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# The Influential Factors of the Feeder Service Development in Malaysia towards its Sustainability

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*ABSTRACT*

Feeder service is important for transporting goods from hub to spoke or vice versa in Malaysia. It is due to the draft restriction at most of the access channel and berth in the Intra-Asia ports. The lack of research information on the feeder development in Malaysia has generated the idea to fullfil the research gap on accomplishing the objective of identifying and ranking the development factors of the Malaysian feeder service. The factors are classified, compressed and calculated in the division of criteria safety, technology, economy, and environment by using the Arithmetic Mean (AM) and Analytic Hierarchy Process (AHP) method. The results of this study contribute to the rank establishment of influential factors in determining the development of feeder service in Malaysia. Based on the result, the service sub-criteria is the most influential factor on the feeder service development in Malaysia. The result of this research also can be used by researchers and maritime players to focus on strengthening the imperative factors and overcome the vulnerability of the feeder service sector. Therefore, the industrial players could utilize the analysed data for effective measures to develop strategic plans for the future growth of the feeder service in Malaysia. Keywords: Feeder service, Feeder Selection Factors, Short Sea Shipping, Decision Making Method, Analytic Hierarchy Process (AHP).

## 1. Introduction

According to (Varbanova, 2011) and (Doderer, 2011), feeder service is a part of short sea shipping which is transported containers with its carrying capacity is ranging from 100 (Twenty foot of equivalent units as container's length) Teus to 2500 Teus (Rudic and Hlaca, 2005; Gorski and Giernalczyk, 2011; Varbanova, 2011). Somehow, (Polat, 2013) stated that a feeder vessel can reach up to 4300 Teus of carrying capacity. The suitability of the feeder vessel to be assessable within the Intra-Asian ports are in between 501 to 2000 Teus (Adolf and Jeremy, 2008).

In fact, the research problem is derived from the opening of the Northern Sea Route (NSR) which has prospects of decreasing number of vessels passing through the Malaysian waterways (Abdul Rahman et al., 2014). Actually, NSR is an alternative route for transporting cargo between Far East of Asia and European countries. However, NSR seems potentially acceptable by shipping companies due to the great saving of fuel consumption, bunker cost, operating cost, emissions and journey time (Abdul Rahman et al., 2014). The NSR also has been predicted to become more accessible within 20 to 30 years from now and the shipping market in the region is bound to be increased (Ragner, 2008). Recently, there are 207 vessels had transit through NSR from the year of 2011 to 2015 (Protection of the Arctic Marine Environment, 2016). Based on the ongoing problem created by the NSR, it is crucial for Malaysia to have a strategy by identifying the potential shipping service that need to be strengthened and developed. According to (ASEAN Ports Association Malaysia (MAPA), 2015), the average of highest ship calling in Malaysia from 2010 to 2014 is generated by feeder vessel (38%), secondly followed by tanker (19%), third is the general cargo vessel (11%) and etc. (32%). Consequently, feeder service has helped Port Klang in main-

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taining its position as one of the top 20 of world container ports (United Nations Conference on Trade and Development, 2015). Port Klang also has gained the highest container throughput per annum among the Malaysia's ports which resulted from an efficient feeder service (Westport, 2012).

Feeder service has been identified as a very essential of a cargo transportation method towards Malaysia shipping and ports sustainability. It is important to assist the feeder operators in improving their service capability. However, due to the lack of academic research, the researchers need to identify the influential factors on its growth. The assessment on how feeder operators can be improved is one of the keys to encounter the NSR problem. Hence, the current benchmark of the influential factors on feeder service development in Malaysia is calculated by using Arithmetic Mean (AM) and Analytical Hierarchy Process (AHP) method. A list of parameters in priority order can helps feeder operators to be more focus on specific developmental factors.

## 2. Methodology

This research paper incorporates between the Arithmetic Mean (AM) and Analytical Hierarchy Process (AHP) method. Initially, AM is used for calculating the average criterion intensity obtained from the respondents (Had and Kasim, 2014). Then, it was proceeds with the manual calculation by using AHP Algorithms.

