THE EFFECTIVENESS OF IMPLEMENTING WAREHOUSE MANAGEMENT SYSTEM ON PRODUCTIVITY IMPROVEMENT AND STOCK ACCURACY (A CASE STUDY ON FMCG LOGISTIC SERVICE COMPANIES IN PALEMBANG, INDONESIA)

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ABSTRACT
This study investigates the effectiveness of implementing Warehouse Management Systems (WMS) on productivity improvement and stock accuracy in FMCG logistics service companies in Palembang, Indonesia. By comparing manual, outsourced, and in-house WMS, the research analyzes their impact on key performance indicators through a quantitative research design using descriptive analytics and multiple regression analysis. Data collection involved measuring productivity per person per hour and stock accuracy per SKU, complemented by interviews with employees. The findings reveal that in-house WMS significantly enhance productivity and stock accuracy compared to outsourced and manual systems. This research provides valuable insights for logistics companies aiming to optimize their warehouse operations and improve overall efficiency.

KEYWORDS
Warehouse Management System, Stock Accuracy, FMCG Logistics

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INTRODUCTION

Warehouse Management System (WMS) is a warehouse management system designed to help companies organize warehouse operations by means of automation and better organization of various activities within the warehouse. In this context, a warehouse management system or WMS mainly aims to control the movement and storage of materials within the warehouse and process related transactions, including shipping, receiving, storing and picking. (Ramaa et al., 2012)

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Logistics businesses use Warehouse Management Systems (WMS) to facilitate warehouse operations through IT systems for better tracking and management of inventory effectively (Andiyappillai & Prakash, 2019). Based on the data collected from the case company, the proposed Internet of Things (IoT)-based WMS shows that warehouse productivity, picking accuracy and efficiency can be improved and robust to order variability. (Lee et al., 2017)

One of the main benefits of implementing a WMS is the improvement of stock accuracy (Andiyappillai & Prakash, 2019). Since warehouses store inventory (or goods), warehousing adds value to businesses and supply chains in the same way that inventory does (Frazelle, 2016). (Frazelle, 2016). With this system, real-time monitoring of the availability of goods and stock movement within the warehouse can be done. The integration of (RTLS) and WMS not only provides real-time visualization of the warehouse but also avoids errors and utilizes warehouse space. (Halawa et al., 2020).

In addition, WMS also helps to optimize productivity essential for allocating warehouse resources efficiently and effectively to increase productivity and reduce operating costs. (Ramaa et al., 2012) warehouse within the warehouse by reducing the time and operational costs associated with stock or inventory management. (M Zhang, 2021). In its operation, WMS can manage pick routes, minimizing the distance in picking routes (Ramirez et al., 2021). (Ramirez et al., 2013), (Micale & La Scalia, 2018). (Chiang et al., 2011).

WMS also helps with efficient put-aways, ensuring the placement of goods in the right location, and avoiding lost goods. Thus, companies can save costs and improve operational efficiency. The support of an effective goods retrieval system is ensured by the implementation of controlled storage principles (i.e., Warehouse Management System - WMS). (Kašparová & Dyntar, 2021) and storage assignment: how to assign loads to empty locations, picking tour optimization (Picking list management) (Baruffaldi et al., 2019).

The implementation of WMS can also improve stock accuracy in the warehouse. The WMS will continuously monitor the amount of stock available in the warehouse and provide notifications if there is a difference between the amount of stock registered in the system and the amount of stock available in the warehouse. (Zhang, 2022). This will help reduce picking errors, improve stock accuracy, and avoid overstock and understock. (Ramaa et al., 2012)(Ramirez et al., 2013)

However, implementing a WMS also has some challenges. One of them is the high cost of implementation (Faber et al., 2002). In addition, the implementation of WMS also requires sufficient time and resources for employee training and system setup (Faber et al., 2013). (Faber et al., 2013) In addition, this study on WMS is a popular study. Scopus data searches that the author conducted in January 2024 according to the table below with the keyword warehouse management system search results of 8,570 documents. With the addition of the keywords "AND productivity AND inventory" the search results are 228 documents, and if you add the keywords inventory and accuracy the search results are only 43 documents, and if you add the keywords "3rd party and inhouse" then no corresponding documents are found. This data shows that this study is an interesting study to continue because in addition to
being a popular study but there is no study that specifically discusses the choice of the most effective WMS to increase productivity and stock accuracy.

