TOSHIBA

WES | Warehouse Execution System

Challenges of automating logistics and the need for WES

Toshiba Infrastructure Systems & Solutions Corporation

Challenges of automating logistics and the need for WES

In the logistics industry, challenges such as an absent workforce, an increase in smaller items and frequency of deliveries, as well as supply chain diversification are becoming more apparent.
The situation in a warehouse changes by the minute, and it's quite common that a high workload is continually put on a limited number of workers in order to meet deadlines.
For this reason, more warehouses have been implementing, Warehouse Management Systems (WMS) to manage in/outbounds, stock levels, and human tasks, as well as automation equipment with Warehouse Control Systems (WCS) to control these equipment.
To efficiently execute a series of tasks in the warehouse, close collaboration between humans (operators) and machines is crucial.
However, it's often the case that the WMS to manage humans, and the WCS to control the machines, are not integrated with each other.
So, in order to properly allocate work between humans and machines, while also making sure they are operating efficiently, it's necessary to rely on the experience and intuition of talents who are familiar with both logistics operations and automation equipment.
The Warehouse Execution System (WES) is a system that links the WMS and WCS.
By collecting, visualizing, accumulating, and analyzing data of the operation status of humans and machines in a logistics site, the WES is capable of predicting work completion times and providing guidance on appropriate resource allocation, by optimally planning and executing the entire operation inside the warehouse, solving various issues which would usually occur on a site.
In this document, we introduce two functions of the WES: "Optimizing outbound shipments," and "Forecasting demand/work progress," by using the Goods-to-Person AMRs as an example.

1.What are Goods-to-Person AMRs?

Before diving into the WES, we will first explain Goods-to-Person AMRs.
Goods-to-Person AMRs refers to a system consisting of usually more than one AMR (and/or AGVs) and shelves containing goods, which are to be picked, packed, then shipped from a warehouse, based on orders received. The AMRs transport the shelves (also called "PODs") containing the goods corresponding to an order to a picking (or work) station, where operators then pick the required number of goods from these shelves, to pack for shipping out. (Figure 1)
AMRs recognize their current positions by reading QR codes placed on the floor, and then moves between QR codes.
Charging stations are also installed in the same area, so that the AMRs are able to recharge themselves when their batteries are running low.
AMRs transport shelves upon receiving instructions (orders) from the WMS, to take goods inbound for stocking, or outbound for picking, or to take inventory.
The inside of the shelves are typically divided by partitions like in the image in Figure. 2, but can also be arranged freely to accommodate various types of goods a warehouse would handle.

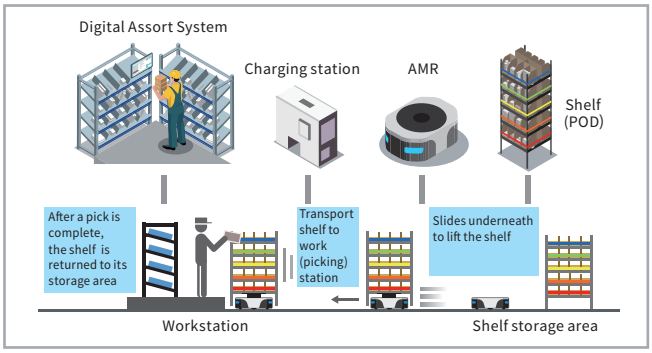

Figure 1. Goods-to-Person AMRs

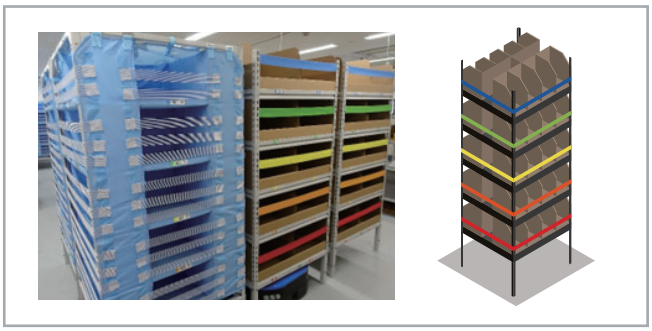

Figure 2. Shelves for Goods-to-Person AMRs

For stocking (inbound) goods, an operator can specify the size or type of the shelf needed at the workstation, and the AMR will bring a shelf (or shelves) with the specified space available, to the designated workstation.
For picking (outbound) goods, a specific shelf containing the ordered good(s) and/or needed quantity, is brought to the workstation.
Once the AMR arrives at the workstation, instructions on what and how many to pick from which shelf is displayed to the operator on the operator screen, so the operator only has to pick and scan the barcode of the good(s) as instructed.
After scanning the barcode, the goods are to be Put To Light, into the corresponding location of the Digital Assort System (DAS) on the workstation.
Improving the throughput of the in/outbound operations has always been an issue of focus, but conventional AMRs have not performed as anticipated, when it comes to route planning and the picking process, so hopes have been pinned on improvements in software.
Operational optimization software for Goods-to-Person AMRs are mainly made up of: Operation Control, Supervise Module, Planning Module, AGV Driving Control, WMS, and interface, as well as the database (Figure 3).

