

USING PIVOTTABLES IN MANUFACTURING TO EVALUATE INVENTORY COUNT ACCURACY: AN INFORMATION SYSTEMS BUSINESS CASE ANALYSIS STUDY

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CASE DESCRIPTION

PivotTables can be used in manufacturing to summarize large quantities of data without extensive formula development. The primary purpose of this case study is to provide students with an opportunity to use spreadsheet-based PivotTables to analyze the count accuracy of a single factory's monthly physical inventory. To conduct this investigation, students apply concepts from their undergraduate accounting courses and learn how to improve their use of spreadsheet software. The case has a difficulty level appropriate for junior- or senior-level undergraduates taking an AIS (Accounting Information Systems) or Auditing course. The case should require approximately half an hour of class time to generate the PivotTables and an hour of student time outside of class to analyze the results.

CASE SYNOPSIS

The purpose of this assignment is to determine whether the materials manager of M'Zadi, Inc., a Japanese-owned American parts manufacturer, can rely on the accuracy of the count following a monthly physical inventory. After reading a brief description of the company, students receive a spreadsheet file containing pre- and post-inventory counts (thousands of records) for April at M'Zadi's Ohio factory. Acting as the materials manager, students create spreadsheet-based PivotTables to summarize the inventory data for analysis. Without having to build complex formulas, students can use the PivotTables to identify problem areas in the inventory count that require investigation. Their analyses should include inventory accuracy for (a) total inventory, (b) inventory types (e.g., raw materials, WIP, and finished goods), (c) inventory production areas (e.g., production line, receiving, and shipping), (d) individual inventory items, and (e) service inventory. Students also develop PivotTable-supported evaluations to validate acceptance or rejection of the inventory count.

INTRODUCTION

In the automotive industry, the product life cycle of a vehicle model line (e.g., Honda Civic and Nissan Sentra) usually has an overall average of 6.7 years (Center for Automotive Research, 2017). Nominal changes to the basic model during its lifespan are common, but major changes are rare. Automotive parts manufacturers (e.g., Dana, Goodyear Tires, and Tenneco) produce inventory on a daily basis to supply their automotive customers (e.g., Ford, Honda, and Nissan) with required parts (active inventory) for current models. Additionally, "the supply chain needs to ensure parts are available to service vehicles, repair mechanical failures and damages, and perform vehicle enhancement" (Botha, 2017, p. 1). Therefore, parts manufacturers must

keep quantities of raw materials on hand to produce parts for both active models and automotive service providers.

THE COMPANY

M'Zadi, Inc. is a fictional Japanese-owned American automotive parts manufacturer that operates three factories in Ohio, Tennessee, and Mississippi, respectively. The company makes door inserts, using a combination of plastic and fabric, for car manufacturers such as Honda and Nissan. M'Zadi makes some parts using plastic injection molding and then assembles those parts with other purchased parts to produce the finished product. Among the parts they order, some are unassembled so they can be assembled-to-order, and others come pre-assembled to be sold as finished goods. M'Zadi maintains both active and service (replacement parts) inventories. The company's total inventory includes thousands of parts.

MRP Operations at the Ohio Factory

M'Zadi factories in the United States use the Manufacturing Accounting Production and Inventory Control System (MAPICS), a commercial Enterprise Resource Planning (ERP) software platform, to control operations. ERP is an integrated software suite; "it treats the functions inside an organization as interconnected processes" (Avram, 2010, p. 198).

The engineering design team at the Ohio Factory creates the bills of materials (BOM) that determine the parts and quantities needed to produce both active and service parts. Based on the BOMs, the engineering design team creates unique part numbers for all inventory items (e.g., internal and purchased) and enters them into the MAPICS database. All parts used in production must be entered into the MAPICS database to facilitate materials requirements planning (MRP), an inventory control system that enables businesses to schedule, order, and manage materials needed to manufacture products (Dziak, 2019).

