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Market matching online for recommending MSME export products destination using fuzzy control

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ABSTRACT

MSME is a business group of society that does not have an integrated system like a large industry which make them difficult to access information about the location of foreign markets. This study develops Market Matching application to determine the location of foreign marketing and the type of products that must be exported to reduce the number of losses due to the congestion of turnover of goods to make it profitable for MSME. Stages to develop this market matching system are the identification and analysis of ongoing export marketing activities in MSME, designing marketing system that fits the analysis, establishing market matching system, and system implementation. This study proposes fuzzy control to determine the number of export and export market destination. Market Matching application resulted recommendation of export destination based on the types of product and level of importer need.

Keywords: Micro Small Medium Enterprises (MSME), market matching, fuzzy control, economy

INTRODUCTION

When the economic crisis occurs in the world, it will automatically worsen economic condition in Indonesia. The crisis condition hits the world in the period of 1997 to 1998. This caused the Indonesian economy getting worse and worse, but only the sector of *MSME (Micro Small Medium Enterprises)* are able to remain strong (Suci, 2017). Based on data from *Badan Pusat Statistik (BPS)* after the crisis, the number of *MSME* in Indonesia was not reduced even increased until 2012. In that year the number of *MSME* reached the percentage of 99.99%, and the remaining 0.01% was a large-scale business.

MSME is a productive business to be developed to support macro and micro economic development in Indonesia and affect other sectors, for example banking services sector.

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Currently, the export of MSME products has constraints in slow product turnover in importer countries because the product stock is not sold out soon in those countries and sometimes until it reaches the expiration limit. This is because there is no information about the development of market location and MSME competition with the same product. The lack of information on the amount of demand and supply of products in each country greatly affect the turnover of goods. For example, there are five industries with the same type of product delivering to Australia where the demand for the product is small. Without proper information the five industries only export products regardless of the availability of products in the country. Therefore, the number of products in Australia exceeds the number of request. This resulted in the accumulation of products, so the industry losses due to the lack of sales. Products with fast turnover are goods sold out in a relatively quick time. Determination of the right export market based on the criteria needed is one of the efforts made by business actors in order to increase profits and reduce losses due to the risk of delayed turnover of the products.

Considerations of the purpose of the goods export are the criteria to be taken into account. Criteria considered include: (1) financial limitations of MSME in producing commodities; (2) the difficulty in knowing the needs of the export market, (3) the difficulty of knowing the fast or slow turnover of goods in the market.

MSME become the target of this study object, because MSME is a business group of society that does not have an integrated system like a large industry. MSME are difficult to conduct surveys and market analysis by themselves, due to limited capital and human resources in the field of information technology. This study proposes fuzzy control to determine the right target market at MSME. Fuzzy control method is used to overcome the determination of a market that is influenced by the subjectivity of marketing actors. Determination of this market cannot be separated from the subjectivity and experience of MSME export marketing actors. Some target markets for the same product will elicit a complex calculation to consider which markets and countries in which the product will be distributed.

Sari et al., 2017 states that fuzzy has reasoning ability that is similar to human reasoning ability. This is because the fuzzy system has the ability to provide responses based on inaccurate, qualitative, and ambiguous information. Therefore, in this study, output will be used as consideration in deciding the export destination of goods.

RECENT STUDY

Some previous researchers have successfully executed market matching by using a variety of approaches.

Ackermann, et al. executed market matching with a stable matching approach introduced by Gale and Shapley (Ackermann et al., 2009). Stable matchings can be computed in polynomial time, but many real-life markets lack a central authority to match agents. In those markets, match behaviors are formed by actions of dynamics. The results show that coordination is necessary in two-sided markets, as well as these markets do not stabilize quickly.

Che and Tercieux study efficient and stable mechanisms in many-to-one matching markets when the number of agents is large and individuals' preferences are drawn randomly from a class of distributions allowing for both common value and idiosyncratic components (Che and Tercieux, 2013). They propose a new mechanism that is asymptotically efficient, asymptotically stable and asymptotically incentive compatible. The result of this study is the proposed mechanism is able to link matching markets efficiently and stable.