The Operation Control Module controls the instructions displayed on the screen at the workstation, DAS, label printer, and other connected devices through the hardware I/F (interface).
The Supervise Module provides system status monitoring, setting changes, data aggregation, and maintenance functions.
The Planning Module performs route planning of the AMRs and manages inventory information.
The AGV Driving Control converts the route plan output from the Planning Module into commands suitable for each AMR manufacturer and sends the commands to the AMRs.
It also notifies data and events received from the AMR to the Operation Control and the Supervise Module.

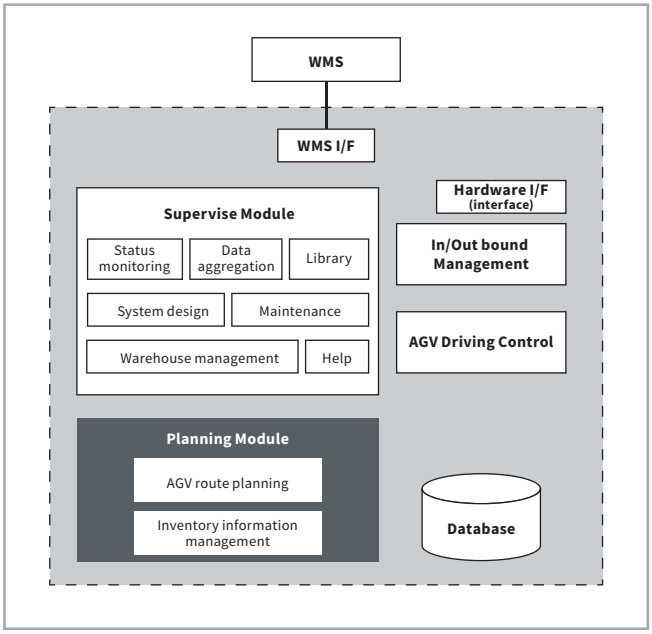

Figure 3 . Goods-to-Person AMR: system configuration

2.Enhanced performance by connecting devices with WES

From here, we'll explain what enhancements can be achieved when Goods-to-Person AMRs are connected to WES.
In warehouses where operations are centralized around humans, the assumption is that the WMS exchanges data with humans through information terminals or print media.
Therefore, the AMR system would directly connect to each individual WMS, receive an order, process in/outbound goods, and send the results to the WMS as if there were only one operator working the system.
However, the AMR system was not able to reenact the critical decision makings of a seasoned warehouse operator, such as changing to a more efficient picking sequence or allocating tasks while considering the work time remaining until cut-off.
The WES is equipped with functions to solve exactly these types of problems.

2.1.Order sequence optimization

From here, we will refer to "the variety of different items which can be picked from one shelf/POD" on an AMR system as the "Hit Rate."
The higher the Hit Rate, equals the less times a shelf needs to come and go from a workstation, resulting in higher throughput, as the AMRs do not need to travel as much. This also means that, the lower the Hit Rate, the lower the throughput.
The AMR system connects to the WMS and receives orders, and sends the results of the in/outbound goods it has processed back to the WMS.
As the WMS normally does not consider the Hit Rate, if orders are processed in the order provided by the WMS, it's possible that the Hit Rate does not increase.
For that reason, the WES acts as an intermediary between the WMS and AMR system, and rearranges the sequence of orders initially given by the WMS, to get a higher Hit Rate.

