sector budget (Medeiros & Ferreira, 2018). Management of these products is critical because they must be transported and stored in specific conditions, there can be no stockout, and they come with an expiration date. Thus, the purchasing experts must carefully decide which products to order, in what quantities, and when to place orders, so as to serve patients in a timely and efficient way (Uthayakumar & Priyan, 2013). Furthermore, considering the vast differences in the characteristics of the products, often it is necessary to organize and categorize them in order to define adequate purchasing strategies. For this, PPMs are useful tools to manage medicine purchases strategically in accordance with the specific characteristics of each product (Medeiros & Ferreira, 2018).

Kraljic (1983) created the most frequently used and recognized portfolio approach to purchasing (Pardo et al., 2011). The KPM considers the strategic impact and supply risk dimensions. It can be beneficial to management, namely in having a trustworthy insight into supply risk and negotiating power and making it possible to define the most appropriate purchasing strategies. Kraljic (1983) highlights a matrix that classifies products (or classes of products) purchased by a company in four categories: non-critical, bottleneck, leverage, and strategic; and according to two dimensions – the supply risk and the profit impact (Table 1). However, some authors have introduced changes to the matrix dimensions in order to adjust them to their own applications.

Table 1: Kraljic matrix (Kraljic, 1983).

Strategic impact	Supply Risk	
	Low	High
Low	Non-critical	Bottleneck
High	Leverage	Strategic

The non-critical category represents products that are purchased frequently and are low in value; however, they take up 80% of purchasing department time and account for less than 20% of the purchasing volume. The bottleneck category represents products whose suppliers have a dominant position due to supply shortage (Caniëls & Gelderman, 2005). The leverage category represents products that are used regularly and in large quantities. Finally, strategic items represent products with a small number of suppliers in the market and a high strategic impact (Gelderman & Van Weele, 2003). Each category has a set of recommended strategies that can be found in the literature (Caniëls & Gelderman, 2005; Kraljic, 1983). In order to allow purchasers to get to know their bargaining power better and identify an appropriate strategy to reduce corporate risk and increase purchasing efficiency, Kraljic (1983) defined a set of criteria for each matrix dimension (Ferreira et al., 2015; Kraljic, 1983). Kraljic (1983) took the volume of purchases or the total costs into consideration in assessing the strategic impact. In determining supply risk, he recommended incorporating the supply market complexity, which includes supply shortage, technological advances, substitute products, entry barriers, logistics costs, and monopoly and oligopoly conditions. Montgomery et al. (2018) assert that the Kraljic approach is the most important diagnostic and prescriptive tool in purchasing management. Gelderman & Van Weele (2003) consider KPM an innovative procurement practice.

Gelderman & Mac Donald (2008) applied the KPM to a logistics infrastructure developed within an oil company. Arantes et al. (2014) used the KPM in two branches in markets with differing characteristics in which a multinational construction company operates and compared the results. Botes et al. (2017) investigated mechanisms whereby the buyer-supplier relationship enables the petrochemical industry's resilience. These examples in the literature confirmed the versatility of the Kraljic matrix, as it can be applied to a wide range of areas and contexts, some of them very distinct.

Accordingly, this study aims to expand the applicability of the PPMs in the health sector by applying the KPM to a Central Hospital (CH) in Portugal using a simplified model (practitioner wise), combined with an action research approach.

3 RESEARCH METHOD

This study combined Action Research (AR) with a case study in a CH in Portugal and had the main objective of supporting the change to a more structured process in defining medicine purchasing strategies for the CH, integrating supply risk and strategic impact. Due to difficulties in medicine purchasing, namely the perceived misalignment between purchasing strategies and product characteristics, the CH invited the researchers to develop a process of establishing suitable and practicable purchasing strategies.

The CH under study comprises six hospital units, with the Purchasing, Logistics and Distribution Department (PLDD) responsible for medicine purchases for all units. In hospitals, the purchase processes are complex, given that they deal with a set of constraints; for this reason, they are continually looking for new solutions (Serrou & Abouabdellah, 2016). The supply policy must meet the organizational and patient needs (Almeida & Lourenço, 2009). In 2017, the CH's purchases exceeded 144 million euros, about 52% of the total annual budget, with medicines accounting for around 46% of the volume of purchases. This figure is in line with Medeiros & Ferreira (2013), who stated that, generally speaking, medicines make up about 45% of total hospital purchases.

