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IMPLEMENTATION OF BUSINESS INTELLIGENCE FOR SALES PREDICTION AND INVENTORY OPTIMIZATION AND MAINTENANCE IN SME CARTON BOX COMPANY WITH OPEN-SOURCE APPLICATION

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Abstract:
This study aims to implement business intelligence (BI) as a solution to the challenges faced by the carton box manufacturing company in improving operational efficiency and supporting data-based decision-making. The main problems include inaccuracy in sales forecasting, which causes an imbalance between demand and stock; inefficiency in inventory management, resulting in overstock and stockout; and a reactive maintenance approach, which results in significant machine downtime. In addition to overcoming these problems, this study uses various methods such as Artificial Neural Networks (ANN) to improve the accuracy of sales predictions, Economic Order Quantity (EOQ) and Material Requirements Planning (MRP) for inventory optimization and Overall Equipment Effectiveness (OEE) to improve maintenance efficiency. The Power BI platform is the primary analytical tool to visualize data, identify patterns, and support decision-making. The results of the BI implementation show significant improvements in various aspects of the company's operations. Sales predictions become more accurate with ANN, which allows the company to manage stock more efficiently and reduce storage costs. Analysis using EOQ and MRP successfully reduced the risk of overstock and stockout, while applying the OEE method increased the machine's availability, performance, and operational quality. Data visualization with Power BI provides deeper insights for management, facilitates problem identification, and supports faster and more precise strategic decision-making.

Key words: analytical neural network, business intelligence, maintenance management, material requirement planning

INTRODUCTION

Globalization and increasingly tight business competition today have made information technology essential to a company's success in making decisions and managing data [1]. The company's system and system that has an important role is ERP. ERP (Enterprise Resource Planning) can help companies manage daily operations more effectively, reduce operating costs, and increase productivity by integrating the company's internal functions, namely finance, human resources, production and logistics services, in one integrated system [2]. In addition, Big Data Analytics technology allows companies to predict invisible patterns, market trends, and customer preferences by analyzing data quickly and in large quantities [3].

Business Intelligence (BI) helps companies generate useful information by gathering, storing, and analyzing data. With BI, companies can optimize their business operations and target market segments to understand market trends better. All decisions can be made clearly and with accurate data [4].

Companies must be able to make decisions using correct data quickly. Carton Box Company collaborates in the manufacturing sector and faces obstacles to balancing market demand, available commodities, and operational efficiency [5]. Another problem is the inability to forecast sales, resulting in an imbalance between supply and demand. This imbalance can affect performance centrally [6]. In addition, it will be challenging for Carton Box Company to optimize inventory; errors in managing inventory locations will cause regular waste and even production constraints. In addition to helping the business grow, stock management must also be considered [7]. Usually, safety stock is an extra inventory system for security (carried out by companies) due to high demand and uncertainty in the supply chain. Companies must keep a specific reserve inventory to reduce the risk of running out of stock when demand is high [8]. The purpose of applying safety stock is to maximize profit, prevent fluctuations in market demand, facilitate the process of scheduling goods production, and determine inventory according to the amount needed. Inventory that is too large will slow down the turnover of money, and inventory that is too small will cause stockout problems [9].

It is related to asset maintenance, such as production equipment, which is crucial and also a factor determining the smoothness of the company's production process. This study found that errors in supervision and maintenance can cause unexpected downtime and reduce productivity, thereby increasing operational costs. The absence of support from sophisticated analytical tools often makes this process less effective and causes a high risk of prediction processes involving errors [10].

Carton Box Company is a manufacturing company that produces cardboard boxes in the packaging field. Carton Box company produces cardboard boxes through various production processes, from corrugators to Flexo printing machines and quality control checks. The output produced in the production process is cardboard boxes, die-cut boxes, partitions/layers, and sheets. In the production process, there is production scheduling, production supervision, and control of the availability of raw materials [11]. Currently, the carton box company only forecasts sales with assumptions based on sales data from the previous month. Therefore, the forecasting is still inaccurate because it is not based on accurate data and is adequately analyzed [12].

Therefore, this study aims to determine how implementing Business Intelligence and open-source applications can improve sales prediction, inventory optimization, and maintenance efficiency at Carton Box Company. The results of this study are expected to provide suggestions for companies in managing data and information to support them in making better decisions.

LITERATURE REVIEW

Business Intelligence and Power BI

Business Intelligence is a term used for the process or tool used to collect, analyze, and visualize data in a business. Business Intelligence can support companies in making better and more strategic decisions by utilizing available data [13]. Companies use Business Intelligence to transform raw data into meaningful and valuable information for the company. Business Intelligence is a series of processes, technologies, and tools that aim to transform data into information and information into knowledge for companies to improve the quality of decision-making [4]. Meanwhile, BI is not a product or system. BI is a collection of integrated operational applications and databases so companies can easily access business data to make decisions [14]. With BI and combined with company strategy, BI will analyze historical data to find appropriate business operations. Business Intelligence has several essential roles in the company. The following are some of the primary roles of BI in the company [15].

