



Designing a warehouse management system in Vietnam

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Abstract

Warehouses have played an essential role in operating production as well as services. Therefore, scientists have constantly researched and developed simple, low-cost, and effective warehouse operation models to reduce storage costs while maintaining uncertain demands. Company G. is an e-commerce company that distributes a wide range of products with its focused market in the southern region of Vietnam. The company is having problems in warehouse management that affect the accomplishment of its goals and its ability to compete with other companies. This study proposes a set of solutions consisting of methods to change the layout of goods in the warehouse, standardize the warehouse management process, and design an information system to support inventory management to increase operational efficiency. These solutions have begun to be implemented at the company and have shown some positive signals.

Keywords: Warehouse management, layout, management processes, inventory, e-commerce, import, and export ratio

1. Introduction

One of the basic features of today's e-commerce warehouse is the massive amount of product categories. For example, in the case of company G., the warehouse has contained more than 1500 different types of items. Currently, the company is operating under the "business to customer" (B2C) model, so purchasing a variety of goods and stocking is necessary when the competition trend on delivery time is increasing between distributed companies through e-commerce. Because the characteristics of goods are often small in size, there is no need for too large storage space which is also an advantage of the company despite a large number of goods.

The process of operating an e-commerce warehouse has 3 main tasks that are importing, exporting, and inventory control. The company's problem is facing that the goods in the warehouse are arranged according to experience, and there are no clear rules which makes it difficult for employees in the operation process. In addition, the company's warehouse management process has not been standardized, and the time to deploy tasks is often long and overlaps between employees and departments in the warehouse. At the same time, there is an inconsistency in the storage of goods characteristics information because the company's barcode system is different from their suppliers. From the above problems, combined with research proposals from businesses, three solutions are proposed to solve the problems: arrange the layout of the warehouse, adjust the warehouse operations management process, and design an inventory management system.

2. Literature Review

From the end of the 20th century, with the development of industry, the research on warehouse operation solutions to improve productivity gradually became stronger. Berry (1968) ^[1] conducted research on warehouse's layout design based on information about the moving distance of products and inventory volume, and successfully improved warehouse operational efficiency: can store larger volumes, make full use of the warehouse's area, and generally reduce the total cost of production. Roberts (1968) ^[2] completed a book on warehouse floor plan design with the content referring to the use of analytical tools based on warehouse information such as limited size, and quantity inventory, to develop space-optimized models. Roberts and Reed (1972) ^[3] studied the

The topic of optimizing warehouse compartment configuration to increase management efficiency with the assumption that goods are randomly stored in the warehouse.

3. Materials and Methods

3.1. Layout design

For the layout of the warehouse, this study will apply the export/import ratio algorithm. This is an algorithm that products are arranged product locations in the warehouse to minimize the required time and distance for picking and packing tasks. For products in stock, the problem of using the advantage of controlling a large amount of access of a product, a product with a large frequency placed at a close distance will greatly reduce the moving distance by employees. The problem model is described as follows [11, 270]:

- q = number of storage units.
- n = number of product types.
- m = number of the warehouse's doors.
- S_j = number of units of inventory needed for product j .
- T_j = number of moves in/out of the warehouse with product j .
- p_j = percentage moving in/out of the warehouse from/to door i
- d_{ik} = distance (or time) required to travel from inlet/outlet i to storage location k .
- $x_{jk} = 1$ if product j is placed in location k ; otherwise = 0.
- $f(x)$ = average distance (or time) traveled by workers

$$Min = \sum_{j=1}^n \sum_{k=1}^q \frac{T_j}{S_j} \sum_{i=1}^m p_i \cdot d_{ik} x_{jk}$$

$$\sum_{j=1}^n x_{jk} = 1 \quad k = 1, \dots, q$$

$$\sum_{k=1}^q x_{jk} = S_j \quad j = 1, \dots, n$$

$$x_{jk} = \{0,1\} \text{ For all } j \text{ and } k$$

The algorithm to minimize the moving distance:

1. Number the products in descending order of the ratio T_j / S_j
2. $\frac{T_1}{S_1} \geq \frac{T_2}{S_2} \geq \dots \geq \frac{T_n}{S_n}$
3. Calculate the value of f_k for all storage locations
4. Place product 1 in storage locations S_1 with the smallest f_k , product 2 in storage position S_2 with the next f_k , etc.

