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Integration of Kraljic's Portfolio Model and Purchasing Price Assessment-DEA in Improving Procurement Efficiency

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Abstract

The object of research is one of the companies engaged in aircraft catering using a variety of raw materials. Currently, the procurement department considers that all raw materials are routine raw materials, so the procurement process is carried out repeatedly by suppliers at the lowest prices without entering into contracts or cooperation (regular purchasing). In the absence of contract management, companies lose the opportunity to improve supplier compliance and negotiate price reductions. The decline in supplier performance is also a problem faced, but the procurement department has not assessed supplier performance. With these problems, it is necessary to evaluate the ongoing procurement strategy to improve the efficiency of the procurement process. This study aims to develop recommendations for procurement strategies that include relationships with suppliers and company internal policies. In this study, the preparation of procurement strategy recommendations was taken based on the results of Kraljic's Purchasing Portfolio Model (KPM) which was used to differentiate each raw material based on the level of supply risk and the effect of each raw material on company profits, and the results of the Purchasing Price Assessment–DEA (PPA-DEA) in the category of leveraged goods related to the level of efficiency in purchasing goods. KPM shows that: the group of ingredients for milk, eggs, jam, and chocolate is strategic; dyes, yeast, and coconut milk are classified as bottlenecks; flour and sugar are classified as leverage; oil, packaging, mineral water, utilities, and plastics are classified as non-critical.

Keywords
Procurement Strategy, *Leverage*, Kraljic, Purchasing

1. Introduction
Procurement activities are a series of processes that involve the provision of goods or services needed, with the appropriate quantity and quality, from the right source and delivered to the right place at the right price (Baily, Farmer, Crocker, Jessop, & Jones, 2008). Purchasing management effectively and efficiently has an important role in the success of a company (Boute & Mieghem, 2014).

The purchasing strategy is a necessary medium to achieve such efficiency and effectiveness, and the approach using the portfolio method is the method used by the majority of companies (Montgomery et al., 2018). So, in this case, the ability to evaluate the efficiency of the price offered by the company becomes a critical benchmark (Farres, 2012). The approach taken by previous research focuses on building relationships with strategic suppliers only (Det et al., 2015), where quantitative dimensions such as price, delivery, and quality must be analyzed simultaneously with qualitative dimensions such as risk (Hosseininasab & Ahmadi, 2015) and sustainability. companies (Neumuller et al., 2016).

Only a few studies focus on the category of leverage (Razmi & Keramati, 2011). Along with the development of the literature, the approach is increasingly complex so it is rarely used in the field (Genovese et al., 2013). To make its application easier, the price variable is used as a focal point to determine the efficiency of purchasing leveraged goods (Visani & Boccali, 2020). The object of research is a company engaged in aircraft catering operating in the city of Semarang. The desired catering product is in the form of snacks such as sandwiches, bread rolls, and so on.

Based on the results of interviews with research objects, they do not yet tend to differentiate related to the level of importance of each raw material, both in terms of the smoothness of the production process and on the financial side. The procurement party still considers that all raw materials are routine materials. This is evident from the implementation of the raw material ordering process, where the company only uses one strategy for each raw material, namely entrusting one raw material to one salesman at a supplier company with the concept of regular purchasing. Based on this, it can be said that the object of research does not yet have a reference to perform contract management on its suppliers, which can cause the company to lose some of the benefits that can be obtained by building contract management with suppliers, namely increasing supplier compliance, good performance management, cost reduction. related to market price fluctuations (Daryaatmaka, 2021).

The next problem is that the company has not tried to evaluate the efficiency of the purchasing process, this is due to the priority of the procurement department which focuses only on the success of getting the cheapest goods, without considering the performance of the supplier. On the other hand, the company is facing a decline in the performance of suppliers, which can be seen from 2 indicators, namely timeliness of delivery and quality of delivery. In the absence of guidance on the right procurement strategy and the decline in performance from suppliers, it requires the procurement department to make purchases outside the plan. This leads to cost overruns in the procurement department.

From the problems that arise in the process of purchasing raw materials on the object of research, it is necessary to evaluate the procurement strategy based on the characteristics of each item and the level of efficiency of the purchasing process. The researcher chose Kraljic's Purchasing Portfolio Model as the solution to the problem of the object of research. Overall Kraljic's Purchasing Portfolio Model is an effective tool for discussing, visualizing, and describing the possibilities of developing a differentiated procurement strategy (Gelderman & Van Weel, 2003).

