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SAFETY STOCKS: ARBITRARY VERSUS STATISTICAL METHOD

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ABSTRACT

To manage fluctuation in demand, organizations usually set safety stocks of finished goods to help buffer fluctuating demand as it arrives from the market. Sometimes called buffer stocks, safety stock inventory is a term used by Supply Chain Managers to describe extra stock that is kept to cover late supplier deliveries and even fluctuating demand. This study looks at determining safety stocks using a statistical approach of determining demand variability to see whether any savings can be made in days of finished goods inventory held. Comparisons between the trial and error approaches versus statistically driven safety stocks using probability and the standard deviation of historical demand will be used to compare the days target of inventory versus actual inventory held for a single organization with multiple warehouses for a fast moving consumer goods business. The findings show that days of inventory can be substantially saved using the statistical approach. In addition, this study will also help Supply Chain Managers to understand sources of demand variation and help them try to minimize the variation before attempting to determine statistically calculated safety stocks in an attempt to reduce costs associated with holding inventory.

Key Words: Days cover, demand fluctuation, inventory categorization, re-order point, safety stock, service levels, usage during the lead time.

1.Introduction

In capitalist societies, demand of products vary as humans currently live in a world of abundance. We are spoilt for choice when it comes to deciding between products and variation in demand occurs when we have a choice of when to buy and how much to buy. Consumers never buy things on fixed days of the month which in part leads to such variation. Our demands can be influenced by fads, trends and unforeseen day-to-day circumstances which in turn lead to such variation. As a result, organizations usually keep a particular level of safety stocks to avoid supply interruption of goods to their customers.

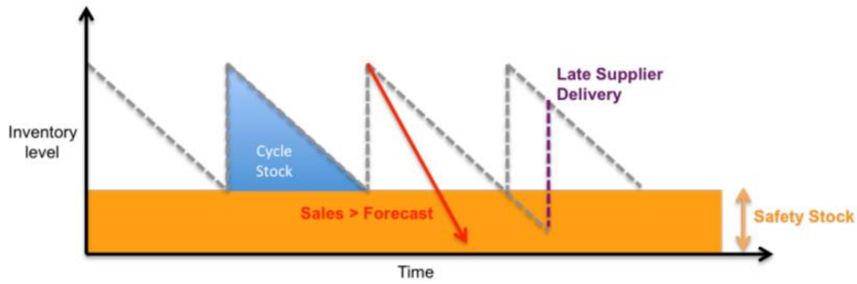


Figure 1: Safety stocks and the associated effects of variability in the supply chain

Besides covering usage during the lead time from suppliers (Figure 1), safety stocks help to mitigate increases of stock-outs of finished goods and raw material due to uncertainties in demand. Many companies look at their own demand fluctuations and fail to predict future variability statistically and therefore fall back on trial and error or rule-based approaches such as to hold a certain number of weeks of historical average demand. For example, 4 weeks of cycle stock and 2 weeks of safety stock (Fritsch, 2015).

1.1 How Actual Consumer Demand Variation Occurs

Actual consumer demand variation may happen in many ways. When the marketing department of an organization decides to promote a product through marketing campaigns, we can expect demand to increase. For example, a buy 2 get 1 free offer will encourage the consumer to buy more than usual even though he or she may not need to use the product immediately. There are many items in our homes that we consumers keep inventory, for example, soaps, shampoos, detergents, toothpaste, aerosol sprays, floor cleaning liquid, kitchen equipment, cooking ingredients, pet food, etc. When housewives become aware of potential price increases for future purchases, there is a tendency for some short-term forward purchases to be made for such items. In addition, when there are annual festivities, there is usually an increase in demand for festive items. For example, fire crackers, children's clothes, ingredients for cookie making, prayer accessories and the practice of exchanging gifts during festivities also contribute to demand and its fluctuations. The same occurs during climate related seasonal demand where warm clothes may be purchased more often in winter and loose blouses and ice-creams sell better in summer.

