Performance Measurement Using the Balanced Scorecard and Business Intelligence in Logistics Companies

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Abstract

Smart companies should have technological advantages to improve their performance. The research used is a case study of courier and cargo business in collaboration with a rail transportation company. The existing data is processed by applying a Balanced Scorecard and Business Intelligence which aims to support decisions and get great benefits for the company. Data is retrieved for 3 months in the data warehouse. Data operations and processing are carried out to determine which perspectives have a great influence and will help stakeholders in the company get accurate results from patterns. The use of decision tree c 4.5 is used to support the analysis and result in an accuracy of more than 70%. The Kimball Method is used to assist in performance monitoring of data warehouses, customer and financial analysis as well as learning before decision making is made.

Key words: Courier and Cargo, Balance Scorecard, Business Intelligence, Data Mining, Data Warehouse, Decision Tree

I. INTRODUCTION

Logistics performance measurement is adjusted to the percentage of occupancy. Occupancy is determined as the proportion of vehicles covered by vehicles with consideration of composition and traffic speed [1]. The research uses a case study in a logistics company based on rail transportation. With railroad logistics transportation becomes faster than land transportation because it has its own lane. The train used is a lease from a state-owned company. The rental value used remains in accordance with the contract. Therefore, occupancy must be increased by each train by 70% allocated to increase profits. The company also has branches in each region, so the train modes used are also different. As companies realize the benefits of improvised logistics, attention is increasing on seeking more process integration [2]. In supporting policies in an organization, information is needed for performance measurement. Thenformed the performance measurement system [3]. One form of performance measurement system is the Balanced Scorecard (BSC) [4]. Nobody likes other renewals agreed on oversight, BSC provides opportunities for member motivation to achieve goals that support long-term vision [5]. The BSC can also foster communication between several divisional units in the organization, to enhance strategic development, implementation, and performance of actions [6]. BSC is well designed because it consists of goals and actions that are interrelated, consistent and mutually reinforcing [7]. BSC has been widely used as a strategy and supports performance in the private sector in the world [8]. In logistics companies also have applications that are used to record operational activities. But the data has not been used to analyze data. Business Intelligence (BI) is also an integrated architecture and operational data collection for decision acquisition applications and databases that provide business protection access to business data [9]. In addition, data analysis must be a primary and vital requirement in enhancing the competitiveness of businesses or corporate organizations [10].

Data Warehouse is one of the dominant components of BI, which has been widely adopted as a result of a system database developed to retrieve results [11]. A data warehouse is a subject-oriented database that is relevant at certain times that is collected and integrated and has the aim of supporting decision making [12]. BI influences the sharing of knowledge in organizations through the provision of data, knowledge, and information [13]. BI is a concept that encompasses the techniques and methods used to support high-level tools to serve analytical purposes to support decision makers [14]. The BI system is an opportunity for companies to quickly and effectively use the information it gets and turn it into a useful knowledge that allows them to fulfill their business objectives. The business objectives of each company are different, even if the company is engaged in the same field. Being the

focus and similarity in any company is that the BI system should improve organizational knowledge management in a strategic, tactical and operational sense. At the strategic level they allow for more precise targeting, quick and no follow-up. They make it possible to create a variety of comparative comparisons, such as historical results, profitability, distribution efficiency, up to development simulations, and future estimated results based on certain assumptions.At the level of the BI tactical system can provide a basis for assisting decision-making in marketing, sales, finance, capital management. BI enables to optimize the future actions that have been obtained in previous processes and modify the organizational aspects, finance and technology functions of the company, so that they meet the strategic objectives. At the operational level, BI analysis is conducted by responding to inquiries relating to the operations department, state finances, sales, cooperation of countries with suppliers, customers, clients, and other more cooperative [15].

Organizations that succeed in changing performance management such as BSC and strategy mapping, then choose a framework that suits strategic objectives, and use BI solutions to collect data needed to optimize performance [16]. A well-designed BI system makes all information produced in all organizations and markets available with reliable and quality [17]. To survive, companies and other organizations need a competitive advantage to get better information so knowledge management is needed. Collection of information about organizing, BI related to the submission and analysis of information within and outside the organization, and management of knowledge about the mastery of information and competencies in the organization [18]. To get a specific KPI (Key Performance Indicator) data mining techniques are used. The data mining classification algorithm uses a Decision Tree that can classify aspects that are approved for KPI.

