Improving Inventory Visibility by Spreadsheet Modelling: A Case Study

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Abstract

This paper presents a case study highlighting the use of a spreadsheet to improve inventory visibility at one of the leading frit manufacturing firms. Inventory visibility is the ability to monitor and track inventory in real-time, as well as get insights into how many units of each SKU are in stock at each location and where it is held inside a warehouse or fulfillment facility. The frit manufacturing process consists of using different natural rock powders as raw materials and heating them to high temperatures to convert them into frit. At this manufacturing facility, inventory management and raw material procurement relied heavily on the warehouse manager's observation skills and knowledge. The procurement of raw materials was done depending upon the decrement in the existing stockpile of that raw material and consumption behavior. There was a need to have a real-time inventory monitoring system to track the internal flow of stock in real-time, plan future purchases, and increase inventory visibility in the industry. The use of this spreadsheet will help to bridge the gap between unforeseen human error and inventory visibility.

Keywords
Supply Chain Management, Inventory Visibility, Procurement, Warehousing, Inventory Control

1. Introduction

In recent times, practitioners and researchers have been more interested in the concept of Supply Chain Visibility (SCV) (Catalayud et al. 2019). SCV refers to the ability to trace goods in transit from manufacturer to end destination. It is a complex process that involves people, processes, technology, and the flow of information. Sharma et al. (2020) presented the vulnerabilities faced by the companies due to low SCV in the events such as Covid-19. The disruption in the supply chain has affected the material supply, productivity, deliveries, and revenue. Low visibility is one of the biggest hindrances in achieving supply chain resilience. Sodhi and Tang (2019) revealed low visibility is one of the highlighted concerns expressed by many manufacturers. With challenges in SCV becoming more prevalent, it is critical to comprehend the development and implication of SCV (Swift et al. 2019). Poor visibility and uncoordinated multi-tier operations can result in increased inventory carrying costs, premium freight expenditures, and longer cycle times for these businesses.

The increasing complexity in the supply chains is forcing organizations to adapt tools and technologies that improve visibility in daily functioning. Caridi et al. (2010) suggested that enterprises will need to invest more to deal with increased supply chain complexity. Dubey et al. (2019) stated that improving SCV can be used to construct a robust supply chain. An improved SCV can help in identifying costs and reducing them to improve the performance of the supply chain (Jüttner and Maklan 2011). An improved visibility helps to view the entire supply chain from the base level and contributes to the reduction in unnecessary costs such as inventory overheads (Bartlett et al. 2007). Many studies have found that SCV can help organizations improve their competitiveness and profitability (Holcomb et al. 2011). Lee et al. (2014) suggested that SCV can boost a firm's market worth. Alongside economic sustainability, SCV also results in environmental sustainability (Dubey et al. 2020). Based on the information available, SCV can be divided into inventory, demand, and logistics visibility (Goh et al. 2009).

Inventory Visibility (IV) is crucial for improving supply chain performance, and it has been identified as a significant performance metric (Daugherty et al. 2006). IV is the ability to monitor and track inventory in real-time, as well as obtain insights into how many units of each Stock Keeping Unit (SKU) are in stock at each location and where it's located inside a warehouse or fulfillment facility. It supplies the latest and accurate data from in-stock inventory to in-transit inventory and helps optimize the end-to-end supply chain process. IV is an important aspect of SCV, as it provides companies with information about their inventories to make their supply chain as effective as possible. Any improvement in SCV directly increases IV in the process. Higher levels of SCV are likely to help inventory management in general. Improved stock levels and lesser uncertainty, for example, can be achieved through increasing inventory visibility (Barratt and Oke 2007).

Christopher and Lee (2004) presented that many supply chains have limited inventory visibility. This means that a specific entity in the network is oblivious of the state of the upstream and downstream activities of inventory levels and flow as it moves through the chain. The lack of visibility in the process affects the ongoing operations both upstream and downstream, ultimately affecting the financial health of the company. Though IV is a popular buzzword and well understood by the supply chain workforce yet it remains poorly executed. There is a lot of ongoing research and development going on to improve inventory visibility in real-time.

1.1 Objectives

Understanding the existing unsystematic inventory management operations of a frit manufacturing firm and developing an inventory management system using advanced spreadsheet modelling to improve inventory visibility in the facility.

