

Design of Performance Indicators in Warehouse Management

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Article Information:**Keywords:**Warehouse Management;
KPI;
Cost;
Productivity;
Quality;
Time;
Utilization;**Article History:**Received : Nov 21, 2022
Revised : Nov 29, 2022
Accepted : Dec 8, 2022**Cite This Article:**Putri, A., & Wahyudi, B. (2023). Design of Performance Indicators in Warehouse Management. *Indikator: Jurnal Ilmiah Manajemen dan Bisnis*, 7(1), 73 - 86. doi:<http://dx.doi.org/10.22441/indikator.v7i1.17843>**Abstract**

To maintain the continuity of product flow in the supply chain system, good warehouse management is needed. Dynamic market conditions are able to cause instability in the product flow. Moreover, there are many disruptions occur as technology continues to develop in Indonesia. This instability will indirectly affect the warehouse performance in a company. So, to minimize the effects of instability, it is necessary to design indicators that are used as a reference for designing mitigation strategies and as a controlling tool so that the company's growth is relevant to the objectives that have been created. In addition, these indicators can be used as a benchmark to improve the warehouse regularly. So, this research aims to design performance indicators in warehouse management that can be used as a measurement reference to increase warehouse productivity. The result showed that there are 17 validated indicators which are categorized into 5 dimensions. These dimensions are 4 cost dimension indicators, 4 productivity dimension indicators, 3 quality dimension indicators, 4 time dimension indicators, and 2 utilization dimension indicators.

INTRODUCTION

Market conditions are dynamic following the socio-economic life of the community. This affects on the company's operational activities which are complex and interrelated. Indirectly, this will affect the supply chain system in the company. This tendency will cause a decrease in the company's performance. Performance improvement is something that must be done regularly. However, performance can be improved if measurement indicators are available. The warehouse is an important thing in a supply chain system because it intersects with the logistics system of the company. Most companies have warehouses that function for the storage of raw materials, but the function of the warehouse as storage of production is becoming more important (Rendy et al., 2015). Warehouse activities are not only putting goods into storage but also related to planning and organizing so that the warehouse activities will be more effective (Kusuma et al., 2017). Improvements in employee performance and timely logistics delivery will have an impact on better warehouse activities (Kusrini et al., 2017). The productivity of warehouse performance is very influential in the finances of a company related to the expenses and income of an organization or company (Karim et al., 2020). Therefore, to improve warehouse performance, indicators are compiled that can be used as a reference to measure warehouse performance. Several researchers have designed indicators to measure performance, for example in research conducted by (Kusrini et al., 2021). This research focused on designing indicators for suppliers in sustainable organic agriculture. In a study conducted by (Ramadhan, 2022) the KPI (Key Performance Indicator) method was used to analyze picking and loading performance in warehouses in a company. Then in a study conducted by

(Nurwahidah et al., 2021), the indicators are designed as a benchmark for measuring employee performance in warehouses. Based on these things, this study focuses on designing indicators that will be used as benchmarks for measuring warehouse performance in increasing warehouse productivity.

LITERATURE REVIEW

Warehouse Management

Warehouse management has a function to controlling materials consisting of raw goods, semi-finished goods to finished goods. Warehouse management handles the main jobs of a warehouse such as storage management, storage unit management, hazardous goods management, order processing, incoming and outgoing materials, stock taking, inspection, and replenishment (Pitoy et al., 2020). The warehouse is a facility that aims not only to store goods but also to support demand so that customer demands are still met. Warehouse management makes the delivery and receipt of goods fast, effective and efficient (Makatengkeng et al., 2019). The warehouse is defined as a special facility that is permanent. The purpose of designing a warehouse is to achieve the target of the maximum level of service with the lowest possible total cost. In addition, warehouses are needed in the process of coordinating the distribution of goods which can occur if there is an imbalance in the supply and demand process (Sumartono & Jan, 2019)

