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Customer Relationship Management in Increasing Customer Loyalty using the K-Means Algorithm

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Abstract

Advances in technology allow humans to more quickly and precisely in carrying out various activities in everyday life. One of the companies engaged in the field of vehicle washing services is Doorsmeer Keluarga Nasution. Doorsmeer. The Nasution Family Doorsmeer, located on Jl. Medan Padang Aek Godang Panyabungan, Mandailing Natal Regency, provides services in the form of car and motorcycle washing. Bookkeeping at the Nasution Family Doorsmeer is still done manually, allowing for loss of important transaction data, as well as a lack of business promotion in the community resulting in slow business development. The purpose of this study is generally to apply Web-based Customer Relationship Management with the K-means algorithm method for marketing/transactions at the Nasution Family Doorsmeer. This research is a combined type, using descriptive qualitative and quantitative methods. From the research results it is known that with the existence of Web-based Customer Relationship Management it can simplify and assist in managing good marketing strategies so that they can increase sales revenue, and by providing the best service will encourage customer loyalty and make it easier to determine loyal customers with the K-means algorithm in order to continue to provide convenience to customers.

Keywords: Customer Relationship Management, K-means Algorithm, Loyalty, Web, Manual ..

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1. Introduction

Advances in technology allow humans to be faster and more precise in carrying out various activities in everyday life. Along with the rapid advancement of technology, companies are required to continue to improve their ability to process information more accurately in order to meet needs, desires, and levels of satisfaction so that customers remain loyal. use the company's products [1].

One of the companies engaged in the field of vehicle washing services is Doorsmeer Keluarga Nasution. Doorsmeer Family Nasution is located at Jl. Medan Padang Aek Godang Panyabungan, Mandailing Natal Regency. The Nasution Family Doorsmeer accepts motorized vehicle washing services such as car and motorcycle washing[2]. The Nasution Family Doorsmeer already has many customers and records it manually in a ledger book containing the name of the vehicle, the vehicle's license plate number, the date the washing was carried out, the officer who washed the vehicle and so on. The Nasution Family Doorsmeer has implemented a strategy to build customer loyalty[3].

This strategy includes giving coupons to customers, and these coupons can be exchanged after 10 washings. However, in determining this strategy, Doorsmeer has not based on a particular customer pattern. Here, we need a way to see loyal customers so that in determining strategies to build loyalty is more targeted. [4].

Customer Relationship Management (CRM) is a strategy that builds relationships to build customer loyalty or build long-term relationships to create greater value so as to be able to maintain market share and increase customer loyalty. CRM is a strategy on how to optimize profitability through developing customer satisfaction. This CRM strategy requires knowledge gained from customer data. One method that can be used in analyzing CRM is data mining. There are several data mining methods, namely prediction, association, decision tree, clustering and classification. With clustering , data patterns can be analyzed from naturally formed groups [5].

CRM is a means of establishing sustainable relationships between companies and their stakeholders and shareholders. Currently, many companies are using CRM to establish close relationships with customers, by using CRM, companies will know what their customers expect and need so that bonds will be created . emotional capabilities that are able to create close and open business relationships as well as two-way or reciprocal communication between them, thereby maintaining customer loyalty and not easily switching to other products and brands, especially those of competing companies [6] .

Customer Relationships Management (CRM) is a systematic effort to foster profitable relationships with customers[7][8]. CRM covers all aspects related to prospective and current customers, including marketing, providing up-to-date information, ordering

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products, technical support, field service, and handling problems and complaints. customers [9][10].

The goal of Customer Relationship Management is to provide an optimal service and maintain existing relationships, know customer behavior, what are the needs needed by customers, because the key to a business is very dependent on how far we know about customers and what the needs are. needed by customers to maintain good relations between customers and business owners [11]

Data mining is a step in knowledge discovery in databases (KDD) which has a technique of analyzing data to explore hidden information in large and complex quantities, so as to produce output in the form of characteristics or patterns from the data. One of the data mining analysis techniques is cluster analysis, which is better known as clustering. Clustering is a data analysis method whose goal is to group data with the same characteristics into the same area [12]. One method of grouping data is non-hierarchical (border) which attempts to partition data into the form of two or more groups (clusters) with the same characteristics that are put into the same group [13].