Combining Action Research (AR) with a case study in a CH in Portugal, this research project is exploratory in nature. AR is used to solve existing problems in organizations in a group decision context, and it is centered on solving issues (Rytter, Boer, and Koch, 2007). Kurt Lewin (1946) defines AR as "comparative research on the conditions and effects of various forms of social action and research leading to social action". Middel et al. (2006) claimed that the use of AR models contributes to research on collaborative and continuous improvements, contributing both to the body of knowledge and practitioners' concerns.

The research method presented in Figure 1, made up of five phases, required close collaboration between the researchers and six representatives from the CH divided into two independent groups, Group 1 (G1) and Group 2 (G2). The utilization of two groups allows for the consistency and validity of results (Lee & Drake, 2010; Padhi et al., 2012):

- G1 is used to define the dimension criteria (Phases I and II);
- And, G2 to apply the criteria to the products under analysis, develop the PPM and validate it (Phases III, IV, and V).

The research lasted for eight months, and several group sessions were held for data collection, development, and results validation. In the sessions, all group members had equal weight in decision-making processes, and the session coordinator (one of the researchers) always endeavored to reach a consensus. When consensus was not reached, the final decision was by majority vote.

Finally, the list of the CH's medicines contains over 2000 items with different characteristics, which was too much to be dealt with in this study. Hence, an ABC analysis was carried out to classify medicines' importance by purchasing cost, whereby only those in category A were considered in this research, accounting for 5.3% of the medicines and 80.09% of the amount spent. Lastly, category A medicines were grouped according to their characteristics, resulting in 22 Medicine item classes (MICs) (Table 2).

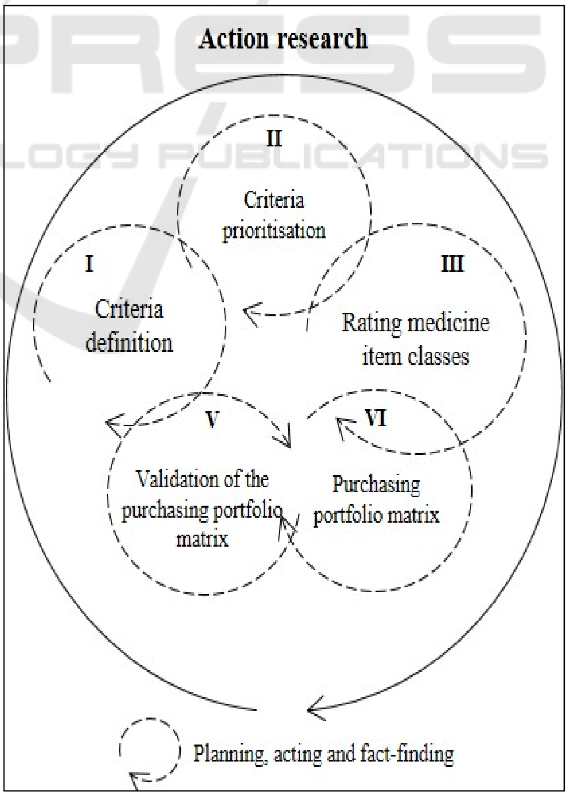

Figure 1: Research method based on AR principles (adapted from Ferreira et al. (2015)).

Table 2: MICs by the total annual amount spent.

Medicine item class	Purchase Volume
Antivirals	29.50%
Antiretrovirals	15.13%
Immunomodulators A	14.38%
Immunomodulators B	10.45%
Hemostatics A	6.42%
Cytotoxic	3.61%
Immunoglobulins	3.28%
Enzymes	2.26%
Medicinal Gases	2.21%
Hemostatics B	1.87%
Eye disorders medicines	1.67%
Nervous system	1.65%
Antifungals	1.26%
Tyrosinacinase inhibitors	1.25%
Antibacterials	0.98%
Plasma substitutes	0.97%
Hypothalamic hormones	0.96%
Electrolyte Changes	0.80%
Intoxications antidotes	0.65%
Cardiovascular system medicines	0.25%
Breathing system medicines	0.25%
Medical ultrasound	0.19%

4 PURCHASING PORTFOLIO MODEL

To apply the Kraljic matrix required the use of a multiple criteria decision-making tool, which is essential in problem-solving situations characterized by various actors, criteria, and objectives (Kumar et al., 2017). This tool's main goal is to support decision-makers, as there is usually not just one optimal solution for problem-solving, and it's is often necessary to differentiate between existing solutions (Saaty, 1980).

