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The Influence of ERP-SAP Implementation and Inventory Management on Production Efficiency through Inventory Control Performance Using Partial Least Square (PLS) Method

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Abstract

PT XYZ is the largest manufacturing company in Indonesia that produces biscuits with the support of the SAP system, which has integrated data from each division, especially the inventory control division. Due to the accessibility of real-time data, it was observed that there were two late arrivals of raw materials, causing the company to only achieve 75% of the weekly production target. Therefore, this study aims to determine the effect of ERP-SAP implementation and inventory management on smooth production and provide recommendations for improvement through inventory control performance at PT XYZ. The method used is Partial Least Square (PLS) which uses SmartPLS. Based on the research conducted, it was found that the implementation of ERP-SAP does not have a positive impact on production flexibility, but has a positive impact on inventory management performance, and then inventory management directly positively affects production efficiency and inventory control performance.

A. Introduction

In society 4.0, everything certainly requires a significant role of technology, such as the increasing use of computer technology, especially in companies. Therefore, companies are now starting to implement Enterprise Resource Planning (ERP) systems. ERP is a computer system built to handle company transactions, production planning, and customer relations in real time. An ERP system is a tool that supports and accelerates the entire order processing process, including product distribution [1]. The benefits of using ERP include the ability to plan and control the flow of materials from production estimates, company orders, to scheduled delivery plans [2]. This enables companies to achieve their goals while improving communication and relationships with stakeholders [3]. Most companies entrust the implementation of their ERP systems to SAP. SAP is Enterprise Resources Planning (ERP) software, which is an IT and management tool to help companies plan and perform various daily activities [4]. The modules implemented by each company vary. Some only use it for specific areas such as Financial Accounting or Sales and Distribution, while many integrate only a few modules [5].

In addition to paying attention to the effectiveness and efficiency of employee performance, another equally important aspect is the efficiency of production. The efficiency of the production process is influenced by the availability of raw materials to be processed in production. Since inventory facilitates and smoothens the operations of a company that must be carried out sequentially, inventory management affects production efficiency [6]. Inventory management is one of the important activities in a series of closely related activities in the entire production operations of a company according to what has been pre-planned in terms of time, quantity, quality, and cost [7]. Inventory can serve various functions that add flexibility to a company's operations [8]. If decisions about inventory policies can be made effectively and efficiently, inventory management can create a competitive advantage for the company [9]. The objectives of inventory management include ensuring that the company does not run out of stock, thus causing production activities to stop, ensuring that the formation of inventory by the company is not too large or excessive, and avoiding small-scale purchases because this will increase ordering costs [10]. Another goal is to maintain and, if possible, increase the company's sales and profits [11]. Meanwhile, the efficiency of the production process is one of the highly anticipated goals for companies, especially those engaged in production activities [12]. Production can be said to be smooth if the production process does not encounter obstacles in producing goods, thus being able to produce products in the planned quantities and qualities, and the production process can be completed on time [13].

An inventory controller must make all necessary preparations for acquiring raw materials, ensuring that it is done as efficiently as possible so that the existing raw material inventory can truly support the company's production process. To effectively control raw material inventory, precise inventory management is required. Efforts that can be undertaken include the use of systems and inventory management models aimed at minimizing total costs by determining what, how much, and when orders are optimally placed.

PT. XYZ is the largest food and beverage company in Indonesia, founded in 1990. The company has five factories spread across Indonesia. PT. XYZ is also

supported by a strong information technology system with the implementation of the SAP system, which has integrated data from every division, especially the PPIC division's Inventory Control section, with the expectation of achieving real-time information so that management can quickly make decisions or execute business strategies effectively and efficiently. From a brief interview conducted, problems such as delays in the arrival of raw materials due to internal communication mishaps within the company or from vendors have been identified, thus affecting production efficiency, which can result in a 25% decrease in production outturn. The occurrence of delays can be observed through the predetermined delivery dates and the MIGO in the creation of each raw material's purchase order.