From this background, the formulation of the problem will be discussed here regarding how to design BI in the Courier division with the Balance Scorecard Model, how BI can help monitor the performance measurement of the application database, how the Balance Scorecard model is dynamically visualized for performance measurement, and how Decision Tree can be used as pattern analysis to achieve company goals, namely occupancy of more than 70%.

II. THEORITICAL BASIS

A. Balanced Scorecard (BSC)

BSC was created in 1990 by Kaplan and Norton, and was one of the management tools and technologies that were not popular at the time, but became popular today [19]. BSC has four mutually inclusive perspectives namely learning & growth, internal business, finance and customer. Each perspective addresses unique but inherently related problems. Customer preparation addresses issues about how organizations respond and satisfy customer needs. Internal business discusses the processes that must be mastered by the organization. The learning and growth perspective addresses the problem of how organizations improve and create value continuously. The financial perspective addresses the issue of how organizations view their finances [6]. The application of the BSC in the strategic management process is targeted at clarifying the vision and strategy, communicating and linking goals and actions, planning strategic initiatives, and improving feedback and learning [20]. Indicators are ranked according to their importance for the particular organization for which the measure is calculated [25].

B. Business Intelligence (BI)

BI is a processing process consisting of extracting, transforming, analyzing and processing data to support the decision-making process [21]. Bi is also used to support companies in achieving various success criteria such as assisting in decision making, shortening the product development cycle, accelerating operations, creating a better and more focused market, maximizing the value of available products, improving supplier and customer relationships and anticipating new opportunities [9].

The BI process uses five processing steps, starting from data sourcing, then data analysis, followed by situation awareness, risk assessment, and finally decision support will be obtained. A data source is extracting data from various data sources that have been selected from various business units that have been targeted. Data analysis is the stage of data being converted into information or knowledge through various analysis techniques such as visualization and data mining. Situation awareness provides a deeper understanding of current situational decisions based on the results of data analysis. Risk assessment is an awareness of various situations that can help managers and stakeholders to predict the future, identify threats and exploit opportunities, and how to respond according to needs. The decision support stage is BI's main goal that can help managers make informed decisions based on current business data [21].

C. Data Mining

Data Mining is a technology used to predict from a data obtained or perform analytics on the domain [22]. Data Mining is usually used to find and sort between useful and unexpected knowledge. From the analysis of data generated in various types / models of systems and processes, continued through the disclosure of behavioral patterns that serve for strategic decision making [23].

III. RESEARCH METHODS

This section is a chronology of the approach using the BSC framework. Research that uses case studies in logistics companies that transport mainly

uses trains. Based on the results of the discussion, literature study, we get Figure 1 as the framework used in research :
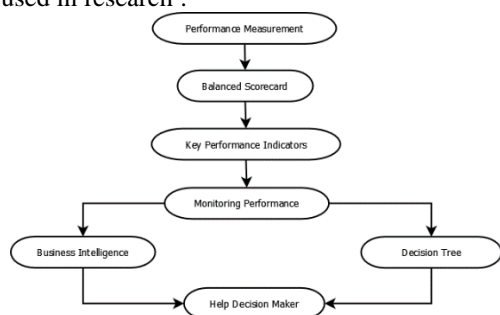

Figure 1: Research framework

Problem indicator is monitoring of performance measurement. The proposed method is to make performance measurements using the Balanced Scorecard (BSC). In the BSC there are KPIs that must be monitored. For monitoring is to use Business Intelligence (BI). BI can make it easier for users to make decisions from the graphics and dashboards that are displayed. But to get a pattern of how occupancy can reach targets greater than 70%, the data mining technique uses the decision tree C4.5 algorithm. With the presence of decision tree C4.5, we will find out how occupancy patterns above 70% are formed to help decision makers. In research conducted by Elacio *et al*, machine learning using C 4.5 algorithm strongly supports human resource management in identifying and archiving employees. The calculations use Herzberg theory motivation which combines an applied and experimental evaluative approach with employee satisfaction and dissatisfaction indicators. The result of decision tree is less time-consuming and has fast classification speed, which can avoid decision error and deviation of all kinds [24].

Based on the interview results from the Vice Precident courier division at the case study site, the BSC parameters used consisted of total transportation costs, profit loss, total tonnage, total revenue, tonnage capacity, active outlets, number of active users, and total transaction errors. BSC grouping as in Table 1.