### 2.1. Arithmetic Mean (AM)

To calculate the arithmetic mean of a set of data we must first add up or sum all of the data values $a_i$, $a_j$, $a_k$ and then divide the result by the number of values, $n$. Since $\sum$ is the symbol used to indicate that values are to be summed or see Sigma Notation. The following formula is derived for the mean (Foerster, 2006).

$$A = \frac{1}{n}\sum_{i=1}^{n} a_i \ \ also\ same\ as\ \ A = \frac{\sum x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_n}{n} \tag{1}$$

Where, the average of the criteria intensity, $A$; the number of respondents, $n$; number of criteria, $a_i$; the intensity of scale (1-9) denoted as $x$; $n$ represented as respondent = $x_n$

### 2.2. Analytical Hierarchy Process (AHP)

According to (Kou et al., 2013), there are five steps in AHP as listed below:

*Step 1:* Identify and decompose the problem

*Step 2:* Build a set of pair-wise comparison matrices

*Step 3:* Calculate the weight values of the main criteria and sub-criteria

*Step 4:* Test the consistency of all comparison matrices

*Step 5:* Aggregate the final priorities of the main criteria and sub-criteria

*Step 1: Identify and decompose the problem*

According to (Kou et al., 2013) in the first step, a decision problem should be defined, then, structured hierarchically by breaking down the decision problem into a hierarchy of interrelated decision elements, which usually include three hierarchy levels: objective level or goal, and main criteria and sub-criteria level.

*Step 2: Build a set of pair-wise comparison matrices*

The same level of criterion was compared with one to one basis which grouped based on the same elements to assess. The assessment was based on the expertise decision which was justified based on their experience and knowledge due to the subject matters. The scaling assessment of nine point integer was used in the questionnaire which applied the pair-wise comparison between intangible criteria (Saaty, 2008). The matrix of the main criteria and sub-criteria were constructed by assessing their pair of criteria intensity. The weight value assessment is arranged in the form of matrix. The attributes of $a_i$ and $a_j$ are denoted as follows (Abdul Rahman, 2012):

$$A = (a_{ij}) \begin{pmatrix} 1 & a_{12} & ... & a_{1n} \\ \frac{a}{a_{12}} & 1 & ... & a_{2n} \\ . & . & ... & . \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & ... & 1 \end{pmatrix} \tag{2}$$

Where, the items denoted as $i, j = 1, 2, 3, ..., n$ and each $a_{ij}$ is respect of attribute $a_i$ to attribute $a_j$.

*Step 3: Calculate the weight values of the main criteria and sub-criteria*

The weight values of the main criteria and sub criteria were obtained using manual calculation as refer to Equation 3 (Abdul Rahman, 2012; Asuquo et al., 2014):

$$W_K = \frac{1}{n}\sum_{i=1}^{n} \frac{a_{kj}}{\sum_{i=1}^{n} a_{ij}} \tag{3}$$

Where $a_{ij}$ stand for the entry of row $i$ and column $j$ in a comparison matrix of order $n$. $k = 1, 2, 3, ..........., n$.

*Step 4: Test the consistency of all comparison matrices*

The AHP provides a measure of the consistency for the pair-wise comparisons by computing a consistency ratio, CR. A CR value less than 0.1 means that the evaluation is consistent (Saaty, 1990). The $\lambda_{max}$ is the maximum eigenvalue of $n\ x\ n$ comparison matrix $A$ that is calculated as follows (Asuquo et al., 2014).

$$\lambda_{max} = \frac{\sum_{i=1}^{n} \frac{\sum_{k=1}^{n} w_k a_{jk}}{w_j}}{n} \tag{4}$$

Where, $w_K$ = the weight value of specific criterion, $a_{jk}$ = the pair-wise criterion base on specific row and column, $w_j$ = the weight value of criterion. Then, the Consistency Index (CI) was calculated by using Equation 5 as follows (Saaty, 2008):

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{5}$$

(n = 1, 2, 3, ..., k, matrix size)

Then, the Consistency Ratio can be calculated as Equation 6. While *RI* is the random index for the matrix size, A. The value of *RI* depends on the number of items being compared and is given in Table 1 (Saaty, 2008).

$$CR = \frac{CI}{RI} \tag{6}$$

Table 1: Random consistency index from 1-8 of matrix size

| n | 1 | 2 | 3 | 4 | 5 | 6 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| RI | 0 | 0 | 0.58 | 0.9 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 | 1.45 |

Source: Saaty, 2008

*Step 5: Aggregate of the final priorities main criteria and sub-criteria*

In the final step, the priority vectors calculated from the comparison matrices in each level are used to weigh the priorities in the next level. The steps were repeated, and then all priorities of criteria and sub-criteria were synthesized until the hierarchal order of the sub-criteria in the bottom level was obtained (Saaty, 1994).