3.2 Design warehouse operation process

Warehouse operations will be fine-tuned based on Frazelle's research, which argues that the activities required in a warehouse are receiving, transferring and storing, picking, sorting, cross-entry, and transportation (Fazelle, 2002) [12]. This study is based on the company's existing process, and opinions from experts and combined with the qualitative method of Istiqomah *et al* (2020) [7]. From there, it is possible to give a complete process of the application of barcode coefficients in the warehouse management system.

3.3. Design inventory management system

To be able to design an inventory management information system for company G, first, data on more than 1500 products traded by the company was collected. Next, a survey of the process as well as the management system was carried out. Then, based on the collected results, make requirements for the main functions of the system including the list of material management, import/export management, and inventory control function. From there, combine with basic Excel tools as well as VBA to design spreadsheets as well as system interfaces.

4. Result and Discussion

4.1. Layout design.

With the current warehouse space marked with the order of the shelves as shown in Figure 1, this study has collected data on the distance and rate of input/output of items to rearrange the storage location of each type of product. Products. Total travel distance is improved when applying the algorithm. Products that support weight loss (L1), male vitality (L4), and beauty tools (L13) are arranged on shelf 3 as shown in Figure 2. However, products of the same type must be placed together. need to recalibrate as shown.

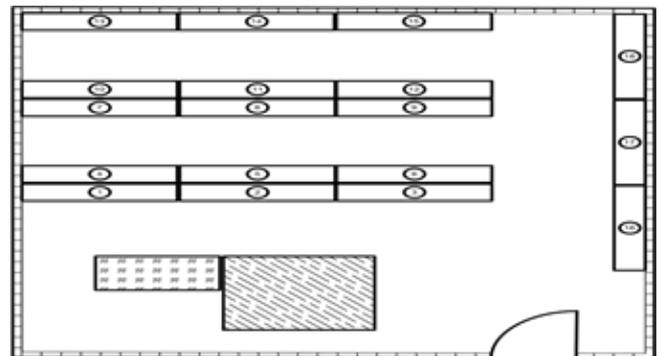


Fig 1: Schematic of shelves in the warehouse

L13	L13	L13	L13	L13
L4	L13	L13	L13	L13
L4	L4	L4	L4	L4
L4	L4	L4	L4	L4
L4	L4	L4	L4	L4
L1	L1	L1	L1	L4

Fig 2: Optimizing storage location by selected algorithm

L13	L13	L13	L13	L13
L13	L13	L13	L13	L13
L4	L4	L4	L4	L4
L4	L4	L4	L4	L4
L4	L4	L4	L4	L4
L1	L1	L1	L1	L1

Fig 3: Location of storage cells when adjusted

4.2 Design of warehouse operating procedures

Based on the existing processes, the company finds that it is still difficult because an effective warehouse management process has not been clearly defined. The study will deploy the application of the barcode system in the warehouse management process and offer a more complete process.

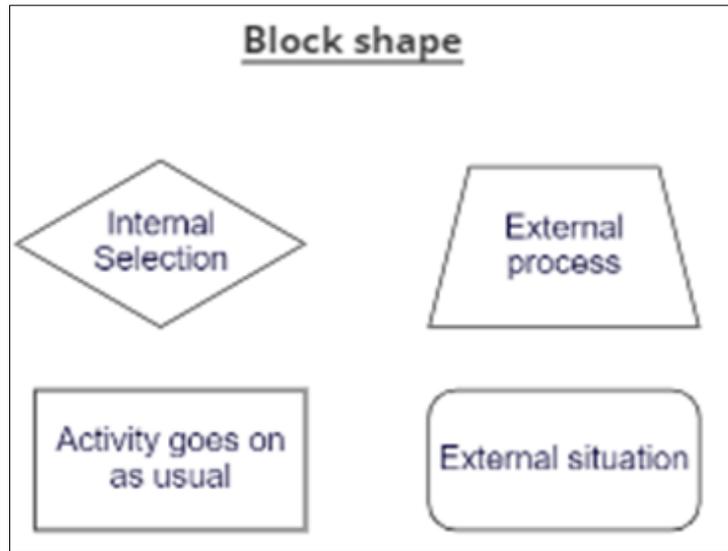


Fig 4: Block shape

1. Process of receiving goods.

- Made after the order process is successful.

Includes the following main processes

- Check the number of goods.
- Check the product's barcode on the system.
- Enter product information and print stock list (Including product SKU, product name, and storage location).
- Put the goods in the warehouse.