KPI

Performance is a description of the results of an activity that has been carried out previously in a company and can be used as a reference for carrying out further activities. The level of performance will affect productivity so the stability of performance is important. To monitor the company's growth, a performance measurement is needed so that the company's goals can be achieved (Agustianna et al., 2020). Key Performance Indicators (KPIs) are part of a performance management system that is applied to a company. KPIs not only function as a monitoring tool but also can be used to ensure that the direction of the company's growth by following per under the vision and mission that has been prepared. (Angelia et al., 2021). In measuring performance, the elements that are arranged in the KPI can vary according to the type of industry of the company. The elements that are arranged in the KPI consist of strategic objectives, indicators relevant to strategic goals, targets that become benchmarks, and the period time for which the KPIs are valid. The key elements in performance evaluation are useful for understanding what steps are used by companies in conducting performance appraisals. These elements include defining the mission, setting the goals and objectives of the company, then determining the strategic plan or general and operational policies of the company, as well as determining and developing performance indicators which are something that will be calculated and measured (Akseptori et al., 2022). So in this research, the key elements are cost, productivity, quality, time, and utilization.

RESEARCH METHOD

To measure and evaluate the performance of a warehouse, indicators are needed that become benchmarks in measurement or performance. This research focuses on determining Key Performance Indicators (KPIs) that can be applied to measure performance in the Warehouse. By determining KPIs, the company will find it easier to monitor how much the target has been achieved and can find out how deviations can hinder the achievement of targets (Ferdiansyah et al., 2016). Warehouses can have different activities according to product

specifications, customer requirements, and the level of service offered. The complexity of warehouse activities depends on the number and types of items to be handled, the number of daily workloads to be completed and the number, nature, and variety of processes required to meet customer and supplier needs and demands (Kusrini et al., 2017). In this research, indicators compiled from various literature focus on warehouse activities consisting of receiving, putting away, storage, order picking, and shipping. The various indicators that have been obtained from various credible literature sources are presented in Table 1 below.

Table 1. Key Performance Indicators (KPIs) from Various Research

No	Key Performance Indicators	References
1	Staging fee	(Kim, 2020)
2	Demurrage cost	(Kim, 2020)
3	Labor costs	(Kim, 2020)
4	Inventory cost	(Kim, 2020)
5	Number of item positions	(Elbert & KarlKnigge, 2020)
6	Simulation time	(Elbert & KarlKnigge, 2020)
7	Order quantity	(Elbert & KarlKnigge, 2020)
8	Required time	(Elbert & KarlKnigge, 2020)
9	Total cost	(Elbert & KarlKnigge, 2020)
10	Maximum number	(Elbert & KarlKnigge, 2020)
11	Distance reduction	(Horta, et al., 2016)
12	Reducing work hours	(Horta, et al., 2016)
13	% Order quantity according to order	(Faozanudin & Susanto, 2019)
14	% Rejected order	(Faozanudin & Susanto, 2019)
15	% Space utilization	(Faozanudin & Susanto, 2019)
16	% LS Accomplished	(Faozanudin & Susanto, 2019)
17	Total distance (meter)	(Yener & Yazgan, 2019)
18	Simulation duration (hour)	(Yener & Yazgan, 2019)
19	Total lead time for orders in the system (minute)	(Yener & Yazgan, 2019)
20	Average number of orders in a system	(Yener & Yazgan, 2019)
21	Average Order Pick-up Time (minute)	(Yener & Yazgan, 2019)
22	Receipt per working hour	(Kusrini, et al., 2018)
23	Putaways cycle time (per putaway)	(Kusrini, et al., 2018)
24	% of occupied locations and squares	(Kusrini, et al., 2018)
25	Order pick-up cycle time (per order)	(Kusrini, et al., 2018)
26	Orders prepared for delivery per hour person	(Kusrini, et al., 2018)
27	Order pick-up time	(Ghaouta, et al., 2018)
28	Order lead time	(Ghaouta, et al., 2018)
29	Order processing fee	(Ghaouta, et al., 2018)
30	Pick-up productivity	(Ghaouta, et al., 2018)
31	Delivery on time	(Ghaouta, et al., 2018)
32	Labor cost	(Ghaouta, et al., 2018)
33	Labor productivity	(Ghaouta, et al., 2018)
34	Customer satisfaction rate	(Ghaouta, et al., 2018)

