Quantitative Strategic Planning Matrix (QSPM) in Determining Alternative Strategies for the Covid-19 Epidemic in the Food and Beverage Manufacturing Companies in Indonesia

Jakfat Haekal

Industrial Engineering, Mercu Buana University

DKI Jakarta, Indonesia

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ABSTRACT

The food and beverage industry is one of the manufacturing sectors relied upon to make a significant contribution to national economic growth. Since the beginning of 2020, the world has been shocked by the coronavirus outbreak that originated in China. The impact of Covid-19 has hit various aspects of human life, including the food and beverage industry. For this reason, stakeholders are expected to focus on formulating strategies for the Covid 19 Epidemic in manufacturing companies in the food and beverage sub-sector. This study aims to identify internal factors' strengths and weaknesses and external factors' opportunities and threats to determine alternative strategies for the covid 19 epidemic in manufacturing companies in the food and beverage sub-sector. This research is a qualitative descriptive study. It knows the right marketing strategy to develop the company based on a SWOT analysis. It knows the right alternative strategy based on QSPM analysis. This research was conducted at Nutrifood; Data were collected using observation, interview, and questionnaire techniques. Nutrifood Indonesia is in quadrant I, which means a company with high market growth and a solid competitive position; on the results of the SWOT matrix analysis with quantitative model analysis, an effective formulation, namely the SO strategy, uses strengths to take advantage of various opportunities (opportunities). The implementation of SO's strategy is to expand market share, maintain and improve service quality to customers and improve product quality. The results showed that the internal and external factors were processed using the SWOT matrix. Based on the results of using the QSPM method, the alternative strategy that is by current conditions is product development by increasing creativity.

Key Words: *SWOT analysis, Quantitative Strategic Planning Matrix, Covid-19.*

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1. INTRODUCTION

The food and beverage industry is one of the manufacturing sectors relied upon to make a significant contribution to national economic growth. The performance of the food and beverage industry has been consistently and positively recorded, starting from its role in increasing productivity, investment, exports to employment. However, the Ministry of Finance stated that the Indonesian economy was only able to grow 2.97% in the first quarter of 2020 due to the impact of the Corona or Covid-19 pandemic. This figure is the lowest growth rate since the fourth quarter of 2001, wherein the fourth quarter of 2001 Indonesia's economic growth was recorded at 2.57%.

Since the beginning of 2020, the world has been shocked by the coronavirus outbreak that originated in China. The coronavirus has caused panic in China and has killed thousands of people in China. As a result, many small, medium, and large companies are temporarily forced to close their businesses. In addition, thousands of places of business were also forced to close. According to the Coordinating Minister for Economic Affairs, Airlangga Hartarto, Indonesia's economic growth rate can be influenced by China's economic growth. If the Chinese economy slows down by 1-2%, it will impact the Indonesian economy declining by 0.1-0.3% on the Indonesian economy.

The impact of Covid-19 has hit various aspects of human life, including the food and beverage industry. Based on data obtained from the Ministry of Industry, the food and beverage industry in the first quarter of 2020 grew by 3.94%. This number is relatively low compared to 2019 at 7.78%. This condition has an impact on the Industry manufacturers such as PT Nutrifood Indonesia as a manufacturing company in the food and beverage sub-sector.

PT. Nutrifood Indonesia is a portion of the instant food and beverage business developed 40 years ago. Committed to inspiring and cultivating a healthy and enjoyable life through distinctive and premium brands. Now the Nutrifood brand has distributed its

products in more than 30 countries. During the COVID-19 pandemic, the company will be affected by this pandemic if we examine it further. One of the problems is the decline in sales of some products.

Table 1 Product Sales Data of PT Nutrifood Indonesia

Years	Months	Sales (box)	Target box)
2019	July	452.640	418.200
	August	428.040	418.200
	September	447.720	418.200
	October	442.800	418.200
	November	467.400	418.200
	December	423.120	418.200
2020	January	333.760	418.200
	February	326.380	418.200
	March	321.050	418.200
	April	314.080	418.200
	May	344.400	418.200
	June	323.920	418.200

The data above explains that sales of food and beverage industry products at PT Nutrifood Indonesia have an average sales target of 418,200 boxes per month. As seen from the sales data above for the last two semesters (12 months), monthly sales of food and beverage industry products at PT Nutrifood Indonesia tend to be unstable and have experienced a decline in sales several times. However, in the last 12 months, sales of food and beverage industry products at PT Nutrifood Indonesia experienced a decrease in the first half of 2020.