2. Literature Review

One of the greatest impediments to IV is the inaccuracy of inventory data. The majority of manufacturing facilities lack a robust inventory system that oversees the inward and outward flow of raw materials from the warehouse. The lack of accountability in the warehouse leads to increased inventory carrying costs. The absence of a proper Inventory Management System (IMS) results in poor production planning since raw materials are not sourced on time. This results in additional expenses and a longer lead time. This case study emphasizes the significance of using advanced spreadsheet modelling to remove the inaccuracies in raw material inventory data at a frit production factory. The basic materials used in the manufacturing of frit are natural rock powders. These powders are procured in two sizes- Jumbo Packing (1-ton bag) or Regular Packing (25 kg bag). To make a batch, these powders are mixed in various combinations. This batch is then heated in a high-temperature furnace and then rapidly cooled in water to turn it into frit. The company followed a very outdated and inaccurate inventory management approach that relied on the warehouse manager's knowledge and observation skills. The features of this approach included:

1. A particular powder was replenished by looking at the lowering level of existing piles of that material.
2. It was extremely difficult to know the real-time stock and location of powder in absence of a warehouse manager due to the absence of IMS.
3. Since these powders come in different shades of true white, which can be only analyzed by reflectance/luminous meter and not by visible eye so the probability of intermixing the powder bags is high during the unloading operation.
4. The warehouse operator had to prepare a daily stock sheet to inform the production department about the amount of raw materials available for manufacturing.

Accounting for any discrepancy in inventory data caused by replenishment issues, improper handling of damaged material bags, and imperfect inventory audits became extremely challenging. As a result, the lack of an IMS reduced the company's IV. Poor IV has an indirect undermined economic impact on the firm by restricting working capital needlessly, in addition to diminishing material accountability. For a wholesaler and retailers affected by erroneous inventory data, the economic repercussions of limited visibility were described using a newspaper framework (Sahin and Dallery 2009)**.** The absence of an IMS leads to poor production planning as sourcing of the raw materials doesn't happen timely. This leads to additional costs and increased lead time.

It was observed that implementing a robust IMS can reduce dependence on warehouse operators while also improving IV and material accountability. It could also help in keeping accurate inventory levels, the reduction of holding costs, the promoting real-time Inventory data, and the forecasting demand. Goel (2010) demonstrated the benefits of gradually increasing the amount of visibility for a supply chain in the automobile sector through a case study.

3. Method

The goal of a systematic literature review is to develop a comprehensive understanding of the subject. Performing a literature review can assist in gaining a new and thorough understanding of the topic, as well as identifying additional helpful study areas. This case study helped to develop an advanced spreadsheet for improving the IV at a frit manufacturing facility. It follows a simple 2 step process: (i) Raw material data entry, (ii) Entry verification and stock updating.

(i) Raw material data entry

After clearing the quality parameters, whenever new powdered bags had to be unloaded, an inward entry in the spreadsheet was to be created. Figure 1 shows the homepage of IMS and the various parameters that must be filled while Table 1 displays the different data entry features and their interpretation. After entering all of the data, the operator clicks the 'material inward' button, which updates the new material inward details in the inward sheet. When taking material from the warehouse to production, the 'material outward' button has to be hit after filling out the data like in the inward case. The 'inward sheet', 'outward sheet', and the 'stock' can be clicked to visit the corresponding sheet within the same workbook. They're provided for easy navigation within the workbook.

