# Automating Inventory Management in Distribution Centers of a Leading Fast Moving Consumer Goods (FMCG) Industry Player in the Beverage Market: A Supply Chain 4.0 Journey

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## Abstract

Inventory accuracy and check in check out (CICO) are vital key performance indicator in total supply chain warehouse operation in the beverage industry. As a result of manual counting of products and using of manual paper-based process, ineffective check-in logistic operation, the inbound delivery trucks may experience a delay in waiting between arrival and check-in, which resulted to irrelevant cost to the company in terms of delay and inaccuracy of inventory. Furthermore, extended time delays in trucks will cause inefficiency in the operation of the company in servicing the customers. The main goal of this research paper is to decrease the long processing time and the inaccuracy of inventory by intensifying the receiving process of the inbound trucks, and the subsequent goal is to minimize the inaccuracy in inventory. Adaptation of automation in supply chain 4.0 barcoding and eliminating of waste in lean implementation are recommended and compared to the existing operations. The results suggest the adoption of automating the manual processes (counting and paper base) in receiving (inbound) to loading (outbound) and cycle count will improve the accuracy in inventory and processing time (CICO), and it sustain the company's competitive advantage and defending its leadership position in the market.

## Keywords
Inventory Accuracy, Check in Check Out, Barcoding, Supply Chain 4.0

## 1. Introduction

Industry 4.0 was marked by scientific/technological developments, notably industrial automation, the Internet of Things, and smart factory (Hwang et al., 2017). This is to develop smarter and more sustainable industrial systems to produce goods. This concept affects not only the production systems but also supply chains, particularly warehouse management, where accurate and real-time information is essential in optimizing the value chain activities of satisfying the end-consumer.

Industry 4.0 has been adopted by many sectors including the fast-moving consumer goods (FMCG) industry. As such, the beverage market players have seen a lot of developments in the areas of enterprise resource planning, logistics, warehousing & distribution, and sales & operations planning. The FMCGBPI, a leading beverage giant, has set its sights on adopting Industry 4.0 in retaining its global leadership and stay on top of the beverage competition in the long term, with Supply Chain 4.0 as one of its pillars.

In the Philippines, Food Manufacturing Consumer Goods Beverages Philippines Inc. (FMCGBPI) is also the acknowledged leader in the beverage market, with a total of 78 Distribution Centers across the archipelago. Said facilities serve as the logistics hubs for its distributors, wholesalers and retailers, and business partners who are instrumental in the nationwide delivery of FMCGBPI products nationwide. Currently, all transactions in these distribution centers are manually handled with the aid of stand-alone systems and computerization but not in an integrated manner, resulting in long lead times for data retrieval, report preparation, and order fulfillment. Hence, the risk of manual errors and inaccurate information would present operating concerns affecting timely deliveries, order fulfillment, and stock replenishment, which are critical success factors in the FMCG industry. With logistics as a driver of defending its leadership position, FMCGBPI needs to ensure meeting the key performance indicators of inventory accuracy and check in-check out (CICO) cycle time, among others.

In the present operations of Food Manufacturing Consumer Goods Beverages Philippines Inc. (FMCGBPI), specifically in warehouse management, the company encounter a huge problem in the errors in encoding from manual paper-based counting then if they transfer to excel file this will lead to inaccurate data encoding due to human errors due to manual transactions. The results of this in warehouse operations will rework, time-consuming, and inaccurate reports at the end of the week or in monthly reports submitted. In the CICO this is affected also by the time and motion due to manual interventions which upon check-in and check-out (inbound and outbound) of the trucks coming from manufacturing plants and to our warehouses. From the checker up to the encoder, the time consumes a lot which an opportunity for the Company to improve to process more transactions which to avoid delays and out of stock in some warehouses.

The performance of the FMCGBPI was affected by the 2 major KPIs in the Supply Chain aspects which the Inventory Accuracy & Check in Check Out. These KPI's has a vital role and if this will continue the poor performance the net income of the Company also affected which need to address and to also fulfill the goal of the company in terms of servicing to the customers and ensuring the performance will achieve versus the set target to sustain the competitive advantage in the beverage industry.

For the year 2020, FMCGBPI performed poorly on the two (2) KPIs – inventory accuracy of only 98.01% versus the desired level of 99.25% or a variance of 1.24% and a CICO cycle time of 57 minutes versus the target of only 30 minutes or a 50% gap, resulting in a lost opportunity of **Php 12,725,000** in terms of unattained replenishment rates and production schedule adherence.

For reference, the following are the tabulated summaries of the FMCGBPI performance in these areas are represented in Table 1.

Table 1: Actual Performance vs Target

Summary Report for 2020

| | TARGET | | | | ACTUAL | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MIN | SAT | EXC | 2020 YTD | P1 | P2 | P3 | P4 | P5 | P6 | P7 | P8 | P9 | P10 | P11 | P12 |
| Inventory Accuracy | 98.3% | 98.8% | 99.3% | 98.0% | 98.6% | 98.8% | 96.7% | 97.3% | 97.3% | 98.3% | 97.8% | 98.9% | 97.9% | 98.5% | 97.9% | 98.3% |
| Full goods | 98.5% | 99.0% | 99.5% | 98.2% | 98.4% | 98.8% | 98.0% | 98.2% | 98.1% | 97.6% | 97.6% | 98.8% | 98.5% | 98.7% | 97.5% | 98.5% |
| Empties | 98.0% | 98.5% | 99.0% | 97.8% | 98.8% | 98.8% | 95.4% | 96.3% | 96.5% | 98.9% | 97.9% | 98.9% | 97.2% | 98.4% | 98.2% | 98.0% |
| | | | | | | | | | | | | | | | | |
| Check in Check Out (in min) | 1:00 | 0:45 | 0:30 | 0:57 | 1:00 | 1:01 | 0:58 | 0:55 | 0:56 | 1:02 | 0:58 | 0:56 | 0:58 | 0:58 | 0:53 | 0:52 |