This study aims to analyze internal and external factors, formulate alternative strategies, and formulate strategic priorities for the Convid 19 Epidemic in manufacturing companies in the food and beverage sub-sector. For this reason, several problems are developed, which will become the objectives of study and analysis—a proper understanding of the Industry's internal and external conditions. The status of components and technological capabilities possessed by the Industry to produce optimally—business and technology strategies to increase innovation and competitiveness during the Covid 19 pandemic.

2. RESEARCH METHOD

The research steps in this research are part of a series of interrelated and systematic research processes. This research was conducted to conduct a Quantitative Strategic Planning Matrix (QSPM) Analysis in Determining Alternative Strategies for the Convid 19 Epidemic in Manufacturing Companies in the Food and Beverage Sub-Sector. This research was conducted at PT Nutrifood Indonesia. This research was carried out in several stages as follows:

1. IFE and EFE Matrix Analysis

Internal Factor Evaluation (IFE) matrix analysis is used to summarize and evaluate the main strengths and weaknesses in the functional areas of the business, which are then weighted. External Factor Evaluation (EFE) matrix analysis summarizes and evaluates demographic, economic, natural, technological, political, cultural, and competitive information, which is then given the exact weighting as the IFE matrix analysis. The IFE matrix can be developed in five steps, namely:

a. List the main internal factors. Include 10 to 20 internal factors, including the company's strengths and weaknesses. The weight given to a specific factor indicates the relative significance of that factor for the company's success.

b. Give each factor a weight that ranges from 0.0 (not significant) to 1.0 (very important). Calculate the weight value by dividing the value of each rating by each number of ratings.

c. Give each factor a rating of 1 to 4 to indicate whether it is very weak (rating = 1), weak (rating = 2), strong (rating = 3), or very strong (rating = 4). Note that strengths must be ranked 3 or 4 and weaknesses a 1 or 2.

d. Multiply the weight of each factor by the rating to determine the weighted score for each variable.

e. Add up the weight scores of each variable to obtain the company's total weight score.

Regardless of how many factors are included in the IFE matrix, the total weighted score ranges between 1.0 as the low point and 4.0 as the highest point, with a mean score of 2.5. A total weight score below 2.5 indicates an internally weak company, while a significantly above 2.5 indicates a strong internal position.

Furthermore, as with the IFE matrix, the EFE matrix can also be developed in five steps, namely:

a. List the main internal factors. Include 10 to 20 external factors, including the company's opportunities and threats. The weight given to a specific factor indicates the relative significance of that factor for the company's success.

b. Give each factor a weight that ranges from 0.0 (not important) to 1.0 (very important). Calculate the weight value by dividing the value of each rating by each number of ratings.

c. Give each factor a rating of 1 to 4 to indicate whether it is very weak (rating = 1), weak (rating = 2), strong (rating = 3), or very strong (rating = 4). Note that strengths must be ranked 3 or 4 and weaknesses a 1 or 2.

d. Multiply the weight of each factor by the rating to determine the weighted score for each variable.

e. Add up the weighted scores to get the company's total weight score.

Regardless of how many factors are included in the EFE matrix, the total weighted score ranges between 1.0 as the low point and 4.0 as the highest point, with a mean score of 2.5. The total weight score of 4.0 indicates that the company responds very well to the opportunities and threats that exist in the company.

2. IE Matrix (Internal – External)

The IFE and EFE metrics will produce a matrix, namely the Internal – external matrix (IE matrix), which is used to analyze the company's position in more detail and see what strategy is suitable for the company to implement. On the x-axis of the IE matrix, the total value of IFE, which is weighted from 1.0 to 1.99, indicates a weak internal position; the importance of 2.00-2.99 is considered moderate; a value of 3.00-4.00 substantial. On the y-axis of the IE matrix, the total value of EFE, which is weighted 1.00-1.99, is considered low; the value 2.00-2.99 moderate; and 3.0-4.0 high. the IE matrix can be divided into three major parts:

1. The provisions for the divisions that fall into cells I, II, and IV can be described as growing and developing.
2. The divisions that fall into cells III, V, and VII can be adequately handled through a strategy of guarding and defending.
3. The general provisions for divisions included in cells VI, VIII, and IX are harvest or divestment.