For several reasons, power BI is often the top choice over other Business Intelligence applications. First, Power BI has a user-friendly and intuitive interface, making it suitable for technical and non-technical users. Second, Power BI is well integrated into the Microsoft ecosystem, such as Excel, SharePoint, and Azure, making it easy for users to process and analyze data without obstacles. Third, this application offers a variety of advanced and interactive data visualization capabilities, helping users convey information in an engaging and easy-to-understand way. In addition, Power BI has a competitive price, with a free option through Power BI Desktop and affordable paid versions for more complex needs. Fourth, Power BI supports connections to various cloud and on-premises data sources, providing high flexibility in data processing. Finally, Power BI's large user community and active support from Microsoft make it easy to learn, with many resources and solutions available to help solve various challenges. This combination of features makes Power BI an efficient, flexible, and economical choice for various business data analysis needs [16].

Forecasting and Analytical Neural Network

Sales forecasting is a process to estimate the number of products or services that can be sold by a company in a certain period of time in the future. Sales forecasting is essential for companies because it can affect production planning, inventory management, resource allocation, marketing strategy, and financial planning. The following is an explanation of the purpose of sales forecasting, namely [17].

1. The Moving Average (MA) method is a simple yet effective forecasting technique, especially when sales data shows a stable pattern without clear trends or complex seasonal fluctuations. Moving Average works by calculating the average of several consecutive historical data periods to predict the next period. This method assumes that the future will be similar to the past regarding data behaviour. The Simple Moving

Average (SMA) calculates the average of the last n data periods [18].

$$MA_n = \frac{1}{n}\sum_{i=1}^{n} X_{t-i} \quad (1)$$

description:
MA_n = Moving average in period t.
n = Number of periods.
X_{t-i} = Data value in the previous period.
The Moving Average method is beneficial for data that does not have a clear trend or seasonality. Still, its weakness is that it cannot handle significant changes in trends or seasonal patterns.

2. Linear regression is a statistical technique used to model the relationship between independent variables (e.g., factors influencing sales, such as price, promotion, or time) and dependent variables (i.e., sales). In simple linear regression, this relationship is assumed to be linear, meaning that a change in the independent variable will cause a proportional change in the dependent variable. Mathematically, linear regression can be described by the equation [19]:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_{2+\cdots} + \beta_n X_n + \epsilon \quad (2)$$

description:
Y = Predicted value (sales).
β_0 = Intercept (value of Y when X_1, X_2,..., X_n = 0).
$\beta_1, \beta_2, \ldots, \beta_n$ = Predicted value (sales).
$\in$ = Error (deviation from actual value).

3. The Multiplicative Decomposition Method is a forecasting method used to analyze and break down time series data into simpler components: trends, seasonality, and residuals (random). This model assumes that the data can be explained by multiplying these components, not adding them as in the additive model. The formula can express the multiplicative decomposition model [20]:

$$Y_t = T_t \times S_t \times E_t \quad (3)$$

description:
Y_t = Data value at time t.
T_t = Trend component at time t.
S_t = Seasonal component at time t.
E_t = Residual or Error component at time t.

4. Forecasting Error Verification

Some methods can be used to calculate the best prediction, such as the following [21]:

a. MAE (Mean Absolute Error) is the average of the absolute values of the differences between the original values and the predicted values

$$MAE = \frac{1}{n}\sum_{i=1}^{n}|y_i - \hat{y}_i| \quad (4)$$

description:
y_i = the i-th observed value,
$\hat{y}_i$ = the corresponding predicted value for y_i,
n = the number of observations.

b. MSE (Mean Square Error) is the average of the squared differences between the original and predicted values.

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2 \quad (5)$$

description:
y_i = the i-th observed value,
$\hat{y}_i$ = the corresponding predicted value for y_i,
n = the number of observations.

c. MAD (Mean Absolute Deviation) is the average of the absolute deviations of prediction errors.

$$MAD = \frac{1}{n}\sum_{i=1}^{n}(y_i - \bar{y}_i)^2 \quad (6)$$

description:
y_i = the i-th observed value,
$\bar{y}$ = the mean,
n = the number of observations.

d. (SE) Standard Error is the standard deviation of prediction error.

$$SE = \frac{\delta}{n} \quad (7)$$

description:
SE = Standard Error of the sample,
δ = sample standard deviation,
n = number of samples.

e. MAPE (Mean Absolute Percentage Error)

$$MAPE = \frac{1}{n}\sum_{i=1}^{n}\frac{|y_i - \hat{y}_i|}{y_i} \quad (8)$$

description:
y = the actual value of the data point, also known as a valid value,
$\hat{y}$ = the predicted value of the data point. The model returns this value,
n = the number of data points.