Previous study has successfully developed the application of markets matching to look for export destinations of *MSME* products (Nurdewanto et al., 2017). Market matching application is used to determine the location of overseas marketing and the types of products to be exported. Market matching application produces recommendation of export destination according to product category and level of importer requirement.

Besides using those approaches, to be more effective and efficient, an approach is needed by using artificial intelligence for market matching globally (many to many). The proposed approach is market matching using fuzzy control.

FUZZY CONTROLS

This study used fuzzy control to determine the location of foreign marketing and the types of product that must be exported. In fuzzy method, every consequence of the IF-THEN rules should be modeled with a fuzzy set with the same membership function (Sari and Mahmudy, 2015). As a result, the inference output of each rule is given explicitly. Fuzzy control has several stages, namely fuzzification, fuzzy inference engine, and defuzzification (Sari et al., 2017) shown in Figure 1.

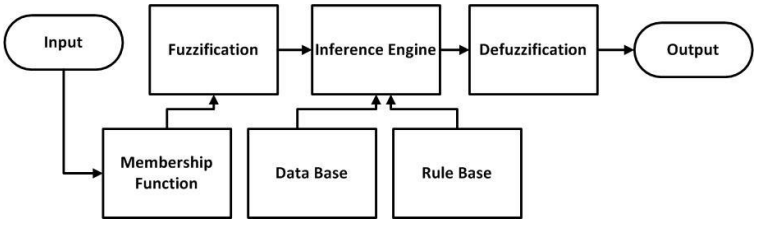

Fig. 1. Fuzzy Control's Diagram
Adapted : Sari, et al. (2016) and Farzilah, et al. (2017)

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Fuzzification

The input and output variables in fuzzy control were divided into one or more fuzzy sets (Noor and Kamal, 2017). In this process, the parameters used to determine the market were efficiently represented as input variables. The input variables used in this study were Stock, Capacity, and Competitive, while the output variable in this process was in the form of export. The fuzzy set is a unity representing a particular state in a fuzzy variable. In this process used fuzzy set of three linguistic variables which were LOW, MEDIUM, and HIGH. The formation of this fuzzy set was customized based on expert opinion. The function for determining membership value is illustrated by Triangular Fuzzy Number shown in Figure 2 (Sameer and Bakar, 2017). Membership function in each set is formulated in Eq. (1) - Eq. (10), where μ is the degree of membership and x is the object set (Sameer and Burn, 2017).

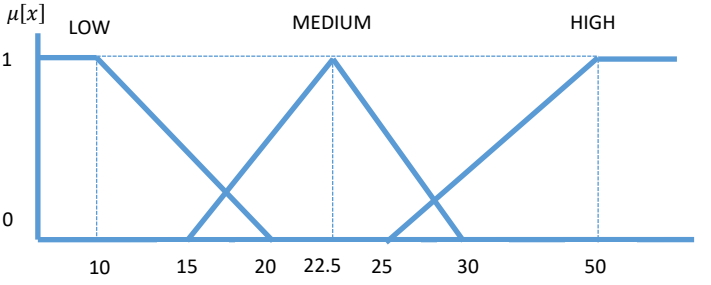

Fig. 3. Triangular fuzzy number variable input "Stock".

$$\mu StockLOW[x] = \begin{cases} 1, & x \leq 1 \\ \dfrac{20-x}{20-10}, & 10 < x < 20 \\ 0, & x \geq 20 \end{cases} \quad (1)$$

$$\mu StockMEDIUM[x] = \begin{cases} 0, & x \leq 15 \; or \; x \geq 30 \\ \dfrac{x-15}{22.5-15}, & 15 < x \leq 22.5 \\ \dfrac{30-x}{30-22.5}, & 22.5 < x < 30 \end{cases} \quad (2)$$

$$\mu StockHIGH[x] = \begin{cases} 0, & x \leq 25 \\ \dfrac{x-25}{50-25}, & 25 \leq x \leq 50 \\ 1, & x \geq 50 \end{cases} \quad (3)$$