The planning cycle for finished goods at the Ohio factory is normally three days long. The factory receives customer orders on the first day and schedules them for production on the second day. On the third day, the completed production orders (finished goods) are shipped from the plant and received by the customer. Most of the parts produced are repetitive (i.e., not unique), so some production runs might produce quantities that are greater than the actual quantities ordered. This approach improves efficiency by reducing the number of production setups. However, M'Zadi does not want to keep on hand any active inventory for more than seven days.

Materials buyers, production planners, materials handlers (i.e., forklift drivers), and shipping and receiving personnel report to the materials manager of the Ohio factory. The planners review current orders from customers (e.g., Nissan and Honda) to determine which finished goods to make in order to fill those orders. Then, the planners enter production orders into the system so that the buyers will know which parts to purchase and the production floor (line) operators will know which goods to make. Based on the production orders and the BOMs for finished goods, MAPICS generates a report detailing items that need to be purchased for production.

The buyers review the MAPICS report for possible errors. For example, the report might show that an item needs to be ordered based on the recorded quantity on hand. However, the buyer might be aware that the item has, in fact, recently been received but perhaps not entered as

received in the system. If inventory on hand reported by the system is inaccurate, the buyers could order incorrect quantities resulting in over or under stocked inventory.

Assuming the MAPICS report looks reasonable, the buyers create purchase orders in the MAPICS system. Purchase orders should show both the internal part number based on the BOM and the corresponding supplier part number for each item ordered. The buyer is responsible for sending the newly created purchase orders to suppliers by direct connection, email, fax, or snail mail. When filling an order of parts, suppliers are supposed to attach barcode labels that include M'Zadi's internal part number. However, some suppliers are small and lack the equipment to include barcode labels on the items they ship.

In Ohio, M'Zadi produces active inventory in the main factory and produces service inventory in an adjacent warehouse. All factory location areas, including those in the adjacent warehouse, are barcoded. All materials are supposed to include a barcode label that indicates the internal part number according to MAPICS and the quantity on hand by package (e.g., box of washers and barrel of oil). The transfer of materials and/or finished goods from one location to another is a two-step transaction process. If the receivers, handlers, operators, or shippers forget to scan the inventory at the "to" or "from" locations, the system report will not be accurate. Materials management personnel can also manually enter part and/or location codes into the MAPICS system.

When purchase order items arrive from the supplier to the receiving area of the Ohio factory, the receiving personnel scan the barcode labels on the ordered items. MAPICS then updates the inventory to show the newly arrived raw materials. If a received item is missing an identifying barcode label, the receiver is supposed to create a barcode label that includes the "correct" internal part number and quantity (e.g., 100 washers per box).

Materials handlers (i.e., forklift drivers) move the items onto the raw materials storage racks either inside the factory or inside the adjacent warehouse. When moving parts to the adjacent warehouse, the materials handlers are supposed to scan them ("from" and "to") to update their location. If the forklift driver forgets to scan the moved parts, the recorded location for those parts will not be accurate.

Twenty production lines inside the Ohio factory make active inventory via molding and/or assembly. Two additional production lines make service inventory in the warehouse adjacent to the factory. When the line operators need materials to make a part, they create a handwritten materials requisition list of items with quantities needed to fill an order and give it to the material handlers. The material handlers take the list, which should be legible and accurate, to the raw materials storage area to retrieve the requested items. They are supposed to scan the parts they retrieve from the storage area to indicate the target WIP locations on the production floor. If the part is repetitive (e.g., screws), the handlers will take a full box to the line instead of counting out a specific number. Once they fulfill the materials requisition, they place the list in a folder with the other materials requisitions made that day. Material requisition lists remain on file for one year in case supplementary inventory investigations become necessary.

Once the raw materials reach the production area, the production operators convert them to finished goods. Resin silos are located outside the factory. Resin is pumped from a silo into centralized locations in the WIP and service goods production areas via vacuum tubes. The resin then moves to different production lines via additional vacuum tubes. The setup is spider-like, with individual lines delivering resin as needed during injection molding production. Resin scrap results when the vacuum tubes become damaged or detached during production or resin spills out of a machine when the hopper is loaded. Other raw materials also become scrap during the

production process. For example, parts might be damaged when loaded or unloaded during production, or small parts (e.g., screws) might spill onto the shop floor.

