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Application of Fuzzy Inference System using Tsukamoto technique as Strategy management (Case: Sales "Custom Case")

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Abstract

The purpose of this research is to analyze the results of "custom case" sales predictions using intelligent systems with fuzzy techniques in digital printing. This research uses the location of "Arvi Digital Printing" which is a printing press in Pematangsiantar city that uses digital as well as producing "custom cases" of his own work. Data sources obtained through direct observation by interviewing the printing owner. The fuzzy technique used to solve this problem is the Tsukamoto method. The variables used are demand (X), inventory (Y), and production (Z). However, Arvi Digital Printing has not been able to determine how many custom cases that must be produced every week. Demand (X) has fuzzy set {up, down}, inventory (Y) has fuzzy set {few, many} and production (Z) has fuzzy set {increase, decrease}. The results of research using the Tsukamoto method can predict the number of "custom case" productions with input is demand (X) and inventory (Y) and output is production (Z) is 39 pcs a week with demand (X) 20 pcs and inventory (Y) 60 pcs.

Keywords*: Fuzzy System, Tsukamoto, Management Strategy*

1. Introduction

Printing is a business that is most interested in today. There are many types of printing businesses, one of which uses digital. Almost in every city there is a printing business that uses a digital system, because this business has the advantage of being able to serve orders in small quantities or even units. Digital printing is capable of printing banners, stickers, brochures, business cards, mugs, umbrellas, and also "custom case". "Cutom case" is a cell phone accessory in the form of a casing that can be made based on the design of the image according to consumer demand. In this day and age "custom case" are increasingly enjoyed, especially among young people and has its own market share, so that it can become a new business opportunity with quite promising results.

Printing "Arvi Digital Printing" is one of the businesses engaged in digital printing that was founded in 2013. "Arvi Digital Printing" is in Pematangsiantar. Products produced by "Arvi Digital Printing" include "custom case". This "custom case" is often used by young people who are fond of gadgets and want the device to look different from the others. Because with the advantages that can be made with pictures, personal photos and writings with the wishes of consumers, making a "custom case" is not just just a protective casing for mobile phones. However, unspecified requests result in "Arvi Digital Printing" having difficulty in determining the amount of production that must be produced every week. this is certainly less effective because it has not been able to estimate the amount of production of "custom cases" with high demand and a large supply or vice versa. Therefore we need a more practical and orderly way. Therefore we need an application that can help the production of the number of "custom cases" through predictions. In the process of determining the amount of production of "custom case" there are several factors of decision constraints, namely determining the maximum and minimum demand for a certain period, the maximum and minimum inventory for a certain period. With a variety of decision constraints, of course, a method is needed to solve the problem of determining the number of production processes. One method that can be used is the application of fuzzy logic [1]. To solve various problems, Fuzzy logic has several advantages compared to strict logic [2], namely: conceptually easy to understand, flexible, tolerant of inaccurate data, able to model nonlinear functions that are very complex, can be mixed with conventional control techniques and based on human language [3].

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Based on these advantages, it is expected that the determination of the number of "custom cases" can be done considering this is very important and very useful for printing "Arvi Digital Printing". Because with the prediction of the number of "custom case" production, printing can provide more optimal benefits. Losses can be reduced because production has been determined from the beginning without having to produce excess or less than demand. Therefore, the authors are interested in examining the application of the Tsukamoto method to the sale of "Custom Cases" in "Arvi Digital Printing".

2. Methodology

2.1. Fuzzy Logic

Fuzzy is a method used to capture uncertainty and obscurity. In this system, inaccuracy is generally expressed using the term fuzzy linguistics which is usually defined as fuzzy set [4]. Each fuzzy set is marked by its membership function; therefore, these functions must be carefully defined [3]. The membership value of item x in a set A, written mA [x], has 2 possibility:

a) One (1): means that an item is a member in a set
b) Zero (0): means that an item is not a member in an the set.

In general, fuzzy has four stages in solving problems, namely:

a) Fuzzification.
b) Inference.
c) Composition.
d) Defuzzification.

2.2. Fuzzy Tsukamoto

Fuzzy Tsukamoto is one of the methods of the Fuzzy Inference System where in the Tsukamoto method, every consequence of the form rules if-then must is represented by a fuzzy set with a monotonous membership function [5]. Terms in Tsukamoto Fuzzy:

a) Fuzzification is a process carried out to change real variables into fuzzy variables.
b) Fuzzy Inference System is a process of merging a lot the rules based on available data. Inference system fuzzy is a computational framework based on fuzzy set theory, IF-THEN fuzzy rules, and fuzzy reasoning.
c) Defuzzyfication is the process used to convert fuzzy variables back into real variables [6].

The Fuzzy Logic Membership Function is the value of the degree of membership of a fuzzy set. The membership function uses a curve that shows the mapping of data input values into membership values or membership degrees & has interval values between 0-1 [7].

2.3. Research Method

The research methods carried out in this study include several stages, namely: a preliminary study, a stage of data collection, a stage of system development and conclusions. This study uses the location of "Arvi Digital Printing" which is one of the printing companies in the city of Pematangsiantar that uses digital as well as producing "custom cases" of their own work. Sources of data obtained through direct observation by conducting interviews with printing owners. The variables used are demand (X), inventory (Y), and production (Z). in this case "Arvi Digital Printing" Printing prints "Custom Case" Mobile for the last 1 week of data, where the biggest demand is 25 pcs/ day, and the smallest request is 5 pcs/ day. While the most inventory in the warehouse reaches 100 pcs and at least 50 pcs. Printing "Arvi Digital Printing" is currently only able to produce goods up to 45 pcs and at least 25 pcs.