5. Analytical Neural Network

Artificial Neural Networks (ANN) is a computational model inspired by how the human brain works, consisting of a network of interconnected neurons that can be used to predict or forecast something, including sales. In sales forecasting, ANN processes historical sales data and factors influencing future sales, such as seasonal trends, promotions, or economic conditions. This forecasting process begins with input data containing information about past sales, which is then processed through hidden layers in the neural network to find complex patterns or relationships between these factors [22]. This neural network consists of three main layers, namely the input layer that receives data, the hidden layer that processes and finds patterns, and the output layer that produces sales predictions for the future period. In addition to training the ANN, the backpropagation algorithm is used, which optimizes the weight of the connections between neurons through an iterative learning process to minimize the Error between the predicted results and the actual values. One of the essential components of ANN is the activation function, which determines whether a neuron will send a signal to another neuron based on the input received [23]. However, although ANN can capture complex non-linear relationships, this model must also be trained carefully to avoid overfitting, which is when the model is too specific to the training data and cannot generalize well to data that has never been seen. For this reason, techniques such as regularization, dropout, or division of training and testing data are usually applied to keep the model accurate and efficient [24].

In practice, several types of ANN that are often used in sales forecasting include Multilayer Perceptron (MLP), which is a basic neural network for regression forecasting, as well as Recurrent Neural Networks (RNN) and Long Short-Term Memory (LSTM) which are more suitable for sequential data or data that has a time pattern, such as sales influenced by seasonal factors or long-term trends [25]. By using ANN, companies can improve the accuracy of their sales forecasts, which can help them make better decisions regarding inventory, marketing, and other business strategies. However, applying ANN in sales forecasting also has challenges, such as the need for extensive data and a reasonably long training time. However, with the right approach and selection of the appropriate model, ANN can provide very effective results in predicting sales and identifying patterns that traditional forecasting methods may not detect [26].

Inventory

Inventory, commonly referred to as stock, is a collection of products or goods owned by a company. These goods are usually resold to customers or used for the production process. Inventory is a company's most important asset, especially in manufacturing, distribution, and retail. Inventory can include various goods and reflect a company's investment in raw materials, semi-finished goods, and finished goods. Inventory can be categorized into several types based on the stage in the supply chain and its intended use [27].

1. Bill of Materials

BOM (Bill of Materials) lists all raw materials, components, sub-components, and other materials needed to produce a product.) In manufacturing or production, BOM serves as a blueprint or guide for assembling a finished product, which includes detailed information about each element needed, the amount required, and how the material should be processed or assembled. Typically, BOM includes information about raw materials, more minor parts or components, and tools or machines used in production. Furthermore, BOM also consists of a hierarchical structure that shows the relationship between parts and components. For example, a final product may consist of several sub-components, each of which may have several more parts. In this case, BOM acts as a map that connects all elements in the production process. With BOM, companies can ensure that all materials and components are available on time, which is crucial for smooth production and cost efficiency [28].

2. Safety Stock

Safety stock is additional inventory a company holds to anticipate uncertainties in the demand or supply of goods. The primary purpose of safety stock is to prevent stock shortages that can occur due to unexpected fluctuations in customer demand or disruptions in the supply chain, such as shipping or production delays. A company can ensure smooth operations and meet customer demand despite variability in the production or distribution process by having safety stock [29].

Determining the right amount of safety stock requires considering several factors, such as the level of demand variability, lead time (the time it takes to get stock back from the supplier), and the desired service level (for example, customer satisfaction levels or the chance of losing sales if stock runs out). If the safety stock is too low, the company risks running out of goods when demand is higher than expected, while if it is too high, there will be higher storage costs and decreased inventory efficiency [30].

The calculation of safety stock generally involves historical analysis of demand fluctuations and lead times, using statistical formulas to estimate the level of uncertainty. Common methods used in this calculation include using the standard deviation of demand and lead times, which reflects the extent to which the data can vary. Thus, safety stock is essential in supply chain management and inventory control, which aims to reduce the risk of shortages and ensure stable product availability. The formula for calculating safety stock is as follows [31]:

$$\text{Safety Stock} = Z \times \sigma_d \times \sqrt{L} \tag{9}$$

description:

Z = Safety stock.

σ_d = Standard deviation of demand.

L = Lead time.

3. Material Requirement Planning

Material Requirement Planning (MRP) is one of the critical activities in a company's operations because it is the process of monitoring and controlling the ordering and use of raw materials to ensure that the correct amount can be provided at the right time. Poor inventory management can cause problems such as stockouts, where the company is short of stock, resulting in production delays or lost sales. Overstock is an excess stock that can increase storage costs and the risk of obsolescence. In addition, inventory turnover can also be disrupted; a low ratio indicates overstock, while a too-high ratio can indicate understock [32]. Therefore, MRP is needed where companies are assisted in adjusting the amount and type of inventory stored to minimize costs and meet customer demand at the right time. The following methods and strategies can be used to optimize inventory methods: Economic Order Quantity, Period Order Quantity, Least Total Cost, and Least Unit Cost [33].