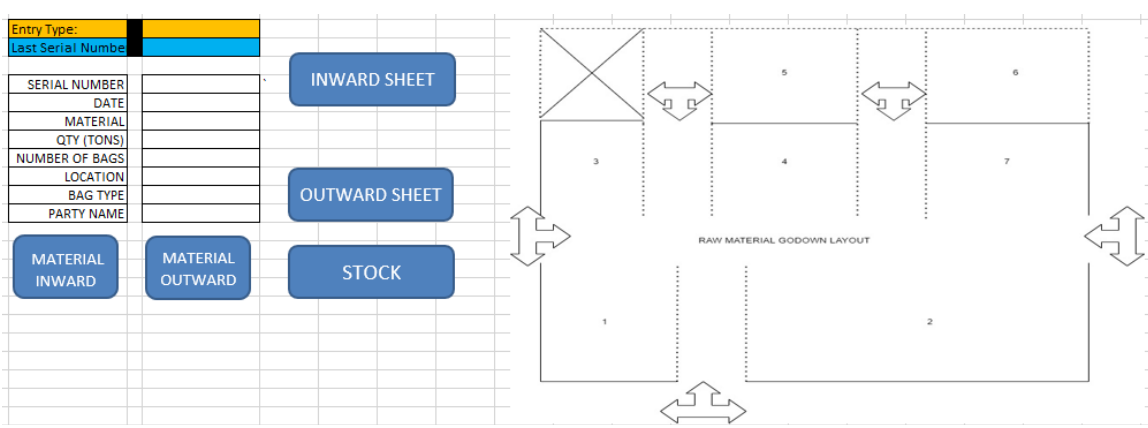

Figure 1. IMS Homepage

Table 1. Data Entry Features and their Interpretation

Feature	Interpretation
Entry Type*	Inward or outward data entry type
Serial Number	To provide a systematic data entry method
Date	To track the raw material inward/outward
Material*	The item that is getting inward/outward
Qty	Quantity of material getting inward/outward (in Tons)
Number of Bags	The number of bags getting inward or outward
Location	The place of storage of RM by referring warehouse map
Bag Type*	Jumbo: If 1 TON packing & Regular: If 50 kg packing
Party Name*	Name of the supplier

*dropdown list is provided

A warehouse map shown in Figure 2 is provided on the home page of the spreadsheet that helps to guide the location for material storage. The places marked from 1 to 7 show the space in the warehouse where the powder bags are stored. Any inward/outward entry made should reflect the location space also. The three-way arrows show the possible movement of the forklift. The dotted lines show that the boundaries of this region are flexible depending on the stockpiles. The continuous line shows a fixed boundary for the warehouse.

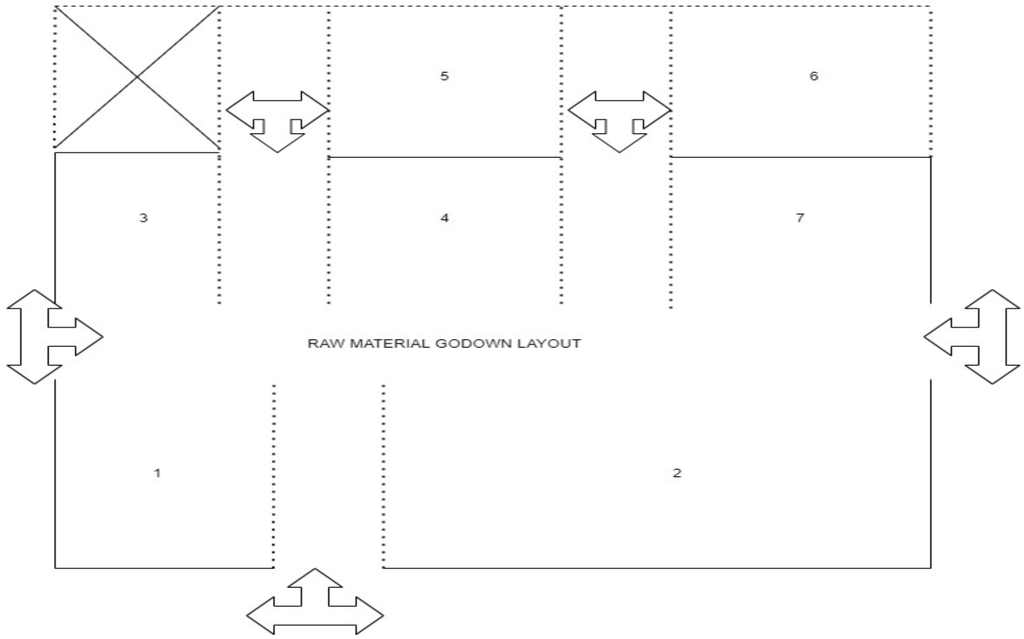

Figure 2. Warehouse Layout

(ii) Entry verification and stock updating
Once the operator makes an entry in the home sheet and clicks the 'material inward' or 'material outward' button depending upon the entry, he can navigate to the corresponding sheet to verify his entry. Since all the suppliers are given a fixed quote per month for the supply of raw materials, the operator can also know in real-time the quantity of material that has been supplied in that month by a particular supplier and how much is pending. This would eliminate the need of going to the accounts department to fetch the data. Figure 3 and Figure 5 show the pilot samples for data entry for material inward and outward operations. Figure 4 and Figure 6 show inward and outward data entry sheets after entering the pilot sample data details.

