Warehousing performance improvement using Frazelle Model and per group benchmarking: A case study in retail warehouse in Yogyakarta and Central Java

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Abstract. Warehouse performance management has an important role in improving logistic's business activities. Good warehouse management could increase profit, time delivery, quality and customer service. This study is conducted to assess performance of retail warehouses in some supermarket located in Central Java and Yogyakarta. Performance improvement is proposed base on the warehouse measurement using Frazelle model (2002), that measure on five indicators, namely Financial, Productivity, Utility, Quality and Cycle time along five business process in warehousing, i.e. Receiving, Put Away, Storage, Order picking and shipping. In order to obtain more precise performance, the indicators are weighted using Analytic Hierarchy Analysis (AHP) method. Then, warehouse performance are measured and final score is determined using SNORM method. From this study, it is found the final score of each warehouse and opportunity to improve warehouse performance using peer group benchmarking

1 Introduction

Warehousing management becomes very important because it contributes to cost improvement in logistics system (Liviu et al., 2009). Good warehouse management contribute cost and the quality both in terms of service to customers and the quality of the resulting product (Ackah and Eric, 2016; Speh, 2009). One of the best practice in good management warehouse is performance measurement which can be used to improve warehouse to be more effective and efficient. Performance measurement is useful for manager in order to carry out some improvement action base on periodic review.

Base on literature study on warehouse performance, many models and indicators for measuring warehouse performance are existed, that differ in term of time, cost, quality and productivity dimensions (Staudt et al., 2015). Therefore, warehouse managers need to choose which model comply with their warehouse environment. One of the model for measuring warehouse performance that measures operational activity is Frazelle model (2002). This model use measurement metrics that commonly used in industries. The advantage of Frazelle model is comprehensive, since it does not only measures quality, cost, time and productivity dimensions, but also it measures in terms of warehouse activities (receiving, put away, storage, picking, shipping. Therefore this study decide to focus on warehouse performance measurement using Frazelle model (2002) that measure on five indicators, namely Financial, Productivity, Utility,

Quality and Cycle time along with five business process in warehousing, i.e. : Receiving, Put Away, Storage, Order picking and shipping. A case study on warehouse performance measurement in retail warehouse is conducted. Based on the result, then improvement is proposed using benchmarking by comparing warehouse performance with the best performance among peer group.

2 Literature Review

Now days, there is growing interest in the analysis and measurement of performance, because performance analysis allows the development of decision support systems for the design, planning and management of enterprise. A performance measurement system can be defined as the set of metrics used to quantify both the efficiency and effectiveness of actions (Neely et al., 1994). Although warehouse performance can be measured in to hard metric (such as order cycle time, fill rates and costs) and soft metric (such as manager's perceptions of customer satisfaction and loyalty (Staudt et al, 2015), however, in general, efficiency and effectiveness is the most widely utilized as a measure of performance (Ammons, 1995; Kusriani et al., 2014).

Warehouse performance measurement has been explored in different ways by researchers. These works differ from one another with respect to the objectives (long- or short-term decisions), the way to measure these objectives (variety of performance indicators), the type of

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warehouse systems (distribution centre, cross-dock platforms, etc.), the focus area inside the warehouse (storage, picking, etc.) and the tools used for measurement (statistical tools, mathematical programming, etc.) (Staudt et al., 2015). Warehouse manager needs to choose which type of suitable measurement with their warehouse environment. This is not an easy job since all of the measurement are different (Keebler and Plank, 2009).

Warehouses could have different activities according to product specification, customer requirements and service levels offered. The complexity of the warehouse activities depends mainly on: (i) the number and variety of items to be handled; (ii) the amount of daily workload to be done; and (iii) the number, nature and variety of processes necessary to fulfill the needs and demands of the customers and suppliers (De Koster and Warffemius, 2005). According to Frazelle (2002), warehouse activities are divide into 5 activity, i.e.: receiving, put away, storage, order picking and shipping. Each activity can be measured by using 5 Key Performance Indicator (KPI), namely financial, productivity, utility, quality and cycle time. Therefore there are 25 KPIs for measuring warehouse as depicted in Figure 1

Table 4-1: Warehouse key performance indicators (Frazelle, 2002, 56)

	Financial	Productivity	Utilization	Quality	Cycle Time
Receiving	Receiving cost per line	Receipts per man-hour	% Dock door utilization	% Receipts processed accurately	Receipt processing 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 cube 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	Orders prepared for shipment per man-hour	% Utilization of shipping docks	% Perfect shipments	Warehouse order cycle time

Fig 1. Warehouse Key Performance Indicators (Frazelle, 2002)

3 Research Methods

3.1 Research Objects

Warehouse performance measurement is conducted in four retail/supermarket warehouses in Yogyakarta and Central Java. The retail/supermarket sell the needs of households, schools and offices. This warehouses has an average space ranging from 175m² to 200m² and an average 3-5 labor dedicated to this warehouse. In general, business processes in this retail warehouse starts from the goods received and the process of checking goods, the transfer of goods into the warehouse, put the goods into storage racks. The goods in the warehouse is picked and delivered if there is an order from the store.