When scrap is produced, the production operator is supposed to report it by scanning the internal part number of the damaged inventory out of WIP and into scrap using the designated code in the system. Scrap codes are not part of the inventory count process; they do not have an internal part number or a physical location code. They are controlled and monitored by the QA function and reconciled after the post inventory count is accepted. If the production operator does not properly scan scrap, the post inventory count will be too low because the transactions to cover scrap loss will be missing.

When a finished good is completed, the production operator places it into its designated bin. For example, the car sideliner bin has a barcode label containing the internal part number. If the customer order calls for ten sideliners, the operator places all ten completed items in the bin. Then the operator scans the bin label and records the quantity produced. MAPICS removes from inventory the parts necessary to create the sideliners, increases finished goods for sideliners by ten, updates the production order to show order fulfillment. The operator will affix new finished goods barcode labels to the sideliners showing a WIP location code and the internal part number for finished sideliners.

When the materials handler moves the finished items from WIP to the Finished Goods and Shipping area, the move is supposed to include a “from” and “to” scan. The final transaction is to ship the finished goods to the customer. Shipping personnel scan items to be shipped to fill the customer order. This final scan takes the items out of the finished goods inventory and the Finished Goods and Shipping location and triggers the system to create an invoice for the customer.

Raw materials and finished goods are constantly changing locations in the factory during a normal day of operations. Prior to physical inventory, however, the amount of movement of raw materials and finished goods to different locations increases. Materials handlers transfer all unused or excess raw materials inventory back to storage so that the production operators in WIP do not have to count unused materials. The handlers also empty the finished goods bins in factory WIP and move the finished goods from WIP to Finished Goods and Shipping. Handlers must also transfer service goods completed in the adjacent warehouse to the factory Finished Goods and Shipping area.

Any time the inventory moves, someone is supposed to scan it “from” a location and “to” a location unless the move is shipment to the customer. According to Leech (2003), the Sarbanes Oxley Act (2002) has been interpreted to mean that a customer cannot be invoiced until after the product has physically left the premises. Shipments made during physical inventory cannot be scanned out because the system is frozen. Therefore, items shipped during this period must be scanned after the system is unfrozen using paperwork instead of the barcoded parts labels.

Increased activity during physical inventory might result in incomplete scan transactions. Also, the paperwork for items shipped when the system is frozen might be inaccurate. If the scans are incomplete or inaccurate, MAPICS will not show accurate physical counts and locations.

Inventory Control

Typically, manufacturing companies perform a full physical inventory annually to report assets in use to internal (e.g., management) and external (e.g., banks and stockholders)

stakeholders (Johnston, n.d.). M'Zadi's policy is to conduct physical inventory at its U.S. factories once a month. While labor intensive, this practice allows management to identify inaccurate inventory counts early to prevent excessive inventory dollar discrepancies.

A physical inventory is necessary to reconcile pre-count inventory amounts recorded in MAPICS with post-count actual amounts. The standard goal for inventory control in the manufacturing industry is at least 97% post-count inventory dollar accuracy (Rose, n.d.). In addition, the materials manager and the controller at the Ohio factory decided that when an inventory item (i.e., part number) has a pre/post difference greater than +/- \$10,000 by item or item location, they should investigate to determine the cause. Depending on the findings of the investigation, a recount of a location or an individual part might be necessary.

MAPICS pre-count records are "frozen" at the start of a physical inventory. After the count is finished for all raw, WIP, and finished goods inventory items, the actual physical inventory amount (i.e., post-count) is entered into MAPICS. The pre-count records remain frozen in the system.

The purpose of the physical inventory is to determine whether the inventory count reported in the system is acceptable (Steinhoff, 2001). Investigations confirm or update post-count entries prior to rejecting or accepting the final post-count results. If the count is unacceptable, the post-count is removed and a new count of all items in the factory begins. If the count is acceptable, the post-count inventory data will overwrite the inventory recorded in MAPICS as the starting point for the next month. The factory remains shut down until the controller and materials manager accept the inventory count.

