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# Application of TOPSIS and AHP methods to select a wastewater treatment technology for Poong In Vina Factory

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***ABSTRACT***

*Selecting wastewater treatment technology is not an easy matter. In this study, TOPSIS and AHP methods are used to support decision-making in choosing a wastewater treatment alternative for Poong in Vina factory. A total of 9 criteria belonging to 3 groups of economic, social and environmental issues were used to select an alternative. The results of TOPSIS and AHP analysis showed that aerobic biotechnology integrated with membrane bioreactor technology (MBR) is the optimal solution (score 1). The outcomes of this study will help the company in choosing the best option among these technologies. Furthermore, it will provide an insight for relevant stakeholders such as engineers, manufacturers and other organizations for making decisions.*

***Keywords:*** *TOPSIS, AHP, technology selection, wastewater treatment*

## 1. Introduction

Garment company 's wastewater is mainly generated from workers' activities, employees and the kitchen. The chemical composition of pollution is main pollutants enclosed COD, BOD, TSS, N, P, grease, ammonium and microorganisms. Currently, domestic wastewater treatment methods are very diverse such as chemical - physicochemical, physicochemical, biological methods, wetlands, etc. The choice of technology for wastewater treatment depends on many factors such as treatment efficiency, land area, investment costs, environmental friendliness, upgradeability, etc (the Ministry of Natural Resources and Environment, 2019). To solve this problem, a multi-criteria decision support method is the first choice. The applications of the multi-criteria method are very diverse and rich in most areas requiring decision-making, classification, ranking and evaluation... Multi-criteria analysis tools are commonly used such as complex proportional assessment of alternatives (COPRAS) (Podvezko, 2011), multi-objective optimization on the basis of ratio analysis (MOORA)(Gadakh, 2011), simple additive weighting (SAW) (Vyas Gayatri, 2013), TODIM (an acronym in Portuguese of Interactive and Multi-criteria Decision Making) (Fahriye Uysal, 2014), preference ranking organization method for enrichment evaluations (PROMENTHEE) and VIKOR (an acronym in Serbian of Vlse Kriterijumska Optimizacija I Kompromisno Resenje) (Podvezko, 2011).

Among the multi-criteria analyses, TOPSIS is the method that has received much attention. TOPIS is a decision support tool among many ideal alternatives. This tool is used in many fields such as minerals (Wu Liyun, 2006), business (Marković, 2010), environment (Juan Li, 2016). TOPSIS is one of the most efficient and easiest methods in terms of conception and application compared to other multi-criteria decision-making methods. Widianta MMD et al. (2018) performed to compare TOPSIS, AHP, SAW and PROMENTHEE to ranking for employee position. The results of the study shown that the TOPSIS has the highest accuracy of 95%, followed by PROMENTHEE at 93.34% and SAW of 81.67% (Widianta MMD, 2018). TOPSIS is simple, rational and offers good computational efficiency (Hsu-Shih Shih, 2007). In the field of environment, TOPSIS is quite commonly used to support the selection of wastewater treatment technology options. Yahya, et al. (2020) used TOPSIS to evaluate wastewater treatment technologies. This study has shown that the activated sludge process is the best option for wastewater treatment (Mukhtar Nuhu Yahya, 2020). Khattiyavong C. and Lee HS assessed the six wastewater treatment technologies based on the following four environmental criteria including land requirement, electricity use, sludge production and $CO_2$ emissions (Chanthephar Khattiyavong, 2019). Therefore, TOPSIS method is used by many scientists and engineers to select wastewater treatment technology.

Poong In Vina Co., Ltd. has the main business of "producting clothes (except fur clothes)" and producing fashion goods for famous brands in the world. The factory's wastewater is mainly generated from the daily activities of workers, managers and canteen. The average amount of wastewater at the company is 155m$^3$/day. Currently, the company has an operating wastewater treatment system with a designed capacity of 300m$^3$/day. The wastewater treatment technology being applied at the plant is biofor biotechnology. However, the wastewater treatment performance of the system is not stable and un-efficient. Therefore, in this study, we propose the TOPSIS method to analyze the domestic wastewater treatment technologies for Poong In Vina Company. In the following, the study of datasets and the methodology used in the analysis are described in Section 2. The results of the analysis and discussion are presented in Section 3, followed by the conclusions in Section 4.