### Table 1
Scopus Warehouse Management System Data Search

<table>
<thead>
<tr>
<th>Search Record</th>
<th>Search within</th>
<th>Search Document</th>
<th>Filter</th>
<th>Result Doc</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Article title, Abstract, Keywords</td>
<td>Warehouse Management System</td>
<td>No</td>
<td>8.570</td>
</tr>
<tr>
<td>2</td>
<td>Article title, Abstract, Keywords</td>
<td>Warehouse Management System</td>
<td>Limit to: article, journal, business-management-accounting, english</td>
<td>588</td>
</tr>
<tr>
<td>3</td>
<td>All fields AND productivity AND inventory</td>
<td></td>
<td></td>
<td>228</td>
</tr>
<tr>
<td>4</td>
<td>All fields AND productivity AND accuracy</td>
<td></td>
<td></td>
<td>78</td>
</tr>
<tr>
<td>5</td>
<td>All fields AND productivity AND inventory AND accuracy</td>
<td>AND inhouse</td>
<td></td>
<td>43</td>
</tr>
<tr>
<td>6</td>
<td>All fields AND productivity AND inventory AND accuracy AND inhouse AND 3rd party</td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Scopus Data January 2024

Therefore, the author is interested in examining the use of which WMS options can increase productivity and optimize stock accuracy. Whether warehousing operations, using WMS manually, using WMS built by third parties (outsourced) or using WMS built in-house.

A Warehouse Management System (WMS) is necessary to manage a modern warehouse as it can improve productivity and stock accuracy. However, implementing a WMS is costly, from development to training and implementation, so companies need to consider the benefits and impacts thoroughly. This research examines the effectiveness of various types of manual, outsourced, and in-house WMS in improving productivity and stock accuracy. The aim is to determine which WMS options are most effective in improving company performance. The benefits of this research include a better understanding of improving productivity and stock accuracy with WMS, helping stakeholders understand the advantages of WMS implementation, and assisting in choosing the right type of WMS. Thus, FMCG logistics service companies in Palembang can adopt this technology to manage the supply chain more effectively and efficiently.

**RESEARCH METHOD**

**Research Design**

The research design used in this study is quantitative research with descriptive analytic research type. This design is used to describe existing phenomena in the population or sample, then analyze the relationship between the variables studied.
Descriptive analytical research is a type of research that describes or measures the characteristics of a phenomenon (Verma, 2013) or population using systematic and structured data collection methods. In this study, researchers will collect data on the pattern of implementation of WMS development, on productivity, and stock accuracy in the warehouse of FMCG logistics service companies in Palembang, Indonesia, then measure the effect using Multiple Regression Dummy Variables.

**Research Population and Sample**

The population in this study is all FMCG logistics service companies located in Palembang, Indonesia that have implemented Warehouse Management System in several years. The sample in this study is monthly data for the period before the implementation of WMS and during the implementation of WMS both outsourced and in-house WMS.

**Data Collection Technique**

The data collection technique used in this study is to use raw data from the measurement of productivity per person per hour and stock accuracy per SKU. In addition, researchers also conducted interviews with several respondents to get more detailed information about the implementation of the Warehouse Management System.

**Data Analysis Technique**

This study uses multiple regression data analysis techniques to understand the relationship between several independent variables and one dependent variable. (Chatterjee & Simonoff, 2013). This method is suitable for observational data and is used to model the relationship between Warehouse Management System (WMS) implementation and productivity and stock accuracy. (Arum Janir, 2012). The independent variables in this study include the implementation of a third-party built WMS and an in-house built WMS, while the dependent variables include productivity, measured by the warehouse output-input ratio, and stock accuracy, measured by the percentage difference between stock records and the physical quantity of goods in the warehouse. Regression models were used to test the effectiveness of WMS on productivity and stock accuracy. (Purnomo, 2016) (Setyawarno, 2016) (Sugiyono, 2013). The test is carried out through the T-test for the partial effect of the independent variables and the F-test for the simultaneous effect of all independent variables. In addition, the coefficient of determination (R²) is used to evaluate the extent to which the regression model fits the data. (Sugiyono, 2013). This study also involved interviews with workers who directly operate the WMS to obtain qualitative data related to the implementation and effectiveness of the WMS.