4. Maintenance

Maintenance management is a process of planning, controlling, supervising, and implementing systematically to maintain facilities, equipment, and other assets. Maintenance management manages maintenance activities on every asset in the company, including machines, facilities, and infrastructure. In maintaining operational continuity, maintenance management includes damage prevention, routine maintenance, and repairs when damage occurs [34]. Maintenance management aims to minimize damage, reduce downtime, reduce maintenance and repair costs, and ensure occupational safety and a good work environment. This maintenance is carried out so that the company can run its production process according to the schedule that has been prepared. Some methods can be

applied, one of which is OEE (Overall Equipment Effectiveness) [35].

Overall Equipment Effectiveness (OEE) is a key performance indicator (KPI) used to measure the operational efficiency of equipment in the production process. Seiichi Nakajima introduced this concept in the context of Total Productive Maintenance (TPM) to help companies increase productivity through optimal asset utilization. OEE provides insight into how the production process runs, identifying lost time, capacity, and quality in three main components: Availability, Performance, and Quality. The OEE score is calculated as a percentage, where 100% indicates perfect production operations with no downtime, ideal speed, and no product defects. The following explains the three components [36].

METHODS

This research started with problem identification and determining the research objective, then continued with Literature and Field Study. The research method continues with sales, inventory, and maintenance data collection. After sufficient data collection, the research method continues with Data Processing (Power BI, Forecasting, MRP and Maintenance with OEE applications). The result will show the improvement and finish with the conclusion. Figure 1 shows the research method of this study.

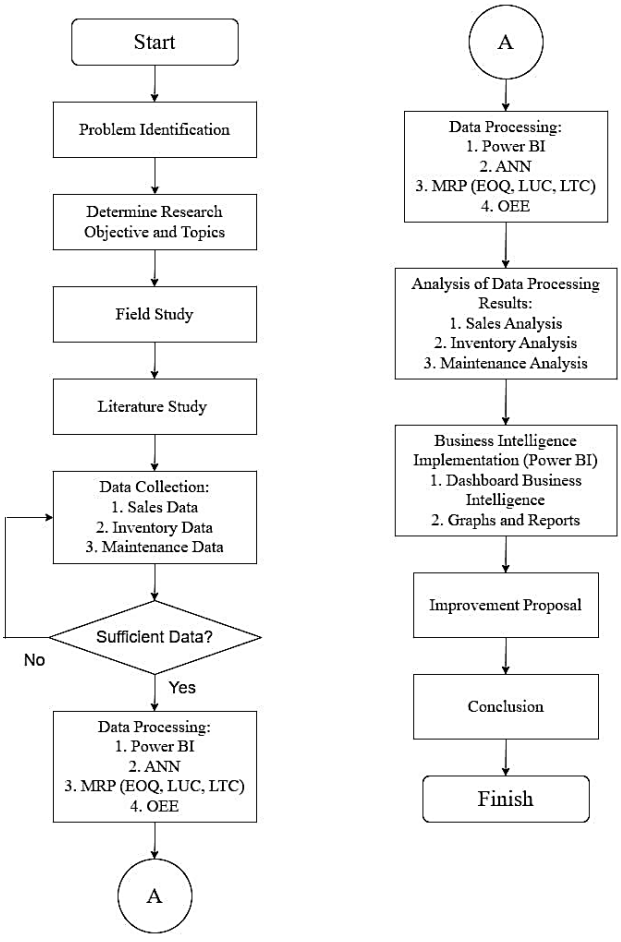

Fig. 1 Research Method of This Study

RESULT

Forecasting Error Verification

After forecasting demand using Python and QM for Windows applications, the forecast error results show that the ANN method looks better because it has the slightest prediction error. The forecasting results can be seen in Table 1 below.

Table 1
Forecasting method from Error Verification

Method	MAE	MSE	MAD	SE	MAPE
ANN	1.137	1.523	0.923	1.238	2.63%
Moving Average	1.150	1.621	1.043	1.333	3.73%
Linear Regression	2.250	8.210	1.49	2.330	2.63%
Multiplicative Decomposition	2.150	6.210	1.67	2.450	2.77%

Result of The ANN Method Forecasting

The results of forecasting using the ANN method and company targets are shown in Table 2.

Table 2
The result of carton box forecasting using the ANN Method

Period	Forecast of Carton Box
January 2025	8363
February 2025	7234
March 2025	11026
April 2025	6456
May 2025	7403
June 2025	8712
July 2025	7573
August 2025	7451
September 2025	7256
October 2025	6553
November 2025	9272
December 2025	7464

Bill of Material of Carton Box

Raw material demand is the materials needed to support a product's production process. These raw materials are used to process or produce finished goods according to market needs and demands. Various factors, such as planned production volumes, market demand levels, seasonal changes, production efficiency, and capacity, can influence demand for raw materials. The bill of material for the carton box can be seen in Figure 2.

