PROCEEDINGS

2015 3rd International Conference on Adaptive and Intelligent Agroindustry (ICAIA)

ICAIA 2015

August 3rd - 4th, 2015
IPB International Convention Center
Bogor, Indonesia

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Bogor Agricultural University

Bogor, Indonesia

Welcome Message from The General Chairs of ICAIA 2015

On behalf of the organizing committee, it is our pleasure to welcome you to International Conference on Adaptive and Intelligent Agroindustry, Bogor, Indonesia. This is the 3rd conference on the topic that is held by the Department of Agroindustrial Technology, Bogor Agricultural University, Indonesia.

The conference is expected to provide excellent opportunity to meet experts, to exchange information, and to strengthen the collaboration among researchers, engineers, and scholars from academia, government, and industry. In addition, the conference committee invited five renowned keynote speakers, i.e. Prof Irawadi from Bogor Agricultural University; Prof Kenneth De Jong from George Mason University, USA; Dr Yandra Arkeman from Bogor Agricultural University; and Dr Guillermo Baigorria from University of Nebraska-Lincoln, USA.

The conference committee also invited Prof Noel Lindsay from University of Adelaide, Australia; Kiyotada Hayashi from National Agricultural Research Center-Tsukuba, Japan; Prof Margareth Gfrerer from Islamic State University of Jakarta, Indonesia; Dr Barry Elsey from University of Adelaide, Australia; Dr Gajendran Kandasamy from Melbourne University, Autralia; and Imperial College London-British, Prof Allan O'Connor from University of Adelaide, Australia; Dr Wisnu Ananta Kusuma from Bogor Agricultural University ,Indonesia; and Dr Frank Neumann from University of Adelaide, Australia, as invited speakers.

This conference was organized by Department of Agroindustrial Technology, Bogor Agricultural University and Asosiasi Agroindustri Indonesia, and technically sponsored by IEEE Indonesia Section. Furthermore, it was supported by Departement of Computer Science, Bogor Agricultural University; Surfactant amd Bionegergy Research Center; PT Bogor Life Science and Technology; Indonesian Ministry of Industry; PT Pachira Distrinusa; and PT Kelola Mina Laut.

I would like to take this opportunity to express my deep appreciation to the conference’s committee members for their hard work and contribution throughout this conference. I would like to thank authors, reviewers, speakers, and session chairs for their support to participate in the Conference. Lastly, I would like to welcome you to join ICAIA 2015 and wish you all an enjoyable stay in Bogor.

Sincerely,
Dr Yandra Arkeman
General Chairs, ICAIA 2015

WELCOMING ADDRESS

Prof. Dr. Ir. Nastiti Siswi Indrasti
Head of Agroindustrial Technology Department
Faculty of Agricultural Engineering and Technology
Bogor Agricultural University

on

3rd International Conference on Adaptive and Intelligence Agroindustry (3rd ICAIA)

Bogor, August, 3 – 4, 2015

Assalamu'alaikum Warohmatullahi Wabarokatuh
In the name of Allah, the beneficent and the merciful,

Distinguish Guest, Ladies and Gentlemen
Let me first thank you all for accepting the invitation to participate in this 3rd International Conference on Adaptive and Intelligence Agroindustry (ICAIA). In particular I would like to thank Rector of IPB (Institut Pertanian Bogor/Bogor Agricultural University) Prof. Herry Suhardiyanto for supporting this event as part of the series academic event in celebrating the 52nd Anniversary of Bogor Agricultural University.

We are certainly proud to have been able to assemble this event in IPB, Bogor. The range of participants and audience at this conference is precisely something I would like to stress. Participants who followed the event more than 150 people, coming from various countries including the USA, Australia, Japan, Vietnam, Philippine, Germany and Indonesia. The main goal of the conference is to provide an effective forum for distinguished speakers, academicians, professional and practitioners coming from universities, research institutions, government agencies and industries to share or exchange their ideas, experience and recent progress in Adaptive and Intelligent Agroindustry.

The 2015 3rd International Conference on Adaptive and Intelligent Agro-industry (ICAIA) is the third forum for the presentation of new advances and research results on various topics in all aspects of innovative agro-industry that highlights the development and improvement for today and tomorrow's global need for food, energy, water and medicine. The aim of the conference is to stimulate interaction and cohesiveness among researchers in the vast areas of innovative agro-industry. Innovative Agro-industry has the ability to adapt intelligently to future global challenges, i.e. food, energy, water, and medical. Global challenges needs a new breed of Agroindustry which could produce innovative products to fulfill the needs through advanced processing technology, production systems and business strategy supported by cutting-edge information and communication technology.

