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USING FUZZY INFERENCE SYSTEM ON PRODUCTION PLANNING CASE STUDY : PANDANUS HANDICRAFT INDUSTRY

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ABSTRACT

Handicraft pandanus industry is one of type of micro industry that used leaves of pandanus to create many woven handicraft. These industries are emerging in some rural areas of Indonesia. Pandanus woven in sheet form used as a mat and through the creative process are processed into functional product such as bags, hats, sandals and others were exported to several countries. In order produce the product, are needed the production planning which is arranged by knowledge and experience of craftmens. These knowledge are present as linguistic data. Fuzzy Inference System (FIS) are particularly suited for modeling between linguistic variables which make reference to expert knowledge. This study is proposed to develop and validate FIS to production planning with case study at pandanus handicraft industry. The input of FIS are quality, the complexity of the design and the availability of working time. Some rule have developed to decide production level. The number of level production are arranged based on range production capacity. Research conduct based on survey and knowledge acquisitions from stakeholder (expert, produsen, retailer) of supply chain pandanus handicraft industry at West Sumatera and North Sumatera, Indonesia. This paper illustrates, how the expert management system approach was applied to manage production planning on handicraft pandanus industry. According to the result, FIS could arrange the production planning on pandanus handicraft industry.
Key words: fuzzy inference system, pandanus handicraft, production planning.

1. INTRODUCTION

Handicraft industry which uses woven pandanus leaves as raw material is one of handicraft business that are dispersed widely as microenterprise in Indonesia. Pandanus woven in sheet form are used as a mat and through the creative and innovative process have been processed into functional items such as bags, hats, sandals and others. Many handicraft from pandanus woven have been exported to many countries.

Rapid changes in tastes and variations of customer trends requires an approach on production management, especially with regard to raw materials. In order to assist the planning and production control in pandanus handicraft industry, the research developed software with expert management system approach. The model used in this application refers to a method of managing production in modern industry, especially to solve a lot of problem in estimating the need for raw materials to make woven pandanus handicraft. Production planning at handicraft industry is a complex concept that refers to make proper decisions under ucertainty and lack information about the the product quality and the availaibility of working hours.

Research on utilization of information technology in the handicraft industry has been done by Bowonder et al (2005) to improve the competitiveness of handicraft carpet industry in India. Related to knowledge management Arias et al. (2010) using fuzzy expert system approach in order manage information and knowledge to achieve the company's goals. The model based on fuzzy rules to simulate the behavior of the firms, is presented under the assumption of determined input parameters previously detected and an algorithm is developed to achieve the minimal structure of the model.

This research aims to develop an expert system to make decision about production planning on handicraft industry. The pandanus handicraft industry has a representative to find the actual about

production planning and its problem. This research aims to develop FIS to make decision about production planning on handicraft industry. The pandanus handicraft industry has selected as case study to application fuzzy Inference System approach to design production planning with linguistic variable. Most of handycraft industri have not made production planning because lack of data and unsufficient capability on operasional management Fuzzy Inference System are particularly suited for modeling the relationship between variables in complex environment because they introduce a process of decision making which is more human-like (Azeem 2012). These system are based on fuzzy logic modeling approach, and allow reaching solution based on linguistic variables which makes reference to expert knowledge. They are useful in the cases were human knowledge is available and there is not enough information as quantitative value. FIS need parameters as inputs and outputs. The fuzzy numbers are quantified using fuzzy logic method using membership function.The generic structure of a typical FIS illustrated in Figure 1.

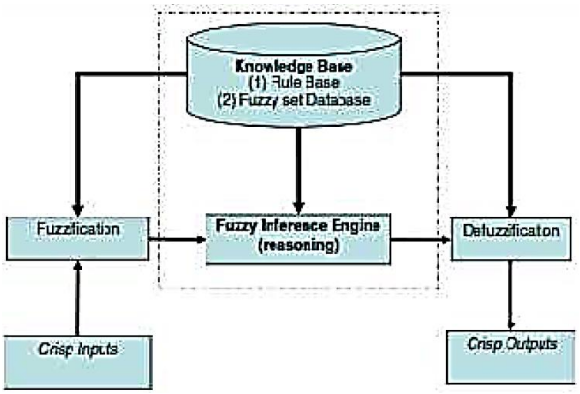

Figure 1. The inference process of Fuzzy Inference System

2. THEORETICAL BACKGROUND

The Sugeno and Mamdani fuzzy models are the most known types of FIS, which have been implemented in software such as Matlab. The main components of FIS are the knowledge base and the inference engine. The knowledge base component must defines the membership functions of the fuzzy set, and rule base of linguistic. The rules in FIS are fuzzy “IF-THEN” that define the relationship between system input and ouput , and the general form : if “antecedent proposition” then “consequent proposition”.

