PERANCANGAN SISTEM APLIKASI KLASIFIKASI JENIS RAW MATERIAL IKAN TUNA BERBASIS WEB DENGAN MENGGUNAKAN ALGORITMA K-MEANS DAN METODE EXPONENTIAL SMOOTHING (STUDY KASUS : PT. PAHALA BAHARI NUSANTARA)

TUGAS AKHIR

Syuhada Nurjuliadi
41516310010

PROGRAM STUDI TEKNIK INFORMATIKA
FAKULTAS ILMU KOMPUTER
UNIVERSITAS MERCU BUANA
JAKARTA
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Oleh:
Syuhada Nurjuliadi
41516310010

PROGRAM STUDI TEKNIK INFORMATIKA
FAKULTAS ILMU KOMPUTER
UNIVERSITAS MERCU BUANA
JAKARTA
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Nama	:	Syuhada Nurjuliadi
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PENGUJI

(Drs. Achmad Kodar. MT, M.Kom)

Penguji 1

LEMBAR PERSETUJUAN PENGUJI

NIM	:	41516310010
Nama	:	Syuhada Nurjuliadi
Judul Tugas Akhir	:	Perancangan Sistem Aplikasi Klasifikasi Jenis Raw Material Ikan Tuna Berbasis Web Dengan Menggunakan Algoritma K-Means Dan Metode Exponential Smoothing (Study Kasus : PT. PAHALA BAHARI NUSANTARA)

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PENGUJI

(Harni Kusniyati, M.Kom)

Penguji 2

LEMBAR PERSETUJUAN PENGUJI

NIM	:	41516310010
Nama	:	Syuhada Nurjuliadi
Judul Tugas Akhir	:	Perancangan Sistem Aplikasi Klasifikasi Jenis Raw Material Ikan Tuna Berbasis Web Dengan Menggunakan Algoritma K-Means Dan Metode Exponential Smoothing (Study Kasus : PT. PAHALA BAHARI NUSANTARA)

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PENGUJI

(Runi)

(Saruni Dwiasnati. ST, MM, M.Kom)

Penguji 3

LEMBAR PENGESAHAN

NIM	:	41516310010
Nama	:	Syuhada Nurjuliadi
Judul Tugas Akhir	:	Perancangan Sistem Aplikasi Klasifikasi Jenis Raw Material Ikan Tuna Berbasis Web Dengan Menggunakan Algoritma K-Means Dan Metode Exponential Smoothing (Study Kasus : PT. PAHALA BAHARI NUSANTARA)

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Menyetujui,

(Ir. Emil R. Kaburuan, Ph.D., IPM.)
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Jakarta, 15 Februari 2022

Syuhada Nurjuliadi

DAFTAR ISI

DAFTAR TABEL

DAFTAR GAMBAR

Implementation of the K-Means Algorithm in the Classification Application System for Tuna Fish Raw Materials (Case Study : PT. Pahala Bahari Nusantara)

Syuhada Nurjuliadi[1] , Emil R. Kaburuan[2*]

Abstract – *PT. Pahala Bahari Nusantara wishes to increase the fulfillment of consumer demand for export raw materials and production to be processed into a processed tuna fish product, namely frozen loin tuna. In the phenomenon of fulfilling consumer demand for export raw materials and raw materials for factory production, the provision of tuna raw material stock based on the desired type of tuna is one of the supporting factors for smooth business activities. Not infrequently there is also a shortage of raw material supplies of tuna based on the type of tuna needed both for production and for export raw material needs, so that services to consumers for export needs and production needs at the factory can be reduced or hampered. To solve this problem, the author tries to apply the K-Means algorithm to the classification application system for tuna raw material types based on the type of tuna needed to help classify which types of tuna raw material are widely used and must also always be available in cold storage as a storage place. tuna raw material so that there is no shortage of tuna raw material supplies caused by the high demand for production in the factory and the need for raw material exports to consumers can be met.*

Keywords: *Smart Raw Material Classification, K-Means, Mercu Buana University*

I. INTRODUCTION

The relationship between consumers and the company is one of the main values in developing the company's business PT. Pahala Bahari Nusantara. The stock of tuna raw materials for production demand needs in the factory and export raw materials to consumers is very important for companies, where with the availability of this tuna raw material stock, companies can take the right decisions or strategies for factory production needs and export raw materials to consumers. One of the most important sources to *analyse* is the purchase transaction data and the release of raw materials stored in the company database.

The problems that arise at this time are the presentation of data that is still manual, large data resources which result in opening the data it takes a long time, *Frequent* misclassification of raw materials needed is not appropriate so that it affects the purchase of raw materials for the company's business needs. So we need a classification system that applies an algorithm, in this study the author tries to apply the K-means algorithm for the raw material classification system based on existing data.