## 2. Data and research methods

### *2.1 Data*

The study was collected secondary data encompassing Report on environmental protection work and Report on the current state of production and business of Poong In Vina Co., Ltd in 2022, calculation data and consultation from experts for scoring alternative selections.

Consult with 03 experts to compare the importance of the criteria for selecting wastewater treatment options. The consultants include 01 expert in environmental engineering, 01 expert in environmental management and 01 expert in environmental science.

### *2.2 Analytic hierarchy process*

Analytical hierarchy process *(AHP)* method is one of the weight methods applied to multi-objective decision-making problems introducted by Thomas L. Saaty (2008). The weights are determined by pairwise comparison of the importance of each criterion on a scale from 1 to 9, specifically as follows:

*TABLE 1.* Pairwise comparison values of Saaty

| Comparative value of Saaty | Define |
|---|---|
| **1** | Equal importance |
| **3** | Week dominance |
| **5** | Strong dominance |
| **7** | Demonstrated dominance |
| **9** | Absolute dominance |
| **2, 4, 6, 8** | Intermediate values |

In this study, the pairwise comparison scores of the criteria were consulted from 03 experts. The average score of the pairwise comparison of 03 experts is used as a pairwise comparison score for the criteria for selecting the wastewater treatment technology alternative shown in Table 2:

*TABLE 2.* Average importance matrix of criteria

| Criteria | TC1 | TC2 | TC3 | TC4 | TC5 | TC6 | TC7 | TC8 | TC9 |
|---|---|---|---|---|---|---|---|---|---|
| Investment cost (TC1) | **1** | 5 | 7 | 9 | 7 | 2 | 3 | 3 | 3 |
| Operation, maintenance and maintenance costs (TC2) | 1/5 | **1** | 3 | 6 | 4 | 1/4 | 1/7 | 1/7 | 1/7 |
| Upgradability (TC3) | 1/7 | 1/3 | **1** | 3 | 1 | 1/7 | 1/5 | 1/5 | 1/5 |
| Operational Requirements (TC4) | 1/9 | 1/6 | 1/3 | **1** | 1/8 | 1/7 | 1/5 | 1/5 | 1/5 |
| Stability (TC5) | 1/7 | 1/4 | 1 | 8 | **1** | 1/8 | 1/4 | 1/4 | 1/4 |
| Processing Performance (TC6) | 1/2 | 4 | 7 | 7 | 8 | **1** | 1/2 | 1/2 | 1/2 |
| Safe and environmentally friendly (TC7) | 1/3 | 7 | 5 | 5 | 4 | 2 | **1** | 1 | 1 |
| Saving construction area (TC8) | 1/3 | 7 | 5 | 5 | 4 | 2 | 1 | **1** | 1 |
| Energy Saving (TC9) | 1/3 | 7 | 5 | 5 | 4 | 2 | 1 | 1 | **1** |

Calculate the geometric mean for each criterion of each row:

$$m_i = \prod_{i=1}^{n} a_{ij},\ \overline{w_i} = \sqrt[n]{m_i},\ w_i = \overline{w_i} / \sum_{i=1}^{n} \overline{w_i}.$$

To illustrate, we take the investment cost criterion as an example, we have:

$$M_{TC1} = \prod_{i=1}^{9} a_{ij} = 1 \times 5 \times 7 \times 9 \times 7 \times 2 \times 3 \times 3 \times 3 = 11.91$$

$$\overline{w_{TC1}} = \sqrt[9]{m_{TC1}} = \sqrt[9]{12.44} = 3.66$$

Similarly, the geometric mean of the selection criteria for the improvement alternative of the wastewater treatment system is obtained as follows: {$m_{TC1}$ , $m_{TC2}$ , $m_{TC3}$ , $m_{TC4}$ , $m_{TC5}$ , $m_{TC6}$ , $m_{TC7}$ , $m_{TC8}$ , $m_{TC9}$ } = {0.80, 0.38, 0.21, 0.44, 1.66, 1.80, 1.80, 1.80}.