In accordance with the description above, the researcher wants to know how the effect of ERP-SAP implementation, and inventory management on production efficiency and recommendations for improvement through inventory control performance at PT XYZ using Partial Least Square (PLS). Partial Least Squares (PLS) is a regression method developed by Herman O. PLS assumes that survey data are freely distributed, meaning that survey data do not follow a uniform distribution (such as a normal distribution). PLS is an alternative method to Structural Equation Modeling (SEM) which can be used to overcome the problem of the relationship between complex variables but the data sample size is small (30 to 100) [14]. PLS is used to determine the magnitude of the relationship between structures and other structures, as well as the relationship between structures and their dimensions. PLS is defined by two equations, namely the internal model and the external model. The inner model defines the definition of the relationship between the structure and other structures, while the outer model defines the definition of the relationship between the structure and its parameters. The first step is to evaluate the measurement model using True test and Reliable test. True test is carried out with two categories, namely Convergent Trueity and Discriminant Trueity. Then the Reliable test is also carried out with two categories, namely Internal Consistency Measurement and Reliability Measurement of All Indicators in the Model [15]. Then the second stage is the evaluation of the process model and testing called the internal model test. This test is carried out with five stages, namely Coefficient of determination test, Direction of variable relationship, Bootstrapping (Bootstrapping), Predictive Relevance, and Model Fit. The advantages of applying verification analysis using PLS-SEM can use small samples or large samples as well as exploratory research and are able to explain latent variables [16].

Through the implementation of this research, it is hoped that it can assist PT XYZ in understanding the influence of ERP-SAP implementation and inventory management on production efficiency, and provide recommendations for improvements through inventory control performance that can be given to PT. XYZ when similar problems occur in the future, serving as an evaluation to enhance the company's performance.

B. Research Method

This section will explain the variables used in this study and the methods used to collect data.

Identification of Variables

In conducting a study, it is necessary to identify its variables. The related variables for the study are listed below about the study's title.

Independent Variables (X)

Independent variables are variables that affect or cause the dependent variable to change or occur. The independent variables in this study are the implementation of ERP-SAP and inventory management.

Intervening Variables (Y)

Intervening variables are variables involved in a process that cannot be observed or measured and retrieved the relationship between the independent variable and the dependent variable. The intervening variable in this study is inventory control performance.

Dependent Variables (Z)

The dependent variable is often referred to as the outturn variable, parameter, and effect. The dependent variable in this study is production efficiency.

Data Collection Methods

In conducting research, it is necessary to collect data where the method used to collect data is research using a survey in the form of a questionnaire. A survey is a form of communication between the researcher and the research subject or respondent and contains a list of questions or statements of the researcher that must be answered by the respondent. Data collection is done by distributing surveys to office production employees.

C. Result and Discussion

The data obtained in this study were collected through the distribution of questionnaires to employees of PT. XYZ. The Questionnaire Data Recap with the data collected through the questionnaire is then summarized and transformed into Comma Delimited or CSV format, which will be used to create the framework. Measurement model evaluation is used to measure the model using the MTMM (Multi Trait Multi Method) approach with true testing consisting of convergent trueity and discriminant trueity, as well as reliable testing conducted through two procedures: Reliability Measurement of All Indicators in the Model and Internal Consistency Measurement.

Convergent True Test

The research results should retrieved that all indicators of each variable have outer loading values > 0.7. After conducting the outer loading, it was found that indicator X 14 has a value below 0.7, which means that the indicator is not true.

Therefore, elimination of the intrue indicators was carried out, resulting in the following outer loadings.

Table 1. Result of Outer Loading

	X 1	X 2	Y	Z
X 1[1]	0.779			
X 1[2]	0.851			
X 1[3]	0.815			
X 2[1]		0.835		
X 2[2]		0.897		
X 2[3]		0.832		
Y 1			0.920	
Y 2			0.852	
Z 1				0.870
Z 2				0.773
Z 3				0.928
Z 4				0.821

From the outturn table, it can be observed that all indicators have values above 0.7, indicating that all indicators of the variable constructs are true. Mean coefficient of variance extraction (AVE) > 0.5 to be considered true. The outturn from the Mean coefficient of variance extraction (AVE) stage is as follows.