There are two types of data clustering that are often used in the data grouping process, namely hierarchical (hierarchical) and non-hierarchical (non-hierarchical) data clustering [1]. In this study of the application system for tuna raw material classification, the author focuses more on grouping non-hierarchical data clustering in this study, with a non-hierarchical Clustering Algorithm using a partial approach, there are several kinds, including Fuzzy C-Means, K-Means and so on [1], *the* author *uses* the clustering algorithm in this study, *namely, the* K-Means Clustering Algorithm.

The K-Means algorithm is a non-hierarchical data clustering method that *partition* data into one or more clusters/groups, so that data with the same characteristics are grouped into the same cluster and data with different characteristics are then grouped into other groups (Agusta, 2007). This algorithm is expected to help users a little faster in determining the raw material for tuna fish that is needed.

The K-Means Clustering Algorithm, apart from being able to cut the time for determining the type of raw material, can also make precise and accurate determinations. It is expected that the results obtained from this research are, PT. Pahala Bahari Nusantara – Jakarta can find out the availability of tuna raw material and can find out which type of tuna will be stocked appropriately based on the type needed for business needs and minimize mistakes in purchasing tuna that is not needed for production or export of tuna raw material.

So that the *fulfilment* of the demand for fish raw materials for production needs in the factory and export of raw materials to consumers in the future can be carried out appropriately and can improve services to consumers.

A. Data Mining

Data Mining is the process of finding interesting patterns or information on selected data by using certain techniques or methods in the calculation process. Data Mining is able to analyse large data sources of information in the form of

meaningful patterns in decision support [2].

B. Clustering

The purpose of this clustering data is to cluster the types of tuna that are set in the clustering process, which generally tries to group variable data into a cluster and maximize a variable data between clusters [3]. Cluster analysis can be divided into hierarchical (hierarchical) clustering techniques and non-hierarchical (non-hierarchical) clustering techniques. Examples of the hierarchical technique are single link, complete link, mean link, median and ward. While the non-hierarchical techniques are k-means, adaptive k-means, k-medoids, and fuzzy clustering. To determine a good algorithm, it is seen from the types of data available and the specific purpose of the analysis [4].

Current clustering techniques can be classified into three categories, namely partitional, hierarchical and locality-based algorithms. There is a set of objects and criteria for clustering or grouping, positional grouping obtains the partition of objects into clusters so that objects in the cluster will be more similar to objects in the cluster than objects in different clusters. Partitional tries to decompose the dataset into a set of clusters by determining the desired initial number of clusters [5].

C. Algorithm K-Means

The K-means algorithm is one of the partition algorithms, because the K-Means algorithm is based on determining the number of initial group values by defining the initial centroid value[6]. K-Means separating data into K sub-regions *are* well known for its *late* and its ability to classify large data and outliers very quickly [7].

At its completion, the K-Means algorithm will produce the centroid point that is the goal of the K-Means algorithm. After the K-Means iteration stops, each object in the dataset becomes a member of a cluster. The cluster value is determined by searching all objects to find the cluster with the closest distance to the object. The K-means algorithm will group data items in a dataset into a cluster based on the closest distance[8].

D. MySQL

MySQL is one of the many database systems which is the right breakthrough solution in database applications. MySQL is a derivative of one of the main concepts in a database system for a long time, namely SQL (Structured Query Language). MySQL was developed in 1994 by a software development and database consulting company in Sweden called TcX Data Konsullt AB. The initial purpose of developing MySQL was to develop web-based applications on the client [9].

As a database server that has a modern database concept, MySQL has many advantages, including [9] :

- *Portability*, can run stable on various operating systems, such as Windows, Linux, MacOS, and others.
- *Open Source*, distributed free of charge under the GPL (General Public License).
- *Multiuser*, can be used by several users at the same time without experiencing problems.
- *Performance Tuning*, has amazing speed in handling simple queries, can process more SQL per unit time.

- *Security*, has several layers of *security, such* as subnet mask level, host name, user access permissions with detailed licensing systems and encrypted passwords.
- *Scalability and Limits*, capable of handling large-scale databases, with more than 50 million records and 60 thousand tables and 5 billion rows. In addition, the index limit that can be accommodated reaches 32 indexes in each table.
- *Connectivity*, can connect with clients using the TCP / IP protocol, *the Unix socket* (Unix), or Named pipes (NP).
- *Localitation,* can detect error messages on the client using more than 20 languages.
- *Interface*, has an interface to several applications and programming languages using API (Application Programming Interface) functions.
- *Clients and Tools,* equipped with various tools that can be used for database administration, and online instructions are included with each tool.

