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Investment Prioritization Based on TOPSIS Euclidean Distance and Manhattan Distance: Mathematical Approach

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Abstract

The global fast-moving consumer goods sector is rapidly evolving driven by the increasing of consumer sensitivity to personal care products. Innovative ideas that supporting continuous improvement program continue to emerge in accordance of the challenges that businesses need to overcome. These ideas are then developed, resulting in time-bound investments. This later become a challenge for decision-makers in prioritizing investments, given their financial constraints in advance. Financial evaluation is less effective for investments with intangible benefits, such as addressing customer complaints, improving product quality, new product innovation, or investments with social impact. This study aims to identify appropriate investment prioritization strategies that address both business objectives and policymakers' considerations. The method used is multi-criteria decision analysis, a comparison of the technique for order preference by similarity to ideal solution (TOPSIS) using euclidean distance and manhattan distance, considering both financial and non-financial criteria. The study using the expert judgement for sub-criteria with more than 10 years of experience in personal care industry within operational and financial sector. The sub-criteria using in this study are net present value and payback period for financial criteria while the sub-criteria for non-financial criteria are new innovation impact, quality improvement result, recall likelihood and social impact. With the criteria ratio based on focus group discussion with the expert stated financial is 70% against non-financial 30% consideration, the final result show that investments priority using euclidean distance TOPSIS is the same as manhattan distance TOPSIS.

Keywords
Investment, Personal Care, TOPSIS, Euclidean Distance and Manhattan Distance.

1. Introduction
The rapid development of the global fast-moving consumer goods industry is increasing complexity driven by consumer sensitivity to products (Munir et al., 2025). Despite this increasing complexity, innovation and continuous improvement continue to emerge as businesses face challenges to maintain sustainability. The competitive landscape creates dynamic pressure to optimize operational processes by maintaining innovation and cost efficiency. This must occur simultaneously to deliver high-quality products that meet consumer expectations and maintain customer loyalty, given the quality-sensitive nature of personal care consumers (Siregar et al., 2017).

Ideas for innovation and continuous improvement are typically grouped into two main categories: profit-generating (such as product innovation or market expansion) and cost-efficiency (such as process optimization or waste reduction). Ideas are then developed based on discussions with experts resulting in an improvement project (Makgopa & Antonites, 2021). A project is considered well-defined when it considers exponential growth, even though growth does not always align with available funding allocations. This presents a challenge for decision-makers in prioritizing and selecting investments within the overall financial constraints of a company (Luo & Luo, 2022).

Conservative evaluation methods rely on financial measures such as Net Present Value and/or payback period. Although conservative methods are widely used to justify investments, they have limitations. Financial evaluation is effective for evaluating investments against cash flow movements over time yet financial evaluation is less effective for investments with unquantifiable benefits, such as improvements to customer complaints, improving product quality, new product innovation, or investments with social impact (Kalinina et al., 2021). This limitation leads to a recurring problem in investment planning: the reprioritization of investments that, in the long term, may impact operational resilience and brand strength in the market. This is due to the difficulty in financially measuring the qualitative benefits of these investments. Some illustrative examples include a vision system procurement project, which increases sensitivity to product quality. However, this investment is not necessarily linear with a reduction in customer complaints and increased customer loyalty, so financial measurements cannot be directly linked and impact NPV. or investments in AI-based CCTV to improve security against potential disruptions caused by external parties in the work area (Iannacone & Bridges, 2020).

Recognizing the limitations that arise when investment evaluation is based solely on financial measurements, all organizations will be challenged to explore more impactful and holistic approaches to investment evaluation (Silva Junior et al., 2019). The Multi-Criteria Decision Analysis-based approach is generally widely used by decision-makers, considering a set of criteria defined or determined by experts or specialists in related fields so that qualitative and quantitative evaluations can be used together (Mahase, 2016). Products with low profits and high demand require optimal production and rigorous quality control to maximize profit margins. Another challenge is shifting consumer behavior due to changing product preferences and changes in product quality. Despite these challenges, adaptive production processes must remain in place without compromising workplace safety and high quality. Continuous improvement to ensure comprehensive challenges are addressed requires investments that are not always easily measured through financial metrics such as net present value (Ehie et al., 2016).

1.1 Objectives
Previous studies discussing multi-criteria-based investment prioritization in the fast-moving consumer goods sector, particularly in diaper manufacturing, are still limited, even though the potential profit from the resulting product is highly linear with the birth rate. This situation reflects a gap for the need of an objective and systematic decision-making model that also considers less easily measurable benefits to ensure the sustainability of the investment prioritization process. Therefore, this article seeks to develop an investment prioritization model based on a multi-criteria approach to assist decision-makers with greater accuracy and focus on long-term sustainability by obtaining investment prioritization based on TOPSIS model with different distance approach euclidean and manhattan.

2. Literature Review
As technology advances, various industries are impacted by this advancement, one of which is FMCG industries diapers. This aligns with self-care practices from birth, leading to a linear relationship between the birth rate and the development of the diaper sector (Bachra et al., 2020; Easson et al., 2018; Massengale et al., 2022; Mulyawan et al., 2022). Several companies have recognized opportunities in the personal care diaper sector and have slowly evolved, adding various technologies to address the competitive dynamics of the market. Companies operating in the diaper

sector are gradually improving their manufacturing quality through automation, aiming for higher-quality products and more efficient processes (Abdul Rasib et al., 2020; Gencturk et al., 2021; Khan et al., 2023; Khdoudi et al., 2024; Wang et al., 2018).