Table 2: Summary of Variances

Summary Report for 2020

| | TARGET | | | | |
|---|---|---|---|---|---|
| | MIN | SAT | EXC | 2020 YTD | Variance |
| Inventory Accuracy | 98.3% | 98.8% | 99.3% | 98.0% | -1.2% |
| Full goods | 98.5% | 99.0% | 99.5% | 98.2% | -1.3% |
| Empties | 98.0% | 98.5% | 99.0% | 97.8% | -1.2% |
| | | | | | |
| Check in Check Out (in min) | 1:00 | 0:45 | 0:30 | 0:57 | 0:27 |

**The study, therefore, aims to achieve the following objectives:**

1. To assess the inbound and outbound process activities affecting the two (2) major KPIs of interest, inventory accuracy, and CICO cycle time.
2. To determine the root causes contributing to the non-attainment of desired performance levels on inventory accuracy and CICO cycle time; and
3. To recommend long-term and sustainable solutions in improving inventory accuracy to at least 99.25 and CICO cycle times to do minutes.

## 2. Review of Related Literature

### 2.1 Industry 4.0

Currently most of the businesses are now heading to 4th Industrial Revolution, which accepts the technology and computerization system Industry 4.0 is designed by the Internet of Things (IIoT) and use computer-based methods to observe and manage physical things like logistics operations and manufacturing industry.

Industry 4.0 is a radical shift in how the company operates from manual process to automated process. This is the beginning of digitalization these changes consider improvement in the processes, operations, and systems. Tjahjono, B. et al. (2017) stated that the introduction of Industry 4.0 into manufacturing has many effects on the total supply chain. Engagement between manufacturers, customers and suppliers is critical to increment the clarity of all the actions from when the products is produced until in delivered to the consumers.

Al-Talib, M. et al. (2020) stated that companies are increasing the competition in which this will resulted to globalization and evolution in information technology. Manufacturing companies at present are seeking to expand their share of market geographically to gain new clients. upgrading in technology, it is mandatory to most of the companies or organizations to become more competitive edge in the marketplace through automation technology. Internet of Things (IoT) give opportunities to lessen risks, manage complexity and provide tangible business benefits to be more transparent in terms of data in the whole supply chain.

Manavalan, E. et al (2019) stated that Supply Chain in current situation in global scenario are more being complex and dynamic specially in marketplace. Sustainable supply chain operation become unavoidable to experience the demand of customers. Based on the study, it is revealed that companies need to adapt new technology like Internet of Things (IoT) to become more competitive and advantage in the industry.

### 2.2 Warehouse Management System

A distribution center is a facility for storing products for business purposes. distribution centers play a vital role in the supply chain, including manufacturers, wholesalers, retailers, and logistics operations. Distribution Centers are important elements of the beverage industry because this is the facility where they will transfer the finished goods for

selling from the manufacturing plant. Manual warehouses or distribution centers have opportunities such as inefficient space management, damaged material, inefficient operations, human errors like encoding, and reporting of inventory. Jabbar et al. (2018) stated that the smart or automated warehouses is outlined to operate in highest efficiency and use of advance technology in operations. Therefore, this automated warehouse will easily adapt and flexible in dynamic marketplace.

To reinforce the automated warehouse operations, warehouse management systems specifically for the inventory management barcoding system is one of the technologies that can develop in the company. It is also pertained to design automated warehouse monitoring and control systems such as the inventory accuracy and inbound and outbound of the products from the manufacturing plant. With the assistance of these technologies, warehouse automation provides cost-effective operations, efficient retrieval and warehousing, and minimal setback and errors. He et al., (2020).

Abdel-Basset, M.et al. (2018) stated that the conventional supply chains face various challenges such as variability, cost, complications. To control these problems the supply chains must be sharp witted. For creating a large-scale automated infrastructure to combine data, information, products, and all processes of the supply chain, we apply the internet of things (IoT) in supply chain management (SCM) through building an automated and secure system of SCM.

### 2.3 Internet of Things

According to Gnimpieba, Z. D. R. et al (2015), the Internet on Things (IoT) is a one part of Industry 4.0 which serves communication between the computer technology which connect the information and use of technology with the use of internet. This is very important in the technology because this will be the flow of information and events from the data which will use in the business operation thru tracking, coordination, reports, and management. Technology or automation has a nig impact in the present situation in modern world. Technology can make life easier, and all task will more efficient and being more productive specially in business industry (Amanda Istiqomah, N. et al.,2020).

### 2.4 Barcode

One of such technologies that are in current use is Barcode. A Barcode system can utilize in the warehouse operation like in distribution centers. The advantages of this technology if implemented in the operation will minimized human error and give accurate data in real time. It will be resulted also to better and efficient warehouse and logistic operation. This will simplify the process and avoid the complication in terms of reports and data that can be use in the business for planning and strategies to become more competitive and more sustainable company in the industry where it belongs.

Barcodes will use a scanner which this is the tool that will generate the information needed in the system which use for monitoring and assigning products an identification (ID). Van Geest, M. et al (2020).

### 2.5 Benefits for the Company

Yaoa and Carlson (1999) stated that to improved profitability it must be focus on inventory control and must be increase the inventory accuracy and real-time data in order to permits the distribution activities. Barut et al (2002) stated in supply chain directions should the effectiveness of logistics and the magnitude must be measured. Helo and Szekely (2005) stated that the supply chain management (SCM) to get the benefits it must reviewed the functionalities of software application and impact to the operations.

The use of automation (barcoding system) in warehouse management of the beverage industry is not yet adapted specifically for the transfer of finished products from manufacturing plant across all warehouses or distribution centers which has various benefits that may achieve and being more efficient in terms of operations. The researcher has observed that despite these benefits for the beverages industry the use of this automation there was no implementation yet in every distribution center.

This research will fill the gap in achieving the main key performance indicators in the warehouse which will big improve the impact on the business operation.