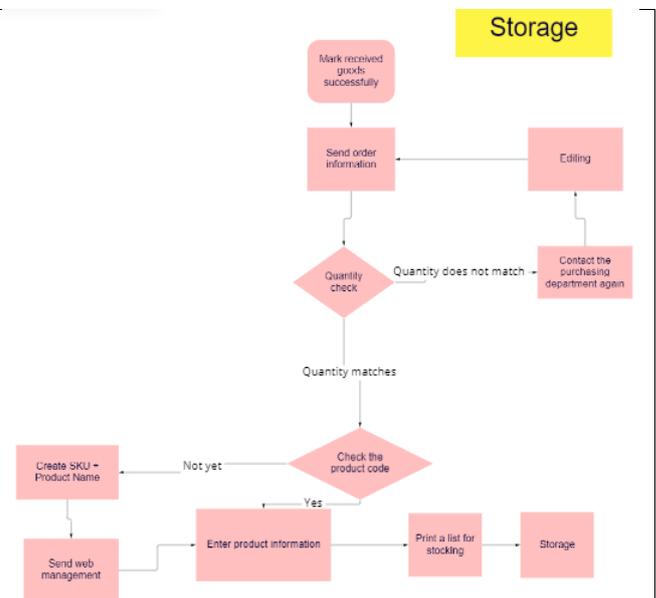


Fig 5: Storing process

2) Inventory stock check process

Prepare

- Manage to close the number of goods in the warehouse before performing the inventory. Assign staff to each warehouse area.
- The staff prepares bar code scanning equipment.

Physical inventory check

- Each employee goes to the divided area, scans the product barcode, and counts the total amount of each corresponding type to enter into the system.

Compare

- The inventory control system automatically compares the quantity in stock and the quantity after checking.

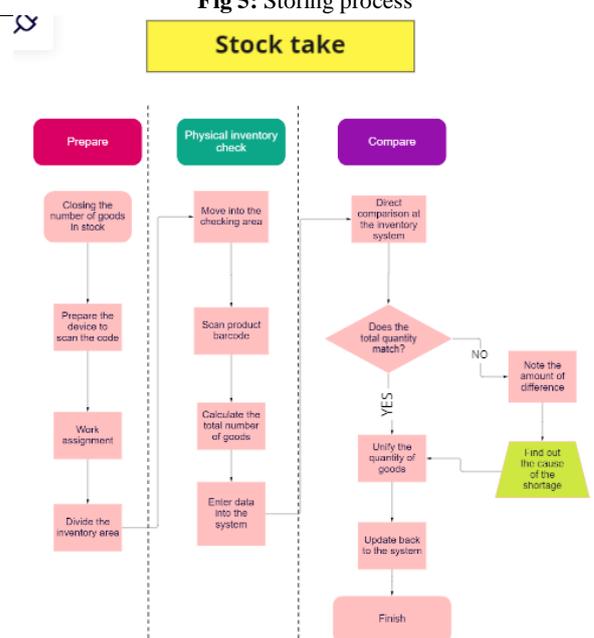


Fig 6: Inventory stock check process

3. Pick & Pack

Picking

- The employee outputs the order list (Including the main items: product name, SKU code, and order quantity).
- Enter the SKU codes of the products in the order into the warehouse management system to check the availability and expiry date.
- Pick up and check product quality

Update inventory level.

- Create order
- Create delivery note

Packing

- Staff in the packing department: Packing goods and delivering goods.