3. Grand Strategy Matrix

The Grand Strategy Matrix is a matching stage in the strategy formulation process. This matrix is based on two evaluation dimensions: competitive position and market growth. The Grand Strategy matrix has four quadrants that represent the state of a company. The appropriate strategies for an organization to consider are listed in the order of their attractiveness in each quadrant of the matrix.

Quadrant I represents companies with high market growth and a strong competitive position. Companies in this quadrant have excellent work. Concentrating on the current market (market penetration and market development) and present products (product development) is a suitable strategy for this company. It is not wise for a company in Quadrant I to move away from the competitive advantage. When an organization in Quadrant I has excess resources, backward, forward, or horizontal integration can be an effective strategy. If companies in Quadrant I are too committed to a product, then concentric diversification can reduce the risk associated with a narrow product line.

In Quadrant II, it is necessary to evaluate their current market approach seriously. Even if their industry is growing, they cannot compete effectively, and they need to determine why the company's current approach is ineffective and how the company can change in the best way to improve its competitiveness. Because companies in Quadrant II are in industries whose markets are overgrowing, an intensive (rather than integrative or diversified) strategy is usually the first option considered. However, if the firm does not have a unique competency or competitive advantage, horizontal integration is often the preferred alternative. As a last resort, Divestment and liquidation are ways that can be considered. Divestment can provide the funds needed to buy another business or buy back shares of the company.

Companies in Quadrant III compete in slow-growing industries and have a weak competitive position. These companies had to make drastic changes to avoid further declines and possible liquidation. Extensive asset and cost reduction (retrenchment) must be carried out first. Another alternative is to carry out verification to divert resources from the business to other fields; if that fails, options such as divestment or liquidation can be carried out.

For Quadrant IV, the company has a strong competitive position in a slow-growing industry. The company has the power to introduce verified programs into areas of promising growth. Companies in Quadrant IV have high cash flow rates and limited need for internal development and can often execute verified strategies successfully. The company can also run a joint venture.

How to determine the correct quadrant, it is necessary to calculate the difference between the subtotal factors of strengths and weaknesses (first point) and the difference between the subtotals of factors of opportunities and threats (point two). If the difference between the strengths and weaknesses subtotals is positive (+), then the first point will be on the horizontal line to the right of point 0. If the result is negative (-), then the first point will be on the horizontal line to the left of point 0. If the impact of the difference between the subtotals of opportunities and threats is positive (+), then the second point will be on the side of the vertical line below 0. Finally, two points will determine which quadrant area to choose to find out the right strategy.

4. SWOT Matrix

SWOT analysis is the identification of various factors systematically to formulate corporate strategy. The basic logic built is to maximize strengths and opportunities while simultaneously minimizing weaknesses and threats.

5. QSPM Matrix

The final stage after choosing several alternative strategies is deciding to determine what strategy is most appropriate for the company to use, namely by using the Quantitative Strategic Planning Matrix (QSPM) matrix, which is to summarize and evaluate various alternative strategies objectively based on the company's internal and external factors. Six steps must be taken to develop a QSPM, namely:

a. List the various internal strengths and weaknesses and the main external opportunities and threats in the left column of the QSPM. This information must be taken directly from the IFE matrix and the EFE matrix, consisting of at least 10 internal and 10 external factors.

b. Examine the stage 2 (matching) metrics, and identify alternative strategies that the company should consider and implement. Previously identified.

c. Determine the attractiveness score (AS) of each alternative strategy determined by observing each of the main external and internal factors. The range of attractiveness scores was 1 = no attractiveness, 2 = low attractiveness, 3 = moderate attractiveness, 4 = high attractiveness. If there is no effect on the strategic alternatives being considered, then do not assign a value to the US.

d. Calculate the Total Attractiveness Score (TAS), defined as the product of the weights (step 2) and the attractiveness scores (step 4) in each row. The TAS indicates the relative attractiveness of each alternative strategy, considering only the impact of adjacent external/internal critical success factors. The higher the TAS, the more attractive the alternative strategy.

e. Calculate the total attractiveness of the total by adding up the total attractiveness score in each strategy column of the QSPM. The total attractiveness score (Sum Total Attractiveness Scores - STAS) indicates the most attractive strategy in each alternative set. A higher score indicates a more attractive strategy, given all relevant internal and external factors influencing strategic decisions.