No	Key Performance Indicators	References
35	Receipt productivity	(Ghaouta, et al., 2018)
36	Reception time	(Ghaouta, et al., 2018)
37	Inventory utilization	(Ghaouta, et al., 2018)
38	Dock to stock	(Ghaouta, et al., 2018)
39	Labor hours	(Hiruwat, et al., 2017)
40	Average delivery cycle time	(Hiruwat, et al., 2017)
41	Average warehouse order cycle time	(Hiruwat, et al., 2017)
42	Labor cost per sales ratio	(Hiruwat, et al., 2017)
43	Storage cost per sale ratio	(Hiruwat, et al., 2017)
44	Transportation cost per sale ratio	(Hiruwat, et al., 2017)
45	Maintenance cost ratio per sale	(Hiruwat, et al., 2017)
46	Infrastructure cost per sale ratio	(Hiruwat, et al., 2017)
47	Ratio of information processing costs per sale	(Hiruwat, et al., 2017)
48	Warehouse utilization	(Hiruwat, et al., 2017)
49	Equipment utilization	(Hiruwat, et al., 2017)
50	Transportation utilization	(Hiruwat, et al., 2017)
51	Inventory accuracy	(Hiruwat, et al., 2017)
52	Customer satisfaction level	(Hiruwat, et al., 2017)
53	Perfect order	(Hiruwat, et al., 2017)
54	Inventory accuracy	(Laosirihongthong, et al., 2018)
55	Accuracy in taking orders	(Laosirihongthong, et al., 2018)
56	Accuracy in order delivery	(Laosirihongthong, et al., 2018)
57	% of products transferred without transaction errors	(Laosirihongthong, et al., 2018)
58	% of orders received with correct shipping documents	(Laosirihongthong, et al., 2018)
59	Space utilization	(Laosirihongthong, et al., 2018)
60	Utilization of equipment when taking	(Laosirihongthong, et al., 2018)
61	Labor productivity and utilization	(Laosirihongthong, et al., 2018)
62	Shipping costs	(Laosirihongthong, et al., 2018)
63	Inventory holding costs	(Laosirihongthong, et al., 2018)
64	Product damage rate	(Laosirihongthong, et al., 2018)
65	Insurance fee	(Laosirihongthong, et al., 2018)
66	Shortage cost	(Laosirihongthong, et al., 2018)
67	Response to urgent delivery	(Laosirihongthong, et al., 2018)
68	Transport speed	(Laosirihongthong, et al., 2018)
69	Customer request time	(Laosirihongthong, et al., 2018)
70	Order size flexibility	(Laosirihongthong, et al., 2018)
71	Delivery flexibility	(Laosirihongthong, et al., 2018)
72	Service system flexibility	(Laosirihongthong, et al., 2018)
73	Layout configuration	(Kusrini, et al., 2019)
74	Storage system	(Kusrini, et al., 2019)
75	Orders processed on time	(Kusrini, et al., 2019)