**RESULT AND DISCUSSION**

**Research Object**

The object of research is a company engaged in logistics services, also known as 3PL (Third Party Logistics Provider), which offers various types of logistics.
services such as storage, distribution, shipping, and supply chain management. The company has operational facilities and offices in strategic locations throughout Indonesia, one of which is in Pelambang.

The company’s main customers are logistics service providers for chemicals that support the plantation and agriculture sectors. Based on data until November 2023, the FMCG revenue contribution from the company's storage, handling, and transportation services is 4.46% to the overall business, with the Palembang branch contributing 2.49%.

<table>
<thead>
<tr>
<th>CUSTOMER</th>
<th>YTD</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMCG (Fast Moving Consumer Goods) Jakarta</td>
<td>14,032,368,350</td>
<td>1.98%</td>
</tr>
<tr>
<td>Construction</td>
<td>25,495,966,470</td>
<td>3.59%</td>
</tr>
<tr>
<td>One Time Project</td>
<td>133,390,491,192</td>
<td>18.80%</td>
</tr>
<tr>
<td>Chemical</td>
<td>126,700,019,302</td>
<td>17.86%</td>
</tr>
<tr>
<td>Government Project</td>
<td>22,934,150,671</td>
<td>3.23%</td>
</tr>
<tr>
<td>Chemical</td>
<td>29,591,829,713</td>
<td>4.17%</td>
</tr>
<tr>
<td>Chemical</td>
<td>100,836,712,611</td>
<td>14.21%</td>
</tr>
<tr>
<td>Chemical</td>
<td>33,554,006,784</td>
<td>4.73%</td>
</tr>
<tr>
<td>FMCG (Fast Moving Consumer Goods) Palembang</td>
<td>17,641,485,570</td>
<td>2.49%</td>
</tr>
<tr>
<td>Chemical</td>
<td>11,872,246,702</td>
<td>1.67%</td>
</tr>
</tbody>
</table>

Source: Revenue Data for 2023 until November

Nonetheless, Palembang branch’s contribution to FMCG logistics service revenue is very significant, as this revenue constitutes 30.25% of the total revenue of Palembang branch. Consequently, in order to achieve customer satisfaction that continues to increase year after year, every effort is made to improve efficiency, effectiveness, and service quality, taking into account the use of Warehouse Management System (WMS) as one of the main strategies. Here is how Palembang branch enriches these efforts with the implementation of WMS:

**Improving Operational Efficiency with WMS**

Implemented a WMS to automate and optimize the process of storing, picking, and shipping goods in the warehouse. Utilize WMS features such as task scheduling, real-time inventory management, and operational performance monitoring to improve efficiency and reduce operation cycle time.

**Improving Service Effectiveness through WMS**

Utilize the capabilities of the WMS to provide better visibility of stock and goods flow, enabling faster and more accurate service to customers. Using data generated by the WMS to improve capacity planning and management, optimize delivery routes, and respond to customer requests in a more timely manner. By combining efforts to improve efficiency, and service effectiveness with the
implementation of WMS, the Palembang branch is able to strengthen its contribution to FMCG logistics service revenue and continuously meet customer expectations and needs.

**Research Subject**

The subject of this study is to investigate and analyze the impact of Warehouse Management System (WMS) implementation on productivity and stock accuracy in the context of an FMCG logistics services company in Palembang, Indonesia.

*Warehouse Management System (WMS):*

The research subject will focus on the implementation of a WMS in the context of an FMCG logistics services company in Palembang, Indonesia. This includes understanding how the system is implemented, operated, and its impact on productivity and stock accuracy in a warehousing environment.