3. RESULT

3.1. IFE Data Processing Results

Based on the results of IFE, it can be seen that having guaranteed product quality and being suitable for consumption during the Covid-19 pandemic is the main strength of PT. Nutrifood Indonesia with a score of 0.437. In the second place, with a score of 0.387, the factor has many product variants in third place, supported by-products readily available everywhere 0.364. Then in fourth place, the marketing system using today's technology gets a score of 0.252. And finally, in fifth place, there is a good service factor to consumers with a score of 0.243.

Meanwhile, the main weakness of this business unit is that the delivery of products is not on time due to the PSBB policy during the Covid-19 pandemic with a score of 0.266. In the second and third place is the lack of application of health protocols to consumers, and the price of the product is less affordable, with a score of 0.200. In the fourth place, facilities and infrastructure are still limited, with a score of 0.183. And the fifth is 0.178 discounts and little promos. The combination of the two internal factors resulted in a total average score of 2,710

3.2. EFE Data Processing Results

Based on the results of the EFE, the main opportunities that PT can exploit. Nutrifood Indonesia is to meet the community's needs for Vitamin C and D during the Covid-19 pandemic with a score of 0.577. In the second position, people's patterns and lifestyles changed during the Covid-19 pandemic with a score of 0.482. Consumer loyalty to the third company's products with a score of 0.305. The order of the four brands from companies widely known to the public with a score of 0.258. In fifth place, good cooperation with the government was established to improve the economic sector with a score of 0.237.

As the main threat obtained from the calculation results, it was found that the weakening of consumer purchasing power was the impact of the economic downturn during the Covid-19 pandemic with a score of 0.264. And the second place is economic conditions that are not conducive during the Covid 19 pandemic, with a score of 0.237. The third order is the price of the competitor's product is cheaper with a score of 0.164. The number of competitors with sales of the same product is in fourth place with a score of 0.142. And finally, the fifth rank is the aggressiveness of competitors in carrying out marketing strategies, with a score of 0.090. Combining the two external factors resulted in a total average score of 2,755.

3.3. Internal and External Environmental Analysis

Mapping the company's position is carried out to facilitate the company in determining the right alternative development strategy to face competition and business growth in the future. The results obtained from the IFE and EFE matrices are used to compile the IE matrix so that the position of the Company.

The total value of the average score on the IFE matrix is 2,710, while the EFE matrix obtains an average total score of 2,755. These results put PT. Nutrifood Indonesia in cell V which is called the defense and maintenance strategy. In this position, market penetration and product development are two strategies that are mainly used when the company is in this cell.

Market penetration and product development are carried out by expanding market share through marketing/promotional efforts, market development by expanding market share geographically into new areas, and product development by modifying products.
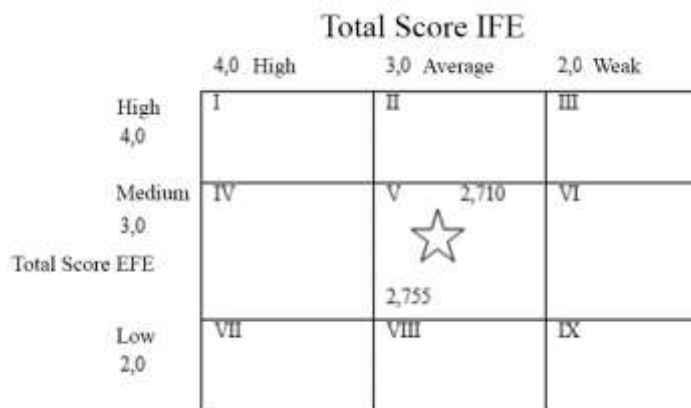

Figure 1 IE Matrix

3.4. SWOT Matrix Analysis

The SWOT matrix is one way to get alternative strategies by combining each factor, namely the SO (strengths-opportunities) strategy, the WO (weaknesses-Opportunities) strategy, the ST (strengths-threats) strategy, and the WT (weaknesses-threats) strategy. This analysis uses data that has been obtained from the EFE and IFE matrices above. The study results in the table advantage of using this model are that it is easy to formulate strategies based on a combination of external and internal factors.