No	Key Performance Indicators	References
76	Inventory optimization	(Kusrini, et al., 2019)
77	MHE Maintenance and Servicing (MMS).	(Kusrini, et al., 2019)
78	Inbound Processes (IP).	(Kusrini, et al., 2019)
79	Storage Processes (SP).	(Kusrini, et al., 2019)
80	Outbound Processes (OP).	(Kusrini, et al., 2019)
81	Work In Process.	(Kusrini, et al., 2019)
82	Cost Associated with EHS.	(Kusrini, et al., 2019)
83	Shipping cost per customer	(Kusrini, et al., 2019)
84	Order pick-up	(Kusrini, et al., 2019)
85	Physical Load Index.	(Kusrini, et al., 2019)
86	Daytime use	(Kusrini, et al., 2019)
87	Temperature control	(Kusrini, et al., 2019)
88	Water consumption	(Kusrini, et al., 2019)
89	Noise pollution	(Kusrini, et al., 2019)
90	Cross-Docking Facility (CFD).	(Kusrini, et al., 2019)
91	Warehousing Strategy and Roadmap (WSR).	(Kusrini, et al., 2019)
92	Electrical system hazards	(Kusrini, et al., 2019)
93	Energy storage system	(Kusrini, et al., 2019)
94	Renewable energy sources	(Kusrini, et al., 2019)
95	Carbon sequestration by trees	(Kusrini, et al., 2019)
96	Shift Roster (SR).	(Kusrini, et al., 2019)
97	Utilization that considers the effectiveness and efficiency of space use.	(Kusrini, et al., 2019)
98	General training	(Kusrini, et al., 2019)
99	Occupational Health and Safety (OHS).	(Kusrini, et al., 2019)
100	Emergency room (ER).	(Kusrini, et al., 2019)
101	Performance measurement	(Kusrini, et al., 2019)
102	Job satisfaction level	(Kusrini, et al., 2019)
103	Wages	(Kusrini, et al., 2019)
104	Number of employees	(Kusrini, et al., 2019)
105	Driver/operator training	(Kusrini, et al., 2019)
106	Average length of service of employees	(Kusrini, et al., 2019)
107	Reduce shipping costs	(Ferdiansyah, et al., 2016)
108	Delivery on time 95%	(Ferdiansyah, et al., 2016)
109	98% order fulfillment	(Ferdiansyah, et al., 2016)
110	Inventory management	(Ferdiansyah, et al., 2016)
111	Delivery process	(Ferdiansyah, et al., 2016)
112	Productivity	(Ferdiansyah, et al., 2016)
113	Warehouse utilization	(Ferdiansyah, et al., 2016)
114	Knowledge	(Ferdiansyah, et al., 2016)
115	Reduce alpha	(Ferdiansyah, et al., 2016)
116	Reduce turn over	(Ferdiansyah, et al., 2016)

No	Key Performance Indicators	References
117	Lateness	(Ferdiansyah, et al., 2016)
118	Implementation of 5S activities	(Ferdiansyah, et al., 2016)
119	Financial (Rp/Line receiving)	(Kusrini, et al., 2018)
120	Productivity (box/man-hour)	(Kusrini, et al., 2018)
121	Utilization (%)	(Kusrini, et al., 2018)
122	Quality (%)	(Kusrini, et al., 2018)
123	Cycle time	(Kusrini, et al., 2018)
124	Delivery on time	(Buonamico, et al., 2017)
125	Obstacles in providing logistics services	(Buonamico, et al., 2017)
126	Finished product inventory	(Buonamico, et al., 2017)
127	Semi-finished product inventory	(Buonamico, et al., 2017)
128	Supply inventory	(Buonamico, et al., 2017)
129	Inventory accuracy	(Buonamico, et al., 2017)
130	Number of articles with positive quantity	(Buonamico, et al., 2017)
131	Incoming order accuracy	(Buonamico, et al., 2017)
132	Pick-up accuracy	(Buonamico, et al., 2017)
133	Order delivered on time	(Buonamico, et al., 2017)
134	Delivery without damage	(Buonamico, et al., 2017)
135	Billing properly	(Buonamico, et al., 2017)
136	Value Stream Mapping	(Buonamico, et al., 2017)
137	5S Implementasi Implementation	(Buonamico, et al., 2017)
138	Polyfunctional employees	(Buonamico, et al., 2017)
139	Team work	(Buonamico, et al., 2017)
140	Number of employees working with continuous improvement projects	(Buonamico, et al., 2017)
141	Number of improvement suggestions per employee	(Buonamico, et al., 2017)
142	Permanent staff	(Makaci, et al., 2017)
143	Temporary employee	(Makaci, et al., 2017)
144	Variable cost	(Makaci, et al., 2017)
145	Fixed cost	(Makaci, et al., 2017)
146	Collaboration	(Makaci, et al., 2017)
147	sharing information	(Makaci, et al., 2017)
148	Delivery frequency	(Makaci, et al., 2017)
149	Transportation fee	(Makaci, et al., 2017)
150	CO2 emissions	(Makaci, et al., 2017)
151	Service level	(Makaci, et al., 2017)
152	Warehousing costs	(Indrawati, et al., 2018)
153	Labor costs	(Indrawati, et al., 2018)
154	Perfect quality item	(Indrawati, et al., 2018)
155	Delivery on time	(Indrawati, et al., 2018)
156	Inventory accuracy	(Indrawati, et al., 2018)
157	% Turnover	(Indrawati, et al., 2018)

