

Optimization of Inventory Management using Supplier Evaluation

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Abstract

With the focus of many industries being on supply chain efficiency and Inventory effectiveness, there are various factors that play a major role in affecting the outcome for the organization, prioritizing Inventory control, statistically they are bound to be one of the most variate networks in any supply chain of an organization. The reasoning effectively funnels towards the vast network of suppliers involved merged with the staggering market conditions of unique SKU's that establish unmatched demand with supply

Furthermore, the effect on ineffectiveness of inventory has a crucial cascade, seeping into the financial structure of the organization burning through potential profits that have turned into ashes to be able to never recover.

We plan to establish criteria for an objective evaluation of all suppliers which shall directly/indirectly influence in the organization – quality of the final product, effective usage of inventory, improved inbound/outbound inventory SKU's and not restricted to improved profit margins induced by the above. Adding further, we also establish assignment of penalties or rewards for the potential low-rated or high-rated suppliers, and to be able incorporate direct audits and improvements with one segment of suppliers whilst terminating relationship with the counter segment of suppliers.

Keywords: Supply Chain; Inventory Management; Vendor Rating; Efficiency; Optimization; Supplier Evaluation

1.0 Introduction

Inventory Turnover

Inventory turnover ratio is the total number of times the organisation uses an item in a particular timeframe

The below is the subsequent equations for calculating Inventory turnover:

$$\text{Average inventory} = \frac{(\text{Beginning inventory} + \text{Ending inventory})}{2}$$

$$\text{Inventory turnover} = (\text{Sales} + \text{Average Inventory})$$

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Inventory Analysis

Inventory analysis is that the study of how product supply changes over time and stock the correct amount of products.

ABC analysis is one of the most common practices, which is detailed below:

A inventory: This is the best-selling products that is least in terms space and price. This is assumed to be around 20%

B inventory: B items move at an analogous rate to A items but cost more to store. This represents about 40% of your inventory.

C inventory: The rest of your stock costs the foremost to store and returns all-time low profits. C inventory represents the opposite 40% of your inventory.

Problems faced in the inventories

Inventory management is one of the most complex process in the supply chain. Having an efficient inventory is the biggest asset for an organisation. Here are some of the most common issues:

- Inconsistent tracking
- Warehouse efficiency
- Inaccurate data
- Changing demand
- Supply chain complexity
- Managing warehouse space
- Insufficient order management
- Increasing competition
- Evolving packaging
- Expanding product portfolio
- Overstocking
- Inventory loss
- Poor production plan
- Lack of expertise

1.2 Business-to-Business (B2B)

Business-to-business (B2B), is considered a range of transactions between businesses or organisations, like one involving a manufacturer and wholesaler, or a wholesaler and a retailer. Business-to-business refers to the business that is conducted between companies, rather than between a company and individual consumer.

B2B Model – How Businesses profit on each other

There is a general assumption that customers and businesses are poles apart- the customer being the patron, and so the business being the provider. Shattering these assumptions, the B2B business model introduces us to a plan wherein businesses act like customers too.

B2B might be a sort of business model where the exchange of products and services takes place between two or more businesses. The patron usually isn't involved in these forms of models and comes into play only at a later stage.

A huge chunk of these transactions takes place within the exchange of raw materials.

1.3 Business to Consumer (B2C)

The term business-to-consumer (B2C) refers to the strategy of selling products and services directly between a business and consumers who are the end-users of its products or services. Most companies that sell on to consumers is also stated as B2C companies.

B2C became immensely popular during the dotcom boom of the late 1990s when it had been used to talk over with online retailers who sold products and services to consumers through the web.

1.4 Fulfilment by Amazon (FBA)

Fulfilment by Amazon is a service offered by Amazon, as a way for third-party sellers to automate their order fulfilment and shipping services. It's an easy concept: Sellers sell, Amazon ships. Anyone enrolled in Amazon FBA can let Amazon handle all shipping, including returns and refunds, additionally as product warehousing in Amazon's warehouses, picking and packing, and more.

Sellers send their products to Amazon, who warehouses everything so processes all the orders as they are available in.