The topic for this event is "Empowering Innovative Agroindustry for Natural Resources, Bioenergy and Food Sovereignty". The topics clustered into four main parts:
Track 1 : Innovative Agroindustrial and Business System Engineering

Track 2 : Frontier Approaches in Process and Bioprocess Engineering
Track 3 : Frontier Approaches in Industrial Environmental Engineering
Track 4 : Intelligent Information and Communication Technology for Adaptive Agroindustry of the Future

This event also hosts four (4) workshops: (1) Strategies for Agroindustry Development (2) LCA for Agroindustry (3) Innovation and Technopreneurship for Agroindustry and (4) Agroindustry Informatics.

Distinguish Guest, Ladies and Gentlement,
Agroindustry transforms agricultural commodities into high value-added products. Agroindustry is industry that process agricultural products to increase their value added significantly by using technology and by considering environmental aspect and sustainability. However, with changing global demand and technology advancement, innovative agroindustry is needed in order to be competitive as well as sustainable. The challenge of future agroindustry is not merely efficiency and productivity anymore, but also the challenge to appropriately apply frontier technology as well as meeting future global demands.

Agroindustry needs to deal with the application of advance technologies and cope future global issues. Current global issues which arise and expected to exist in the future are food sovereignty, renewable energy, sustainable water management and pharmacy. The ability of agro-industry to respond the future global issues and the undoubtedly substantial increase in demand in future decades will be highly dependent on the increased application of existing technologies as well as the exploitation of new and innovative technologies.

The emergence of high technology could be applied in the agro-industry are: nanotechnology, biotechnology, bioinformatics, food processing, food packaging-waste, state-of-the-art computation and many others. The aforementioned high-technology along with computation technology could greatly advance agro-industry from a traditional system into a smart-intelligent and innovative technology. Therefore, in the new millennia, adaptive-intelligent and innovative agro-industry will contribute to solutions to global problems and brings agriculture into perfection.

Hope this conference will also discuss this issue in more detail as it is an important matter for all of us. We should no more think just how to produce high value product but it is also necessarily important how to keep our live in good quality by understanding following old saying… “You do not live at once. You only die once and live every day”.

I do not to take up any more of your time with these opening remarks. Let me simply thank you once again for sharing your thoughts with us. Here’s wishing every success for the conference. May Allah bless all of us.

Thank you for your kind attention,
Wassalamu’alaikum Warohmatullahi Wabarokatuh

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AGENDA

Time	Activities
Monday, August 3rd 2015	
08.00 - 09.00	Registration
09.00 - 10.00	Opening Ceremony • Welcoming Address: Prof. Nastiti Siswi Indrasti (Head of DAT, Fateta, IPB) • Welcoming Speech Head of Bogor Regency • Conference Opening: Prof. Herry Suhardiyanto (Rector of IPB) • Opening Speech and Conference Opening : Minister of Industry Indonesia * • Launching Expose International program DAT
10.00 – 10.05	*Photo Session*
10.05 - 10.15	*Coffee break*
	Keynote Speech :
10.15 - 10.45	1. Prof Irawadi (Bogor Agricultural University, Indonesia)
	2. Prof. Kenneth De Jong (George Mason University, USA)
10. 45 - 11.30	3. Dr. Yandra Arkeman (Bogor Agricultural University, Indonesia)
11.30 – 12.00	4. Dr. Guillermo Baigorria (University of Nebraska, Lincoln, USA)
12.00 – 12.30	
12.30 – 13.30	Lunch break
	Plenary Session 1 :
13.30 – 13.50	Prof. Noel Lindsay (University of Adelaide, Australia)
13.50 – 14.10	Dr. Kiyotada Hayashi (National Agricultural Research Center, Tsukuba, Japan)
14.10 – 14.30	Prof. Margareth Gfrerer (Islamic State University of Jakarta, Indonesia)
14.30 – 14.50	Dr. Barry Elsey (University of Adelaide, Australia)
14.50 – 15.10	Ir. M. Novi Saputra (Marketing Director KML Food Group)
15.10 – 15.45	*Discussion*
15.30 – 15.45	*Coffee break*
15.45 – 18.00	Parallel session A, B and C
18.00 – 21.00	Welcome Dinner