## 3. Modelling The Influential Factors Of The Feeder Service Development In Malaysia

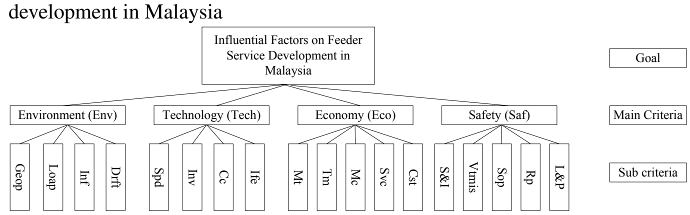
*Stage 1: Problem finding and setting up goal*

The researchers have identified the gap from literature and applied the discussion technique with experts from academic and industrial experts to set up an appropriate goal that needs to be achieved based on the current situation faced by most feeder operators (Also refer to Section 2.2, Step 1). Due to the potential problem of opening the Northern Sea Route (NSR), the goal of this research is to investigate the influential factors of the feeder service development in Malaysia by means of helping the feeder operators to discover the developmental factors that can be focused to prepare for any circumstances if the NSR becoming vital in future.

*Stage 2: Comprehensive discussion and development of model*

According to (Asuquo et al., 2014), a comprehensive research is supposed to have the following characteristics; simplicity, transparency, robustness, and accountability. The Analytical Hierarchy Process (AHP) method is capable of being used to accommodate qualitative and quantitative data sets (Asuquo et al., 2014). There are seven feeder companies have been approached. It was selected from the top managerial level that absolutely involved in company decision-making. According to (Kangas, 1994) and (Soma, 2003), the independence of AHP methodology is relative to the sample size and the application for this survey does not affect the survey response rate and size. A small sampling size, which is less than 10 respondents were necessary if the data obtained were gathered from the experts (Saaty, 2008). It was due to the fact that professionals or experts should share the consistent belief and consequently diminish the requirement for a huge sample size (Asuquo et al., 2014). All the criteria were obtained from the literature and discussion with the experts. Then, 18 of the criteria had been selected by having a screening and verification process. It is essential to ensure the criterion is suitable to the research subject. The main criteria and sub-criteria were summarised in Figure 1 as follows:

Figure 1: A proposed analysis model of influential factors on feeder service development in Malaysia




Indicators: Strategic geographical area of service (Geop); Low emission of air pollution (Loap); Efficient of ports infrastructure (Inf); Ship's draft restriction at ports (Drft); Efficient of ship's speed (Spd); Investment by stakeholders (Inv); Suitable size of ship carrying capacity (Cc); Exchanging ideas between experts (Ife); Suitability of current trading market (Mt); Efficient of service timing (Tm); Miscellaneous factors such as delivery distance and fuel price (Mc); Efficiency of service in term frequency (Svc); Cost efficiency: operating, chartering cost etc. (Cst); Compliance of Survey and Inspection (S&I); Efficient of Vessel traffic management information system (Vtmis); Implement of excellent standard operating procedure (Sop); Reliable route planning (Rp); and Protection by law and policy (L&P).

### 3.1. Stage 3: Perform Arithmetic Mean (AM) and AHP method

The Arithmetic Mean formula was used to average the mean of the criteria intensity evaluated by the respondents (Refer Section 2.1). Then, the pair-wise comparison matrix and the weight of the criteria calculated and computed in Table 2. By the means of pair-wise matrix calculation, according to (Javanbarg et al., 2012), was reasonable if criterion A is absolutely more important than the criterion B and is rated at $x_1$, then B must be absolutely less important than A and is valued at $\frac{1}{x_1}$. As referred to Section 2.1, Equation 1 absolutely proves the data was realistically done using the pair-wise comparison, a manual calculation was shown as two main criteria were compared; the economy was compared to the environment criteria:

$$\frac{5+4+2+5+6+3+7}{7} = 4.5714 \; (marked\ in\ Table\ 2) \tag{7}$$

Where the average of criteria intensity = $A$; number of respondents, $n$ = 7; number of criteria, $a_i$ = 4; intensity of scale (1-9) denoted as $x$; $n$ represented as respondent = $x_n$. As an early result, economy was 4.5714 more important compared to the environment. Then, the environment was compared to the economy and calculated as follows:

$$\frac{1}{4.5714} = 0.2188 \tag{8}$$

The environment criterion was 0.2188 important compared to the economy.

