

# The development of Expert Management System for Handicraft Production Planning (Case study: Embroidery at Bukittinggi)

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**Abstract.** This paper discusses design and development of an expert management system for decision making for embroidery handicraft production planning. Embroidery industry could become a powerful sector to develop local economy, while promoting and sustaining the Minangkabau handicraft skills and culture. Bukittinggi is one of the cities that produces many kinds of embroidery. Cost Embroidery (Costemb) is a production planning and calculation cost using expert system that supports the microenterprise to make decision making and manage their business. It relies on using Fuzzy Inference system to predict level of production cost as expert model system. Fuzzy Expert System are design was structured by model of production forecasting based of quality, complexity and material are used. The other models are built by calculated material requirement, working time to produce embroidery. The model will be validated at small enterprise at Bukittinggi, West Sumatera Province, Indonesia.

**Keywords:** expert system, fuzzy inference system, embroidery, handicraft, production cost

## 1. Introduction

Indonesia is recognized as a producer many kinds of embroidery. Embroidery is a handicraft product that is widely used to increase the value added of clothing especially for aesthetic value. Some embroideries are products traditional weaving craft, practiced by generation of artisans (craftmen) to make attractive fashion designs. Embroidery industry is one of type of micro industry that produce embroidery handicraft. These industries are emerging in some rural areas of Indonesia. Scarves and clothings are some types of embroidery products that show cultural value of a certain region. Bukittinggi is one of the cities in West Sumatera Province, Indonesia which have been producing many kinds of embroidery. The embroidery products and types have specific names as “Kapalo Samek”, Sulam Bayang, Sulam Pita and many others. One of the most popular as Minangkabau icon is “Kapalo Samek Scarf”. This product has distinctive beauty and colors, and relatively very expensive. This product has been successfully marketed to various regions in Indonesia and has even entered the international market. Embroidery industry could be a powerful sector to develop the local economy, while promoting and sustaining Minangkabau handicraft skills and culture [4].

Micro and small companies produce embroidery with traditional approaches that rely on instinct and experience. There is no structured decision-making mechanism in production planning and control. The development of craft industry requires a management approach that applies modern production management approaches based on knowledge and experience of business owner. Owner of an enterprise must calculate production cost before making a decision about how many products that

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will be produced according to customer's order and market demand. Calculation approach for production cost analysis is necessary to consider the feasibility of upcoming order. This study is proposed to design an Expert System (ES) for production management of embroidery industry, especially for estimating production cost based on expert knowledge.

The Expert System will be designed using Fuzzy Inference System (FIS) as a model to estimate of production cost. Many researches related to knowledge management of fuzzy expert system approach are used to manage information and knowledge, leading to achieve the company's goals [1-2]. Fuzzy Inference System is particularly suitable for modeling the relationship between variables in complex environment because they introduce a more-human-like process of decision making. The system is based on fuzzy logic modeling approach and allows it to reach solution based on linguistic variables which makes reference to expert knowledge. They are useful in the cases in which human knowledge is available and there is no enough information as quantitative value [1].

Computer-based technology is being developed to improve the effectiveness of managerial decision making, especially in complex tasks. Focus on decision making requires an understanding of human decision making process, and some of them are Decision Support System and Expert System. The integration between Decision Support System (DSS) with Expert System (ES) is named as Expert Management System (EMS), such as Intelligence Decision Support System.

## **2. Methods**

The research is conducted based on survey and knowledge acquisitions from stakeholder of supply chain of embroidery handicraft industry in Bukittinggi, West Sumatera, Indonesia. A case study approach is performed to investigate production and calculation of production cost. Forecasting of production cost is determined using Fuzzy Inference System Approach. For this study, data is collected using in depth investigation applying semi-structured interviews and field observation. The interview is conducted to craft workers (artisans) and the microenterprise owner that produces and manages trading. FIS rules are calculated using software Matlab, while Expert Management System is developed using programming language.

## **3. Result and Discussion**

Process for estimating production cost is complicated. Inaccurate production cost estimation leads to over- or under-costing. Over-costing production will reduce its opportunity to compete in the market and the under-costing production leads to lose profit. Therefore, the production cost estimation must be carried out based on the required production processes. Calculation for cost production must be carried out before executing production. Fast analysis is needed based on the experience of business owner and embroidery craft workers.

Cost Embroidery (Costemb) is a production planning and cost calculation using an expert system that supports the microenterprises to make decision and to manage their business. It relies on Fuzzy Inference system to predict the level of production cost. Fuzzy Expert System's design is structured by model of production forecasting based of quality, complexity, and material used

### *3.1. Fuzzy Expert System*

There are many researchers who interest in how to acquisition knowledge in various research type. In order to construct knowledge stored in the minds of experts, are known methods of the expert system. The expert system using FIS Mamdani-Sugeno are used to develop an expert system to select material for the main structure of transfer crane [6]. This method is capable of structuring knowledge and deposited into the machine to be used as a substitute for an expert in making decisions. To develop the expert system of embroidery production cost, the material and design of product have been choosen.

