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The Impact of Layout, Material Handling & WMS on the Effectiveness of Warehouse Management 2023

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Abstract: DHL Global Forwarding is a domestic and foreign goods transportation service company that deals with logistics and transportation. The aim of this research is to find out the impact of layout, material handling, and the warehouse management system (WMS) on the effectiveness of warehouse management at the DHL Global Forwarding branch office in Soewarna Tangerang 2023. The methods used in this research are quantitative and data collection techniques by observation and dissemination of questionnaires. The sources of data used by the authors in this study are primary and secondary. The population and samples used in this research are all employees at DHL Global Forwarding's warehouse to test the hypothesis using multiple linear regression and for data calculations using the SPSS application.

Keywords: *Layout, Material Handling, Warehouse Management System (WMS), Effectivenes of Warehouse Management*

1. INTRODUCTION

A warehouse is an activity of storage of goods, while a warehouse is a space for storing goods, which starts with the activities of receipt, recording, delivery, storage, arrangement, maintenance, production, and distribution and ends with the report of liability of the warehouse manager. A network to support a system of working units to the goals of effective and efficiency of the organization. Therefore, the activity of storage is not merely the activity of putting goods into the storage space of goods in the warehouse, but storage activities have a more meaningful meaning that requires planning, organization, and control of the goods. A well-managed warehouse can have a positive impact on the efficiency of warehouse management, such as goods receipt and withdrawal running smoothly, orderly administration, security of goods guaranteed, goods stored and arranged properly so that they are easy to find again, and facilitating the maintenance of the goods. (Purwanto, 2020).

An optimal layout will clearly help companies develop differentiation strategies, cost leadership, and a rapid response to market demand. Warehouse layout or space utilization effectively related to the layout is an important consideration for facility planners, as the cost of renting, contracting, or building a new warehouse is very expensive. According to Hadiguna and Setiawan (2008; 4), one way to create effective and efficient enterprise bodies is by paying attention to the layout of the warehouse that exists within the enterprise.

Through effective material handling management, the company's operational performance can be improved (Chopra & Meindl, 2001; Rosenbloom, 2003), aimed at satisfying customers or meeting their expectations in terms of their needs, desires, and demands. (Oliver, 2010; Stock & Lambert, 2001). Material handling makes production flow possible, as it gives dynamism to static elements such as materials, products, equipment, layouts, and human resources.

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With a warehouse management system (WMS), it is expected to make it easier for employees to clearly know the location, type of goods, and flow of such goods. This system can cover all handling operations in the warehouse, for example: receiving stocks with receipt documentation and storage labels, creating pickup lists, picking up stocks for pickup views, replenishing pickup views, etc. (Emmett, 2005).

2. LITERATURE REVIEW

2.1 Layout

Refer to Heizer et al. (2019), the warehouse layout is a design that reduces the overall cost of determining the optimal guidelines for space product handling. One of the major operational decisions that affects a company's long-term operational efficiency is its layout (Nurjamudin and Haming, 2014). Planning the layout and facilities also aids in maximizing the relationship between the various activities by Kwdutami (2012). According to Wignjosoebroto (2003), the layout is a basic foundation in the industrial world. A well-designed warehouse layout will result in an efficient flow, shorter distances for transferring goods, shorter transportation times, and lower moving costs. It is critical to consider effectiveness and productivity while entering and releasing items when designing a warehouse plan.

Dimensions are used to measure good layout or spatial layout based on Heizer as well as Render (2009). Space planning measurement dimensions include:

a. Equipment and Material Handling.
b. Capacity and space needs.
c. Environment and beauty.
d. Information flow

2.1.1 Purpose of Planning Layout System

The goal of the layout, defined by Russell and Taylor in (Murdifin Haming and Mahfud Nurnajamuddin, 2013:392), is to minimize the cost of material handling, enhance the utility room's effectiveness, increase the productivity of the factory's workforce, lower process barriers, and make it easier for employees to communicate and interact with one another and with the company's customers.