With intense market competition driven by the potential profits generated by producing low-cost, high-volume products, diaper manufacturers face pressure to innovate and increase operational efficiency (S. Huang & Zheng, 2025). Both processes are closely linked to the availability of technology that can help refine their processes. However, the various technological options required for innovation and efficiency also require significant investment costs or capital expenditures, which contribute to depreciation (Khdoudi et al., 2024).

Investment in the manufacturing sector is one way to remain competitive in the FMCG industry as economic growth accelerates (Munir et al., 2025). Strategically prioritizing investments is crucial for aligning capital allocation with business objectives. Investments must also ensure long-term sustainability and resilience, while rapidly increasing capacity through innovations (Jácome et al., 2022; Meng & Gong, 2024; Nurjaman, 2025). Harmonized investment decisions are expected to result in improved outcomes in terms of cost, workmanship, and flexibility. Investment prioritization also needs to consider competitive strengths, minimized risk, and regional manufacturing policies to increase investment effectiveness in line with manufacturing needs (Sang et al., 2023).

3. Methods

3.1 Multi Criteria Decision Analysis

Multi-criteria decision analysis is a systematic approach that involves evaluating alternative choices based on multiple criteria (H. Huang et al., 2024). In the context of investment decision-making, the criteria for some investment project alternatives have conflicting metrics, such as financial disadvantage while providing numerous intangible benefits in other areas, such as product quality (Holtorf et al., 2021). Multi-criteria decision analysis methods generally do not have a single solution; in fact, solutions have quite unique definitions, such as the alternative most preferred by experts based on subjective preferences (Jit, 2018). Multi-criteria decision analysis generally involves mathematical calculations with the aim of eliciting qualitative values from all alternatives so they can be analyzed quantitatively and measurably.

Multi-criteria decision analysis methods address subjectivity in criteria by involving several experts from various sectors (Melnik-Leroy & Dzemyda, 2021). Subjectivity, including that which occurs among experts, arises from differences in preferences and backgrounds of each individual when assessing an investment (Tan et al., 2024). The step taken in multi-criteria decision analysis to neutralize subjectivity is through criteria weighting (Makwakwa et al., 2024). Several widely used multi-criteria decision analysis methods include the analytical hierarchy process (AHP), the technique for order of preference by similarity to ideal solution (TOPSIS), multi-attribute utility theory (MAUT), and the best-worst method (BWM).

3.2 Technique for Order Preference by Similarity to Ideal Solution

The Technique for Order Preference by Similarity to Ideal Solution is a multi-criteria decision analysis method used to determine the best alternative based on the closest distance from the positive ideal solution and the furthest from the negative ideal solution. The TOPSIS method is considered simpler, especially when handling multiple criteria and alternatives, especially conflicting criteria (Krishnan et al., 2023). This method is also capable of handling quantitative and qualitative data, but is quantified with weights so that the distance can be measured (Corrente & Tasiou, 2023). The TOPSIS method is commonly used to replace AHP, but it is also often combined with AHP, so that in the process the weighting is done through AHP and the ranking is done through TOPSIS (Nazim et al., 2022). The steps in conducting TOPSIS include:

1. Form a decision matrix X that identifies the alternatives and criteria.

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}$$

2. Transform the decision matrix X into a normalized matrix R for each criterion.

$$y_n = \sqrt{\sum_{m=1}^{M} x_{mn}^2}$$

$$R = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \dots & \dots & \dots & \dots \\ r_{m1} & r_{m2} & \dots & r_{mn} \end{bmatrix}; r_{mn} = \frac{x_{mn}}{y_n}$$

3. Calculate the normalized weight matrix V.

$$v_{mn} = r_{mn} \times w_n; \sum_{n=1}^{n} w_n = 1$$

4. Determine the positive ideal solution v^* and the negative ideal solution v^- and determine the distance (generally euclidean).

$$D_m^* = \sqrt{\sum_{n=1}^{n} (v_{mn} - v_n^*)^2}\ ; n \in \{1,2, \dots, n\}$$

$$D_m^- = \sqrt{\sum_{n=1}^{n} (v_{mn} - v_n^-)^2}\ ; n \in \{1,2, \dots, n\}$$

5. Determine the closeness value of each alternative.

$$C_m^* = \frac{D_m^-}{D_m^* + D_m^-}$$

One of the advantages of TOPSIS is its simplicity in quickly determining the best alternative. TOPSIS is also highly relevant for multidimensional analysis involving multiple criteria (Krishnan et al., 2023; Madanchian & Taherdoost, 2023). The main weakness of this method lies in the determination of weights, which, if carried out with bias or subjectivity, will also produce subjective results (Zulqarnain et al., 2023). Another weakness is that TOPSIS assumes that the criteria are independent, but in practice, there are instances where criteria are highly correlated, so the number of correlated criteria should be simplified (Chen, 2019). The key point in the TOPSIS method is determining the relative proximity of alternatives to the ideal solution for a number of criteria. In general, if there are n criteria, each alternative represents a point in the n-vector space ($\boldsymbol{R^n}$) whose distance to the positive ideal solution and the negative ideal solution is measured using several alternative methods: (Ciardiello & Genovese, 2023; Madanchian & Taherdoost, 2023; Vega et al., 2014; Vishny et al., 2024)