No	Key Performance Indicators	References
158	Workers not present	(Indrawati, et al., 2018)
159	Employee competency improvement	(Indrawati, et al., 2018)
160	Eco-friendly tools	(Indrawati, et al., 2018)
161	Waste handling	(Indrawati, et al., 2018)
162	5S Implementasi Implementation	(Indrawati, et al., 2018)
163	Environmental awareness	(Indrawati, et al., 2018)
164	Good quality product	(Chen, et al., 2017)
165	Delivery accuracy	(Chen, et al., 2017)
166	Delivery on time	(Chen, et al., 2017)
167	Short delivery time	(Chen, et al., 2017)
168	The safety of the goods sent	(Chen, et al., 2017)
169	Acceptable price	(Chen, et al., 2017)
170	Best service quality	(Chen, et al., 2017)
171	Latent needs are met	(Chen, et al., 2017)

Then from the 171 indicators in Table I, an elimination process was carried out for indicators that were considered similar to the previous indicators and were categorized into 5 KPI dimensions, namely the dimensions of cost, productivity, quality, time, and utilization, so that 40 indicators were presented in Table below:

Table 2. Categorized Warehouse Key Performance Indicators (KPI) Warehouse

No	KPI	Category	Reference
1	Labor cost	Cost	(Kim, 2020), (Hiruwnwat, et al., 2017), (Ghaouta, et al., 2018), (Ferdiansyah, et al., 2016), (Indrawati, et al., 2018)
2	Inventory cost	Cost	(Kim, 2020), (Hiruwnwat, et al., 2017), (Laosirihongthong, et al., 2018), (Indrawati, et al., 2018)
3	Order quantity	Cost	(Elbert & KarlKnigge, 2020), (Faozanudin & Susanto, 2019), (Yener & Yazgan, 2019)
4	% Rejected order	Cost	(Faozanudin & Susanto, 2019)
5	Order processing fee	Cost	(Ghaouta, et al., 2018), (Kusrini, et al., 2019)
6	Transportation cost	Cost	(Hiruwnwat, et al., 2017), (Laosirihongthong, et al., 2018), (Kusrini, et al., 2019), (Ferdiansyah, et al., 2016), (Makaci, et al., 2017), (Chen, et al., 2017)
7	Maintenance cost	Cost	(Hiruwnwat, et al., 2017), (Kusrini, et al., 2019)
8	Infrastructure cost	Cost	(Hiruwnwat, et al., 2017)
9	Perfect order	Cost	(Hiruwnwat, et al., 2017), (Ferdiansyah, et al., 2016)
10	Insurance cost	Cost	(Laosirihongthong, et al., 2018)
11	Shortage cost	Cost	(Laosirihongthong, et al., 2018)