1.2 What do Supply Chain Managers do When There is Demand Variation

A central problem in Supply Chain management is to determine a desired level of service for every stock-keeping unit in the business and this service refers to the probability of a stock-out for inventory items. To begin the discussion on safety stocks, we need to initially understand that Supply Chain Managers monitor an item continuously using inventory control systems and a replenishment quantity is ordered each time the inventory reaches the re-order level (Krajewski, Malhotra & Ritzman,2013) and re-order points (ROPs) for stock keeping units (SKUs) or finished goods items are firstly based on the usage of an inventory item during the lead time. For example, if the lead time is 5 days for either a make or a buy item, the replenishment point will be set at 5 days multiplied by the daily usage of an item. Lead times are usually within the control of an organization who may have developed agreed service polices in customer service level agreements to ensure consistency of lead times. To ensure consistency of lead times, an organization will have sufficient capacity equipment and labor to meet target lead times. In the study by Oliva and Watson (2011), days of inventory performance was used as a performance measure of operational effectiveness. Usage during the lead time for this study uses the formula:

*Lead time in days * daily sales units ordered* (1)

Daily sales units ordered = sales units ordered annually / 365 days(2)

Formulas (1) and (2) are therefore used to determine the usage of inventory during the lead time period. 365 days is used instead of working days (usually about 250 days a year) because financial statements use 365 days in the determination of days of inventory, irrespective of actual days worked. This is a standard measure in the field of accounting although some analysts prefer using a standard 360 days (Business Encyclopedia, 2016). Randall, Nowicki & Kulkarni(2016) explained that lead time is the physical lead time to physically move goods from supplier to buyer. There is also informational lead time which is the time taken to process an order transaction and informational lead time can be shortened through the use of technology and IT systems.

To cover the demand fluctuation, Supply Chain Managers set policies for safety stocks, usually arbitrarily. For example, a Supply Chain Manager may arbitrarily set a buffer of 1 or 2 weeks to cover supply and demand variability without actually determining true variation between actual demand and planned demand. In this study, 2weeks is considered as a starting point and this is added to the usage during the lead time to determine ROPs for every SKU in a business (Fritsch, 2015). The detailed approach for safety stocks calculation will be explained in the literature and other sources of demand variation besides consumer related demand variation will also be researched in the literature. This study will then compare target days of finished goods inventory for the 2-week safety stock policy with a statistically determined policy for every SKU. This will also be compared to the actual inventory held in warehouses of finished goods inventory for a single fast moving consumer goods (FMCG) organization and recommendations will be provided for Supply Chain Managers to use such statistical methods for safety stock calculations as well as to consider approaches to reduce variation in demand.

1.3 Problem Statement

There are generally higher finished goods held in make for stock environments compared to make to order environments and there are opportunities for Supply Chain Managers to minimize inventory held whilst maximizing customer service to consumers. In attempting to push inventory through the distribution network, customer service has become the number one objective with attempts to reduce cost coming a close second but in attempting to optimize customer service, there is a tendency to overstock finished goods to prevent stock-outs. This adds to holding costs for an organization and reduces an organization's ability to compete effectively on costs. In a study conducted in the US (Table 1),stock-outs was ranked number one as an inventory management objective compared to cash flow, inventory turns, lead times, fill rates and inventory obsolescence (Fraser & Brandel, 2007). There is less emphasis in these make for stock type organizations to reduce holding costs unlike make to order type organizations.

Table 1. Ranking of inventory management objective in US study (Fraser & Brandel, 2007)

Inventory management objective	**Ranking**
stock-outs	1
cash flow	2
inventory turns	3
lead times	4
fill rates	5
inventory obsolescence	6

Table 2. Annual inventory turnover in leading organizations

Inventory turnover in organizations			
Make to order organizations		Make for stock organizations	
Dell Computer	90	Coca-Cola	14
Nissan	150	Home Depot	5
McDonalds	112	Anheuser Busch	15
		Johnson Controls	22

We can note from Table 2 that there is significantly more inventory in make for stock compared to make to order environments (Heizer, Render & Munson, 2017). The main reason for this as explained earlier is that inventory-related importance among companies tend to focus on product availability as a main objective (Fraser & Brandel, 2007) because consumers will not wait for the product when they attempt to make a purchase whereas consumers in make to order environments may wait for products after an order has been made, for example, in laptop assembly or car manufacture. When replenishment policies involving the amount of safety stock to be held are not reviewed regularly, an organization can be out of stock or hold excess inventory.

2.0 Literature Review

We can begin the review of the literature by considering safety stocks calculation using 2 approaches, namely, an arbitrary approach or a statistical approach.

When inventory reaches a user defined ROPor level (ROP or R), a quantity to be ordered (Q) is placed periodically (Figure 2).