Table 2 SWOT Matrix

FACTOR INTERNAL / FACTOR EXTERNAL	Strengths 1. Has many product variants. 2. Products are easy to get everywhere. 3. Good service to consumers. 4. The marketing system uses today's technology. Having guaranteed product quality and suitable for consumption during the Covid-19 pandemic	Weaknesses 1. Product delivery is not on time due to the PSBB policy during the Covid-19 pandemic 2. Lack of application of health protocols to consumers 3. The price of the product is less affordable. 4. Discounts and limited promos Intensive promotional activities by the company
Opportunities 1. Changes in people's patterns and lifestyles during the Covid-19 pandemic 2. Meeting the needs of the community for Vitamin C and D during the Covid-19 pandemic 3. Brands from companies that are well known to the public. 4. Establish good cooperation with the government in an effort to improve the economic sector 5. Consumer loyalty to company products	**S – O . Strategy** 1. Maintain and improve service quality to customers (S1,S2,S4,O1,O2,O5) 2. Improve product quality (S5,O2,O5)	**W – O . Strategy** 1. Capture opportunities from lifestyle and consumer loyalty in winning the competition with competitors (W3, W4, W5,, O1, O2, O3, O4) 2. Improve health protocols (W2,O1,O2)
Threats 1. Economic conditions are not conducive during the Covid 19 pandemic 2. Weakening consumer purchasing power due to the economic downturn during the	**S – T Strategi Strategy** 1. Establish a market price strategy to face the competition (S3,S4,S5,T1,T2,T3,T4) 2. Increase promotions	**W – T . Strategy** 1. Increase customer satisfaction to maintain customer retention (W1,W2,W4,,T2,T3) 2. Increase creativity

Covid-19 pandemic 3. The number of competitors with the same product sales 4. The price of competitors' products is cheaper 5. The aggressiveness of competitors in carrying out marketing strategies	(S2,S3,S4,S5,T1,T2,T3,T4,T5)	(W3,W4,W5,T2,T3,T4,T5)

From the formulation of strategies in the SWOT matrix, several alternative strategies are produced, including:

1. Maintain and improve service quality to customers (SO-1)
2. Improve product quality (SO-2)
3. Capture opportunities from lifestyle and consumer loyalty in winning the competition with competitors (WO-1)
4. Improve health protocols (WO-2)
5. Establish a market price strategy to face the competition (ST-1)
6. Increase promotion (ST-2)
7. Increase customer satisfaction to maintain customer retention (WT-1)
8. Increase creativity (WT-2)

3.5 Grand Strategy Matrix Analysis

Based on table 4.3 of the IFE matrix, the results show that the score for the strength factor is 1.683, and the score for the weakness factor is 1.027. Meanwhile, based on table 4.4 of the EFE matrix, the score for the opportunity factor is 1.858, and the score for the threat factor is 0.897. To determine the difference in the scores, the next step is to use the formula $\frac{(S-W)}{2}$ for internal factors, $\frac{(O-T)}{2}$ for external factors. The following are the results of the difference in the scores of internal factors and external factors.

Table 3 Difference in Score

Factor	Score	Total
Internal		
Strength	1,683	+0,328
Weaknesses	1,027	
External		
Opportunities	1.858	+0,481
Threats	0,897	

From the results of the identification of all internal and external factors and the determination of the difference in score scores. Internal factors get +0.328 results and external factors get +0.481 results. Then it is described in the grand strategy matrix as follows:
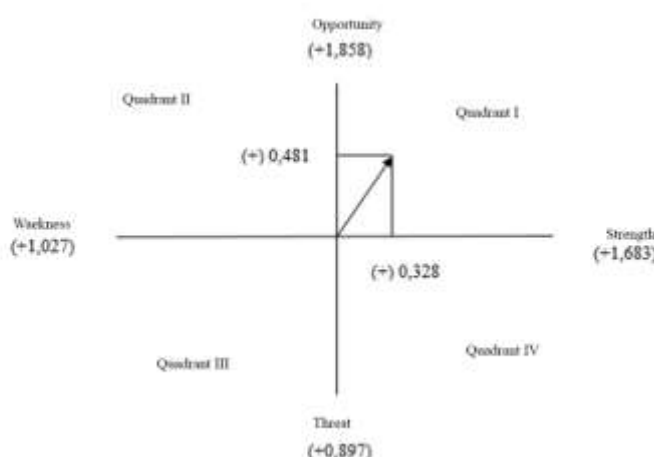

Figure 2 The Grand Strategy Matrix

In Figure 2, the Grand Strategy Matrix of PT. Nutrifood Indonesia is in quadrant I. Quadrant I represents companies with high market growth and a strong competitive position. Companies in this quadrant have excellent work. Concentrating on the current market (market penetration and market development) and present products (product development) is a suitable strategy for this company.