There are (figure 1) several designs of embroidery product used to estimate the linguistic input data. The quality of product depends on material and design of embroidery. The specific case in this paper is the use of craft with different design and material. Based on the observation to and knowledge from the embroidery expert, product will be classified into three categories such as quality, design

complexity, and working hours. The classification of product is determined by expert based on experience and knowledge. Value of product's quality is presented in linguistic form, not in a precise measurement.



**Figure 1.** The sample of design embroidery handicraft

Depending on the visual of product, attributes are classified into linguistic data. Classification process to create fuzzy input data involves these steps:

1. Defining the group of material
2. Preselecting the quality of design
3. Estimating the working hours.
4. Identifying the category of each fuzzy input data
5. Estimating the embroidery production cost
6. Identifying the category of production cost as fuzzy output data

There are three fuzzy inputs used in preparing the FIS to calculate production cost of embroidery products. The significant consideration are the quality, the complexity of the design and the working hours required. According to [4], the inputs have criteria such as :

1. Quality inputs are grouped into two categories, namely high and low.
  - a. High: if the quality of embroidery product uses good material, has tight embroidery, and looks smooth.
  - b. Low: if the quality of embroidery product uses ordinary material, has less tight embroidery, and looks rough.
2. The complexity of design determined by the complexity of embroidery makers based on decorative design and the use of yarn. This input is determined by variations in color. Criteria related to the complexity of design are grouped into three, namely:
  - a. Difficult: if the embroidery product looks beautiful, decorative design with embroidery surface area is on more than 50% of fabric, and the yarn uses more than 8 colors.
  - b. Moderate: if the embroidery product has ordinary decorative design with embroidery surface area of 30 - 50% of fabric, and the yarn uses 5-7 colors.
  - c. Easy: if the embroidery product has ordinary decorative design with embroidery surface area of 10% to 30% of fabric, and the yarn uses less than 4 colors.
3. Working hours is related to the required working hours to make embroidery handicrafts. The embroidery makers commonly take it as a side job to spend their spare time. Based on the required time, the working hours are grouped into:
  - a. High: if the working hours requires 32 - 60 hours/(9 - 20 days)
  - b. Moderate: if the working hours requires 12 - 32 hours/(4 - 8 days)
  - c. Low: if the working hours requires 4 - 10 hours/(2-3 days)

In calculating the embroidery production cost, there are 3 categories of production cost in which the

output criteria is stated below:

1. High: if the production cost is from IDR 1,500,000 to 2,000,000
2. Moderate: if the production cost is from IDR 700,000 to 1,499,000
3. Low: if the production cost is from IDR 100,000 to 699,000.

The most important components of expert system 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 of linguistic rules which constitute 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 “if-then” are linguistic variables associated with fuzzy concept. A fuzzy rule can be written “if  $x_1$  is a, and  $x_2$  is b, where  $x_1$  and  $x_2$  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 shows the fuzzy interpretation of some parameters based on fuzzy linguistic rules. The extracted rules are entered into the rule editor of software developed. The next step is fuzzification, which is the process of converting precise or imprecise data into fuzzy data by assigning membership function. This research uses triangular membership function which is exploited due to its prevalence. There are 18 rules are built from using Matlab as shown at Table below.

**Table 1.** Rule of alternative for calculation of production cost

Rules	Fuzzy Input (If)			Fuzzy Output (Then)
	Quality	Design complexity	Working hours	Production cost Estimation
1	Low	Difficult	Moderate	Moderate
2	Low	Difficult	Low	Low
3	Low	Difficult	High	Low
4	Low	Moderate	Moderate	High
5	Low	Moderate	Low	Moderate
6	Low	Moderate	High	Low
7	Low	Easy	Moderate	High
8	Low	Easy	Low	High
9	High	Easy	High	High
10	High	Difficult	Moderate	High
11	High	Difficult	Low	Moderate
12	High	Difficult	High	Low
13	High	Moderate	Moderate	High
14	High	Moderate	Low	High
15	High	Moderate	High	Moderate
16	High	Easy	Moderate	High
17	High	Easy	Low	Moderate
18	High	Easy	High	Low