Purchasing Price Assessment – Data Envelopment Analysis (PPA-DEA) is the method chosen as a solution to assess purchasing efficiency, to decide on a strategy related to follow-up with the right supplier (Visani & Boccali, 2020). The evaluation of purchasing efficiency focuses on goods with leverage characteristics in Kraljic's Matrix. The selection of the characteristics of leveraged goods is based on the fact that in this category, goods have a large financial impact, but the supply risk is small, so it becomes an important thing to be able to exploit strategies for suppliers on leveraged raw materials (Razmi & Keramati, 2011).

1.1 Objectives

This study aims to design a strategy for the procurement of goods on the object of research. Raw materials that have not been classified so far will be mapped into Kraljic's Matrix. For goods with leverage characteristics, deeper processing will be carried out using PPA-DEA to determine the level of efficiency of purchasing the goods. The results of the mapping into Kraljic's Matrix and the level of purchasing efficiency on the leverage characteristics will be used as the basis for making recommendations for procurement strategies.

2. Literature Review

2.1 Procurement

Today, procurement is increasingly crucial in supporting the success of a company. Procurement is no longer only a function of purchasing goods from external parties but also shows production planning to affect the level of profitability of a company. More than 56% of production costs are estimated to consist of procurement costs only (Ellram, 1992). However, procurement costs can be saved by improving the performance of the procurement department. The better the procurement function can be determined, including the level of professionalism and procurement position in the company (Gelderman & Van Weel, 2003).

2.2 Kraljic's Purchasing Portfolio Model

Procurement items that have been mapped into the Kraljic Matrix based on the dimensions of Expenditure and supply risk will be classified into four classifications of procurement items as follows (Gelderman & Van Weel, 2003):

1. Bottleneck Items

Bottleneck items are purchase items that have a low-profit value and high risk. This happens possibly due to the scarcity of suppliers which makes the company depend on suppliers. So that the main strategy that can be done is to ensure that the volume of ordered items can be fulfilled so that backup supplies or safety stock can be maintained. Companies should look for alternative suppliers to maintain a continuous flow of materials (Lee & Drake, 2010).

2. Non-Critical Items

Non-critical items are purchase items that are easy to manage because these items have a low level of risk and profit value. So this item is usually ordered through many suppliers which of course increases administrative costs. Therefore, the focus of the routine items purchasing strategy is to reduce transaction costs through efficient processes, product standardization, and optimization of material volume orders and inventory levels (Lee & Drake, 2010).

3. Leverage Items

Leverage Items are purchase items with low risk and high profit. According to Lee & Drake (2010), a strategy that can be done by companies with material leverage items is to increase the company's purchasing power by selecting as many suppliers as possible and negotiating prices.

4. Strategic Items

Strategic Items are purchase items with high profits and risks, thus close interaction between the company and suppliers is needed so that mistakes do not occur and cause losses for both parties. The strategy that can be done by the company is to maintain and increase the intensity of partnership relationships with suppliers by frequently exchanging information with suppliers, and establishing long-term relationships (Lee & Drake, 2010).

2.3 Fuzzy Multi-Attribute Decision Making

Fuzzy Multi-Attribute Decision Making (FMADM) is an approach used in making decisions on several alternative decisions to get an accurate and optimal decision (Moon & Kang, 2001). FMADM can solve problems in the form of calculating data that is not presented completely and contains uncertainty with very good performance. FMADM can represent subjective, objective assessments, and integration between subjective and objective approaches (Kusumadewi, Harjoko, & Wardoyo, 2006).

2.4 Multidimensional Scaling (MDS)

Multidimensional scaling or commonly called perceptual mapping is a procedure that allows a researcher to determine the relative picture of a company object, product, idea, etc.). Multidimensional scaling aims to transform respondents' judgments (perceptions and preferences) into distances in a multidimensional space (Hair, Black, Babin, & Anderson, 2010).