E. Framework

Framework is a framework. The framework can also be interpreted as a collection of scripts (especially classes and functions) that can assist programmers dealing with various problems. Among them are connections to databases, calling variables, files, and so on so that developers can focus more and build applications faster. The types of frameworks that are often used are .NET Framework, PHP Framework, Ruby On Rails (to create web applications in Ruby), Django (to create web applications in Python), Google Web Toolkit (GWT).

How to call functions that are already in the framework vary depending on the type of framework used. Some examples of standard functions that are already available in a framework are paging, encryption, email, SEO (search engine optimization), sessions, security, calendars, languages, image manipulation, graphics, Framework can be interpreted as a tool used to help work. Validation, upload, captcha, templates, compression, and others.

Because for website creation, the framework here can be interpreted as a tool that can be used to facilitate website creation. If with a CMS, developers only need to run it, they no longer need to think about writing their own program code, but this is not the case with frameworks.

In using the framework, developers still have to write code, the difference is that the code written must adapt to the framework environment used. A framework in addition to providing a development environment, each also provides a variety of ready-made functions that can be used in the creation of websites.

So there will be a lot of code or functions that look unusual, because these functions are built-in functions of the framework and are not native functions of PHP. These functions are sometimes developments or adjustments to PHP's original functions to make them easier to use or to better suit user needs[10].

F. Code Igniter

CodeIgniter is one of the many existing PHP frameworks. CodeIgniter was developed by Rick Ellis (http://www.ellislab.com). In addition to

codeigniter, there are also several php frameworks such as cake, symphony, yii, zend and prado. The purpose of making this CodeIgniter framework according to the user manual is to produce a framework that can be used for the development of website creation projects faster than making a website by coding manually, by providing a lot of libraries needed in making a website, with simple interface and logical structure to access the required libraries. CodeIgniter allows developers to focus on building websites by minimizing the code generation for various website building purposes.

CodeIgniter implements the development environment with the MVC (Model View Controller) method. MVC separates the logic of code generation for creating templates or website views. Using MVC makes building a website project more structured and simpler. In simple terms, the MVC concept consists of three parts, namely the Model section, the View section and the Controller section. A dynamic website consists of at least 3 main things, namely the database, application logic and how to display website pages. These 3 things are represented by MVC, namely the model for the database, the view of how to display website pages and the controller for the application logic. The explanation is as follows:

- Model

Represents the data structure of a website which can be in the form of a database or other data, for example, in the form of a text file or an xml file. Usually in the model will contain classes and functions to retrieve, update and delete website data. Because a website usually uses a database to store data, the Model section will usually deal with SQL query commands. The model is specifically used to connect to the database, therefore the programming logic in the model must also be related to the database. For example, the selection of conditions, but to choose which query to perform.

- View

Is information that is displayed to website visitors. As much as possible in the View does not contain code logic, but only contains variables that contain data that is ready to be displayed. A view is a website page that is created using HTML with the help of CSS or JavaScript. There should never be any code in the view to connect to the database. The view is only devoted to displaying data from the model and controller.

- Controller

The controller is a link between Model and View in the framework. Inside the Controller, there are classes and functions that process requests from the View into the data structure in the Model. Also the controller must not contain code to access the database. The task of the controller is to provide various variables that will be displayed in the view, call the model to access the database, provide error handling, perform logical processing of the application and validate or check the input. So briefly the order of a request is as follows: the user is associated with a view, where in this view all information is displayed. When the user makes a request or request, for example, clicks a button, the request will be processed by the controller.

What to do, what data do you want, do you want to see the data, or enter data or maybe do data validation first, all are processed by the Controller. Then the Controller will ask the Model to complete the request, whether it's doing a query or whatever. From the Model, the data will be sent back for further processing in the Controller and new data from the Controller will be displayed in the View.

G. Research Methods

The dataset to be processed is in the form of an Excel file taken from the PBN Record application, in the dataset there *are* transaction master data. The master transaction data that will be used in the study for clustering tuna species are as follows:

- The type of tuna with the lowest transaction ratio.
- The type of tuna with the highest transaction ratio.

In this study using the K-Means Clustering method which is where this method can classify existing data into several groups, where the data in one group have the same characteristics [1]. Where transaction data are grouped into three clusters, namely the type of tuna with the least transactions, the type of tuna with medium transactions and the type of tuna with the most transactions, then each cluster is classified based on which criteria are prioritized.