A. Euclidean Distance:

The distance commonly used in classical TOPSIS and in n-vector spaces ($\boldsymbol{R^n}$) has a hyperspherical shape and is calculated using the formula:

$$D_m^* = \sqrt{\sum_{n=1}^{n} (v_{mn} - v_n^*)^2}\ ; n \in \{1,2, \dots, n\}$$

B. Manhattan Distance:

The distance used in L1-TOPSIS due to its simplicity but not good enough in handling extreme alternatives and is calculated with the formula (Ciardiello & Genovese, 2023; Hadi & Abdullah, 2022; Mitra et al., 2023):

$$D_m^* = \sum_{n=1}^{n} |v_{mn} - v_n^*|\ ; n \in \{1,2, \dots, n\}$$

4. Data Collection

Respondents were experts in various fields related to manufacturing, at least at managerial level, who had made investment decisions and had a minimum of 10 years of experience in the manufacturing and supply chain industry. The individuals selected possessed knowledge and experience in their respective fields, enabling optimal data collection, even with limited resources. Respondent characteristics data were obtained from a demographic questionnaire completed by each respondent. Demographic characteristics recorded included: identity, job level, field of work (e.g., finance, operations, engineering, etc.), length of work experience, and the weighting of each criterion and subcriterion.

The criteria in this study are financial and non-financial metrics. The financial metrics will use two sub-criteria: net present value (NPV) and payback period (PBP). The non-financial metrics will use four sub-criteria: new innovation impact, quality improvement result, recall likelihood and social impact with the criteria ratio based on focus group discussion. The 5 expert is aligning in focus group discussion that the financial criteria weigh is 70% against non-financial weight 30% while the evaluation is conducted once resulting in one single result agreed by the experts. The subcriterion from non-financial criterion are also being discussed resulting in one perspective in form of a score or ratio between 1-5 indicating least or most impact.

The investments evaluated in this study are top 5 investment from one of Indonesia's diapers industries. These investments are planned to be executed between before 2030 to support business strategies and achieve future goals. The evaluated investment alternatives are valued at over 150 million rupiah (Table 1- Table 3).

Table 1. Initial Criteria and Subcriteria Table

	Criteria		**Subcriteria**	**Definition**	
C1	Financial Metric	C1.1	Net Present Value	The difference between the current value of cash inflows and outflows at	(Xia et al., 2022)
		C1.2	Payback Period	The time required to recover the initial investment value through cash inflows	(Xia et al., 2022)
C2	Non Financial Metric	C2.1	New Innovation Impact	Impact of innovation success (scale 1-5) for product renewal according to consumer preferences	(Yashin et al., 2019; Yi et al., 2021)
		C2.2	Quality Improvement Result	Increasing the quality of the products produced and preventing the occurrence of hold products	(Patel et al., 2024)
		C2.3	Recall Likelihood	The possibility of a product recall from the market due to consumer complaints	(Raithel et al., 2024)
		C2.4	Social Impact	The positive impact that investment has on the surrounding environment	(Dunuwila et al., 2025; Marc & Ponikvar, 2022)

Table 2. Alternatives with financial criteria score

Alternatives	**Net Present Value (USD)**	**Payback Period (Years)**
Packaging Automation Western Plant Indonesia	11,145	3.03
Singlepack Automation Process for Sachet Innovation	5,430	3.14
Automatic Casepacker Pilot Project	8,096	2.68
Packaging Automation Eastern Plant Indonesia	2,830	4.24
Weighing Automation Process on Product Weight	1,200	10.00

Table 3. Alternatives with nonfinancial criteria score

Alternatives	**New Innovation Impact** (1: Least Impact - 5: Most Impact)	**Quality Improvement Result** (1: Least Improving - 5: Most Improving)	**Recall Likelihood** (1: Least Likelihood (Best) - 5: Most Likelihood (Worst))	**Social Impact** (1: Least Impact - 5: Most Impact)
Packaging Automation Western Plant Indonesia	2	4	5	2
Singlepack Automation Process for Sachet Innovation	3	3	4	5
Automatic Casepacker Pilot Project	2	3	5	2
Packaging Automation Eastern Plant Indonesia	2	4	5	2
Weighing Automation Process on Product Weight	5	5	1	5

5. Results and Discussion

Focus group discussion results from five expert respondents with over 10 years of experience and holding at least managerial positions who have made investment decisions in various fields were the criteria weight are 70% for financial criteria and 30% of non-financial criteria with the sub-criteria weight are 60% for net present value and 40% for payback period while for non-financial sub-criteria are 20% for new innovation impact, 40% for quality improvement result, 30% for recall likelihood, and 10% for social impact that form an array of subcriterion

$$\begin{bmatrix} \textit{Net Present Value} \\ \textit{Payback Period} \\ \textit{New Innovation Impact} \\ \textit{Quality Improvement Result} \\ \textit{Recall Likelihood} \\ \textit{Social Impact} \end{bmatrix}^{T} = \begin{bmatrix} \mathbf{0.42} \\ \mathbf{0.28} \\ \mathbf{0.06} \\ \mathbf{0.12} \\ \mathbf{0.09} \\ \mathbf{0.03} \end{bmatrix}^{T}$$

Furthermore, with the weighting determined by the experts then processed using the technique for order preference by similarity to ideal solution (TOPSIS) method with both euclidean and manhattan distances to obtain alternative priority results as shown below:

The steps in conducting TOPSIS include:

1. Form a decision matrix X that identifies the alternatives and criteria.

$$X = \begin{bmatrix} \textit{Packaging Automation Western Plant Indonesia} & | & 11{,}145 & 3.03 & 2 & 4 & 5 & 2 \\ \textit{Singlepack Automation Process for Sachet Innovation} & | & 5{,}430 & 3.14 & 3 & 3 & 4 & 5 \\ \textit{Automatic Casepacker Pilot Project} & | & 8{,}096 & 2.68 & 2 & 3 & 5 & 2 \\ \textit{Packaging Automation Eastern Plant Indonesia} & | & 2{,}830 & 4.24 & 2 & 4 & 5 & 2 \\ \textit{Weighing Automation Process on Product Weight} & | & 1{,}200 & 10.00 & 5 & 5 & 1 & 5 \end{bmatrix}$$

2. Transform the decision matrix X into a normalized matrix R for each criterion

$$R = \begin{bmatrix} 0.737 & 0.252 & 0.295 & 0.462 & 0.521 & 0.254 \\ 0.359 & 0.262 & 0.442 & 0.346 & 0.417 & 0.254 \\ 0.535 & 0.223 & 0.295 & 0.346 & 0.521 & 0.254 \\ 0.187 & 0.353 & 0.295 & 0.462 & 0.521 & 0.254 \\ 0.079 & 0.833 & 0.737 & 0.577 & 0.104 & 0.635 \end{bmatrix}$$

3. Calculate the normalized weight matrix V

$$V = \begin{bmatrix} 0.310 & 0.071 & 0.018 & 0.055 & 0.047 & 0.008 \\ 0.151 & 0.073 & 0.027 & 0.042 & 0.038 & 0.019 \\ 0.225 & 0.062 & 0.018 & 0.042 & 0.047 & 0.008 \\ 0.079 & 0.099 & 0.018 & 0.055 & 0.047 & 0.008 \\ 0.033 & 0.233 & 0.044 & 0.069 & 0.009 & 0.019 \end{bmatrix}$$

4. Determine the positive ideal solution v^* and the negative ideal solution v^- and determine the distance.

$$V^* = [0.310 \quad 0.062 \quad 0.044 \quad 0.069 \quad 0.009 \quad 0.019]$$
$$V^- = [0.033 \quad 0.233 \quad 0.018 \quad 0.042 \quad 0.047 \quad 0.008]$$

A. Euclidean Distance to Positive Ideal Solution & Negative Ideal Solution

$$D_{euclidean} = \begin{bmatrix} 0.003 & 0.103 \\ 0.027 & 0.040 \\ 0.010 & 0.066 \\ 0.057 & 0.020 \\ 0.105 & 0.003 \end{bmatrix}$$

B. Manhattan Distance to Positive Ideal Solution & Negative Ideal Solution

$$D_{manhattan} = \begin{bmatrix} 0.097 & 0.453 \\ 0.243 & 0.307 \\ 0.188 & 0.362 \\ 0.357 & 0.193 \\ 0.447 & 0.103 \end{bmatrix}$$

5. Determine the closeness value of each alternative.

A. Closeness value from Euclidean Distance

$$C^*_{euclidean} = \begin{bmatrix} 0.98 \\ 0.59 \\ 0.87 \\ 0.26 \\ 0.03 \end{bmatrix}$$

B. Closeness value from Manhattan Distance

$$C^*_{manhattan} = \begin{bmatrix} 0.82 \\ 0.56 \\ 0.66 \\ 0.35 \\ 0.19 \end{bmatrix}$$

6. Actual Rankings based on TOPSIS with 2 Distance Method
   A. Ranking based on Euclidean Distance

$$\begin{bmatrix} Alternatives\ 1: Packaging\ Automation\ Western\ Plant\ Indonesia \\ Alternatives\ 2: Singlepack\ Automation\ Process\ for\ Sachet\ Innovation \\ Alternatives\ 3: Automatic\ Casepacker\ Pilot\ Project \\ Alternatives\ 4: Packaging\ Automation\ Eastern\ Plant\ Indonesia \\ Alternatives\ 5: Weighing\ Automation\ Process\ on\ Product\ Weight \end{bmatrix} = \begin{bmatrix} 0.82 \\ 0.56 \\ 0.66 \\ 0.35 \\ 0.19 \end{bmatrix} = \begin{bmatrix} 1 \\ 3 \\ 2 \\ 4 \\ 5 \end{bmatrix}$$

   B. Ranking based on Manhattan Distance

$$\begin{bmatrix} Alternatives\ 1: Packaging\ Automation\ Western\ Plant\ Indonesia \\ Alternatives\ 2: Singlepack\ Automation\ Process\ for\ Sachet\ Innovation \\ Alternatives\ 3: Automatic\ Casepacker\ Pilot\ Project \\ Alternatives\ 4: Packaging\ Automation\ Eastern\ Plant\ Indonesia \\ Alternatives\ 5: Weighing\ Automation\ Process\ on\ Product\ Weight \end{bmatrix} = \begin{bmatrix} 0.98 \\ 0.59 \\ 0.87 \\ 0.26 \\ 0.03 \end{bmatrix} = \begin{bmatrix} 1 \\ 3 \\ 2 \\ 4 \\ 5 \end{bmatrix}$$

The result clearly shown there is no different between Euclidean distance TOPSIS and Manhattan distance TOPSIS. This result is driven by several reason, 1.) Dominant financial criteria weight – 70% – supported by the score range between alternative is very high (e.g. NPV have min: 1,200, max 11,145, Social impact have min: 1, max: 5) and 2.) is all the alternatives is naturally separated and no project with near identical score as shown by matrix $\boldsymbol{X}$.