Time	Activities
Tuesday, August 4rd 2015	
08.30 – 09.00	Registration
	Plenary Session 2 :
09.00 – 09.20	Dr. Gajendran Kandasamy (PhD in Physic, Melbourne University ; PhD in Innovation Imperial Collage, London)
09.20 – 09.40	Prof. Allan O'Connor (University of Adelaide, Australia)
09.40 – 10.00	Dr. Eng. Wisnu Ananta Kusuma, ST, MT (Bogor Agricultural University, Indonesia)
10.00 – 10.20	Dr. Frank Neumann (University of Adelaide, Australia)
10.20 – 10.45	*Discussion*
10.45 – 13.00	Parallel Session A, B and C
13.00 – 14.00	Lunch break
14.00 – 15.30	Parallel Workshop • Strategies for Agroindustry Development • LCA for Agroindustry • Innovation and Technopreneurship for Agroindustry • Agroindustrial Informatics
15.30 – 15.45	Coffee Break
15.45 – 16.15	Closing remark

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A System Analysis and Design For Selecting Chitin and Chitosan Industry Location By Using Comparative Performance Index Method

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***Abstract*— The chitin and chitosan industry development is motivated by its wide application of chitin and chitosan as biopolymer and by its potential raw material from crustacean shell which is known as waste in shrimp processing industry, to help reducing the environment pollution. Indonesia only has three establish chitin and chitosan industries, all centralized in Java Island. Non-Java location expansion is required in order to support industrialization focus of government policy. This paper presents a system analysis and design with Business Process Modeling and Notation to select best location for a new initiative of chitin and chitosan industry. Several steps for location selection formed alternatives of location by identifying selection criteria for chitin and chitosan industry, and eventually deciding the best location. The Pairwise Comparison Method was deployed in deciding the best location and supported with Comparative Performance Index Method. The computation results revealed that North Sumatera Province is the best location for a new chitin and chitosan industry.**

I. INTRODUCTION

CHITIN and chitosan are new renewable resources of polymer from crustacean shell and used widely in industrial, food, medical and agriculture. In industrial uses, chitosan are used for water treatment, waste water treatment and metal removal. In food uses, chitosan mainly used as natural preservative and edible coating for fruit, foods and meat. Chitosan give higher value for medical used. In medical needs, chitosan can be used for cosmetic, wound healing and drug delivery. In contrary, agriculture uses contribute low value from chitosan. in agricultural uses, chitosan is applied for soil conditioners, coating seed, and fungicide.

Based on its function, chitin and chitosan have a good prospect to be developed. It is also stated by Ministry of Industry Regulation No. 41 year 2010 about Strategy Map and Key Performance Indicator and Echelon 1 Ministry of Industry, that one of target for agro based industrial cluster in 2010-2015 is to increase the use of sea product waste to be functional food material and pharmaceutical/supplement e.g. gelatin and chitin and chitosan. Another government support is represented by Decision of Directorate General of Non Consumption Fisheries Product Processing and Marketing No 17 Year 2013 about General Guideline for Registration of Non Consumption Fisheries Products Handling and Processing Unit that chitin and chitosan are one of the non-consumption products which become another focus to develop.

On the other hand, Indonesia has almost 170 shrimp processing industries scattered on all over islands. They generate a typical by-product such as shrimp waste (shells and head) with estimation 300.000 tons of shrimp waste per year are generated. This huge amount of shrimp waste is potency for chitin and chitosan industrial development due to its raw material availability. Meanwhile, Indonesia has only three (3) established chitin and chitosan industries which are centralized in Java Island. This fact is contradictive with one of the goals of industrialization as stated in the Law No 3 year 2014 about Industrialization, that industrial development must be equal in all regions of Indonesia. Recalling that law, it is important to support the industrialization development of chitin and chitosan industry by locating new industry out of Java Island.

A system analysis and design for selecting a new location for chitin and chitosan industry is needed to provide a general view of a complex system. The system is approached by modeling its business process based on its activities. A business process is a collection of activities or related tasks that have a starting and ending point, as well as clearly defined

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inputs and outputs, focus on the way the activity is carried out within organization. A business process can be decomposed into several sub-processes, with specific features that together contribute the aims of basic process [3].

A research about a generic structure for business process modeling was conducted [7]. It helps to understand BPM methods as modeling method that represent processes activities. Another research about solving a location selection problem by using the Utility Additive (UTA) method as one of a Multi-Criteria Decision-Making (MCDM) tools was also conducted [5]. Another related work is how to design the decision supports model for industrial location selection based on Analytical Hierarchy Process, focused on how to determine factor priority to select industrial location [6].

