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Analysis of Warehouse's Performance (Shipping, Order Picking, Storage, Putaway, Receiving) to Achieve Effective and Efficient Performance (Financial, Productivity, Utilization, Quality, Cycle Time)

Andre Yosafat Simarmata[1*], Juliater Simarmata[2]
Institut Transportasi dan Logistik Trisakti, Jakarta, Indonesia, andre.yosafat@gmail.com
Institut Transportasi dan Logistik Trisakti, Jakarta, Indonesia, juliaters@gmail.com

[*]Corresponding Author: andre.yosafat@gmail.com

Abstract: Warehousing plays a pivotal role in ensuring the smooth flow of materials and spare parts to support production processes. The efficiency and reliability of warehouse operations significantly impact overall company operations, enhancing their reliability, effectiveness, and efficiency. Achieving optimal performance relies on various interconnected factors, with one crucial aspect being the enhancement of warehouse performance. Employing methodologies such as Analytical Hierarchical Process (AHP), Key Performance Indicators (KPIs), and Standard Normalization (S-NORM) aids in data processing and evaluation. For instance, PT XYZ Café Indonesia's warehouse in Jakarta utilizes 25 KPIs, divided into categories like Receiving, Putaway, Storage, Order Picking, and Shipping, each containing 5 KPIs. Analysis reveals 10 KPIs in the green category, signaling satisfactory performance, while 11 fall into the yellow category, indicating areas for improvement, and 4 are in the red category, signifying critical areas requiring immediate attention. Utilizing the S-Norm De Boer method for performance evaluation, the Jakarta warehouse achieves a performance index of 93.20335, meeting expected performance levels. However, there's a need for targeted improvements in KPIs categorized as yellow or red to enhance overall warehouse efficiency and effectiveness.

Keywords: Efficient; AHP; KPI; Warehouse; Effective; S-No

INTRODUCTION

In the current era of globalization, knowledge and technology are advancing rapidly and modernizing, impacting companies operating in industrial sectors, sales, and services. Given this situation, it is inevitable that these companies will face intense competition in releasing similar products. The increasing competition in the industrial world necessitates managers in the manufacturing industry to play a crucial role within the industrial system.

In such fierce competition, the role of Warehouse Management becomes paramount as warehouses serve as storage spaces for both raw materials awaiting processing and finished goods ready for marketing (Purnomo,2004).

Effective and efficient warehousing entails the ability to adapt to demands to enhance the speed of processes from reception to storage and through to delivery.

Effective warehouse management plays a crucial role in the success of a company. Well-maintained warehouse conditions and organization are expected to prevent company losses, minimize costs, and expedite warehouse operations and services. Improved productivity and warehouse services will significantly impact the overall performance of the company.

PT XYZ Cafe Indonesia is a company focused on the beverage industry under the brand name "XYZ Café / XYZ Thé". XYZ Café / XYZ Thé is an international brand originating from Taiwan, established since 2006, and developed in Indonesia since 2013. PT XYZ Cafe Indonesia operates several warehouses scattered across several cities to support operational activities across all outlets in Indonesia.

With the recent expansion undertaken by PT XYZ Café Indonesia over the past two years, there has been a significant increase in inventory for ingredients, packaging, utensils, and machinery to meet the needs of each new outlet.

The above factors contribute to the need for a considerable warehouse space to store all these items. Therefore, PT XYZ Café Indonesia needs to conduct warehouse management evaluations to optimize space utilization and warehouse performance.

To assess warehouse performance, it can be measured based on various activities conducted in the warehouse, such as Receiving, Put-away, Storage, Order Picking, and Shipping, which are common warehouse operations. Due to the significant number of warehouses owned by PT XYZ Café Indonesia, the author chose to conduct a case study at the Jakarta warehouse, which serves as the Warehouse Distribution Center for receiving, storing, and distributing raw materials and machinery to warehouses outside the city and outlets located in Jakarta.

To measure warehouse performance, Key Performance Indicators (KPIs) can be utilized. KPIs are indicators used to measure the level of performance achievement against predetermined strategic objectives (Suwardi Luis, 2007: 43). These indicators typically include Financial, productivity, utilize, quality, dan cycle time. By employing KPIs, companies can enhance warehouse utilization in terms of the accuracy and speed of material reception, storage, and delivery. Additionally, KPIs enable companies to assess warehouse conditions and strategically improve productivity.