### 3.2. Step 2: Build a set of pair-wise comparison matrices

All the main criteria applied the calculation from Section 2.1, Equation 1. It also applied the same steps as shown in Stage 3. As referred to Equation 2, the weights of the main criteria were computed as follows:

### 3.3. Step 3: Calculated weight values of criteria and sub-criteria

The priority vector for the main criteria was sum for each column of the reciprocal matrix for the economy, safety, environment and technology:

Then, each element of the matrix was divided by the sum of its column and obtains normalized relative weight. The sum of each column was 1. For example, the main criteria of environment:

$$\frac{Weight\ of\ main\ criteria}{Sum\ of\ environment} = normalized\ relative\ weight\ of\ main\ criteria \quad (9)$$

Then, the normalized relative weight of the main criteria was calculated as follows:

$$\frac{0.2188}{1.7164} = 0.1275 \quad (10)$$

Other normalized relative weights of main criteria were computed in Table 4 as follow:

The weight values of all the main criteria are determined using Equation 3. Given the criterion 'Economy' as an example, the weight value is computed as follows:

$$W_k = \frac{(0.5826 + 0.6177 + 0.5669 + 0.5397)}{4} = 0.5767 \quad (11)$$

The same calculation formula is applied to assess the other criterion. By averaging across the rows in Table 5, the Normalized Principal Eigenvector or weight value of the main criteria was obtained as follows:

Legends: NOC = Number of Criterion, $W_k$ = Weight value, NPE = Normalized principal Eigenvector

### 3.4. Step 4: Test the consistency of all comparison matrices

As referred to Equation 4, the average of Normalized Principal Eigenvector was calculated to obtain the maximum eigenvalues, $\lambda_{max}$ as follows:

Then, sum all the consistency measure of each criterion; each row from Table 6. The value of $\lambda_{max}$ is obtained from as follows:

$$\frac{4.0268 + 4.0125 + 4.0008 + 4.0104}{4} = 4.0126 \quad (12)$$

The Consistency index CI was obtained by applying Equation 5 as below:

$$CI = \frac{\lambda_{max} - n}{n - 1} = \frac{4.0126 - 4}{4 - 1} = 0.0042 \quad (13)$$

The suitable value of the Random Consistency Ratio $RI$ is obtained from Table 1; $RI$ = 0.9, matrix size of four of pairwise criterion. The calculation of the Consistency Ratio $CR$, as referred to Equation 7 is shown as follows:

$$\frac{CI}{RI} = CR\ then\ applies\ to\ calculate \quad (14)$$

$$\frac{0.0042}{0.9} = 0.0046\ equal\ to\ 0.46\%`10\%,\ which\ is\ consistent.$$

Consistency Ratio = 0.0046 or 0.46%, $CI$ = 0.0042, Principal Eigenvalue, $\lambda_{max}$ = 4.0126.

### Step 5: Rank or aggregate the final priorities of the main criteria and sub-criteria

Each of the main criteria and sub-criteria were ranked based on the value of Normalized Principal Eigenvector. The Normalized Principal Eigenvector could be converted to a percentage by multiplying 100%. The weight of the Normalized Principal Eigenvector reflected the rank of the criteria such higher value means more prioritised to the higher rank.

According to the result in Table 8, the influential factors of the feeder service development in Malaysia are orderly arranged with the first rank was economy (0.5767), followed by safety (0.1923); the environment was ranked third (0.1249); finally, technology was ranked the fourth (0.1061). The Consistency Ratio was 0.0046 which confirmed that the results of the survey were consistent and reliable.