The cluster with the largest value at the final centroid is a cluster that is recommended to be a reference in purchasing raw materials for fish raw material stock needs, *while* the cluster with the smallest value at the final centroid is a cluster that is not eligible to be selected in purchasing raw materials based on the results of many transactions.

The results of this process form clusters that are used to provide advice and considerations in determining the raw material purchasing strategy, namely, providing good product results for customers with the top cluster position.

This is a step to solving a problem using the K-Means Clustering method, namely:

- Define the number of K clusters.
- Initialize K cluster centres (centroids) as seed points (initial cluster prototype). This centroid can be obtained randomly or selected from the first K data objects.
- For each data component, calculate and mark the distance (distance) to the initial centroid, then enter the data into the centroid closer to the distance 2.
- Calculate and change the centroid of each cluster as the average of all members of the cluster.
- Check all data again and put each *datum* closest to the new centroid. If the members of each cluster do not change (converge), then the step stops and if it still changes, returns to step 2.

From the explanation above, it can be concluded that, to determine the type of tuna that must be purchased in this application, when the process of grouping the data requires a clustering algorithm for grouping data according to the characters inputted from the user based on information on the transaction data for buying fish and releasing fish.

H. Study lecture

Table H.1. Table Previous Research Studies

No	Nama Peneliti	Tahun	Tema Penelitian	Metode	Hasil Penelitian
1.	Purba W. *Jurnal Sains Dan Teknologi (2020)* [11]	2020	Cluster Analysis of Indonesian Provinces Based on Foodstuff Production Using the K-Means Algorithm	K-Means Clustering Algorithm	The application of the K-Means Clustering Algorithm can be input to the government in analysing Which province has the number of Dominant food production Corn, peanuts, cassava, soybeans, and rice.
2.	Santoso Setiawan[12]	2018	Utilization of K-Means Method in Determining Inventory	K-Means	From the results of the research that has been carried out, it is found that the data that has been the least sold are in the 4th,5th, 6th, 7th, 8th, 9th, 13th, 14th, 15th, 16th, 17th, 18th,19th, 20th, and 21st products. Product choices that can be promoted by the company to increase sales.
3.	Fina Nasari, Charles Jhony Manto Sianturi[13]	2016	Application of K-Means Clustering Algorithm for Classification of the Distribution of Diarrhoea in the District Langkat	K-Means Clustering Algorithm	The first cluster centre is the area for the spread of diarrhoea for the number of sufferers intermediate level or not a centre for the spread of diarrhoea. The second cluster centre is the centre of the spread of diarrhoea, for that the central areas of the second cluster should be the government's area of concern for diarrhoea management.

4.	Setiawan Qodri Nugroho, Ricardus Anggi Pramunendar[14]	2015	Coconut Wood Grouping Using K-Means Algorithm Based on Two Dimensional (2D) Coconut Wood Image Texture	K-Means	From the results of testing the grouping data carried out by the system on 105 coconut wood test image data with labels A, B and C, the f-measure value or accuracy is 0.93, or 93%.
5.	Asrul Sani[15]	2018	Application of K-Means Clustering Method in Companies	K-Means Clustering	From the calculation results, the sample obtained is 216 transactions, clustering data is grouped into 4 groups based on available data. Each group is determined by the centroid value obtained from the minimum value, maximum value and the middle value of the available data. The cluster process is carried out by calculating the closest distance using the Euclidean formula.

II. MATERIAL AND METHOD

A. Experiment Stage

The stages of research on the design of this Raw Material Classification System application are:

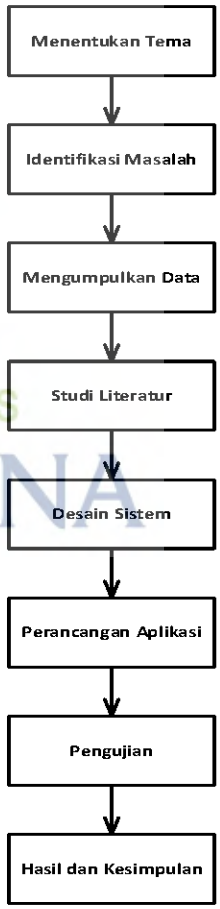

Figure A.1. Experiment Stage

- Determining the Theme, the first stage is to find out what *the theme* is appropriate to be raised to be the topic of the problem.