Moreover, KPIs serve the purpose of comparing expected values with actual values achieved, facilitating the enhancement of warehouse performance targets from one period to another. This comparison helps to prevent wasteful spending on material storage costs and ensures the quality of materials stored in the warehouse.

Each indicator has a different weight and scale, thus requiring a normalization process to standardize parameters. Normalization is essential to ensure that each performance indicator shares the same scale.

If performance indicators have different scales, their values may not accurately reflect the company's performance. The normalization process is carried out using the normalization formula Snorm by De Boer (Trienekens & Hvolby, 2000).

For data processing and analysis, *Analitycal Hierarchy Process AHP, Standard Normalization (S-Norm)* and *Key Performance Indicators (KPI)*

The aims of this study are twofold: (1) To assess the performance of the Jakarta warehouse at PT XYZ Café Indonesia using Key Performance Indicators (KPIs) that speak about receiving, putting away, storing, order picking, and shipping all tasks related to warehouse operations. This evaluation employs five indicators to measure warehouse KPIs: Financial, cycle time, quality, utilization and productivity, (2) To identify efforts or actions aimed at finding solutions to enhance the performance of the Jakarta warehouse at PT XYZ

Cafe Indonesia, enabling it to operate more effectively and efficiently while supporting the activities and production operations of PT XYZ Cafe Indonesia outlets.

Every warehouse should be designed to meet specific supply chain needs. However, certain operations are common to most warehouses. Some activities that occur in the warehouse include receiving, placement, storage, movement, and dispatch (Rushton, 2010).

METHODS

This research employs the AHP method, KPI, & S-Norm to determine the effectiveness and efficiency levels of warehouse performance.

The Analytical Hierarchy Process (AHP) approach basically consists of the following steps: (1) Identifying the issue and figuring out the ideal fix. (2) Establishing a hierarchy of the encountered issues. (3) evaluating the options and criterion items in terms of priority. Following the AHP analysis, we will proceed with the KPI method. Warehouse performance measurement is conducted using Key Performance Indicators (Frazelle, 2002, 56), utilizing measurements as depicted in the diagram below:

Figure 1. Frazell Key Performance Indicators

	Financial	**Productivity**	**Utilization**	**Quality**	**Cycle Time**
Receiving	Receiving cost per line	Receipts per man-hour	% Dock Door utilization	% Receipsts processed accurately	Receipt Processig time per receipts
Putaway	Putaway cost per line	Putaways per man-hour	% Utilization of putaway labor and equipment	% Perfect putaways	Putaways cycle time (per putaway)
Storage	Storage space cost per item	Inventory per square foot	% Locations and cupe occupied	% Locations without inventory discrepancies	Inventory days on hand
Order picking	Picking cost per order line	Order lines picked per man-hour	% Utilization of Picking labor and equipment	% Perfect Picking lines	Order picking cycle time (per order)
Shipping	Shipping Cost per customer order	Order prepared for shipment per man-hour	% Utilization of Shipping docks	% Perfect Shipments	Warehouse order cycle time

Source: Processed by the author

Afterward, each indicator has different Value and scales. Therefore, a parameter alignment process is necessary through normalization. The data collection methods employed include field research and literature review. Field research involves: (1) Observation through direct observation and recording of facts encountered at the Jakarta warehouse of PT XYZ Café Indonesia during warehouse operational processes, (2) Unstructured or open interviews with company personnel such as the Logistic Manager, Warehouse Supervisor, and Assistant Warehouse Supervisor of PT XYZ Café Indonesia, who can provide information for research purposes.

RESULT DAN DISCUSSION

The first step is to identify the main activities: Shipment, Receiving, Order Picking, Storage, and Put Away. Once identified, the KPI weighting is done through pairwise comparisons based on these main activities. The results are then normalized using the Geometric Mean method. The calculation results are as shown in the diagram below:

Table 1. Value of each performance indicator

Process First Level	Criteria Second Level	No KPI	*Key Performance Indicator* Third Level	Value
Receiving	Financial	KPI #1	Cost per line for receiving	0.146
	Produktifity	KPI #2	Receipts processed per labor hour	0.145
	Utilization	KPI #3	Dock door utilization percentage	0.077
	Quality	KPI #4	Receipt processing time per receipt	0.200
	Cycle Time	KPI #5	Time taken for processing each receipt	0.432
Put Away	Financial	KPI #1	Cost per line for putaway	0.074
	Produktifity	KPI #2	Putaway operations per labor hour	0.237
	Utilization	KPI #3	Utilization percentage of putaway labor and equipment	0.177
	Quality	KPI #4	Percentage of perfect putaways	0.126
	Cycle Time	KPI #5	Cycle time for each putaway	0.386
Storage	Financial	KPI #1	Cost per item for storage	0.099
	Produktifity	KPI #2	Putaway operations per labor hour	0.237
	Utilization	KPI #3	Percentage of location and cube occupancy	0.188
	Quality	KPI #4	Percentage of locations without inventory discrepancies	0.228
	Cycle Time	KPI #5	Inventory turnover days	0.273
Order Picking	Financial	KPI #1	Cost per order line for picking	0.070
	Produktifity	KPI #2	Order lines picked per labor hour	0.220
	Utilization	KPI #3	Utilization percentage of picking labor and equipment	0.094
	Quality	KPI #4	Percentage of perfect picked lines	0.095
	Cycle Time	KPI #5	Cycle time for each order picked	0.521
Shipping	Financial	KPI #1	Cost per customer for shipping	0.106
	Produktifity	KPI #2	Orders prepared for shipment per labor hour	0.169
	Utilization	KPI #3	Utilization percentage of shipping docks	0.118
	Quality	KPI #4	Percentage of perfect shipments	0.142
	Cycle Time	KPI #5	Shipping cycle time per order	0.465

Source: Processed by the author

Once the weights of each performance indicator are determined, the next step is Performance Measurement. Since each indicator has different weights and scales, a parameter alignment process is necessary through normalization using the S-Norm method by De Boer. In this measurement, each indicator value is converted into a specific value interval ranging from 0 (zero) to 100 (one hundred). Zero (0) signifies the poorest performance, while one hundred (100) represents the best. This ensures uniform parameters for each indicator, leading to an analyzable result. Below is the recapitulation of the weights of each KPI and the Normalization Results by De Boor

Figure 2 Recapitulation of the weights of each KPI and De Boor Normalization Results

Process	Criteria	No KPI	*Key Performance Indicator*	Average Actual Achievement	Target Min	Target Max	Category	S-Norm
Level 1	Level 2		Level 3	January 2018-January 2019	(Base)	(Strecht)		
Receiving	*Financial*	KPI #1	Cost per line for receiving	Rp720,000	Rp1,000,000	Rp500,000	*Lower is preferable.*	44
	Productivity	KPI #2	Receipts processed per labor hour	0.5	1	0.3	*Lower is preferable.*	71.4
	Utilization	KPI #3	Dock door utilization percentage	24%	24%	50%	*Bigger is preferable.*	0.0
	Quality	KPI #4	Receipt processing time per receipt	72%	50%	80%	*Bigger is preferable.*	73.33333
	Cycle Time	KPI #5	Time taken for processing each receipt	2 Jam / Order	3 Jam / Order	1 Jam / Order	*Lower is preferable.*	50
Put Away	*Financial*	KPI #1	Cost per line for putaway	Rp720,000	Rp1,000,000	Rp500,000	*Lower is preferable.*	44
	Productivity	KPI #2	Putaway operations per labor hour	8 Jam	8 Jam	4 Jam	*Lower is preferable.*	0.0
	Utilization	KPI #3	Utilization percentage of putaway labor and equipment	68%	50%	80%	*Bigger is preferable.*	60.0
	Quality	KPI #4	Percentage of perfect putaways	100%	90%	100%	*Bigger is preferable.*	100.0
	Cycle Time	KPI #5	Cycle time for each putaway	2 Jam/ Put Away	3 Jam/ Put Away	1 Jam/ Put Away	*Lower is preferable.*	50
Storage	*Financial*	KPI #1	Cost per item for storage	Rp. 25.908 / Item	Rp. 30.000/ Item	Rp. 15.000/ Item	*Lower is preferable.*	27.28
	Productivity	KPI #2	Putaway operations per labor hour	68%	50%	80%	*Bigger is preferable.*	60.0
	Utilization	KPI #3	Percentage of location and cube occupancy	68%	50%	75%	*Bigger is preferable.*	72.0
	Quality	KPI #4	Percentage of locations without inventory discrepancies	100%	80%	100%	*Bigger is preferable.*	100.0
	Cycle Time	KPI #5	Inventory turnover days	60 Days	264 Days	66 Days	*Lower is preferable.*	103.0
Order Picking	*Financial*	KPI #1	Cost per order line for picking	Rp90,000	Rp180,000	Rp90,000	*Lower is preferable.*	100.0
	Productivity	KPI #2	Order lines picked per labor hour	320	240	380	*Bigger is preferable.*	57.1
	Utilization	KPI #3	Utilization percentage of picking labor and equipment	25%	20%	30%	*Bigger is preferable.*	50.0
	Quality	KPI #4	Percentage of perfect picked lines	100%	90%	100%	*Bigger is preferable.*	100.0
	Cycle Time	KPI #5	Cycle time for each order picked	1 Jam / Order	2 Jam / Order	0.5 Jam / Order	*Bigger is preferable.*	66.7
Shipping	*Financial*	KPI #1	Cost per customer for shipping	Rp180,000	Rp250,000	Rp120,000	*Lower is Better*	46.15385
	Productivity	KPI #2	Orders prepared for shipment per labor hour	0.5	0.6	0.4	*Lower is preferable.*	50
	Utilization	KPI #3	Utilization percentage of shipping docks	75%	75%	90%	*Bigger is preferable.*	0.0
	Quality	KPI #4	Percentage of perfect shipments	100%	90%	100%	*Bigger is preferable.*	100.0
	Cycle Time	KPI #5	Shipping cycle time per order	2 Bulan	3 Bulan	2 Bulan	*Lower is preferable.*	100.0