A fuzzy rules based system is developed by human operators with the aid of practical experience to handle complex situations, with only a set imprecise linguistic if then rules and an imprecise system state. This system incorporate fuzzy inference and rule based expert system resembling what human do daily. Inputs and outputs are two basic elements in the system using handling approaches. The input constitues some ambiguous verbal semantic or unclear concept for sepecific event. Following the fuzzy inference mechanism, the output can be fuzzy set or precise set certain fatures. Therefore, defuzzification is necesary to convert the output result into crisp number. Fuzzy inference infers the results from the existing rule-based system (Juang et al., 2007).

3. RESEARCH METHOD

This research having done at handicraft industry especially handicraft use leaves of pandanus plant. In order to collect data, information about handicraft industry, the research have done at DI Yogyakarta, West Sumatera and North Sumatera province at Indonesia. Data and information are collect from producer leaves, craftman of woven, handicraft producer where as doing business as trading of handicraft.

The lack of accuracy information about production condition in pandanus handicraft industry are used fuzzy approach. This research are conducting with Fuzzy Rule-Based Inference System (FIS) for proper production planning at handicraft. Despite the complexity of such decision making, FIS use linguistic value to define the input and output. FIS involves three important concepts: membership function, inference rules and fuzzy set operation. Membership functions represent the fuzzy sets of input and output variables, fuzzy set operations are main operations among fuzzy sets (Zadeh, 1965) and inference rules are linguistic fuzzy rules in the form of “ IFTHEN”. In this study input fuzzy Since

there are uncertainty about production of handicraft product.

4. RESULT AND DISCUSSION

4.1. Production System of Pandanus Handicraft

The expertise to make woven pandanus are usually hereditary of rural people in Indonesia village. The process is not too complicated but require several days to obtain raw materials in the form of strands woven pandan leaves. Pandanus leaves that have been separated from the stem cut into small pieces, boiled, drained with cold water and allowed to stand. After that, the dried and pressed so that the leaves flaccid to easily woven. The next stage is colored with a dye smeared food and vegetable oil in the drying process so that the color does not fade. The leaves have been further processed woven to be webbing. Woven fiber size adjusted to the product to be produced.

Most of the results in the form of woven mats used for surrounding communities region and some have been distribute and selling to various regions of Indonesia. Many motif webbing was produced has a good appearance in design style, construction and color. The more complicated /intricate workmanship and more number of materials, accessories are used will impact to the higher price. Many product of pandanus handicraft have been exported to another country such as Europe, Malaysia, Singapore Some of handicraft product from pandanus are commonly used as map, tissue boxes, sandals an bag are present in Figure 2.

Figure 2. The sample of pandanus handicraft product

The business activities of woven pandanus handicraft industry, based on observations and interviews with experts and respondents, establish an order of the supply chain from upstream to downstream. Based on the viewpoint of the process sequence of the decision-making process and the implementation of the flow of products, information and funds, supply chain network woven crafts industry shown in the Figure 3.

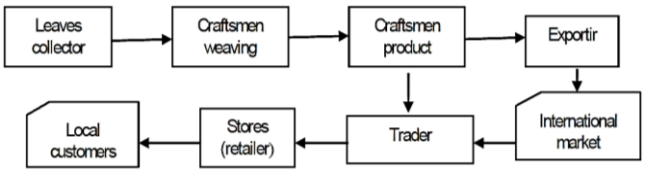

Figure 3. The structure of supply chain onf pandanus handicraft industry

4.2. Developing of Fuzzy Inference System of production planning

Knowledge management are useful as a fundamental role in the process to collect the correct information transfer and dissemination within the organization. Knowledge is intellectual capital, it is critically important for organization. There are so many researchers who interest in how to acquisition knowledge in various research type. In order to construct knowledge stored in the minds of experts, known methods of the Expert system. This method is capable of structuring knowledge and deposited into the machine to be used as a substitute for an expert in making decisions.

Knowledge of woven pandanus handicraft businesses related to the production control has not been compiled into a systematic knowledge and easy to navigate. Various models of the craft that is not yet classified into specific categories. Demand for raw materials in the form of ready woven pandan leaves has not been calculated so as to ensure availability.

The process for acquiring knowledge begins with the process of socialization is done through observation and brainstorming.