2.5 Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) introduced by Charner, Cooper, and Rhodes (CCR) in 1978 was applied to measure the efficiency of educational institutions. DEA is a linear programming technique that calculates the ratio of output to input from the Decision-Making Unit (DMU) whose result is called relative efficiency (Utoro & Singgih, 2011).

3. Methods

The research was conducted on companies engaged in aircraft catering. The time required to conduct research is 4 months, starting from April 2021 to August 2021. The targeted respondents are experts in the field of procurement on the research object, with the amount of total 5 people with a minimum of 4 years of work experience.

In this study, the variables for KPM tools are supply risk and profit impact. The supply risk variable has indicators of supply availability, supplier performance, and the level of material complexity, while profit impact has indicators of the effect of materials on profits, procurement urgency, and total expenditure. PPA-DEA calculation uses price as input and quality of raw materials, delivery performance as output.

This study will use 2 types of data, namely primary data and secondary data. Primary data was obtained through communication studies. and filling out the questionnaire. Communication studies are carried out with practitioners of the research object procurement unit to identify the problems faced, and adjust the research variables to the real situation of the company. The research questionnaire will be divided into 2 types of questionnaires. Questionnaire A is a questionnaire to assess the importance of each attribute on the dimensions of impact on profit and supply risk. Questionnaire B is a questionnaire that assesses each procurement item for each attribute. Secondary data is obtained from the files available at the company. In this study, the secondary data used is a list of procurement goods, data on expenditures for goods, and data on receipt of procurement goods for the period January 2019 to December 2019.

Data processing begins with collecting attribute importance values then converting them to fuzzy numbers, calculating the average importance value of each criterion, measuring the normalization of the importance value, calculating the weighted average and global average, then mapping it into Kraljic's Purchasing Portfolio Matrix (KPM).

Followed by processing goods with leverage classification on KPM using PPA-DEA with details of evaluating efficiency with CCR-DEA, then proceeding with efficiency assessment using BCC-DEA. Calculating scale efficiency (SE) and pure technical efficiency (PTE). It ends by classifying raw materials into the PTE-SE matrix.

4. Results

Data collection begins with determining what raw materials will be differentiated into Kraljic's Purchasing Portfolio Matrix and then grouped based on the same characteristics. (e.g., **Table 1.** Raw Materials Group).

Table 1. Raw Materials Group

Raw Materials Group	Raw Material
Mineral Water	Mineral Water 1,5 L
	Mineral Water 240 ml
	Mineral Water 330 ml
	Mineral Water 600 ml
	Mineral Water Galon
Milk	Full Cream 1L
	Chocolate Condensed Milk
	White Condensed Milk
Flour	Rice Flour
	Glutinous Rice Flour
	Flour High Protein
	Flour Medium Protein
	Plain Flour

Coconut Milk	Coconut Milk
Yeast	Yeast
Sugar	Castor Sugar
	Granulated Sugar
	Corn Sugar
	Sugar Jelly
	Liquid Sugar
	Palm Sugar
Chocolate	Chocolate Powder
	Compound White
	Dark Chocolate
Jam	Strawberry
	Blueberry
	Peanuts
	Pineapple
	Banana
Oil	Palmia
	Margarin
	Cooking Oil
Color	Blue
	Green
	Yellow
	Red
	Pink
Egg	Egg
Packaging	Air Sickness Bag
	Paper Bag
	Dos Lunch Box
	Tissue
Utility	Tooth Pick
	Plastic Knife
	Plastic Spoon
	Plastic Fork
Plastic	OPP

Collecting data on the purchase track record regarding quantity, description of supplier delays, and information on the number of rejects from each shipment is something that needs to be done after grouping raw materials into each group. Gathering expert opinions regarding the importance of each criterion are the next step that can be done using the first questionnaire. Followed by data collection related to the level of performance of each raw material against each criterion on the dimensions of supply risk and profit impact which can be facilitated by the second questionnaire. The next step is to test the validity and reliability of the results of the first and second questionnaires.

a) Mapping of Raw Materials into Kraljic's Purchasing Portfolio Matrix (KPM)

To be able to produce a KPM mapping, it takes coordinates (x, y) for each raw material, where the x coordinate represents the high or low supply risk of each raw material, while the y coordinate represents the high or low influence of raw materials on the company's profits (Padhi, 2012). The calculation to get the coordinates to start from the conversion process from the results of the respondents' assessments in the first questionnaire into fuzzy numbers, then looks for the average value of each interest called the deffuzified number, which is then continued to look for the normalization value of each criterion (e.g., **Table 2**. Weight Normalization Profit Impact Dimensions).