The objectives of this paper are: to analyze and design the chitin and chitosan industrial development system, to identify location alternatives that are suitable for chitin and chitosan planning location, to identify the criteria for factory location selection, and determine the best location. Furthermore, problem description and methodology of this paper is described consecutively in section 2 and 3. Finally, results and discussion are provided in section 4, followed by conclusions in section 5.

II. PROBLEM DESCRIPTION

In this paper, the system analysis and design for the development of chitin and chitosan industry in Indonesia is focused on the processes of how to select the best location for industry by using a business process modelling (BPM) approach. BPM is used to represent the system. Identify, explain and decompose a business process (collection of activities) related to the system [3].

Based on objectives of this paper, there are four (4) main activities that will be discussed in the next section, which are (1) Analyzing and designing chitin and chitosan industrial development system, (2) identifying the alternative location for new chitin and chitosan industry, (3) identifying the criteria for location selection and (4) determining the best location. There are 4 general procedures for making location decisions: decide the criteria to evaluate location alternatives, identify important factors, develops location alternatives and evaluate the alternatives and make a selection [2].

III. METHODOLOGY

Business Process Model Notation (BPMN) is selected as a language to make a model of business process in location selection for new chitin and chitosan industry. The BPMN is chosen because of its ability to capture the business processes in the system development [1]. On the other hand, the primary goal of BPMN is to provide a notation that is readily understandable from analyst that create initial drafts of the processes, to the technical developers responsible to implement the technology that will perform those process and finally to stakeholder who will manage and monitor those processes. There are four step in BPMN method:

1. Identifying element systems. System consists of its inputs, outputs, stakeholder, entities, controls, roles, objectives, opportunities, threats and constraints.
2. Creating the Process Hierarchy Diagram (PHD). Process Hierarchy Diagram (PHD) is a high level diagram, which analyze the function of business as a hierarchy process. PHD consists of a set of processes and decomposition link that connect them.
3. Creating the Business Process Diagram (BPD). Business Process Diagram (BPD) is a graphic view from control flow or data flow between processes on each level of system. BPD provides a relationship among processes, workflow and stakeholder.
4. Building the Business Process Modelling Notation (BPMN). BPMN is a graphic view that represents all detailed relationship among process, sub process, workflow, stakeholder and formulation which are involved in the system.

IV. RESULTS AND DISSCUSSION

A. *Analyzing and Designing Location Selection System*

The goal of this system is deciding the best location for new chitin and chitosan industry or for expansion. To achieve that goal, the system needs three inputs: chitin and chitosan industries distribution data, criteria factor for location selection, and the value data for all criteria in each Indonesian Provinces.

Based on business process analysis, there are three (3) stakeholders with different and important roles, who are involved in this system: Secretary of General Director for Industrial Areal Development (*Sesdirjen PPI*), Head of Center of Data and Information (*Pusdatin*) and Director of Food, Marine and Fisheries Product Industries (*Dir. IMHLP*). All stakeholders are working under Minister of Industry who has the big role for industrial development in Indonesia. In this system *Dir. IMHLP* plays an important role, due to its responsibility for the development of chitin and chitosan industry. *Dir. IMHLP* cannot work individually because the system needs interaction with *Sesdirjen PPI* for determination criteria factor of location selection and with Head of *Pusdatin* for providing the data.

The system entity for selecting new location for chitin and chitosan industry is illustrated on Fig. 1.

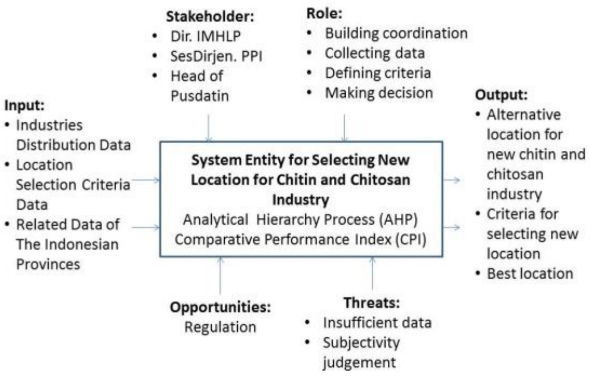

Fig. 1. System Entity for Location Selection

B. Identifying alternative location

After constructing the element system, next step is identifying alternative location. This process involves *Sesdirjen PPI* as a stakeholder who is responsible in determining alternative location. In this system, the location is focused in the province level. So, the output for this system is to determine which province in Indonesia that suitable for new chitin and chitosan industry or for expansion.