The obtained weight vectors of the criteria are denoted: $W_1$, $W_2$, $W_3$, … $W_n$ . In which, W = ($W_1$, $W_2$, $W_3$, … $W_n$ ) = $\sum_{j=1}^{n} w_j$= 1. The weights are determined based on the geometric mean of the obtained criteria. Investment cost criteria weight obtained:

$$w_{TC1} = \overline{w_{TC1}} / \sum_{i=1}^{n9} \overline{w_{TC1}} = \frac{3.66}{12.56} = 0.29.$$

Similarly, the weights for the remaining criteria are determined as {$W_{TC1}$, $W_{TC2}$, $W_{TC3}$, $W_{TC4}$, $W_{TC5}$, $W_{TC6}$, $W_{TC7}$, $W_{TC8}$, $W_{TC9}$} = {0.29, 0.06, 0.03, 0.02, 0.03, 0.13, 0.14, 0.14, 0.14}.

- Conduct a consistency test of the evaluation matrix to compare between the criteria.

We have the weight vector $\vec{w} = \begin{bmatrix} w_1 \\ w_2 \\ w_n \end{bmatrix}$ and $A = \begin{bmatrix} a_{11} & a_{12} & a_{1n} \\ a_{21} & a_{22} & a_{2n} \\ a_{31} & a_{32} & a_{3n} \end{bmatrix}$ from the importance score matrix.

- The consistency of matrix A is calculated as follows:

Multiply the matrix A by the weight vector W to get the vector B: $\vec{B} = \vec{A}\vec{w} = \begin{bmatrix} b_1 \\ b_2 \\ b_n \end{bmatrix}$

Where: $b_1 = a_{11}w_1 + a_{12}w_2 + a_{1n}w_n$, $b_3 = a_{21}w_1 + a_{22}w_2 + a_{2n}w_n$, $b_n = a_{31}w_1 + a_{32}w_2 + a_{3n}w_n$. Substituting the input values, we get vector B = [2.77; 0.63; 0.28; 0.18; 1.36; 1.36; 1.36; 1.36].

Divide each element of vector B by its corresponding element in vector w to get a new vector c: $\vec{c} = \begin{bmatrix} b_1/w_1 \\ b_2/w_2 \\ b_n/w_n \end{bmatrix}$ = [9.5; 9.89; 9.38; 10.60; 11.03; 10.23; 9.47; 9.47; 9.47].

$\lambda_{max}$ is the average of the elements of the vector c: $\lambda_{max} = \frac{1}{n} \sum_{j=1}^{n} c_j$. Substituting the values into the formula we get $\lambda_{max}$ = 9.89.

Then calculate the consistency index using the formula: $CI = \frac{\lambda_{max} - n}{n-1} = \frac{9.89-9}{9-1} = 0.11$

- Calculating the consistency ratio CR = CI/RI, CR < 0.1 the evaluation matrix is reasonable, otherwise we have to re-evaluate the pairwise comparison score of the A matrix. In which, RI is taken according to the following table of values:

*TABLE 3.* Scale of coefficients RI

| **n** | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **RI** | 0.58 | 0.9 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 | 1.49 | 1.51 | 1.48 | 1.56 | 1.57 | 1.59 |

The consistency ratio CR obtained $\frac{CI}{RI} = \frac{0.11}{1.45} = 0.08$

According to (Zayed & Halpin, 2004), CR = 0.08 < 0.1 proves the importance matrix of the criteria is consistent and appropriate. Therefore, the weights for the criteria obtained from the comparison matrix are reasonable.