*Productivity Improvement:*

The research will examine how the implementation of a WMS contributes to productivity improvements in the warehouse operations of an FMCG logistics services company in Palembang. This includes an evaluation of the operational processes updated with the WMS and its impact on work efficiency, throughput, and resource utilization.

The productivity referred to in this study is the Company's productivity formulated in the number of cartons per person per hour on average, calculated based on the number of cartons produced in 1 day divided by the total working hours of direct manpower in 1 day including overtime. The formula for calculating productivity is as follows, Productivity per month = Total throughput one month/Total working hours of all Direct Manpower one month.

*Stock Accuracy:*

The research subject will also explore how WMS implementation affects stock accuracy per SKU in the warehouse of an FMCG logistics service company in Palembang. The formula for calculating stock accuracy per SKU is as follows, Accuracy per SKU = Number of accurate SKUs/Total SKUs recorded in WMS. This accuracy includes the variables of SKU code, location, and number of cartons, whether the physical match found during stocktaking is compared to the stock recorded in the WMS system. Which is the more effective inventory management that occurs before implementing a WMS, after implementing an outsourced WMS or after implementing an inhouse WMS.

**Research Stages**

The stages of this research include several main steps: first, a preliminary study and literature review to understand the concepts, functions, and applications of Warehouse Management System (WMS) as well as the characteristics of the FMCG logistics industry. Then, research planning was conducted by determining
objectives, questions, and hypotheses, as well as designing data collection methods and techniques. Data were collected through interviews, observations, and questionnaires at FMCG logistics service companies in Palembang. Data analysis used statistical and qualitative techniques to evaluate the relationship between WMS implementation and productivity and stock accuracy. The results were interpreted to identify patterns and key findings. Conclusions and recommendations were drawn based on the research findings, and a comprehensive research report was prepared to reflect the research process and results.

**Stages of WMS Implementation**

The Company has undergone three stages of Warehouse management system implementation, since starting operations in 2011 until now. The Company has implemented a manual WMS, implemented a WMS developed by a third party (outsourced) and implemented a WMS developed in-house.

1. Implementing WMS manually, the time span from 2011 to 2019, namely implementing Warehouse Management System (WMS) manually involves managing warehouse operations without using a computerized or automated system.
2. Implement a Warehouse Management System (WMS) spanning from 2019 to 2021, built by a third party or outsourced, where the company contracts an external vendor or third party to develop, a WMS for their warehouse operations.
3. Implementing an in-house Warehouse Management System (WMS), timeframe 2022 to date, an in-house WMS is the process by which a company develops, builds, and manages its own WMS system without involving a third party.

**Key Activities of WMS Implementation**

This research examines the main activities of the Warehouse Management System (WMS) implementation which include several activities: storage of goods, where operators move goods to the appropriate storage location based on the warehouse layout and SKU; product picking in pallet units, which is done manually with a forklift to pick goods from high shelves; product picking in carton units, where operators pick products from carton storage locations using hand pallets; replenishment of pick face stock, where operators move products from pallet storage to carton storage so that products are always available; and stock monitoring and inventory, which is done manually to record the movement of goods and ensure stock accuracy.

**Pros and Cons of Manual WMS, Third-Party WMS, and In-House WMS**

This research combines two data collection methods: structured interviews via Google Form and secondary data from the company. Google Form interviews made it easy for respondents from remote locations to participate, while secondary data helped to complete the understanding of productivity and stock accuracy. This approach provides a comprehensive picture of the phenomenon under study.
The respondent profile consisted of 56% direct manpower and 44% indirect manpower. The majority of respondents (81.3%) had previous experience in operating a WMS, enabling them to provide informative comparisons on the ease, difficulty and performance of different types of WMS.

Activities compared in the WMS process include putaway, picking, replenishment, and stock-taking. Manual WMS has the advantage of being able to place products at any empty location. However, manual WMS also has disadvantages such as being prone to errors, difficult to know the amount of inventory in real-time, and causing delays and complexity in warehouse management.