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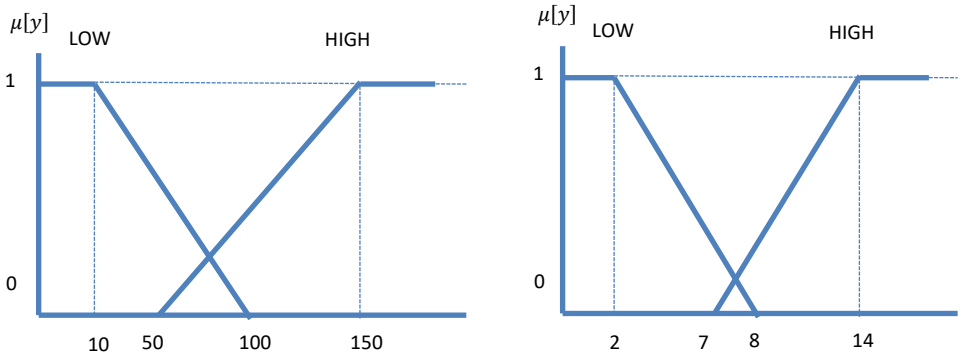

Fig. 4. Triangular fuzzy number variable input “Capacity” (left) and “Competitive” (right).

$$Low\ Capacity[y] = \begin{Bmatrix} 1, & y \le 10 \\ \dfrac{100-y}{100-10}, & 10 < y < 100 \\ 0, & y \ge 100 \end{Bmatrix} \quad (4)$$

$$\mu High\ Capacity[y] = \begin{Bmatrix} 0, & y \le 50 \\ \dfrac{y-50}{150-50}, & 50 < y < 150 \\ 1, & y \ge 150 \end{Bmatrix} \quad (5)$$

$$\mu Low\ Competitive[z] = \begin{Bmatrix} 1, & z \le 2 \\ \dfrac{8-z}{8-2}, & 2 < z < 8 \\ 0, & z \ge 8 \end{Bmatrix} \quad (6)$$

$$\mu High\ Competitive[z] = \begin{Bmatrix} 0, & z \le 7 \\ \dfrac{z-7}{14-7}, & 7 < z < 14 \\ 1, & z \ge 14 \end{Bmatrix} \quad (7)$$

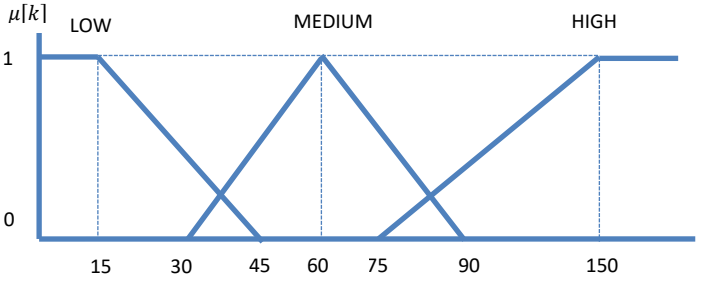

Fig. 4. Triangular fuzzy number variable input “Export”.

$$\mu Low\ Export[k] = \begin{cases} 1, & k \leq 15 \\ \dfrac{45-k}{45-15}, & 15 < k < 45 \\ 0, & k \geq 45 \end{cases} \quad (8)$$

$$\mu Medium\ Export[k] = \begin{cases} 0, & k \leq 30\ atau\ k \geq 90 \\ \dfrac{k-30}{60-30}, & 30 < k \leq 60 \\ \dfrac{90-k}{90-60}, & 60 < k < 90 \end{cases} \quad (9)$$

$$\mu High\ Export[k] = \begin{cases} 0, & k \leq 75 \\ \dfrac{k-75}{150-75}, & 75 < k < 150 \\ 1, & k \geq 150 \end{cases} \quad (10)$$

Fuzzy Inference Engine

The results of the fuzzy membership value calculation process were then inferenced against fuzzy rules. In fuzzy control, the implication function used is Min. There are three input variables (t) that need to be implemented against fuzzy rules. The calculation of the number of rules is by multiplying the number of fuzzy set (two linguistic variables) by the number of input variable. In this stage the number of rules used 13 rules obtained from all input combinations. The fuzzy rules used in this study are shown in Table 1.