### *2.3 TOPSIS method*

Technique for order of preference by similarity to ideal solution (TOPSIS) is a method used to evaluate the object ranking, introduced by Hwang & Yoon (1981) with the following idea: The choice is said to be the best if it is closest to the positive ideal solution (PIS) and the farthest from the negative ideal solution (NIS) of multi-state. Wang and Chang (2007) considers that TOPIS is all the best achievable values of the evaluation criterion. NIS is all the worst achievable values of the evaluation criterion. The TOPSIS fuzzy association is built on the AHP weight (Hwang & Yoon, 1981). The TOPSIS method includes the following steps:

Step1: Developing a normalized decision matrix.

This step standardizes the selection criteria for wastewater treatment technology. The data is normalized as follows: $r_{ij} = x_{ij} / (Sx^2{}_{ij})$

In which, i = 1, …, m is the criterion for selection of wastewater treatment technology; j = 1, …, n is a technology alternative for wastewater treatment.

Step 2: Determining the weights for the criteria

The weights for the criteria were determined using the AHP method. The steps for determining AHP weights have been mentioned above.

Step 3: Set up a weighted decision matrix.

We have a set of weights for each criterion $w_j$ with j = 1…n.

Multiply each column of the normalized decision matrix by the corresponding weight. The elements of the resulting matrix are such as $v_{ij} = w_j r_{ij}$

Step 4: Identify the best and worst alternatives

Positive ideal ($A^+$).

$$A^+ = \{v_1^*, \ldots, v_n^*\}$$

Where $v_j^* = \{\max(v_{ij}) \text{ if } j \in J; \min(v_{ij}) \text{ if } j \in J'\}$

Worst alternative ($A^-$):

$$A^- = \{v_1', \ldots, v_n'\}$$

Where: v' = {min ($v_{ij}$) if j ∈J; max ($v_{ij}$) if j ∈J'}

Step 5: Calculate the measure of difference versus for each alternative.

The difference from the best alternative ($S^+$) is:

$$S_i^+ = [\, S\, (v_j^* - v_{ij})^2]^{1/2}, i = 1, \ldots, m$$

Similarly, the difference from the negative alternative ($S^-$) is:

$$S_i^- = [S\, (v_j' - v_{ij})^2]^{1/2}, i = 1, \ldots, m$$

Step 6: Calculate the degree of close association for the best option $C_i^*$

$$C_i^* = S_i^- / (S_i^+ + S_i^-), 0 < C_i^* < 1$$

Choosing the alternatives with $C_i^*$ closest to 1 is the best wastewater treatment technology.

## 3. Research results

### *3.1 Current status of operation and source of wastewater generation*

The type of operation of the factory is sewing and processing clothes (without dyeing) with employ about 2,500 employees. Based on the demand for water use, the amount of wastewater generated is about 80% of the total input water supply. So the average total volume of wastewater in a month is about 4,030$m^3$ (equivalent to about 155$m^3$/day) (Poong In Vina, 2020).

*TABLE 4.* Output wastewater analysis results at Poong In Vina Co., Ltd

| STT | Parameters | Unit | Result | QCVN 40:2011/BTNMT Column A (with $K_q$ = 0.6; $K_f$ = 1.1) |
|---|---|---|---|---|
| 1 | pH | - | 7.18 | 6 - 9 |
| 2 | COD | $mgO_2/L$ | 220 | 75 |
| 3 | $BOD_5$ (20ºC) | $mgO_2/L$ | 189 | 30 |
| 4 | TSS | mg/L | 174 | 50 |
| 5 | Ammonia | mg/L | 51.2 | 5 |
| 6 | Total Nitrogen | mg/L | 52.6 | 20 |
| 7 | Total Phosphorus | mg/L | 5.36 | 4 |
| 8 | Total oil, grease | mg/L | 87 | - |
| 9 | Total Coliforms | MPN/100ml | 150.000 | 3000 |

The results of the analysis of wastewater samples after treatment of the existing wastewater treatment system showed that the concentration of COD, $BOD_5$, TSS, N, P, oil and grease, Ammonium, microorganisms exceeded the permitted threshold of QCVN 40: 2011/BTNMT, column A. Wastewater after treatment will flow into a self-permeable lake in the campus. Therefore, if there are no sollutions to improve the treatment system, the quality of groundwater will be affected by this source.