Supporting with BPMN diagram as shown in Fig. 2, there are 5 sub processes included in the process of identifying alternative location. First sub process is collecting data of all provinces in Indonesia. The second is collecting the distribution of registered chitin and chitosan industries data in all provinces in Indonesia. In the collecting data process, Data and Information Center is involved to provide the data.

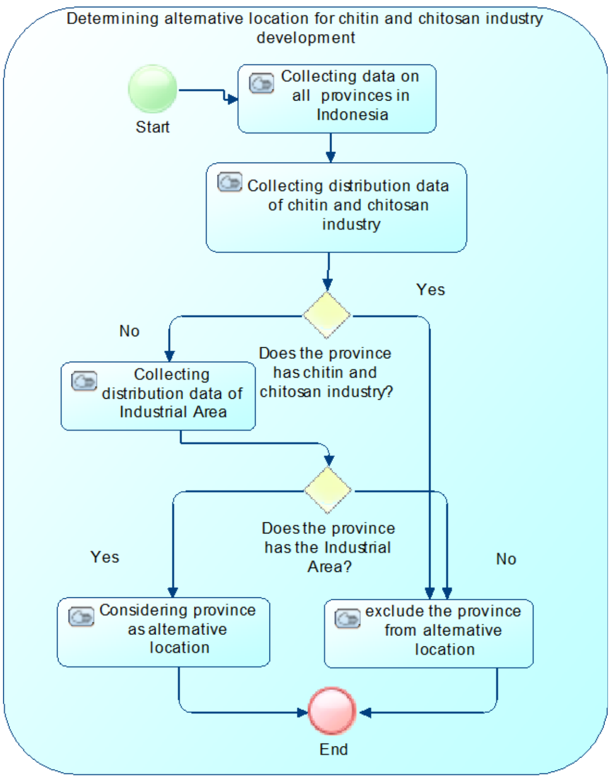

Fig. 2. Process in determining alternatives of location

There are 2 decisions making in this process. First decision is whether the province has one or more chitin and chitosan industry or not. If the answer is yes, then remove location from list of alternative location. If the answer is no, then continue the process to collect distribution data of Industrial Area location. The industrial area in this research refers to Industrial Area which has been established and still in the development planning.

The second decision is whether the province has industrial area or not. Based on Government Regulation No 24 Year 2009 about Industrial Area, Indonesian Government obliges new industry to be located inside the industrial area. Thus, province which has an Industrial Area is considered as an alternative location for new chitin and chitosan industry or expansion. Meanwhile, if the province does not have Industrial Area location, then exclude it from the list of alternative location.

Another consideration that, the alternative location is focused on decentralization industries out of Java Island, thus all provinces in Java Island is excluded from the list of alternative location. From 34 provinces in Indonesia, 28 alternative provinces are remained and then filtered again into 14 alternative provinces, which are North Sumatera, West Sumatera, Riau, Lampung, Bangka Belitung, West Kalimantan, South Kalimantan, North Sulawesi, Central Sulawesi, South Sulawesi, Southeast Sulawesi, North Maluku and West Papua.

C. Identifying the criteria for location selection

Location selection is important in industry in term of minimizing risk and maximizing profit, recalling that the location affects the fixed cost and the variable cost [4]. Selection of industrial location largely depends on many criteria, which have either direct or indirect impact on the product operation [5].

Process of identifying criteria for location selection for chitin and chitosan industry involves *Dir. IMHLP* as stakeholder. As shown in Fig. 3, the process consist 2 sub processes which are (1) determining general criteria for industrial location selection, and (2) determining criteria for chitin and chitosan industry location by using Pairwise comparison method.