2.1.2 Layout Scheme Planning Steps

The following are the steps in layout planning, based (H. A. Rusdiana, 2013:292):

a. Product evaluation. Analysis of the kind and volume of goods that need to be produced while taking economic and technical factors into account.
b. Analyzing processes. An examination of the type and order pf the production processes that are planned.
c. Analysis of markets. Determining the kinds and amounts of goods that the costumer requires. This data is used to calculate the production capacity, which can then be used to decide how many machines are provided in the production facility.
d. An examination of the kind and quantity of machinery and equipment needed, as well as the area that is needed. It is possible to determine the necessary number of equipment and facilities, including operators, by factoring in the volume of items to be produced, standard hours, working

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hours, and efficiency. In order to ensure a seamless procedure, the path, workstation, and area requirements can all be established.

e. Development of an alternate layout. An alternate development should be done first, taking into consideration the following factors, before deciding which layout is deal to choose.

2.2 Material Handling

Material handling is the art and science of movement, storage, protection, and supervision. The art of material handling cannot be explicitly solved solely by a mathematical formula or model. (Hari Purnomo, 2004: 240). However, the material handling activity is what will drive up expenses. Therefore, the best approach to lower the cost of material handling is to move the material as close to its original location as feasible by arranging the departments or production facilities as they are now set up. Alternatively, such material handling operations can be avoided. (Wignjosoebroto, 2003).

2.2.1 Material Handling Tools

Refer to (Sofjan Assuari 2008:130) the equipment of material handling which is usually used by a company can distinguished, namely:

a. Equipment for handling materials that has been fixed in a production process and cannot be used for other purposes is known as fixed path equipment.
b. Varied path gear, or flexible material handling equipment that isn't designed with a single material or good in mind but may be employed for a wide range of tasks.

2.2.2 Purpose of Material Handling

While the purpose of Material Handling according to Hari Purnomo (2004:243) among others is:

a. Preserve or improve the quality of the product, minimize damage, and safeguard working conditions.
b. Enhancing security and creating favorable working environments.
c. Increased productivity: materials will move in a straight line, as closely as feasible, in multiplies at once, through automation of material handling and mechanization of material lifting.
d. Accelerate the pace of facility utilization by making better use of existing structures, acquiring adaptable equipment, standardizing material handling equipment, maintaining, and relocating entire equipment sets as needed, and creating preventative maintenance plans.
e. Lowers the dead weight

2.3 Warehouse Management System (WMS)

WMS is a database-driven computer application that improves warehouse productivity by guiding cutaways and keeping inventory accurate by recording warehouse transactions (Ramaa, A., K.N. Subramanya, and T.M. Rangaswamy, 2012). WMS is one of the most successful ways to accelerate an organization's development by focusing on the dependability of its supply chain (Reza Pulungan, 2013).

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A warehouse management system's primary role is warehouse management. On the one hand, these systems maintain a record of storage capacity, i.e., the specifications of existing storage bins (location management). However, of the stored units (inventory management), numerous control functions should be included to optimize storage activities (Michael ten Hompel and Thorsten Schimdt in Warehouse Management 2008).

The administration of linked temporary storage activities is what is commonly referred to as WMS. The inventory management system, or WMS, is the primary component of the supply chain. Its primary goal is to regulate every process that occurs within it, including receiving, storing, moving, picking and shipping.

According to Erqorni (2009), a warehouse is a location where temporary items are stored, where a system is a collection of sub-systems interacting, and management is the science of managing resources. The primary lines of the storage activity are the intended storage activities, which include receiving from the supplier, managing the items, and spending the goodds at the destitnation.

A company's inventory management system keeps goods at and between sites of consumption and source and gives management information about the location, state, and disposal of stored goods. (Lambert, 2001)

2.4 The Effectiveness of Warehouse Management

According to Ricky W. Griffin (2004:8), efficiency is the prudent and economical use of resources, whereas effectiveness is the making of the proper judgements and their successful implementation.Warehouse management is the coordination of all warehouse procedures and activities in an efficient and successful manner (Harmon, 1993; Tompkins et al., 2003). The capacity of a warehouse to optimize its operations and resources in order to reach the necessary level of performance in terms of speed, accuracy, and cost-effectiveness is referred to as warehouse efficiency. The study found that warehouse efficiency may be measured by a variety of parameters, including inventory accuracy, order correctness, order cycle time, and ordering processing cost (Ballou, R.H. 2007).

