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LOCATION DETERMINATION WITH ASSIGNMENT METHOD IN DESIGN SEAWEED SUPPLY CHAIN

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Abstract

Assignment methods are widely used to determine the suitability of several supply and demand choices if the availability of each option is one. Property owned by the assignment method can also be used to determine the suitability of the location of the placement that has resources with its production capabilities, so that the assignment method can be used to determine the exact location adapted to the capabilities of the location. This study aims to obtain an industrial location in accordance with the capabilities of the industry in an area consisting of four locations, which have the ability to be a location of agriculture (plant), processor (producer), basic materials (distributors), and finished products (main industry). Industry capability is measured by factors that influence the success of the supply chain, namely: procurement cycle, manufacturing cycle, replenishment cycle, customer order cycle. Each location has advantages and disadvantages to carry out industrial activities, in order to obtain information on the advantages of each location, weighting is done using the Analytical Hierarchy Process (AHP). After obtaining the next weight, determining the location is predicted to have a strong preference to be used as an area for the development of the seaweed commodity industry, by obtaining the maximum amount of weight from the four observation locations, using the assignment method. Results of this research showed that in supplier side and the producer side, the quality dimension must be emphasized on the performance. Meanwhile, in the distributor have to focused on performance of excellence in packaging, likewise, in the main industry, the conformance aspect is the main focus where the main industry is able to follow the schedule made by consumer.

Keywords: AHP, Assignment method, Location, Supply chain design.

1. Introduction

Placement of resources at a location is the beginning of efforts to increase the productivity of an industrial area. An area that has natural resources is also required to have the ability to convert these resources, into forms that have added value. The strategy to get a suitable location to place a location based on the resources and capabilities possessed is the phenomenon of placing supply and demand appropriately. Supply can be seen as a resource that is owned by a location, and demand is an industrial potential to process the resources owned. Attention to the phenomenon of placing the resources owned by a location to the ability of the industry, is a problem of placing the capacity of an industry to the ability of the processing industry owned by several regions in an area to form a supply chain, is a characteristic that can be solved by the method of assignment. In this study an area will be observed, the development of the seaweed industry consisting of four locations called A, B, C, and D. The four locations already have an initial processing industry, which requires further development, especially with regard to determining which areas are the location of the supplier (supplier), the location of the industry producing the basic ingredients of food, medicine, and cosmetics (producer), the location of the industry collecting the basic ingredients (distributors), and the industry that utilizes the basic ingredients from seaweed into food, medicine, and cosmetics (main industry), which will be linked into a supply chain.

The development of research that utilizes the assignment method is divided into two major parts, namely: improvement of the method and application. The development of the first assignment method research was the application of traveling salesmen [1], which resulted in a new revised one’s assignment method approach, in which traveling salesmen displayed conditional constraints in the form of changes in direction of travel, without changing travel time. The search for the shortest route from a traveling salesman with regard to intuition, so that the algorithm of the assignment method to determine the condition constraints is done with a fuzzy approach [2]. A balanced assignment method was developed using a combinatorial optimization to get the shortest route, with the constraint that on the supply and demand side there is a limited allocation of resources, which is similar to the transportation method problem [3].

Some research that utilizes the assignment method was carried out by Akpan and Abraham [2], which applied the determination of workers' skills to a decent job using Hungarian techniques. Zavlanos et al. [4] which applies the technique of distributed auction algorithm to the assignment method, to get the ability to communicate the tasks that must be carried out by an agent, is different from Idriss and Hussein [5] who uses linear programming techniques to place workers on proper tasks. Chen [6] applies fuzzy techniques to the assignment method, in order to deal with multi-criteria factors that influence decision making. Won and Kim [7] conducted a study to determine the formation of machine cells against multiple process routes, while Bokal et al. [8] carried out a combination of Hungarian and Hall theory on assignment methods to detect sensor networks.