Based on sub process (1), the general criteria for industrial location selection are obtained from discussion with *Sesdirjen PPI* as a responsible stakeholder. In line with it, characteristic of chitin and chitosan industry is assessed by *Dir. IMHLP* cooperated with related industrial player or industrial association. The characteristic are required in the process next subprocess of criteria selection for chitin and chitosan industry location. As shown in Figure 3, after collecting general criteria for industrial location, then move to sub process (2) to obtain important criteria by using Pairwise Comparison from expert analysis and judgment. Pairwise Comparison method is used as a step to

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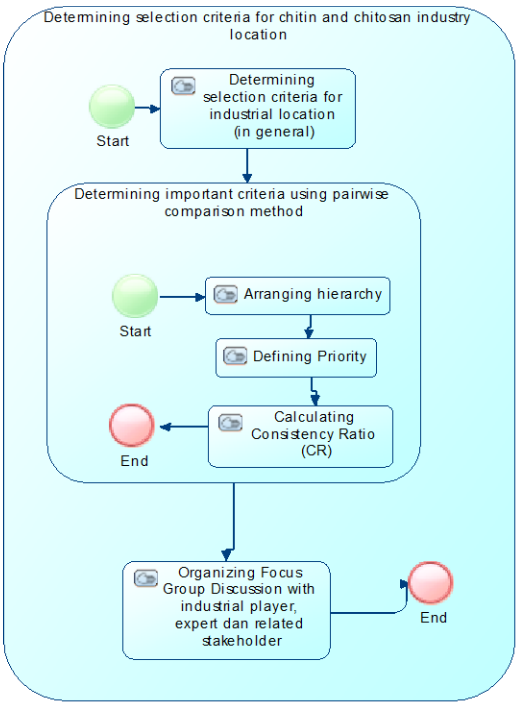

Fig. 3. Process in determining criteria for chitin and chitosan industry location

determine location factors priority and provide a rating based on qualitative factors [10].

There are 6 factors for industrial site selection, society, proximity to market, labor, availability of raw material and supplier, facility and transportation cost, and another natural resources [9]. As stated in sub process (2), steps for pairwise comparison are arranging hierarchy (Fig. 4), defining priority and calculating consistency ratio.

To define priority of criteria by pairwise comparison, Saaty Comparison Scale is used to quantify the expert judgment [8]. The comparison scale (Table I), is used by an expert as a guide to fulfill the pairwise comparison matrices (Table II).

To get the Total Priority Value (TPV), the priority value of all criteria are calculated by using the matrices manipulation with formulation 1,2,3 and 4 on the next page,

1. $$JK_j = \sum_{i=1}^{n} a_{ij}$$

2. $$b_{ij} = \frac{a_{ij}}{JK_j}$$

$$\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}$$

3. $$JBi = \sum_{j=1}^{n} b_{ij}$$

4. $$PR_i = \frac{JB_i}{n}$$

Where,

n : the number of criteria
i,j : 1,2,..., n
a_{ij} : element of pairwise matrices A, row-i column-j
JKj : the number of column-j
bij : element of new matrices, row-i column-j
JBi : the number of row-i
PRi : TPV row/criteria-i

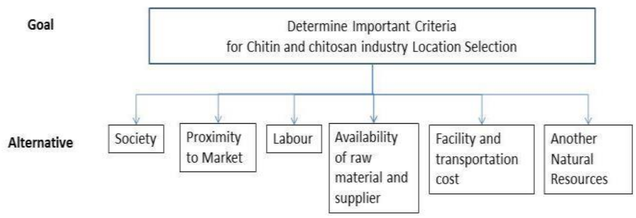

Fig. 4. Hierarchy for Pairwise Comparison

Based on formulation 1,2,3 and 4, shown the results that the dominance criteria in location selection are availability of raw material and supplier (0,325), proximity to market (0,213), labor (0,2) and facility and transportation cost (0,123).

TABLE I
Comparison Scale by Saaty

Preference Level	Definition
1	Vertical factor equal importance with horizontal factor
3	Vertical factor moderate importance compared with horizontal factor
5	Vertical factor strong importance compared with horizontal factor
7	Vertical factor very Strong importance compared with horizontal factor
9	Vertical factor extreme importance compared with horizontal factor
2,4,6,8	Uncertainty between two nearest elements
1/(2-9)	In contrary with value of 2-9

TABLE II
. Pairwise Comparison Matrices

Criteria	A	B	C	D	E	F
A. Society	1	1/3	1/3	1/4	1/3	1/3
B. Proximity to market		1	1	1/2	3	3
C. Labor			1	1/2	3	2
D. Availability of Raw Material				1	3	4
E. Facility and transportation cost					1	3
F. Other Natural Resources						1

For the next analysis, availability of raw material and supplier will be approached by the amount of shrimp processing industries who are supplying the shrimp shell as raw material. In term of proximity to market, the criteria will be approached by the amount of processing and preservation industries (fish, meat, fruit and vegetable) as potential users. In term of labor factor, will be approached based on the lowest nominal of regional minimum salary. On the other hand, facility and transportation cost criteria will be approached by the amount of

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seaports because it is related to product distribution (raw material and finished product).