Table 2. Result of Mean coefficient of variance extraction

	Mean coefficient of variance extraction (AVE)
ERP-SAP Implementation (X 1)	0.665
Inventory Management (X 2)	0.731
Inventory Control Performance (Y)	0.786
Production Efficiency (Z)	0.722

From the outturn table, all variables are deemed true in terms of Mean coefficient of variance extraction, indicating that all indicators are true and have achieved convergent trueity, demonstrating that each indicator effectively explains its respective variable.

Discriminant Validity Test

This test is used to ensure distinction trueity, where the Mean coefficient of variance extraction for many latent variable must be greater than value square root comparison measure of all variables present.

Table 3. Result of Square root comparison measure

	X 1	X 2	Y	Z
X 1	0.815			
X 2	0.522	0.850		
Y	0.622	0.605	0.887	
Z	0.396	0.656	0.464	0.855

According to the this table square root comparison measure, it is known if the result Square root comparison measure of the ERP-SAP implementation variable with itself is 0.794, and it can be seen that the latent variable values are greater than the result square root comparison measure with all other latent variables. Additionally, the correlation between variable trueity are checked. If an parameters has a greater connection with other latent variable rather than its own, the model's fit needs to be reconsidered.

Table 4. Result of Cross Loading

	X 1	X 2	Y	Z
X 1[1]	0.779	0.260	0.314	0.637
X 1[2]	0.851	0.480	0.514	0.555
X 1[3]	0.815	0.255	0.350	0.481
X 2[1]	0.484	0.835	0.308	0.449
X 2[2]	0.285	0.897	0.514	0.416
X 2[3]	0.247	0.832	0.642	0.421
Y 1	0.508	0.566	0.920	0.633
Y 2	0.288	0.540	0.852	0.413
Z 1	0.559	0.380	0.545	0.870
Z 2	0.516	0.484	0.463	0.773
Z 3	0.615	0.386	0.556	0.928
Z 4	0.534	0.533	0.487	0.821

The results of the true test retrieved that all Cross Loading values are true because each manifest (measurer) in the construct has a Cross Loading value greater than other variables, with values > 0.7. This indicates that each manifest in each construct is appropriate for measuring that construct.

Internal Consistency Measurement Test

After conducting true tests using two stages, the next step is to perform the Internal Consistency Measurement test. Internal Consistency Measurement Test measures internal consistency with values ≥ 0.6. If < 0.6, it is considered unreliable.

Table 5. Result of Internal Consistency Measurement

	Reliability Measurement of All Indicators in the Model	rho_A	Internal Consistency Measurement	Mean coefficient of variance extraction (AVE)
X 1	0.752	0.767	0.856	0.665
X 2	0.816	0.826	0.890	0.731
Y	0.734	0.776	0.880	0.786
Z	0.870	0.874	0.912	0.722

According the outturn table above, it is retrieved that after conducting the Internal Consistency Measurement test, all variable values obtained are above 0.6.

This indicates that the measurement of internal consistency is appropriate and reliable.

Reliability Measurement of All Indicators in the Model Reliable test

The next is Reliability Measurement of All Indicators in the Model reliability. This value reflects the reliability of all indicators in the model. The minimum value is 0.7.

Table 6. Result of Reliability Measurement of All Indicators in the Model Reliable test

	Reliability Measurement of All Indicators in the Model	rho_A	Internal Consistency Measurement	Mean coefficient of variance extraction (AVE)
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Z	0.870	0.874	0.912	0.722

The results of Reliability Measurement of All Indicators in the Model test are good because all variables received values > 0.7. This indicates that all variables can be considered reliable.