Sensitivity Analysis is conduct to give a counter example by changing the weight of financial criteria to 50%:50% for net present value and payback period. The steps in conducting TOPSIS include:

1. Form a decision matrix X that identifies the alternatives and criteria.

$$X = \begin{bmatrix} Packaging\ Automation\ Western\ Plant\ Indonesia & | & 11{,}145 & 3.03 & 2 & 4 & 5 & 2 \\ Singlepack\ Automation\ Process\ for\ Sachet\ Innovation & | & 5{,}430 & 3.14 & 3 & 3 & 4 & 5 \\ Automatic\ Casepacker\ Pilot\ Project & | & 8{,}096 & 2.68 & 2 & 3 & 5 & 2 \\ Packaging\ Automation\ Eastern\ Plant\ Indonesia & | & 2{,}830 & 4.24 & 2 & 4 & 5 & 2 \\ Weighing\ Automation\ Process\ on\ Product\ Weight & | & 1{,}200 & 10.00 & 5 & 5 & 1 & 5 \end{bmatrix}$$

2. Transform the decision matrix X into a normalized matrix R for each criterion

$$R = \begin{bmatrix} 0.737 & 0.252 & 0.295 & 0.462 & 0.521 & 0.254 \\ 0.359 & 0.262 & 0.442 & 0.346 & 0.417 & 0.254 \\ 0.535 & 0.223 & 0.295 & 0.346 & 0.521 & 0.254 \\ 0.187 & 0.353 & 0.295 & 0.462 & 0.521 & 0.254 \\ 0.079 & 0.833 & 0.737 & 0.577 & 0.104 & 0.635 \end{bmatrix}$$

3. Calculate the normalized weight matrix V – the normalized matrix is changed due to weight modification of financial criteria

$$V = \begin{bmatrix} 0.221 & 0.050 & 0.029 & 0.092 & 0.078 & 0.013 \\ 0.108 & 0.052 & 0.044 & 0.069 & 0.063 & 0.032 \\ 0.161 & 0.045 & 0.029 & 0.069 & 0.078 & 0.013 \\ 0.056 & 0.071 & 0.029 & 0.092 & 0.078 & 0.013 \\ 0.024 & 0.167 & 0.074 & 0.115 & 0.016 & 0.032 \end{bmatrix}$$

4. Determine the positive ideal solution v^* and the negative ideal solution v^- and determine the distance.

$$V^* = [0.221 \quad 0.045 \quad 0.074 \quad 0.115 \quad 0.016 \quad 0.032]$$
$$V^- = [0.024 \quad 0.167 \quad 0.029 \quad 0.0069 \quad 0.078 \quad 0.013]$$

C. Euclidean Distance to Positive Ideal Solution & Negative Ideal Solution

$$D_{euclidean} = \begin{bmatrix} 0.007 & 0.053 \\ 0.018 & 0.021 \\ 0.012 & 0.034 \\ 0.035 & 0.011 \\ 0.054 & 0.008 \end{bmatrix}$$

D. Manhattan Distance to Positive Ideal Solution & Negative Ideal Solution

$$D_{manhattan} = \begin{bmatrix} 0.155 & 0.337 \\ 0.244 & 0.248 \\ 0.233 & 0.259 \\ 0.340 & 0.151 \\ 0.319 & 0.172 \end{bmatrix}$$

5. Determine the closeness value of each alternative.

C. Closeness value from Euclidean Distance

$$C^*_{euclidean} = \begin{bmatrix} 0.89 \\ 0.54 \\ 0.74 \\ 0.24 \\ 0.13 \end{bmatrix}$$

D. Closeness value from Manhattan Distance

$$C^*_{manhattan} = \begin{bmatrix} 0.69 \\ 0.50 \\ 0.53 \\ 0.31 \\ 0.35 \end{bmatrix}$$

6. Actual Rankings based on TOPSIS with 2 Distance Method

C. Ranking based on Euclidean Distance

$$\begin{bmatrix} Alternatives\ 1: Packaging\ Automation\ Western\ Plant\ Indonesia \\ Alternatives\ 2: Singlepack\ Automation\ Process\ for\ Sachet\ Innovation \\ Alternatives\ 3: Automatic\ Casepacker\ Pilot\ Project \\ Alternatives\ 4: Packaging\ Automation\ Eastern\ Plant\ Indonesia \\ Alternatives\ 5: Weighing\ Automation\ Process\ on\ Product\ Weight \end{bmatrix} = \begin{bmatrix} 0.89 \\ 0.54 \\ 0.74 \\ 0.24 \\ 0.13 \end{bmatrix} = \begin{bmatrix} 1 \\ 3 \\ 2 \\ 4 \\ 5 \end{bmatrix}$$

D. Ranking based on Manhattan Distance

$$\begin{bmatrix} \boldsymbol{Alternatives\ 1: Packaging\ Automation\ Western\ Plant\ Indonesia} \\ \boldsymbol{Alternatives\ 2: Singlepack\ Automation\ Process\ for\ Sachet\ Innovation} \\ \boldsymbol{Alternatives\ 3: Automatic\ Casepacker\ Pilot\ Project} \\ \boldsymbol{Alternatives\ 4: Packaging\ Automation\ Eastern\ Plant\ Indonesia} \\ \boldsymbol{Alternatives\ 5: Weighing\ Automation\ Process\ on\ Product\ Weight} \end{bmatrix} = \begin{bmatrix} \mathbf{0.69} \\ \mathbf{0.50} \\ \mathbf{0.53} \\ \mathbf{0.31} \\ \mathbf{0.35} \end{bmatrix} = \begin{bmatrix} \mathbf{1} \\ \mathbf{3} \\ \mathbf{2} \\ \mathbf{5} \\ \mathbf{4} \end{bmatrix}$$