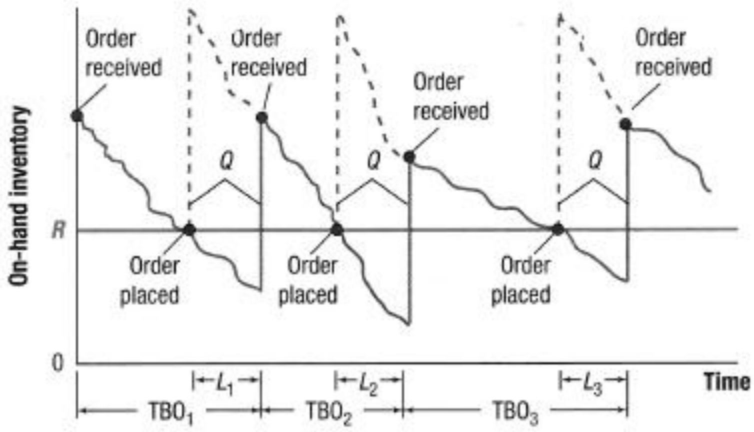


Figure 2. Fixed quantity review system (continuous review)

Note. L = Lead time; R = Re-order level; Q = Quantity; TBO = Time between orders

In Figure 2, we can note that inventory actually arrives well before it reaches zero level and this is usually because some safety stock has been set to ensure zero stock outs. In the real world today, consistency of demand happens less frequently so Supply Chain Managers set these safety stocks as a buffer for inconsistent demand.

Two approaches that will be explained in this study are:

- determine safety stocks by arbitrarily setting 'x' weeks of cover
- determine safety stocks by calculating standard deviation of the demand data and determining the probability of meeting 'x' percentage of demand.

Many other statistical approaches can be used but the researcher has opted to use an easy-to-understand approach as other approaches can be a bit confusing. For example, a well-known approach called the Brown formula can be used to better determine lost sales due to stock-outs but several problems arise and the user must perform awkward interpolation on the data which many may find confusing (Kumar & Evers, 2015).

2.1Determining Safety Stocks by Arbitrarily Setting 'x' Weeks of Cover.

Earlier in Formula (1), we mentioned that the lead time in days multiplied by the daily sales units ordered would allow Supply Chain Managers to determine the usage during the lead time. Similarly, the amount for a 2-week safety stock policy would be:

*Safety stock in 14 daysor (SID 14 days or 2 weeks) * daily sales units ordered* (3)

Daily sales units ordered uses Formula (2).

In this scenario, when demand during the lead time exceeds the average daily usage during the lead time, a 2-week buffer will ensure a high proportion of demand is met as it arrives.

2.2 Determining Safety Stocks by Calculating Standard Deviation of the Demand Data and Determining the Probability of Meeting 'x' Percentage of Demand

Instead of using an arbitrarily set safety stock of 2 weeks, Supply Chain Managers may also determine safety stocks by determining the degree of fluctuation in past demand data and apply a z-score to determine the probability of meeting a high percentage of demand. According to Heizer et al. (2017), if the demand fluctuates and a desired service level of 95% (or higher) is required, we can use normal distribution tables to determine such z-scores. Z-scores are used to determine the safety stock required by multiplying with the standard deviation of past demand data. In a study, Beamon(1998) looked at setting of safety stock levels using single echelon approximations of lead time, demand and supply variation to achieve a desired inventory performance. The z-score then determine a single number that can be applied to the standard deviation(Render, Stair Jr., Hanna & Hale, 2015) to determine the probability of meeting fluctuating demand, thus applying:

*Re-Order Point= Average demand during the lead time + z-score * the standard deviation (σ) of the data distribution* (4)

This can also be expressed as:

*Re-Order Point= Usage during the lead time (lead time in days * average daily usage) plus safety stocks (to cover the probability of meeting a percentage of total demand, usually about 95% at least)* (5)

The standard deviation of the sampling distribution will equal the population standard deviation divided by the square root of the sample size (n).

$$\sigma_{\bar{x}} = \frac{\sigma_x}{\sqrt{n}}$$

$\sigma_{\bar{x}}$ *is the standard deviation of 'x' number of samples* (6)

2.3 Factors That Contribute to Higher Degree of Fluctuation in Demand

In the Introduction, we considered how consumer demand variation occurs. The literature will also consider other factors in addition to consumer demand variation that may contribute to fluctuation in incoming orders within an industry.

2.3.1 The Outbound Supply Chain and the Bullwhip Effect

Let us first consider the outbound supply chain of a manufacturing and distribution organization. In the modern trade, an organization may deliver directly to shelves in supermarkets or an organization may deliver directly to a consumer for orders received through an online portal. However, many traditional businesses exist where the organization may distribute their products through a distributor, who then distributes through a wholesaler, then to a retailer before a consumer walks into the retail outlet to purchase it (Figure 3).

