Featured Articles

Framework for Collaborative Creation with Customers to Improve Warehouse Logistics

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OVERVIEW: Hitachi has developed a framework for collaborative creation with customers to analyze and improve operations at their distribution warehouses to achieve better logistics and operational efficiency. The framework is made up of three steps: (1) review current warehouse performance and identify problems, (2) conduct analyses and formulate improvement measures, and (3) assess the benefits. A notable feature of the second step is that it involves conducting the review on site while building consensus with the customer, adopting two different approaches for this purpose, namely workshops that focus of human factors and analyses that utilize data. Conducting the review on site enables improvement measures to be trialed at an early stage to support appropriate warehouse operation that responds to rapidly changing markets. This article describes the framework along with supporting case studies.

INTRODUCTION

FACTORS such as more intense competition in the distribution industry and the rapid spread of online shopping are raising the importance of logistics. Competitiveness in the distribution industry is maintained by measures such as shortening the time taken from product purchase to delivery (in the case of online shopping) and minimizing inventory at retail stores to improve profitability. Logistics support, especially improvements to working practices at distribution warehouses, has an important part to play in these measures. The requirements for achieving this include shortening the time taken for "picking" (retrieving the product from inventory) and shipment when an order is received from a retailer or individual, and the reliable execution of working practices to ensure that various deadlines are met.

Growing use is being made of 3rd-party logistics (3PL) services that draw on sophisticated know-how and expertise to handle complex warehouse operation on the customer's behalf.

This article describes a framework for collaborative creation with customers that seeks to improve their warehouse logistics through collaboration between the Research & Development Group of Hitachi, Ltd. and the 3PL service of Hitachi Transport System, Ltd. (see Fig. 1).

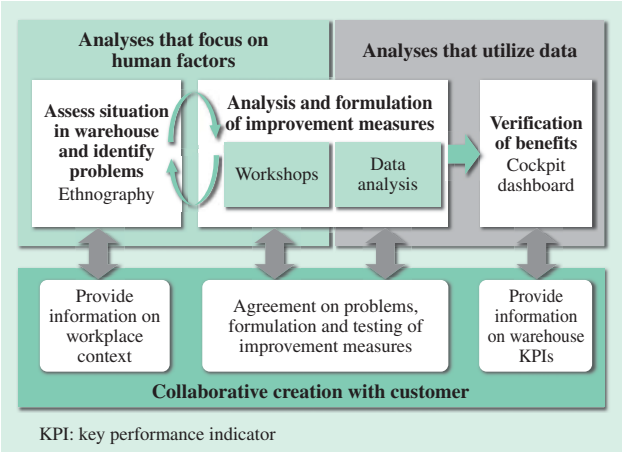

Fig. 1—Overview of Framework for Collaborative Creation with Customers to Improve Warehouse Logistics.
The framework extends from building consensus with the customer to the formulation of improvement measures and the verification of the benefits, with repeated hypothesis testing based on two approaches to dealing with the identified problems involving, respectively, analyses that focus on human factors and analyses that utilize data.

UNDERSTANDING OF WORKING CONTEXT AND IDENTIFICATION OF WORKPLACE ISSUES

This section describes the methodology of ethnographic research conducted to understand the context of working practices for warehouse logistics and identify

workplace issues, and presents examples of its use at Japanese warehouses.

Ethnographic research is a technique used in fields such as anthropology and sociology. It involves living alongside the people being studied and using techniques such as interviews and observation to determine the culture and other living practices of the group (ethnic group or society). It has attracted attention in recent years as a way of identifying factors to consider in regard to operational improvements or product planning, and Hitachi has been fostering and utilizing ethnography for these purposes since 2003.

If interviews alone are used to assess working practices, the collected information tends to focus on those explicit aspects of which the workers being studied are consciously aware. In contrast, because ethnographic research conducts extensive observation of the actual behaviors of those involved, it can shed light on the overall mechanisms associated with workplace problems.