3. Results and Discussion

In the discussion we will try to apply the Tsukamoto method in producing "custom cases" where the number of requests is 20 pcs and the inventory is 60 pcs. The following is fuzzyfication of 3 variables that are modeled using the linear representation membership function.

a) Demand
The membership function that will be used on demand (X) is the set down and up.

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$$\mu X[\text{down}] = \begin{cases} 1 & x < 5 \\ \frac{25-x}{25-5} & 5 < x < 25 \\ 0 & x > 25 \end{cases}$$

$$\mu X[\text{up}] = \begin{cases} 0 & x < 25 \\ \frac{x-5}{25-5} & 5 < x < 25 \\ 1 & x > 5 \end{cases}$$

The membership value of the set goes up and down:

$\mu x \text{ down } (20) = \frac{(25-20)}{20} = 0{,}25$

$\mu x \text{ up } (20) = \frac{(20-5)}{20} = 0{,}75$

b) Inventory

The membership function used in inventory (Y) is a set of Few and Lots.

$$\mu Y[\text{few}] = \begin{cases} 1 & y < 50 \\ \frac{100-y}{100-50} & 50 < y < 100 \\ 0 & y > 100 \end{cases}$$

$$\mu Y[\text{lots}] = \begin{cases} 0 & y < 100 \\ \frac{y-50}{100-50} & 5 < y < 25 \\ 1 & x > 50 \end{cases}$$

The membership value of the set of few and lots:

$\mu y \text{ few } (60) = \frac{(100-60)}{50} = 0{,}8$

$\mu y \text{ lots}(60) = \frac{(60-50)}{50} = 0{,}2$

c) Production

The production membership function (Z) used is an increasing and decreasing set:

$$\mu Z[\text{increasing}] = \begin{cases} 0 & z < 45 \\ \frac{z-25}{45-25} & 25 < z < 45 \\ 1 & z > 25 \end{cases}$$

$$\mu Z[\text{decreasing}] = \begin{cases} 1 & z < 25 \\ \frac{45-z}{45-25} & 25 < z < 45 \\ 0 & z > 25 \end{cases}$$

After determining the fuzzyfication of the 3 variables that are modeled using the linear representation membership function, the next step is to determine the fuzzy rule used, the following is the fuzzy rule used in the prediction of "custom case" sales in "Arvi Digital Printing" printing.

Table 1. Fuzzy Rule

Rules	Demand (X)	Inventory (Y)	Production (Z)
1	Down	Lots	Decreasing
2	Down	Few	Decreasing
3	Up	Lots	Increasing
4	Up	Few	Increasing

After the fuzzzy rule is formed in table 1, do the calculations to find the α-predicate value of each rule.

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Rule 1:

$$\begin{aligned} v &= \min(0{,}25\,;0{,}2) \\ Z &= 0{,}2 \\ 0{,}2 &= \frac{45-x}{20} \\ 45-x &= 0{,}2 \text{ x } 20 \\ 45-x &= 4 \\ -x &= 4-45 \\ -x &= -41 \\ x &= 41 \end{aligned}$$

Rule 2:

$$\begin{aligned} \propto -\text{predicate} &= \min(0{,}25\,;0{,}8) \\ Z &= 0{,}25 \\ 0{,}25 &= \frac{45-x}{20} \\ 45-x &= 0{,}25\ x\ 20 \\ 45-x &= 5 \\ -x &= 5-45 \\ -x &= -40 \\ x &= 40 \end{aligned}$$

Rule 3:

$$\begin{aligned} \propto -\text{predicate} &= \min(0{,}75\,;0{,}2) \\ Z &= 0{,}2 \\ 0{,}2 &= \frac{x-25}{20} \\ x-25 &= 0{,}2 \text{ x } 20 \\ x-25 &= 4 \\ x &= 4+25 \\ x &= 29 \end{aligned}$$

Rule 4 :

$$\begin{aligned} \propto -\text{predicate} &= \min(0{,}75\,;0{,}8) \\ Z &= 0{,}75 \\ 0{,}75 &= \frac{x-25}{20} \\ x-25 &= 0{,}75 \text{ x } 20 \\ x-25 &= 15 \\ x &= 15+25 \\ x &= 40 \end{aligned}$$

After the process of determining α-predicate is done on each rule, the last step is to do defuzzyfication

$$\begin{aligned} Z &= \frac{(0{,}2 \text{ x } 41)+(0{,}25\text{x}40)+(0{,}2\text{x}29)+(0{,}75\text{x}40)}{0{,}2+0{,}25+0{,}2+0{,}75} \\ &= \frac{8{,}2+10+5{,}8+30}{1{,}4} \\ &= \frac{54}{1{,}4} \\ &= 39 \end{aligned}$$

From the above calculation it can be concluded that the amount of production produced by "Arvi Digital Printing" printing is 39 pcs.

4. Conclusion

Based on these results it can be concluded that the Tsukamoto method can be implemented in predicting the number of "custom case" productions in "Arvi Digital Printing" printing. There are 3 variables used in this study, namely: the input variable consists of demand (X), inventory (Y) and the

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output variable consists of production (Z). Demand (X) has fuzzy set {up, down}, inventory (Y) has fuzzy set {few, many} and production (Z) has fuzzy set {increase, decrease}. The rules produced using the Tsukamoto method are six rules with the production yield (Z) is 39 pcs in a week for demand (X) = 20 pcs and inventory (Y) = 60 pcs. It is expected that the results of this research can facilitate the printing of "Arvi Digital Printing" in estimating the amount of production that must be produced.

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