Investigating Physical Inventory Count Accuracy at the Ohio Factory

To facilitate comparison of pre- and post-inventory counts for accuracy in quantity and cost, the materials manager downloads the pre- and post-inventory counts from MAPICS into a spreadsheet file (MZadi_PrePost_Inventory_Data.xlsx) with a single worksheet (PrePost). The column labels in the worksheet are described in Table 1.

Table 1 M'ZADI, INC. Description of Column Labels in Pre/Post Spreadsheet	
LQNTY	Item quantity (counted in location)
CURUC	Item current unit cost
EXTCOST	Item extended cost = LQNTY * CURUC
ITNBR	Item part number
ITDSC	Item description
VNDNR	Vendor identification number
LLOCN	Location in the factory
ITYP	Item type (1 = active raw materials, 2 = WIP, 3 = finished goods, 9 = other raw materials)
UCC	Service inventory (SV) and obsolete inventory (OB) items identified
TYPE	Pre- or Post-inventory identified

The Ohio factory's MAPICS physical inventory location codes located in the LLOCN column of the PrePost worksheet are described in Table 2.

Table 2	
M'ZADI, INC.	
Physical Locations of Inventory at the Ohio Factory	
MAPICS Inventory Location (LLOCN) Codes	Actual Physical Location of Inventory
fg	Active finished goods, located in the Finished Goods and Shipping section of the factory
glue	Raw materials of glue in large containers, located in the WIP area of the factory
qa	Quality assurance hold area for inventory items segregated to the side of the factory WIP area
rm	Raw materials, located in the receiving area of the factory
rmbkv	Raw materials used in service production, located in the warehouse adjacent to the factory or raw materials in service production shipped as finished goods
silo	Resin silos, located outside the plant (high dollar values)
svc fg	Finished service goods, located in the Finished Goods and Shipping area of the factory (usually made once a month)
W + number (not 49)	Parts purchased from outside suppliers, located in various production line areas of factory WIP
W49 + number	M'Zadi-made parts used in production, located in various production line areas of factory WIP
Wbkv	Service parts purchased from outside suppliers for assembly on production line 1, located in the warehouse adjacent to the factory
Wbkv2	Service parts purchased from outside suppliers for assembly on production line 2, located in the warehouse adjacent to the factory
WINJ	Resin brought into the factory from silos in each production line area in WIP to make parts, located in the factory (approximately 20 production lines for active inventory)
WPT00	Specialized parts purchased from outside suppliers and required for active parts assembly, located in various production line areas of factory WIP

With thousands of records to evaluate, the materials manager uses PivotTables to extract summary information from the PrePost worksheet to determine inventory accuracy for total inventory, different inventory types (e.g., raw materials, WIP, and finished goods), different inventory production areas (e.g., production line, receiving, and shipping), individual inventory items, and service inventory.

After selecting the PrePost sheet tab in the MAPICS spreadsheet file, the manager creates the first PivotTable to determine inventory accuracy for total inventory and inventory types, expressed in dollars:

1. Click any cell in the dataset (e.g., A2), excluding label header cells in row 1.
2. Go to Insert -> Tables (Group) -> PivotTable (see Figure 1).
3. When the Create PivotTable dialog box opens, a marquis will surround all cells in the sheet, including the labels.
4. Click OK to accept the default options (see Figure 2).

