

A Performance Comparison of Manual Dispensing and Automated Drug Delivery

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ABSTRACT

Recently, the automatic distribution in pharmacies has solved the problems associated with traditional drug distribution, such as, quality of service to the customers, slow operation speed, inventory management, and savings in labour costs. The main contribution of this article is to present and to highlight the benefits of using a free-fall flow-rack automated storage and retrieval system for automating drug distribution in the pharmacies. For this, a comparison study has been carried out between the automatic and manual drug distribution according to the total delivery time of customer request. The total delivery time of customer request for the automatic distribution was calculated via simulation, while manual distribution was evaluated by an empirical study. 10 scenarios for each customer request have been performed to emulate the real distribution in pharmacies. We found that the deviation between the manual and automatic distribution can reach 94%.

KEYWORDS

Automated Storage and Retrieval System (AS/RS), Drug Distribution, Free-Fall Flow Rack (AS/RS), Simulation

1. INTRODUCTION

Hard competition is increasingly forcing pharmacies to adopt different technologies such as the use of the medicine automated dispensing system. These systems offer various advantages such as: fast dispensing and stocking rates, managing inventory and controlling medication expiration date. The delivery time is a key factor for drug distribution to meet the customer request. For this, a modern automated material-handling technology for the drug distribution based on a free-fall-flow-rack automated storage and retrieval system (FF-flow-rack AS/RS) has been developed for use in pharmacy. This system is known by the trade name “APOTEKA.”

As stated by the Material Handling Institute of America, an automated storage and retrieval system (AS/RS) is a generic term that today refers to a variety of means under computer control for automatically depositing and retrieving loads from defined storage locations (MHI, 2018).

The AS / RS are used in warehouses and consist of multiple parts, such as storage racks, aisles, storage and retrieval (S / R) machines, pickup / delivery (P / D) stations, that are all controlled by a computer system. The racks contain several bins that can store items. The racks are separated from each other by aisles. The storage and retrieval machines are fully automated cranes that move along

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an aisle to pick up and retrieve loads. The Pickup / Delivery (P / D) stations are used for inbound and outbound loads. The control system is used to manage the storage and retrieval operations.

The major types of ASRS are: AS / RS unit load, AS / RS mini load, AS / RS man-to-edge, AS / RS carousel, AS / RS multi-aisle, AS / RS support mobile, and AS-RS (deep-lane AS / RS).

The majority of papers in the literature dealing with automated dispensing systems have focused in evaluating the impact of these systems on reducing dispensing errors (Fanning et al., 2016) (Hoffman and Proulx, 2003) (Hyland et al., 2007) (Oswald and Caldwell, 2007) (Pedersen et al., 2015) (Serrano et al., 2012). Some researchers have studied the economic impact of the introduction of automated dispensing systems (Chapuis et al., 2015) (Risør et al., 2018). In this article, we are interested in time savings that an automated dispensing system can generate in a pharmacy.

The main contribution of this paper is to propose a comparative study between manual and automated drug-distribution in term of the total retrieval time of customer request. We performed this comparison in order to highlight the several and the major benefits of using a free-fall flow-rack automated storage and retrieval system for the automating of the drug distribution in the pharmacies. In this paper, we study the issue of dispensing drugs in the pharmacies where the prescribed drugs are full medicine box (SKU), which this method of drug dispensing is the most used in Europe and Africa.

The rest of this paper is as follows. In section 2 the automated distribution (FF-flow-rack AS/RS) and is described. In section 3 the manual distribution is presented. The retrieval-travel-time models are developed in section 4. Section 5 shows the obtained results of the comparison between the manual and automated distribution. The conclusion is reported in Section 6.

2. AUTOMATIC DISTRIBUTION (FF-FLOW-RACK AS/RS)

2.1. System Description

The Mekapharm Company has designed and marketed a new solution based on a flow-rack AS/RS (Mekapharm, 2016) (Figure 1). This new system is used basically to automate the distribution of drugs in pharmacies, it can be used also to store and deliver all products of small size and weight; able to withstand a free fall. This new system is called the Free-Fall-flow rack AS/RS, or FF-Flow-rack AS/RS (Metahri et Hachemi, 2018).

The special feature of this system compared to other types of flow-rack AS/RS studied in (Sari et al., 2005), (De Koster et al., 2008) and (Chen and Gupta, 2015), is that it does not need to use an automated crane to transport the products. It combines only the free fall with a conveyor to transport the products from the rack to the delivery station.

As shown in Figure 2, the FF-flow-rack AS/RS is made up of: a deep rack composed of a multitude of bins, which uses a gravitational conveyor equipped with rollers and wheels so that the stored products slide by gravitation, each time a product is picked from the bin. Each bin is configured as a first-in-first-out ("FIFO") queue with multiple segments (locations). All the segments of a bin contain the same SKU (Stock Keeping Unit). A pickup station is located on the storage face, and a drop-off station is located on the retrieval face. The drop-off station is linked to the rack via a transport conveyor. The items are loaded either by an operator or by a storage machine.

As highlighted in Figure 2, the rack dimensions are: length (L), height (H) and depth (D). The number of rack bins is N_L in each tier and the number of bins by column is N_C . Let M the number of storage segments for each bin. For practical and ergonomic reasons, the maximum height of the rack should be less than 3 m since the loading operations are performed by an operator.

2.2. System Operation of the FF-Flow-Rack AS/RS

The storage operation is performed by an automated crane or an operator, the products are handled from the pickup station to be loaded into the corresponding bin of the rack. The retrieval operation happens in two steps. The first one is the ejection of the desired product from the corresponding bin,

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