Source: Processed by the author

From the above warehouse performance measurement results using the Standard Normalization (S-Norm) method and utilizing the Traffic Light System, it can be determined that there are 10 KPIs classified under the green category, 11 KPIs under the yellow category, and 4 KPIs under the red category.

The green color is assigned to performance numbers falling within the range of 70 to 100, indicating that the KPI performance is close to or even equal to the company's target.

The yellow color is assigned to performance numbers falling within the range of 41 to 69, indicating that management should exercise caution due to the possibility of biases occurring as KPI performance has not yet approached the target and is still fluctuating.

The red color is assigned to performance numbers falling within the range of 0 to 40, signifying that the KPI performance is significantly below the target and immediate improvement is needed.

The final performance score of the warehouse is calculated by multiplying each normalized score obtained from the De Boer's S-Norm normalization formula by the weights of each scope of the key performance indicators, processes, and criteria. This calculation aims to find the final score of the KPIs in the process and criteria. The score is obtained from the normalization calculation, and the weights are obtained from the AHP calculation. The normalized value is then averaged over the actual achievement for a period of 3 (three) months.

Figure 3 Calculation of KPI Final Value

Process	**Criteria**	**No KPI**	***Key Performance Indicator***	**Weight**	**S-Norm**	**Value Performance Weight x S Norm**
Level 1	**Level 2**		**Level 3**			
Receiving	*Financial*	KPI 1	Cost per line for receiving	0.146	44	6.424
	Productivity	KPI 2	Receipts processed per labor hour	0.145	71.4	10.35714
	Utilization	KPI 3	Dock door utilization percentage	0.077	0.0	0
	Quality	KPI 4	Receipt processing time per receipt	0.2	73.33333	14.66667
	Cycle Time	KPI 5	Time taken for processing each receipt	0.432	50	21.6
Put Away	*Financial*	KPI 1	Cost per line for putaway	0.074	44	3.256
	Productivity	KPI 2	Putaway operations per labor hour	0.237	0.0	0
	Utilization	KPI 3	Utilization percentage of putaway labor and equipment	0.177	60.0	10.62
	Quality	KPI 4	Percentage of perfect putaways	0.126	100.0	12.6
	Cycle Time	KPI 5	Cycle time for each putaway	0.386	50	19.3

Source: Processed by the author

The next step is to calculate the final criteria score. This process aims to find the final value of the criteria in the process. The score is obtained from the total KPI score calculation for each criterion, and the weights are obtained from the AHP calculation (Table 2).