The result show that with the 50%:50% financial to non financial criteria weight, the ranking on alternatives based on Euclidean and Manhattan distance TOPSIS become different. Alternatives 5: Weighing Automation Process on Product Weight is having priority number 4 on Euclidean distance TOPSIS but having priority number 5 on Manhattan distance. This is due to dominance of criteria is removed so that the the closeness value of two alternatives is happening

6. Conclusion

The recommendations for prioritizing investment in the fast-moving consumer goods manufacturing using financial and non-financial criteria and sub-criteria that objectively influence investment priorities in diaper manufacturing. Furthermore, it also provides weighting for these criteria and rankings for these financial and non-financial criteria and sub-criteria that objectively influence investment priorities in diaper manufacturing. The literature review, validated by five experts, established financial and non-financial criteria as the two criteria for determining investment. Furthermore, the sub-criteria used in the financial criteria were net present value and payback period. The sub-criteria used in the non-financial criteria were new innovation impact, quality improvement result, recall likelihood, and social impact. Finally, based on focus group discussion with experts, investment priorities were 70% influenced by financial benefits and 30% by non-financial benefits. Furthermore, using the specified ratio of financial and non-financial criteria, there is no different in priority result measured by TOPSIS using euclidean distance and manhattan distance.

The finding of this research is that in some circumstances, both euclidean distance and manhattan distance TOPSIS will have no different result. The case study shows that if the criteria is dominance and alternatives clearly show no different in decision matrix. The finding is also proven by adding counter example in sensitivity analysis in changing weight on criteria so that the closeness value of alternative is happening because the natural separated alternatives based on score is now close one another. Future research is good to have the third distance as a reference such as chebyshev distance or minkowski distance to give wider point of view.

References

Abdul Rasib, A. H., Mahamad Noor, R., and Ahmad, M. N., "Sustainable Production Flexible Improvement by Internal Activities Time Reduction in Manufacturing Industry," *IOP Conference Series: Materials Science and Engineering*, vol. 994, no. 1, p. 012003, 2020. https://doi.org/10.1088/1757-899X/994/1/012003.

Bachra, Y., Grouli, A., Damiri, F., Bennamara, A., and Berrada, M., "A new approach for assessing the absorption of disposable baby diapers and superabsorbent polymers: A comparative study," *Results in Materials*, vol. 8, p. 100156, 2020. https://doi.org/10.1016/j.rinma.2020.100156.

Chen, P., "A Novel Coordinated TOPSIS Based on Coefficient of Variation," *Mathematics*, vol. 7, no. 7, p. 614, 2019. https://doi.org/10.3390/math7070614.

Ciardiello, F., and Genovese, A., "A comparison between TOPSIS and SAW methods," *Annals of Operations Research*, vol. 325, no. 2, pp. 967–994, 2023. https://doi.org/10.1007/s10479-023-05339-w.

Corrente, S., and Tasiou, M., "A robust TOPSIS method for decision making problems with hierarchical and non-monotonic criteria," *Expert Systems with Applications*, vol. 214, p. 119045, 2023. https://doi.org/10.1016/j.eswa.2022.119045.

Dunuwila, P., Daigo, I., Rodrigo, V. H. L., Liyanage, D. J. T. S., Gong, W. T., Hatayama, H., Shobatake, K., Tahara, K., and Hoshino, T., "Social Life Cycle Assessment Methodology to Capture "More-Good" and "Less-Bad" Social Impacts—Part 1: A Methodological Framework," *Sustainability*, vol. 17, no. 11, p. 4830, 2025. https://doi.org/10.3390/su17114830.

Easson, M., Edwards, J. V., Mao, N., Carr, C., Marshall, D., Qu, J., Graves, E., Reynolds, M., Villalpando, A., and Condon, B., "Structure/Function Analysis of Nonwoven Cotton Topsheet Fabrics: Multi-Fiber Blending Effects on Fluid Handling and Fabric Handle Mechanics," *Materials*, vol. 11, no. 11, p. 2077, 2018. https://doi.org/10.3390/ma11112077.

Ehie, I. C., Oyatoye, E. O., and Joseph, I. G., "Capital project selection using an integrated AHP-LP model: A case study in a developing economy," *International Journal of Services and Operations Management*, vol. 24, no. 2, p. 267, 2016. https://doi.org/10.1504/IJSOM.2016.076506.

Gencturk, U., Ozgec, M., and Kaleoglu, A., "Researching on Baby Diaper Performance with 3D Absorbent Layer," *Textile Research Journal*, 2021.

Hadi, A., and Abdullah, M. Z., "Web and IoT-based hospital location determination with criteria weight analysis," *Bulletin of Electrical Engineering and Informatics*, vol. 11, no. 1, pp. 386–395, 2022. https://doi.org/10.11591/eei.v11i1.3214.

Holtorf, A.-P., Kristin, E., Assamawakin, A., Upakdee, N., Indrianti, R., and Apinchonbancha, N., "Case studies for implementing MCDA for tender and purchasing decisions in hospitals in Indonesia and Thailand," *Journal of Pharmaceutical Policy and Practice*, vol. 14, no. 1, p. 52, 2021. https://doi.org/10.1186/s40545-021-00333-8.