Table 4 Combination of Quantitative Strategies

INTERNAL FACTOR EXTERNAL FACTOR	*STRENGTH* (S)	*WEAKNESS* (W)
OPPORTUNITIES (O)	SO STRATEGY = 1,683 + 1.858 = 3,541	WO STRATEGY = 1,027 + 1.858 = 2,885
THREATS (T)	ST STRATEGY = 1,683 + 0,897 = 2,580	WT STRATEGY = 1,027 + 0,897 = 1,924

The combination of strategies presented in table 4 analyzes the quantitative model of strategy formulation based on the sum of the scores on each of the existing factors and each strategy for SO, WO, ST, and WT strategies. Based on the table, The Company should use the SO strategy because it has the highest score of 3.541 compared to other strategies. This is followed by the WO strategy with a score of 2.885, the ST strategy with a value of 2.580, and the last one is the WT strategy with a value of 1.924. In the results of the SWOT matrix analysis with quantitative model analysis to obtain an effective formulation, namely the SO strategy, by using strengths to take advantage of various opportunities, the SO strategy implementation is (1) Maintaining and improving service quality to customers. (2) Improve product quality.

3.6. QSPM Matrix Analysis

QSPM is a tool that is recommended for strategy experts to evaluate alternative strategy choices objectively, the assessment of the QSPM matrix is the same as the IFE and EFE matrices, namely on a scale of 1-4 where the higher value indicates that the strategy is by the company's conditions. Formulation based on calculations performed with AS and TAS values. The AS value shows the attractiveness of each strategy to its key factors. AS value is obtained through a questionnaire shown to respondents, namely management, this company which is considered to know about the development of business units. The following are the results of the QSPM matrix assessment.

Table 5 Strategy ranking based on QSPM

No	Strategy	Nilai TAS (*Total Attractiveness Score*)
1	Increase creativity (WT-2)	6,996
2	Establish market pricing strategy to face competition (ST-1)	6,830
3	Improve product quality (SO-2)	6,577
4	Maintain and improve service quality to customers (SO-2)	6,386
5	Increase promotion (ST-2)	6,278
6	Increase customer satisfaction to maintain customer retention (WT-1)	6,041
7	Seize opportunities from lifestyle and consumer loyalty in winning the competition with competitors (WO-1)	5,605
8	Improve health protocols (WO-2)	5,279

Based on the results of the QSPM analysis, it can be seen that the best strategy that can be done at this time is product development by increasing creativity. This strategy was carried out to increase sales and an effort to face a high level of competition, with the highest Total Attractiveness Score (TAS), which was 6.996.

4. CONCLUSION

Conclusion

Based on the analysis that has been carried out from data processing, the following conclusions are obtained:

1. Based on the analysis of internal factors, it is known that several factors are the strengths of PT. Nutrifood Indonesia, among others: (1) Has many product variants. (2) Products are easy to get everywhere. (3) Good service to consumers. (4) The marketing system uses today's technology. (5) Have guaranteed product quality and are suitable for consumption during the Covid-19 pandemic. At the same time, the internal factors became the weakness of PT. Nutrifood Indonesia, among others: (1) Delivery of products is not on time due to the PSBB policy during the Covid-19 pandemic. (2) Lack of application of health protocols to consumers. (3) The price of the product is less affordable. (4) Limited discounts and promotions. (5) Intensive promotional activities by the company. External factors that become opportunities for PT. Nutrifood Indonesia includes (1) Changes in people's lifestyles and patterns during the Covid-19 pandemic. (2) Meeting the community's needs for Vitamin C and D during the Covid-19 pandemic (3) Brands from companies that are well known to the public. (4) Establish good cooperation with the government to improve the economic sector. (5) Consumer loyalty to the company's products. Meanwhile, external factors pose a threat to PT. Nutrifood Indonesia, among others: (1) Unfavorable economic conditions during the Covid 19 pandemic (2) Weakening consumer purchasing power due to the economic downturn during the Covid 19 pandemic (3) Many competitors selling the same product (4) Lower prices for competitor products (5) The aggressiveness of competitors in carrying out marketing strategies.