Table 1: Business Scorecard Grouping

Aspect	Measurement	Target
Financial	Total shipping mode cost	Greater than the specified target
	Profit & Loss	Increased from the previous day
Customer	Total tonnage	Greater than previous tonnage
	Total income	Greater than previous income
Internal Business	Mode tonnage capacity	Total load of goods reaches the maximum

	Target		
	capacity		
	Total outlet active	The active total outlets must match the total outlets available	
Learning and Growth	Number of users	The number users must same the total number registered	
	Total void	Min 0 void transaction	

In addition there is a grade for each perceptive achieved. This is to get the final value for BSC. The following Table 2 displays the balance scorecard grade used.

Table 2: Grade Balanced Scorecard

Measurement	Target	Grade	Score
Total shipping mode cost	Greater than the specified target	A	3
	Same with target	B	2
	Smaller than the specified target	C	1
Profit & Loss	Increased from the previous day	A	3
	Same with the previous day	B	2
	Less from the previous day	C	1
Total tonnage	Greater than previous tonnage	A	3
	Same with the previous day	B	2
	Less from the previous day	C	1
Total income	Greater than previous income	A	3
	Same with the previous day	B	2
	Less from the previous day	C	1
Mode tonnage capacity	Total load of goods reaches the maximum capacity	A	3
	Total load of goods same the maximum capacity	B	2
	Total load of goods less the maximum capacity	C	1
Total outlet	The addition	A	3

active	of outlets		
	The active total outlets match the total outlets available	B	2
	The active total outlet less than the total outlets available	C	1
Number of users	The addition of users	A	3
	The active total users match the total users available	B	2
	The active total users less than total users available	C	1
Total void	Min 0 void transaction	A	3
	Void transaction less than 20	B	2
	Void transaction more than 20	C	1

From the BSC grouping, data collection is then performed. From interviews with IT, data based on BSC parameters can come from various sources, such as human resources development application databases, freight forwarding application databases. Therefore a data warehouse is created. To design a data warehouse, several stages of design are needed, namely process selection, grain selection, identification and dimension adjustment, fact selection, pre-calculation storage in the fact table, adding an explanation to the dimension table, selecting database duration, determining methods for changing dimensions, and determining priority and query mode [12]. To do the data warehouse design, the selection process that is done is the calculation of user data that performs daily transactions, the calculation of branch data that performs transactions, and recording the daily transactions of railways. Grain selection is based on measured measurement data. Identification and adjustment of dimensions, namely dimensions, day, month, date, train, and daily transactions per train. The table fact are selected using the calculation of the weights from the BSC. There is pre-calculation stored in the fact table such as Table 3 guides.

Table 3: Guides Calculation Fact Table

Aspect	Total Indicator	Score Indicator	Weight	Weight Indicator	Weight-ed Score Max
Financial	2	3	26	13	78
Customer	2	3	25	12.5	75
Internal Business	2	3	25	12.5	75
Learning and Growth	2	3	24	12	72

The duration used in processing the database uses 2022 in March to Mei. The next step is to determine the response if there is a change of each record in the dimension table. The final stage of Kimball's nine-step method is deciding the physical design, which is mapping logical designs into a data warehouse and converting the entities to be visualized. In disiding the physical design using the star schema shown in Figure 2.
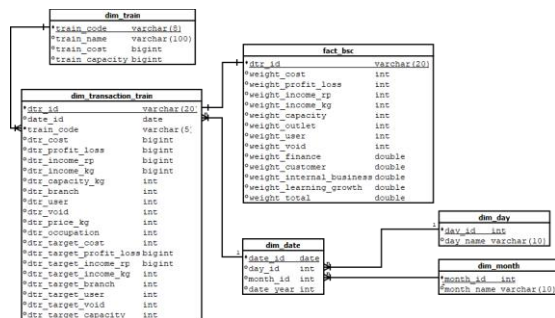

Figure 2: Data Warehouse Schema

The software used to do DW is Pentaho Data Integration version 9. To create a Business Intelligence display using Power BI software. Meanwhile, to do the data mining process, using Rapid Miner. The algorithm used uses the C4.5 decision tree.

IV. RESULT AND DISCUSSION

In this section consists of the design implementation of each process consisting of system design and evaluation phase.

A.   System Design

The first part of the system design is Extract, Transform, Load (ETL) which is required to move operational data to the data warehouse. The following Figure 3 is the result of the ETL implementation.
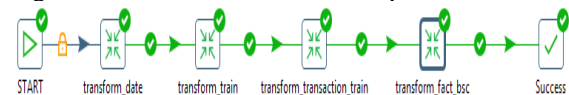

Figure 3: Extract, Transform, Load Design

In Figure 3 the start process is used to load data into the dimension table and fact table. Each data entered follows the contents of the data warehouse scheme in Figure 2.