Table 2 Calculation of KPI Final Value

Process Level 1	Criteria Level 2	No KPI Level 3	*Key Performance Indicator*	Value	Performance Value x S Norm	Final Value x Skor	Final Value of Each Process
Receiving	*Financial*	KPI #1	Cost per line for receiving	0.146	6.424	0.937904	14.704223
	Productivity	KPI #2	Receipts processed per labor hour	0.145	10.35714	1.501786	
	Utilization	KPI #3	Dock door utilization percentage	0.077	0	0	
	Quality	KPI #4	Receipt processing time per receipt	0.2	14.66667	2.933333	
	Cycle Time	KPI #5	Time taken for processing each receipt	0.432	21.6	9.3312	
Put Away	*Financial*	KPI #1	Cost per line for putaway	0.074	3.256	0.240944	11.158084
	Productivity	KPI #2	Putaway operations per labor hour	0.237	0	0	
	Utilization	KPI #3	Utilization percentage of putaway labor and equipment	0.177	10.62	1.87974	
	Quality	KPI #4	Percentage of perfect putaways	0.126	12.6	1.5876	
	Cycle Time	KPI #5	Cycle time for each putaway	0.386	19.3	7.4498	
Storage	*Financial*	KPI #1	Cost per item for storage	0.099	2.70072	0.267371	19.059424 7
	Productivity	KPI #2	Putaway operations per labor hour	0.237	14.22	3.37014	
	Utilization	KPI #3	Percentage of location and cube occupancy	0.188	13.536	2.544768	
	Quality	KPI #4	Percentage of locations without inventory discrepancies	0.228	22.8	5.1984	
	Cycle Time	KPI #5	Inventory turnover days	0.273	28.12727	7.678745	
Order Picking	*Financial*	KPI #1	Cost per order line for picking	0.07	7	0.49	22.696081
	Productivity	KPI #2	Order lines picked per labor hour	0.22	12.57143	2.765714	
	Utilization	KPI #3	Utilization percentage of picking labor and equipment	0.094	4.7	0.4418	
	Quality	KPI #4	Percentage of perfect picked lines	0.095	9.5	0.9025	
	Cycle Time	KPI #5	Cycle time for each order picked	0.521	34.73333	18.09607	
Shipping	*Financial*	KPI #1	Cost per customer for shipping	0.106	4.892308	0.518585	25.585534 6
	Productivity	KPI #2	Orders prepared for shipment per labor hour	0.169	8.45	1.42805	
	Utilization	KPI #3	Utilization percentage of shipping docks	0.118	0	0	
	Quality	KPI #4	Percentage of perfect shipments	0.142	14.2	2.0164	
	Cycle Time	KPI #5	Shipping cycle time per order	0.465	46.5	21.6225	
Total Value of Jakarta Warehouse Performance							**93.20335**

Source: Processed by the author

By using the S-Norm De Boer method to measure the performance of the Jakarta warehouse at PT XYZ Café Indonesia, a performance index of **93.20335** is obtained. Referring to the Performance Indicator Monitoring System (From Trienekens & Hvolby, 2000), it can be concluded that the performance is **Excellent**

CONCLUSION

Based on the data processing and analysis results, the following conclusions were reached: (1) Performance analysis of the Jakarta warehouse at PT XYZ Café Indonesia utilizing key performance indicators (KPIs) for warehouse activities such as receiving, putting away, storage, order picking, and shipping. This research uses five variables to track warehouse KPIs: financial, productivity, utilization, quality, and cycle time.

The final results of the performance measurement of warehouse process indicators are found.

The performance of 5 warehouse indicators is low, as follows: (a) The S-Norm value % Dock door utilization is 0, categorized as Red.(b) The S-Norm value Put away per man hour is 0, categorized as Red.(c) The S-Norm value Storage Cost per item is 20.957, categorized as Red.(d) The S-Norm value % Utilization of shipping docks is 0, categorized as Red. (2) The results support the hypothesis proposed by the author earlier. The author hypothesized that the development of the warehouse would lead to better warehouse management. This can be evidenced by the S-Norm results, which indicate an improvement that will result in better performance.

After analyzing the research findings, the author has identified several recommendations: (1) Solution or improvement recommendation for % Dock door utilization: Maximizing warehouse space by installing vertical racks and rearranging them. Shortening the material procurement process. Updating existing Kimap PO text to prevent specification, quantity, and authenticity certificate errors. (2) Solution or improvement recommendation for Put away per man hour: Maximizing the use of outsourced labor and avoiding replacing retiring outsourced labor. Utilizing inadequate warehouse space by installing vertical racks.

(3) Solution or improvement recommendation for Storage Cost per item: Offering unused materials to other business units and removing dead stock or unused items. (4) Solution or improvement recommendation for Utilization of shipping docks: Procuring or upgrading existing transportation equipment with new ones.

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