D. Determining the best location

After identifying the alternative locations and criteria for chitin and chitosan industry location, next process is finding the method to select several alternative locations that fulfil most of the criteria and decide it as the best location. Comparative Performance Index (CPI) is one of Multiple Criteria Decision Making (MCDM) method that usually used to determine the best location. CPI is chosen for this analysis since the criteria for location selection have different units [8].

Process of determining the best location involves *Dir. IMHLP* as a stakeholder. The process is divided into two sub processes: homogeneous sizing value (Fig. 5), and calculating score of each criterias (Fig. 6).

Fig. 5 illustrates the steps on homogeneous sizing value process. Before move to the process, it is important to find actual data from reliable source to fulfill the value of each criteria in all provinces. Table III represents the value of 4 criteria in 14 different alternative locations.

Regarding to Fig. 5, the first step is homogeneous sizing the value of all criteria in each province. Homogeneous sizing value process consists of three stages:

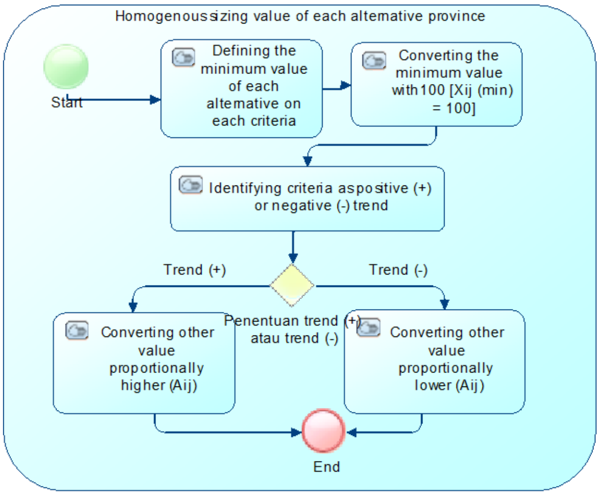

Fig. 5. Process of homogeneous sizing value

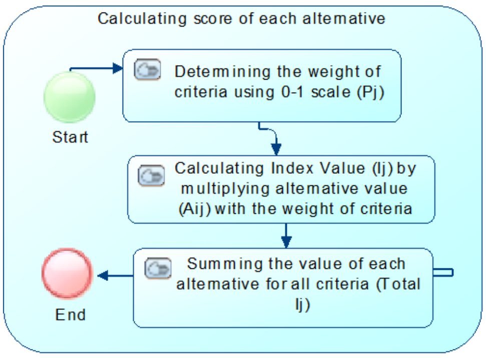

Fig. 6. Process of Score Calculation

(1) Defining minimum value of alternative in each criteria. Refers to Regional Minimum Salary (UMR) criteria in Table III, Central Sulawesi is the alternative location with minimum UMR. Meanwhile, for other criteria such as amount of processing and preservative industry (fish, meat and fruit), amount of seaport and amount of shrimp processing industry, the province that has minimum value are consecutively North Maluku (4 industries), South Kalimantan (5 seaports) and North Sulawesi (1 industries).

(2) Converting minimum value into 100. Regarding to the data in Table III, change the value of criteria 1 for Central Sulawesi, criteria 2 for North Maluku, criteria 3 for South Kalimantan and criteria 4 for North Sulawesi into 100.

(3) Identifying whether the data trend are positive or negative. Positive trend means the higher the value of alternative for each criterias, the better the value is. Whilst, negative trend means the lower the value of alternative, the better the value is. From Table III, it can be seen that alternative value for Regional Minimum Salary (UMR) criteria has negative trend, while Processing and Preservation Industry, amount of seaport and shrimp processing industry criteria have positive trend. For positive trend, convert the other value proportionally higher. In contrary, convert the other value proportionally lower. In order to obtain the homogeneous data, convert the value in Table III by using equation I and II.

$$A_{ij} = \frac{x_{ij(min)}}{x_{ij(\min)}} \text{x}100 \qquad \text{Eq. 1}$$

$$A_{i+1.j} = \frac{x_{(i+1.j)}}{x_{ij(\min)}} \text{x}100 \qquad \text{Eq. II}$$

Where,

A_{ij}	=	Alternative value –i for criteria-j
$x_{ij(min)}$	=	Alternative value –i for minimum initial criteria-j
$A_{i+1.j}$	=	Alternative value –i+1 for criteria-j
$X_{(i+1.j)}$	=	Alternative value -1+1 for initial criteria-j

After homogenous sizing the value of every criterias in every province, continue to the second sub process (Fig. 6) which is calculating the score of each alternative. Calculating score process consists of three subprocess, determining the weight of criteria, calculating Index Value and summing the value of all crteria for each alternative location

The score can be obtained after determining the weight of each criterias from pairwise comparison value and then defining Index Value by multiplying the homogenized value with the weight (Equation III). Then, the total index is obtained by adding alternative value for all criteria (Equation IV).