The meaning of an effective warehouse is that the existing warehouse must be able to minimize material damage as well as damage to goods as a result of the handling of goods. So, the existence of a warehouse represents a supporting medium that ensures the quality of the materials and goods produced, not a medium or place that can lower the quality of the products and materials produced during the production process. (Abdul Azis, 2011)

Large warehouse capacity optimization, warehouse location, product selection speed, unloading speed, flow of goods in warehouses, receipt procedure, product selection, maintenance procedure, utilities, warehousing security management, quality management of stored products, and other related activities are all considered to be part of warehouse management. (Haryono, 2020)

3. HYPOTHESIS

A hypothesis is a speculative answer to a research problem that has been given in the form of questions. It is believed to be transient because the solutions provided are based on newly developed, appropriate theories rather than empirical facts gathered through data collection. Hypotheses can thus be expressed as theoretical responses to the phrasing of research problems rather than empiric responses (Sugiyono, 2016, p. 63).

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From some previous explanations, some of the following hypotheses can be drawn:

1) **For T-Test**
(Layout)
H_0: There is no impact of layout (X1) on the effectiveness of warehouse management (Y).
H_1:There is an impact of layout (X1) on the effectiveness of warehouse management (Y).
(Material Handling)
H_0:There is no impact of material handling (X2) on the effectiveness of warehouse management (Y).
H_2: There is an impact of material handling (X2) on the effectiveness of warehouse management (Y).
(WMS)

2) **For F-Test**
H_0: There is no impact simultaneously of layout (X1), material handling (X2), and WMS (X3) on the effectiveness of warehouse management (Y).
H_4:There is an impact simultaneously of layout (X1), material handling (X2), and WMS (X3) on the effectiveness of warehouse management (Y).

As a result, the conceptual framework of this research is as follows:

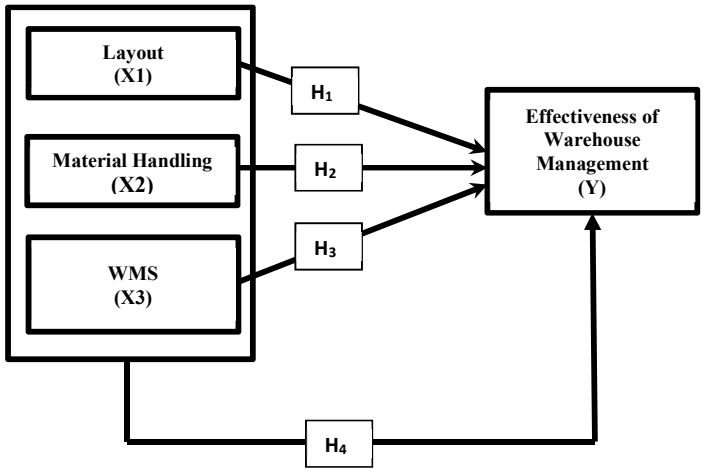

Fig. 1. Conceptual framework

4. RESEARCH METHOD

4.1 Data Type

According to Juliansyah (2011, p. 147), the type of data that authors use in their research is quantitative data. Quantitative data is the information received about an empirical fact or phenomenon, which can be a set of measures that are numbers. In this script, numerical data is obtained from Likert scale assessments in questionnaire responses on layout (X1), material handling (X2), warehouse management system (WMS) (X3), and the effectiveness of warehouse management (Y) filled by

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respondents. In this research, the 5-point Likert scale from "strongly disagree (1)" to "strongly agree (5)" was used to assess the impact of independent and dependent factors.

4.2 Population and Sample

The population used in this study is the employee at the DHL Global Forwarding Branch of Soewarna, Tangerang in 2023 of 21 employees. A sample is the number of members selected from the population. Boring sampling is a sample that represents the number of populations. This is usually done if the population is considered small or less than 100.