Defining the criteria inputs and outputs

There are three fuzzy inputs used in preparing the FIS is the quality, the complexity of the design and the availability of working hours.

a. Quality inputs are grouped into two categories such as high and low. The definition of them are:
   1. High if the handicraft woven pandanus is strong, tightly webbing and smooth.
   2. Low if the handicraft woven pandanus have webbing as brittle. sparse and coarse.

b. Design complexity factor is determined by the complexity of workmanship webbing. Wicker motif is determined by variations in the color used. Criteria relating to the use of color are grouped into three, namely:
   1. Difficult if using a motif woven pandan leaves with the colors of more than two types
   2. Medium if the motif woven using two colors
   3. Lower if the motif woven using only one color.

c. Working time is related to the availability of working hours of craftmens to produce handicrafts. Based on the availability of time to make handicraft, the working time are grouped into:
   1. Higher if work hours available more than 40 hours / week
   2. Medium if work hours available within 20 to 40 hours / week
   3. Low if work hours available within 10 to 20 hours / week

The next step after defined inputs is collect some informatioan of production level as output variables. Because lack of number of production level in this study have defined production planning with sub criteria, low, medium and high.

Rule Based Expert System

Expert systems are defined as consulting systems that simulate the reasoning behavior of human expert. The most important components of expert systems are the knowledge base and the inference engine. The main part of the FIS model is the rules. The behavior of a fuzzy system is characterized by a set linguistic rules which constitues a rule base. The fuzzy “if-then” rules are defined on the basis of experts knowledge in each area. In Mamdani approach the premises and the consequences of the ifthen are linguistic variables associated with fuzzy concept. Every rules has a weight as the number between 0 nd 1 which assign the importance of each rule. A fuzzy rule can be written “ if x1 is a , and x2 is b, where x1 and x2 are variables, y is solution variable, and a, b, and c are fuzzy linguistic terms.

The linguistic rules are extracted based on FIS approach. Table 1. present the fuzzy interpretation of some parameters based on fuzzy linguistic. The extracted rules are entered in to the rule editor of software developed using MATLAB.

Table 1. Fuzzy Rules of Alternative for Production Planning Handycraft

Rules	Fuzzy Inputs			Fuzzy Outputs
	Quality	*Design complexity*	*Work hours*	*Production planning*
1	Low	Difficult	Average	Moderate
2	Low	Difficult	Low	Low
3	Low	Difficult	High	Low
4	Low	Moderat	Average	High
5	Low	Moderat	Low	Moderate
6	Low	Moderat	High	Low
7	Low	Easy	Average	High
8	Low	Easy	Low	High
9	High	Easy	High	High
10	High	Difficult	Average	High
11	High	Difficult	Low	Moderate
12	High	Difficult	High	Low
13	High	Moderat	Average	High
14	High	Moderat	Low	High
15	High	Moderat	High	Moderate
16	High	Easy	Average	High
17	High	Easy	Low	Moderate
18	High	Easy	High	Low

Fuzzification - Defuzzification

Fuzzification is the process of converting precise or imprecise data into fuzzy data by assigning membership function. In this study the linguistic criteria adopted from Table 1 as fuzzy variables. The subciteria as inputs of the proposed fuzzy inference approach. In this research are used triangular membership function is exploited due to its prevalent. The criteria linguistic are assigned as three categorise. The experts are involved in the formulation of criteria and their input factors are craftsmen who make webbing, craftmen who produce handicrafts from the webbing, wholesalers and store that sent the craft products to end customers. Fuzzy set input and output

model are entered to Matlab software. present at Figure 4.

Defuzzification is a process to taransform a fuzzy output to a criep output. The centre of area method (COA) are used in this study, while defuzification to get crisp number of output.

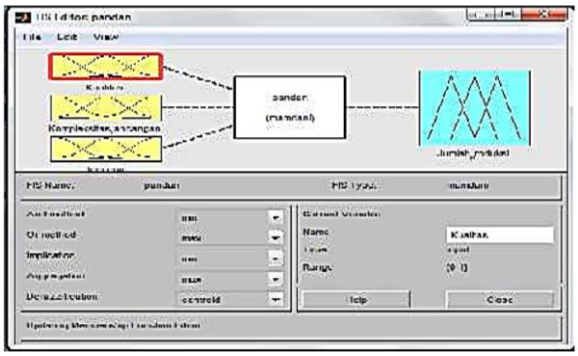

Figure 4. The FIS editor of Fuzzy input and Fuzzy Output

5. CONCLUSION

In this paper, a fuzzy inference system is proposed to solve the the problem for production planning of handicraft pandanus industry. The nature of the problem is complex due to the lack of accurate information as well as the need for knowledge of experts. A fuzzy rule-based system with linguistic variables an some of set ‘if-then” rules are applied to solve the production planning. The production planning consider about quality, complexity design, availibilty working hours as input FIS. The experts are involved in the formulation of criteria and their input factors are craftsmen who make webbing, craftmen who produce handicrafts from the webbing, wholesalers and store that sent the craft products to end customers. Based on using FIS based on the expert opinions, the developing rules FIS can be helpful to develop a production planning.

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