Evaluation Of Structural Model/Inner Model Test

The Inner Model Test is conducted to predict the causal relationships between variables and test hypotheses. Firstly, the Coefficient of determination test (SQUARE ROOT) values are examined to determine the extent of variability in endogenous variables explained by exogenous variables. Coefficient of determination test values are specific to the Y variable, indicating how much the X variable influences Y.

Table 7. Result of Coefficient of determination test

	R Square	R Square Adjusted
Y	0.560	0.531
Z	0.444	0.420

From the outturn table, it is known that the Coefficient of determination test value of the Y variable is 0.560, meaning that 56% of the performance of inventory control is explained by the formed variable, while the Coefficient of determination test value of the Z variable is 0.444, indicating that 44.4% of the efficiency of production is explained by the formed variable. Direction of variable relationship is a value used to indicate the direction of the relationship between variables.

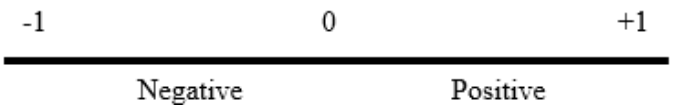

Figure 1. Scala Direction of variable relationship

If the direction of variable relationship value produced is below 0 approaching -1, it is said that the Direction of variable relationship value of Variable X to Y has a negative effect. Conversely, if the Direction of variable relationship value produced is above 0 approaching 1, it is said that the Direction of variable relationship value of Variable X to Y has a positive effect.

Direct Influence of Direction Variable Relationship

This calculation is done to determine the direction of the relationship between variables X1 and X2 with variable Y and variable Z. The following are the results of the path calculation coefficient with direct influence:

Table 8. Result Direction of variable relationship for Direct Influence

	X 1	X 2	Y	Z
X 1			0.520	0.158
X 2			0.258	0.456
Y				0.295
Z				

From the table above, it can be seen that all variables for direct influence in this study have Direction of variable relationship values above 0, indicating that all X 1 and X 2variables positively influence Y variables, and X 1 and X 2variables also positively influence Z variables.

Indirect Influence of Direction Variable Relationship

This calculation is done to determine the direction of the relationship between variables X1 and X2 with variable Z through variable Y because variable Y is an intervening variable. The following are the results of the path coefficient calculation with indirect effects indirect effect:

Table 9. Result Direction of variable relationship for Indirect Influence

	Specific Indirect Effects
X 1 -> Y -> Z	0.153
X 2-> Y -> Z	0.076

The Y variable in the table above is shown to be a positive mediator of X 1 and Z, both with respect to X 2. Next is the Bootstrapping Test where the bootstrapping evaluation results in Bootstrapping values used in decision-making during hypothesis testing. When the generated Bootstrapping value is above 1.96, it can be said that the value is significant.

Direct Influence of Bootstrapping Test

This calculation is carried out for decision making on hypothesis testing between each variable. The following is Bootstrapping calculation with direct influence:

Table 10. Result Bootstrapping Bootstrapping for Direct Influence

	Original Sample	*Sample Mean*	*Standard Deviation*	*Bootstrappings*
X 1 -> Z	0.456	0.475	0.129	0.937
X 1 -> Y	0.258	0.257	0.120	4.341
X 2-> Z	0.158	0.136	0.168	3.644
X 2-> Y	0.520	0.530	0.118	2.037
Y -> Z	0.295	0.299	0.116	2.470

The information from the table suggests that the ERP-SAP implementation variable (X 1) has a value of 0.937, indicating it has no significant impact on production efficiency (Z). However, it also shows a value of 4.341 for the same variable, suggesting a significant influence on inventory control performance (Y), and so on.