The clustering algorithm used in this article is K-Means, which is an algorithm that can define objects in a data group center which is usually the midpoint of the data group [14]. The K-Means algorithm is a non-hierarchical algorithm derived from the data clustering method. The K-Means algorithm starts with the formation of a cluster partition at the beginning and then iteratively repairs this cluster partition until there is no significant change in the cluster partition [15]. The K-Means algorithm is a non-hierarchical algorithm derived from the data clustering method. The K-Means algorithm starts with the formation of a cluster partition at the beginning and then iteratively repairs this cluster partition until there is no significant change in the cluster partition [16].

The purpose of this writing is that the writer wants to make a research so that he can help and manage the business by applying information technology, namely Customer Relationship Management which is required by the Nasution Family Doorsmeer.

2. Research methodology

To assist in the preparation of this research so that the steps in solving the problems discussed can be clearly structured, a research framework is needed. The research framework used in this study can be seen in Figure 1 below:

Figure 1. Research Framework

Based on the research stages in Figure 1, each stage can be explained in detail as follows:

2.1 Preliminary Research

Preliminary research is the first step in conducting a study by first analyzing the problems to be developed. The purpose of problem identification is to find out about the problems that can be identified at the Nasution Family Doorsmeer, namely the process of giving promotions to loyal customers is still done manually, so it is very difficult for research objects to carry out this task because the promotion and discount must be given repeatedly. - Repeatedly due to inaccurate and precise calculation results or calculations that are not in accordance with the criteria and data owned by the customer, as a result the process takes quite a long time. Preliminary research is the first step in conducting research. By using the Customer Relationship Management approach with the K-Means algorithm method to provide promotions to customers who are entitled to receive them and provide solutions to problems that occur in the Nasution Family Doorsmeer .

2.2 Data collection

In this study, data was collected by interviewing the owners and their trustees who are engaged in the service sector. To get data about the Nasution Family Doorsmeer.

2.3 Analysis

The analysis phase is the identification of the problem as a whole with the aim of obtaining a fact based on the research method used. The process of finding, collecting and researching a problem from research conducted on the Nasution Family Doorsmeer.

2.4 Design

At the design stage, researchers used UML (Unifield Modellin Language) diagrams. However, not all diagrams provided by UML are used in designing this system. Only a few UML diagrams are used, namely Use Case Diagrams, Activity Diagrams, Class Diagrams, Sequence Diagrams.

2.5 Implementation

In the implementation process, of course, it will involve the use of hardware (hardware) and software (software). As for the hardware (hardware) used.

2.6 Testing

This stage is the stage of testing the application that has been made, with the aim of knowing whether the application can be used or is able to run according to the design that has been done.

3. Results and Discussion

3.1 Data Mining Analysis

Data analysis is the most important stage in the development of a system, data processing and assessment will find solutions in solving existing problems. This study uses data on the number of visits and total transactions in the Nasution Family Doorsmeer business, which can be seen from Table 1. as follows :

Table 1. Nasution Family Doorsmeer Transaction Data

Name	Plate No	Number of Visits	Total Transactions
Aghna	BK 1264 QZ	3	210000
Adivas	BK 1263 ABL	4	240000
Alif	BK 1822 VN	2	120000
Lubis	BB 1446 FQ	7	420000
Dzaki	BK 2671NAH V	9	120000
Anisa	BM 9985 DI	1	70000
Novrida	BB 3280 RQ	10	138000
Grace	BK 1979 JBL	5	350000
Nabila	BA 1168 QH	4	240000
Aira	BK 1933 MX	1	50000
rara	BB 1752 AK	8	480000
Ramli	BB 1079 EC	6	360000
Sakdiah	BK 888 MDL	10	700000
Izza	BK 1752 AK	4	200000
Jaza	BK 11 HSB	6	420000
Flower	T 1425 DQ	10	600000
Holy	BB 1503 XR	2	140000
Budi	BK 4150 AGK	9	132000
Afiq	BA 1152 US	4	200000
Son	BK 1939 Y.D	2	120000

Where the initial *centroid value* that has been determined is as follows:

1) *Clustering* Number of Transactions (X)
   a) *Centroids* 1 : 3
   b) *Centroids* 2 : 4
2) *Clustering* Total Transactions (Y)
   a) *Centroids* 1 : 210000
   b) *Centroids* 2 : 240000

After the initial *centroid value* has been determined, the next step is to enter the distance calculation stage for each data $d_i(x, y)$using formula 1 as follows:

$$d_i(x,y) = \sqrt{\sum_{i=1}^{n}(x_i - C_x)^2 + (x_i - C_y)^2 : i = 1,2,3,\dots n} \quad (1)$$

Where d_i is the i-th data distance . x_i is the i-th data value . C_x *the initial centroid* value of Transaction Amount (C1 ,C2). C_Y is the initial *centroid value* of Total Transactions (C1, C2).

