Modeling Salesperson Performance Based On Sales Data Clustering

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***Abstract*— The case study in this research is a company in Indonesia. Currently, the company needs to assess the performance of salesperson, but it does not have yet criteria for classifying the salesperson's performance. The research purpose was developing salesperson performance model based on sales data clustering. The research is adopted CRISP-DM framework. As the result, the proposed model is connected with the prior sales order database. The model grab multidimensional features and classification data label from the database. The multidimensional features was formulated through Kohonen SOM clustering evaluation result with the value of quantization error was 0.95 and topographic error value was 0.13. The best multidimensional features are product, transaction, and monthly price. It can be concluded that the dimensional combination is considered capable of representing salesperson performance. Therefore, it can be used as base criteria or features in classification. The contribution of the research is built a new model of salesperson performance for the company.**

Keywords—Intelligent System, sales data analytics, salesperson performance, multidimensional clustering, self organizing map.

I. INTRODUCTION

Pattern recognition in sales data can be used in the business world. Pattern recognition can be used as a basis in determining a sales strategy. One part of pattern recognition is clustering. Clustering will form groups of objects with similar patterns [1]. By looking at the patterns created, it can be easier to understand market developments. Pattern recognition consists of four main models, namely detection, clustering, classification and identification. Clustering and classification are often confused so that the main difference is whether there is a class that is the key to grouping. In clustering, groups are created without any class rules (unsupervised). While classification has class rules that are used as the basis for grouping.

Data clustering, cluster analysis, segmentation analysis, taxonomy analysis or unsupervised classification is a method that used to create groups of objects or clusters, namely groups of similar or similar objects [1]. Clustering makes it possible to form groups of customers who have similar buying habits based on transaction history. Several studies that have implemented clustering in business are among others [2-16]. It is very important to segment customers because it allows marketers in decision-making to better tailor marketing efforts to different subsets of audiences in terms of sales, promotion, and development strategies [5]. In addition to customer clustering, product clustering can also be done based on transaction data [6]. Transaction data consists of a group of data with various data types, so it is important in the data clustering algorithm to carry out data normalization stages that affect the clustering results.

Some business objectives are carried out through clustering. Research [7-12] used clustering for sales forecasting purposes. Research [3,4,13] used clustering for the purpose of customer segmentation. There are also studies [6, 13,14] utilized clustering for product segmentation. Meanwhile research [15] for clustering sales agent turnover and research [16] conducted investigations on stock market prediction, sales forecasting and market segmentation. Table 1 described the dimension that was used on the clustering in sales data.

There are several types of clustering algorithms, including hierarchical clustering, fuzzy clustering, center-based clustering, search-based clustering, graph-based clustering, grid-based clustering, density-based clustering, and other algorithms [1]. Various traditional clustering algorithms have been implemented including the K-Means algorithm and its combination used by [7,12,13,24,25]. Hierarchical clustering and its combination are used by [8,25]. In intelligent systems, the Self Organizing Maps (SOM) algorithm can be used in the clustering process. SOM is an unsupervised neural network algorithm created by Kohonen. SOM is widely used in multidimensional data clustering [26-29]. Besides SOM, there is also a Genetic Algorithm used by [2].

TABLE I. CLUSTERING DIMENSIONS ON PREVIOUS RESEARCH

Dimension	Research
Product	Research [17-19]
Price	Research [20-21]
Product and Price	Research [22]
Product, Category, Profit/Price	Research [23]

The case study in this research is a company in Indonesia that territorially has 7 regions which oversee 61 regions. Each region has sales unit that has target in different territories and market segments. Based on interviews and observations, so far sales data storage is done through a centralized system. The available reporting features have not been able to display in detail according to the needs of the operational level. The Business Service Sales Unit in Bali region is already built a website that collect the sales order data in operational level. But both the systems did not have analytics report features yet. Every week the company held a sales evaluation that need many analytics information from the sales data. Currently, the company needs to assess the performance of salesperson, but the company does not have yet criteria for classifying the salesperson's performance. Therefore, this research needs to develop a model that can determine the dimensions that will be used in sales data classification for assessing the performance of salesperson. Previous studies have not discussed yet about salesperson performance based on sales data clustering. Some research studied about salesperson behavior and knowledge in affecting the sales performance [30-32]. The novelty of this research is using the sales data for making salesperson performance clustering and found the model for the company.