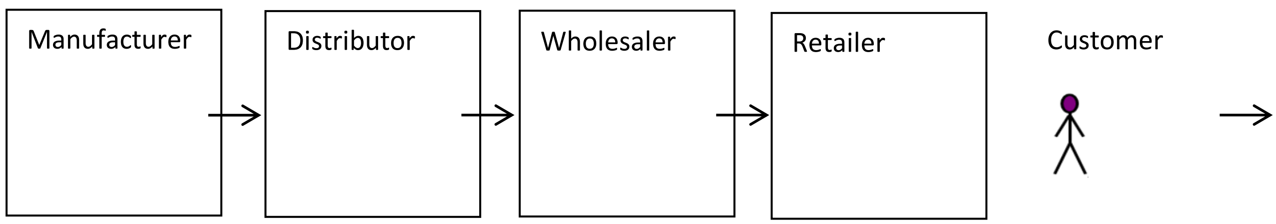


Figure 3: Traditional trade within outbound supply chains

Within the outbound supply chain, a phenomenon called the bullwhip effect happens where orders moving upstream are either overstated or understated which causes demand fluctuation. Managing supply chains is a challenging task in a dynamic business environment, particularly when there are multi-products, multi-national supply networks and when different products with very different demand patterns share the same resources, specifically production and distribution facilities.

Early demand amplification studies within the traditional outbound supply chain can be traced to the work done by Forrester (1958), who found that the order size began to fluctuate in size as it moved higher upstream from the retailer towards the manufacturer. Jay Forrester, a system theorist began his early work in analyzing demand patterns, utilizing computer simulations to monitor the effect of interactions between suppliers, distributors and manufacturers and industrial business cycles. One of his main contributions has been the bullwhip effect on outbound supply chain systems, where he observed the phenomenon that customer demand in terms of order variability increases as they moved higher up the supply chain from retailer to distributor to the manufacturer as seen in Figure 4 (Forrester, 1958).

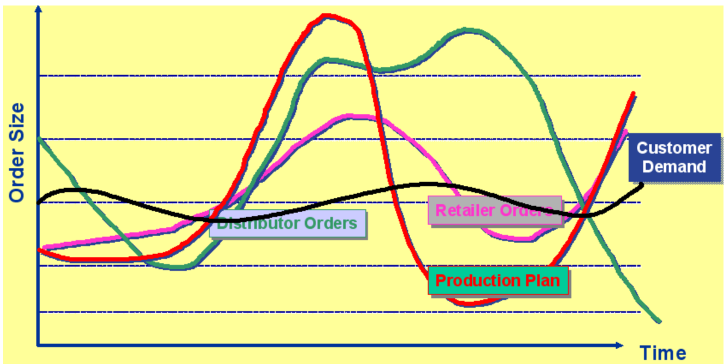


Figure 4: The Bullwhip effect

This was followed by other studies such as those by Burbridge (1961), Saporito (1994), Lee, Padmanabhan & Whang (1997) and McGuffog (1997) who also looked at various contributions on demand amplification in different industry sectors. A number of these studies have used the System Dynamics (an organization based in the US) methodology and used computer-aided simulation of supply chain activity to test theoretical strategies to reduce demand amplification (Wilkner, Towill & Naim, 1991, Towill, 1996). Studies since then have continued to contribute to this area and the work by Geary, Disney & Towill (2006) indicated that although the effects of demand fluctuations have been well understood for many years and solutions are available, many industries have yet to address the issue. Detrimental effects of demand amplification are well known and include excess inventory (Taylor, 2000).

2.3.2 Decentralization of Inventory Held in Many Warehouses

Another source of demand variation happens when organizations spread incoming demand using many warehouses. An organization may operate a single or centralized warehouse and rely on fast transportation to deliver to the trade. Whilst this may save the organization in terms of reduced holding inventory costs, many organizations prefer to operate multiple or decentralized warehouses so that their products are nearer to customers in their market. The savings from a centralized warehouse are in the form of combining fixed assets into one location and additional savings can be obtained just by the effect of combined demand. Companies therefore gain economies of scale when centralizing products in one location, which leads to an increase in efficiency. On the other hand, this efficiency increase comes at the expense of responsiveness, as many of the customers may be located far from the facilities (Chopra & Meindl,2016). Increasing the number of facilities increases facility and inventory costs but decreases transportation costs and reduces response time. When a centralized policy is used, there is increased daily transportation and time required from the central facility to deliver to remote locations to meet demand whereas when facilities are located nearer to customers, transportation costs may be reduced. In centralized scenarios, Supply Chain Managers set safety stocks based on the degree of variability and the standard deviation of the demand data can be reduced in these centralized scenarios. To explain this, let us consider some arbitrary demand numbers for a centralized and decentralized scenario for 3 warehouse facilities, WH1, WH2 & WH3 over a 12-month demand period.