The problem of determining the location in an industrial development area, needs to pay attention to the distribution of concentration of industrial capacity [9]. So that there is an economic balance and public welfare. In this study the location division is based on location concentration, based on the ability of the initial industry and the readiness of the government and the local community, in the form of the availability of seaweed farming (plant), the availability of the initial processing industry from seaweed (producer), the availability of the food processing industry, medicine and cosmetics (distributors), as well as the presence of the main industries producing food, medicine and cosmetics (main industry) that utilize the basic ingredients processed by seaweed. Furthermore, in order to create an economic balance, it is important to form a supply chain pathway [10]. Based on the capability of the industry and the location capacity it has an assessment of industry capacity is based on industry capacity including performance [11], revenue [12] and services [13] owned by the government, the community, and industry players in a location. Noting this phenomenon, the decision making on the feasibility of an area, to become the location of a plant, producer, distributor and main industry, is highly dependent on the multi-criteria preferences of stakeholders involved in seaweed commodities, so this research will use Analytical Hierarchy Process (AHP), to get the preference weight [14] which is the main input for the assignment method. Noting the phenomena that have been described, the research will focus on determining the location of industries that have a supply chain network by utilizing the relationship that exists between the AHP method and the assignment method.

2. Theory

2.1. Assignment method

Assignment method, also called Hungarian method, is a method used to solve problems related to optimal allocation of various productive resources. The method is a combinational algorithm for optimization to find the optimal solution to the personnel assignment problems. This algorithm is named the Hungarian Method in honour of two Hungarian mathematicians, namely Knig and Jenı Egerváry. The Hungarian method modifies rows and columns in the effectiveness matrix until a single zero component appears in each row or column that can be selected as the assignment allocation. All assignment allocations made are optimal allocations, and when applied to the initial effectiveness matrix, it will provide the most minimum assignment results [15].

There are two ways of interpretations of this algorithm, namely with matrices and bipartite graphs. *A* matrix is a scalar arrangement of elements in the form of rows and columns. *A* matrix that has the size of *m* row and *n* column (*m* x *n*), is a matrix element in the nth row and nth column (shown in Equation 1) [15].

$$A = \begin{pmatrix} a_{11} & a_{12} & \cdots_{\dots} & a_{1n} \\ a_{21} & a_{22} & \cdots_{\dots} & a_{2n} \\ \cdots_{\dots} & \cdots_{\dots} & \cdots_{\dots} & \cdots_{\dots} \\ a_{n1} & a_{n2} & \cdots_{\dots} & a_{nn} \end{pmatrix} \tag{1}$$

The use of the Hungarian method (Assignment method) with a weighted matrix consists of three stages, namely the preparation of the assignment matrix/table, analysis of the feasibility of optimum determination, and matrix rearrangement. The conditions of the Hungarian method are [15-18]:

- The number of *i* must be equal to the number of j that must be performed.
- Each *i* can perform only one task.
- If the number of *i* is not equal to the number of j or vice versa, dummy variable of *i* or *j* is added.
- There are two problems that must be solved: to minimize the loss (cost, time, distance, etc.) or to maximize the profit.

The steps in using the Hungarian Method (Assignment method) algorithm for the matrix are as follows [15-18]:

- Find the element in each row in the matrix with the lowest value. Subtract all elements in that row with lowest value element.
- The element in each column with the lowest value is taken. Subtract all elements with the lowest value taken.
- Draw a line that covers all elements that have zero.
- Check:
    - if the number of lines = n, then choose the combination of the elements in the matrix that has a sum of zero.
    - if the number of lines < n, go to Step 5.
- Find the element with minimum value that is not covered by the line. Subtract the lowest value element with the elements that are not covered by other lines. Add the lowest value element with the elements that cover the vertical and horizontal line. If the subtraction yields negative value, then then lowest value element should not be subtracted. Go back to Step 3.
- Note: if the problem is to maximize, multiply the matrix C with the scalar -1.

The assignment problem requires that the number of facilities equals to the number of tasks, for example n. In this case, there will be $n!$ ways to assign a task at the facility that is based on one-to-one basis. The number of assignments is $n!$ because there are n ways to assign the first task, n - 1 to assign the second task, n - 2 to assign the third task, and so on, which the sum of it is $n\ (n-1)\ (n-2)\ ...\ (n-(n-1)) = n!$. To define the optimal assignment appropriately, some quantities are introduced, such as Cij = the cost to assign a task to j in facility i, for i, j = 1, 2, …, n. The unit of Cij can be in rupiahs, dollars, miles, hours, and others, and the unit should be appropriate with the problem. In solving the problem, the assignment is divided into two: maximizing and minimizing assignment. Maximizing assignment is used to calculate profits, while minimizing assignment is to optimize the cost, time, distance, and others. The algorithm in Hungarian method is as follows [15-18]:

- Create an assignment table. Put tasks in the row and workers (machines) in the column. The number of rows and columns must be equal to fulfil the assumption. If not, a dummy is required.
- For each row, subtract all values with the highest value (in maximizing assignment) or the lowest value (in minimizing assignment) in the row.
- Check the column. If there is no zero-value found in the column, all values in the column must be subtracted with the lowest value in the column. This is done to have at least one zero in the row.
- Check if the solution is optimum. The checking is done by drawing the vertical and horizontal lines that has zero. If the number of lines equals to the number of rows and columns, the optimum solution is obtained.

The assignment problem is a problem about assigning an object to complete the task in order to maximize the profit or minimize the cost, time, distance, and others. The assignment problem is a specific linear programming in which the resources are allocated to the activities on one-to-one basis. Thus, each resource or assignee (such as employees, machineries, or time unit) is assigned to a specific activity or task (such as a job or task, location, or event/occurrence). There is a cost of Cij spent by the employee *i* (*i*=1, 2, …, *m*) who performs the task *j* (*j*=1, 2, …, *n*), and the aim is how the task is completed to minimize the costs [15-18].

Therefore, the general mathematical model of the assignment is to maximize or minimize [16-18]:

$$min \sum_{i=1}^{m} \sum_{j=1}^{n} Cij\ Xij \tag{2}$$

$$\sum_{j=1}^{n} Xij = 1, \qquad (j = 1,2, \dots n)$$

$$\sum_{i=1}^{m} Xij = 1, \qquad (i = 1,2, \dots m)$$

The model can also be illustrated in the assignment matrix shown in Fig. 1.

SOURCE	DESTINATION				CAPACITY OF SOURCES PER PERIOD
	D1	D2	. . .	Dn	
S1	C11 X11	C12 X12	. . .	C1n X13	1
S2	C21 X21	C22 X22	. . .	C2n X2n	1
. . .	. . .	. . .	. . .	. . .	. . .
Sm	Cm1 Xm1	Cm2 Xm2	. . .	Cmn Xmn	1
PURPOSE CAPACITY PER PERIOD	t1	t2	. . .	tn	∑sj ∑tj

Fig. 1. The assignment matrix.

In this case, it applies:

- $Xi1 + Xi2 + \dots + Xin = 1$ for *i* = 1, 2 ..., *m*. It means that in each *i*, there is only one Xij having the value of 1 while the others have zero.
- $X1j + X2j + \dots + Xmj = 1$ for *j* = 1, 2 ..., *n*. It means that in each *j* there is only one Xij with the value of 1 while others are zero.
- The allocation value from the source to the location depends on the value of *Cij* and *Xij*. If the value of *Xij* is 1 or 0, the allocation value is highly dependent on *Cij*.

where, X: the unit of targeted goods, C: the contribution value of the object *i* towards the task *j*, Si: the ith source capacity, *Tj*: the jth requested location, Xij: 0 if there is no assignment, Xij: 1 if there is an assignment, Xij: the assignment from source *i* to location *j*, and Ci: measurement unit from source *i* to location *j*.

3. Research Method

This study employed a case study design to examine the supply chain of seaweed in the level of suppliers, producers, distributors, and consumers among small and medium industries. The specific aim of this study is to establish an industrial cluster as a part of developing industrial potentials in one region. This study is focused on four cycles, including procurement, manufacturing, replenishment and customer order cycle. Each performance was assessed using quality dimension including performance, features, conformance, and serviceability.

This study involved four stages in analysing the development of supply chain, including describing supply chain performance, determining quality dimension of performance, collecting data from respondents, weighting each component using AHP, and determining supply chain location with assignment method.

3.1. Description of supply chain performance

In this stage, supply chain performance was examined, and the locations designated as suppliers, producers, distributors, and consumers or main industries were determined. There were two suppliers (A1 and A1), two producers (B1 and B2), two distributors (C1 and C2), and three main industries (D1, D2, and D3) involved in this study. Table 1 shows the functions and locations in each performance.

Table 1. Functions and design components.