4.3 Technical Data Analysis

To find out the impact of layout, material handling, and warehouse management systems on the effectiveness of warehouse management at the PT. DHL Global Forwarding branch office in Soewarna Tangerang 2023, the authors used the multiple linear regression analysis method.

5. RESULTS AND DISCUSSION

5.1 Multiple Linear Regression Test

Multiple linear regression analysis is used to determine the measurement of the impact of layout, material handling and warehouse management system, both partially and simultaneously, on the effectiveness of warehouse management.

Table I
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.771	1.936		1.431	.170
	Layout	-.325	.070	-.389	-4.655	.000
	Material Handling	.517	.114	.511	4.533	.000
	WMS	.721	.098	.766	7.327	.000

a. Dependent Variable: The Effectiveness of Warehouse Management

Source: Data processing SPSS 25.0

The model of regression equations that can be written from such results in the form of linear regressive equations is as follows:

$$Y = 2{,}771 - 0{,}325X1 + 0{,}517X2 + 0{,}721X3$$

Description:

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a. The constant value a = 2,771 means that if the free variable is ignored or in other words if there are no variables on layout, material handling and WMS then the effectiveness of warehouse management at PT. DHL Global Forwarding branch office in Soewarna Tangerang will be worth 2,771.
b. The value of the coefficient b_1 = - 0,325 this means that each unit change in the layout, then the effectiveness of warehouse management PT. DHL Global Forwarding branch office in Soewarna Tangerang has a decrease of -0,325.
c. The value of the coefficient b_2 = 0,517 means that every unit change in the handling material, then the effectiveness of the warehouse management of PT. DHL Global Forwarding branch office in Soewarna Tangerang has been improved by 0,517.
d. The value of the coefficient b_3 = 0,721 means that every unit change in the handling material, then the effectiveness of the warehouse management of PT. DHL Global Forwarding branch office in Soewarna Tangerang has been improved by 0,721.

5.2 Double Correlation Coefficient Analysis

This double correlation coefficient is used to determine how strong the impact of independent variables (layout, material handling and WMS) on dependent variables is as follows:

Table II
Double Correlation Table
Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.941[a]	.885	.865	1.117

a. Predictors: (Constant), WMS, Layout, Material Handling

b. Dependent Variable: The effectiveness Warehouse Management

Source: Data processing SPSS 25.0

Based on the above table, the value of the double correlation coefficient R = 0,941 is obtained. Thus, the magnitude of the impact of layout, material handling and WMS on the effectiveness of warehouse management PT DHL Global Forwarding is 0,941 at the interval (0.80-1,00) means has a very strong, directed and positive impact.

5.3 Analysis of Simple Relation Coefficients

To see the impact of independent variables with dependent variables, it is necessary to perform a correlation analysis between the partial variables of the study, the results of which can be seen in the following table:

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Table III

Table Analysis Correlation between Variables X1, X2 and X3 on Y

Correlations

		X1	X2	X3	Y
X1	Pearson Correlation	1	.404	.622**	.402
	Sig. (2-tailed)		.069	.003	.071
	N	21	21	21	21
X2	Pearson Correlation	.404	1	.706**	.996**
	Sig. (2-tailed)	.069		.000	.000
	N	21	21	21	21
X3	Pearson Correlation	.622**	.706**	1	.712**
	Sig. (2-tailed)	.003	.000		.000
	N	21	21	21	21
Y	Pearson Correlation	.402	.996**	.712**	1
	Sig. (2-tailed)	.071	.000	.000	
	N	21	21	21	21

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Data processing SPSS Version 25

From the table above it can be explained that:

a. The value of the correlation coefficient between the layout (X1) and the effectiveness of warehouse management (Y) of 0,402 indicates that the level of moderate at the interval (0,40-0,59).
b. The correlation coefficient value between material handling (X2) and the effectiveness of warehouse management (Y) of 0,996 indicates the level of very strong correlation at the interval (0,80-1,00).
c. The correlation coefficient value between WMS (X3) and the effectiveness of warehouse management (Y) of 0,712 indicates that the level of strong correlation is at the interval (0,60-0,79).
d. Based on three correlation coefficients above, it turns out that material handling variable has the greatest degree of relation of its significance of 0,996 compared to a layout with an average degree of connection of 0,402 and WMS with a strong degree of contact of 0,712.