Nowadays, Witkowski, K. (2017) stated that most of the companies like logistics they are creating innovations in terms of technical and organizational and they are determined to improve by creating value for customer and suffice the customer demand or requirements which deals to lead time delivery services, service level satisfaction and reliability. With the help of the industry 4.0 like Internet of Things, Big Data will increase the development to address the opportunities in supply chain management.

## 3. Methodology

To be able to address the problem identified earlier, the study will adopt an Input-Process-Output approach in the activities of data gathering, data analysis, and interpretation of results, as summarized in the following Table 3 on a per objective basis:

Table 3: Summary of Data Gathering & Analysis Tools

| | Input | Process | Output |
|---|---|---|---|
| **Objective 1** | Process flow chart<br>Observations<br>Incident reports | Process Mapping<br>SIPOC Analysis<br>Value Stream Analysis | Bottlenecks / Delays<br>Areas of Improvement |
| **Objective 2** | Interview<br>Data on Performance<br>Areas of Improvement | Fishbone Analysis<br>5 Whys<br>Pareto Analysis<br>Tree Diagram | Root Cause<br>Identification, Validation<br>& Prioritization |
| **Objective 3** | Validated Root Causes<br>Areas of Improvement<br>Industry 4.0 Pre-requisites and<br>KSFs based on interviews | Systems Analysis & Design<br>How-How Diagram<br>Cost-Benefit Analysis<br>Pro-Model Simulation | New System Platform<br>Industry 4.0<br>Implementation Strategy<br>Validation of Benefits |

### Objective 1

Data will be gathered from the Distribution Centers specifically the weekly inventory reports and the weekly Check in Check Out (CICO) reports for the details of the tabulated summaries in Table 1 and Table 2 found in Chapter 1 to validate the basis of the problem identified.

Additionally, observations will be conducted on the operations processes from the manufacturing plant to the warehouse. Data collected is 2020 performance vs target on the Key Performance Indicator (KPI) for logistic and operation department were used in this study.

Reading the incidents reports, this steps or process will be the bases on all aspects that get the opportunity and what will be the action plan in every opportunity or gaps that identified. Also, read some of the guiding documents that the company does use to come up with the required standard inventory processes of Coca-Cola Company. Ciesielska, M., et al (2017) stated that observation is one of the vital research methods in social sciences and this is most complicated, and it will used in several complementary qualitative methods in the study.

In the process phase, various techniques have been used to identify the opportunities for improvement in the areas of enterprise resource planning, logistics, warehousing & distribution, and sales & operations planning that will benefit the FMCGBPI and its affiliates in providing a reference approach in solving problems with significant contribution to the attainment of KPIs and in exploring the applications of Industry 4.0 in an actual setting of its beverage operations.

Through analysis come up of the following output which to identify the bottlenecks/delay or areas of improvement under the inventory accuracy was the manual encoding in the paper which prone to human error while in Check-in Check-Out will be a delay in the checking in the inbound and outbound upon receiving the stocks in the warehouses or distribution centers.

### Objective 2

The interview was conducted with 5 key personnel relevant to the study which are the driver, checker, security guard, encoder, and warehouse supervisor which they provided the relevant data needed for the study. Then after reviewing the data and based on the interviews process analysis will apply based on the relevance which can help to get the output.

Pareto Analysis specifies that 80% of consequences come from 20% of the causes, asserting an unequal relationship between inputs and outputs. It is used to identify the causes in the processes.
The Fishbone Analysis is one of the tools that conduct to identify the root cause of the problem that needing a solution. This analysis adopts the shape of a fish's skeleton. In general, this is used for brainstorming to identify various causes of a problem which impacted the problem and will identify the right solution based on the result of causal analysis.

The output of this analysis was to identify the root causes and validated the whole processes of the operation that affects the total supply chain which contributes almost 80% of the problem. Then prioritization to which root causes will be resolved first to improve the total operations of the Company.

### Objective 3

Identifications and validated root causes in the problem already put in the priority and this will be the basis for the analysis on how to improve the total operations streamlining the process with consideration of Supply Chain 4.0 elements of automating inventory management and support systems in line with the corporate thrusts toward sustaining the company's competitive advantage and defending its leadership position in the market.

With the analysis that applied in this study the researcher's recommendation is to implement the new platform of Industry 4.0 to the Company specific on the Logistic and Warehouse management. The benefits of this new system have a huge impact in terms of improvement in inventory accuracy and time processing which give the company a sustainable and competitive advantage and defending its leadership position in the market through automation improve your warehousing, transportation, and products handling. And with industry 4.0, automated warehousing and logistics, accuracy in inventory and the time on the check-in check out of delivery trucks can be improved. Benefits will include cost reduction and competitive advantage being a market leader in the beverage industry.

## 4. Results and Discussion

Process Flow in Warehouse Inventory Management (Distribution Centers)

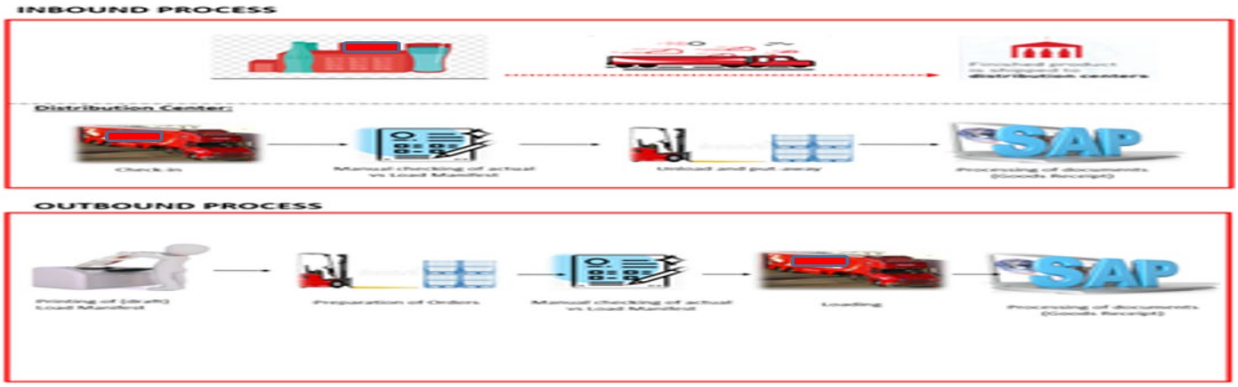



Figure 1. Process Flow Inbound and Outbound

The process flow in figure 1 identified that the manual checking process using the paper base count sheet will greatly affect the total processes which the factor of failing to achieve the desired target or KPI of the Company.