Then, all of the sub criteria calculated using the similar steps and computed in Table 9, 10, 11, and 12. Then, the new weights or normalised weighting vectors of all the sub-criteria are calculated after obtaining the weighting vector values of all the main criteria and sub-criteria. The purpose of this calculation is to obtain the normalised weighting vector values of the evaluation criteria by multiplying the weighting vector value of each sub-criterion in the specific group with the weighting vector value of the main criteria of the group. Referring to the groups of Economy and Environment as examples, the normalised weighting vector $w(S_{vc}T_mC_{sc}M_tM_c)$ values of all the sub-criteria in this group were obtained as follows:

Sub-criteria Economy:

$$w(S_{vc}T_mC_{sc}M_tM_c) = \begin{array}{c} SVC \\ TM \\ CST \\ MT \\ MC \end{array} \begin{pmatrix} 0.3674 \\ 0.1313 \\ 0.0859 \\ 0.3330 \\ 0.0825 \end{pmatrix} (w(S_{vc}T_mC_{sc}M_tM_c)) =$$

$$= w(S_{vc}T_mC_{sc}M_tM_c) \cdot 0.5767 = \begin{array}{c} SVC \\ TM \\ CST \\ MT \\ MC \end{array} \begin{pmatrix} 0.3674 \\ 0.1313 \\ 0.0859 \\ 0.3330 \\ 0.0825 \end{pmatrix} \quad (15)$$

Sub-criteria Environment

Table 2: Pair-wise comparison and weights of criteria

| Main Criteria | Economy | Safety | Environment | Technology |
|---|---|---|---|---|
| Economy | 1.0000 | 3.4286 | $x_{ij} = 4.5714$ | 4.8571 |
| Safety | 0.2917 | 1.0000 | 1.7143 | 1.8571 |
| Environment | $\frac{1}{x_{ij}} = \frac{1}{4.5714} = 0.2188$ | 0.5833 | 1.0000 | 1.2857 |
| Technology | 0.2059 | 0.5385 | 0.7778 | 1.0000 |

Table 3: Sum of pair-wise comparison

| Main Criteria | Economy | Safety | Environment | Technology |
|---|---|---|---|---|
| Economy | 1.0000 | 3.4286 | 4.5714 | 4.8571 |
| Safety | 0.2917 | 1.0000 | 1.7143 | 1.8571 |
| Environment | 0.2188 | 0.5833 | 1.0000 | 1.2857 |
| Technology | 0.2059 | 0.5385 | 0.7778 | 1.0000 |
| SUM | 1.7164 | 5.5504 | 8.0635 | 8.9999 |

Table 4: Normalized relative weight

| Main Criteria | Economy | Safety | Environment | Technology |
|---|---|---|---|---|
| Economy | 1/1.7164 = 0.5826 | 3.4286/5.5504 = 0.6177 | 4.5714/8.0635 = 0.5669 | 4.8571/8.9999 = 0.5397 |
| Safety | 0.2917/1.7164 = 0.1699 | 1.0000/5.5504 = 0.1802 | 1.7143/8.0635 = 0.2126 | 1.8571/8.9999 = 0.2063 |
| Environment | 0.2188/1.7164 = 0.1275 | 0.5833/5.5504 = 0.1051 | 1.0000/8.0635 = 0.1240 | 1.2857/8.9999 = 0.1429 |
| Technology | 0.2059/1.7164 = 0.1200 | 0.5385/5.5504 = 0.0970 | 0.7778/8.0635 = 0.0965 | 1.0000/8.9999 = 0.1111 |
| SUM | 1 | 1 | 1 | 1 |

Table 5: The weight value of evaluation criteria

| Economy | Safety | Environment | Technology | Total $W_k/NOC$ | NPE |
|---|---|---|---|---|---|
| 0.5826 + | 0.6177 + | 0.5669 + | 0.5397 + | 2.3069/4 | 0.5767 |
| 0.1699 | 0.1802 | 0.2126 | 0.2063 | 0.7690/4 | 0.1923 |
| 0.1275 | 0.1051 | 0.1240 | 0.1429 | 0.4995/4 | 0.1249 |
| 0.1200 | 0.0970 | 0.0965 | 0.1111 | 0.4246/4 | 0.1061 |
| SUM | 1 | 1 | 1 | 1 | |

$$w(L_{oap}I_{inf}G_{eop}D_{rft}) = \begin{array}{c} LOAP \\ INF \\ GEOP \\ DRFT \end{array} \begin{pmatrix} 0.1016 \\ 0.4334 \\ 0.1712 \\ 0.2938 \end{pmatrix} (w(L_{oap}I_{inf}G_{eop}D_{rft}))$$

$$= w(L_{oap}I_{inf}G_{eop}D_{rft}) \cdot 0.1249 = \begin{array}{c} LOAP \\ INF \\ GEOP \\ DRFT \end{array} \begin{pmatrix} 0.0127 \\ 0.0541 \\ 0.0214 \\ 0.0367 \end{pmatrix} \quad (16)$$