### *3.2 Proposing alternatives of wastewater treatment technologies*

In this study, we propose 03 options to improve the domestic wastewater treatment system for Poong In Vina Factory in Uyen Hung ward, Tan Uyen city, Binh Duong province. The plans are as follows:

- Option 1: Using aerobic biotechnology combined with anoxic Biofor for treatment.
- Option 2: Use aerobic biotechnology combined with anoxic MBBR for treatment.
- Option 3: Using anaerobic combined aerobic biotechnology with MBR membrane technology for treatment.

***Criteria for selection of domestic wastewater treatment technology***

Criteria for choosing a plan to renovate the wastewater treatment system include 9 criteria

*TABLE 5.* Criteria for choosing the plan to renovate the wastewater treatment system

| STT | Issues | Criteria | Define | Calculation method | Unit | Source |
|---|---|---|---|---|---|---|
| 1 | Economy | Investment cost (TC1) | The entire construction investment cost of the project is determined in accordance with the basic design, including: construction cost; equipment costs; project management costs; consultancy costs | Investment cost = Construction cost + Project management cost + Equipment cost + Consulting cost | Million dong | Calculate |
| | | Operation, maintenance and maintenance costs (TC2) | Is the total cost incurred to operate the operation of the wastewater treatment system, including: labor costs, maintenance costs, chemical costs, electricity, water, probiotics, sludge collection costs. waste | Operating cost = Labor cost + Maintenance cost + Chemical cost + Electricity and water cost + Probiotic cost + Sludge collection cost | Million VND/year | Calculate |
| | | Upgradability (TC3) | Is the ability to expand capacity or improve processing efficiency in the future | Quantitative assessment on a scale of 1 to 10 (1 is the lowest, 10 is the highest) | Scores | Consultation |
| 2 | Social – Technical | Operating Requirements (TC4) | As a person working in the wastewater treatment system, directly monitoring, operating, checking and maintaining equipment so that the wastewater treatment process is guaranteed. | Operational requirements = Number of employees | Labor | Consultation |
| | | Stability (TC5) | As a guarantee of stable operation in the event of abnormal changes in input water quality, weather and climate change. | Quantitative assessment on a scale of 1 to 10 (1 is the lowest, 10 is the highest) | Scores | Consultation |
| 3 | Environment | Processing Performance (TC6) | Is the ability to process the expected wastewater parameters, saving costs | $H\% = \frac{C_{before} - C_{after}}{C_{before}}$ | % | Refer to the document of combined consultation |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Safe and environment-friendly (TC7) | A substance in solid, liquid, gaseous or other form that is discharged from the wastewater treatment operation of a wastewater treatment system. | Average total amount of CTR generated in the year | kg/year | Consultation |
| | | Saving construction area (TC8) | Is to use land sparingly because land is a limited resource, in accordance with the general requirements of society. | $\frac{S_{before} - S_{after}}{S_{before}}$ | % | Calculate |
| | | Energy Saving (TC9) | Is to use an economical, sufficient and efficient way of energy resources. | $\frac{E_{before} - E_{after}}{E_{before}}$ | % | Calculate |

### *3.3 Choosing a plan to improve the wastewater treatment system*

The data on the selection criteria for improvement options for the wastewater treatment system was consulted by engineers of Kaizen Environment Co., Ltd and O&M Co., Ltd. The quantitative rating scale from 1 to 10 (1 is the lowest, 10 is the highest) is as follows:

*TABLE 6.* Criteria and plan for improvement of Poong In Vina wastewater treatment system

| **Technology plan** | | | **Option 1** | **Option 2** | **Option 3** |
|---|---|---|---|---|---|
| **Criteria** | **Unit** | **Type** | | | |
| TC1 | (Million Dong) | - | 1,000 | 1,100 | 1,200 |
| TC2 | (Million Dong) | - | 295 | 295 | 300 |
| TC3 | (Scores) | + | 9 | 9 | 8 |
| TC4 | (Labor) | - | 2 | 2 | 2 |
| TC5 | (Scores) | - | 5 | 7 | 6 |
| TC6 | (%) | + | 85 | 95 | 90 |
| TC7 | (kg/year) | - | 5 | 10 | 20 |
| TC8 | (%) | + | 0 | 0 | 10 |
| TC9 | (%) | + | 5 | 5 | 10 |

Selection Criteria The plan to improve the wastewater treatment system is divided into 2 types. The positive type "+" is the criterion with the greatest possible value, and the negative type "-" has the lowest possible value. Based on the data information of the options for improvement of the wastewater treatment system, the data is normalized in Table 7.

