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## Abstract

Evaluation of warehouse processes is required for decision making purposes and the improvement of warehouse operations. To evaluate warehouse processes, it is essential to identify key indicators in the warehouse operations. This research was intended to identify the significant indicators of warehouse performance that would support management decision making on the improvement of warehouse operations. In this research 20 indicators were identified in four warehouse activities based on Frazelle model. The most important indicators in each warehouse were then determined. The study was conducted through a descriptive design using a survey of 3 medium warehouses in Nakuru. The study employed purposive sampling to select the sample and sample elements. The sample size of 10 warehouse management officers were used in the study. Structured questionnaire was adopted as data collection instrument. The research findings indicated that most important performance indicators for receiving is productivity, for storage is space utilization, for order picking is cycle time and for shipping is productivity. Process improvement steps were proposed based on benchmarking among warehouses handling similar goods. It was noted that different types of warehouses require different indicators. The study concluded that measurement of warehouse processes is important and enables operations improvements and cost reduction.

**Keywords:** *Warehouse procedures, warehouse performance, warehouse improvement, medium sized warehouses, Nakuru town, Kenya*

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## 1.0 Introduction

A warehouse is a planned space for the well-organized storage and handling of goods. Warehousing creates time utility by bridging the time gap between production and consumption of goods, and therefore, is important for international trade (Ackerman, 1999). The following characteristics represent the role of warehouses in the 21<sup>st</sup> century (Frazelle, 2002): they provide more customization, they offer more value-added services, they process more returned products, they execute more, smaller transactions due to increased B2C e-fulfillment and lastly, they handle and store more diverse products with international origins and destinations due to offshoring activities. To meet the diverse consumer needs and save on costs of operations, warehouses need to continuously review and improve on their operations and service delivery. Evaluation of warehouse is used to measure the degree of achieving the desired objectives of the warehouse. Warehouse performance analysis will enable the warehouse management to improve on consumer satisfaction, quality of services and achieve cost reduction. This research aims at identifying the key performance indicators that may be used to evaluate warehouse activities, and determine their role in improving service performance in the warehouse.

## 2.0 Literature Review

### 2.1 Warehouse activities

Warehouse activities are the procedures and operations that are undertaken in the warehouse (Bolten, 1997). The warehouse activities include the following:

#### i. Receiving

This is the orderly receipt of all merchandises coming into the warehouse. It includes unloading from the inbound transportation, verification and acceptance of goods.

#### ii. Inspection and quality control

This activity provides the assurance that the quantity and quality of the received merchandises conforms to the specified standards on the accompanying documents.

#### iii. Cross Docking

A cross docking is the transfer of merchandises from an inbound carrier directly through the sorting procedure to an outbound carrier, with little storage time. It involves receiving bulk shipments and then breaking these shipments into smaller orders, packing them, and shipping them immediately without being stored in the warehouse

#### iv. Putaway

Putaway is the act of moving the received merchandises from the point of receipt or quality inspection area to a storage area within the warehouse.

v. Storage

This is the safekeeping of merchandises in a designated appropriate space in the warehouse. Goods are temporarily stored in the warehouse as they await value addition, customization or consumption.

vi. Order Picking

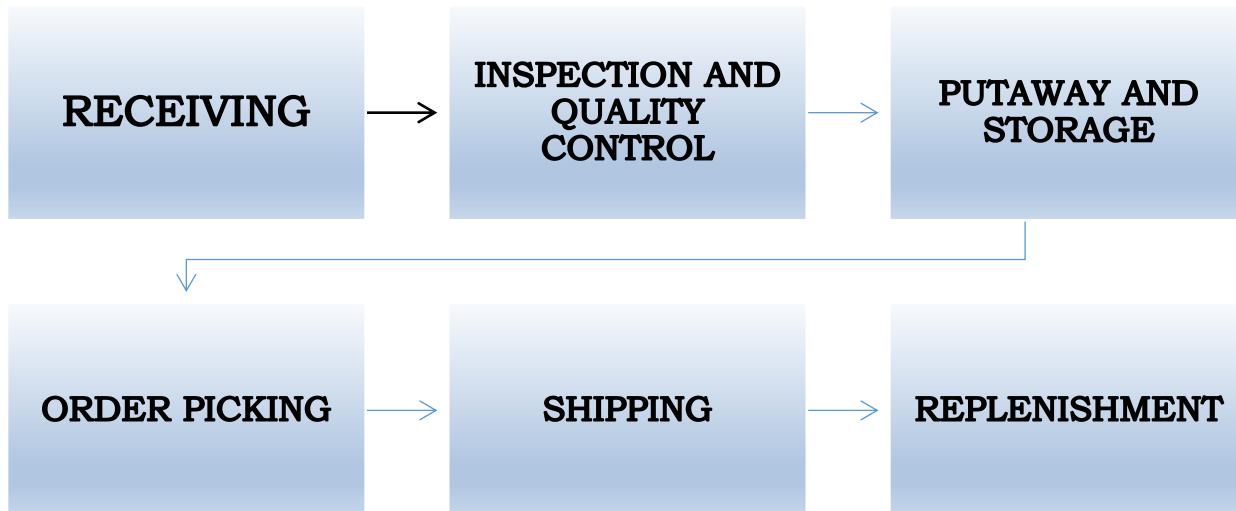
This is the preparation of merchandises in appropriate packages as requested by the customer

vii. Shipping

This is activity that involves scheduling and assignment of transportation to the merchandises, after recording the required data and packing appropriately. It is the physical movement of merchandise from the warehouse to the consumer.