Legends: M-C = Main-criteria, sub-criteria = SC, Normalized Principal Eigenvector = NPE, Sub-Criteria Rank = SCR, O = Overall, Rank = R, CI = Consistency Index, CR = Consistency Ratio. The abbreviation of sub-criteria can refer to Section 3.3, Stage 2.

The weighting vector values of all the 18 sub-criteria in level two can be summarized as follows:

$S_{VC} = 0.2115$
$M_T = 0.1917$
$T_M = 0.0756$,
$R_P = 0.0557$
$I_{NF} = 0.0541$
$C_{ST} = 0.0495$
$M_C = 0.0475$
$I_{NV} = 0.0470$
$S_{/I} = 0.0418$
$V_{TMIS} = 0.0392$
$D_{RFT} = 0.0367$
$S_{OP} = 0.0320$
$S_{PD} = 0.0252$
$L_{\&P} = 0.0236$
$G_{EOP} = 0.0211$
$I_{FE} = 0.0128$
$L_{OAP} = 0.0127$

## 4. Results And Discussion

As referred to Tables 8 and 9, 10, 11, and 12, the main criteria of economy (0.5767) was positioned as the first rank of the main criteria while the service (0.2115) was the highest rank among the eighteen sub-criteria. Therefore, the service of the feeder operators itself is the most important factor which influences the feeder development. The efficiency of service could attract and retain the loyalty of the shipper and the cargo owner in the long term of business (Shipping, 2016). The market is the second highest Normalized Principal Eigenvector, it was derived from shipper nor charterer and cargo owner demand; it absolutely created competition between the companies to offer lower rates of freight rate combined with the finest service provided (Westport, 2012). If the demand increases, the company could not immediately buy new ships to overcome the problem. As a short term solution, the company would strive to have more frequent service by setting up the efficient schedule to increase the vessel movement from port to port ((Syarikat Perkapalan Dai Zhun , 2016). The well huge established company used the strategic planning by merging or buying the smaller company which can also influence the feeder market (Shipping, 2016). Somehow, other companies could apply a joint venture strategy or have a contract of agreement for certain trans-shipment. The concept of cooperation or helping each other has been implemented among the players (Westport, 2012). Although it could build pressure to the small company, but this is how they survive in terms of the freight rate competition (Syarikat Perkapalan Dai Zhun , 2016).

Table 6: Calculation process of maximum eigenvalues

| Main Criteria | Economy | Safety | Environment | Technology | Consistency Measure |
|---|---|---|---|---|---|
| Economy | 1.0000 x 0.5767 = 0.5767 | 3.4286 x 0.1923 = 0.6593 | 4.5714 x 0.1249 = 0.5710 | 4.8571 x 0.1061 = 0.5153 | 2.3223 / 0.5767 = 4.0268 |
| Safety | 0.2917 x 0.5767 = 0.1682 | 1.0000 x 0.1923 = 0.1923 | 1.7143 x 0.1249 = 0.2141 | 1.8571 x 0.1061 = 0.1970 | 0.7716 / 0.1923 = 4.0125 |
| Environment | 0.2188 x 0.5767 = 0.1262 | 0.5833 x 0.1923 = 0.1122 | 1.0000 x 0.1249 = 0.1249 | 1.2857 x 0.1061 = 0.1364 | 0.4997 / 0.1249 = 4.0008 |
| Technology | 0.2059 x 0.5767 = 0.1187 | 0.5385 x 0.1923 = 0.1036 | 0.7778 x 0.1249 = 0.0971 | 1.000 x 0.1061 = 0.1061 | 0.4255 / 0.1061 = 4.0104 |
| | | | | SUM | 16.0505 |