Hitachi Transport System, Ltd. has been engaged in a wide range of activities that deal with workplace efficiency improvement at distribution warehouses, including ethnographic studies of workers. Fig. 2 shows such work in progress along with the outcomes it has achieved.

Activity	Issues	Scope	Cause and effect
(1) Receiving (of goods)	Not covered by study		
(2) Restocking	Regular restocking is too slow.	Addition	Cause
(3) Picking	No products available for picking	Initial	Effect
(4) Inspection and packing	Backlog of buckets awaiting inspection		
(5) Shipment (of goods)	Not covered by study		

Fig. 2—Warehouse Ethnographic Research and Outcomes. The photograph shows a researcher observing "picking" work (retrieving products from inventory to fill an order) and the table lists the types of activity studied, the main issues identified, and the scope of the study.

The sequence of operations from receiving (of goods) to shipment (of goods) at the warehouse being studied can be broken down into the following five steps.
(1) Receiving (of goods) (inward goods from the factory are stored in the warehouse's backyard)
(2) Restocking (transfer of products from warehouse backyard to picking area)
(3) Picking (retrieval of products to fill retailer order)
(4) Inspection and packing (inspection and packing of retrieved products)
(5) Shipment (of goods) (dispatch of packed products)

Based on consultation with the warehouse manager at the start of the study, the two steps selected for observation were picking and inspection and packing, both of which were believed to pose a challenge for productivity improvement. During the study, however, both were found to be reasonably efficient, with no evidence being found of underlying causes of lower productivity.

Accordingly, the study was extended to include the previous step (restocking). This found that the underlying causes of lower productivity lay in the restocking step. The study also identified the conditions under which these manifested and the extent of their impact. The response from the warehouse manager when these results were reported was the study had uncovered problems spanning multiple steps that would have been difficult to identify through routine improvement activities alone. The manager also expressed an intention of utilizing the improvement suggestions to look into the problems immediately. This represents a classic example of how extensive observation of workplace activities identified the mechanisms through which problems manifest (underlying causes, relationships between specific causes, scope of effects, and so on) and highlighted the problems to be addressed.

USE OF WORKSHOPS FOR CONSENSUS-BUILDING AND FORMULATING IMPROVEMENT MEASURES

A workshop in which the people involved can all meet under one roof is an example of a human-based initiative for encouraging consensus on the problems to be addressed and how to address them. Compared to assigning investigation work to individuals, the advantage of this approach is that it enables a high quality of discussion, bringing together the people

Fig. 3—Workshop to Study Problems to be Addressed and How to Address Them.
The workshop aims to build consensus by presenting the results of ethnographic research as a process flowchart and bringing together the people with the necessary knowledge and authority to make improvements.

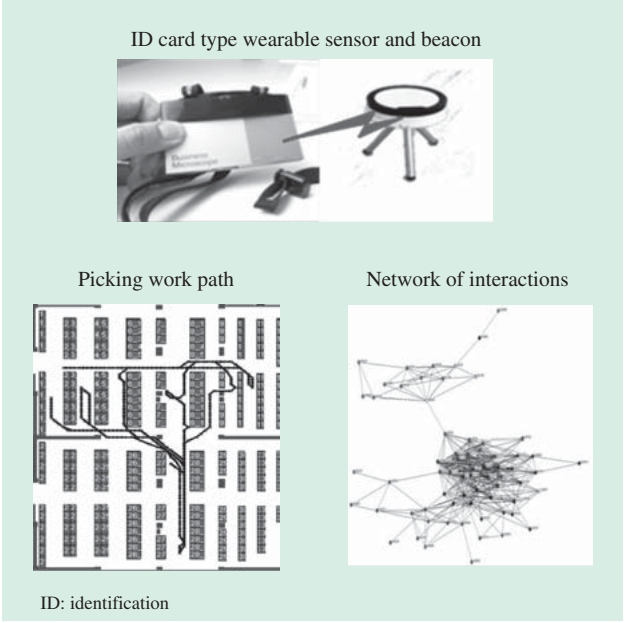

Fig. 4—ID Card Type Wearable Sensor and Example Applications.
ID card type wearable sensors with infra-red sensors identify and analyze interactions between workers and between supervisors and workers, and to detect where they are in the warehouse.

with the necessary knowledge and authority, so that subsequent improvement activities can be undertaken on the basis of their being supported by key staff.