Analytical Hierarchical Process (AHP) is a technique that supports reducing the uncertainty in subjective assessments (Saaty, 1980). Complex decision-making requires the establishment of different "trade-offs" between criteria. The decision elements are compared with each other and weights assigned to define the priorities in the decision-making process (Subramanian & Ramanathan, 2012).

In this study, an AHP model with four levels is the basis for the development of the KPM (Figure 2). At Level 1, the goal provides the overall score of each MIC in terms of the two dimensions of the KPM, namely strategic impact and supply risk (chosen by the G1 experts).

The criteria that the experts considered relevant for measuring the strategic impact or supply risk are located at Level 2. Level 3 contains the rating scale for measuring each MIC in each criterion. Finally, Level 4 includes alternative MICs. To find the relative weight of the criteria, pair-wise comparisons based on a "1 to 9" relative importance scale were utilized (Table 3). To score each alternative (MIC) for each criterion, a direct (or absolute) measurement was chosen, which is an advantage over pair-wise comparisons, which would require a high and impractical number of comparisons (Bruno et al., 2012; Drake & Lee, 2009).

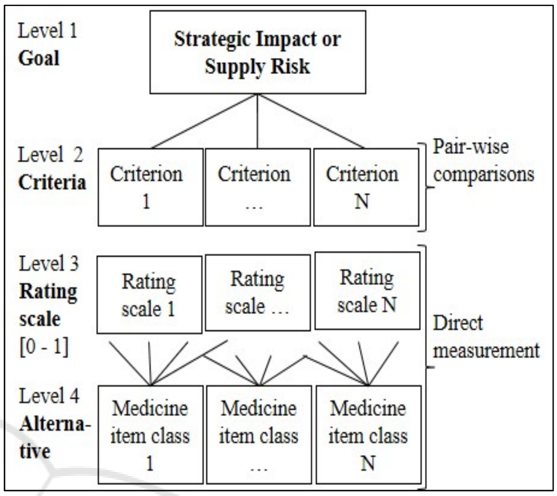

Figure 2: AHP model for each KPM dimension (adapted from Ferreira et al. (2015)).

Table 3: Pair-wise comparisons "1 to 9" scale for AHP (adapted from Saaty (2008)).

Intensity of importance	Definition	Explanation
1	Equal importance	Two criteria contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one over another
5	Strong importance	Experience and judgment strongly favor one over another
7	Very strong importance	A criterion is strongly favored, and its dominance is demonstrated in practice
9	Absolute importance	The importance of one over another is recognized unassailably.
2, 4, 6, 8	Intermediate values	Used to represent a compromise between the priorities listed above
Reciprocals of above	If criterion *i* has one of the above non-zero members assigned to it when compared with criterion *j*, then *j* has the reciprocal value when compared with *i*.	

4.1 Criteria Definition

The choice of the dimension criteria in PPMs was a complicated matter. In this study, the criteria and respective assessment scales were developed by the G1 experts in accordance with their experience and knowledge (stages I and II of the research method).

4.1.1 Strategic Impact

From criteria found in the application of KPM available in the literature, experts selected a set of three criteria as appropriate for classifying the strategic impact of the MICs. Moreover, two criteria were adjusted, and a new criterion was added (importance of the product in the patient's life), considering that they must be comprehensive, non-redundant, operational, thrifty, and independent (Saaty, 1980).

To complete the definition of the strategic impact criteria, the experts were requested to develop a rating scale for each qualitative criterion (Table 4). The first criterion chosen was the 'purchase volume', as a generic criterion suggested by Kraljic (1983). The second was 'importance of the product in the patient's life,' giving that a lack of certain medicines can endanger patients' lives. Finally, 'expected growth in demand' allowed the experts to anticipate changes in purchasing strategies in the long-term.

Table 4: Criteria rating scales for the Strategic Impact (SI) dimension. (*) The final rating is presented on a 0 to 1 scale.