Table 3: The effect of demand variability as measured by standard deviation for centralized vs decentralized warehouses.

Month	Combined Sales all markets (centralized warehouse)	Unit sales per market (local warehouses, WH1, 2 & 3)		
		WH1	WH2	WH3
1	18	9	0	9
2	22	6	3	13
3	24	7	5	12
4	20	8	4	8

5	17	2	4	11
6	29	10	5	14
7	21	7	6	8
8	26	7	7	12
9	18	5	6	7
10	24	9	5	10
11	23	8	4	11
12	23	12	2	9
Total Sales	265	90	51	124
Average monthly Sales	21.1	7.5	4.3	10.3
Standard deviation	**3.5**	**2.5**	**1.9**	**2.1**

From Table 3, we can note that the combined standard deviation of the demand data (3.5)for a centralized scenario is just over half for the same demand for decentralized warehouses (2.5+1.9+2.1=6.5). While a centralized warehouse policy will increase daily transportation and time to deliver to remote customers, there are savings that can be made to safety stock calculations when combining WH1, WH2 & WH3 to a central warehouse. This is because the standard deviation which is a key component of safety stock calculations can be reduced through centralization.

We can therefore conclude that decentralization of warehousing contributes to higher demand fluctuation which is a factor not caused by consumer demand but originates from the number of warehouse policy of the organization.

2.4 Using Days Cover Policies in Inventory Management

This section explains the underlying theory in using days cover policies in inventory management and explains how average inventory is determined which also includes safety stocks when needed and how Supply Chain Managers use inventory categorization to set days cover policies by inventory categories and how target days of inventory are determined.

2.4.1 Average Inventory

This is a general rule of thumb policy that uses days cover policies to determine how much to order. Organizations may order a month's inventory at a time, simply because they pay their creditors monthly payments. This can be considered a weak policy because the Q ordered will determine the average level of inventory held (Figure 5).

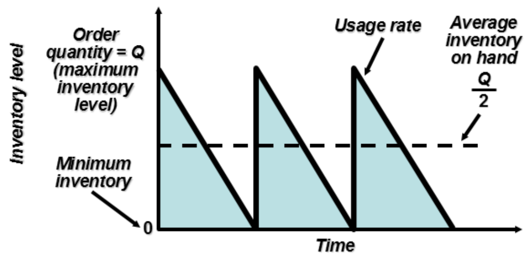


Figure 5. Average inventory is Q ordered divided by 2

When quantities are ordered, average inventory held is determined by the formula:

Average Inventory (or target inventory held) = Q/2 (7)

Q/2, or the midpoint between the time inventory arrives and the time it depletes to zero (if no safety stocks are held) will result in a 2-week inventory held if 4 weeks of inventory is ordered.

2.4.2 Adding Safety Stocks to Average Inventory Held

In a perfect world where no fluctuation exists, no safety stocks are required. So, we can say the average stocks as determined by Q/2 can be used on its own since no safety stocks are required. However, when safety stocks are held due to variation in supply and demand, we can determine average (or target) inventory held as:

Safety stocks + Q ordered/2 (8)

On average, the level of inventory held based on user defined policies will be the level of safety stock and a point between the minimum and maximum of Q (or Q/2). This then becomes the target inventory and the number of days held and the value of the inventory can be calculated using the formula:

Target days of inventory held = (Safety stocks + Q ordered/2 in sales units) / average daily sales units ordered(or sales units ordered annually / 365 days)(9)

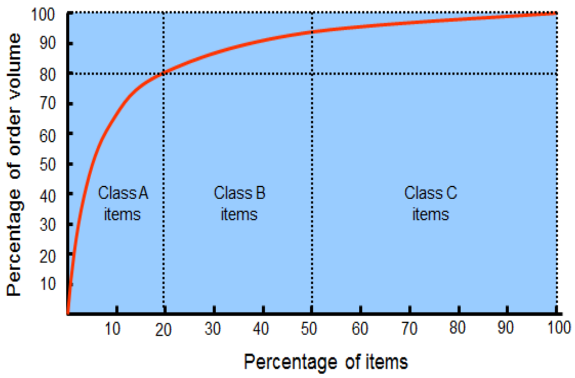
These target days of inventory can then be compared with actual days of inventory held, so that Supply Chain Managers may determine reasons for the differences and work towards an optimized solution of keeping inventory. According to Randall et al. (2016),the perfect formula for determining the right amount of inventory (also called the Science of theoretical minimums) helps Supply Chain Managers to minimize the level of inventory to optimize customer service, as both working level targets and customer service satisfaction are conflicting in nature. If inventory is kept high, it increases working capital. If inventory is kept low, customer service is affected.