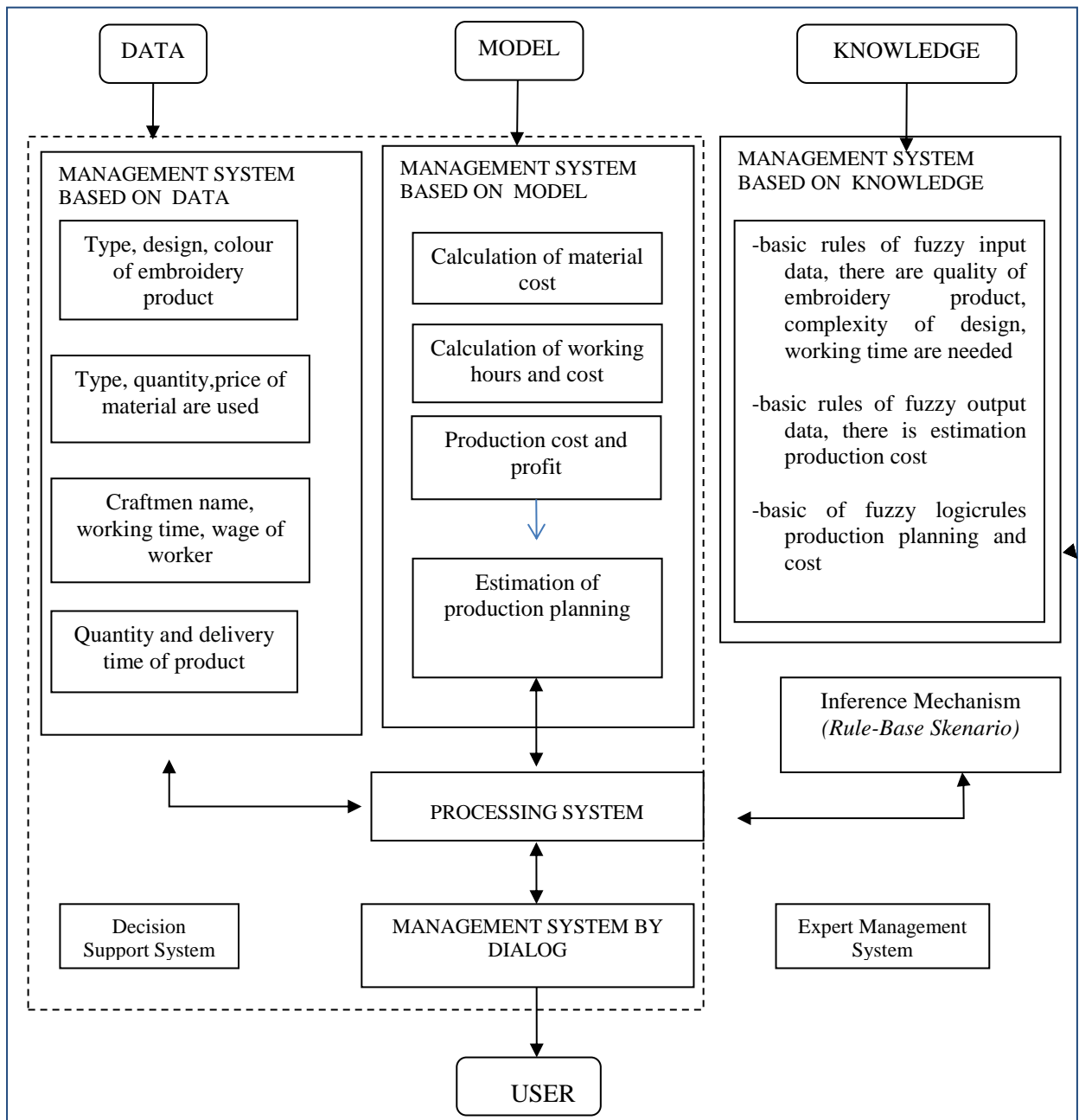
*3.2. Developing the Expert Management System*

To construct of Expert Management System is to have a stucture which is integrated with Expert System and Decision Support System. Model configuration of Expert Management System construct into three management system, there are :

- a. Management system based on knowledge
- b. Management system based on model
- c. Management system based on data

All of the constructions of EMS for production palnning based on production cost are shown in

Figure 2. All of the models of knowledge-based management are built from expert system that are developed. To develop DSS to be the knowledge-based model, there are models to calculate material cost, working hours, production cost, and profit. The data is needed to calculate the model built in database consisting of characteristic of embroidery product, quantity, and price of all materials that are used, data of craft workers, and their wage during working hours. Technology and formulation of model the EMS will be used to make decision for production planning.



**Figure 2.** Configuration of Expert Management System in COSTEMB

Cost Embroidery (Costemb) is a production planning and cost calculation using expert system supported by model and data. Model for production cost is estimated by using direct and indirect cost element. Many factors must be considered in calculating embroidery cost. Production cost comprises

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fixed cost and variable cost. Fixed cost is relatively fixed in amount and continues to be issued even if the outputs obtained increase or decrease [5]. Production process of embroidery needs simplified calculation. Cost element for calculating production cost consists of the cost for raw materials in the form of fabric and yarn, labor cost, and overhead cost.

The inference mechanism is a part of expert system that directs and manipulates facts, and is the knowledge of experts, which is stored in the knowledge base, to work on embroidery. Based on the number of assessments for each type, motive, and raw material prices stored in the database, model base and knowledge base are used to calculate the processing time, cost, and production plan. This configuration can still be developed by learning more about the required cost components and by exploring further about types of embroidery products and the required cost components.

#### 4. Conclusions

The output of this study is the creation of a Fuzzy Expert System which facilitates the development of an expert management system on production planning of embroidery. The case study object is a handicraft embroidery production in Bukittinggi, West Sumatera. The production costs put into consideration the quality, design complexity, and working hours availability. The problem is complex due to the lack of accurate information as well as the need for knowledge of experts. The product calculates the production cost which considers quality, design complexity and working hours requirement. In this paper, an expert system combined with decision support system is built using computational management approach. This Expert Management System perform production cost and profit calculation modelling.

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