Table 1. The Formation of Fuzzy Rules.

Fuzzy Rules
[R1] IF stock LOW AND capacity LOW AND competitive LOW THEN ekspor MEDIUM
[R2] IF stock LOW AND capacity LOW AND competitive HIGH THEN ekspor LOW
[R3] IF stock LOW AND capacity HIGH AND competitive LOW THEN en ekspor HIGH
[R4] IF stock LOW AND capacity HIGH AND competitive HIGH THEN ekspor MEDIUM
[R5] IF stock MEDIUM AND capacity LOW AND competitive LOW THEN ekspor MEDIUM
[R6] IF stock MEDIUM and capacity LOW AND competitive HIGH THEN ekspor LOW
[R7] IF stock MEDIUM AND capacity HIGH AND nd competitive LOW THEN ekspor HIGH
[R8] IF stock MEDIUM AND capacity HIGH AND competitive HIGH THEN ekspor MEDIUM
[R9] IF stock HIGH AND capacity LOW AND competitive LOW THEN ekspor MEDIUM
[R10] IF stock HIGH AND capacity LOW AND competitive HIGH THEN ekspor LOW
[R11] IF stock HIGH AND capacity HIGH AND competitive LOW THEN ekspor MEDIUM
[R12] IF stock HIGH AND capacity HIGH AND competitive HIGH THEN ekspor LOW

Defuzzification

To get the output value (crisp) is by converting the input into a number on the fuzzy set domain or by defuzzification (Sari et al., 2016). Having obtained the value of α_i, then will be the process of calculating the value of each consequence each rule z_i in accordance with the membership function used. The defuzzification method in fuzzy control is Center Average Defuzzyfier which is formulated in Eq. (11).

$$Z = \sum_{i=1}^{n} \propto_i z_i \frac{\sum_{i=1}^{n} \propto_i z_i}{\sum_{i=1}^{n} \propto_i} \quad (11)$$

CASE STUDY

The Dataset

MSME become the target of this study object, because MSME is a business group of society that does not have an integrated system like a large industry. MSME are difficult to conduct surveys and market analysis by themselves, due to limited capital and human resources in the field of information technology.

The case study used is the right selection of importers with the right amount, so that the exports made by MSME are efficient. This study used importer or buyer data which consisted of Buyer, Address, City, Nation, Region, Contact (Telephone, fax, Email), and Product. The data obtained from the Department of Industry and Trade of East Java Province in 2010. This study used sample data of six data. Company data is shown in Table 2. The data will be processed and will be input data.

Table 2. MSME Data in Some Regions.

No.	Buyer	Address	Nation	Region	Product
1	ALBA IMPEX AND ALBA INTERNATIONAL	Sabder Ali Building 15 Korbanigonj Road	Bangladesh	Asia	Cocoa Powder, Containing Added Sugar / Other Sweetening Matter, Palm Oils, Robusta Coffee
2	DINEX TRADE LTD	47A Tzarigradsko Shosse Fl 4	Bulgaria	Europe	Cocoa Beans, Whole Or Broken, Raw Or Roasted, Coffee
3	GUAN CHONG COCOA MANUFACTURER SDN BHD	Plo 273 Jalan Timah 2, Pasair Gudang 81700 Johor Bahru	Malaysia	Asia	Cocoa Beans, Whole Or Broken, Raw Or Roasted
4	TETOL	Zikova 1	Slovenia	Europe	Cocoa Beans, Whole Or Broken, Raw Or Roasted, Electric Lighting or Signalling Equip.; Parts, Paper Product
5	TONEX, INC	27, Park Row	USA	America	Cocoa Beans, Whole Or Broken, Raw Or Roasted, Coffee
6	TWIN FOODS LTD STI	Merkez Mah Cumhuriyet Cd No. 2 G.Y Silivri	Turkey	Europe	Cocoa Beans, Whole Or Broken, Raw Or Roasted, Fish, frozen, Food and Beverages, Footwear

Experiment

This section presents case study related to matching market. There is a problem and a solution. The solution is a proposed approach in this study that is using fuzzy control method with the provisions that have been described in Section Fuzzy Control. The problem is there are two buyers who import the bag product that is buyer XX.