### Interview and Observation

Following were observed as findings during interviews with the concerned personnel in warehouse inventory and logistics management about the end-to-end process activities and cycle times from inbound to outbound:

### Inventory Accuracy: (Full Goods)

a.) Inbound process: upon arrival check-in of the trucks from the source manufacturing plant it will be check by the following: 1. Security Guard - he will use a manual count sheet and fill it up manually based on the incoming stocks to be unloaded in the warehouse. 2. Warehouse Checker – also using a manual count

sheet and fill up manually based on the load of the truck – Driver – turnover the invoice from the source plant to the Warehouse Supervisor for receiving the stocks to be unloaded.

b.) Unloading process: forklift operator will unload the stocks and placed them in the available bin or vacant bay for the good stocks.
c.) Encoding process: when the encoder received the manual count sheet it will compile and manually encoded the actual count by the checker and security guard to the system.
d.) Manual Process: in the total process flow the manual encoding from a security guard and checker has an opportunity for the following: wrong placing of the figure in the SKU which will be the basis of the encoder and the inventory will not be tally based on the invoice from the source plant.
e.) The schedule of inventory count is once a week and monthly basis (cutoff), so the variances or error was not addressed upon the day of the transaction. Therefore, the accuracy of inventory during cut-off (weekly or monthly) is very hard to find out what or where the variances came from.
f.) Prone for the error in the manual count sheet was the inputting of the figure in the right column or row due to fatigue especially on the night shift schedule of receiving the stocks in the warehouse.
g.) Outbound Process – preparation of the invoice for loading thru load manifest and will give to forklift operator for loading.
h.) Picking Process – the opportunity was the picking especially for those SKUs that not properly arrange per bay in the warehouse instances wrong picking of the SKUs because of manual picking thru the forklift operator.
i.) Loading Process – some instances wrong SKUs were loaded which will be the actual load and the manual manifest is not the same so the tendency the final invoice and load out will have a discrepancy.
j.) Inventory count cycle process – the daily count was done thru the system, but the actual count was done on a weekly and the recon and final count was done in a monthly cycle which if the discrepancy was revealed hard for the warehouse supervisor to backtrack due to manual paper reference.

**Inventory Accuracy: (Empties)**

a.) Inbound Receiving Process – upon arrival in the distribution center the empties are not segregated accordingly per SKU and need for sorting.
b.) Encoding Process – Manual process in the paper base from the security to encoder then it will encode to the system.
c.) Validation Process – no double-checking on the figure or SKUs listed figure in the manual sheet which prone to wrong figure inputted and will translate to the wrong figure will be encoded in the system.

**Check In-Check Out (CICO)**

- In this Key Performance Indicator (KPI) the bases are the length of time a truck stays in a warehouse facility to be processed and computed the processing time by waiting time + check in unloading time + unloading time + loading end departure time. the following are my findings during my observations:

**Inbound Process:**

a.) Check-in Process – upon arrival of the truck in the Distribution Center the driver will give the documents to a security guard for confirmation for receiving the delivery and submit the documents to an encoder.
b.) Checking Process – After check in the security guard and the checker will do the manual counting of truckload using the manual paper count sheet and inputted manually. In this process, this will consume time which will be the time that was counted in the whole process.
c.) Unloading Process – in this process the products will be forklifts and place in the bin of the assigned space for the SKU's. then the truck will wait for the loading in the loading area for check out.

**Outbound Process:**

a.) Loading Process – The driver will get the printed documents from the warehouse supervisor and give them to the forklift operator for picking the products to be loaded on his truck.
b.) Checking Process – The driver will check the loaded products on his truck based on the load manifested provided by the encoder for checking manually.
c.) Check-out Process – The security guard and the checker will do manual checking of products loaded in the truck thru a manual paper count sheet and will turn them over to the encoder for encoding with the day.

## Process Review

### Inventory Accuracy & CICO: (Delivery, Cycle Count and Processing Time)

As far as the first Key Performance Indicator (KPI) Inventory Accuracy, two main processes affect the low inventory accuracy that deals with it. The first is the delivery process from the source plant which delivered the products to the distribution center which upon receiving part of the process was upon receiving it will use a paper-based manual count which obviously, the receiving process is labor-intensive, time-consuming, and subject to human error. Secondly, the cycle count which during the conduct of the inventory count weekly and monthly they is also using the same practice which same output in delivery/receiving process that the figure inputted in the paper was potential to discrepancy because of human intervention. In this kind of process if the discrepancies are found the labor counts all or this will be additional expenses to the Company by repeating the process and affect the efficiency of the operation and productivity of the employee.

The second Key Performance Indicator (KPI) Check in Check Out (CICO) – the main contributor having a long processing time was the use of manual process as part of the process of the inbound and outbound deliveries; during this process, it consumes time in checking and inputting to the manual paper-based count sheet and this will prolong the process and will affect to the efficiency and productivity of the Company in terms of service level.

### Pareto Analysis on Inventory Accuracy

Pareto diagram is a tool to identify the 80% that most impacted of the productivity which 20% of the time. This a technique uses in decision making to address the problem and can direct the solution to identify the 80% of consequences or effects come from 20% of the causes.