After the start, it continues to the transform date stage, which contains data that is loaded for date purposes in the date (*dim_date), dim_month,* and *dim_day* dimension tables. Each section has variables that must be filled in by paying attention to the data name, data type, date format, data length and others. The next process is the transform train. Contains data loaded for the purposes of the mode of delivery of

goods. The ETL process for train dimensions is to use table input, select value and dimension update data warehouse. Each table still contains variables that must be filled in, such as product name, description to capacity.

Next is the transform transaction train stage, which contains data for the needs of railway and calendar revenue transaction data. Inside the table consists of a dimension field, stream field and type of dimension. The data that need to be filled in are dates, train code, profit to income. Continue to the transform fact transaction stage. Data contained for the purposes of transaction facts from the proposed Balanced Scorecard (BSC) method. At this stage it contains a fairly long stage which can be seen in Figure 4.
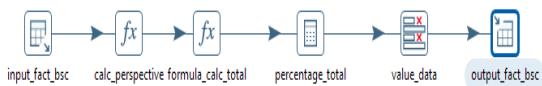

Figure 4: ETL fact transaction

Data entered into the table such as transaction code, weight profit-loss, weight capacity train, weight income, weight cost to weight void. Each table content has a threshold value which is categorized with values 1-4 which means the higher the category the better. So at this stage it is also necessary to make a perspective calculation formula. The perspective calculation function is used to calculate the perspective weight with its parameters. Perspective parameters can be seen in Figure 5.
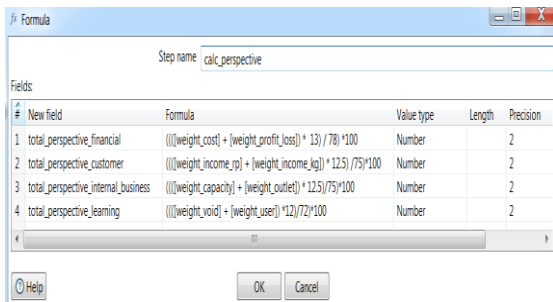

Figure 5: ETL Calculation Perspective

The perspective values must be added up and rounding is required so that there are no commas. Before getting the output value, the value data stage must be completed. The data entered is a combination of all previously entered data such as transaction code, income weight, profit to capacity, and the total value from the calculation perspective in Figure 5. Next is a picture of the grand total BSC which can be seen in Figure 6.
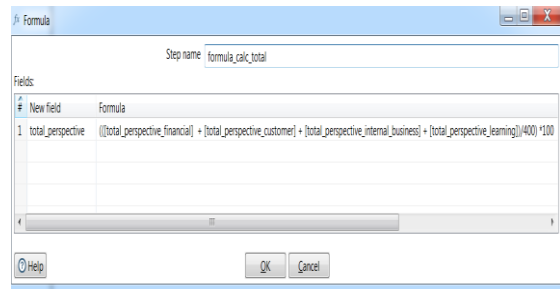

Figure 6: Formula Final Score BSC

The output above will be taken to the data warehouse to collect all incoming data including the results of the analysis prior to implementation in business intelligence.

The next stage displays the results of the business intelligence design using Power BI and the entered and processed database. As expected, the expected data value is not less than 70%. The following is Figure 7 and Figure 8 which show the dashboard of the results of the business intelligence design.
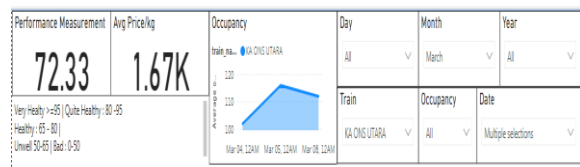

Figure 7: Header Dashboard Power BI result

Figure 7 above shows the total profit & loss, occupation, and the average price / kg obtained, displayed in the header section as the main part of the dashboard.
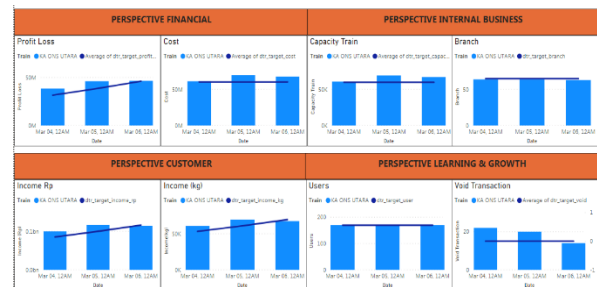

Figure 8: Power BI Dashboard

Figure 8 above shows the appearance of financial, internal business, customer to learning & growth. A detailed explanation will enter the evaluation phase.