Criteria	Rating scale
SI1 - Purchase volume	(Purchase Volume/Maximum Purchased Volume)^2
SI2 - Expected growth in demand (%)	1: Lower; 2; 3: Remains equal; 4; 5: Higher
SI3 - Importance of the product in the patient's life (*)	1: No risk; 2; 3: Medium; 4; 5: High risks

4.1.2 Supply Risk

For classifying the supply risk dimension, four criteria were selected by the experts (Table 5). For the first criterion, experts agreed that the 'number of suppliers' is key, as in hospitals the trade-off between price and quality depends on the number of potential suppliers available on the market (Medeiros & Ferreira, 2018). The second criterion is 'substitute products' because alternative medicines, for example, can help to solve some of the problems that managers face daily, such as delays in delivery, damaged products, suppliers' stockouts. The third is 'logistic proximity,' given that, for hospitals, the logistics risk is a mix between distance and complexity if the supply chain, which is highlighted by the fact that the medicines purchased come from Portugal and all over the world. Lastly, the criterion 'transportation requirements' is essential, given that certain medicines require specific packaging and conditions during transportation.

Table 5: Criteria rating scales for the supply risk dimension. (*) The final rating is presented on a 0 to 1 scale.

Criteria	Rating scale
SR1 - Number of suppliers	Number of suppliers^-1.1
SR2 - Substitute products (*)	1/(n+1) n – average number of acceptable substitutes in the MIC
SR3 - Logistic proximity (*)	1: Local; 2; 3: Distant or complex; 4; 5: Distant and complex
SR4 - Transportation requirements (*)	1: None; 2; 3: Some complexity; 4; 5: Specific and complex

4.2 Criteria Prioritization

The next step was determining the relative weights of each criterion, which must reflect their "importance" in the dimensions of the PPM (Olsen & Ellram, 1997). For calculating the weights, the pair-wise comparisons inherent in the AHP application were carried out as a team exercise in sessions with G1. The final results were reached by consensus (Table 6 and Table 7).

According to the results, the most important criterion in the strategic impact dimension is the "purchase volume," which has a relative weight of 63.5%, as was already expected. However, in the literature, the values found for similar criteria lie at around 50% (Lee & Drake, 2010; Padhi et al., 2012). Next, the second most important criterion is the "importance of the product in the patient's life" which has a weight of 28.7%, reflecting hospitals' primary goal of ensuring efficient treatment for all their patients by providing quality services (Medeiros & Ferreira, 2018). Lastly, the criterion "expected growth in the demand", which has a weight of 7.8%, is the least important criterion. The consistency ratio (CR) for the strategic impact criteria is 9.8%, which is acceptable, as it is less than the threshold of 10% (Saaty, 1980).

As far as the supply risk dimension is concerned, the "number of suppliers" is the most important criterion, having a relative weight of 54.6%. This figure can be explained by the high impact that the number of suppliers has on the hospital service level, given that the hospitals are responsible for supplying the required products for health care activities and treatment of the patients. In second place, experts considered the "substitute products" criterion, which has a 29.5% relative weight, because it is important to have alternative medicines so that the supply of medicines does not fail. In third place comes the "logistic proximity" criterion with 11.3%; in last place is the criterion "transportation requirements", with 4.6%. In the supply risk dimension, CR is 8.8%, which is an acceptable value, as it is less than 10%.

Table 6: Relative weights of the strategic impact criteria.

Criteria	SI1	SI2	SI3	Weight
SI1 - Purchase volume	1	6	3	63.5%
SI2 - Expected growth in demand	1/6	1	1/5	7.8%
SI3 - Importance of the product in the patient's life	1/3	5	1	28.7%
Consistency Ratio (CR) = 0.098				

Table 7: Relative weights of the supply risk criteria.

Criteria	SR1	SR2	SR3	SR4	Weight
SR1 - Number of suppliers	1	3	5	7	54.6%
SR2 - Substitute products	1/3	1	4	7	29.5%
SR3 - Logistic proximity	1/5	1/4	1	4	11.3%
SR4 - Transportation requirements	1/7	1/7	1/4	1	4.6%
Consistency Ratio (CR) = 0.088					

Table 8: Classification of medicines item classes according to both matrix dimensions.