Third-party (outsourced) and in-house WMSs each have advantages and disadvantages. Respondents stated that the in-house WMS is more effective in directing putaway routes and faster in responding to system disruptions than the third-party WMS. However, the third-party WMS is considered better at providing product location information that speeds up the picking process. In terms of replenishment, both systems have their advantages, but the in-house WMS is considered better at ensuring timely product availability.

Difficulties in the stock-taking process are also faced by both types of WMS, but the in-house WMS is considered more responsive in terms of technical support. In terms of stock accuracy, the majority of respondents stated that the in-house WMS is more accurate than third-party WMS and manual WMS.

In terms of productivity, the majority of respondents stated that in-house WMS and third-party WMS are more productive than manual WMS. This shows that implementing a WMS can improve productivity and stock accuracy compared to manual processes.

Overall, this study shows that each type of WMS has its own advantages and disadvantages, but in-house WMS tends to provide better results in terms of effectiveness, responsiveness, and accuracy compared to third-party WMS and manual WMS.

**Productivity comparison between Manual WMS and Outsourced WMS**

Secondary data that the author collects from monthly reports and after being processed using statistical tests in accordance with the explanation in Chapter II of this paper, the author conducts the T-Test, F-Test and calculation of the Coefficient of Determination (R2). The first test is to conduct a T-test on productivity and stock accuracy between WMS Manual and WMS Outsourced, WMS Outsourced and WMS Inhouse, to see if there is an average difference in the use of WMS Manual and WMS Outsourced on productivity and stock accuracy, and whether there is an average difference in the use of WMS Outsourced and WMS Inhouse on productivity and stock accuracy using the SPSS application.

i) T-test of productivity of Manual WMS and Outsourced WMS

ii) T-test of stock accuracy of Manual WMS and Outsourced WMS

iii) T-test of productivity of Outsourced WMS and Inhouse WMS

iv) T-test of stock accuracy of Outsourced WMS and Inhouse WMS

T-test of productivity of Manual WMS and Outsourced WMS as follows:
Based on the results of the paired T-test according to the data in Table-6 below, it can be seen that the T-count is 1.078 while the T-table is, with a sample size of 12, the DF number is obtained as follows 12 samples are reduced by 3 variables, the DF number is 9, with a two-sided test, the T-table is 2.262. Thus, the comparison between productivity of Manual WMS and Outsourced WMS, T-calculated with T-table is $1.078 < 2.262$, then the hypothesis is accepted which means that there is a positive influence on the application of Outsourced WMS on productivity.

**Table 3. Paired Samples Test Productivity of Manual WMS vs Outsourced WMS**

<table>
<thead>
<tr>
<th>Paired Samples Test</th>
<th>Paired Differences</th>
<th>95% Confidence Interval of the Difference</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Mean</td>
<td>Std. Error</td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>Pair 1</td>
<td></td>
<td>22.08393</td>
<td>70.98930</td>
<td>20.49111</td>
<td>-23.01730</td>
</tr>
</tbody>
</table>

Source: SPSS

Next is the effect of WMS Outsource implementation on stock accuracy, based on SPSS Paired Samples Test data processing in Table-7 for stock accuracy, the T-count is 5.230 and, T-table, with a DF number of 12 samples minus 3 variables, namely 9, the T-table is 2.262. Thus the comparison between T-count and T-table is $5.230 > 2.262$, so the hypothesis is not accepted, meaning that there is no positive effect of Outsource WMS implementation on stock accuracy.