- Problem Identification, in finding information Raw material stock inventory is a problem that often occurs in the company's daily environment, especially in some cases when you want to know stock supplies, which type of tuna is most widely used and others. This Raw Material Classification System application is needed to be used as a helper in making decisions for purchasing raw material stock. However, the information system currently available in the company's environment is only transaction data input and the rest uses processed data using Ms. Excel or manual. So that this becomes an obstacle or obstacle in finding and determining the type of tuna that must always be available as raw material and in accordance with the desired criteria. To solve these problems, an application is needed that can provide information to support purchasing decisions for tuna raw materials in detail and the process in determining these decisions according to user needs.
- Collecting data, at this stage the authors collect transaction data for the release of tuna raw material in the PBN Record System belonging to the company PT. Pahala Bahari Nusantara - Jakarta.
- Literature study, at this stage the author conducts a literature review journals, E-books, papers and websites related to research for references to concepts and algorithms that can be implemented in the design of Decision Making System applications.
- System design, at this stage the author makes a design flow and application concept through UML diagrams such as use case diagrams, activities, class diagrams, and makes *designing* for the user interface of the application to be designed.
- Application design, at this stage the author begins to implement the system design that has been made into a website-based application development through the PHP programming language using the Code Igniter framework as the back-end process, using the Bootstrap framework as the user interface and My SQL as the database system. In designing this classification system application the author uses the K-Means Clustering Algorithm Method to calculate the estimated type of tuna needed.
- Testing, at this stage the testing process is carried out using the black box method. In this blackbox testing stage, several test scenarios are made, namely positive tests and negative tests, whether the output generated from the designed application is in accordance with the expected scenario expectations or not.

B. Software Development Method

Application program development does not have a structured standard and methodology. The approach taken in general is implementation, test and release. Application program development has a need for coordination, namely the provision processes, aspects of development, testing, evaluation, deployment and maintenance of applications that are integrated in the

design process through the development life cycle. The software development model in this study uses the Waterfall process model (Sommervilee, 2007) which is described as follows:

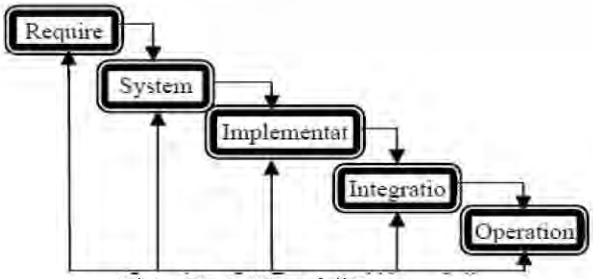

Figure B.1. Waterfall Process
(Source Sommervilee, 2007)

C. Requirement Sistem

Functional requirements are requirements that have a direct relationship with the design of the tuna raw material classification application. These functional requirements include:

- **User Admin:**
  - Entering transaction data for the entry of tuna.
  - Input transaction data for tuna fish release.
  - See the results of data analysis that has been processed.
- **User Pimpinan:**
  - View a list of incoming fish raw material transaction data.
  - View a list of outgoing fish raw material transaction data.
  - View the results of data analysis that has been processed.

D. Desain Sistem

The design model used in the development of this raw material classification application is the *Unified Model Language* (UML). The UML models used include *use case diagrams, activity diagrams, and class diagrams.*

E. Use case diagram

Use Case Diagram aims to help users understand and understand a lot about how the usefulness of the system to be built. Use Case Diagrams in the design of the tuna type classification application of this raw material, there are 2 actors, namely the Admin User and the Leader User and the process are divided into two, namely the data input process and the data report process. Here's the Use Case Diagram:

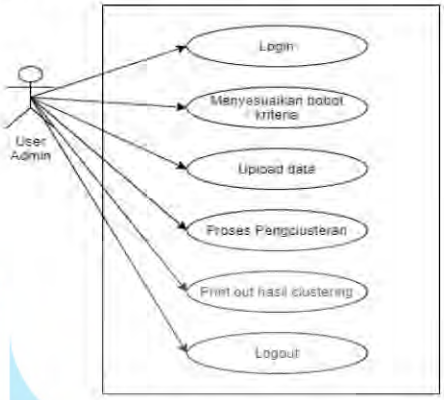

Figure C.1. Use Case Diagram User Admin

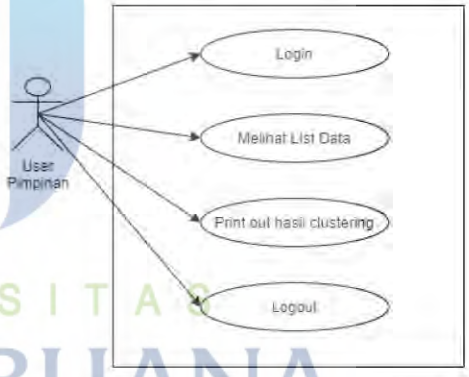

Figure C.2. Use Case Diagram User Pimpinan

F. Activity diagram

Activity diagram is a description of the various flows of activities in the designed system, how each of them will start, the decisions that may occur and how they end. Activity Diagram in the design of this raw material classification system application, there are 2 actors, namely User Admin and User Management and the process are divided into two, namely the data input process and the data report process. Here's the Activity Diagram:

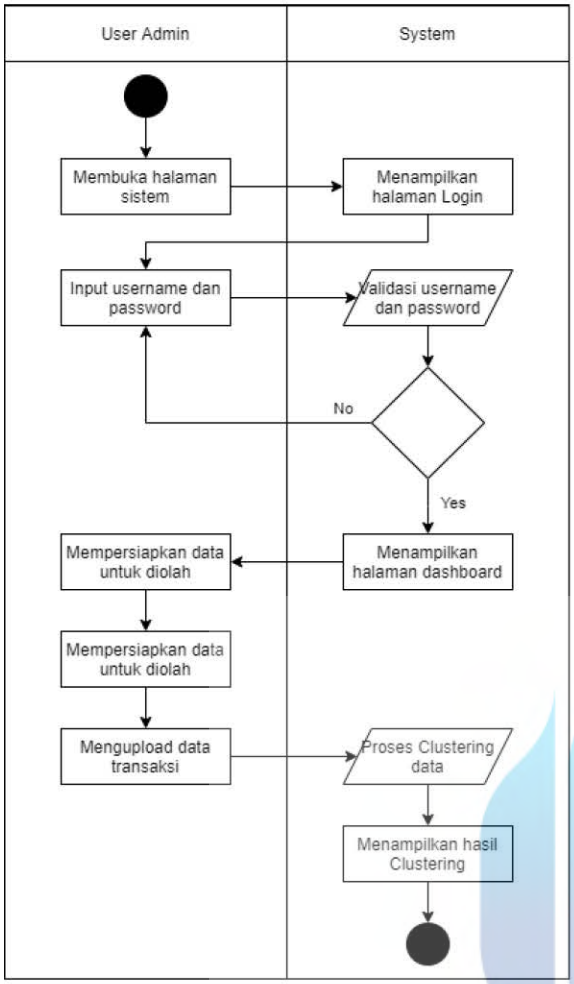

Figure E.1. Activity Diagram *User Admin*

The explanation of the Activity Diagram above, then the scenario for the Application of the Raw Material Classification System is as follows:

- Start.
- User Admin opens the Login page, then the system will display the Login page.
- User Admin enters username and password, then the system will validate.
- If the username or password is incorrect, the system will display the login page again, if correct, the system will display the dashboard page.
- User Admin prepares data to be processed in the determining system, from transaction data taken from the PBN Record application.
- User Admin inputs data to be processed in the system, then the system will start the calculation and data clustering.
- After the system has finished processing the data, the data will be presented on the dashboard page and the final clustering results page with the data that has been clustered.
- Finish.

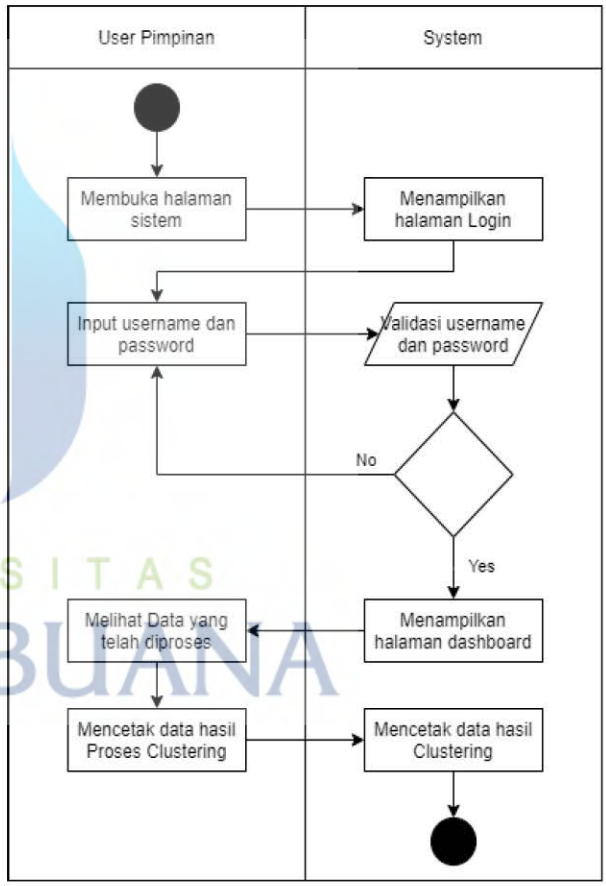

Figure E.2. Activity Diagram *User Pimpinan*

The explanation of the Activity Diagram above, then the scenario for the Application of the Raw Material Classification System is as follows:

- Start.
- The leader opens the Login page, then the system will display the Login page.