Huang, H., Heuninckx, S., and Macharis, C., "20 years review of the multi actor multi criteria analysis (MAMCA) framework: A proposition of a systematic guideline," *Annals of Operations Research*, vol. 343, no. 1, pp. 313–348, 2024. https://doi.org/10.1007/s10479-024-06357-y.

Huang, S., and Zheng, W., "Adoption Strategies for Innovation Technology Under Asymmetric Competition," *Systems*, vol. 13, no. 12, p. 1097, 2025. https://doi.org/10.3390/systems13121097.

Iannacone, M. D., and Bridges, R. A., "Quantifiable & comparable evaluations of cyber defensive capabilities: A survey & novel, unified approach," *Computers & Security*, vol. 96, p. 101907, 2020. https://doi.org/10.1016/j.cose.2020.101907.

Jácome, N. R., Medina-Tovar, F., Rodríguez-Herás, J., Vásquez-Peñaloza, L., and Gómez-Charris, Y., "Model for the development of innovation as a dynamic capability for an organization in the furniture industry," *Procedia Computer Science*, vol. 198, pp. 542–547, 2022. https://doi.org/10.1016/j.procs.2021.12.283.

Jit, M., "MCDA from a health economics perspective: Opportunities and pitfalls of extending economic evaluation to incorporate broader outcomes," *Cost Effectiveness and Resource Allocation*, vol. 16, no. S1, p. 45, 2018. https://doi.org/10.1186/s12962-018-0118-7.

Kalinina, N., Kurochka, P., Perevalova, O., and Zenkova, E., "Determination of the Quality of Implementation and Financing of Social Investment Projects," *2021 3rd International Conference on Control Systems, Mathematical Modeling, Automation and Energy Efficiency (SUMMA)*, pp. 401–404, 2021. https://doi.org/10.1109/SUMMA53307.2021.9632147.

Khan, M., Alshahrani, A. N., and Jacquemod, J., "Digital Platforms and Supply Chain Traceability for Robust Information and Effective Inventory Management: The Mediating Role of Transparency," *Logistics*, vol. 7, no. 2, p. 25, 2023. https://doi.org/10.3390/logistics7020025.

Khdoudi, A., Masrour, T., El Hassani, I., and El Mazgualdi, C., "A Deep-Reinforcement-Learning-Based Digital Twin for Manufacturing Process Optimization," *Systems*, vol. 12, no. 2, p. 38, 2024. https://doi.org/10.3390/systems12020038.

Krishnan, A. R., Hamid, M. R., Tanakinjal, G. H., Asli, M. F., Boniface, B., and Ghazali, M. F., "An investigation to offer conclusive recommendations on suitable benefit/cost criteria-based normalization methods for TOPSIS," *MethodsX*, vol. 10, p. 102227, 2023. https://doi.org/10.1016/j.mex.2023.102227.

Luo, Q., and Luo, J., "Financing decisions in a supply chain when considering product returns," *Applied Stochastic Models in Business and Industry*, vol. 38, no. 1, pp. 49–72, 2022. https://doi.org/10.1002/asmb.2646.

Madanchian, M., and Taherdoost, H., "A comprehensive guide to the TOPSIS method for multi-criteria decision making," *Sustainable Social Development*, vol. 1, no. 1, 2023. https://doi.org/10.54517/ssd.v1i1.2220.

Mahase, M. J., "A survey of applications of multi-criteria decision analysis methods in mine planning and related case studies," *Journal of the Southern African Institute of Mining and Metallurgy*, vol. 116, no. 11, pp. 1051–1056, 2016. https://doi.org/10.17159/2411-9717/2016/v116n11a7.

Makgopa, S., and Antonites, A., "Influence of Service Innovations on Profit Growth: A Case of Motor Vehicle Retailers," *Journal of Innovation Management*, vol. 9, no. 1, pp. 70–83, 2021. https://doi.org/10.24840/2183-0606_009.001_0006.

Makwakwa, T. A., Moema, D. E., and Msagati, T. A. M., "Multi-criteria decision analysis: Technique for order of preference by similarity to ideal solution for selecting greener analytical method in the determination of mifepristone in environmental water samples," *Environmental Science and Pollution Research*, vol. 31, no. 20, pp. 29460–29471, 2024. https://doi.org/10.1007/s11356-024-32961-3.

Marc, M., and Ponikvar, N., "How to Measure Our Impact on Society: An Illustration of Social Impact Analysis," *Dynamic Relationships Management Journal*, vol. 11, no. 2, 2022. https://doi.org/10.17708/DRMJ.2022.v11n02a06.

Massengale, K. E. C., Jones, M. A., Liao, J., Park, C., and Old, M., "Priority Areas for Child Diaper Access: Low-Income Neighborhoods with Limited Retail Access to the Basic Need of Diapers," *Health Equity*, vol. 6, no. 1, pp. 767–776, 2022. https://doi.org/10.1089/heq.2021.0192.

Melnik-Leroy, G. A., and Dzemyda, G., "How to Influence the Results of MCDM?—Evidence of the Impact of Cognitive Biases," *Mathematics*, vol. 9, no. 2, p. 121, 2021. https://doi.org/10.3390/math9020121.

Meng, X., and Gong, X., "Digital transformation and innovation output of manufacturing companies—An analysis of the mediating role of internal and external transaction costs," *PLOS ONE*, vol. 19, no. 1, p. e0296876, 2024. https://doi.org/10.1371/journal.pone.0296876.