Figure 1

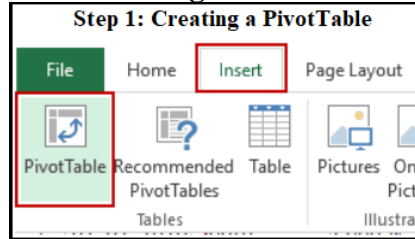
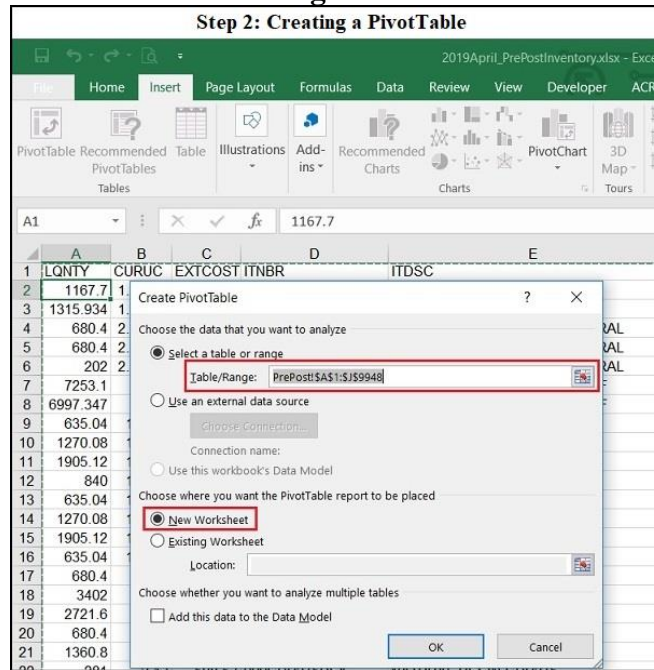
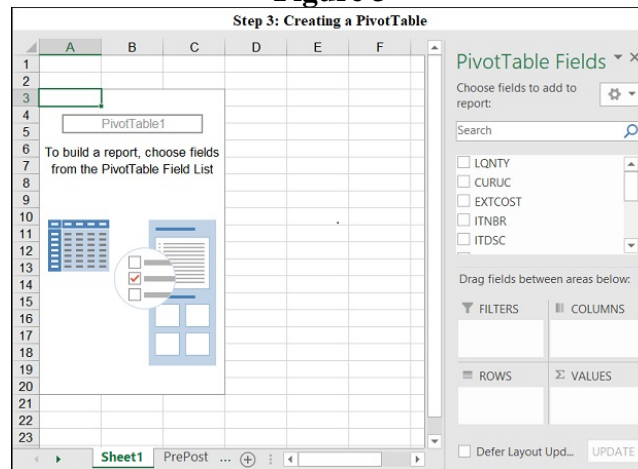


Figure 2



A new worksheet containing an unpopulated PivotTable appears (see Figure 3). The PivotTable name and a single line of instructions are on the left, and PivotTable Fields options based on the backend data used to create the PivotTable are on the right. The Areas section is under the PivotTable Fields section.

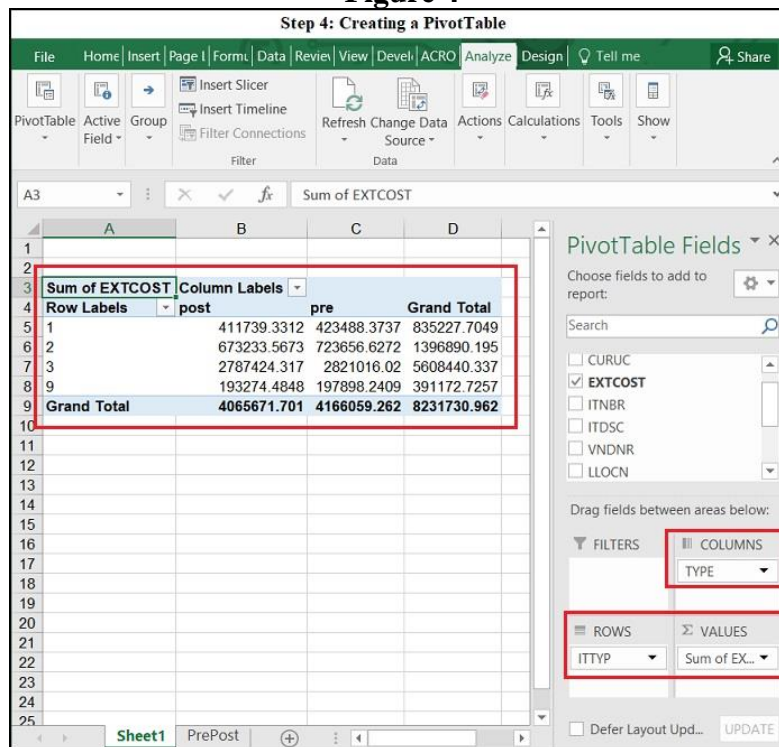
Figure 3



Using drag and drop, the materials manager follows the steps below to move fields into the different boxes in the Areas section to update the PivotTable so that it displays inventory cost in total and by type for pre- and post-inventory:

1. Using the scroll bar on the right in the PivotTable Fields section, scroll down to the ITTYP field.
2. Click on the ITTYP field and drag it into the ROWS box in the Areas section under the Fields list.
3. Click on the TYPE field and drag it into the COLUMNS box in the Areas section.
4. Click on the EXTCOST field and drag it into the VALUES box in the Areas section.
5. The updated PivotTable should look like Figure 4.