Table 7: Pair-wise comparison of the weight criteria with Normalized Principal Eigenvector

| Main Criteria | Economy | Safety | Environment | Technology | Normalized Principal Eigenvector |
|---|---|---|---|---|---|
| Economy | 1.0000 | 3.4286 | 4.5714 | 4.8571 | 0.5767 |
| Safety | 0.2917 | 1.0000 | 1.7143 | 1.8571 | 0.1923 |
| Environment | 0.2188 | 0.5833 | 1.0000 | 1.2857 | 0.1249 |
| Technology | 0.2059 | 0.5385 | 0.7778 | 1.0000 | 0.1061 |

Table 8: The Percentage Values of the Normalized Principal Eigenvector

| Main Criteria | Normalized Principal Eigenvector | Principal Eigenvector in Percentage Values | Rank |
|---|---|---|---|
| Economy | 0.5767 | 57.67% | 1 |
| Safety | 0.1923 | 19.23% | 2 |
| Environment | 0.1249 | 12.49% | 3 |
| Technology | 0.1061 | 10.61% | 4 |

The safety criterion (0.1923) has positioned at number 2. Generally, one of the important factors is survey and inspection that need to be conduct regularly. The feeder company also needs to be aware of the aspect of maintenance and quality of the vessel for each sailing period (Syarikat Perkapalan Dai Zhun , 2016). The safety of the ship, crews, and cargo contribute to the seaworthiness of the voyage and can minimize the losses caused by an accident resulting from irregular maintenance and machine failure which delayed the cargo delivery (Shipping, 2016). Standard operating procedure and route planning both ensured the crews follow the guidelines by not taking their own risk on operational wise and also ensure the passage is safe in the aspects of technical and environmental factors. Law and policy are established and acceptable regulation is used to protect the feeder company. The cabotage policy had secured the Malaysian domestic trades from involvement of foreign companies. The environment (0.1249) became the third ranked main criteria, it is also considered as a catalyst to the growth of other main criteria. Peninsular Malaysia seems to have the geographical advantage of being located alongside the Straits of Malacca (Abdul Rahman et al., 2014). This potential benefit assists along the growth of the feeder service. By listing in the top 20 busiest ports in the world, the function of ports such Port Klang and Port of Tanjung Pelepas (PTP) are growing in numbers of container loads helps the local feeder service providers to increase their profitability by frequent services. Then, less of air pollutants such as Carbon Monoxide, Sulphur Dioxide that harm the living things, has made the feeder service become the choice of cargo transportation using waterways compared to the other mode of transportation.

The main criteria technology (0.1061) was positioned at fourth. It is important to develop the shipping industries by having good incentives or investment in terms of research and development. The improvement of engine technology is an example to reduce the cost elements such as optimising the ship fuel consumption. The short distance cargo delivery would incur higher cost compared to long distance service (Shipping, 2016). The size of vessel equivalent to the engine and thrust propulsion also could minimize the cost generated by the fuel consumption. Currently, the feeder operators have deployed a suitable vessel's size in terms of carrying capacity to be operated within the Intra-Asia port waterway (Syarikat Perkapalan Dai Zhun , 2016). Some of the shipping companies have as strategy to buy a larger vessel compared to the common type, but it is still not profitable because of certain ports required a specific feeder's draft and size to be entered (Shipping, 2016).

## 5. Conclusions

In the nutshell, the criteria and sub-criteria have been ranked accordingly based on the expert's judgement, Arithmetic Mean and Analytic Hierarchy Process. The outcomes of this study provide alertness to the feeder operators to enhance their performance based on the analysis of the influential factor on feeder development in Malaysia. The economy criterion has become the main factor while the criterion of service efficiency (Svc) has been ranked as the first in the overall analysis. In Malaysia, excellence of service is the key of feeder players to remain competitive in the industry. Good quality of service attracts and remains loyal customers, which contribute toward consistent of the company profitability (Westport, 2012). A good profit margin per annum could enhance the controlling power of the feeder operator in the market where they can buy a number of new ships, offer lower freight charges, buy a small shipping company, and offer chartering service (Westport, 2012). The service efficiency also can be improved from the perspective of on-time delivery of containers to customers, excellent of cargoes secured, reasonable freight charges, and others aspects which can be further studied in detail. In addition, the proposed model can be used by academician and industrial players regarding to their test case.