Medicine item class	Supply risk	Strategic impact
Antivirals	0.48	0.96
Antiretrovirals	0.10	0.51
Immunomodulators A	0.44	0.26
Immunomodulators B	0.27	0.17
Hemostatics A	0.38	0.29
Cytotoxic	0.43	0.34
Immunoglobulins	0.41	0.06
Enzymes	0.55	0.12
Medicinal Gases	0.52	0.01
Hemostatics B	0.53	0.19
Eye disorders medicines	0.70	0.01
Nervous system	0.39	0.16
Antifungals	0.52	0.05
Tyrosinacinase inhibitors	0.08	0.30
Antibacterials	0.13	0.22
Plasma substitutes	0.57	0.22
Hypothalamic hormones	0.35	0.18
Electrolytes	0.45	0.07
Intoxications antidotes	0.96	0.14
Cardiovascular system medicines	0.88	0.22
Breathing system medicines	0.96	0.18
Medical ultrasound	0.84	0.04

5 RESULTS AND DISCUSSION

Once the criteria and prioritization of the PPM's dimensions have been defined, the next step is to rate all 22 MICs using the rating scales presented in Tables 4 and 5 (stage III of the research method). For the qualitative criteria, the experts in G2 met and used direct measurement. When it came to the quantitative criteria, the rating scales were used. Finally, after accounting for the weights of the criteria defined in the AHP model (Tables 6 and 7), the results are presented (stage IV of the research method):

- The classification of MICs according to Strategic impact and Supply risk (Table 8);
- The distribution of the purchasing amount in the quadrants of the PPM (Table 9);
- The PPM plot (Figure 3);
- And, the mapping of the MICs in the quadrants of the PPM (Figure 4).

Table 9: Distribution of the purchased amount among the four categories.

	Categories			
	Strategic	Leverage	Bottleneck	Non-critical
No. of classes (%of 22)	1 (4.5%)	3 (13.7%)	5 (22.7%)	13 (59.1%)
Purchasing volume	29.5%	17.4%	3.0%	50.1%

However, at first glance the results in Figure 3 seem misleading. Distributing the MICs across the PPM quadrants can be both challenging and subjective. The MultiDimensional Scaling (MDS) approach was adopted to position the MICs in the PPM (Padhi et al., 2012). Considering the Euclidean distances between MICs, calculated using the scores presented in Table 8, MDS looks for possible clusters, which contain MICs that are inter-related, and provides a visual representation of the pattern of proximities. This approach allowed for a clear link between these clusters and the four purchasing categories, as shown in Figure 4.

In the final G2 session, the experts had the opportunity to discuss and comment on the results presented in Figure 5 (phase V of the research method), based on their specific and practical expertise. They helped explain the results and confirmed PPM's potential, as developed for their hospital, while also showing its general applicability to the health sector, thus satisfying this study's main objective.

The non-critical category has the largest number of MICs, accounting for 50.1% of the total purchasing volume (Table 9). These MICs are of low supply risk, mainly due to the existence of many suppliers and substitute products, and a low strategic impact, given the small purchase volumes for each MIC. Thus, for these MICs, it is recommended that one reduce logistical and administrative complexity through standardization and aggregation with a view to reducing transaction costs (Caniëls & Gelderman, 2005).