Table 2. Weight Normalization Profit Impact Dimensions

Dimension	Criteria	*Defuzzified*	Normalization
Profit Impact (P)	P1	9,22	0,340
	P2	8,89	0,328
	P3	9,00	0,332
Supply Risk (S)	S1	4,33	0,302
	S2	6,00	0,419
	S3	4,00	0,279

The second questionnaire processing is done by converting the respondents' assessment results into fuzzy numbers, then that value is multiplied by the normalized value of each criterion to produce a weighted average. The weighted average value is then multiplied by the weighting of the experts on the dimension of supply risk: profit impact, which in this study uses a ratio of 40:60, because the experts are more focused on the profits generated instead of debating the supply risk problems that may be faced (e.g., **Table 3**. Recapitulation of Weighted Average and Global Average Values).

Table 3. Recapitulation of Weighted Average and Global Average Values

Dimensions	***Profit Impact***		***Supply Risk***	
Criteria	**Weighted Avg.**	**Global Avg.**	**Weighted Avg.**	**Global Avg.**
Mineral Water	5,408	**3,245**	3,028	**1,211**
Milk	7,334	**4,400**	4,884	**1,953**
Flour	7,772	**4,663**	4,056	**1,622**
Coconut Milk	5,666	**3,399**	4,856	**1,942**
Yeast	6,203	**3,722**	5,005	**2,002**
Sugar	7,421	**4,453**	4,112	**1,645**
Chocolate	7,807	**4,684**	6,121	**2,448**
Jam	7,795	**4,677**	5,633	**2,253**
Oil	6,335	**3,801**	3,972	**1,589**
Color	6,270	**3,762**	4,512	**1,805**
Egg	7,291	**4,374**	4,805	**1,922**
Packaging	6,066	**3,640**	3,502	**1,401**
Utilitas	4,930	**2,958**	3,321	**1,328**
Plastic	4,536	**2,722**	3,126	**1,250**

Subtracting each global average value from its mean will produce the required coordinates. After getting the coordinates, mapping is carried out using a scatter diagram on SPSS. The output is the result of Kraljic's Purchasing Portfolio Matrix (e.g, **Figure 1**. KPM).