*TABLE 7.* Normalized Values and Weights of Criteria

| **Technological alternatives** | **Option 1** | **Option 2** | **Option 3** | **Weight** |
|---|---|---|---|---|
| Investment cost (TC1) | 0.52 | 0.58 | 0.63 | 0.29 |
| Operation, maintenance and maintenance costs (TC2) | 0.15 | 0.58 | 0.58 | 0.06 |
| Upgradability (TC3) | 0.6 | 0.6 | 0.53 | 0.03 |
| Operating requirements (TC4) | 0.58 | 0.58 | 0.58 | 0.02 |
| Stability (TC5) | 0.48 | 0.67 | 0.57 | 0.03 |
| Processing Performance (TC6) | 0.54 | 0.61 | 0.58 | 0.13 |
| Safe and environment-friendly (TC7) | 0.22 | 0.44 | 0.87 | 0.14 |
| Saving construction area (TC8) | 0 | 0 | 1 | 0.14 |
| Energy Saving (TC9) | 0.41 | 0.41 | 0.82 | 0.14 |

Multiplying the weights and normalized values of each criterion, we get the decision matrix for the improvement options of the domestic water treatment system.

*TABLE 8.* Decision matrix for alternatives weighted

| Technology plan | The most beneficial factor | The most negative factor |
|---|---|---|
| Investment cost (TC1) | 0.18 | 0.15 |
| Operation, maintenance and maintenance costs (TC2) | 0.04 | 0.01 |
| Upgradability (TC3) | 0.02 | 0.02 |
| Operating Requirements (TC4) | 0.01 | 0.01 |
| Stability (TC5) | 0.02 | 0.02 |
| Processing Performance (TC6) | 0.08 | 0.07 |
| Safe and environment-friendly (TC7) | 0.13 | 0.03 |
| Saving construction area (TC8) | 0.14 | 0 |
| Energy Saving (TC9) | 0.12 | 0.06 |

On the basis of analyzing the most advantageous and disadvantageous criteria of each option, we measure the difference of each option compared with the benefit and disadvantage criteria from the weighted data normalization matrix:

*TABLE 9.* Difference of each alternative from the most profitable criterion

| No. | Criteria | Option 1 | Option 2 | Option 3 |
|---|---|---|---|---|
| 1 | Investment cost | $(0.15 - 0.18)^2$ | $(0.17 - 0.18)^2$ | $(0.18 - 0.18)^2$ |
| 2 | Operating costs | $(0.01 - 0.04)^2$ | $(0.04 - 0.04)^2$ | $(0.04 - 0.04)^2$ |
| 3 | Possibility to upgrade | $(0.02 - 0.02)^2$ | $(0.02 - 0.02)^2$ | $(0.02 - 0.02)^2$ |
| 4 | Operation requirements | $(0.01 - 0.01)^2$ | $(0.01 - 0.01)^2$ | $(0.01 - 0.01)^2$ |
| 5 | The stability | $(0.02 - 0.02)^2$ | $(0.02 - 0.02)^2$ | $(0.02 - 0.02)^2$ |
| 6 | Processing performance | $(0.07 - 0.08)^2$ | $(0.08 - 0.08)^2$ | $(0.08 - 0.08)^2$ |
| 7 | Safe, environment-friendly | $(0.03 - 0.13)^2$ | $(0.06 - 0.13)^2$ | $(0.13 - 0.13)^2$ |
| 8 | Save area | $(0 - 0.14)^2$ | $(0 - 0.14)^2$ | $(0.14 - 0.14)^2$ |
| 9 | Energy saving | $(0.06 - 0.12)^2$ | $(0.06 - 0.12)^2$ | $(0.12 - 0.12)^2$ |
| **Total beneficial difference ($Si^+$)** | | 0.035 | 0.035 | 0.028 |

The total difference of the most favorable criteria, option 1 has the largest total difference of 0.035, followed by option 2 is 0.027 and the lowest option 3 is 0.000033.