No	KPI	Category	Reference
12	Lateness	Productivity	(Kim, 2020)
13	Distance reduction	Productivity	(Horta, et al., 2016), (Yener & Yazgan, 2019)
14	Receipt per working hour	Productivity	(Kusrini, et al., 2018), (Ghaouta, et al., 2018), (Kusrini, et al., 2018)
15	Orders prepared for delivery per hour person	Productivity	(Kusrini, et al., 2018)
16	Pick-up productivity	Productivity	(Ghaouta, et al., 2018), (Kusrini, et al., 2018)
17	Labor productivity	Productivity	(Ghaouta, et al., 2018), (Laosirihongthong, et al., 2018)
18	Customer satisfaction level	Productivity	(Ghaouta, et al., 2018), (Hiruwnwat, et al., 2017),
19	Response to urgent delivery	Productivity	(Laosirihongthong, et al., 2018)
20	Transport speed	Productivity	(Laosirihongthong, et al., 2018)
21	Delivery flexibility	Productivity	(Laosirihongthong, et al., 2018)
22	Layout configuration	Productivity	(Kusrini, et al., 2019)
23	Implementation of 5S aktivitas activities	Productivity	(Ferdiansyah, et al., 2016), (Buonamico, et al., 2017), (Indrawati, et al., 2018)
24	Product damage rate	Quality	(Laosirihongthong, et al., 2018), (Indrawati, et al., 2018), (Chen, et al., 2017)
25	Delivery on time	Quality	(Ghaouta, et al., 2018), (Ferdiansyah, et al., 2016), (Buonamico, et al., 2017), (Indrawati, et al., 2018), (Chen, et al., 2017)
26	Inventory accuracy	Quality	(Hiruwnwat, et al., 2017), (Laosirihongthong, et al., 2018), (Buonamico, et al., 2017), (Indrawati, et al., 2018)
27	Accuracy in taking orders	Quality	(Laosirihongthong, et al., 2018), (Buonamico, et al., 2017)
28	Accuracy in order delivery	Quality	(Laosirihongthong, et al., 2018), (Chen, et al., 2017)
29	Working hours	Time	(Horta, et al., 2016), (Hiruwnwat, et al., 2017)
30	Order lead time	Time	(Yener & Yazgan, 2019), (Ghaouta, et al., 2018)
31	Simulation time	Time	(Elbert & KarlKnigge, 2020), (Yener & Yazgan, 2019)
32	Average pick-up time (minutes)	Time	(Yener & Yazgan, 2019), (Ghaouta, et al., 2018), (Kusrini, et al., 2018)
33	Put aways cycle time (per putaway)	Time	(Kusrini, et al., 2018)
34	Reception time	Time	(Ghaouta, et al., 2018), (Kusrini, et al., 2018)
35	Average delivery cycle time	Time	(Hiruwnwat, et al., 2017)
36	Average warehouse order cycle time	Time	(Hiruwnwat, et al., 2017)
37	% Space utilization	Utilization	(Faozanudin & Susanto, 2019), (Kusrini, et al., 2018), (Hiruwnwat, et al., 2017), (Laosirihongthong, et al., 2018), (Kusrini, et al., 2019), (Ferdiansyah, et al., 2016)

No	KPI	Category	Reference
38	Inventory utilization	Utilization	(Ghaouta, et al., 2018), (Ferdiansyah, et al., 2016), (Kusrini, et al., 2018)
39	Equipment utilization	Utilization	(Hiruwnwat, et al., 2017), (Laosirihongthong, et al., 2018)
40	Transportation utilization	Utilization	(Hiruwnwat, et al., 2017), (Makaci, et al., 2017)

From the selected indicators, validation is carried out so that the existing indicators are relevant to the practice in the field. These indicators are assessed by experts for validation and the results of the assessment are presented in the table below.

Table 3. Indicators That Have Been Assessed

No	KPI	Category	R1	R2	R3	R4	R5	Total
1	Labor cost	Cost	5	4	4	5	5	23
2	Inventory cost	Cost	5	4	4	5	5	23
3	Order quantity	Cost	3	3	4	3	4	17
4	% Rejected order	Cost	3	3	4	2	3	15
5	Order processing fee	Cost	3	2	2	2	2	11
6	Transportation cost	Cost	5	4	5	4	4	22
7	Maintenance cost	Cost	3	4	3	3	3	16
8	Infrastructure cost	Cost	2	3	2	2	2	11
9	Perfect order	Cost	4	4	4	4	4	20
10	Insurance cost	Cost	4	5	5	4	4	22
11	Shortage cost	Cost	2	2	3	2	3	12
12	Lateness	Productivity	4	4	5	5	5	23
13	Distance reduction	Productivity	3	3	2	2	3	13
14	Receipt per working hour	Productivity	2	2	3	3	2	12
15	Orders prepared for delivery per hour person	Productivity	4	4	2	3	4	17
16	Pick-up productivity	Productivity	3	3	3	3	3	15
17	Labor productivity	Productivity	2	3	2	2	3	12
18	Customer satisfaction level	Productivity	4	4	4	4	4	20
19	Response to urgent delivery	Productivity	5	4	5	5	5	24
20	Transport speed	Productivity	3	2	2	3	3	13
21	Delivery flexibility	Productivity	4	4	4	3	3	18
22	Layout configuration	Productivity	4	4	4	5	4	21
23	Implementation of 5S activities	Productivity	4	4	4	5	4	21
24	Product damage rate	Quality	5	4	5	5	4	23
25	Delivery on time	Quality	5	5	5	5	4	24
26	Inventory accuracy	Quality	3	3	2	2	2	12
27	Accuracy in taking orders	Quality	3	4	3	3	3	16
28	Accuracy in order delivery	Quality	4	4	3	3	3	17
29	Working hours	Time	4	4	5	5	5	23