Performance	Location
Procurement cycle (A)	Regional supplier A1 Regional supplier A2
Manufacturing cycle (B)	Regional producer B1 Regional producer B2
Replenishment cycle (C)	Regional distributor C1 Regional distributor C2
Customer order cycle (D)	Regional main industry D1 Regional main industry D2 Regional main industry D3

3.2. Determination of quality dimension of performance

This stage was the identification of quality dimension for each performance shown in Table 1. Each element of the performance was grouped into the quality dimension (see Table 2).

Table 2. Performance quality dimension.

Quality Dimension	Factor
Performance [11-13]	Procurement cycle: The availability of raw materials (P1) Manufacturing Cycle: Production scheduling (P2) Replenishment cycle: Product packaging (P3) Customer order cycle: Order fulfilment (P4)
Conformance [11-13]	Procurement cycle: Volume of raw material volume (F1) Manufacturing Cycle: Product delivery (F2) Replenishment cycle: Product order fulfilment (F3) Customer order cycle: Product order receipt (F4)
Serviceability [11-13]	Procurement cycle: Goods delivery scheduling (S1) Manufacturing Cycle: Receipt of raw materials (S2) Replenishment cycle: Product distribution (S3) Customer order cycle: Product delivery (S4)

3.3. Data collection from respondents

A questionnaire was distributed to 40 respondents who were involved in supply chain process. The respondents were seaweed suppliers (seaweed farmers), producers (small industries that processed raw materials of seaweed into jelly sheets, jelly powder, and jelly), distributors (small industries involved in processed product packaging), and main industries (producers of main seaweed-based products, such as medicinal, pharmaceutical, and cosmetics products).

3.4. Value weighing of each component using AHP

Performance quality dimension was assessed using AHP method [18], and supply chain approach [19-21]. The assessment was assisted by Expert Choice Software version 11.

3.5. Locating the supply chain

In this stage, the best location of cluster industries was selected using assignment method [8, 18].

4. Results and Discussion

4.1. Step 1: Making hierarchical diagrams using AHP method

The first step taken in the Analytic Hierarchy Process (AHP) method is to make a hierarchy diagram. In this study, there are four hierarchy diagrams which include procurement cycle, manufacturing cycle, replenishment cycle and customer order cycle. In general, each cycle has similar process of drawing the hierarchy diagram. The diagram is illustrated from Figs. 2 until 5.

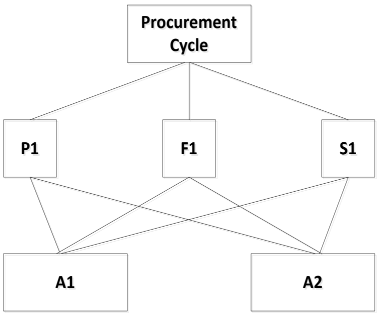

Fig. 2. AHP diagram in procurement cycle.

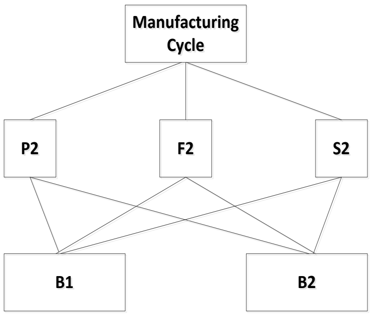

Fig. 3. AHP diagram in manufacturing cycle.

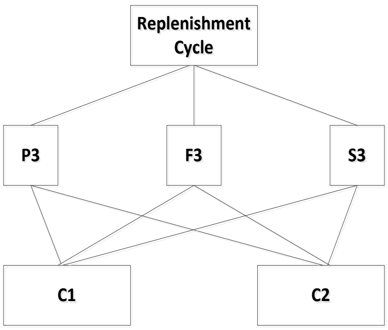

Fig. 4. AHP diagram of replenishment cycle.

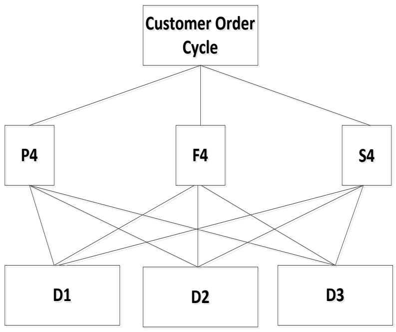

Fig. 5. AHP diagram of customer order cycle.