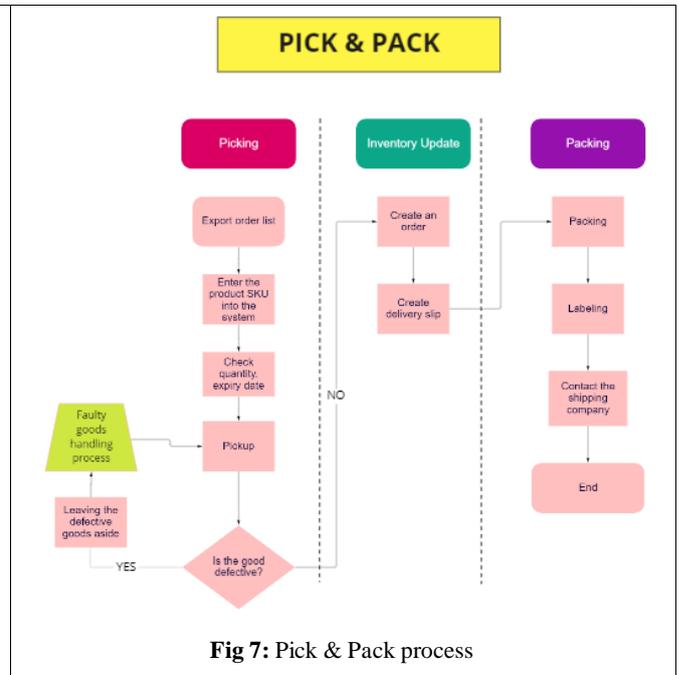


Fig 7: Pick & Pack process

4.3 Regulation of barcodes for products

a. Regulation of barcodes for products

Inconsistent product code is one of the factors that are having a great influence on the warehouse operation of enterprises. Therefore, before proceeding to build an inventory management system, it is necessary to unify the stock-keeping unit (SKU).

With a variety of products, setting the product code will also be quite complicated because it must contain enough information to distinguish between product types, and it must be simple enough for employees to remember the rules for creating codes for each type of product.

The new product code is 11 characters long, including numbers and capital letters. Each code will consist of 4 fields of information provided by the product name, which are the type of supplies, brand name, capacity, and specific characteristics in the product name.

b. Design inventory management system

The inventory management system has been built based on Microsoft Excel with additional applications of VBA to perform some complex functions. The system will consist of 5 main components, and each of them supports a different function during inventory management operation.

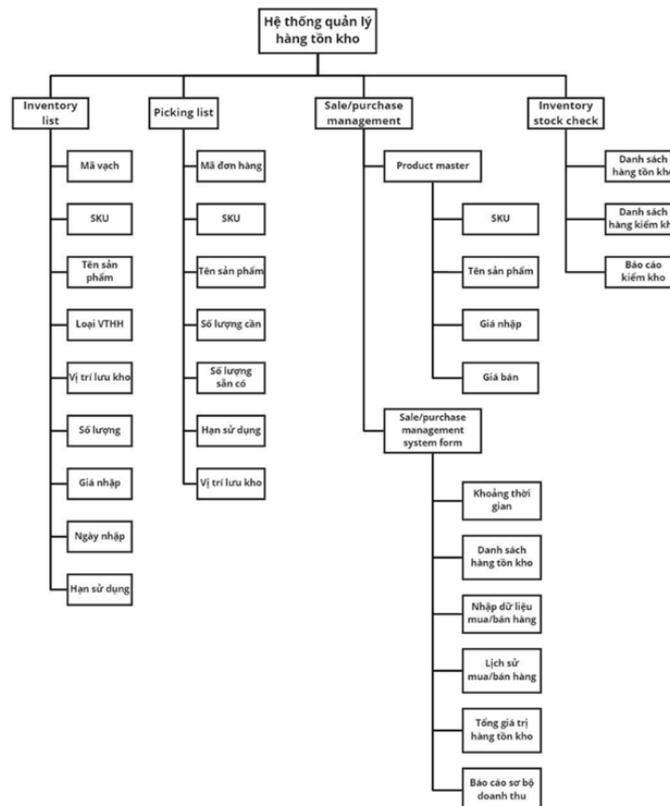


Fig 8: Functional diagram of the inventory management system

Through the research and design process, the main functions and interfaces of the inventory management system were formed.

The inventory list management interface will help manage

basic information about goods, and create barcodes for products when newly entered into the system. Expiry date management, as well as re-order points, were emphasized in the design process.

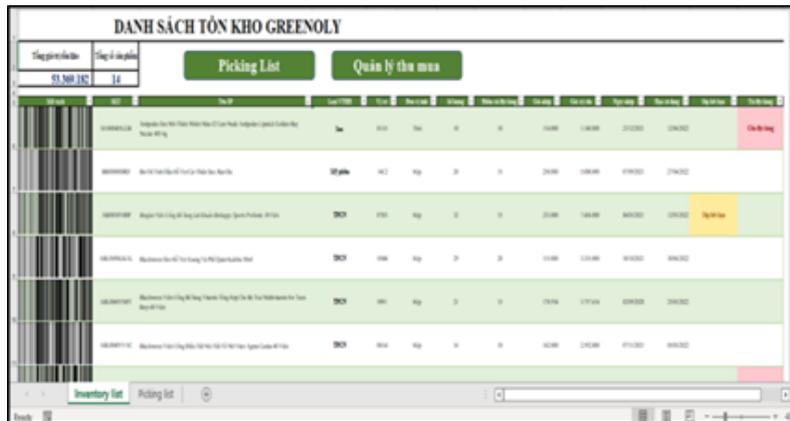


Fig 9: Inventory management interface

Inventory pick list” is a tool to help warehouse staff avoid errors in the picking process, and at the same time compare the information in the warehouse to meet the requirements of the order or not.