No	KPI	Category	R1	R2	R3	R4	R5	Total
30	Order lead time	Time	4	4	5	3	3	19
31	Simulation time	Time	3	2	2	3	3	13
32	Average pick-up time (minutes)	Time	2	3	2	2	3	12
33	Put aways cycle time (per putaway)	Time	3	3	2	2	2	12
34	Reception time	Time	3	2	2	2	2	11
35	Average delivery cycle time	Time	2	2	2	2	3	11
36	Average warehouse order cycle time	Time	5	5	4	4	4	22
37	% Space utilization	Utilization	4	4	3	3	3	17
38	Inventory utilization	Utilization	3	3	3	3	3	15
39	Equipment utilization	Utilization	2	2	3	2	1	10
40	Transportation utilization	Utilization	4	4	3	3	2	16

The indicators that have been validated can be used as benchmarks for measuring warehouse performance in companies or small and medium businesses that have warehouses for storage. The indicators that have been validated are presented in the table below.

Table 4. Validated Indicators

No	KPI	Category	Reference
1	Labor cost	Cost	(Kim, 2020), (Hiruwnwat, et al., 2017), (Ghaouta, et al., 2018), (Ferdiansyah, et al., 2016), (Indrawati, et al., 2018)
2	Inventory cost	Cost	(Kim, 2020), (Hiruwnwat, et al., 2017), (Laosirihongthong, et al., 2018), (Indrawati, et al., 2018)
3	Transportation cost	Cost	(Hiruwnwat, et al., 2017), (Laosirihongthong, et al., 2018), (Kusrini, et al., 2019), (Ferdiansyah, et al., 2016), (Makaci, et al., 2017), (Chen, et al., 2017)
4	Insurances cost	Cost	(Laosirihongthong, et al., 2018)
5	Lateness	Productivity	(Kim, 2020)
6	Response to urgent delivery	Productivity	(Laosirihongthong, et al., 2018)
7	Layout configuration	Productivity	(Kusrini, et al., 2019)
8	Implementation of 5S activities	Productivity	(Ferdiansyah, et al., 2016), (Buonamico, et al., 2017), (Indrawati, et al., 2018)
9	Product damage rate	Quality	(Laosirihongthong, et al., 2018), (Indrawati, et al., 2018), (Chen, et al., 2017)
10	On time delivery	Quality	(Ghaouta, et al., 2018), (Ferdiansyah, et al., 2016), (Buonamico, et al., 2017), (Indrawati, et al., 2018), (Chen, et al., 2017)
11	Accuracy in order delivery	Quality	(Laosirihongthong, et al., 2018), (Chen, et al., 2017)

No	KPI	Category	Reference
12	Working hours	Time	(Horta, et al., 2016), (Hiruwnwat, et al., 2017)
13	Order lead time	Time	(Yener & Yazgan, 2019), (Ghaouta, et al., 2018)
14	Reception time	Time	(Ghaouta, et al., 2018), (Kusrini, et al., 2018)
15	Average warehouse order cycle time	Time	(Hiruwnwat, et al., 2017)
16	% Space utilization	Utilization	(Faozanudin & Susanto, 2019), (Kusrini, et al., 2018), (Hiruwnwat, et al., 2017), (Laosirihongthong, et al., 2018), (Kusrini, et al., 2019), (Ferdiansyah, et al., 2016)
17	Transportation utilization	Utilization	(Hiruwnwat, et al., 2017), (Makaci, et al., 2017)

RESULT AND DISCUSSION

The results of this research show several performance indicators that are adjusted to activities in the warehouse consisting of receiving, putting away, storage, order picking, and shipping which are then divided into 5 KPI dimensions, namely the dimensions of cost, productivity, quality, time, and utilization. Each indicator specified for the warehouse has a different meaning and purpose. Performance indicators in this research were obtained from various sources of literature review of previous research. From the results of the assessment carried out by experts for data validation about warehouse KPIs in Table 4, it is obtained that there are 17 KPIs which are divided into 5 KPI dimensions, namely 4 KPIs for cost dimensions, 4 KPIs for productivity dimensions, 3 KPIs for quality dimensions, 4 KPIs for time dimensions and 2 KPIs. dimensions of utilization. The Warehouse Key Performance Indicator (KPI) can be explained as follows.