The research problem was how is the model of salesperson performance based on sales data clustering? The research purpose was developing salesperson performance model based on sales data clustering. This research was part of big research entitled Sales Analytics Dashboard with Multidimensional Performance Based Clustering and Smart Early Warning for Recognizing Market Pattern.

II. METHODOLOGY

The research object was the salesperson performance model based on sales data clustering. The research time was conducted in July-October 2022. The research case study was a company in Bali Indonesia. The research framework adopted from CRISP-DM (Cross Industry Standard Process for Data Mining) is shown in Fig. 1 that consisted of 6 stages, namely: (1) business understanding, (2) data understanding, (3) data preparation, (4) modeling, (5) evaluation, and (6) deployment.

The business understanding and data understanding stages were conducted by qualitative descriptive approach. The data collection techniques used were observation, in-depth interview, documentation studies and focus group discussion (FGD). The data preparation stage is related to all activities that had purposes to construct the dataset in order to be used in the model. The modeling stage is consisted of clustering process, cluster evaluation, and formulation of the best dimensional combination. Clustering process was conducted by Self Organizing Map (SOM) method that built with Python. The evaluation was done with purpose of model validity that was conducted by transferability, confirmability, credibility test and also dependability test. The transferability and credibility test were done by triangulation model that assessed the data with some different technics among others observation, in-depth interviews and also FGD. The audit process by the experts is conducted to the model for the confirmability and dependability test. Finaly the deployment stage will be done on the future step as the continuation of the big research entitled Sales Analytics Dashboard with Multidimensional Performance Based Clustering and Smart Early Warning for Recognizing Market Pattern.

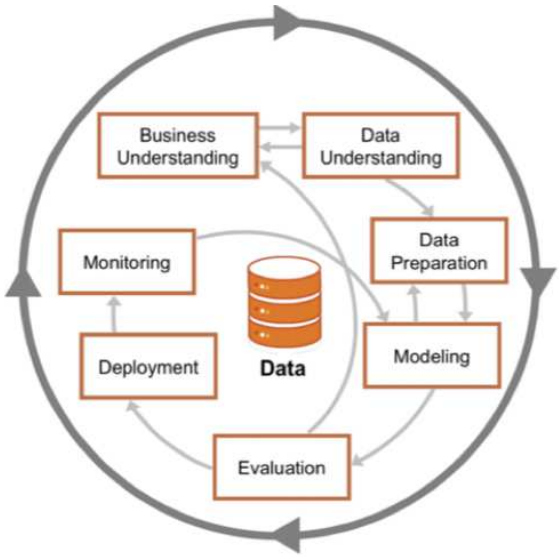

Fig.1. Research Framework Adopted from CRISP-DM [33]

SOM is a competitive learning mechanism. Kohonen SOM is an unsupervised Neural Network (NN) which is widely used to project high-dimensional data points into lower-dimensional space as shown in Fig. 2. Through the learning phase, each node or neuron competes with the others to get closer to the input data point. In the end, the map is constructed in this manner that similar input data points are grouped together.

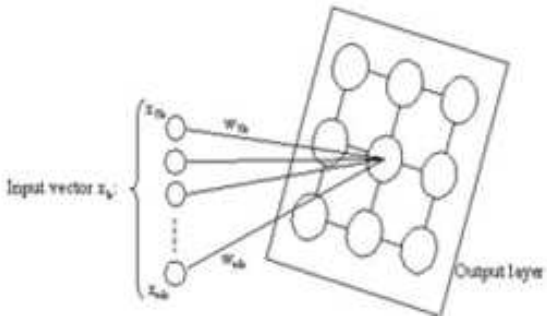

Fig.2. Self Organizing Map Topology

The SOM algorithm creates a low-dimensional matrix in the form of a lattice map where each cell is considered a neuron. Each such neuron has a weight vector of the same size as one of the input data points. This matrix is used to evaluate the distance of each input vector in the dataset from the weight of each cell. At the beginning of the training phase, a random initial initialization process is carried out on the weights used. Then, iteratively and for each data point, the nearest neuron, namely the neuron with the smallest distance to the data point, is found and is referred to as the Best Matching Unit (BMU). The BMU weights are updated, as well as the neighboring BMU neuron weights are also updated. The process is then continued with all data points during training. At the end of the training phase, each data point is assigned to a gridmap SOM cell. Similar inputs are grouped together around neighboring cells [29,34].