TABLE III
Decision Matrices for Location Selection

Alternative (i)	Criteria (j)			
	[1] Regional Minimum Salary (Upah/month)	[2] Amount of Processing and Preservation Industry (Fish, meat and fruit)	[3] Amount of seaport	[4] Amount of Shrimp Processing Industry
North Sumatera	Rp1.375.000	57	30	8
West Sumatera	Rp1.350.000	43	8	1
Riau	Rp1.400.000	12	43	1
Lampung	Rp1.150.000	16	6	4
Bangka Belitung Islands	Rp1.265.000	22	9	2
West Kalimantan	Rp1.060.000	7	7	2
South Kalimantan	Rp1.337.500	21	5	8
East Kalimantan	Rp1.752.100	13	14	9
North Sulawesi	Rp1.550.000	11	7	1
Central Sulawesi	Rp995.000	14	14	1
South Sulawesi	Rp1.440.000	7	62	11
South East Soulawesi	Rp1.125.200	8	6	1
North Maluku	Rp1.200.600	4	143	1
West Papua	Rp1.720.000	5	7	6

Source (Accessed: June 2015)
1. BPS, 2013; 2.Kemenperin.go.id; 3.gis.dephub.go.id; 4.kkp.go.id

$$I_{ij} = A_{ij} x P_j \quad \text{Eq. III}$$

$$I_i = \sum_{j=1}^{n} (I_{ij}) \quad \text{Eq. IV}$$

Where,
P_j = Weight of criteria-j
I_i = Alternative index-i
I_{ij} = Combination Criteria Index for alternative-i
i = 1,2,3,...n
j = 1,2,3,...n

Based on Eq. IV, it can be calculated which province that has the highest alternative value. Based on the final results in Table IV, the highest Index Value total is owned by North Sumatera, followed by North Maluku and South Sulawesi. Thus, North Sumatera is the best location for planning a new chitin and chitosan industry or an expansion.

This research hopefully could be used as a simple guide to capture a complex situation into simple model that understandable. System design of location selection constructed in this paper also could be applied not only for chitin and chitosan industry but also for any type of industry that needs an expansion or move to a new location. In spite of the advantages, this system needs more improvement in detailing the processes into more depth sub processes and involving more related stakeholder.

TABLE IV
Decision Matrices for Location Selection (After Transformation)

No	Alternative (i)	Criteria (j)				Index Value Total (Ii)	Rank
		Regional Minimum Salary (Salary/ month)	Amount of Processing and Preservation Industry (Fish, meat and fruit)	Amount of seaport	Amount of Shrimp Processing Industry		
1	North Sumatera	72	1.425	600	400	521,80	1
2	West Sumatera	74	1.075	160	50	279,65	4
3	Riau	71	300	860	50	200,14	7
4	Lampung	87	400	120	200	182,26	9
5	Bangka Belitung Islands	79	550	180	100	187,52	8
6	West Kalimantan	94	175	140	100	105,77	12
7	South Kalimantan	74	525	100	400	269,00	5
8	East Kalimantan	57	325	280	450	261,27	6
9	North Sulawesi	64	275	140	50	104,88	13
10	Central Sulawesi	100	350	280	50	145,24	11
11	South Sulawesi	69	175	1240	550	382,36	3
12	South East Soulawesi	88	200	120	50	91,30	14
13	North Maluku	83	100	2860	50	405,91	2
14	West Papua	58	125	140	300	152,91	10
	Weight	0,2	0,213	0,123	0,325		

V. CONCLUSION

A system approach can be used for industrial location selection. By identifying alternative locations, it can be defined fourteen provinces as alternative location. The criteria for location selection is prioritized in accordance with its level of importance and obtained 4 specific criteria for chitin and chitosan industry. Finally, North Sumatera province is chosen as the best province for new chitin and chitosan industry location.

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