2.4.3 Inventory Categorization

Inventory categorization attempts to classify inventory into categories. The most common unit of measure used in inventory categorization is order volume and order volume is measured in either sales units, cases, pallets, container loads, weight, length or liters. This study uses:

Order volume as number of orders in sales units received in a year (where d are orders received daily and ∑d is the sum of all orders for an SKU during a year) (10)

A popular way of categorizing inventory (Reid & Sanders, 2010) is to classify volume of sales units by SKUs received into ABC categories (Figure 6).



Percentage of items	Order Volume
20%	80%
30%	15%
50%	5%

Figure 6. ABC classification of inventory, based on the order volume

Usually, as inventory is classified in groups called ABC groupings, Supply Chain Managers attempt to categorize the many number of SKUs into a few categories so that common replenishment rules can be applied to the few categories.

2.4.4Determining Target Days of Inventory Held Using ABC Analysis

We can demonstrate how inventory categories are used to determine target days of inventory held. For example, if we use A=0 to 80%, B=81 to 95% and C=96 to 100%, we can determine ABC categories based on order volume as per Table 4.

Table 4. How ABC categories are developed

No	Inventory items	Order Volume	Cumulative volume	Cumulative percentage	Grade
1	SKU1	50	50	50/100*100=50.00%	A
2	SKU2	30	80	80/100*100=80.00%	A
3	SKU3	9	89	89/100*100=89.00%	B
4	SKU4	5	94	94/100*100=94.00%	B
5	SKU5	3	97	97/100*100=97.00%	C
6	SKU6	2	99	99/100*100=99.00%	C
7	SKU7	1	100	100/100*100=100.00%	C
	Total	100			

Hence, we can determine target days of inventory as per the method below. We begin by looking at average withdrawal rate per day for each ABC category of inventory (Table 5).

Table 5. Average withdrawal rate per day for ABC categories

Categories	Average withdrawal rate
A	80 units a day
B	14 units a day
C	6 units a day
Total	100 units a day

Supply Chain Managers may then set days cover policies for each category as per the parameters set (Table 6).

Table 6. Setting of ROP and Q days cover using inventory categories

Category	ROP (days)	Q (days)	ROP (units)	Q (units)
A	7	14	560	1120
B	14	28	210	420
C	28	84	140	420
Total			910	1960

The ROP is usually set based on days of lead time to obtain supplies plus safety stock (in days), usually to cover fluctuations in demand. Using the data in Tables 4 and 5, we can derive average inventory (or Q/2),as calculated as 1960/2 = 980 units and in terms of days, this is 9.8 days held on average for the inventory policies in the example. If another 1000 units of safety stocks are held, formula for average inventory held will then be Q/2 + safety stocks or 19.8 days. Hence, target days of inventory for any given inventory policy can be determined and this can then be compared with actual inventory held for management to consider policies that may reduce working capital or improve customer service.

3.0 Research Methodology

A scenario consisting of order volume and inventory parameters in Table 6will provide a target days cover of finished goods inventory. We begin the first simulation by setting safety stocks at 2 weeks arbitrarily and then a second scenario by setting safety stocks for each ABC inventory category as A=98%, B=95% & C=90% for service levels. The comparison will yield a result that Supply Chain Managers can consider regarding differences that could explain whether inventory held could be lowered to meet working capital targets.