Figure 4



The Grand Total Column in the updated PivotTable adds the two inventories (pre and post) in dollars. However, the materials manager needs to know the difference between the two inventories to evaluate accuracy. Data manipulation inside a PivotTable is now possible in more recent versions of spreadsheet software. Exporting PivotTable results in order to perform calculations and sorts is no longer necessary.

To create a “Difference” column in the existing PivotTable without deleting the Grand Total column, the materials manager performs the following steps:

1. Click on the “post” label cell (B4) in PivotTable 1 to select it.
2. Click on the Analyze tab on the ribbon.
3. In the Calculations group, click on the down arrow next to Fields, Items, & Sets
4. Click Calculated Item from the dropdown menu (see Figure 5).
5. In the Insert Calculated Item in “TYPE” dialog box, type **Difference** in the Name: text box.
6. In the Formula: text box, backspace over the zero so that only the equal sign appears in the text box.
7. Type **post - pre** next to the equals sign (“= post - pre”) (see Figure 6).
8. Click OK to return to the PivotTable, which should display the new Difference column (see Figure 7).

Figure 5

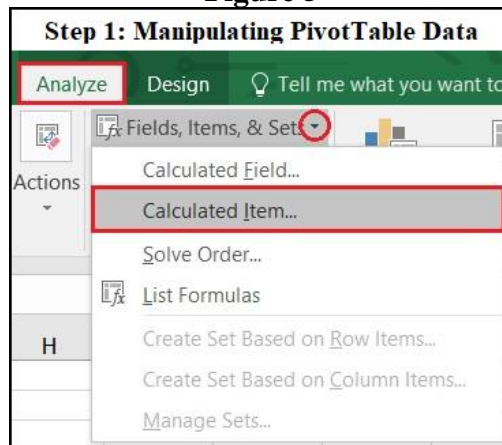


Figure 6

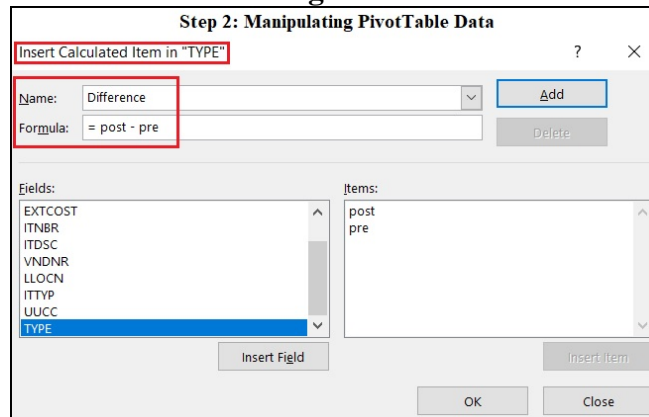


Figure 7

Step 3: Manipulating PivotTable Data					
	A	B	C	D	E
1					
2					
3	Sum of EXTCOST	Column Labels			
4	Row Labels	post	pre	Difference	Grand Total
5	1	411739.3312	423488.3737	-11749.04245	823478.6624
6	2	673233.5673	723656.6272	-50423.05988	1346467.135
7	3	2787424.317	2821016.02	-33591.70232	5574848.635
8	9	193274.4848	197898.2409	-4623.7561	386548.9696
9	Grand Total	4065671.701	4166059.262	-100387.5608	8131343.402
10					
11					

9. To calculate the percentage difference in dollars between pre- and post-inventory, select cell A11 and type **Percentage**.
10. In cell B11, type “=B9/C9” and press Enter. (Note: This is a basic spreadsheet calculation, external to the PivotTable.)
11. The first PivotTable sheet (PivotTable 1) should now contain the new values (see Figure 8).