- The leader enters the username and password, then the system will validate.
- If the username or password is incorrect, the system will display the login page again, if correct, the system will display the dashboard page.
- After entering the dashboard page, the leader can see the results that have been processed on the dashboard page and the clustering results page.
- Finish.

G. Class diagram

An overview of the class diagram for designing the Classification Application of raw materials for taking thesis ideas can be seen in Figure G.1.

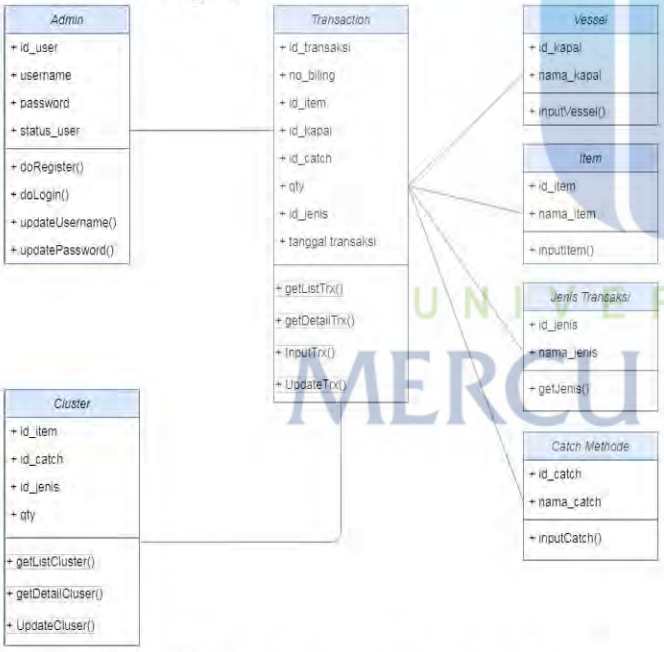

Figure G.1. Class Diagram Clasifications Raw Material

H. Relations Database

In this raw material classification application, there are several entities that make up an ER diagram. ER diagram can be seen in Figure H.1.

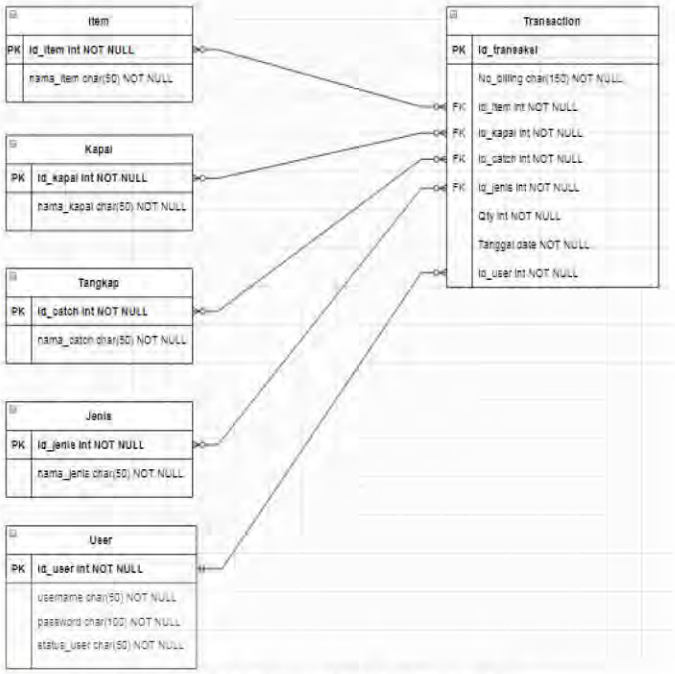

Figure H.1. Relasi Database Clasifications Raw Material

III. RESULT AND DISCUSSION

The K-Means method is a method that is included in the distance-based clustering algorithm which divides the data into several clusters and this algorithm only works on numeric attributes[16]. The grouping of data in this study uses the K-Means method and adds the Exponential Smoothing method as forecasting raw material.