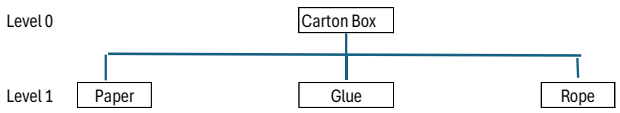

Fig. 2 The Bill of Material of Carton Box

Safety Stock of the Material of Carton Box

Safety Stock is the additional stock kept to avoid running out of raw materials or finished products due to uncertainty in demand or delivery times. The primary purpose of safety stock is to ensure that the company can still meet

production or customer requests, even if there are delays in sending raw materials or unexpected spikes in demand. The result of the safety stock can be seen in Table 3.

Table 3
Safety Stock for Carton Box Material

Raw Material	Safety Factor (90%)	Lead Time (Days)	Lead Time (Months)	Average Demand per Day (Unit)	Standard Deviation of Demand	Safety Stock	
						Amount	Unit
Paper		1	0.03	65.46	4.87	2	kg
Glue	1.28	2	0.07	54.55	4.96	1	bottle
Rope		7	0.23	45.46	3.38	1	strip

Material Requirement Planning

Material requirements planning is a system that is widely used in the production process. The primary function is to plan production needs for each period based on the master production schedule. Therefore, the input data needed to plan material requirements is the master production schedule and bill of materials. The master production schedule in this analysis results from production forecasting according to the bill of materials used for analysis. Based on these two inputs, material requirements planning can be seen in the table below (Table 4).

Table 4
Comparison from some Material Requirement Planning Methods (each month)

Method	Paper Cost (USD)	Glue Cost (USD)	Rope Cost (USD)	Transportation Cost (USD)	Inventory Cost (USD)	Total Cost (USD)
Company	1,037,169.67	12,380.36	82,719.70	25,929.24	25,929.24	1,184,128.22
Economic Order Quantity	1,037,169.67	12,119.33	82,719.70	25,929.24	25,929.24	1,183,867.18
Least Total Cost	1,037,906.63	12,487.81	85,884.95	25,929.24	26,666.20	1,188,999.13

Purchase Order (PO) in the Odoo application is an essential part of the procurement process that allows companies to manage the purchase of goods from vendors efficiently. Thus, using the Purchase Order module in Odoo increases procurement process efficiency and provides better control over cost management and vendor relationships. PQ can be seen in Figure 3.

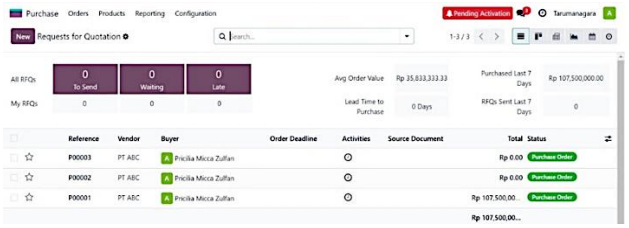

Fig. 3 Purchase Order using ODOO application

The Request for Quotation (RFQ) document in the Odoo application functions as an official request from the buyer to the supplier to provide a price offer regarding a particular product or service. RFQ in Odoo is an essential tool for efficient procurement management. With features like direct email sending and the ability to edit details based on vendor feedback, Odoo simplifies selecting suppliers and negotiating prices. Proper implementation of RFQ can help companies achieve cost efficiencies and improve relationships with suppliers. RFQ can be seen in Figure 4.

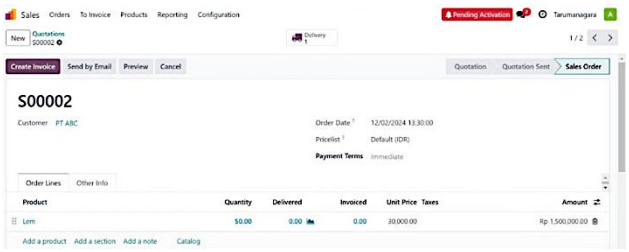

Fig. 4 Material Order Page on Odoo Application

Analysis of Carton Box Production Warehouse Stock and Number of Requests Using the Power BI Application

Accurate and efficient analysis is necessary for correct decision-making in managing carton box production and warehouse stock. Therefore, using the Power BI application is a relevant solution (Fig. 5). This application allows more informative data visualization and integration of various data sources, making identifying trends, patterns or anomalies in the production process and stock management easier. With this approach, management can optimize production planning, reduce the risk of excess or shortage of stock, and increase overall operational efficiency. Further analysis regarding the application of Power BI in the context of fabric production and stock will be explained in this section.

Data on warehouse stock and the number of requests for Cartoon Box Company shows several significant findings. The customer with the highest number of requests is CV. IMM has a total stock of 10,705 units and a total Demand reaching 10,950 units.

This condition indicates that demand slightly exceeds available stock, although the difference is still relatively small.

On the other hand, some customers have an imbalance of stock and demand. For example, HOJ has 662 units, but the demand has reached 1,500.