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Table 9: Priority order of sub-criteria economy

| M-C | SC | Svc | Tm | Cst | Mt | Mc | SCNPE | SCR | ONPE | OR |
|---|---|---|---|---|---|---|---|---|---|---|
| Economy (0.5767) | Svc | 1.0000 | 4.4000 | 5.1250 | 0.8181 | 4.4000 | 0.3674 | 1 | 0.2115 | 1 |
| | Tm | 0.2273 | 1.0000 | 2.8333 | 0.2759 | 2.0000 | 0.1313 | 3 | 0.0756 | 3 |
| | Cst | 0.1951 | 0.3529 | 1.0000 | 0.2273 | 2.0000 | 0.0859 | 4 | 0.0495 | 6 |
| | Mt | 1.2222 | 3.6250 | 4.4000 | 1.0000 | 2.2500 | 0.3330 | 2 | 0.1917 | 2 |
| | Mc | 0.2273 | 0.5000 | 0.5000 | 0.4444 | 1.0000 | 0.0825 | 5 | 0.0475 | 7 |
| | CR = 0.0054, CI = 0.0857, Principal Eigenvalue, $\lambda_{max}$ = 5.3430 | | | | | | | | | |

Table 10: Priority order of sub-criteria safety

| | SC | S/i | Vtmis | Sop | Rp | L&P | SCNPE | SCR | ONPE | OR |
|---|---|---|---|---|---|---|---|---|---|---|
| Safety (0.1923) | S/i | 1.0000 | 1.2222 | 1.2222 | 0.7500 | 1.6667 | 0.2171 | 2 | 0.0418 | 9 |
| | Vtmis | 0.8182 | 1.0000 | 1.3333 | 0.6000 | 2.0000 | 0.2037 | 3 | 0.0391 | 10 |
| | Sop | 0.8182 | 0.7500 | 1.0000 | 0.6000 | 1.3333 | 0.1664 | 4 | 0.0320 | 12 |
| | Rp | 1.3333 | 1.6667 | 1.6667 | 1.0000 | 2.1250 | 0.2898 | 1 | 0.0558 | 4 |
| | L&P | 0.6000 | 0.5000 | 0.7500 | 0.4706 | 1.0000 | 0.1230 | 5 | 0.0236 | 14 |
| | CR = 0.0003, CI = 0.0054, Principal Eigenvalue, $\lambda_{max}$ = 5.0125 | | | | | | | | | |

Table 11: Priority order of sub-criteria environment

| | SC | Loap | Inf | Geop | Drft | SCNPE | SCR | ONPE | OR |
|---|---|---|---|---|---|---|---|---|---|
| Environment (0.1249) | Loap | 1.0000 | 0.3200 | 0.4375 | 0.3200 | 0.1016 | 4 | 0.0127 | 18 |
| | Inf | 3.1250 | 1.0000 | 3.0000 | 1.7500 | 0.4334 | 1 | 0.0541 | 5 |
| | Geop | 2.2857 | 0.3333 | 1.0000 | 0.5000 | 0.1712 | 3 | 0.0214 | 15 |
| | Drft | 3.1250 | 0.5714 | 2.0000 | 1.0000 | 0.2938 | 2 | 0.0367 | 11 |
| | CR = 0.0258, CI = 0.0232, Principal Eigenvalue, $\lambda_{max}$ = 4.0697 | | | | | | | | |

Table 12: Priority order of sub-criteria technology

| | SC | Ife | Inv | Spd | Cc | SCNPE | SCR | ONPE | OR |
|---|---|---|---|---|---|---|---|---|---|
| Technology (0.1061) | Ife | 1.0000 | 0.3103 | 0.6000 | 0.5000 | 0.1206 | 4 | 0.0128 | 17 |
| | Inv | 3.2222 | 1.0000 | 2.8333 | 1.8000 | 0.4433 | 1 | 0.0470 | 8 |
| | Spd | 1.6667 | 0.3529 | 1.0000 | 2.0000 | 0.2376 | 2 | 0.0252 | 13 |
| | Cc | 2.0000 | 0.5556 | 0.5000 | 1.0000 | 0.1985 | 3 | 0.0211 | 16 |
| | CR = 0.0534, CI = 0.0484, Principal Eigenvalue, $\lambda_{max}$ = 4.1441 | | | | | | | | |


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