3.1 Using Case Study Data for Inventory Modelling

In this study, the various formulas mentioned, will be used in spreadsheet modelling to derive the Theoretical Minimum of inventory to be held and the finished goods result (target days of inventory) will be used to make comparisons between the two safety stock scenarios and actual days of finished goods inventory. For this study, one year of order volume data and a snapshot of inventory held will be used. For each ABC category of warehouse/stock keeping unit, a scenario was set using days cover policies that determined Q and the ROP and for each SKU. The first scenario used a 2-week arbitrary safety stock policy as part of the ROP and this will yield an overall target days of inventory for the 2-week safety stock policy for the organization. Safety stocks will then be determined for every single SKU in 28 warehouses for the organization using the statistical approach mentioned in this study. The safety stock for the second scenario will consider the standard deviation of the warehouse/stock keeping unit data for one-year order history and the overall target days for the organization will be recorded. The overall target days for both scenarios were then be compared with the actual days of total warehouse/stock keeping units held and differences noted and discussed. A similar study (Hung Lau, 2012) also used one year of sales data in attempting to analyze demand management for downstream wholesale and retail distribution. The organization in this study is a FMCG manufacturer and distributor. The organization operates 28 warehouses and distributes the many SKUs on offer to wholesalers, retailers and even directly to supermarkets and hypermarkets. Order volume is based on annual orders received and the inventory held is a snapshot of end-period inventory in the 28 warehouses that it operates from.

3.2 Process of Comparing Target vs Actual inventory

When target stock-in-days (SID) using 2 weeks safety stocks has been determined, the researcher can compare the target days of inventory versus the policy of safety stocks using service levels by inventory categories (Table 7) and make comparisons for a policy that may yield both higher service levels and an optimized target days for each warehouse.

Table 7. Comparison of two scenarios (Safety SID at 2 weeks and Safety SID using service levels) versus actual days of inventory by warehouse

	Target SID	**Target SID**	**Actual SID (average =22.4 days)**
Warehouse	Safety stocks set arbitrarily at 2 weeks	Service Levels used in ROP	
W001	18.37	11.69	34.01
W002	18.55	13.41	21.63
W003	17.53	12.29	17.6
W004	18.60	13.70	28.11
W005	18.45	11.63	17.33
W006	19.13	11.52	21.88
W007	19.46	12.75	25.26
W008	18.68	14.06	26.16
W009	19.40	13.23	18.5
W010	18.59	12.74	16.1

W011	19.13	12.41	12.86
W012	19.61	12.26	17.04
W013	18.57	12.00	27.1
W014	19.23	12.58	22.23
W015	18.64	12.27	19.24
W016	18.84	12.57	25.57
W017	18.89	13.00	16.48
W018	19.02	12.55	40.66
W019	19.94	15.24	24.36
W020	17.64	11.83	17.83
W021	18.98	13.32	25.65
W022	19.47	13.06	9.84
W023	19.26	14.16	25.29
W024	18.76	12.44	21.15
W025	19.64	16.02	29.12
W026	18.30	20.44	29.8
W027	18.43	14.87	27.75
W028	18.64	15.80	10.64

3.3 T-Test

To test the effectiveness of the chosen target SID policy, the following hypothesis had been tested:

H_0: μ Safety stocks 2 weeks SID ≤ μ Safety stocks, service levels SID

H_1: μSafety stocks 2 weeks SID> μSafety stocks, service levels SID.

Based on the findings from Table 8, we can conclude that the variance of safety stocks using service levels SID is significantly lower than the variance of safety stocks at 2 weeks SID and as calculated, the p-value is less than 0.05.

Table 8. T-Test: Two-sample assuming unequal variances

F-test (p-value= 0.0001)		
	Target SID, safety stocks set arbitrarily at 2 weeks	Target SID, service levels used in ROP, A=98%,B=95% & C=90%
Mean	18.87461538	13.41296296
Variance	0.326993846	3.41871396
Observations	26	27
Hypothesized Mean Difference	0	
df	31	
t Stat	14.63899001	
P(T<=t) one-tail	9.01517E-16	

t Critical one-tail	2.039513446
P(T<=t) two-tail	1.80303E-15
t Critical two-tail	2.355568282

The P(F<=f) one-tailed value is less than 0.025 and the P(T<t) two-tailed values is less than 0.05. Hence, we can conclude that there are statistically significant differences between the safety stocks using service levels SID and safety stocks using 2 weeks SID in this study.

4. Discussion

This section reviews the key findings in this study as well as looks at other reasons for variability in supply chains such as variability in transportation and overdependence on one supplier.

4.1 Key findings

Based on the initial findings, the target days using an arbitrarily set safety stocks of 2 weeks yielded a target of 18.87 days versus the actual days held across all warehouses of 22.4 days. The organization in this study used a 2-week arbitrary safety stock policy. When we used a statistical approach, we obtained a target SID of 13.41 days. This is a major drop of 5.47 days that the organization in this study can save by using the suggested statistical approach. Thereby, we can conclude that there are significant differences between both the approaches. ROPs can consider these scientific methods of determining safety stocks so that the probability of meeting demand will optimize levels of inventory held and meet incoming demand for less stock outs. Other reasons for variability that Supply Chain Managers may investigate and aim to comprehend for safety stock determination could also arise from variability of transportation and overdependence of one supplier.