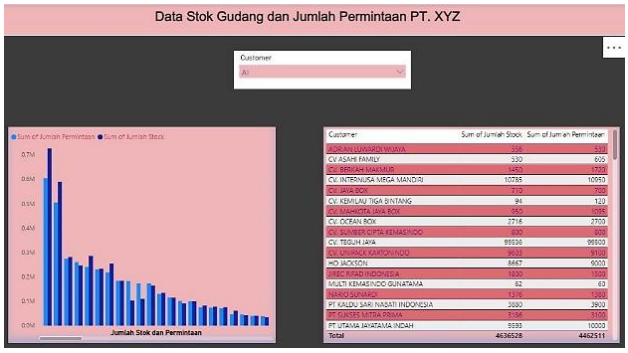

Fig. 5 Production/Warehouse Stock Analysis Using Power BI

This condition indicates a significant stock shortage to meet these customers' needs. Meanwhile, JAI has a stock of 1,600 units, and the demand is only 1,500 units, which means there is an excess stock of 100 units.

For customers like CVTJ, the production and demand for the product appear to be in balance with the stock of 99,563 units and demand of 99,500 units. This condition shows good stock management and close-to-ideal conditions.

In total, the stock available in the warehouse is 4,636,528 units, while the total number of requests reached 4,462,511 units. This condition shows that the amount of stock is still higher than the overall demand. However, the difference is not very significant. Hence, companies need to continue monitoring stock conditions and demand to ensure there is no shortage or excess of stock for specific customers.

Based on this data, companies such as HOJ need to pay special attention to customers with high demand but insufficient stock to meet customer needs on time. On the other hand, evaluations also need to be carried out for customers who experience excess stock so that companies can avoid unnecessary storage costs.

Maintenance

Maintenance management is an activity related to planning, organization, staffing, program implementation and methods of controlling maintenance activities. The term maintenance comes from the Greek word *terein*, which means to look after, look after and look after. Maintenance is a system that consists of several elements in the form of facilities (machines).

The method used in this maintenance management study is problem-solving, which aims to provide improvements related to existing problems at PT. XYZ, by offering recommendations for proposed improvements. The research results can be used as an alternative maintenance action to increase the effectiveness value of flexo based on the OEE (Overall Equipment Effectiveness) method. Factors that influence OEE include availability, performance rate, and quality rate.

Based on data comparing the OEE overview with international standards, it can be concluded that availability has a value of 84.54%, which exceeds the global standard of 90.00% (Table 5).

Table 5

Result of Maintenance using OEE Application

OEE Factor	OEE International Standard	OEE Overview	Action
Availability	90.00%	84.54%	Needs Improvement
Performance	95.00%	96%	OK
Quality	99.90%	97%	NI
OEE	85.40%	97.44%	Needs Improvement

However, it is still noted that "Needs improvement" is needed to ensure consistent performance in the future; Performance shows a value of 96%, which has exceeded the international standard of 95.00%. However, there is room for improvement so that performance remains optimal and stable with an "Ok" note; Quality scored 97%, below the international standard of 99.90%. This overview shows that production quality problems need special attention to improve the quality level to approach or exceed standards and still be given a note of "Needs improvement".

OEE (Overall Equipment Effectiveness) reached 97.44%, which exceeds the international standard of 85.40%. However, an "Ok" note indicates the need for continuous monitoring so that OEE performance remains optimal and avoids decline in the future.

Downtime Analysis Using the Power BI Application

Downtime in machines or production processes can significantly impact company efficiency and productivity. Therefore, downtime analysis is essential to minimize downtime and improve operational performance. The Power BI application provides powerful tools to monitor and analyze downtime in real-time, enabling easier identification of root causes of downtime (Fig. 6).

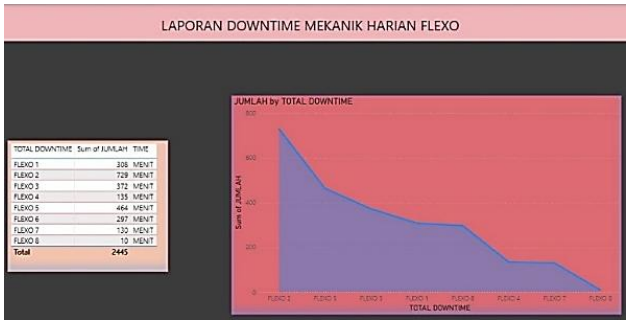

Fig. 6 Downtime Analysis Using Power BI

By collecting data from various sources, Power BI can visualize downtime duration, event patterns, and areas that experience the most frequent disruptions. This analysis provides more profound insight so companies can take appropriate corrective steps, such as preventative maintenance or process improvements, to minimize future downtime and increase production efficiency.

The machine with the highest downtime is the FLEXO 2 machine, with a total downtime of 729 minutes. This condition shows that the FLEXO 2 machine is experiencing the most significant problems compared to other machines.

So, special attention is required to identify and fix the cause not to impact productivity. Furthermore, the FLEXO 5 machine is in second place with a downtime of 464 minutes. Although lower than the FLEXO 2 machine, this figure is still significant and must be addressed to prevent more severe downtime.

On the other hand, the machine with the lowest downtime was the FLEXO 8, which experienced only 10 minutes of downtime. This condition shows that this machine performs well and does not experience significant problems. In total, overall downtime reached 2445 minutes. The graph shows a decrease in downtime from the FLEXO 2 machine to the FLEXO 8 machine, showing a substantial difference between machines with poor performance and more stable ones.