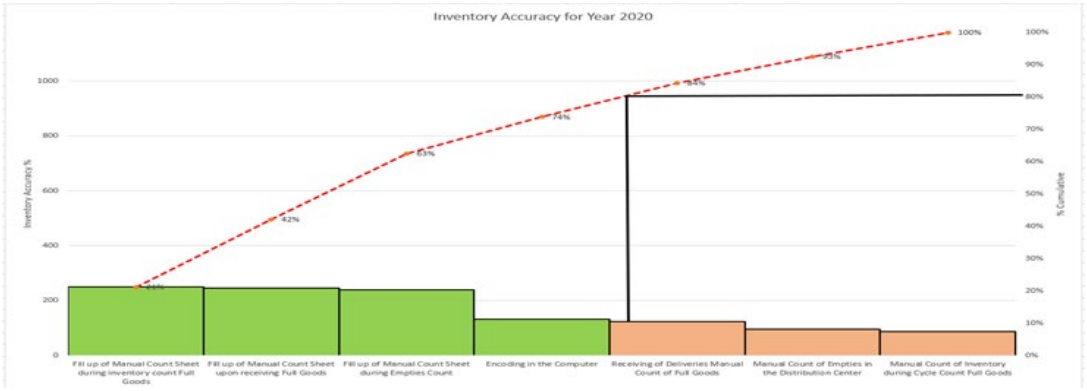



Figure 2. Pareto Diagram of Inventory Accuracy

Figure 2 shows in the inventory accuracy the 80% of the contribution is driven by a manual intervention which will prone to human error and the data inputted will affect the accuracy when the system released the report. This opportunity identified in inventory accuracy is the focus of the study that should be eliminated or improved in the specific KPI that affects the performance.

### Pareto Analysis on Processing Time (CICO)

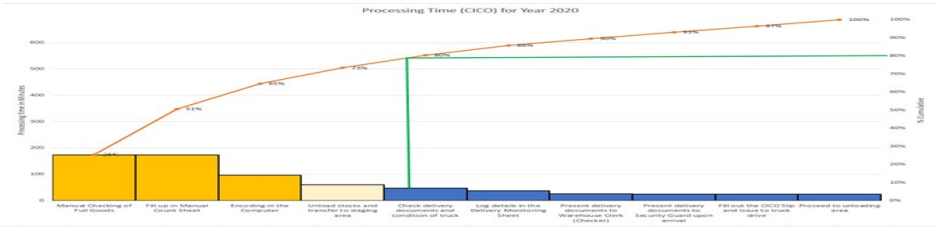



Figure 3. Pareto Diagram of CICO

In Figure 3, it showed in the CICO the main contributor of 80% was also the use of a manual process which affect the long processing time in receiving to loading because of the use of manual counting process and human interventions which is also needed to improve or eliminate some of the unnecessary time-related activities that contributing the long processing time which affect the total operations in the distribution center.

## Validation of Causes

The result of the Pareto Analysis verified and confirmed through observation and interview in the distribution center for 26 days and it was observed in the whole operation in a logistics and warehouse management it was affected the inventory accuracy and CICO was due to the following the use of manual count sheet paper-based process and manual encoding to the system process. Also, it was observed the redundancy of process in the whole operation. If this manual process will be addressed or transformed into automation and implementing of applicable lean improvements like eliminating waste and continuous improvement of the identified processes that can sustain the existing results based on the application towards the desired target of the Company in these 2 key performance indicators. Automation of the process is one solution that will improve the current identified problem in both KPI which the main root cause was the manual processes and human intervention (fig. 3 and fig. 4) with the use of barcoding in the identified bottleneck in the two key performance indicator here are the result that will improve.

Table 4. Inventory Accuracy 2020 vs 2021

| | Percentage Frequency of Accuracy 2020 | | | | | | | | | | | | | Percentage Frequency of Accuracy 2021 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inventory Accuracy | Period 1 | Period 2 | Period 3 | Period 4 | Period 5 | Period 6 | Period 7 | Period 8 | Period 9 | Period 10 | Period 11 | Period 12 | Ave. 2020 | Period 1 '21 | % Improvement | Period 2 '21 | % Improvement |
| Fill up of Manual Count Sheet during inventory count Full Goods | 24 | 22 | 19 | 21 | 22 | 19 | 22 | 20 | 22 | 20 | 19 | 20 | 20.83 | 21 | 0.17 | 21.11 | 0.11 |
| Fill up of Manual Count Sheet upon receiving Full Goods | 22 | 20 | 23 | 19 | 25 | 23 | 19 | 18 | 19 | 18 | 21 | 19 | 20.50 | 20.6 | 0.10 | 20.65 | 0.05 |
| Fill up of Manual Count Sheet during Empties Count | 23 | 24 | 20 | 19 | 19 | 23 | 18 | 20 | 19 | 18 | 19 | 18 | 20.00 | 20.16 | 0.16 | 20.19 | 0.03 |
| Encoding in the Computer | 10.59 | 9.77 | 11.73 | 10.27 | 11.32 | 12.27 | 10.77 | 11.85 | 9.86 | 9.53 | 12.87 | 12.28 | 11.09 | 11.15 | 0.06 | 11.16 | 0.01 |
| Receiving of Deliveries Manual Count of Full Goods | 5 | 9 | 7 | 11 | 8 | 9 | 10 | 13 | 12 | 16 | 10 | 13 | 10.25 | 10.4 | 0.15 | 10.45 | 0.05 |
| Manual Count of Empties in the Distribution Center | 8 | 7 | 9 | 11 | 8 | 5 | 8 | 7 | 8 | 10 | 8 | 7 | 8.00 | 8.12 | 0.12 | 8.15 | 0.03 |
| Manual Count of Inventory during Cycle Count Full Goods | 6 | 7 | 7 | 6 | 4 | 7 | 10 | 9 | 8 | 7 | 8 | 9 | 7.33 | 7.41 | 0.08 | 7.45 | 0.04 |
| Total Inventory Accuracy | 98.59 | 98.77 | 96.73 | 97.27 | 97.32 | 98.27 | 97.77 | 98.85 | 97.86 | 98.53 | 97.87 | 98.28 | 98.01 | 98.84 | 0.83 | 99.16 | 0.32 |

BEFORE AFTER

In Table 4 it there was an impact on automating thru barcoding especially on the process that prone to manual intervention that translates to human error that will affect the inventory accuracy. It shows after the application of automation the percentage accuracy of the transaction was an increase from the average of 98.01% to 99.16% still not achieve the excellent target of 99.25% (Table 2) but it was improved the key performance indicator of the Company.