viii. Replenishment

Replenishment is the restoration of merchandises to a former level after shipping. It ensures that the right merchandises and quantities are in the correct location in the warehouse. The common warehouse activities are illustrated in Figure 1



**Figure 1: Warehouse Activities**

## 2.2 Warehouse Evaluation

Warehouse Evaluation is a process that scrutinizes the warehouse operations by collecting and analyzing information about warehouse activities, and outcomes. The purpose of warehouse evaluation is to make informed judgments about a process, to improve service levels, or to support decisions (Neely A. et al, 2005). Warehouse evaluation is used to evaluate the warehouse with regards to inputs, processes and outputs. Warehouse evaluation is based on Quantitative measures

and Qualitative indicators. Quantitative indicators include measures such as warehouse space utilization, time utilization, order picking accuracy and costs associated with each operation. Qualitative indicators are non-numerical indicators for evaluation of the warehouses' level of progress towards a specific objective. Qualitative indicators are based on opinions, feelings and viewpoints of the consumer; and includes indicators like the ease of access to the warehouse, participation of the consumer in processes, freedom of expression, perceptions of consumer, level of satisfaction with the services. Qualitative indicators influence consumer loyalty and retention (Staudt et al, 2015). Frazelle model classify warehouse performance indicators into five indicators that are used to evaluate the main activities in the warehouse. These indicators are productivity, utilization, quality, time and financial indicators. Frazelle model classify performance measured throughout the warehouse as shown in Table 1 (Franzelle, 2002).

**Table 1: Warehouse evaluation indicators**

	<b>Productivity</b>	<b>Utilization</b>	<b>Quality</b>	<b>Cycle Time</b>	<b>Financial</b>
<b>Receiving</b>	Receipt per hour	% door utilization	% receipts processed accurately	Processing time per receipt	Receiving costs
<b>Storage</b>	Stock per square metre	% space locations occupied	% location without discrepancies	Inventory days	Storage space cost per item
<b>Order Picking</b>	Orders picked per hour	% utilization of picking labour	% accurate pick	Order picking time	Picking costs per order
<b>Shipping</b>	Orders prepared for shipment per hour	% utilization of shipping area	% perfect shipments	Order progression time	Shipping costs per order

### 3.0 Method

#### 3.1 Determining warehouse key indicator

In this research, three warehouses that handle consumer goods were studied. These warehouses are owned by medium-sized businesses in Kenya. The study was carried out in three steps.

**Step 1:** Identifying importance of each warehouse indicator. A questionnaires of pair wise comparisons among indicators was prepared and given to senior managers at the Warehouses. They were asked to give their preferences on the questionnaires. The scale of 1 to 9 (1 = Low, 3 =

Moderate, 5 = Strong, 7 = Very strong, 9 = Extremely strong) is utilized to rate their preferences. The results of questionnaires were analyzed using Analytical Hierarchy Process (AHP) model. The result of importance weight of each warehouse evaluation indicator is presented in Table 2.

**Table 2. The importance weight of each warehouse evaluation indicator**

Activity	Productivity	Utilization	Quality	Cycle Time	Financial
Receiving	<b>0.38</b>	0.06	0.14	0.16	0.18
Storage	0.20	<b>0.32</b>	0.20	0.12	0.16
Order picking	0.16	0.14	0.22	<b>0.30</b>	0.18
Shipping	<b>0.34</b>	0.15	0.24	0.14	0.14

**Step 2:** Determining the most important warehouse indicator for the warehouse. This was done by selecting the highest weight among the indicators on each warehouse activity. The key performance indicator with the highest weight was regarded as the most important indicator. From Table 2:

- The indicator for receiving is productivity (Receipt per hour),
- The indicator for storage is space utilization (percentage space location occupied),
- The indicator for order picking is cycle time (order picking cycle time)
- The indicator for shipping is productivity (order accurately prepared for shipment per hour).

**Step 3:** Evaluating the warehouse using the selected important indicators. The Warehouse performance is measured using the selected indicators. The evaluation of each warehouse is presented in Table 3.

**Table 3: Warehouse Evaluation**

Indicator	Warehouse 1	Warehouse 2	Warehouse 3
Receipt per hour (unit/hour)	164	<b>250</b>	220
Percentage space occupied (%)	40	<b>65</b>	62
Order picking cycle time (Unit per order)	<b>6</b>	4	5
Order prepared for shipment per hour (unit per hour)	164	187	<b>226</b>

#### **4.0 Discussion of the Findings**

From Table 3, warehouse 1 has the best performance on the activity of order picking cycle time, while warehouse 2 has the best performance in receiving and space utilization. Warehouse 3 is the best warehouse on shipping activity. These results may be used to control the inputs, outputs and outcomes of the warehouse and support decision making about what operations and services to stop, continue or start.

#### **5.0 Conclusion**

Based on the findings, it is concluded that evaluation of warehouse activities may lead to improvement based on the selected indicator for each activity. The results of the evaluation enable the warehouses to plan and implement processes that will achieve the desired improvements. It was found that the most important indicator for receiving is productivity, for storage is space utilization, for order picking is cycle time and for shipping is productivity. Based on the indicator score, warehouse operations improvement may be done through benchmarking from the better performing warehouses. Further research needs to be done on how to improve warehouse operations through the evaluation of other performance indicators not captured in this research.

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