Indirect Influence of Bootstapping Test

This calculation is carried out for decision making on hypothesis testing between each variable through the intervening variable variable Y. The following is a Bootstrapping calculation with indirect effects direct effect:

Table 11. Result Bootstrapping Bootstrapping for Indirect Influence

	Original Sample	**Sample Mean**	**Standard Deviation**	**Bootstrappings**
X 1 -> Y -> Z	0.153	0.157	0.077	1.999
X 2-> Y -> Z	0.076	0.079	0.048	1.577

Based on the outturn table above, the Y variable has a significant effect in mediating X 1 towards Z, while for the Y variable, there is no significant effect in mediating X 2towards Z.

The next step is to determine the predictive relevance value. If the resulting value is > 0, it can be said that the model has predictive relevance, indicating that it has achieved good predictive accuracy.

Table 12. Result of Predictive Relevance

	SSO	**SSE**	**Q^2 (=1-SSE/SSO)**
X 1	150.000	150.000	
X 2	150.000	150.000	
Y	100.000	69.562	0.304
Z	200.000	128.434	0.358

The Q2 test results for inventory control performance variables (Y) are 0.304 and for production efficiency variables (Z) are 0.358, indicating that the variables have values > 0, retrieveding that the model has predictive relevance and has achieved good predictive accuracy. If the NFI (Normal Fit Index) value generated is larger, then the models can be considered better or more fitting with the data. NFI is a measure of model fitness compared to a baseline. The outturn table below retrieveds the Model Fit results.

Table 13. Result of Model Fit

	Saturated Model	Estimated Model
SRMR	0.101	0.101
d_ULS	0.800	0.800
d_G	0.523	0.523
Chi-Square	138.606	138.606
NFI	0.643	0.643

From the outturn table, it can be seen that the NFI Saturated Model and Estimated Model values are 0.643, indicating that the model being studied is good and has a fit data of 64.3%. Figure 2 retrieveds the final results of the framework model.