## Improvement Results in Key Performance Indicator (KPI)

There are observed problems that affect the two KPI which most impacted the performance of the Company which related to both parameters which the following: a.) Manual Counting b.) Manual Paper Base c.) Duplication of Activities d.) Long Processing Time, addressed and improved after the results of analysis and applications of the solutions that related to this processes such as the use of automation (Barcoding/RFID) and eliminating the waste found in the VSM analysis and continuous improvement further in the application of lean management.

Table 5. The implication of Manual Process

| Manual Process Implication | | Inventory Accuracy | | | CICO (Processing Time) | | |
|---|---|---|---|---|---|---|---|
| # | Observed Problems | % Impact in Process | % Impact on Productivity | Total % Impact in KPI | % Impact in Process | % Impact on Productivity | Total % Impact in KPI |
| 1 | Manual Counting (receiving to loading and cycle count) | 30% | 26% | 28% | 25% | 25% | 25% |
| 2 | Manual Paper base (receiving to loading and cycle count) | 30% | 26% | 28% | 20% | 25% | 23% |
| 3 | Duplication of activity (checker, security) | 15% | 15% | 15% | 15% | 10% | 13% |
| 4 | Long Processing Time (Delivery trucks processing) | 10% | 26% | 18% | 30% | 35% | 33% |
| 5 | Encoding in computer (receiving, loading cycle count) | 10% | 5% | 8% | 7% | 3% | 4% |
| 6 | Checking of Documents (manifests and receipts) | 5% | 2% | 3% | 3% | 2% | 2% |

Table 5 shows that almost 85% of the observed problem was because of manual intervention which causing the inaccuracy of inventory and long processing of time which after analysis and find the root cause the solution was implemented on the affected process which the results were improved and increase the performance from 2020.

Table 6. Results Before & After Implementation of Automation & Eliminating of Waste

| Pre-Implementation of Automation | | | Check-in Processing Time in mins | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inventory Accuracy_ Actual Performance 2020 (ave. data) | | | Actual Performance Manual Process | Jan '20 | Feb '20 | Mar '20 | Apr '20 | May '20 | Jun '20 | Jul '20 | Aug '20 | Sep '20 | Oct '20 | Nov '20 | Dec '20 | Ave. 2020 |
| | Item | SKUs | # of Trucks Processed per week | 58 | 59 | 58 | 58 | 57 | 59 | 59 | 60 | 59 | 58 | 59 | 59 | 59 |
| | No. of Skus | 35 | Ave. Check-in Unloading in Minutes | 35 | 36 | 34 | 32 | 33 | 37 | 35 | 33 | 34 | 35 | 32 | 31 | 34 |
| | SKUs with variances | 21 | Ave. Check Out Loading in Minutes | 25 | 25 | 24 | 23 | 23 | 25 | 23 | 23 | 24 | 23 | 21 | 21 | 23 |
| | Distribution Center total Inventory | 34258 | Processing Time_ per Truck in Mins | 60 | 61 | 58 | 55 | 56 | 62 | 58 | 56 | 58 | 58 | 53 | 52 | 57 |
| | Sum of Absolute unit in Variances | 579 | CICO Performance in Mins/Hr | 1.00 | 1.01 | 0.58 | 0.55 | 0.56 | 1.02 | 0.58 | 0.56 | 0.58 | 0.58 | 0.53 | 0.52 | 0.57 |
| | *Inventory Accuracy by absolute variance* | 98.3% | # of Hours per day | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |

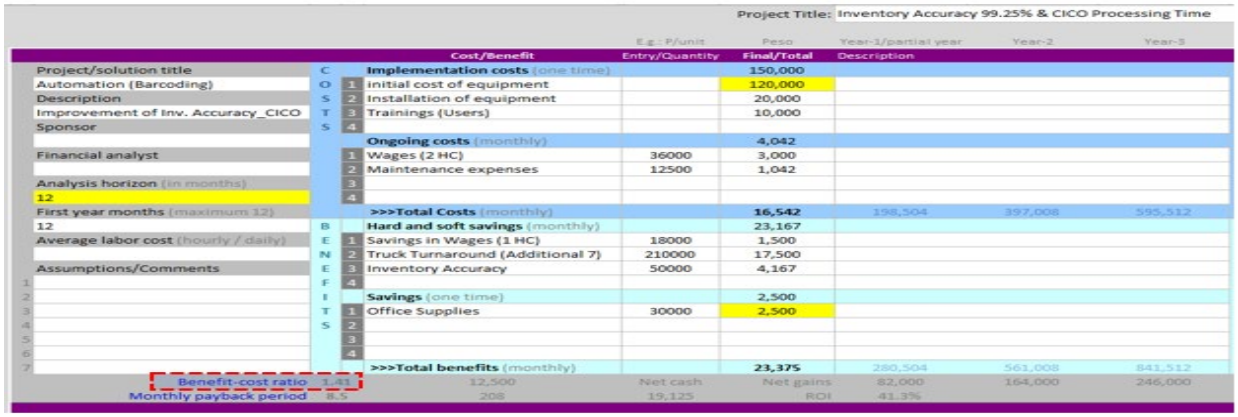
| Post Implementation of Automation | | | Check-in Processing Time in mins | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inventory Accuracy_ Actual Performance 2021 (ave. data) | | | Actual Current Performance Automation | Jan '21 | Feb '21 | Mar '21 | Apr '21 | May '21 | Jun '21 | Jul '21 | Aug '21 | Sep '21 | Oct '21 | Nov '21 | Dec '21 | Ave. 2021 |
| | Item | SKUs | # of Trucks Processed per week | 65 | 67 | | | | | | | | | | | 66 |
| | No. of Skus | 35 | Ave. Check-in Unloading in Minutes | 21 | 19 | | | | | | | | | | | 20 |
| | SKUs with variances | 17 | Ave. Check Out Loading in Minutes | 19 | 18 | | | | | | | | | | | 19 |
| | Distribution Center total Inventory | 33224 | Processing Time_ per Truck in Mins | 40 | 37 | | | | | | | | | | | 39 |
| | Sum of Absolute unit in Variances | 334 | CICO Performance in Mins/Hr | 0.40 | 0.37 | | | | | | | | | | | 0.40 |
| | *Inventory Accuracy by absolute variance* | 99.0% | # of Hours per day | 11 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |

Table 6 shows the result of improvement after implementing the solutions which translate the performance in Inventory Accuracy of 99% vs average of 98.3% in 2020. The increase of .7% in the Accuracy of Inventory has a huge impact on the Company because the target KPI to be excellent was 99.25% to be more efficient and effective in this parameter in warehouse management.

It shows that the improvement will continue and consistent implementation of lean management and consistent eliminating of waste will achieve the desired excellent target. Also, for the CICO with the use of analysis and using tools such as simulations to validate the results after using the identified solutions it shows that the improvement in the processing time was manifested from the average of 57mins and processed 59 trucks per week last 2020. It was increased the trucks to be accommodated to 66 trucks which this additional (7 trucks) or 12% productivity to be utilized by the Company which can contribute to the additional income and the servicing to cater to the customer will also increase and this will be resulting to service level efficiency.

## Cost-Benefit Analysis

This approach is used by the researcher to see the impact of the solution identified to improve the identified problem. Also, it will show the result in terms of the financial implication of this implemented solution to the Company.



Project Title: Inventory Accuracy 99.25% & CICO Processing Time

| | | | Cost/Benefit | E.g.: P/unit Entry/Quantity | Peso Final/Total | Year-1/partial year Description | Year-2 | Year-3 |
|---|---|---|---|---|---|---|---|---|
| Project/solution title | C | | **Implementation costs** (one time) | | 150,000 | | | |
| Automation (Barcoding) | O | 1 | initial cost of equipment | | 120,000 | | | |
| Description | S | 2 | Installation of equipment | | 20,000 | | | |
| Improvement of Inv. Accuracy_CICO | T | 3 | Trainings (Users) | | 10,000 | | | |
| Sponsor | S | 4 | | | | | | |
| | | | **Ongoing costs** (monthly) | | 4,042 | | | |
| Financial analyst | | 1 | Wages (2 HC) | 36000 | 3,000 | | | |
| | | 2 | Maintenance expenses | 12500 | 1,042 | | | |
| Analysis horizon (in months) | | 3 | | | | | | |
| 12 | | 4 | | | | | | |
| First year months (maximum 12) | | | **>>>Total Costs** (monthly) | | 16,542 | 198,504 | 397,008 | 595,512 |
| 12 | B | | **Hard and soft savings** (monthly) | | 23,167 | | | |
| Average labor cost (hourly / daily) | E | 1 | Savings in Wages (1 HC) | 18000 | 1,500 | | | |
| | N | 2 | Truck Turnaround (Additional 7) | 210000 | 17,500 | | | |
| Assumptions/Comments | E | 3 | Inventory Accuracy | 50000 | 4,167 | | | |
| 1 | F | 4 | | | | | | |
| 2 | I | | **Savings** (one time) | | 2,500 | | | |
| 3 | T | 1 | Office Supplies | 30000 | 2,500 | | | |
| 4 | S | 2 | | | | | | |
| 5 | | 3 | | | | | | |
| 6 | | 4 | | | | | | |
| 7 | | | **>>>Total benefits** (monthly) | | 23,375 | 280,504 | 561,008 | 841,512 |
| Benefit-cost ratio | 1.41 | | 12,500 | Net cash | Net gains | 82,000 | 164,000 | 246,000 |
| Monthly payback period | 8.5 | | 208 | 19,125 | ROI | 41.3% | | |

Figure 4. Cost-Benefit Analysis (Inventory Accuracy and CICO)

Figure 4 shows in the Cost-benefit Analysis that the Benefit Cost Ratio is 1.41 which is favorable for the Company, and it gains at first year around 82,000 on specific Distribution Center on this specific 2 KPI that affects the total business. In this new system design automation barcoding it has an ROI of 41.3%.

## Synthesis

To attain the goal of this objective, problems were identified that need to improve or addressed. The problems are the following:

a.) Manual counting and use of Manual count sheets in the process for Inventory Counting and CICO causing the inaccuracy of data due to human error and delay in the whole process in operation.

b.) Duplication of activities in the process which impacted to delay in the whole processes in the operation (waste of motions and time) which implemented the lean on the said specific problem and continuous improvement for the whole process.

c.) Low attainment of KPIs (Low inventory accuracy and CICO) which the 2 KPIs are important in the business operation of Food Manufacturing Consumer Goods Beverages Philippines Inc.

To address these issues and problems in this study, the researcher applied the following method and system.

a.) Lean implementation for the identified waste thru Value Stream Analysis that identified the waste the need to eliminate or improve in the whole process which benefitted for the better result in the 2 KPI's.

b.) Automation of the manual processes thru Barcoding to minimized or improved the existing low performance in Inventory accuracy and Cico.

c.) Continuous other aspects of Industry 4.0 or Supply chain 4.0 that can apply to the warehouse operations and supply chain processes.