After all the data is calculated, allocate each data to the nearest *centroid* and determine the new *centroid value* using formula 2 as follows:

$$v = \frac{\sum_{i=1}^{n} x}{n} : i = 1,2,3 \dots . n \quad (2)$$

Where *v* is the new *centroid* . *n* is a lot of data in *the cluster* .

After the *centroid value* is determined, the distance search process is repeated until the *cluster members* do not change from the previous iteration after being allocated.

First Iteration

The calculation of the object distance is carried out in the following way :

Centroids

$d_{1.1} = \sqrt{(3-3)^2 + (210000-210000)^2} = 0$

$d_{2.1} = \sqrt{(4-3)^2 + (240000-210000)^2} = 30000.00002$

$d_{3.1} = \sqrt{(2-3)^2 + (120000-210000)^2} = 90000.00001$

$d_{4.1} = \sqrt{(7-3)^2 + (420000-210000)^2} = 210000$

$d_{5.1} = \sqrt{(9-3)^2 + (120000-210000)^2} = 90000.0002$

$d_{6.1} = \sqrt{(1-3)^2 + (70000-210000)^2} = 140000$

$d_{7.1} = \sqrt{(10-3)^2 + (138000-210000)^2} = 72000.00034$

$d_{8.1} = \sqrt{(5-3)^2 + (350000-210000)^2} = 140000$

$d_{9.1} = \sqrt{(4-3)^2 + (240000-210000)^2} = 30000.00002$

$d_{10.1} = \sqrt{(1-3)^2 + (50000-210000)^2} = 160000$

$d_{11.1} = \sqrt{(8-3)^2 + (480000-210000)^2} = 270000$

$d_{12.1} = \sqrt{(6-3)^2 + (360000-210000)^2}$ =150000
$d_{13.1} = \sqrt{(10-3)^2 + (700000-210000)^2}$ =490000 .0001
$d_{14.1} = \sqrt{(4-3)^2 + (200000-210000)^2}$ =10000.00005
$d_{15.1} = \sqrt{(6-3)^2 + (420000-210000)^2}$ =210000
$d_{16.1} = \sqrt{(10-3)^2 + (600000-210000)^2}$ =390000 .0001
$d_{17.1} = \sqrt{(2-3)^2 + (140000-210000)^2}$ =70000.00001
$d_{18.1} = \sqrt{(9-3)^2 + (132000-210000)^2}$ =78000.00023
$d_{19.1} = \sqrt{(4-3)^2 + (200000-210000)^2}$ =10000.00005
$d_{20.1} = \sqrt{(2-3)^2 + (100000-210000)^2}$ =90000.00001

Centroids 2

$d_{1.2} = \sqrt{(3-4)^2 + (210000-240000)^2}$ = 30000 .00002
$d_{2.2} = \sqrt{(4-4)^2 + (240000-240000)^2}$ =0
$d_{3.1} = \sqrt{(2-4)^2 + (120000-240000)^2}$ =120000
$d_{4.2} = \sqrt{(7-4)^2 + (420000-240000)^2}$ =180000
$d_{5.2} = \sqrt{(9-4)^2 + (120000-240000)^2}$ =120000 .0001
$d_{6.2} = \sqrt{(1-4)^2 + (70000-240000)^2}$ =170000
$d_{7.2} = \sqrt{(10-4)^2 + (138000-240000)^2}$ =102000 .0002
$d_{8.2} = \sqrt{(5-4)^2 + (350000-240000)^2}$ =110000
$d_{9.2} = \sqrt{(4-4)^2 + (240000-240000)^2}$ =0
$d_{10.2} = \sqrt{(1-4)^2 + (50000-240000)^2}$ =190000
$d_{11.2} = \sqrt{(8-4)^2 + (480000-240000)^2}$ =240000
$d_{12.2} = \sqrt{(6-4)^2 + (360000-240000)^2}$ =120000
$d_{13.2} = \sqrt{(10-4)^2 + (700000-240000)^2}$ =460000
$d_{14.2} = \sqrt{(4-3)^2 + (200000-240000)^2}$ =40000
$d_{15.2} = \sqrt{(6-4)^2 + (420000-240000)^2}$ =180000
$d_{16.2} = \sqrt{(10-4)^2 + (600000-240000)^2}$ =360000 .0001
$d_{17.2} = \sqrt{(2-4)^2 + (140000-240000)^2}$ =100000
$d_{18.2} = \sqrt{(9-4)^2 + (132000-240000)^2}$ =108000 .0001
$d_{19.2} = \sqrt{(4-4)^2 + (200000-240000)^2}$ =40000
$d_{20.2} = \sqrt{(2-4)^2 + (100000-240000)^2}$ =120000