B. *Evaluation Phase*

At this stage, explained more concretely the results carry out of the system design. In this section, the BI power dashboard display functions for decision makers who can find out the value of profit, the occupancy target is achieved or not, and the average selling price made. If the results of the target occupation indicator are green, it means that it is safe, and the company's goals have been achieved, but if the results of the indicator are red, the decision makers must see whether other parameters have also

decreased such as financial, customer, learning growth, and also internal business so that an evaluation of the related parameters is carried out quickly. The following is a Figure 9 to find a financial perspective.
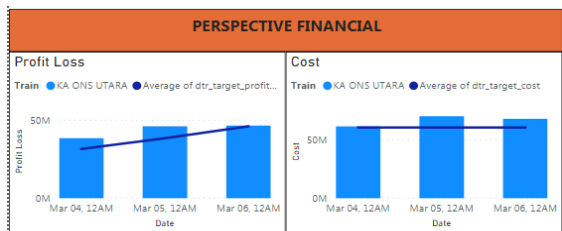

Figure 9: Financial Perspective Result

The parameters displayed are financial aspects to measure organizational finance such as total cost of transportation and profit / loss. The target to be achieved is the total cost of transportation Greater than the specified target. In profit / loss the target must be greater than the previous day. Therefore this dashboard was made in order to get information about the financial perspective. The blue line is the target to be achieved. The target line indicates that the KPI for the financial aspect was achieved because the bar was above the target.
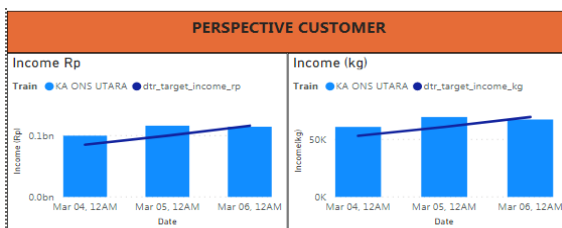

Figure 10: Customer Perspective Result

In Figure 10 customer aspect to measure the performance of customers in a logistics company. The measurements used are total tonnage and total revenue. Total tonnage of shipments must not be less than the previous day, as well as total revenue. The blue line is the target to be achieved. The target line indicates that the KPI for the customer aspect was achieved because the bar was above the target.
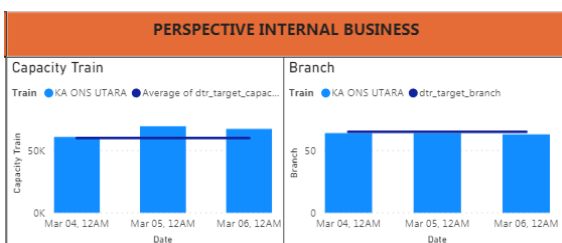

Figure 11: Internal Business Perspective Result

Figure 11 is an internal business aspect that is used to measure the internal business of an organization. The measurements used are capacity train and total outlets. The measured capacity train is not allowed to go down from before. The total outlets measured are not less than the number of registered - active outlets.
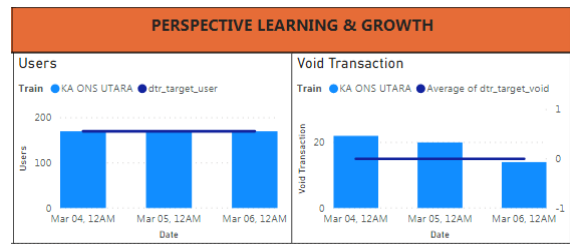

Figure 12: Learning and Growth Perspective Result

Figure 12 is an aspect of learning & growth that is used to measure learning and growth of a logistics company. The measurement is the total transaction void which has min 0 errors. The next measurement for Learning & Growth is that the total active users per day must be in accordance with the number of users registered in the HRIS (Human Resources Information System) application.

The results in Figure 7 and the overall process of financial perspective, customer, internal business, learning and growth perspective, the occupancy target that must be achieved is not less than 70%. From the results obtained, it can be concluded that the occupancy value obtained reaches over 70%. While the value of the BSC is 72.33 and includes a healthy performance.. So that the target can be met, the leaders have to train application users to be more careful in using the program, or investigate the developer section. If the total number of application users per year does not reach the KPI target, which is increasing by 2, and also the occupancy target decreases, the leadership must add more users so that their occupancy can increase.