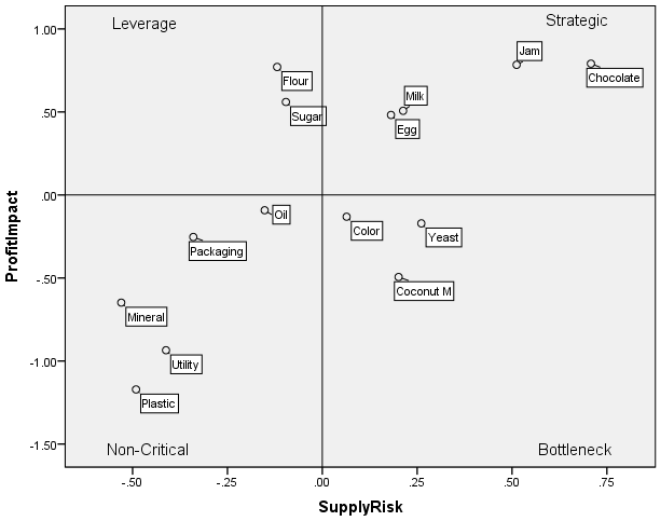

Figure 1. KPM

Based on the figure, it can be interpreted that the 14 groups of raw materials are spread into 4 quadrants consisting of categories of strategic, leveraged, bottleneck, and non-critical goods. These four quadrants have different levels of supply risk and high returns (Bianchini et al., 2019). For example, based on the position of the quadrant in the matrix, quadrant 1, or what is commonly referred to as the Leverage goods category is a group of goods, in this case, raw materials, which have a relatively low supply risk compared to other raw materials, but on the other hand, influence the company's profits. which is relatively higher than other raw material groups. By the criteria on the supply risk dimension, it can be interpreted that the low supply risk is caused by several things, among others, this group of raw materials has a general level of standardization or specifications or is not too complicated, so this causes many potential suppliers to be able to provide supplies following the requirements. with the request of the object of research. By the criteria in the Profit Impact dimension, it can be interpreted that the high influence of raw materials on company profits is caused by several things, including the raw material group in this leverage category being able to produce end-products with large profit margins. by the high costs involved. It is undeniable that the amount of expenditure on raw materials is directly proportional to the number of orders, and the quantity of ordering raw materials is also directly proportional to the number of products produced, which can be concluded that the amount of expenditure on raw material is directly proportional to the company's profits (Daryaatmaka, 2021). This means that the raw materials group in this leverage category has a relatively higher level of expenditure than the raw materials in quadrants 3 and 4.

b) Mapping of Leverage Raw Materials into Pure Technical Efficiency-Scale Efficiency Matrix (PTE-SE)

In this mapping, the Decision-Making Unit (DMU) selected is the item with the leverage category in the KPM. The selection of this category of leveraged goods is based on the small supply risk of leveraged goods and the high profit given to the company, so based on this, it is important to carry out continuous improvement of the sweet spot of KPM. Continuous Improvement in question is a strategy that is following Geldermen's theory to exploit the buying power of the company. This exploitation is based on the small supply risk, in this case, according to the attribute of the supply risk dimension, it can be interpreted that leveraged goods are goods that have standard goods specifications so this also affects the presence of large potential suppliers. With low switching costs, this allows the procurement department to prioritize the search for suppliers with an efficient performance at the most minimal prices, in this case, referred to as buying power exploitation, which is facilitated by Visani and Boccali by using Purchasing Price. Assessment-DEA produces a PTE-SE matrix output.

By using the price of goods as input, the output used is the level of quality of delivery seen from the number of fulfillment of goods, as well as the level of supplier compliance as seen from the number of delivery delays, and efficiency assessment is carried out using Data Envelopment Analysis – CCR (DEA-CCR) to obtain CCR efficiency scores for each DMU, and Data Envelopment Analysis -BCC (DEA-BCC) to obtain PTE scores. The SE score is obtained by dividing the CCR efficiency score against PTE (e.g., **Table 4**. Recapitulation of PTE and SE Values)

Table 4. Recapitulation of PTE dan SE Values

Raw Materials Group	DMU	Raw Material	PTE	SE
Flour	1	Rice Flour	0,878	1,090
	2	Glutinous Rice Flour	1	0,994
	3	Flour High Protein	1	0,937
	4	Flour Medium Protein	0,844	1,125
	5	Plain Flour	1	1
Sugar	1	Castor Sugar	0,859	1
	2	Granulated Sugar	1	1
	3	Corn Sugar	1	0,898
	4	Sugar Jelly	0,734	0,892
	5	Liquid Sugar	1	0,782
	6	Palm Sugar	1	0,548

From these scores, it can be computed in the same way as the KPM, to get the coordinates for each DMU to then be mapped into the PTE-SE matrix. The matrix for the flour raw material group can be seen in **Figure 2**, and the matrix for the sugar raw material group can be seen in **Figure 3**.