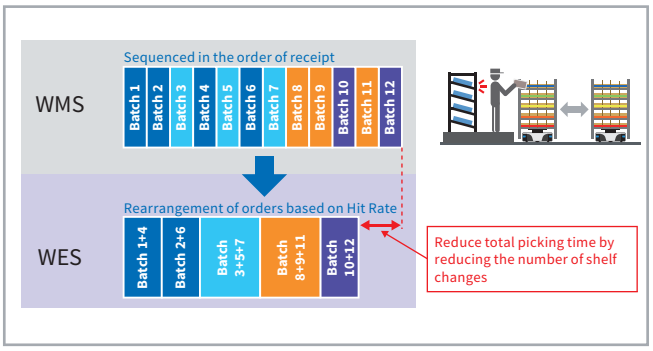

Figure 4. Image of WES order rearrangement

Figure 5 is a simulation of the Hit Rate which can be achieved over a certain period of time, in a distribution center working with an AMR system from another supplier, based on three scenarios; (a) without our optimization, (b) actual values presented by the AMR supplier, and (c) with Toshiba's order sequence optimization. (Actual orders were used to simulate scenarios (a) and (c), whereas in scenario (b) we calculated the Hit Rate based on actual operation results provided.)
The average Hit Rate from this AMR supplier was 1.40, and by optimizing the sequence of orders, the Hit Rate is to improve by an average of 0.30, meaning that we can expect a 21% improvement of the Hit Rate.

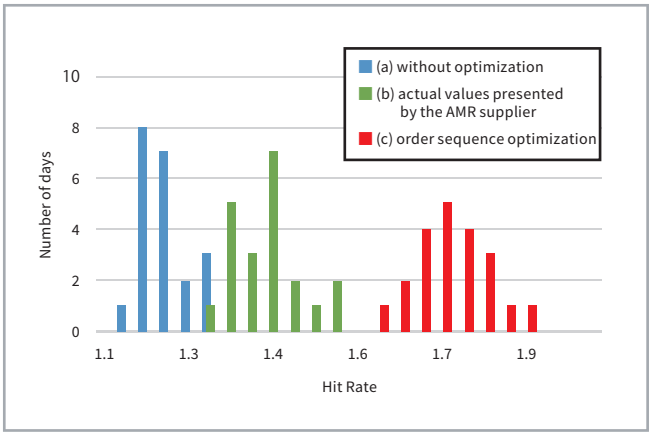

Figure 5. Hit Rate simulation

2.2.Demand and Progress Forecasting

Conventional management of work progress is done through managing the planning and actual results.
Supervisors constantly check data for any anomalies and delays, and in case of a delay, they have to come up with how to recover the delay in a split second.
The WES's demand and progress forecasting function, predicts the number of tasks expected for that day, by making a forecast based on actual results, and provides the expected completion time for that day, while also generating data of the predicted workload for the following month.
This improves the accuracy of predicted work completion times, and makes sure to always be ahead of those shipping deadlines.

3.Additional functionalities of the WES

In addition to the "Order sequence optimization" and "Demand & progress forecasting" introduced here, we at Toshiba plan to further develop and expand the areas where more visualizations, analysis and forecasting, as well as optimizations can be applied, in order to provide higher value-added services.

1. Address risks of delays in advance, through simulation of the expected task completion time, from visualized real time aggregated data collected from analyzing and simulating task progress, and the workload data of humans and machines.

2. Maximize throughput and resource utilization in the warehouse, by simulating and optimizing staff allocation based on tasks. If delays are predicted in the progress forecasting, the WES will navigate a more optimized staff allocation between work areas.

3. Seamlessly integrate with existing systems and WMSs, by using data conversion tools specialized for the logistics industry, which allows easy aligning and editing of data.

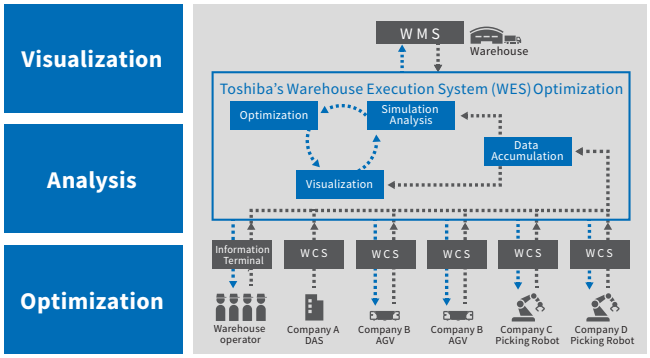

Figure 6. WES Product Summary

4.The Future of WES

In Japan, a company's fate could depend on whether and how well they are prepared for the upcoming inevitable labor shortage.
In future logistics operations, it will become even more necessary to optimize the overall process by making full use of various automation equipment and systems, instead of just improving one specific process.
For that, there will be more situations where seamless collaboration between humans and machines, companies and organizations, centered around a system such as the WES will be needed.
In fact, many end-users, logistics companies, and system vendors, each from different standpoints, are already developing and deploying WES.
It may not be long before many companies and individuals involved in logistics will be required to utilize such systems.

Reference
TOSHIBA REVIEW "Software for Shelf Picking Robots to Support Optimization of Operations in Physical Distribution Warehouses" (Japanese)