Data mining is needed to increase confidence in making decisions. The data mining process uses Rapid Miner. The steps taken are in Figure 13.
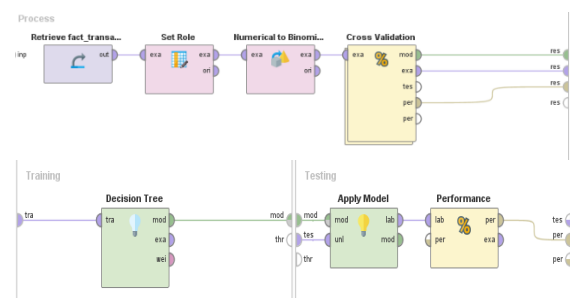

Figure 13: Decision Tree Process Design

The process of data mining aims to make a classification of occupancy numbers to achieve business objectives. Processing starts with retrieving data derived from the database table *fact_transaction* and *avg_occupation* parameters for the operator attribute numerical to binominal with a value of min 0 max 70 and K-fold value = 10. If the 0-70 *avg_occupation* is worth false, the above is true. Next Figure 14 decision tree results.
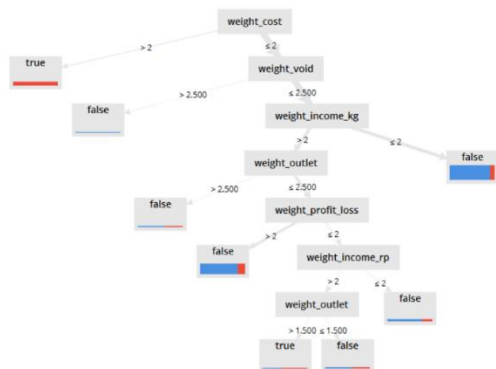
Figure 14: Result Decision Tree Model C4.5

If we look at Figure 14, KPI weight cost dominates. This means that the cost must have grade A, that is, the capital cost must be greater than the target. Costs incurred affect occupancy to reach a value of 70%.

After knowing the overall score, the final stage is to conduct a questionnaire on all elements of the XYZ company. In Table 4 below there are several categories namely totally disagree (TD) 1 point, disagree (D) 2 points, neutral (N) 3 points, agreement (A) 4 points and strongly agreement (SA) 5 points. SA indicates that the implementation went as desired and TD indicates there is an incompatible outcome.

Table 4: Questionnaires

No	Question	Answer					Weight
		TD	D	N	A	SA	
1	How do users respond to BI's implementation of performance measurements in the Courier division?				6	4	44
2	How do users respond to BI deployments using dashboard in performance measurement of the expedition Courier division?				3	7	47
3	Can the BSC model be used in the performance measurement of Courier-Expeditions?				5	5	45
4	Can BI be used to make it easier to share knowledge about the performance of Courier-Expeditions?				2	8	48
5	Is BI with the dashboard technology of BSC models can be used to innovate the organization?				4	6	46

The value of this questionnaire is to find out that the results of high accuracy are proportional to the satisfaction resulting from the implementation of BSC and BI for business purposes. There are 10 correspondents with partitions, namely VP Courier, Operations Manager and operation staff. Most of the answers to this questionnaire agree and strongly agree. From the questionnaire, it can be concluded that the user strongly agrees to use the dashboard in measuring the performance of the courier division. In addition, BI also makes it easier to share knowledge.

Based on the available literature, BSC is a tool used for performance measurement, and BI is used as a tool for monitoring. The purpose of BI is to assist decision-making sourced from data warehouses. BI can be used as a performance measurement based on date, month and mode of transportation. The use of data mining can make it easier to use to get the best pattern for achieving business goals. In addition, the existence of a data warehouse facilitates the user in making reports. The results of performance measurements and occupancy values are displayed in a dynamic form using BI. The results obtained with the existence of BI, is a knowledge organization that can help decision makers to develop logistics companies. And with this generated value, the company is definitely supporting the decision of the report results. And find it easier to operate until the reporting process of each business action is executed.

V. CONCLUSION

The results of this study show that BSC and BI have much significance in the world of business logistics because it effectively holds the right information, effective business data, and valuable knowledge. This can have an influence on better business decision-making. The BI system can help executives better understand the implications of various organizational processes and enhance their abilities and make it possible to plan strategically for a successful future. Suggestions for further research are to decide trends in sales in the logistics and distribution areas. And the addition of models of some algorithms and case studies that have larger and varied data.

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