III. Result and Discussions

A. Business Understanding

The Business Service Unit Manager were the key resource person in the interview. Observations and documentation studies are carried out on the internal system of the business service unit, sales data and required reports. This first phase focuses on understanding goals and needs on the business side. This understanding is then converted into knowledge in determining data mining objectives.

Based on the interview, the manager gave the salesperson a weekly target counted by the number of transaction and also the total monthly revenue. The manager had to assess the performance of salesperson, but had not have yet criteria for classifying the salesperson's performance. The business objectives was to find out the multidimensional criteria for the salesperson's performance, after that find out the salesperson performance pattern. Which salesperson should improve or maintain their performance. Based on the observation, the sales data was organized on mysql database with website under wordpress. It made possible to grab the sales data and used it for clustering. Documentation studies also gave more knowledge for the research to develop a new model for assessing the performance of salesperson. Inline with the business goal, so the goal of data mining process was to formulate the best dimensional combination for salesperson performance through sales data clustering.

B. Data Understanding

This phase is done by collect initial data, describe the data, explore data and verifying the data quality. The sales data is shown by meta data view in Fig.3. On sales data year 2019-2021, there was 33 fields with 5008 rows of raw data that can be used in clustering. Based on business understanding result and the sales data fields in Fig.3, there were 5 candidates of clustering dimensions for assessing salesperson performance. The candidates was AM that stands for salesperson, product, transaction, status that stands for installment status, and bulanan that stands for monthly price. Fig.4 is an example of visualization for showing salesperson performance based on the number of transaction. Fig. 4 vizualized from one dimension perspective. This research need to make a new model that use multidimensional clustering for assessing the salesperson performance

Name	Type	Name	Type	Name	Type
am	varchar(2000)	lastbulanan	int(11)	end	date
alamat	varchar(255)	pic	varchar(255)	wdt_ID	int(11)
koordinat	varchar(255)	email	varchar(255)	tanggalinput	date
odp	varchar(255)	nipnas	varchar(255)	tanggalclose	date
segmen	varchar(2000)	ca	varchar(255)	noorder	varchar(255)
product	varchar(2000)	ba	varchar(255)	inputer	varchar(2000)
jumlah	int(11)	sa	varchar(255)	transaksi	varchar(2000)
satuan	varchar(2000)	quote	varchar(255)	status	varchar(2000)
paket	varchar(2000)	agreement	varchar(255)	namacustomer	varchar(255)
otc	int(11)	sid	varchar(255)	filekfs	varchar(2000)
bulanan	int(11)	startkontrak	date	keterangan	text

Fig.3. Meta Data View of The Sales Data

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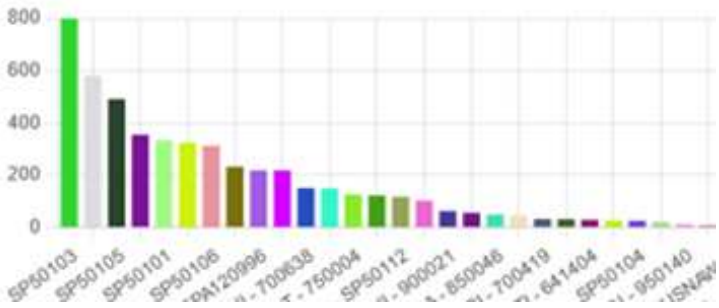

Fig.4. The Visualization of Salesperson Performance Based On The Number Transaction.

C. Data Preparation

The data preparation phase is all activities that was done to create the final dataset. The raw data was selected, cleaned, constructed, integrated and reformated. The dataset will be entered into the model created. Because of the purpose to find the best combination of dimension, this phase prepared 14 forms of dataset that will be used on clustering processes. The dataset forms can be seen in Table II.