Figure 2 shows the hierarchical structure in three levels where the procurement cycle is the top level in the hierarchy. The second hierarchy is the quality performance dimension, which consists of raw material availability (P1), raw material volume (F1), and goods delivery schedule (S1). These three dimensions are the criteria used to make an assessment of the location of the selected supplier, and each dimension has a different value weight. The third hierarchy is the determination of the location of suppliers (A1 or A2).

Figure 3 illustrates three-level hierarchy diagram of manufacturing cycle. The first hierarchy is the manufacturing cycle, followed by the second hierarchy which includes the dimensions of performance quality of production scheduling (P2), product delivery (F2), and receipt of raw materials (S2). These dimensions are used as the criteria in the selection of the third hierarchy (producers B1 or producer B2).

Figure 4 shows that hierarchy structure of three-level diagram of replenishment cycle. The replenishment cycle is the highest level in the hierarchy. The second hierarchy is the dimensions used to determine appropriate distributors. The dimensions relate to the quality of products, which are product packaging (P3), product order fulfilment (F3), and product distribution (S3). Each dimension has a different weighted value. The third hierarchy is the selected producer (C1 and C2).

Figure 5 illustrates the three-level hierarchy diagram of customer order cycle. The cycle of customer order is the first hierarchy that needs to be achieved. The second hierarchy includes the appropriate criteria to determine and assess appropriate main industries. The criteria are order fulfilment (P4), product order receipt (F4), and product delivery (S4). Each criterion has a weighted value in assessing the industries. In the third hierarchy, there are three main industries (D1, D2 or D3) that could be selected in the cycle.

4.2. Step 2: Analysing responses using AHP analysis

The second step in this study is the analysis of responses from questionnaire using a software called Expert Choice 11. The results of the AHP analysis of procurement, manufacturing, replenishment and customer order cycle are presented in Figs. 6(a) and (b), 7(a), and (b) respectively.

Figure 6(a) shows the weighted values of supplier locations (A1 and A2). Based on the results of the analysis, supplier A2 was selected because it has the largest weighted value of 80%. In the quality dimension, the value performance of P1 (the availability of raw materials) obtains a weighted value of 61.5%, which indicates that supplier A2 has the ability to provide raw materials that are larger than supplier A1. The supplier's ability to provide raw materials becomes an important part of the supply chain design. This shows that supplier A2 is able to guarantee the availability of raw materials in the supply chain and to be a standard measurement of performance for other suppliers. In addition to this, the quality dimension of serviceability from supplier A2 is measured by the availability of raw material delivery schedules. The value of serviceability of supplier A2 ranks the second with a weighted value of 31.9%. This shows that, in addition to the ability to provide raw materials, supplier A2 is able to make a structured and scheduled delivery schedule planned with the manufacturers. Meanwhile, on the quality dimension of conformance as represented by F1, namely the volume of raw materials, supplier A2 only has a value of 6.6%, indicating that supplier A2 is able to determine or control the quantity in one order, without having to pay attention to the provisions made by producer.

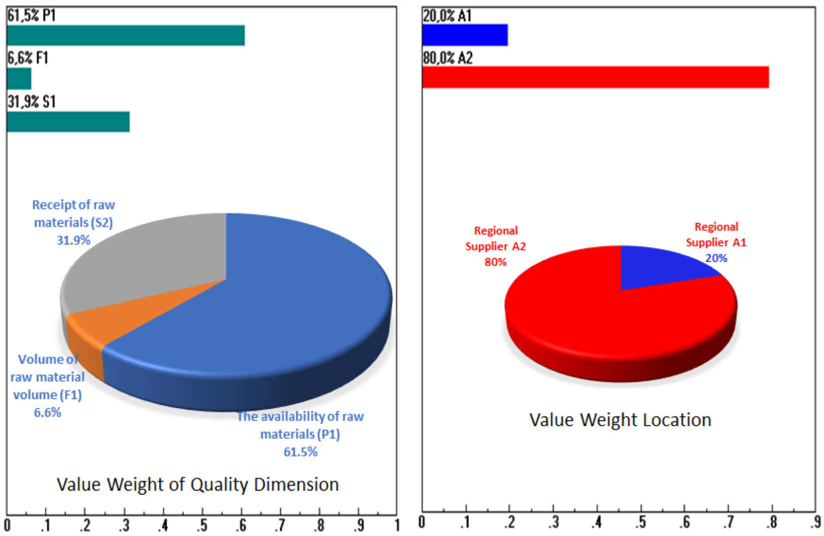

Fig. 6(a) AHP results of procurement cycle.