2. The results of the SWOT matrix analysis produce nine alternative strategies that can be used as business development efforts, namely:

    a. Maintaining and Improving the quality of service to customers (SO-1)

    b. Improve product quality (SO-2)

    c. Seize opportunities from lifestyle and consumer loyalty in winning the competition with competitors (WO-1)

    d. Improve health protocols (WO-2)

    e. Establish market pricing strategy to face competition (ST-1)

    f. Increase promotion (ST-2)

    g. Increase customer satisfaction to maintain customer retention (WT-1)

    h. Increase creativity (WT-2)

3. The results of the QSPM matrix analysis show the best strategy that PT must carry out. Nutrifood Indonesia is developing products by increasing creativity. This strategy was carried out to increase sales and face a high level of competition, with the highest Total Attractiveness Score (TAS), 6.996.

Suggestion

Suggestions that can be considered for follow-up include:

1. PT. Nutrifood Indonesia can increase product creativity and innovation in the face of similar business competition.

2. PT. Nutrifood Indonesia can make adjustments to the internal conditions of the business first. These adjustments include revamping the company's management and the division of tasks based on the ability to smooth the production process during the Covid 19 pandemic.

3. Take advantage of the main opportunities owned by PT. Nutrifood Indonesia is meeting the community's needs for Vitamin C and D during the Covid-19 pandemic to gain profit as the company's efforts to face the difficult times of the Covid-19 pandemic.

REFERENCES

1. Kholil, M., Alfa, B.N., Maulana, I., Hendri and Hidayat, A.A., 2018, November. Quality analysis of trolley shopping cart with six sigma approach. In *AIP Conference Proceedings* (Vol. 2030, No. 1, p. 020306). AIP Publishing LLC.

2. Koeswara, S., Kholil, M. and Pratama, Z., 2018, November. Evaluation on Application of Queuing Theory On Payment System in the Supermarket "Saga" Padang Pariaman West Sumatra. In *IOP Conference Series: Materials Science and Engineering* (Vol. 453, No. 1, p. 012045). IOP Publishing.

3. Hidayat, A.A. and Kholil, M., 2018, November. The Implementation of FTA (Fault Tree Analysis) and FMEA (Failure Mode And Effect Analysis) Methods to Improve the Quality of Jumbo Roll Products. In *IOP Conference Series: Materials Science and Engineering* (Vol. 453, No. 1, p. 012019). IOP Publishing.

4. Almahdy, I., Kholil, M. and Yasin, M.Y., 2018, November. A Case of Study on Correlation between Age, Noise Level, and Productivity at Barge in Oil Industry. In *IOP Conference Series: Materials Science and Engineering* (Vol. 453, No. 1, p. 012009). IOP Publishing.

5. Kholil, M., Alfa, B.N. and Hariadi, M., 2018, April. Scheduling of house development projects with CPM and PERT method for time efficiency (Case study: House type 36). In *IOP Conference Series: Earth and Environmental Science* (Vol. 140, No. 1, p. 012010). IOP Publishing.

6. Haekal, J., Hanum, B., & Adi Prasetio, D. E. 2020. Analysis of Operator Body Posture Packaging Using Rapid Entire Body Assessment (REBA) Method: A Case Study of Pharmaceutical Company in Bogor, Indonesia. *International Journal of Engineering Research and Advanced Technology - IJERAT (ISSN: 2454-6135)*, *6*(7), 27-36.

7. Hanum, B., Haekal, J., & Adi Prasetio, D. E. . 2020. The Analysis of Implementation of Enterprise Resource Planning in the Warehouse Division of Trading and Service Companies, Indonesia . *International Journal of Engineering Research and Advanced Technology - IJERAT (ISSN: 2454-6135)*, *6*(7), 37-50.

8. Kholil, M., Haekal, J., Eko Adi Prasetio, D. ., & Sulaiman Hasan. 2020. The Lean Manufacturing Design For Improving Production Scheduling Using Product Wheel Method in Chemical Manufacturing Company, Indonesia. *International Journal of Engineering Research and Advanced Technology - IJERAT (ISSN: 2454-6135)*, *6*(8), 12-18.

9. Haekal, J., & Setio, H. 2017. Selection of Raw Material Suppliers Using Analytical Hierarchy Process in Food and Beverage Company, South Jakarta. *ComTech: Computer, Mathematics and Engineering Applications*, *8*(2), 63-68.

10. HAEKAL, J. (2018). *PERANCANGAN DAN EVALUASI IMPLEMENTASI SISTEM MANAJEMEN MUTU ISO 9001: 2015 MELALUI KEPUASAN PELANGGAN DI UNIVERSITAS ISLAM AS-SYAFI'IYAH* (Doctoral dissertation, Universitas Mercu Buana Jakarta).