**Table 4. Paired Samples Test Stock Accuracy of Manual WMS vs Outsourced WMS**

<table>
<thead>
<tr>
<th>Paired Samples Test</th>
<th>Paired Differences</th>
<th>95% Confidence Interval of the Difference</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Mean</td>
<td>Std. Error</td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>Pair 1</td>
<td></td>
<td>-1.5893</td>
<td>1.0477</td>
<td>-0.0027</td>
<td>-2.2496</td>
</tr>
</tbody>
</table>

Source: SPSS

The next step is to test whether there is an effect of the Inhouse WMS implementation on productivity and stock accuracy compared to the Outsource WMS implementation. Based on SPPS data processing in Table-8, the T-count is 4.329 while the T-table with 12 samples of 3 variables, then DF is 9, T-table is 2.262. Thus the comparison of T-count and T-table is $4.329 > 2.262$, so the hypothesis is not accepted, meaning that there is no effect of the application of Inhouse WMS on productivity compared to Outsourced WMS.
The effect of *inhouse WMS* implementation on stock accuracy can be seen in Table-9. Based on the results of the Paired Samples Test, the effect of the *Inhouse WMS* on stock accuracy compared to the *Outsourced WMS*, the T-count is 1,000 while the T-table with 12 samples minus 3 variables, the T-table is 2,042. Thus the comparison of T-count and T-table is 1,000 < 2,024, so the hypothesis is accepted, meaning that there is a significant effect of implementing an *Inhouse WMS* on stock accuracy compared to an *Outsourced WMS*.

**Table 5. Paired Samples Test Productivity of *Outsourced WMS* vs *Inhouse WMS***

<table>
<thead>
<tr>
<th>Paired Samples Test</th>
<th>Paired Differences</th>
<th>95% Confidence Interval of the Difference</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>Std. Deviation</td>
<td>95% Lower</td>
<td>95% Upper</td>
<td>Mean</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td>Paired</td>
<td>Outsourcing WMS - Outsourcing WMS Inhouse</td>
<td>-0.33333</td>
<td>49.8829</td>
<td>44.39078</td>
<td>-94.02703</td>
</tr>
</tbody>
</table>

Source: SPSS

**Table 6. Paired Samples Test Productivity of *Outsourced WMS* vs *Inhouse WMS***

<table>
<thead>
<tr>
<th>Paired Samples Test</th>
<th>Paired Differences</th>
<th>95% Confidence Interval of the Difference</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>Std. Deviation</td>
<td>95% Lower</td>
<td>95% Upper</td>
<td>Mean</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td>Paired</td>
<td>Akuras WMS Outsourcing - Akuras WMS Inhouse</td>
<td>-0.0167</td>
<td>0.0017</td>
<td>0.00167</td>
<td>-0.00533</td>
</tr>
</tbody>
</table>

Source: SPSS

Summary of T-test results is as follows:

**Table 7. Paired Samples Test Productivity of *Outsourced WMS* vs *Inhouse WMS***

6501 http://eduvest.greenvest.co.id
Next is the F-test to determine the F-table, the formula is \( F-table = (k; n-k) \), \( F-table (1;11) = 4.84 \). If the significance number is <0.05, or \( F-count > F-table \), then there is a significant influence on the choice of WMS on productivity and stock accuracy, and if the significance number is >0.05, or \( F-count < F-table \) then there is no influence of the variable choice of WMS on productivity and stock accuracy. The hypothesis is as follows:

- **H1** = There is an effect of WMS choice on productivity, if significance <0.005 or \( F-count > F-table \)
- **H2** = There is an effect of WMS selection on stock accuracy, if significance > 0.05 or \( F-count < F-table \).
- **H3** = There is an effect of WMS choice on productivity and stock accuracy together, if significance < 0.005 and \( F-count > F-table \).

F-count based on the results of SPSS testing of productivity levels as shown in Table-10 as follows; productivity significance value 0.018 > 0.05 and T-count 2.497 > 2.262, it can be concluded that there is no significant effect of the application of WMS on productivity. And testing for stock accuracy, the significance value of 0.000 < 0.005 and T-count 5.875 > 2.262, it can be concluded that there is a significant effect of the application of each WMS on stock accuracy.