Figure 8

Calculate the Percent Difference in Dollars between Post and Pre Inventory						
	A	B	C	D	E	F
1						
2						
3	Sum of EXTCOST	Column Labels				
4	Row Labels	post	pre	Difference	Grand Total	
5	1	411739.3312	423488.3737	-11749.04245	823478.6624	
6	2	673233.5673	723656.6272	-50423.05988	1346467.135	
7	3	2787424.317	2821016.02	-33591.70232	5574848.635	
8	9	193274.4848	197898.2409	-4623.7561	386548.9696	
9	Grand Total	4065671.701	4166059.262	-100387.5608	8131343.402	
10						
11	Percentage	0.975903473				
12						
13						

PivotTable 1 now shows the difference between pre- and post-inventory, expressed in dollars and percentage for total inventory and in dollars for inventory type (e.g., raw materials, WIP, and finished goods). While the actual inventory count meets the best practices minimum requirement for accuracy (i.e., 97%), the discrepancy is wide enough to warrant deeper investigation. To proceed, the materials manager needs to create additional PivotTables to summarize inventory accuracy for different production areas, individual inventory items, and service inventory items.

To determine which production areas gained or lost inventory, the manager creates a second PivotTable in a new worksheet following the directions listed above (see Figures 1-3):

1. Drag LLOCN into Rows
 2. Drag TYPE into Columns
 3. Drag EXTCOST into VALUES
- Note: Newer spreadsheet software versions should automatically create the Difference column based on the first PivotTable. If not, repeat the steps for creating the Difference column (see Figures 5-7).

4. Right click on the first data cell in the PivotTable Difference column (i.e., B5, assuming the Difference column appears in the B column) and select Sort -> Sort Smallest to Largest
Note: Calculating a percentage discrepancy for PivotTables 2-4 is not necessary.

To determine which item (i.e., part number) shows the greatest gain or loss, the manager creates a third PivotTable in a new worksheet:

1. Drag ITNBR into Rows
2. Drag TYPE into Columns
3. Drag EXTCOST into VALUES
4. Create the Difference column (if necessary)
5. Sort the Difference column from smallest to largest

To determine whether the service inventory has significant gains or losses, the manager creates a fourth PivotTable in a new worksheet:

1. Drag UUOC into Rows
2. Drag TYPE into Columns
3. EXTCOST into VALUES

In summary, the purpose of a physical inventory is to determine whether the inventory count is acceptable. The process to support this decision begins with the following steps:

Prepare four PivotTables:

1. PivotTable 1: Create a PivotTable that shows the difference between total pre- and post-inventory, expressed in dollars and percentage, and the difference between pre- and post-inventory by type (e.g., raw materials, WIP, and finished goods), expressed in dollars.
2. Pivot Table 2: Create a PivotTable that shows which production areas gained or lost inventory (e.g., production line [W + number], receiving area [rm], shipping [fg], and quality control [qa]), expressed in dollars with the Difference column sorted smallest to largest.
3. PivotTable 3: Create a PivotTable that shows which items (i.e., part numbers) have the greatest gains or losses, expressed in dollars with the Difference column sorted smallest to largest.
4. PivotTable 4: Create a PivotTable that shows the gain or loss of service inventory, expressed in dollars.

Investigate discrepancies found between pre- and post-inventory counts:

1. Based on the description of factory operations, discuss possible reasons for the discrepancies shown in the PivotTables.
2. Deliver a supported “preliminary decision” to accept or reject the physical count.

CONCLUSION

Based on the results of the PivotTables, identified problem areas need to be physically investigated to determine reasons for the differences between pre- and post-inventory counts. Backup visual inspections are necessary to make sure no errors occurred during the physical count. Barring count errors, factory personnel responsible for identified problem areas need to be interviewed to pinpoint reasons for count discrepancies, especially those in the high dollar range. Ultimately, based on supporting documentation, physical inspections, and operations personnel interviews, the materials manager recommends whether to accept or reject the physical inventory count at the Ohio factory.

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