## 5. Conclusion and Recommendation

In Food Manufacturing Consumer Goods Beverage Philippines Inc supply chain and logistics operation, inventory accuracy and processing time (CICO) are essential in key performance indicator therefore the data, time and motion, processes are very crucial for total distribution center warehouse operation in receiving (inbound), storage, loading (outbound) and shipping of products to the customer. This paper presents the research work aimed to assess the inbound and outbound process activities affecting the two (2) major KPIs of interest, inventory accuracy and CICO cycle time; determine the root causes contributing to the non-attainment of desired performance levels on inventory accuracy and CICO cycle time, and to recommend long-term and sustainable solutions in improving inventory accuracy to at least 99.25 and CICO cycle times to do minutes. the methods that applied to this study are the Input-Process-Output approach which uses interview and observations,

Root Cause Analysis, Pareto Analysis, Pro Model Simulation other lean improvement analysis in waste, and Value Stream Mapping in determining the main contributor in the performance. It was shown in the results that the manual processes by using the manual papers and encoding were the main factors and contributing to the poor performance in inventory accuracy and CICO which resulting in human error and time delay of the whole process in the distribution center warehouse operations.

The study has 2 recommendations which can be sustainable and improved the current performance fist the improved the process by identifying the waste which shows in the results of the value stream mapping from this result shows that if this waste was address and removed the KPI will be improved, and the operation will be more efficient and effective long term. Secondly the implementation of the automation of the inventory management in the distribution center warehouse management from manual processes.

As part of the supply chain, 4.0 journey using of the Internet of Things (IoT) which barcoding is one of the tools that can be used because of the following advantages and benefits and supply chain specifically in warehouse management increase of efficiency and speed of processes, improvement on information or data accuracy, reduction of waiting time, redundancy of work and human error will be eliminated and lastly, labor cost will be decreased also and will be maximized to other routine or job need to be done.

This study shows that choosing the right technology and environment is a critical decision for companies to gain the most out of barcode technologies. Also, some related automation that can still improve this study using Supply Chain 4.0 such the Enterprise Resource Planning (ERP) which Integrating and automating business processes eliminates redundancies, improves accuracy, and improves productivity. Warehouse operations with interconnected processes can now synchronize work to achieve faster and better outcomes.

Because this is a journey and researcher focus on the vital current problem to address to prepare the company for this Industry 4.0 concept. It will ensure first to solve the causes of the problem in order if the said another alternative improvement in the process to automation journey the Food Manufacturing Consumer Goods Philippines Distribution Center Operation will be ready to engage in this modern world of technology.

## References

Abdel-Basset, M., Manogaran, G., & Mohamed, M. (2018). Internet of Things (IoT) and its impact on supply chain: A framework for building smart, secure, and efficient systems. Future Generation Computer Systems, 86, 614–628. https://doi.org/10.1016/j.future.2018.04.051

Al-Talib, M., Melhem, W. Y., Anosike, A. I., Garza Reyes, J. A., Nadeem, S. P., & kumar, A. (2020). Achieving resilience in the supply chain by applying IoT technology. *Procedia CIRP, 91, 752–757.* https://doi.org/10.1016/j.procir.2020.02.231

Amanda Istiqomah, N., Fara Sansabilla, P., Himawan, D., & Rifni, M. (2020). The Implementation of Barcode on Warehouse Management System for Warehouse Efficiency. *Journal of Physics: Conference Series, 1573, 012038.* https://doi.org/10.1088/1742-6596/1573/1/012038

Barut, M., Faisst, W., & Kanet, J. J. (2002). Measuring supply chain coupling: an information system perspective. *European Journal of Purchasing & Supply Management, 8(3), 161–171.* https://doi.org/10.1016/s0969-7012(02)00006-0

Ciesielska, M., Boström, K. W., & Öhlander, M. (2017). Observation Methods. Qualitative Methodologies in Organization Studies, 33–52. https://doi.org/10.1007/978-3-319-65442-3_2

Gnimpieba, Z. D. R., Nait-Sidi-Moh, A., Durand, D., & Fortin, J. (2015). Using Internet of Things Technologies for a Collaborative Supply Chain: Application to Tracking of Pallets and Containers. *Procedia Computer Science, 56, 550–557*

He, L., Xue, M., & Gu, B. (2020). Internet-of-things enabled supply chain planning and coordination with big data services: Certain theoretic implications. Journal of Management Science and Engineering, 5(1), 1–22. https://doi.org/10.1016/j.jmse.2020.03.002

Helo, P., & Szekely, B. (2005). Logistics information systems. Industrial Management & Data Systems, 105(1), 5–18. https://doi.org/10.1108/02635570510575153

Hwang, G., Lee, J., Park, J., & Chang, T. W. (2016). Developing performance measurement system for Internet of Things and smart factory environment. *International Journal of Production Research, 55(9), 2590–2602.* https://doi.org/10.1080/00207543.2016.1245883

Jabbar, S., Khan, M., Silva, B. N., & Han, K. (2016). A REST-based industrial web of things framework for smart warehousing. *The Journal of Supercomputing, 74(9), 4419–4433.* https://doi.org/10.1007/s11227-016-1937-y

Manavalan, E., & Jayakrishna, K. (2019). A review of Internet of Things (IoT) embedded sustainable supply chain for industry 4.0 requirements. Computers & Industrial Engineering, 127, 925–953. https://doi.org/10.1016/j.cie.2018.11.030

Tjahjono, B., Esplugues, C., Ares, E., & Pelaez, G. (2017). What does Industry 4.0 mean to Supply Chain? *Procedia Manufacturing, 13, 1175–1182.* https://doi.org/10.1016/j.promfg.2017.09.191 The Application of Barcode Technology in Logistics and Warehouse Management 2009

Van Geest, M., Tekinerdogan, B., & Catal, C. (2021). Design of a reference architecture for developing smart warehouses in industry 4.0. Computers in Industry, 124, 103343. https://doi.org/10.1016/j.compind.2020.103343

Witkowski, K. (2017). Internet of Things, Big Data, Industry 4.0 – Innovative Solutions in Logistics and Supply Chains Management. *Procedia Engineering, 182, 763–769*. https://doi.org/10.1016/j.proeng.2017.03.197

Yao, A. C., & Carlson, J. G. (1999). The impact of real-time data communication on inventory management. *International Journal of Production Economics, 59(1–3), 213–219*. https://doi.org/10.1016/s0925-5273(98)00234-5

## Biographies

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