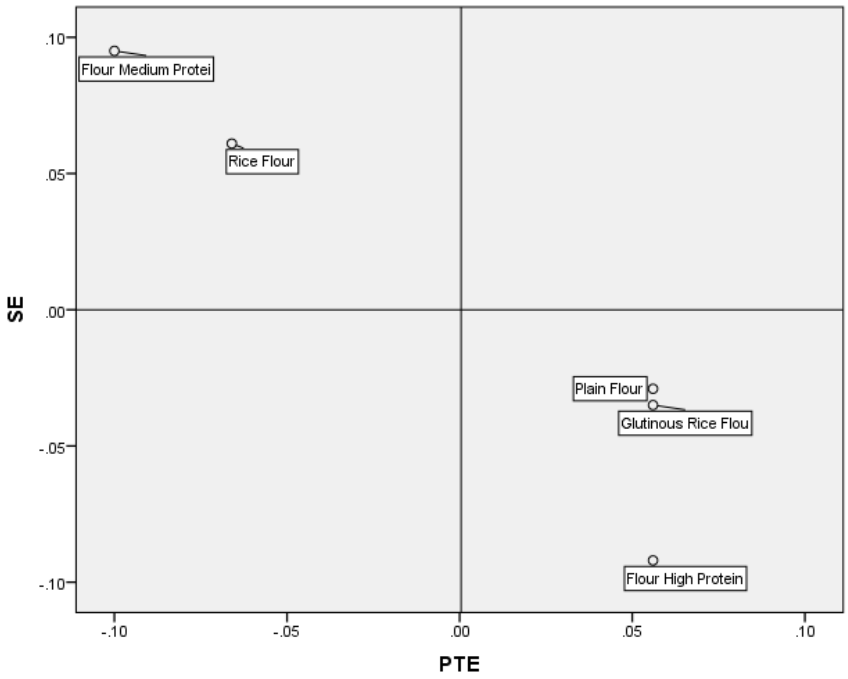

Figure 2. The matrix for the flour raw material group

Based on the figure, it can be seen that the five DMUs in the flour raw material group are spread into 2 quadrants, namely quadrant 1 and quadrant 3. In quadrant 1 there are 2 DMUs, namely Medium Protein Flour and rice flour. In quadrant 3 there are 3 DMUs, namely all-purpose flour, glutinous rice flour, and High Protein Flour.

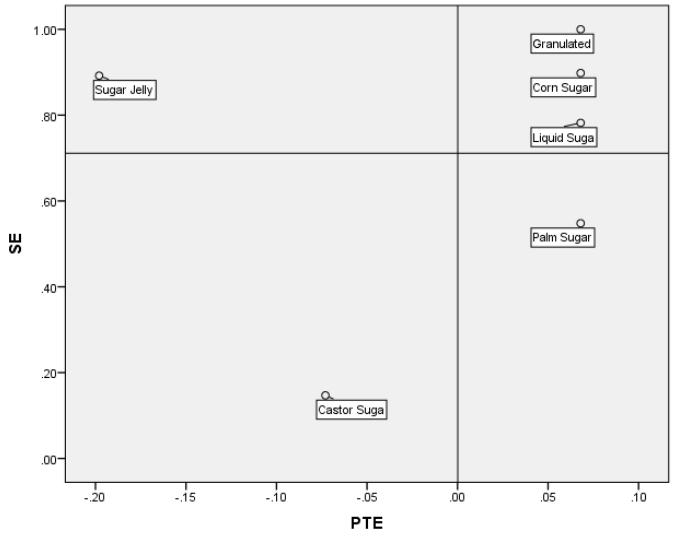

Figure 3. The matrix for the sugar raw material group

Based on the figure, it can be seen that the seven DMUs in the sugar raw material group are evenly distributed into 4 quadrants. In quadrant 1 there is 1 DMU, namely jelly sugar, then in quadrant 2, there are 3 DMUs, namely granulated sugar, corn sugar, and liquid sugar. In quadrant 3 there is 1 DMU, namely palm sugar, and last, in quadrant 4 there is 1 DMU, namely caster sugar. Each quadrant has different characteristics, and these characteristics will later determine what strategy is suitable to be implemented in each DMU, therefore analysis will be carried out for each existing quadrant.

Visani and Boccali (2020) state that the Scale Efficiency (SE) is a parameter to measure whether the scale of purchases made by the company for a supplier is correct or not. Using the company's point of view, low SE can mean that the company has not ordered the right amount, or the amount executed is too low, causing inefficiency in the procurement process. This inefficiency arises from the large number of ordering costs that can be reduced if the ordering frequency can also be adjusted. If a DMU has a high SE level, this indicates that the scale of the order made by the company is correct.
On the other hand, using the supplier's point of view, Pure Technical Efficiency is a parameter to measure the technical readiness of the company to execute the procurement process. With a low PTE, this indicates that the company has not been able to execute the procurement process efficiently on an ongoing basis against the prices offered by the suppliers themselves and tends to overprice when compared to suppliers who can execute the procurement process more efficiently. Likewise with high PTE levels. This shows that the company has been able to carry out all procurement processes efficiently so that the price offered can be said to be a competitive price in the circulating market.

c) Procurement Strategy Recommendations For Each Category of Raw Materials

Each quadrant contained in Kraljic's Purchasing Portfolio Matrix has a different level of supply risk and influence on company profits, and of course, has the most optimal strategy. If viewed from a different perspective, several things can be done to shift each group of procurement materials towards the most optimal position. This position is a leveraged position.