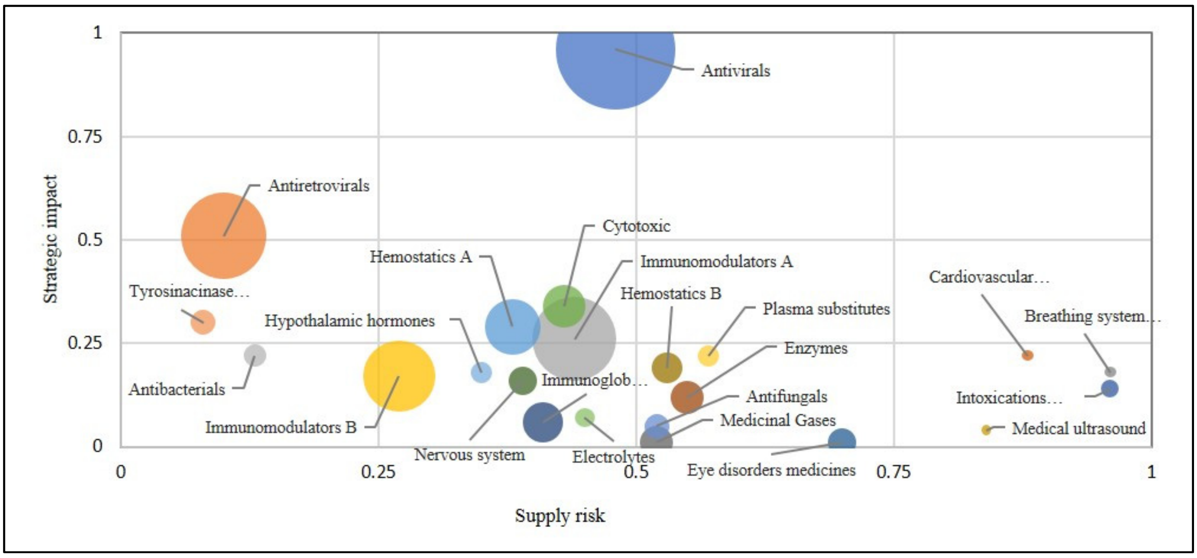

Figure 3: PPM plot (bobble proportional to the amount spent).

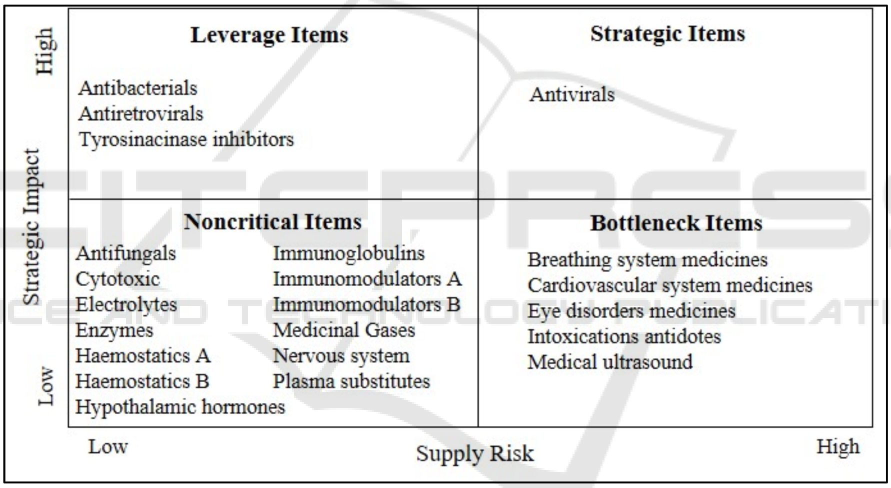

Figure 4: Mapping of the MICs in the quadrants of the PPM.

Despite having the second-largest number of MICs, the bottleneck category has the lowest volume of purchases (3%). These classes present a high supply risk on account of the reduced number of suppliers and the fact that there is no substitute in case of need. They also have a low strategic impact due to their low purchase volumes and the low impact of growing demand on the organization. Accordingly, the recommendation is to guarantee availability of these medicines through larger stocks at the CH or suppliers, the latter being preferable (Caniëls & Gelderman, 2005).

The leverage category comprises three MICs corresponding to 17.4% of the total purchasing volume. These MICs are characterized by low supply risk, which can be explained by the fact that there are several substitute medicines and many suppliers located in Portugal. Furthermore, the high strategic impact of this category on the CH is due to the high purchase volumes for the MICs. The recommendation for the CH is to use purchasing strategies that exploit its buying power through price negotiation, such as competitive bidding (Lee & Drake, 2010). The experts stated that they are already using this strategy; however, they recognize they may not be applying it to the right medicines.

Finally, the strategy category has only one MIC (Antivirals) but one that has a high relative weight (29.5%) in the total purchasing volume. This MIC has a high strategic impact, as it presents a high purchasing volume, demand is expected to grow in the near future, and also represents an increased risk in patients' lives in cases of stockout. Furthermore, the number of suppliers or substitute medicines is small. Accordingly, experts recommend establishing long-term contracts with the suppliers of this category's medicines based on information exchange (at operational and strategic levels), ensuring that there are guarantees of supply, and sharing updated information concerning the CH's medicines demand, present and future.