*TABLE 10.* The difference of each alternative from the disadvantage criterion

| No. | Criteria | Option 1 | Option 2 | Option 3 |
|---|---|---|---|---|
| 1 | Investment cost | $(0.15 - 0.15)^2$ | $(0.17 - 0.15)^2$ | $(0.18 - 0.15)^2$ |
| 2 | Operating costs | $(0.01 - 0.01)^2$ | $(0.04 - 0.01)^2$ | $(0.04 - 0.01)^2$ |
| 3 | Possibility to upgrade | $(0.02 - 0.02)^2$ | $(0.02 - 0.02)^2$ | $(0.02 - 0.02)^2$ |
| 4 | Operation requirements | $(0.01 - 0.01)^2$ | $(0.01 - 0.01)^2$ | $(0.01- 0.01)^2$ |
| 5 | The stability | $(0.02 - 0.02)^2$ | $(0.02 - 0.02)^2$ | $(0.02 - 0.02)^2$ |
| 6 | Processing performance | $(0.07 - 0.07)^2$ | $(0.08 - 0.07)^2$ | $(0.08 - 0.07)^2$ |
| 7 | Safe, environment-friendly | $(0.03 - 0.03)^2$ | $(0.06 - 0.03)^2$ | $(0.13 - 0.03)^2$ |
| 8 | Save area | $(0 - 0)^2$ | $(0 - 0)^2$ | $(0.14 - 0)^2$ |
| 9 | Energy saving | $(0.06 - 0.06)^2$ | $(0.06 - 0.06)^2$ | $(0.12 - 0.06)^2$ |
| **Total negative difference ($Si^-$)** | | 0.000004 | 0.000004 | 0.0021 |

The total difference of the most unfavorable criteria, option 3 has the largest total difference of 0.0345, followed by option 2 is 0.0021 and the lowest option 1 is 0.0000004.

The relative similarity with the best alternative is obtained by the following formula:

- Option 1 = 0.0004/(0.035+0.0004) = 0.0001
- Option 2 = 0.002/(0.028+0.002) = 0.0681
- Option 3 = 0.035/(0+0.035) = 1

The results of TOPSIS analysis showed that option 3 - using anaerobic combined aerobic biotechnology with integrated MBR membrane technology gave the highest score. Therefore, this is the best option among the 3 proposed solutions for domestic wastewater treatment technology at Poong In Vina Factory. Nguyen Minh Ky et al. (2017) showed that the wastewater treatment efficiency of MBR is higher than traditional methods. The membrane filtration technology can be applied to treat high organic loading. Aileen NLN and Albert SK indicated that the membrane bioreactor (MBR) technology is ability to produce high-quality training that meets water quality regulations (Aileen N.L. Ng, 2007).

## 4. Conclusion

The biological wastewater treatment system is the solution that is commonly applied in Vietnam. In this study, the research objective is to select the appropriate domestic wastewater treatment technology. Using TOPSIS and AHP decision support methods based on 9 technology selection criteria under 03 economic, social and environmental issues. 03 technological options for domestic wastewater treatment at Poong In Vina factory were considered and selected, including: Using aerobic biotechnology combined with anoxic Biofor for treatment, Using aerobic biotechnology Combined anoxic MBBR for treatment, Using anoxic combined aerobic biotechnology with integrated MBR membrane technology for treatment. The results of TOPSIS and AHP analysis have shown that using anaerobic combined aerobic biotechnology with MBR membrane technology is the most optimal. In the study, there were not enough conditions and budget to conduct a comparative assessment with other multi-criteria decision making methods. Therefore, this issue is the future research direction of the topic.

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