4.2 Variability in transportation

When trucks breakdown or when an organization outsources transportation, another source of demand variation occurs and buffer stocks are also needed. Safety stock decisions must therefore be made under consideration of the impact that the transportation system (Tempelmeier & Bantel, 2015) has on safety stocks. The decision variables are the safety stocks and the in-house transportation capacity (truck fleet size), with regard to holding, in-house transportation costs and shortage costs (Pyke, 1993). A manufacturing and distribution type organization may operate a fleet of trucks to deliver their products to the market either directly to industrial customers or to the various distribution channels such as distributors, wholesalers and retailers. The management of trucks and drivers is a challenging task and there are occasions when trucks break down or when drivers are on leave that may cause delays in the delivery date when it is supposed to be delivered. Additionally, the manufacturing organization may outsource distribution to a third-party logistics (3PL) type organization and allow the 3PL to handle all deliveries using the 3PL's assets and drivers. Similarly, when trucks belonging to 3PLs break down or when their drivers are on leave, there may be delays in the delivery. Sometimes the 3PL organization may wait for goods from other customers to fill a truck and this again causes delays. These circumstances cause variability in transportation and safety stocks may be set by organizations to overcome delays caused by transportation.

4.3Overdependence on one supplier

Another source of variation happens where buffer stocks are needed due to inconsistent supplies. Coordinating lead times and safety stocks (Boute, Disney, Lambrecht, & Van Houdt, 2014) in auto-correlated demand scenarios require the coordination of orders from a retailer or manufacturer. This in turn influences the resulting lead time which in turn also determines the retailer's orders and its safety stocks. Since the retailer must set safety stocks to cover lead time demand, we can say there is a mutual dependency between orders and lead times which requires safety stocks. A supply chain organization may collaborate with one supplier so that fixed assets such as manufacturing equipment and buildings used are not spread across many suppliers and this may bring down total costs when one supplier is used. However, putting all your eggs in one basket and depending on one supplier can have its problems especially when sudden catastrophes occur. Disruptions in supplies can be caused by natural disasters, example, earthquakes, tsunamis, etc. as well as geo-political risks, example, epidemics, terrorist attacks, etc. and other risks associated with the disruption of key material supplies within a supply chain such as forecasting inaccuracies, supplier performance and execution problems. When more than one supplier is used, risks can be spread but there is evidence that many organizations tend to stick with a key supplier for design and delivery of products within a supply chain. When disruptions happen for key single suppliers, safety stocks are needed as buffer.

5. Limitations and Future Research

This study has attempted to consider how safety stocks can be computed arbitrarily using a 2-week target as well as using a statistical method of determining the degree of fluctuation such as the demand standard deviation and applying a z-score to set safety stocks using service levels for inventory categories where A=98%, B=95% and C=90% service levels. 95% service levels are usually used by Supply Chain Managers because it has been found that beyond 95%, the cost curve increases steeply (Figure 7) but where goods are required in life and death situations, a higher service level may be used.

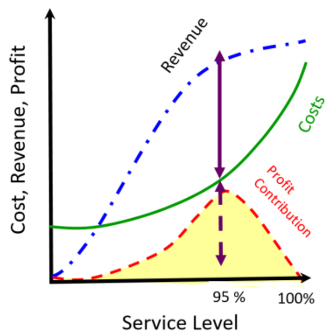


Figure 7.Finding the right balance between Service Level, Cost and Revenue = Maximising Profits

However, the focus of this study will allow Supply Chain Managers who are managing finished goods inventory in FMCG businesses to better manage demand to prevent stock-outs and optimise finished goods inventory held. The field of Sales and Operations Planning (S&OP)

which attempts to balance demand with supply covers a broader area involving forecasting, inventory categorization, inventory replenishment, material requirement planning as well as capacity and procurement planning. There is much scope to expand this study to consider other aspects of S&OP and therefore a major limitation of the study is that it does not cover the full scope of the S&OP process. In addition, the study only covers one organization with multiple warehouses and did not cover broader industry players. But, the value of this study needs to be appreciated because at the heart of inventory management, a Supply Chain Manager could use the findings in this study to better determine safety stocks targets to optimise sales. Based on this study, the Supply Chain Manager may therefore consider strategies to lower inventory, taking into account the growing cost of holding inventory with the aim of reducing slow moving and inventory waste as well consider strategies to reduce variation in demand.

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