Workshops that have the benefit of the ethnographic research described above can be attended by the staff responsible for each step as well as by the warehouse manager, with meticulous planning of the framework for presenting improvement proposals and material for sharing information about workplace issues (see Fig. 3). The workshops take about half a day and involve the following four steps.

(1) Presentation of current situation assessment and improvements
(2) Consideration of ideas
(3) Definition of issues, assessment of practicality
(4) Assessment of improvement benefits and matters of concern

This enables those involved to collate and agree on improvements, such as reviewing task allocations or making changes to restocking timings and working practices, and prepares the ground for subsequent improvement work.

USING DATA ANALYSIS FOR CONSENSUS-BUILDING AND FORMULATING IMPROVEMENT MEASURES

Analyses conducted using customer data provide another approach to building consensus about problems and associated improvement measures. This involves reaching agreement with the customer on the problems to address and how to address them by conducting quantitative measurement and analysis of the movement of people and goods at the warehouse.

The key to analysis is understanding the worker behaviors that make up the bulk of activity at a warehouse. One method for achieving this is the identification (ID) card type wearable sensors worn by staff detect the presence of other staff or beacons installed around the workplace[(1)]. As each beacon transmits a unique ID, the system can record where staff are at each point in time (see Fig. 4).

Table 1 lists analyses performed using the wearable sensor data and warehouse operations data recorded in the warehouse management system (WMS) logs, and also examples of improvement measures undertaken in response to the analysis results. The work confirmed the increased efficiency of picking and other warehouse activities achieved by implementing the various improvement measures.

VISUALIZATION OF WAREHOUSE INFORMATION FOR VERIFICATION OF BENEFITS OF IMPROVEMENT MEASURES

To ensure that the improvement measures introduced using the various approaches described above deliver genuine ongoing benefits, a “cockpit dashboard” is used to help the warehouse manager gain an accurate assessment of these benefits and the situation in the workplace. The cockpit dashboard collates a wide range of logistics data from work logs to organization-

TABLE 1. Example Warehouse Efficiency Improvements based on Data Analysis
The table lists analyses performed using ID card type wearable sensor data and log data from the WMS, and examples of improvement measures undertaken based on the analysis results.

Objective	Analysis tool	Analyses and example improvement measures
Instruction of shortest items gathering path	Layout analysis	Comparison of actual and optimal path followed by workers analyzed using ID card type wearable sensor data Example improvement measure: Use handheld device to follow optimal path
Optimization of order allocation	Work efficiency analysis	Comparison of actual work time obtained from WMS data with estimated work time for a worker handling a number of orders at one time determined from the speed of movement, picking work time, and other parameters identified from ID card type wearable sensor data Example improvement measure: Optimize order combination
Optimization of item arrangement in shelves	Work order analysis	Determine optimal product locations from shipping frequency analysis and records and item restocking analysis in WMS data Example improvement measure: Generate suggestions for how to change current layout
Optimization of worker assignment	Worker path analysis	Calculate where workers are in the warehouse at each point in time, and their direction and speed of movement Example improvement measure: Make changes to inefficiencies in warehouse layout. Optimize worker assignment.
Strengthen the effect of foreman	Face-to-face communication analysis	Calculate change in productivity of worker after face-to-face communication with supervisor Example improvement measure: Conduct efficient work-site observations

WMS: warehouse management system

wide management and presents it in the form of key performance indicators (KPIs) appropriate to each user's role.

The following describes an example where the cockpit dashboard was used to provide a progress management function to field managers and a daily profit management function to the warehouse manager (see Fig. 5).