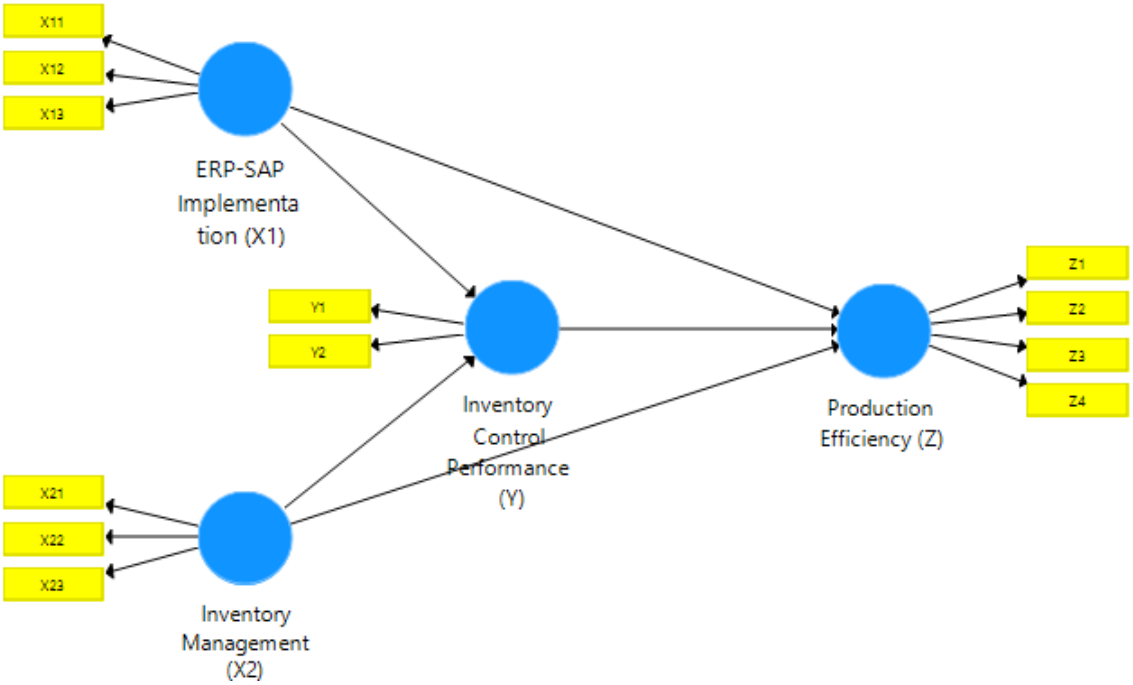

Figure 2. Framework Final

From the evaluation results of Bootstrapping Bootstrapping, there are two test results for direct and indirect influence. For direct influence, the ERP-SAP implementation variable on production efficiency indicates a direction of variable relationship of 0.456 with a bootstrapping value of 0.937, meaning ERP-SAP implementation does not have a positive effect on production efficiency (H1 rejected), the ERP-SAP implementation variable on inventory control performance indicates a direction of variable relationship of 0.258 with a bootstrapping value of 4.341, meaning ERP-SAP implementation has a positive effect on inventory control performance (H2 accepted), the inventory management variable on production efficiency indicates a direction of variable relationship of 0.158 with a bootstrapping value of 3.644, meaning inventory management has a positive effect on production efficiency (H3 accepted), the inventory management variable on inventory control performance indicates a direction of variable relationship of 0.520 with a bootstrapping value of 2.037, meaning inventory management has a positive effect on inventory control performance (H4 accepted), and finally, the inventory control

performance variable on production efficiency indicates a direction of variable relationship of 0.295 with a bootstrapping value of 2.470, meaning inventory control performance has a positive effect on production efficiency (H5 accepted).

Additionally, due to the presence of intervening variables, there is a test to find indirect effects between variables. For the ERP-SAP implementation variable, it results in a direction of variable relationship of 0.153 with a bootstrapping value of 1.999, indicating a positive effect of ERP-SAP implementation on production efficiency mediated by inventory control performance (H6 accepted), while for the inventory management variable, it results in a direction of variable relationship of 0.076 with a bootstrapping value of 1.577, indicating no significant positive effect of inventory management on production efficiency mediated by inventory control performance (H7 rejected).

Based on the results of the direct and indirect hypothesis testing analysis, recommendations for improvement can be made. To assist and improve inventory control performance in using ERP-SAP, training in SAP usage should be provided before or after employees are given workload. Because SAP software always updates its applications related to existing systems. PT XYZ has only provided announcements via email regarding SAP updates, so employees are often confused about operating SAP during system updates. Adequate training will help maximize the potential of inventory control employees.

Furthermore, regarding inventory management, it is one of the main tasks of the inventory control division. To help and improve inventory control performance so that production runs smoothly, collaboration with suppliers should be increased to ensure stable and timely supply. Continuously remind suppliers to send raw materials before the due date. Additionally, discussions can be held beforehand regarding how shipments are made and when they are made to overcome the risk of stock shortages and miscommunication affecting production efficiency, ensuring that product outturn meets expectations.

D. Conclusion

Based on the test results that have been carried out using PLS, it can be confirmed that the implementation of ERP-SAP does not have a positive impact on production flexibility, but the implementation of ERP-SAP has a positive impact on inventory management performance. Additionally, inventory management directly positively affects production efficiency and inventory control performance. Lastly, inventory control performance directly positively affects production efficiency. Furthermore, the results of hypothesis testing with indirect effects indicate that there is a positive effect of ERP-SAP implementation on production efficiency mediated by inventory control performance, and there is no positive effect of inventory management on production efficiency mediated by inventory control performance.

From the results of direct and indirect hypothesis testing analysis, recommendations for improvement can be provided. To assist and enhance inventory control performance in using ERP-SAP, provide SAP usage training before or after employees are assigned tasks. Since SAP software always updates its applications related to existing systems. Additionally, to ensure efficien in production, the inventory control department should increase collaboration with

suppliers to ensure stable and timely supply. Continuously remind suppliers to send raw materials before the due date, and discuss beforehand how shipments are made and when they are made to overcome the risk of stock shortages and miscommunication affecting production efficiency, ensuring that product outturn meets expectations.

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