5.4 T-test

The t test is used to determine the influence of partially independent variables on dependent variables. The following will describe the testing on the table as follows:

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Table IV

X1, X2 and X3 variable T-test table on Y variable

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.771	1.936		1.431	.170
	Layout	-.325	.070	-.389	-4.655	.000
	Material Handling	.517	.114	.511	4.533	.000
	WMS	.721	.098	.766	7.327	.000

a. Dependent Variable: The Effectiveness of Warehouse Management

Source: Data processing SPSS Version 25

a. From the test based on the above table can be obtained the influence of the variable layout (X1) on the effectiveness of warehouse management (Y) is known that the significance level of 0,000 and t-count of -4,655 and from the number of respondents (n) that is as many as 21 people can obtain t-table of 1,729.

   From this data we get the result:

   1) 0,000 < 0,05 then from this result H_0 is rejected and H_1 is accepted.
   2) -4,655 < 1,729 then from that result H_0 has been rejected and H_1 is accepted.

   So, the results above show that the layout variables have a significant impact on the effectiveness of warehouse management at the DHL Global Forwarding branch office in Soewarna Tangerang 2023

b. From the test based on the above table can be obtained the impact of variable material handling (X2) on the effectiveness of warehouse management (Y) is known that the significance level is 0,000 and t-count is 4,533.

   From this data we get the result:

   1) 0,000 < 0,05 then from this result H_0 is rejected and H_2 is accepted.
   2) 4,533 > 1,729 then from that result H_0 has been rejected and H_2 is accepted.

   The above results show that material handling variables have a significant and positive impact on the effectiveness of warehouse management at the DHL Global Forwarding branch office in Soewarna Tangerang 2023

c. From the test based on the above table can be obtained the impact of the variable WMS (X3) on the effectiveness of warehouse management (Y) is

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known that the significance level is 0,000 and t-count is 7,327.

From this data we obtain the result:

1) 0,000 < 0,05 then from this result H_0 is rejected and H_3 is accepted.
2) 7,327 > 1,729 then from that result H_0 has been rejected and H_3 is accepted.

The above results indicate that the WMS variable has a significant and positive impact on the the effectiveness of warehouse management at the DHL Global Forwarding branch office in Soewarna Tangerang 2023.

5.5 F-test

The f test is used to determine whether there is simultaneous impact between all independent variables on dependent variables. Testing can be seen on the table as follows:

Table V

F-test

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	163.914	3	54.638	43.754	.000[b]
	Residual	21.229	17	1.249		
	Total	185.143	20			

a. Dependent Variable: The Effectiveness of Warehouse Management

b. Predictors: (Constant), WMS, Layout, Material Handling

Source: Data processing SPSS Version 25

Based on the calculations of Test F obtained a calculation of 43,754 which means that:

a) 0,000 < 0,05 then of the result H_0 is rejected and H_4 is accepted.
b) 43,754 > 3,52 (F_{table}), then from the result of H_0 is rejected and H_4 is accepted.

Then it can be known that the layout, material handling and WMS simultaneously have a significant and positive influence on the effectiveness of warehouse management at the DHL Global Forwarding branch office in Soewarna Tangerang 2023, based on the results, then H_4 has proven.

5.6 Coefficient Determination

A coefficient determination (r^2) of 0,865 after the r^2 indicates that the layout, material handling, and WMS variables can explain 86,5% of the effectiveness of warehouse management variables, while other factors beyond those indicated in the analysis can explain 13,5%. Then, figure out how to be characterized by a regression model.