The progress management function (shown in the top half of Fig. 5) shows the progress of tasks such as picking or inspection and packing for each shipment time (or other criterion) based on realtime data from the WMS on instructions for the shipment (of goods) due to be dispatched the same day. Field managers refer to this screen as they go about maintaining efficient warehouse operation, which may include reallocating staff, rearranging work schedules, or predicting the workload as it is progressively added to through the day. The function can also be used to determine the benefits of improvement measures from warehouse operations information, such as comparisons with similar days in the past, productivity assessments for individual tasks or workers, or information on equipment operation.

The daily profit management function (shown in the bottom half of Fig. 5) assesses the benefits of improvement measures from a management perspective by collecting quantity and other operational data from sources such as the WMS and attendance management system, and calculating sales and costs to determine whether or not daily performance targets have been achieved. It can also identify the causes of poor profitability by analyzing parameters such as the

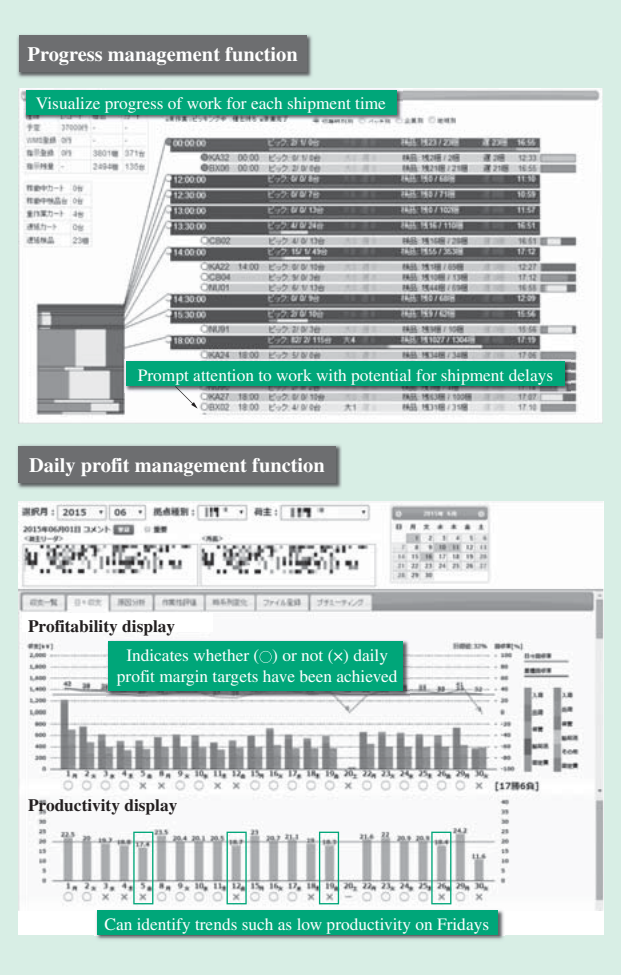

Fig. 5—Cockpit Dashboard System Functions.
The progress management function prevents delays in shipment (of goods) by showing their progress. The daily profit management function presents information on daily profitability and productivity to help manage decision-making and assess the benefits of improvement measures.

difference between planned and actual values for work quantities and man-hours, actual data on the lending and borrowing of workers between departments, whether this is appropriate, amount of overtime, and the productivity of individual processes.

The sharing of this information provided by the cockpit dashboard with the customer has potential for collaborative creation of more sophisticated logistics strategies.

CONCLUSIONS

This article has described a framework for the collaborative creation with customers of warehouse logistics improvements that is made up of three steps: the review of current warehouse performance and identification of problems, analysis and the formulation of improvement measures through consensus with the customer, and assessment of the benefits.

Warehouse operations are expected to become increasingly complex and sophisticated in the future. By using the framework described here, it is possible to maintain appropriate warehouse operations through the analysis from numerous different angles of changes in the external environment, including the workforce.

REFERENCE

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