Table 2. First Iteration Object Distance

NO	C1	C2	CLUSTER
M1	0	30000,00002	C1
M2	30000,00002	0	C2
M3	90000,00001	120000	C1
M4	210000	180000	C2
M5	90000,0002	120000,0001	C1
M6	140000	170000	C1
M7	72000,00034	102000.0002	C1
M8	140000	110000	C2
M9	30000,00002	0	C2
M10	160000	190000	C1
M11	270000	240000	C2
M12	150000	120000	C2
M13	490000,0001	460000	C2
M14	10000,00005	40000	C1
M15	210000	180000	C2
M16	390000,0001	360000,0001	C2
M17	70000,00001	100000	C1
M18	78000,00023	108000.0001	C1
M19	10000,00005	40000	C1
M20	90000,00001	120000	C1

In Table 2., all transaction data is directly allocated so that it can determine a new *centroid value* with the formula listed above by utilizing the value of ∑x as the number of values in the *cluster members* and the value of n as the number of members in the *cluster* . So the new *centroid value* in this iteration is as follows:

Table 3. First Iteration of New *Centroid*

C1	4.272727273	136363,6364
C2	6.666666667	423333,3333

The next stage is to make a new iteration (second iteration) by repeating from the third stage in the previous iteration, it's just that *the centroid* used is the new *centroid* that was obtained in the previous *centroid* . After all stages are completed, the step that needs to be taken is to ensure the number of members in each *cluster* equal to the number of members of each *cluster* in the previous iteration. When the state of the number of *clusters* is the same , then the process is stopped and *clusters* are formed. But if not, then the search will continue. The results of this study produced four iterations which can be seen as follows:

Table 4. *Clustering* Results

Iteration	Centroid value used				Cluster Member	
	C1		C2		1	2
	X	Y	X	Y		
1	3	210000	4	240000	11	9
2	4.272727273	136363,6364	6.666666667	423333,3333	13	7
3	4.230769231	152307,6923	7.428571429	475714,2857	13	7

3.2 System Analysis

System analysis is the first process in a system design that will determine the success of a research. The primary objective of information system analysis is to find deficiencies in the old business procedures so as to determine the requirements for the new system and determine the level of appropriateness of the new system requirements, to mark cases that need to be analyzed against the old system in finding problems with the system [17] .].

So that it can determine the right system to build a new system. Analysis of the running system aims to understand in more detail how the system processes and what constraints are being faced by the system so that it can be used as a system development proposal.

The transaction and promotion system at *Doorsmeer* Keluarga Nasution in Mandailing Natal, which is engaged in car and motorcycle washing services, has several weaknesses, including ineffective transaction processes and sales promotions. The determination of getting a promo is inaccurate because there is no algorithm in making decisions.
In designing or creating a system that is suitable for use as a means of promoting doormeer businesses , the use of computerization can provide benefits in the form of turning manual work into digital, making work easier and so on, and by implementing web-based CRM and assisted by the *K-means method* which is useful in grouping data, which can be applied to the Nasution Family *Doorsmeer business* in Mandailing Natal Regency so that it can become an update on the Nasution Family Doorsmeer business to develop.

3.3 System Implementation

The recommended implementation stage includes the software environment, the continuation stage of system design activities ready to operate, which consists of an explanation of the implementation environment, and program implementation[18].

The program display is a sub-chapter that explains the process in the program, both the program *input process* and the *output execution* of the program being run, along with the program views that have been built including the admin login page which is the initial display when the website is accessed, on the admin page view there are two form for username and password. Like Figure 2.