Entry Type:	INWARD
Last Serial Number:	0
SERIAL NUMBER	1
DATE	22-06-22
MATERIAL	Q1
QTY (TONS)	25
NUMBER OF BAGS	25
LOCATION	4
BAG TYPE	JUMBO
PARTY NAME	ABC

Figure 3. Inward Data Entry Pilot Sample Details

INWARD ENTRY

SERIAL NUMBER	DATE	MATERIAL	QTY (TONS)	NUMBER OF BAGS	LOCATION	BAG TYPE	PARTY NAME
1	22-06-22	Q1	25	25	4	JUMBO	ABC

Figure 4. Inward Data Entry in Inward Entry Sheet

Entry Type:	OUTWARD
Last Serial Number:	0
SERIAL NUMBER	1
DATE	22-06-22
MATERIAL	Q1
QTY (TONS)	15
NUMBER OF BAGS	15
LOCATION	4
BAG TYPE	JUMBO
PARTY NAME	ABC

Figure 5. Outward Data Entry Pilot Sample Details

OUTWARD ENTRY

SERIAL NUMBER	DATE	MATERIAL	QTY (TONS)	NUMBER OF BAGS	LOCATION	BAG TYPE	PARTY NAME
1	22-06-22	Q1	15	15	4	JUMBO	ABC

Figure 6. Outward Data Entry in Outward Entry Sheet

MATERIAL	INWARD	OUTWARD	STOCK
Q1	25	15	10
	0	0	0
	0	0	0
	0	0	0
	0	0	0
	0	0	0
	0	0	0
	0	0	0
	0	0	0
	0	0	0
	0	0	0
	0	0	0
	0	0	0
	0	0	0
	0	0	0
	0	0	0
	0	0	0
	0	0	0
	0	0	0
	0	0	0
	0	0	0

REFRESH
INWARD SHEET
OUTWARD SHEET
HOME

Figure 7. Stock Sheet after Making Inward & Outward Pilot Sample Data Entry

Following a data entry, the spreadsheet handler can use the navigation button to travel to the stock sheet. The sheet must be refreshed to account for the most recent data entry. This is done by pressing the 'refresh' button present on the stock spreadsheet. Figure 7 shows the stock of raw materials after making inward and outward material data entries for the pilot sample data.

One unique aspect of this spreadsheet is that if the operator enters more material than present in the stock during material outward entry, an alert appears on the home screen informing the operator that there is an insufficient quantity of the entered material. From the stock sheet above, we know that only 10 Ton of Q1 was there in the stock. Since the operator made an outward entry of >10 Ton, the spreadsheet showed a message of 'INSUFFICIENT STOCK' indicating that the amount entered isn't available in the inventory currently. Figure 8 shows the alert that is displayed on the screen if the spreadsheet operator enters material outward data greater than the amount present in the current stock.

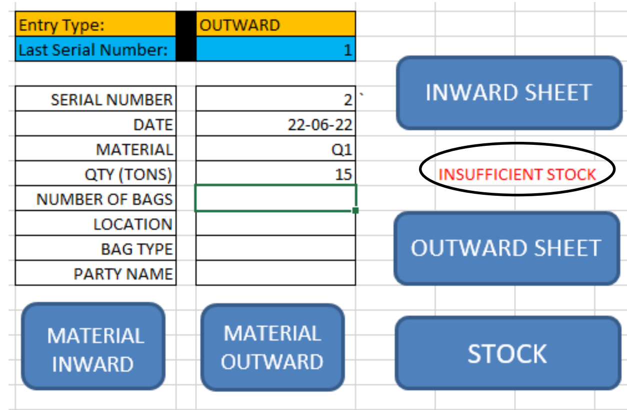

Figure 8. Insufficient Stock Alert

5. Conclusion

The complexities and importance of SCV have gained the attention of many supply chain practitioners and researchers IV. There is a lot of scope in the development of technologies that can help improve IV. In this case study, an underlying issue was identified and solved using advanced spreadsheet modelling. This issue if not solved earlier can impact the financial health of the company in the long run. The developed spreadsheet approach can be utilized by many companies that follow a very outdated approach to managing their inventories. The developed spreadsheet can be beneficial to the supply chain professionals to properly communicate on SCV, which is a major issue for many firms interested in operating in an end-to-end environment.

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Biographies

Mr. Aditya Choksi is a final year Mechanical Engineering student at Institute of Technology Nirma University (ITNU), Ahmedabad, India. He has conducted his research work in the field of Green Supply Chain Management during his undergraduate studies. He is a student member of ASME. He served as the editor-in-chief for the Mechanical Engineering Student Association (MESA) at the Nirma University from 2020-2021. He is going to join The University of Texas at Dallas from August 2022 to pursue a full time master's degree in the Supply Chain Management.

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