TABLE II. DATASET FORMS

Name	Number of Features	Features Representation
Dataset 1	42	the number of transactions for product 1-27, the number of transactions for transaction 1-9, and the number of transactions for status 1-5.
Dataset 2	36	the number of transactions for product 1-27, the number of transactions for transaction 19
Dataset 3	27	the number of transactions for product 1-27
Dataset 4	32	the number of transactions for product 1-27, and the number of transactions for status 1-5.
Dataset 5	14	the number of transactions for the type of transaction 1-9, and the number of transactions for status 1-5.
Dataset 6	9	the number of transactions for the type of transaction 1-9
Dataset 7	5	the number of transactions for status 1-5.
Dataset 8	5	salesperson, product, transaction, status, monthly price
Dataset 9	4	salesperson, product, transaction, monthly price
Dataset 10	3	salesperson, product, monthly price
Dataset 11	5	salesperson, product, transaction, status, monthly price
Dataset 12	4	salesperson, product, transaction, monthly price
Dataset 13	3	salesperson, product, monthly price
Dataset 14	3	product, transaction, monthly price

D. Modeling

The steps on modeling phase are consisted of clustering process, cluster evaluation, and formulation of the best dimensional combination. Clustering process is done using the Self Organizing Map (SOM) method. SOM is a very useful neural network for data visualization and analysis. To evaluate the quality of the feature map produced by SOM, two indicators can be used, namely the quality of learning and the quality of projections. Learning quality indicators are determined by measuring quantization error (QE). Projection quality indicators are determined through topographical error (TE) measurements. If the QE and TE values are small, then the feature map will be rated with good quality [35]. Evaluation of clustering according to reference [35] is done by calculating the quantization error and topographic error first and then conducting a small group discussion to determine the best dimension.

The clustering stage is implemented with the python programming language. Based on [36] it is stated that the Python programming language is reliable for data analysis and interactive, computational exploration and data visualization. Python provides great functionality for handling math, statistics, and scientific functions. In this research, the Python libraries used are numpy, pandas, matplotlib, MiniSom.

The clustering program was carried out with dataset on Table II. Determination of the size map on the SOM is in accordance with the documentation in the MiniSom library, namely to adjust the size of the grid in reducing dimensions, the grid must contain 5*sqrt(N) neurons where N is the number of samples in the data set to be analyzed [36].

Based on the cluster evaluation results in Table III and IV, there were four combinations of dimensions that have the best QE and TE values, namely the dimensions on dataset 3, dataset 6, dataset 12, and dataset 14.

TABLE III. CLUSTER EVALUATION PART I (SIZE MAP 5X5, LEARNING RATE 0,5)

No of Samples	Dimension	Dataset	q_error	t_error
27	42	Dataset 1	3.43	0.27
27	36	Dataset 2	2.29	0.23
27	**27**	**Dataset 3**	**0.482**	**0.15**
27	32	Dataset 4	0.86	0.42
27	14	Dataset 5	2.54	0.38
27	**9**	**Dataset 6**	**0.83**	**0.04**
27	5	Dataset 7	0.43	0.35

One of the results of the clustering is shown in Fig. 5. The cluster with many members was the cluster for extension and new installation transactions with the type of product that was the target of sales.

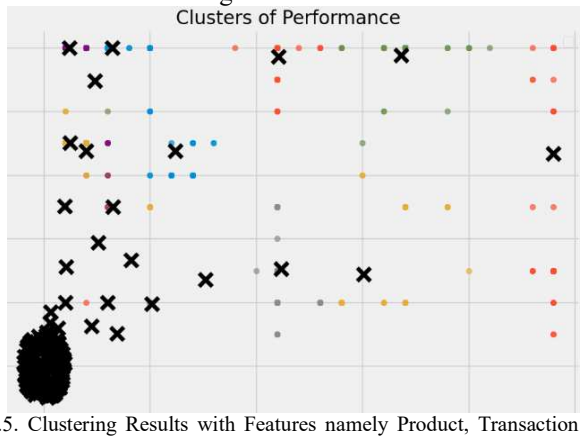

Fig.5. Clustering Results with Features namely Product, Transaction and Monthly Price