In conclusion, repair priority should focus on the FLEXO 2 and FLEXO 5 machines because they have the highest downtime. Furthermore, it is necessary to regularly evaluate the performance of all machines to minimize downtime and maintain overall productivity.

DISCUSSION

Mittal, 2024 in the paper uses Business Intelligence to analyze historical sales data, market trends, and other external factors [37]. Inventory optimization will also reduce the risk of overstock and stockout by predicting sales data. This journal also discusses the importance of maintenance with predictive models to ensure the equipment is in good condition before damage occurs. Wang and Aviles, 2023 in the paper studied Business Intelligence and data analytics to help companies improve operational efficiency [38]. In addition, these tools can also understand market trends, optimize resource allocation, and drive business growth with intense competition. Rautaray et al., in Supply Chain Management (SCM), business analytics is used to manage large-scale or macroeconomic inventory [39]. It focuses on minimizing losses and maximizing revenues. Business analytics is beneficial in understanding existing trends, analyzing time series data, and learning more about seasonal patterns.

Nurdin et al., 2023, Studied to visualize data for sales prediction of avocado fruit companies [40]. Using Business Intelligence, the data is analyzed, and BI can be proven to help. Predictions show that prices and sales volumes per month tend to fluctuate. Power BI allows companies to predict their sales up to a 95% confidence level. Mullaikodi et al., 2024 studied how Business Intelligence can help companies become more efficient and secure. This study uses the literature review method of several journals and proves that sales analysis predictions can be better with BI [41]. Apeko et al., 2023 studied to estimate used car prices [42]. Using three probabilistic models, namely the general model, the unique model of luxury cars, and the unique model of non-luxury vehicles. The results obtained are more accurate by 83.5% for the unique model of luxury cars compared to non-luxury. Picozzi et al. studied 18 KPIs in companies regarding hospital asset maintenance management. KPIs are divided into several divisions, namely logistics, technical, and equipment [43]. The Power BI dashboard helps companies visualize and monitor data directly. Cano Lengua et al., 2023 studied BI in sales to optimize decision-making in telecommunications companies [44]. It was found that poor report quality and long reporting time, with the help of BI, can increase the efficiency of the report by up to 97.22%. In addition, there was an increase in data quality of 29.08%, and customer satisfaction increased by 40%.

The comparison among those studies with this paper is the whole open-source application can be used to monitor and control the production, sales, prediction, inventory, stock, material, and maintenance for small and medium enterprise carton box companies.

Research on Business Intelligence and Sales Forecasting

The study conducted by Alice Johnson and Robert Brown aims to determine the use of BI technology in improving sales predictions using inventory data. Up-to-date and accurate inventory data is critical in sales prediction analysis. This study states that inventory data integration can improve the accuracy of sales predictions. Inventory data shows a 15% increase in prediction accuracy compared to only historical sales data. Companies can also optimize their inventory management because they have predicted sales more accurately [45].

The study conducted by Feng Wang and Joey Aviles is a study that uses a mathematical model to predict future sales accurately. This model automatically identifies hidden patterns and trends contained in the data. This condition allows companies to forecast demand and adjust their stock levels. Companies can obtain accurate and real-time sales estimates with regression models and data neural networks. These results can provide support to companies in making decisions, determining marketing strategies, optimizing inventory management, and making accurate production plans [38].

The study conducted by Alya Aulia Nurdin et al. uses business intelligence to facilitate the process of processing company data and to become the basis for making sales decisions. This study uses Power BI Desktop to visualize data analysis and forecasting results of avocado fruit distributor company sales data.

This study showed that business intelligence helps make it easier for companies regarding income and time. Power BI allows companies to predict their sales up to a 95% confidence level [40].

Research conducted by Mullaikodi et al. states that Business Intelligence can help companies become more efficient and safe. This study uses a literature review method of several journals and proves that sales analysis predictions can be better with BI. According to their findings, business intelligence (BI) helps organizations make safer and more effective decisions. The research supports the idea that employing BI for sales forecasts can result in better decision-making and enhanced business outcomes by examining several studies. This corpus of work highlights BI's contribution to operational efficiency and risk reduction via precise and trustworthy data analytics even further [41].

Research conducted by Jewel Donkor Apeko et al. aims to estimate the price of used cars. By using three probabilistic models, namely the general model, the unique luxury car model, and the special non-luxury car model. The results obtained are more accurate by 83.5% for the unique luxury car model than non-luxury. This study demonstrates the ability of tailored probabilistic models to increase forecast accuracy in particular domains, like the market for high-end automobiles. The study shows how BI models and tools customized for specific markets or sectors can produce more trustworthy insights that companies can utilize to improve their pricing tactics and reach better conclusions [42].