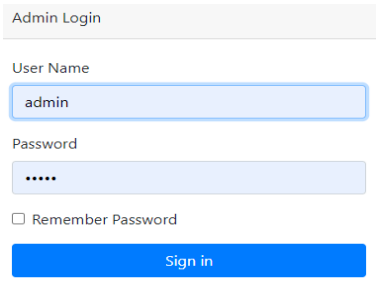

Figure 2. Admin Login Page

Then after a successful login, a display will appear on the *dashboard page* as shown in Figure 3.

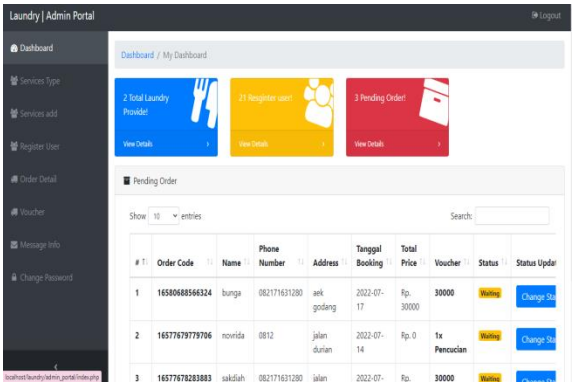

Figure 3. Admin *Dashboard* page

On the admin *dashboard page* , several menus are displayed, namely customers , services type, services add user registration, order details, vouchers, massage info, change password and customers clustering in the voucher menu. The Order details page displays the customer order process at the Nasution Family Doorsmeer. Admin can change order status on this page, consisting of queue, currently being washed, waiting for payment, already paid, canceled. Like Figure 4.

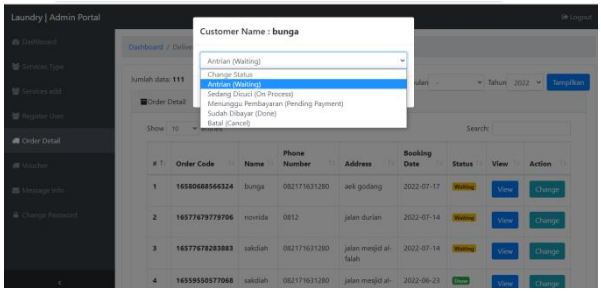

Figure 4. Transaction Page

The Customer Clustering page is a page that contains the K-means algorithm process on the Nasution Family Doorsmeer. Like Figure 5.

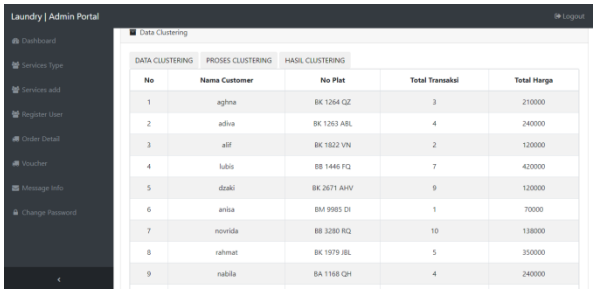

Figure 5. *Customer Clustering*

Whereas on the Customers page there is a menu that can be accessed by customers, namely the order send menu, order confirmation, order detail, change password. Where before entering the system the user will be directed first to register by filling out the existing form after that the login process is carried out by entering an email and passwords. Like Figure 6.

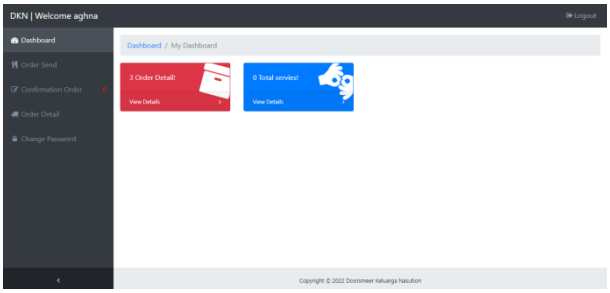

Figure 6. *Customer* Home page

4. In conclusion

Based on direct monitoring and analysis carried out on the Nasution Family Doorsmeer against the background of the descriptions and explanations that have been described, the results obtained with the Implementation of Customer Relationship Management with K-Means can build customer clustering to categorize customers who use services so that service providers can identify the characteristics of their customers. , promotions can be directed to customers who are entitled to get them, reach more new customers through a system that has been integrated directly with the internet network, so that new visitors or those who are not familiar with Doorsmeer Nasution Family, both those who are around the business location and those who are far away, will find it easy to get to know Doorsmeer The Nasution Family through internet searches has increased the number of customers who transact with the Nasution Family Doorsmeer business.

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