TABLE IV. CLUSTER EVALUATION PART II

No of Sample	Size Map	Learning rate	Dataset	q_ error	t_ error
1734	20x10	0,5	Dataset 8	2.52	0.23
1734	14x15	0,5	Dataset 8	2.28	0.34
1734	17x12	0,5	Dataset 8	2.66	0.43
1517	15x13	0,5	Dataset 9	2.29	0.483
1517	19x10	0,5	Dataset 9	2.29	0.13
1510	15x13	0,5	Dataset 10	1.74	0.24
1510	19x10	0,5	Dataset 10	1.59	0.27
1734	20x10	0,7	Dataset 11	2.33	0.35
1734	14x15	0,7	Dataset 11	1.98	0.37
1734	17x12	0,7	Dataset 11	2.19	0.23
1517	**15x13**	**0,7**	**Dataset 12**	**2.85**	**0.10**
1517	19x10	0,7	Dataset 12	1.99	0.32
1510	15x13	0,7	Dataset 13	1.39	0.41
1510	19x10	0,7	Dataset 13	1.29	0.28
1517	15x13	0,7	Dataset 14	0.66	0.26
1517	**19x10**	**0,7**	**Dataset 14**	**0.95**	**0.13**

The last part of modeling phase in this research is formulation of the best dimensional combination. The best dimensional combination that was used in sales data clustering was dataset 14. Dataset 14 is consisted of product, transaction and monthly price with a map size of 19x10 and a learning rate of 0.7.

Based on the previous stages result, the model of salesperson performance for this research was designed as shown in Fig.6. The model is connected with the prior sales order database. Then from the database, the model grab the data and make dataset with features namely: (1) product, (2) transaction, and (3) monthly price. The multidimensional features depend on the best dimensional combination result on formulation stage. Beside the multidimensional performance dataset, the model also grab the label of classification for labeling the salesperson performance on the next step. Finaly the dataset and data label will be used in assessing salesperson performance by salesperson classification as shown in Fig 6.

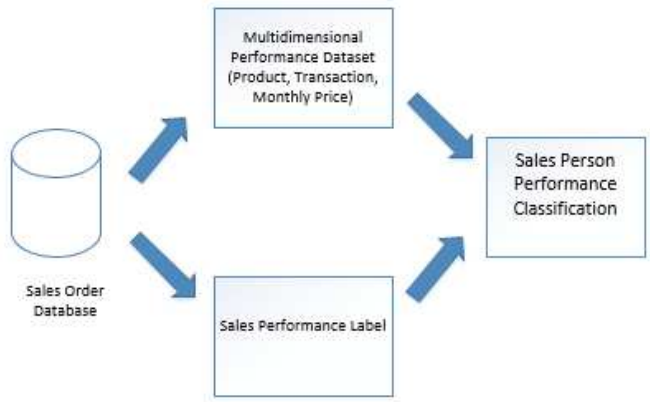

Fig.6. The model of salesperson performance based on sales data clustering

E. Evaluation

The proposed model is validated using a triangulation technique by examining the data that has been obtained through in-depth interviews, observation, and also FGD. In addition, an audit process is also conducted. The observation process was conducted on the prior website. The observation process is done by examining the data grabbing process. In-depth interviews were carried out with sales manager as the business owner. The next step was an FGD that involving the salesperson and the sales manager. A user acceptance test (UAT) prepared for the FGD, the participants filled out the UAT form and validated the proposed model.

The result of the observation and interview was indicated that the proposed model has met the business goal. In line with the result of the FGD that the participants agreed and stated that the model is valid to be deployed. Therefore, the triangulation model concluded that the proposed model was valid and agreed to be implemented.

The proposed model has been presented to the experts from *Politeknik Negeri Bali* and DIKSI *Kementerian Pendidikan, Kebudayaan, Riset dan Teknologi Indonesia.* The presentation is carried out for the audit process and got valid result for it.

IV. Conclusions And Future Work

The model of salesperson performance based on sales data clustering was conducted by research framework that adopted from CRISP-DM framework. The model is connected with the prior sales order database. The model grab multidimensional features and classification data label from the database. The multidimensional features was formulated through Kohonen SOM clustering evaluation result, among athors: (1) product, (2) transaction, and (3) monthly price. It can be concluded that product, transaction and monthly price was the best dimensional combination that are considered capable of representing salesperson performance. Therefore, it can be used as base criteria or features in classification. For future work, the research can continue with the deployment stage by integrating the model into sales analytics dashboard, so the dashboard will completed by early warning of salesperson performance.

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