Research on Business Intelligence and Inventory Optimization

Research conducted by M. Ridho et al. is a study on a technology-based company. Software recording and licensing are still not running well. This condition is less effective because it takes a long time, and a lot of software has run out but is still installed on employees' laptops. Therefore, the company uses a Business Intelligence (BI) Dashboard with a prototype method that provides information related to asset inventory to be more effective and efficient [46].

Research conducted by Siddharth S. Rautaray et al. is a study on supply chain management using tools and techniques to manage inventory. This journal discusses predictive analysis used to predict the collection of inventories that will become stock for sales to gain profit and minimize losses [39].

Research on Business Intelligence and Maintenance

The main topic of Laura Green and Kevin Miller's work is the use of Business Intelligence (BI) for predictive analysis in the optimization of maintenance procedures (Table 6). According to the study, BI tools combined with predictive maintenance methodologies can improve maintenance demand forecasting accuracy by up to 25%. This advancement dramatically reduces downtime and avoids possible operational disruptions by enabling businesses to predict equipment maintenance needs before problems occur. Businesses may take a more proactive stance, guaranteeing that their assets are maintained effectively, cutting repair costs, and prolonging the life of their equipment by using BI to forecast maintenance schedules. This study highlights how crucial it is to incorporate BI into maintenance plans to improve operational reliability [47].

Another study, undertaken by Paola Picozzi and her colleagues, evaluated the use of BI in hospital asset maintenance management by deploying 18 Key Performance Indicators (KPIs). These KPIs are divided into several categories: equipment management, technical, and logistical. A Power BI dashboard was utilized in the study to represent and track these KPIs in real-time visually.

The hospital administration can monitor asset performance, maximize equipment use, and better oversee maintenance tasks by employing Power BI.

Table 6
Research Gap Business Intelligence, Sales Forecasting, Inventory Optimization, and Maintenance

Description	Authors									
	M. Ridho, et al. [46]	Johnson, Brown [45]	Wang, Aviles [38]	Green, Miller [47]	Rautaray, et al. [39]	Nurdin, et al. [40]	Mullaikodi C, et al. [41]	Apeko, et al. [42]	Picozzi, et al. [43]	Aguiar, et al. [48]
Business Intelligence	X	X	X	X	X	X	X	X	X	X
Sales Forecasting		X	X			X	X	X		
Inventory Optimization	X	X	X		X					X
Maintenance				X					X	
Power BI									X	X
Dashboard BI						X			X	
Data Visualization						X				
Information Technology	X	X		X		X	X		X	
Countries	(INA, SEA)	(NY, US)	(PH, SEA)	(BO, US)	(IN, SEA)	(INA, SEA)	(IN, SEA)	(CT, ZA)	(IT, SE)	(SP, BR)

SP: Sao Paulo, BR: Brazil, NY: New York, US: United States, PH: Philippines, SEA: South East Asia, BO: Boston, INA: Indonesia, IN: India, CT: Cape Town, ZA: South Africa, IT: Italy, SE: South Europe, INA: Indonesia

By ensuring that the hospital's assets are running as efficiently as possible in real-time, this monitoring improves patient care, lowers maintenance costs, and delivers better services. The study highlights the usefulness of business intelligence (BI) in facilitating data-driven decisions in intricate settings like hospitals, where asset management is essential [43].

Research by Clara Gouveia Aguiar et al. aims to develop BI using data from ERP systems to help inventory management in small retail companies that provide various party supplies. BI was designed with several steps, starting from problem analysis, data selection and extraction, data modelling, BI implementation, and testing and evaluation. This dashboard improves inventory level assessment, product movement analysis, and identification of the need to create new purchase orders [48].

CONCLUSION

Based on the results of research that has been carried out through the stages of data collection, data processing and data analysis regarding the Implementation of Business Intelligence for Sales Prediction and Inventory Optimization and Maintenance at PT XYZ Company, the Implementation of Business Intelligence (BI) at PT Based on the

research conducted, several important points can be concluded.

Of the various forecasting methods tested, ANN has proven to be the best method that provides the most accurate results for the company's needs. By using the ANN method, the slightest Error was obtained.

In this research, raw material calculations have been carried out through Material Requirements Planning (MRP) with four methods: Economic Order Quantity, Least Total Cost, and Least Unit Cost.

Based on the calculations that have been carried out, it was found that the EOQ method provides efficiency in material management, reducing the risk of shortages or excess stock. The cost of the technique with EOQ is negligible compared to the other methods.

Power BI can be used to analyze warehouse stock and carton box production, and demand quantities can be optimized based on production planning factors, reducing the risk of excess and shortage of stock and increasing overall operational efficiency. It also needs to be able to analyze the company.

The Odoo platform as an open-source application has been successfully implemented to manage various business processes, including production, inventory and maintenance. This application makes tracking data, managing orders, and optimizing procurement easier, increasing the company's overall operational efficiency.

Implementing the Overall Equipment Effectiveness (OEE) method shows maintenance efficiency at PT. These results indicate that the company can maintain machine availability, optimize operational performance, and ensure high product quality. With this level of efficiency close to optimal, production downtime can be minimized, thereby supporting the continuity of a more reliable production process.

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