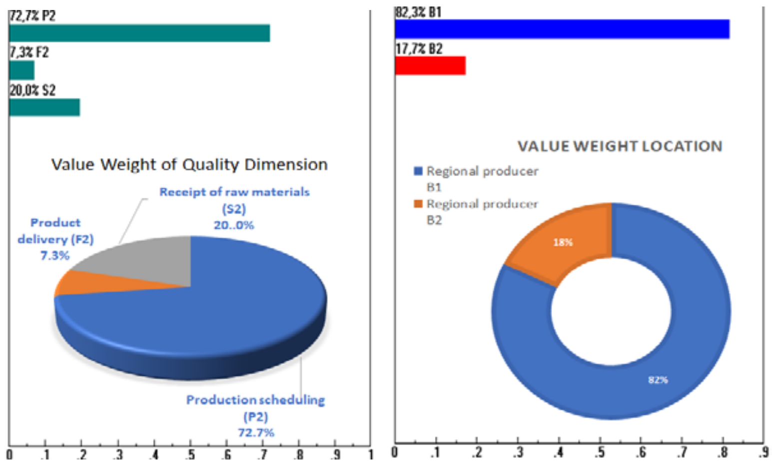

Fig. 6(b) AHP results of manufacturing cycle.

Meanwhile, the value weighting in the selection of producer (B1 and B2) is illustrated in Fig. 6(b) The results show that producer B1 has the largest weighted value of 82.3%. In the dimension of performance quality, the value of P2 (production scheduling) has a value of 72.7%. The result indicates that producer B1 has a performance measure in the form of structured production scheduling for suppliers and distributors. In addition, this result can be used as a reference for suppliers and distributors to receive raw materials and deliver products.

In the serviceability quality dimension, the receipt of raw materials has a weighted value of 20%, which indicates that the factor of the raw material acceptance is the main reference for producer B1 to provide best service for distributors. This weighting result also shows that producer B1 prioritizes service more to suppliers. The service is shown in the form of controlling the delivery schedule of finished raw materials. Meanwhile, the conformance quality dimension obtained a weighted value of 7.3%. This result shows that the delivery of finished raw materials from producer B1 is highly dependent on the schedule set by the distributors.

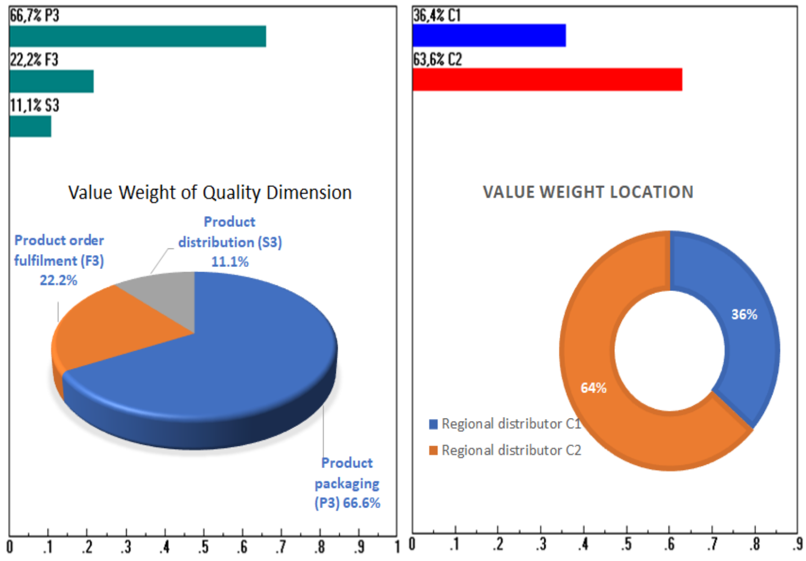

Fig. 7(a) AHP results of replenishment cycle.