The group of items in this quadrant is the group of items that is most profitable for the company (buyer) because of its low supply risk and high nominal expenditure so that the company in this case has a more dominant position than the provider. With a low supply risk, companies can easily find potential providers for items in this quadrant, then with high nominal spending, the company can also touch economies of scale in purchasing which leads to savings in purchasing costs (Indrajit, 2005). On the other hand, continuous improvement must also be carried out for the raw material group which is already in this leverage quadrant.

Based on this, several strategies can be carried out by the company to improve the efficiency of the procurement process on the object of research (e.g., **Table 5**. Recapitulation of recommendations for procurement strategies that can be implemented by the company).

Table 5. Recapitulation of Procurement Strategies Recommendations

Quadran	Decreasing Supply Risk	Increasing Profit Impact
Non - Critical		• Establish short-term relationships by entering into contracts with the Spot-Purchasing type • Conducting pool-purchasing or merging of similar procurement raw materials into one procurement package with a large purchase volume • Forecasting demand using the Economic Order Quantity method
Bottleneck	• Build a long-term relationshipMelakukan kontrak dengan tipe *call-off contract* • Contract with call-off contract type • Conduct in-depth supply market analysis to obtain better information regarding potential suppliers	• Forecasting demand for raw materials to increase buying power • Conducting pool-purchasing or merging of similar procurement raw materials into one procurement package with a large purchase volume
Strategic	• Build a long-term relationship • Contract with partnership type • Do collaborative negotiation • Conduct in-depth supply market analysis to obtain information regarding potential suppliers	• Forecasting demand for raw materials using the Just In Time (JIT) or Lot-for-Lot (LFL) method.
Leverage	Exploit *Buying Power* • Flour Group Replace suppliers with suppliers who can provide more competitive prices/values for the raw materials for Medium Protein Flour and rice flour. • Sugar Group Replace suppliers with suppliers who can provide more competitive prices/values for raw materials for jelly sugar and caster sugar.	Exploit *Buying Power* • Flour Group Do grouping purchases on all-purpose flour, glutinous rice flour, and High Protein Flour. • Sugar Group Replace suppliers with suppliers who can provide more competitive prices/values for raw materials for caster sugar and palm sugar.

5. Conclusions

Based on the results of data processing and analysis related to Kraljic's Purchasing Portfolio Model method, it is obtained the differentiation of interests for each group of raw materials by classification, namely for groups of raw materials milk, eggs, jam, and chocolate classified as strategic goods. The raw materials for dyes, yeast, and coconut milk are classified as bottleneck goods. The flour and sugar raw materials group is classified as leveraged goods. The raw materials for oil, packaging, mineral water, utilities, and plastics are classified as non-critical goods.

Based on the results of data processing and analysis related to the Purchasing Price Assessment-DEA method, the efficiency level of purchasing raw materials in the leverage category is obtained, namely, for the flour raw material group, Medium Protein Flour and rice flour are included in the raw material category with a low level of supplier ability to can provide competitive price. All-purpose flour, glutinous rice flour, and High Protein Flour are classified as raw materials with an inefficient purchasing scale. For the sugar group, granulated sugar, corn sugar, and liquid sugar are classified as efficient raw materials. Jelly sugar and caster sugar belong to the raw material group with a

low level of supplier ability to be able to provide competitive prices. Palm sugar and caster sugar belong to the raw material group with an inefficient purchasing scale.

Based on data processing and analysis, recommendations are obtained regarding strategies to improve the efficiency of the procurement process, namely, for non-critical goods focusing on increasing profit impact which can be executed by doing pool-purchasing, spot-purchasing, and forecasting demand using EOQ. Bottleneck items focus on minimizing supply risk and increasing profit impact which can be executed by establishing long-term relationships, conducting call-off contracts, in-depth supply market analysis, forecasting, and pool purchasing. Strategic goods focus on minimizing supply risk which can be executed by establishing long-term relationships, partnerships, collaborative negotiation, in-depth supply market analysis, and forecasting using the JIT or LFL method. Leveraged goods focus on exploiting buying power which can be executed by changing suppliers and grouping purchases.

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