### Table 8. Coefficient of Influence of WMS Implementation Options on Productivity and Stock Accuracy

<table>
<thead>
<tr>
<th>Uji-T</th>
<th>WMS Manual vs WMS Outsource</th>
<th>Hipotesa</th>
<th>WMS Outsource vs WMS Inhouse</th>
<th>Hipotesa</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Produktivitas</strong></td>
<td>T-hitung dengan T-table adalah (1.078 &lt; 2,262)</td>
<td>Hipotesa ditolak artinya tidak terdapat pengaruh positif penerapan WMS Outsource terhadap produktivitas</td>
<td>T-table dan T-hitung adalah (4,329 &gt; 2,262)</td>
<td>Hipotesa diterima artinya tidak terdapat pengaruh penerapan WMS Inhouse terhadap produktivitas dibandingkan WMS Outsource</td>
</tr>
<tr>
<td><strong>Akurasi</strong></td>
<td>T-hitung dan T-table adalah 5,230 &gt; 2,262</td>
<td>Hipotesa ditolak artinya tidak terdapat pengaruh positif penerapan WMS Outsource terhadap stok akurasi</td>
<td>T-hitung &lt; dari T-table adalah 1.000 &lt; 2.024</td>
<td>Hipotesa diterima artinya terdapat pengaruh signifikan penerapan WMS Inhouse terhadap akurasi stok dibandingkan dengan WMS Outsource</td>
</tr>
</tbody>
</table>

- Nilai \( t \text{ hitung} > \) nilai \( t \text{ tabel} \) maka \( H_0 \) ditolak.
- Nilai \( t \text{ hitung} < \) nilai \( t \text{ tabel} \) maka \( H_0 \) diterima.

The Effectiveness of Implementing Warehouse Management System on Productivity Improvement and Stock Accuracy (A Case Study on FMCG Logistic Service Companies in Palembang, Indonesia)
Source: SPSS

F-test based on SPSS data processing according to table-10 below, the significance number is 0.000 < 0.005, or F-count 20.91 > 4.103, thus it can be concluded that the choice of WMS simultaneously has a significant effect on productivity and stock accuracy.

Table 9. F-test of Productivity of Outsourced WMS vs Inhouse WMS

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>13.266</td>
<td>2</td>
<td>6.633</td>
<td>20.391</td>
<td>.000&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Residual</td>
<td>10.734</td>
<td>33</td>
<td>.325</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>24.000</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Dependent Variable: Pilihan WMS  
<sup>b</sup> Predictors: (Constant), Stok Akurasi Masing-masing WMS, Produktifitas Masing-masing WMS

Source: SPSS  

Table 10. Coefficient of Determination of the Effect of WMS Choice on Productivity and Stock Accuracy

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.743&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.553</td>
<td>.526</td>
<td>.57033</td>
</tr>
</tbody>
</table>

<sup>a</sup> Predictors: (Constant), Stok Akurasi Masing-masing WMS, Produktifitas Masing-masing WMS

Source: SPSS

The R-square data or the coefficient of determination generated by SPSS is as follows, $R^2 = 0.553$, meaning that the application of WMS alternatives to productivity and stock accuracy simultaneously has an effect of 55.3%. The following is a summary of the conclusion of the F-test results and the coefficient of determination;  

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CONCLUSION

Based on the results of statistical testing using SPSS, this study concludes that the implementation of Warehouse Management System (WMS) affects productivity and stock accuracy. Respondents' perceptions show that WMS simplifies the process of placing, retrieving, replenishing products, and stock-taking. The T-test results indicate that the change from manual WMS to outsourced WMS increases productivity but does not affect stock accuracy, while the change from outsourced WMS to inhouse WMS increases stock accuracy but not productivity. The F-test results indicate that there is no significant difference in the effect of WMS implementation on productivity, but there is a significant difference on accuracy stock. The coefficient of determination shows that WMS implementation simultaneously affects productivity and accuracy stock by 55.3%.

Based on this research, it is recommended that stakeholders consider the cost of development, training, and tools such as RF scanners, servers, and computers in choosing a WMS alternative. The interview findings show that outsourced WMSs have weaknesses in responsiveness and technical support, which need to be addressed. Further research is needed to explore the factors that influence the smooth implementation of an inhouse WMS compared to an outsourced WMS, as well as to determine whether an inhouse WMS is easier to implement according to warehouse operators' perceptions.

REFERENCES