6 CONCLUSIONS

The contribution of this study deals with the identified research gap regarding the application of a PPM to the health sector, particularly medicine purchasing, and successful criteria prioritization using the AHP technique in both dimensions of the matrix. The purchasing process at the CH was studied and analyzed. It was concluded that the misalignment between the medicine's characteristics and CH's purchasing strategy is one of the root causes of the problems identified in purchasing medicines. Furthermore, the CH's current medicines purchasing strategy is based only on the purchasing price criterion. In this sense, KPM is a fundamental tool because it considers more criteria defined according to the CH and clients' interests. Its application allowed us to position the 22 item classes in the KPM's most appropriate quadrant, permitting the CH to develop adequate purchasing strategies. The results show that 13 of the MICs are in the non-critical category, representing 59.1% of the purchased volume of medicines; the main strategy proposed to the CH is to reduce logistical and administrative complexity through standardization and aggregation of medicines. With regard to the bottleneck category, which includes five MICs and accounts for only 3% of the purchased amount, the proposed strategy is to guarantee medicines' availability through having larger stocks at the CH or, preferably, the suppliers. Regarding the leverage category, which comprises only three MICs but accounts for 17.4% of the purchased volume, the proposed strategy is competitive bidding, exploiting the CH's buying power. Finally, for the critical category, which only includes one MIC but accounts for almost 30% of the purchased volume, the recommended strategy points to establishing long-term contracts with the suppliers based on information exchange, at operational and strategic levels.

This study has also shown that the combination of AHP and MDS is a practical way of dealing with PPM's critical issue – its subjectivity – while keeping it simple and usable by the CH employees. The CH management agreed on the value of taking a structured approach to developing purchasing strategies in the CH, so that supply risk and strategic impact are integrated into the purchasing decision process. They also recognized the value of the new approach in the process of defining purchasing strategies for each category. They recommended its application regularly. Nevertheless, they also agreed that it is crucial to interpret and reflect on the results. The construction of the PPM matrix should not be the end of the portfolio analysis. Discussions offer more in-depth understanding and may lead more quickly to decisions grounded in consensus. Lastly, the CH management agreed that the PPM facilitates strategic talks to a large degree, taking purchasing to a strategic level.

The main limitation of the present study is that only one case was used, so caution must be taken when generalizing the findings to the whole health sector. Despite that limitation, the principal objective of the study was achieved, having developed and applied the purchasing portfolio model to a hospital and simultaneously shown its value.

Lastly, by way of future work, it was suggested to the CH management that they expand the application of the KPM to products/services other than medicines, so that their buyers can manage their acquisition effectively and economically. The development of the CH's information systems and the implementation of a more powerful warehouse management system was also recommended.

ACKNOWLEDGMENTS

The authors would like to express their profound gratitude to all Central Hospital experts for their participation and support in developing the Purchasing Portfolio Model.

REFERENCES

Almeida, A., & Lourenço, L. (2009). As diferenças regionais ao nível das práticas de aprovisionamento nos hospitais públicos portugueses. *Revista Portuguesa De Saúde Pública*, *27*(1), 81–94.

Arantes, A., Ferreira, L. M. D. F., & Kharlamov, A. (2014). Application of a Purchasing Portfolio Model in a Construction Company in Two Distinct Markets. *Journal of Management in Engineering*, *30*(5), 04014020. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000290

Botes, A., Niemann, W., & Kotzé, T. G. (2017). Buyer-supplier collaboration and supply chain resilience: A case study in the petrochemical industry. *South African Journal of Industrial Engineering*, *28*(4), 183–199. https://doi.org/10.7166/28-4-1736

Bruno, G., Esposito, E., Genovese, A., & Passaro, R. (2012). AHP-based approaches for supplier evaluation: Problems and perspectives. *Journal of Purchasing and Supply Management*, *18*(3), 159–172. https://doi.org/10.1016/j.pursup.2012.05.001

Caniëls, M. C. J., & Gelderman, C. J. (2005). Purchasing strategies in the Kraljic matrix—A power and dependence perspective. *Journal of Purchasing and Supply Management*, *11*(2), 141–155. https://doi.org/https://doi.org/10.1016/j.pursup.2005.10.004

Drake, P. R., & Lee, D. M. (2009). Component prioritisation for strategic purchasing and the case study of a South Korean elevator manufacturer. *International Journal of Advanced Manufacturing Technology*, *43*(9–10), 883–895. https://doi.org/10.1007/s00170-008-1766-0

Ferreira, L. M. D. F., Arantes, A., & Kharlamov, A. (2015). Development of a purchasing portfolio model for the construction industry: an empirical study. *Production Planning & Control*, *26*(5), 377–392. https://doi.org/10.1080/09537287.2014.906679