A. Results of the K-Means Method

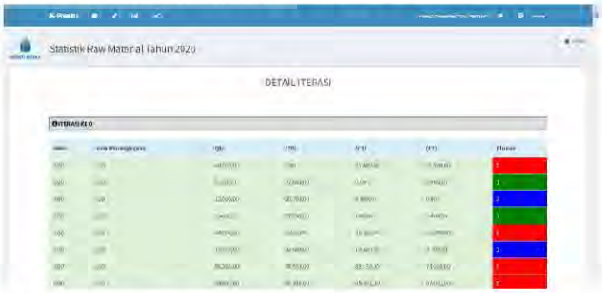

Figure A.1. Clustering Iteration Report

Figure A.1 shows the results of calculating raw material data using the K-Means Clustering algorithm where the data processed to find the centroid value and cluster the processed data are as follows:

Table A.2. Details Iteration

Item	Catch	Qty	C0	C1	C2	Cluster
SJ	PL	40.700	0,00	37.600	28.700	0
YF	PL	3.100	37.600	0,00	8.900	1
SJ	PL	12.000	28.700	8.900	0,00	2
ALB	LL	1.335	39.365	1.765	10.655	1
BE	LL	415	40.285	2.685	11.585	1

The table above is a summary of the table that comes from the application system for the classification of raw material data mode, so that the results are as expected or not.

Based on the results of the summary of table A.1, the raw material data were successfully processed and successfully clustered the data items which can be seen in Figure A.2 where the summary results from table A.1 are shown to be better for reading.

Figure A.2. Clustering Final Results

Where the results obtained are that the most clustered fish raw material items are Yellowfin and Skipjack tuna species, thus the type of tuna that must be considered is the amount of raw material stock so that there is no shortage of raw material stock.

B. Exponential Smoothing Method Results

The Exponential Smoothing method is a moving average or time series forecasting model that performs exponentially decreasing weighting of longer observation objects[17]. This forecasting method is usually used in making short-term predictions that use relatively little historical data.

Figure B.2. Exponential Smoothing Method Results

In this study, using The Exponential Smoothing method to find out the forecast for the next 1 month from the previous, the MAPE value of the error rate in predicting is less than 10% as expected. So that the Exponential Smoothing method can be used in this study to make forecasts of raw materials.

IV. CONCLUSION

Based on the results of the research and the description above, the author concludes that the results of calculations with the K-Means Algortima and Exponential Smoothing method used for forecasting in the short term for the next one month get the following results:

1. The first cluster for the type of tuna that is most needed is the type of Yellowfin tuna.
2. The second cluster for the type of tuna that is most needed is the Skipjack tuna.
3. Forecasting get MAPE results below 10%, for the forecasting error rate.
4. With this application program, it is hoped that it can make a better contribution because the resulting application can help users in their work for a certain period of time as desired.

Suggestions for future researchers:

1. The data used for further research should be the latest sales data so that the information generated is also the latest information.

2. In the next research, it is hoped that it can be compared using other methods to produce a better research.

The current application program is expected to be developed further so that it can be more efficient and effective.

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KERTAS KERJA

RINGKASAN

Metode *Algoritma K-means* yang bertujuan agar dapat membantu memutuskan pencarian jenis ikan tuna yang paling banyak transaksinya sebagai acuan untuk raw material yang akan dipenuhi stocknya, untuk digunakan sebagai bahan baku produksi maupun kebutuhan export raw material. Permasalahan utama pencarian jenis ikan tuna yang harus dibeli untuk kemudian akan menjadi raw material yang dimana akan mempengaruhi pasokan raw material ikan tuna yang akan digunakan untuk produksi maupun kebutuhan export. Namun untuk implementasinya, persoalan ini dapat dikembangkan lebih luas lagi diantaranya untuk mencari sizing ikan tuna yang dibutuhkan, jenis ikan tuna yang rasio rejectnya paling banyak, dll. Intinya adalah mencari solusi yang paling efektif yang dapat diterapkan dalam persoalan yang dihadapi.

Secara umum, terdapat tiga shortest path algorithm yang sering digunakan, yaitu Algoritma SAW, Apriori, K-Means. Setiap algoritma memiliki karakteristik dan kelebihan yang berbeda-beda. Hal inilah yang menyebabkan tidak semua algoritma dapat diterapkan dalam aplikasi ini. Pada aplikasi ini, tujuannya untuk membantu mencari suatu cluster jenis ikan tuna yang paling sering digunakan sebagai raw material produksi maupun export. Setiap jenis ikan tuna mempunyai tekstur daging yang berbeda-beda dan juga kadar estamin yang terkandung di dalam ikan tuna tersebut.

Untuk mengatasi masalah tersebut, maka peneliti mengimplementasikan algoritma K-Means ke dalam aplikasi untuk dapat membantu memberikan informasi tentang Cluster jenis ikan tuna yang sering digunakan dan mempunyai pengaruh terhadap kualitas untuk dipakai sebagai bahan baku produksi maupun export raw material.