Cost

The company's cost is an important thing to consider, for example in the warehouse. KPI warehouse on the cost dimension aims to reduce some of the costs incurred related to the warehouse department. The KPI is determined so that the costs incurred will not exceed the standards set by the company so that the company's profits can increase (Ferdiansyah et al., 2016). In this research, there are 4 key performance indicators (KPI) warehouses for the cost dimension consisting of labor costs, inventory costs, transportation costs, and insurance costs.

Research (Hiruwnwat et al., 2017) explains that if labor costs and inventory costs decrease, the performance of the warehouse will increase. Then (Ferdiansyah et al., 2016) in his research explains that transportation cost indicators need to be considered because the value of transportation costs or shipping costs must be proportional to the value of achievement in product sales. This is by following per under the assessment results from the experts who stated that labor costs, inventory costs, and transportation costs were indicators that were used as benchmarks.

Productivity

In this research, 4 key performance indicators (KPI) of the warehouse were obtained for the productivity dimension, which consisted of delays, response to urgent deliveries, layout

configuration, and implementation of 5S activities. According to (Kim, 2020) in his research KPI delay has a very important effect on the company. This is because if the delivery is delayed it will damage the value of a product, so if there is a delay it must be resolved with the right rescheduling. Furthermore, according to (Buonamico et al., 2017) if 5S can be implemented properly it can reduce waste and improve process control in a warehouse. This is by following per under the results of research which states that these indicators are used as benchmarks for measuring warehouse performance.

Quality

In this research, 2 key performance indicators (KPI) of the warehouse were obtained for the quality dimension consisting of the level of product damage and on-time delivery. (Derick, 2018) explains that the indicator of the level of product damage is important to use because if the damaged product is large or continues to increase, the product quality is low and causes an increase in storage costs. Then according to (Ferdiansyah et al., 2016) in his research stating that the on-time delivery indicator is important to pay attention to because the percentage of this indicator must strive to be 100% fulfilled. This is by following per under the results of research which states that these indicators are used as benchmarks for measuring warehouse performance.

Time

In this research, 4 key performance indicators (KPI) were obtained for the warehouse for the time dimension consisting of working hours, waiting time for orders, receiving time, and average cycle time for warehouse orders. According to (Hiruwat et al., 2017) in their research, explained that the average warehouse order cycle time became one of the important aspects of the warehouse. Because if the order cycle time level decreases, the warehouse performance will increase. This is by following per under the results of research which states that these indicators are used as benchmarks for measuring warehouse performance.

Utilization

In this research 2 key performance indicators (KPI) of the warehouse were obtained for the dimensions of utilization consisting of % of space utilization and transportation utilization. (Ferdiansyah et al., 2016) explained that space utilization indicators are important to use because the capacity of the room should not be overloaded due to the lack of balance between incoming and outgoing goods. If this condition continues, the space in the warehouse will be very limited because the warehouse is full and the goods are in a mess. This is relevant to the results of research which states that these indicators are used as benchmarks for measuring warehouse performance.

CONCLUSION

This research was conducted by designing KPIs for a warehouse based on the results of several literature reviews from previous research. The KPI warehouse is created by dividing indicators into 5 KPI dimensions, namely the dimensions of cost, productivity, quality, time, and utilization. The KPI results in this study can be used to determine assessment indicators in evaluating warehouse performance in a company. If KPI Warehouse is executed properly, then these indicators can be used to monitor how much the target has been achieved and can find out how deviations can hinder the achievement of targets. The results of this research can be used by companies with KPIs that can be adjusted to the company's conditions. These KPIs can be added or eliminated according to the needs and interests of each company. The existence of

KPIs can be used as a standard that can increase the productivity of warehouse performance from various aspects. From this research, 17 KPIs have been validated, which are divided into 5 KPI dimensions, namely 4 cost dimension KPIs, 4 productivity dimension KPIs, 3 Quality KPIs, 4 time dimension KPIs and 2 utilization dimension KPIs.

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