Gelderman, C. J. (2003). *A Portfolio Approach to the Development of Differentiated Purchasing Strategies*. https://doi.org/10.6100/IR569453

Gelderman, C. J., & Mac Donald, D. R. (2008). Application of Kraljic's purchasing portfolio matrix in an undeveloped logistics infrastructure: The staatsolie suriname case. *Journal of Transnational Management*, *13*(1), 77–92. https://doi.org/10.1080/15475770802059610

Gelderman, C. J., & Van Weele, A. J. (2003). Handling measurement issues and strategic directions in Kraljic's purchasing portfolio model. *Journal of Purchasing and Supply Management*, *9*(5–6), 207–216. https://doi.org/10.1016/j.pursup.2003.07.001

Kraljic, P. (1983). Purchasing must become supply management. *Harvard Business Review*, *September*-(83509), 109–117. https://doi.org/10.1225/83509

Kumar, A., Sah, B., Singh, A. R., Deng, Y., He, X., Kumar, P., & Bansal, R. C. (2017). A review of multi criteria decision making (MCDM) towards sustainable renewable energy development. *Renewable and Sustainable Energy Reviews*, *69*(October 2016), 596–609. https://doi.org/10.1016/j.rser.2016.11.191

Lee, D. M., & Drake, P. R. (2010). A portfolio model for component purchasing strategy and the case study of two South Korean elevator manufacturers. *International Journal of Production Research*, *48*(22), 6651–6682. https://doi.org/10.1080/00207540902897780

Lewin, K. (1946). Action Research and Minority Problems. *Journal of Social Issues*, *2*(4), 34–46. https://doi.org/10.1111/j.1540-4560.1946.tb02295.x

Medeiros, M., & Ferreira, L. (2018). Development of a purchasing portfolio model: An empirical study in a Brazilian hospital. *Production Planning and Control*, *29*(7), 571–585. https://doi.org/10.1080/09537287.2018.1434912

Middel, R., Coghlan, D., Coughlan, P., Brennan, L., & McNichols, T. (2006). Action research in collaborative improvement. *International Journal of Technology Management*, *33*(1), 67–91. https://doi.org/10.1504/IJTM.2006.008192

Ministério da Saúde. (2018). *Retrato da Saúde 2018, Portugal*.

Montgomery, R. T., Ogden, J. A., & Boehmke, B. C. (2018). A quantified Kraljic Portfolio Matrix: Using decision analysis for strategic purchasing. *Journal of Purchasing and Supply Management*, *24*(3), 192–203. https://doi.org/10.1016/j.pursup.2017.10.002

Olsen, R. F., & Ellram, L. M. (1997). A portfolio approach to supplier relationships. *Industrial Marketing Management*, *26*(2), 101–113. https://doi.org/10.1016/S0019-8501(96)00089-2

Padhi, S. S., Wagner, S. M., & Aggarwal, V. (2012). Positioning of commodities using the Kraljic Portfolio Matrix. *Journal of Purchasing and Supply Management*, *18*(1), 1–8. https://doi.org/10.1016/j.pursup.2011.10.001

Pardo, C., Missirilian, O., Portier, P., & Salle, R. (2011). Barriers to the "key supplierization" of the firm. *Industrial Marketing Management*, *40*(6), 853–861. https://doi.org/10.1016/j.indmarman.2011.06.029

Rytter, N. G., Boer, H., & Koch, C. (2007). Conceptualizing operations strategy processes. *International Journal of Operations and Production Management*, *27*(10), 1093–1114. https://doi.org/10.1108/01443570710820648

Saaty, T. L. (1980). *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation (Decision Making Series)*. 287.

Serrou, D., & Abouabdellah, A. (2016). Logistics in the hospital: Methodology for measuring performance. *ARPN Journal of Engineering and Applied Sciences*, *11*(5), 2950–2956.

Subramanian, N., & Ramanathan, R. (2012). A review of applications of Analytic Hierarchy Process in operations management. *International Journal of Production Economics*, *138*(2), 215–241. https://doi.org/10.1016/j.ijpe.2012.03.036

Uthayakumar, R., & Priyan, S. (2013). Pharmaceutical supply chain and inventory management strategies: Optimization for a pharmaceutical company and a hospital. *Operations Research for Health Care*, *2*(3), 52–64. https://doi.org/10.1016/j.orhc.2013.08.001