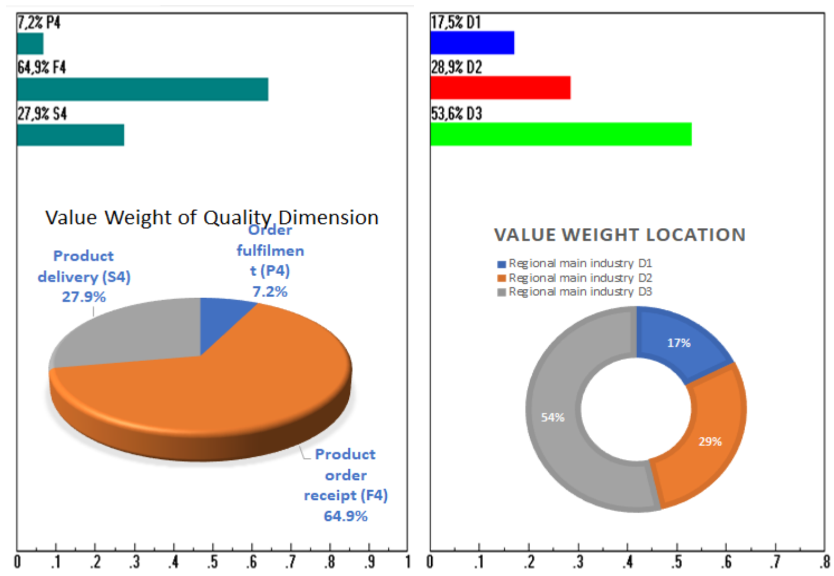

Fig. 7(b) AHP results of customer order cycle.

Figure 7(a) illustrates the value of weighting for the two distributors (C1 and C2). It shows that distributor C2 gets the highest weighted value of 63.6%. In the dimension of quality performance of distributor C2, the weighted value of P3 (product packaging) has a weight of 66.7%. This result indicates that the quality dimension of product packaging and the function of adding value to seaweed-based products are preferred by main industries. Meanwhile, in the conformance dimension, the factor of product order fulfilment weighted 22.2% indicating the distributor C2 must pay attention to the product order schedule to fulfil the needs of main industries, both in volume and in products ready to be shipped. Meanwhile, S3 the dimension of serviceability quality gets a weighted value of 11.1%. This indicates that distribution activities, such as selecting the location, route and type of vehicle must be adjusted to the demand from the main industries.

On the other hand, the results of AHP analysis on customer order cycle is shown in Fig. 7(b). Based on the value weighting of location on the three main industries (D1, D2 and D3), main industry D3 weighted the highest percentage at 53.6%. The selection of main industry D3 is supported by the evaluations on conformance dimensions, in which the factor of product order receipt (F4) weighted 64.9%. This result shows that main industry D3 must have a structured schedule to receive product orders from end consumers who will utilize processed seaweed products. Meanwhile, the serviceability dimension, particularly the factor of product delivery (S4) ranks the second with a weighted value of 27.9%. This indicates that product delivery as a form of service is highly dependent on setting the schedule of product delivery to the consumers.

Meanwhile, the quality performance dimension on order fulfilment (P4) gets a value of 7.2%, indicating that fulfilment of orders depends on the schedule desired by consumers. This implies that the main industry must have a flexible ability to follow the schedule desired by the final consumers.

4.3. Step 3: Determining the location of supply chain for seaweed industries

The third step is to determine the supply chain location for the seaweed industry, which consists of suppliers (procurement cycle), producers (manufacturing cycle), distributors (replenishment cycle), and main industries (customer order cycle). The results of value weighting in AHP are multiplied by 1,000 in order to obtain a numerical number that can be anticipated by QM Version 4.0 software.

The results of value weighing are processed using QM Version 4.0 software. The dummy value of 100 is used to fill the empty boxes in location A, B, and C (see Table 3). The assignment method aims to maximize or minimize the function [8, 21], and the method used in this study is to maximize the location function. By maximizing the location function, it is expected that the best supplier, producer, distributor, and main industry can be selected. To find out the best location, thus, the dummy value is used. The value used to maximize the function should be less than the smallest value (177). As illustrated in Table 3, some blank boxes indicated by X exist. The number of performance and location is not the same. Therefore, a dummy value in both performance and location is used to fill the empty boxes. The weighted value of replenishment cycle (364) is inserted in location column 1 and 3 while the value of replenishment cycle (636) is input in location 2 and 4. Table 4 shows the input of QM software

Table 3. The weighing value of supply chain location.