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6. CONCLUSION

Based on the analysis of the impact of the layout, material handling and warehouse management system (WMS) on the effectiveness of the management of the warehouse of PT. DHL Global Forwarding Branch of Soewarna Tangerang Year 2023, the following conclusions can be drawn:

1) There is a partially significant positive impact between the layout variable (X1) on the effectiveness of warehouse management PT DHL Global Forwarding branch office in Soewarna Tangerang 2023, where -4,655 (t-count) <1,729 (Table) and a significance of 0,000 <0,05 then Ho is rejected and H1 accepted. Seeing from the value of the correlation coefficient between layout (X1) and the effectiveness of warehouse management (Y) of 0.402 shows the moderate impact that is at the interval (0,40-0,59).
2) There is a partially significant positive impact between the variable material handling (X2) on the effectiveness of warehouse management (Y) PT DHL Global Forwarding branch office in Soewarna Tangerang 2023, where 4,533 (t-count) < 1,729 (Table) and a significance of 0,000 < 0,05 then Ho is rejected and H2 is accepted. (0,60-0,79).
3) There is a partially significant positive influence between the variable WMS (X3) on the effectiveness of warehouse management (Y) PT DHL Global Forwarding branch office in Soewarna Tangerang 2023, where 7,327 (t-count) < 1,729 (Table) and a significance of 0,000 < 0,05 then Ho is rejected and H3 accepted. Seeing from the value of the correlation coefficient between WMS (X3) and the effectiveness of warehouse management (Y) of 0,712 shows strong impact that is at the interval (0,60-0,79).
4) Simultaneously there is a significant positive impact between layout variables (X1), material handling (X2) and WMS (X3) on the effectiveness of warehouse management PT DHL Global Forwarding branch office in Soewarna Tangerang 2023, where 43,754 (Calculation) > 3,52 (Fable) and significance of 0,000 < 0,05 then Ho is rejected and H4 accepted. Seeing from the value of the double correlation coefficient R = 0,941 means the magnitude of the impact of layout, material handling and WMS on the effectiveness of warehouse management PT DHL Global Forwarding branch office in Soewarna Tangerang 2023 is 94,1% which has a very strong, directed and positive impact.
5) Based on the analysis of multiple linear regression, it is known that there is a significant positive impact of the layout (X1), material handling (X2) and WMS (X3) on the effectiveness of warehouse management (Y) together (simultaneously). Whereas the contribution of the variables layout (X1), material handling (X2) and WMS (X3) is 86,5%, which means significant in the effectiveness of warehouse management PT DHL Global Forwarding branch office in Soewarna Tangerang 2023, whereas the remaining 13,5% is impacted by other factors.

7. IMPLICATIONS

Based on the analysis of the impact of the layout, material handling and warehouse management system (WMS) on the effectiveness of the management of the warehouse of PT. DHL Global Forwarding Branch of Soewarna Tangerang Year 2023, the following implications can be drawn:

1) On the variable layout (X1) there is already a procedure to know, understand

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and execute the instructions to take outbound and put inbound goods in storage based on the classification or category of goods but the distance of transportation is not close so it is necessary to spend more time and movement. The results show that the X1 variable partially has a significant influence on the effectiveness of warehouse management.

2) On variable material handling (X2), the company already has adequate transportation equipment but employees need to pay more attention to safety factors. The analysis shows that variable X2 partially has a significant impact on the effectiveness of warehouse management.
3) On variable WMS (X3), the company already has a computer system or management system but needs maintenance, maintenance and repairs on a regular basis. The results of the analysis show that the X3 variable partially has a significant influence on the the effectiveness of warehouse management.
4) The results of the analysis show that there is a significant simultaneous influence between the layout variables (X1), material handling (X2), WMS (X3) on the effectiveness of warehouse management PT. DHL Global Forwarding branch office in Soewarna Tangerang 2023.

From the conclusion of the effectiveness of warehouse management affected by the layout, material handling and warehouse management system (WMS) is very strong and there are still some indicators that need to be improved so that can be the evaluation material for the process of activity in the warehouse. Contribution of the influence of the arrangement, material handling, and Warehouse Management System (WMS) on the effectiveness of warehouse management PT. DHL Global Forwarding branch office in Soewarna Tangerang is 86,5% while the remaining 13,5% is influenced by other factors. The authors hope this research can be continued and developed with other factors.

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