3.2 Research Stages

The stages in this research are as follow: (1) Determine warehouse criteria based on Frazelle model; (2) Identifying importance weight of KPIs (3). Conduct a field survey and measuring warehouse performance (4) Normalize data using SNORM (5) Perform peer group benchmarking.

4 Results and Discussion

4.1 Result

This research employ criteria base on frazelle model to find warehouse performance and identify opportunity for improvement. In order to identify the importance weight of indicators, Analytic Hierarchy Process (AHP) model is used. A questionnaires of pair wise comparisons among indicators (KPIs) is prepared and a total of four manager of retail warehouse were asked to give their preferences on the questionnaires. The scale of 1 to 9 (1 = equally, 3 = moderate, 5 = strong, 7 = very strong, 9 = extreme) is utilized to rate the preferences of the expert. Consistency Ratio (CR) is used to check the consistency of the comparison. CR less than 0.1 means that comparison is accepted. The results of questionnaires is analyzed using Analytic Hierarchy Process (AHP) model. Analytic Hierarchy Process was first introduced by Thomas L. Saaty in 1971 and became the most widely method for Multiple Criteria Decision Making (MCDM) (Saaty, 2008). The result of importance weight of each KPIs can be seen in Figure 2.

Fig 2. The important weight

The results of field surveys and measuring warehouse performance for four retail warehouse, i e: retail 1 (M1), retail 2 (M2), retail 3 (M3) and retail 4 (M4) as seen in Table 1.

Warehouse performance indicators then scored using standardized method, i.e. SNORM based on benchmark data among warehouses. The process of normalization (SNORM) De Boer (Trienekens and Hvolby, 2000) employed scale of 0 to 100 to get the value of each metric. The final score is obtain by multiplying normalized data with importance weight, as seen on Table 1.

Table 1. Warehouse Performance Indicators from observation

Activity	M1	M2	M3	M4
1. Receiving				
- Financial (Rp/line receiving)	39.550	31.250	15.052	39.625
- Productivity (box/man-hour)	106,67	216	108,4	100
- Utilization (%)	33,3	90	98	31,3
- Quality (%)	98,75	100	58	99
- Cycle Time	1,5	2,08	0,56	1,5
2. Put Away				
- Financial (Rp/line putaway)	46.151	62.500	38.461	79.250
- Productivity (box/man-hour)	11,4	12	18	16,67
- Utilization (%)	95,24	90	55,78	62,5
- Quality (%)	98,75	100	97	100
- Cycle Time	0,0875	0,0833	0,055	0,06
3. Storage				
- Financial (Rp/line storage)	13.186	16.667	8.333	23.775
- Productivity (box/m ²)	4,76	2,48	7,58	10
- Utilization (%)	70	90	95	50
- Quality (%)	90	99	87	99,2
- Cycle Time	12,5	35	20	14,2
4. Order picking				
- Financial (Rp/line order picking)	5.492	4.375	7.692	33.021
- Productivity (box/man-hour)	119	193	80	125
- Utilization (%)	75	50	90	50
- Quality (%)	100	100	94	100
- Cycle Time	0,0083	0,005	0,0125	0,008
5. Shipping				
- Financial (Rp/line receiving)	32.965	58.333	15.384	33.021
- Productivity (box/man-hour)	20	112	10	60
- Utilization (%)	50	90	90	26
- Quality (%)	100	100	98	100
- Cycle Time	0,05	0,008	0,1	0,017

The final score of the warehouse is then arranged into the spider diagram as it shows the lowest and the highest score on each indicators along five warehouse activities, as shown on Figure 3.

Fig 3. Spider diagram of retail warehouse performance

4.2. Discussion

Base on the performance score, it can be seen that M2 warehouse has the highest overall performance value of 59.92. M2 warehouse is superior for receiving, order picking and shipping. This is because in receiving, order picking and shipping process, M2 warehouse maximize its utility that increase its productivity and reduce cost. Especially in order picking, many authors assume that order picking is one of the most labor- and time-intensive internal logistics processes, and that in many cases it is responsible for more than 50 percent of the operating costs of a warehouse (Tompkins et al., 2003; Richards, 2011). Studies suggest that order picking is automatized only to a small degree in many companies, and that more than 80 percent of all orders are picked manually on average (De Koster et al., 2007). Meanwhile, M3 warehouse has the highest score of put away and storage values. This is because there is no stacking of goods in the staging area and using trolley effectively so speeding up the duration

of the put away process. While good performance in storage due to high inventory turnover, in other words there is no buildup of goods in the warehouse in the long term in M3 Warehouse. This result can be used by the warehouse manager to improve its performance by referring to the best warehouse performance. The highest performance on each activity could be a target setting for other warehouses in order to improve their performance. Opportunity for improvement for each warehouse is described on Table 3.

5 Conclusions

This research focus on measuring warehouse performance using Frazelle model (2002). Frazelle model is selected because its metric commonly used in industries and comprehensive, because it not only measures quality, cost, time and productivity dimensions, but also measures in terms of warehouse activities (receiving, put away, storage, picking, shipping). To find performance score of warehouse, the performance indicators are weighted using Analytic Hierarchy Analysis (AHP) method. Warehouse performance are then measured and final score is determined using SNORM method. From this study, it is found the final score of each warehouse and opportunity to improve warehouse performance using peer group benchmarking

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