Performance	Location		
Procurement cycle (A)	A1 (200)	A2 (800)	X
Manufacturing cycle (B)	B1(823)	B2 (177)	X
Replenishment cycle (C)	C1(364)	C2 (636)	X
Customer Order cycle (D)	D1 (175)	D2 (289)	D3(536)

Table 4. Input of supply chain location.

	Location 1	Location 2	Location 3	Location 4
Supplier	200	800	100	100
Producer	823	177	100	100
Distributor	364	636	364	636
Main industry	175	289	536	100

Mathematical formulation to determine supply chain networking, on seaweed location can be performed as:

$$\begin{aligned} \text{Max} \quad : \quad & 200X_{11} + 800X_{12} + 100X_{13} + 100X_{14} \\ & 823X_{21} + 177X_{22} + 100X_{23} + 100X_{24} \\ & 354X_{31} + 636X_{32} + 364X_{33} + 535X_{24} \\ & 175X_{41} + 289X_{42} + 536X_{33} + 100X_{34} \end{aligned} \tag{3}$$

Constraint 1

Supplier : $X_{11} + X_{12} + X_{13} + X_{14} = 1$

Producer : $X_{21} + X_{22} + X_{23} + X_{24} = 1$

Distributor : $X_{31} + X_{32} + X_{23} + X_{34} = 1$

Main Industry : $X_{41} + X_{42} + X_{43} + X_{44} = 1$

Constraint 2

Location 1 : $X11 + X21 + X31 + X41 = 1$

Location 2 : $X12 + X22 + X32 + X42 = 1$

Location 3 : $X13 + X23 + X33 + X43 = 1$

Location 4 : $X14 + X24 + X34 + X44 = 1$

Constraint 3

Value : $X11 \ldots X\ 44 > 0$

Another way to produce the result of supply chain network from supplier until main industry is Hungarian method an easy way to get the final result without a complexity counting, but we cannot find an optimal one. Another advantage from Hungarian method, we can produce alternative supply chain network immediately than linear programming.

The results of data processing input using QM software in Table 4 is presented in Table 5.

Table 5 illustrates the data processing results from QM software. The results show that the supply chain networking is assigned to supplier S2, producer P1, distributor D2, and main industry M3. Figure 8 give a description about the supply chain network on seaweed problem.

Table 5. Result of supply chain networking.

Optimal solution value = $2795	Location 1	Location 2	Location 3	Location 4
Supplier (S)	200	**Assign 800**	100	100
Producer (P)	**Assign 823**	177	100	100
Distributor (D)	364	636	364	**Assign 636**
Main industry (M)	175	289	**Assign 536**	100

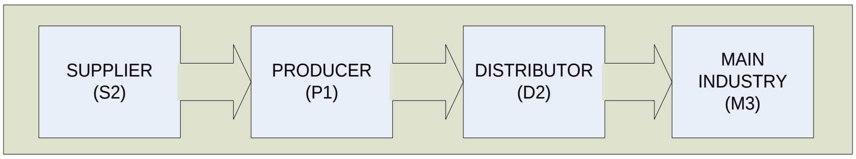

Fig. 8. Supply chain network.

The other alternatives for seaweed supply chain that considered can be applied in this research are delivered in Table 6.

Table 6. Supply chain alternatives.

Alternative	Supply Chain Network Scheme
1.	S1→ P3 → D2 → M4
2.	S3 → P4 → D1 → M2
3.	S4 → P2 → D3 → M1

5. Conclusions

In the supply chain design, the ability of each party to demonstrate performance in the industrial era 4.0 becomes an advantage. The results of this study show that on the supplier side, the main concern of the quality dimension must be emphasized on the performance aspects by taking into account the sustainability of the raw material availability. On the producer side, the quality dimension must be emphasized on the performance aspect, where the producer must have a structured schedule of receiving raw materials and delivering a product as a factor that must be considered. Meanwhile, in the distributor performance, excellence in packaging and additional product functions is still the main concern. Likewise, in the main industry, the conformance aspect is the main focus where the main industry is able to follow the schedule made by end consumers, especially in fulfilling orders.

The results of this study also show that AHP acts as an instrument in assessing the weight of factors to determine location effectively. However, to measure the supply chain and determine maximum performance, the AHP instrument cannot be used. Therefore, the Assignment Method is used to determine the weight of the performance values of each party involved in a supply chain, from the distribution of raw materials to finished products to consumers. As a result, the seaweed supply chain process is comprehensively designed.

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