The "Product master" interface is responsible for managing the purchase and sale prices of goods, providing data for the "Sale/purchase management system" function.

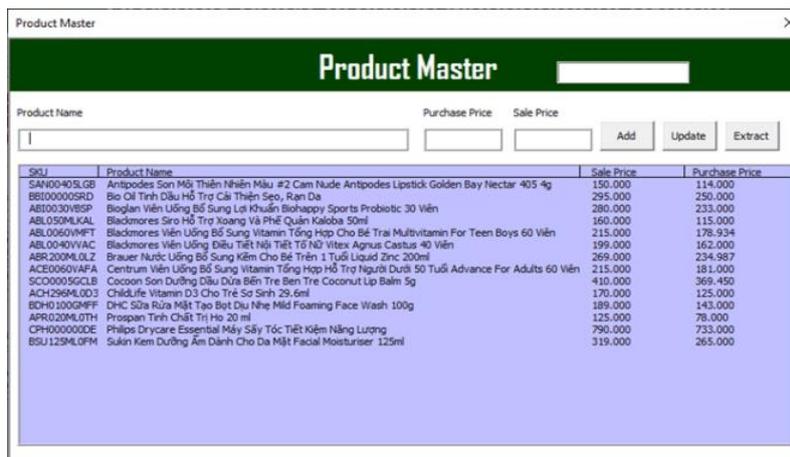


Fig 10: Product master interface-commodity price management

The "Sale/purchase management system" interface will give general information about available inventory, information

on goods imported and exported, as well as some parameters of revenue, profit, and inventory value.

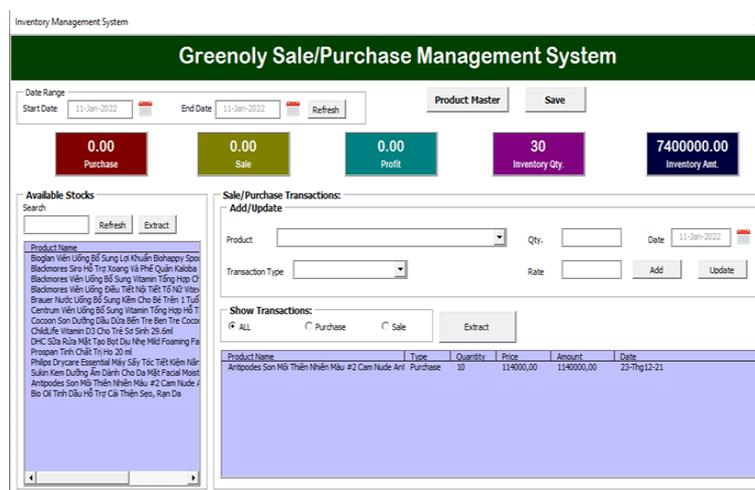


Fig 11: Import/Export management interface

A system inventory function is a tool built to support the inventory process mentioned above that helps to reconcile goods on the system and in the physical warehouse by scanning product barcodes.

4.4 System Deployment

After the design step, the above proposals were put into practice with the enterprise by the compiled manuals combined with training for employees on the changes to the warehouse system. At the same time, continuously receive feedback from staff to adjust the system to best suit the operator. The company will continue to operate normally while implementing system improvements. Therefore, the system completion time will be extended. However, after reviewing the proposal, company G gave positive reviews and recognized the feasibility of the study.

5. Conclusion

The article has completed the research and improvement of the entire warehouse system based on the actual situation and requirements of the business. The research team focused on three important areas for a warehouse: warehouse layout design, warehouse operation process, and inventory management system.

Due to being carried out during the time of social distancing, accessing the actual warehouse is very difficult. Although the solution has been transferred to the enterprise, it is not possible to perform a specific assessment of the data.

Therefore, in the future, the research team will try to collect more data on the results of applying the solution so that the topic can be more complete.

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