11. Kholil, M., Haekal, J. H, Sulaiman. 2020. Lean Manufacturing Design to Reduce Waste in Gear Production Process Using VSM and Kaizen Method Approaches (Case Study: Gear Primary Driven K56 Product). *Journal of Scientific and Engineering Research.* 7(8), 1-9

12. Haekal, J., & Prasetio, D. E. A. Planning Of Production Facilities Layouts In Home Industry With The Systematic Layout Planning Method.

13. haekal, J., & Setiawan, I. (2020). Comparative Analysis of Raw Materials Control Using JIT and EOQ method For Cost Efficiency of Raw Material Supply in Automotive Components Company Bekasi, Indonesia. *International Journal of Engineering Research and Advanced Technology (ijerat)*, *6*(10), 76-82. https://doi.org/10.31695/IJERAT.2020.3661

14. Haekal, J., Hanum, B., & Adi Prasetio, D. E. 2020. Application of Quantitative Strategic Planning Matrix (QSPM) For Determination of Alternative Strategies in Food and Beverage SMES in Bogor Indonesia. *Journal of Scientific and Engineering Research.* 7(7), 137-145

15. Hanum, B., Haekal, J., & Adi Prasetio, D. E. . 2020. SPHC Material Inventory Control Analysis in Project VL01 Centralized by the EOQ Method in Automotive Company Indonesia. *Journal of Scientific and Engineering Research.* 7(7), 130-136

16. Haekal, J. . 2021. Application of Lean Six Sigma Approach to Reduce Worker Fatigue in Racking Areas Using DMAIC, VSM, FMEA and ProModel Simulation Methods in Sub Logistic Companies: A Case Study of Indonesia. *International Journal of Engineering Research and Advanced Technology (ijerat) (E-ISSN 2454-6135) DOI: 10.31695/IJERAT*, *7*(6), 1–11. https://doi.org/10.31695/IJERAT.2021.3716

17. Indra Almahdy, Muhammad Kholil, Jakfat Haekal, Arie Firmansyah, & Dede Rukmayadi. 2021. Implementation of Lean Manufacturing to Reduce Waste in the Maintenance Section in National Automotive Sub Companies of Indonesia . *International Journal of Engineering Research and Advanced Technology (ijerat) (E-ISSN 2454-6135) DOI: 10.31695/IJERAT*, *7*(9), 5–12. https://doi.org/10.31695/IJERAT.2021.3729

18. Atep Afia Hidayat, Muhammad Kholil, Jakfat Haekal, Wahyu Erka Sandra, & Dede Rukmayadi. 2021. Lean Manufacturing Design to Reduce Waste in Customer Complaint Services Using Lean Principles in Coil Industry Companies, of Indonesia. *International Journal of Engineering Research and Advanced Technology (ijerat) (E-ISSN 2454-6135) DOI: 10.31695/IJERAT*, *7*(9), 13–22. https://doi.org/10.31695/IJERAT.2021.3728

19. Muhammad Kholil, Jakfat Haekal, Adizty Suparno, Muhammad Rizki, & Tri Widodo. (2021). Integration of Lean Six sigma in Reducing Waste in the Cutting Disk Process with the DMAIC, VSM, and VALSAT Method Approach in Manufacturing Companies. *International Journal of Engineering Research and Advanced Technology (ijerat) (E-ISSN 2454-6135) DOI: 10.31695/IJERAT*, *7*(9), 26–42. https://doi.org/10.31695/IJERAT.2021.3730

20. Kholil, M., Haekal, J., Suparno, A., Savira, D., Widodo, T. 2021. Lean Six sigma Integration to Reduce Waste in Tablet coating Production with DMAIC and VSM Approach in Production Lines of Manufacturing Companies. *International Journal of Scientific Advances ISSN: 2708-7972.* 2 (5), 719-726

21. Almahdy, I., Kholil, M., Haekal, J., Widodo, T. 2021. Control Analysis of Medicine Inventories Using ABC, VEN, and EOQ Approach in Pharmaceutical Companies. *International Journal of Scientific Advances ISSN: 2708-7972.* 2 (5), 708-712

22. Haekal, J. 2021. Improving Work Efficiency and Productivity with Line Balancing and TPS Approach and Promodel Simulation on Brush Sub Assy Line in Automotive Companies. International Journal of Scientific Advances ISSN: 2708-7972. 2 (3), 387 – 397

Correspondance Author[*]: Jakfat.haekal@mercubuana.ac.id