XX → Stock = 15, capacity = 100, competitive = 5

1. *Fuzzification*

The membership function at fuzzification stage of the "Stock" input variable is shown in Table 3. While the fuzzification membership function in the input variables "Capacity" and "Competitive" are shown in Table 4 and Table 5.

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Table 3. *Fuzzificcation Process in "Stock".*

EMPLOYEE "XX"		
PARAMETER	MIN	MAX
LOW	10	20
MEDIUM	15	30
HIGH	25	50

Table 4. *Fuzzificcation Process in "Capacity".*

EMPLOYEE "XX"		
PARAMETER	MIN	MAX
LOW	10	100
HIGH	80	200

Table 5. *Fuzzificcation Process in "Competitive".*

EMPLOYEE "XX"		
PARAMETER	MIN	MAX
LOW	2	8
HIGH	7	14

Based on calculationS using Eq. (1) - Eq. (7) obtained the membership VALUE on each input variable as follows.

$\mu StockLow[15] = 0.5$ $\mu CapacityLow[100] = 0$ $\mu CapacityLow[5] = 0.5$
$\mu StockMedium[15] = 0$ $\mu CapacityHigh[100] = 0.5$ $\mu CapacityHigh[5] = 0$
$\mu StockHigh[15] = 0$

2. *Fuzzy Inference Engine*

Based on the formation of membership function at fuzzification stage, can be done next process that is fuzzy inference engine. In this stage the process of calculating the function of the implication by applying fuzzy rules that have been established previously. The results of the implication value calculation are shown in Table 7.

[R1] IF stock LOW AND capacity LOW AND competitive LOW THEN Export MEDIUM

$$\alpha{-}predicate_1 = \mu StockLow \cap \mu CapacityLow \cap \mu CompetitiveLow$$
$$= \min(\mu StockLow(15), \mu CapacityLow(100), \mu CompetitiveLow(5)$$
$$= \min(0.5; 0; 0.5)$$
$$= 0$$
$$0 = \frac{x_1 - 30}{60 - 30} => z_1 = 30$$

Table 6. *The Results of Implication Value Calculation.*

Fuzzy Rules	$\alpha{-}predicate_n$	**Implication Value** ***Zn***	$\alpha{-}predicate_n . Zn$
[R1]	0	30	0
[R2]	0	45	0
[R3]	0.5	112.5	56.25
[R4]	0	30	0
[R5]	0	30	0
[R6]	0	45	0
[R7]	0	75	0
[R8]	0	30	0
[R9]	0	30	0
[R10]	0	45	0
[R11]	0	30	0
[R12]	0	45	0
∑	0.5		56.25

3. *Defuzzification*

Having obtained the value of α predicate and implication value (Zn), then it will be done the process of calculating the defuzzification value by using Eq. (11). Based on the results of defuzzification calculation obtained the final value or crisp value of 113. The value is the number of goods from a company to be ready for export.

$$z = \frac{\sum_{n=1}^{12} \alpha - predicate_n \; x \; z_n}{\sum_{n=1}^{12} \alpha - predicate_n} = \frac{56.25}{0.5} = 112.5 = 113$$

CONCLUSIONS

Fuzzy control method used in this study can be implemented to determine the number of export and export destination in a company. This study is still in progress, so the data used in this study is sample data. In this study, fuzzy rule determination is done manually based on expert opinion. If the fuzzy rules are determined manually, it will be more experimental. There is a probability that the determination is less fit. Therefore, the implementation of genetic algorithm in subsequent study is needed to optimize fuzzy rules. The optimization of fuzzy rules aims to improve the accuracy of the system better. Genetic Algorithm has been widely used to solve problems related to optimization such as study that has been done by (Wijayaningrum and Mahmudy, 2016).

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