Mitra, R., Das, J., and Kamruzzaman, M., "Application of TOPSIS method for flood susceptibility mapping using Excel and GIS," *MethodsX*, vol. 11, p. 102263, 2023. https://doi.org/10.1016/j.mex.2023.102263.

Mulyawan, A., Alamsyah, Z., and Marimin, "How digital platform changing people way to buy FMCG products," *IOP Conference Series: Earth and Environmental Science*, vol. 1063, no. 1, p. 012050, 2022. https://doi.org/10.1088/1755-1315/1063/1/012050.

Munir, M. A., Abbas, M. M., Qamar, A., Farooq, M., and Cohen, V., "Managing volatile markets: A dynamic capability approach to analytics-driven performance in fast-moving supply chains for sustainable development," *Sustainable Futures*, vol. 10, p. 101338, 2025. https://doi.org/10.1016/j.sftr.2025.101338.

Nazim, M., Wali Mohammad, C., and Sadiq, M., "A comparison between fuzzy AHP and fuzzy TOPSIS methods to software requirements selection," *Alexandria Engineering Journal*, vol. 61, no. 12, pp. 10851–10870, 2022. https://doi.org/10.1016/j.aej.2022.04.005.

Nurjaman, K., "Technological Disruption in Human Resource Management: A Review of Machine Learning Algorithms for Strategic Decision-Making," *TEM Journal*, pp. 2870–2885, 2025. https://doi.org/10.18421/TEM143-86.

Patel, R., Vhora, A., Jain, D., Patel, R., Khunt, D., Patel, R., Dyawanapelly, S., and Junnuthula, V., "A retrospective regulatory analysis of FDA recalls carried out by pharmaceutical companies from 2012 to 2023," *Drug Discovery Today*, vol. 29, no. 6, p. 103993, 2024. https://doi.org/10.1016/j.drudis.2024.103993.

Raithel, S., Hock, S. J., and Mafael, A., "Product recall effectiveness and consumers' participation in corrective actions," *Journal of the Academy of Marketing Science*, vol. 52, no. 3, pp. 716–735, 2024. https://doi.org/10.1007/s11747-023-00967-x.

Sang, R., Alexander, W. R. J., and Anwar, S., "Policy Drivers of Inter-Regional Investment in China," *Economies*, vol. 11, no. 5, p. 150, 2023. https://doi.org/10.3390/economies11050150.

Silva Junior, A. V., Barreto, B. R., and Farias Filho, J. R., "Gestão de valor em projetos de TI: Um estudio sobre organizações no Brasil," *Gestão & Produção*, vol. 26, no. 2, p. e3064, 2019. https://doi.org/10.1590/0104-530x-3064-19.

Siregar, I., Arif Nasution, A., Prasetio, A., and Fadillah, K., "Analysis of production flow process with lean manufacturing approach," *IOP Conference Series: Materials Science and Engineering*, vol. 237, p. 012002, 2017. https://doi.org/10.1088/1757-899X/237/1/012002.

Tan, Y., Karbassi Yazdi, A., Antunes, J., Wanke, P., Gunasekaran, A., Corrêa, H. L., and Coluccio, G., "The Quest for an ESG Country Rank: A Performance Contribution Analysis/MCDM Approach," *Mathematics*, vol. 12, no. 12, p. 1865, 2024. https://doi.org/10.3390/math12121865.

Vega, A., Aguarón, J., García-Alcaraz, J., and Moreno-Jiménez, J. M., "Notes on Dependent Attributes in TOPSIS," *Procedia Computer Science*, vol. 31, pp. 308–317, 2014. https://doi.org/10.1016/j.procs.2014.05.273.

Vishny, D., Morzfeld, M., Gwirtz, K., Bach, E., Dunbar, O. R. A., and Hodyss, D., "High-Dimensional Covariance Estimation From a Small Number of Samples," *Journal of Advances in Modeling Earth Systems*, vol. 16, no. 9, p. e2024MS004417, 2024. https://doi.org/10.1029/2024MS004417.

Wang, L., Fan, H., and Gong, T., "The Consumer Demand Estimating and Purchasing Strategies Optimizing of FMCG Retailers Based on Geographic Methods," *Sustainability*, vol. 10, no. 2, p. 466, 2018. https://doi.org/10.3390/su10020466.

Xia, Y., Wei, X., and Tang, J., "Analysis and Evaluation of Enterprise Performance Appraisal Index Based on Fuzzy AHP Model," *Scientific Programming*, vol. 2022, pp. 1–9, 2022. https://doi.org/10.1155/2022/6915812.

Yashin, S., Koshelev, E., and Sukhanov, D., "Three-dimensional method of assessing R&D projects using real put options," *IOP Conference Series: Materials Science and Engineering*, vol. 497, p. 012063, 2019. https://doi.org/10.1088/1757-899X/497/1/012063.

Yi, K., Zhang, L., Mao, X., Li, Y., and Bao, J., "Evaluating Technological Innovation of Media Companies from the Perspective of Technological Ecosystem," *Wireless Communications and Mobile Computing*, vol. 2021, p. 4170619, 2021. https://doi.org/10.1155/2021/4170619.

Zulqarnain, R. M., Siddique, I., Asif, M., Ahmad, H., Askar, S., and Gurmani, S. H., "Extension of correlation coefficient based TOPSIS technique for interval-valued Pythagorean fuzzy soft set: A case study in extract, transform, and load techniques," *PLOS ONE*, vol. 18, no. 10, p. e0287032, 2023. https://doi.org/10.1371/journal.pone.0287032.

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