What does one involve into with the FBA:

- % 24/7 Amazon customer service
- % All fulfilment and shipping costs included (pick, pack, and ship)
- % Access to 1 of the world's most dynamic fulfilment networks

1.5 Optimization of Inventory

Vendor Ratings

Vendor ratings, also commonly referred to as supplier ratings, are supported a proper system for evaluating organizations that provide products or services to an organization. It's a process during which suppliers are assigned status or a title counting on several parameters. As an example, various factors like price, quality of products delivered, credibility, delivery time, and other mixed variables affect the ratings. The supplier ratings are supported the vendor's performance and may be categorized into multiple levels: good, average, and best, or regardless of the company decides

Different Types of Vendor Ratings

Evaluation with the assistance of accessible data: during this form of evaluation, you'll collect information about the supplier by using papers like financial reports, logbooks, and notebooks.

Post-event evaluation: Here, you need to answer questions like "What happened?" and "How did it happen?" What went wrong? This information aids in your evaluation of the seller.

Pre-event evaluation: During this instance, gather the vendor's past data to work out his skills.

There are supply chain management solutions (SCM) out there with a list module that has vendor rating and evaluation mechanisms

2.0 Literature Review

The main purpose of this paper is to identify the importance of vendor or supplier rating. This paper also aims at

improving certain criteria's, based on the new and developed technology and several inputs from the industry and daily routines

The vendor rating processes in the past have undergone evolution throughout the years, which can be broadly named as:

1. Improved quality
2. Improved computer communication
3. Improved technical capabilities

In vendor rating, it is always important review the past research and determine its proportionality to supplier selection decision.

In the work of Baker and Talluri, 1997 – Braglia along with Petroni in the year 2000 applied to measure the efficiencies of all the suppliers in DEA. There were a total of 9 evaluating factors which had been proposed for each supplier rating. In order to avoid the selecting process in a sub-optimal or “false positive” supplier, both including cross-efficiency and Maverick index were measured.

Talluri and Baker (2002) used a 3-phase approach for the logistics network distribution design. Potential stakeholders, along with suppliers, manufacturers, and distributors had all be evaluated individually in Phase I using DEA. Based on the performance obtained in Phase I and the optimal number of stakeholders to be utilized obtained in Phase II, the optimal routing of material in transit from individual suppliers to manufacturers to warehouses were identified.

3.0 Problem Definition

There are many problems being faced by the inventory.

Lack of visibility is the most common inventory management issue. It is very essential to locate the inventory very quickly.

Visualisation of inventory stock trends, making better decisions on purchase and inventory is difficult. This directly affects the lower threshold of the company.

As companies expand, the process becomes more inefficient and slower.

Implementing inventories which has to be manually driven gets more challenging across different warehouses. Ineffective inventory management often leads to slowing down of operations. Slow shipping of products leads to a decrease in customer satisfaction. Though software solutions are created, improperly designed or obsolete systems do nothing more to the system rather replicate the inventory management manual process. Inefficiency and redundancy are some of the causes of poor inventory management.

Overstocking is another problem which affects the business' profitability. That is the stock which is bought is more than being sold. Overstocking also leads to the escalation of outdated stock.

Imprecise forecasting trends may leave an impact to the company not expecting seasonal ups and downs in demand.

Maintaining inventory records manually makes it very difficult to understand and access inventory data across multiple locations. The problem of selecting the vendor depends on deciding how one vendor should be selected from various potential factors. Hence, the business firms select their vendors accordingly, and thus, the vendor selection becomes a very important strategic decision.

After brainstorming and with the help of industrial experts, to solve the vendor selection problem, we came up with a vendor rating for each vendor which helps the industries to choose their vendors accordingly to gain their profits.

The objective of evaluation aims to recognize and develop reliable and trust worthy relationships with vendors/suppliers/contractors/consultants so that they consistently surpass the upper threshold, expectations and requirements.

4.0 Methodology

4.1 Vendor Rating (VR)

Vendor rating is that the term used when the suppliers are given a standing or a title supported several factors. Factors can be credibility, delivery time, price, quality of the products supplied, and a group of such mixed variables. The ratings are supported the vendor's performance. Therefore, they will have several levels: good, average best, or the firm's decisions.

4.2 Vendor Managed Inventory (VMI)

Vendor-managed inventory (VMI) is a listing common practice within which a supplier of products, who is usually the manufacturer, is liable for optimizing the inventory for which the distributor is responsible. In ancient inventory management, a retailer often makes their own decisions with regards to the order size, while in VMI the retailer shares their inventory data with a vendor (sometimes called supplier) specified the seller is that the decision-maker who determines the order size for both. Thus, the seller is answerable for the retailer's ordering cost, while the retailer has got to purchase their own holding cost. This policy can prevent stocking undesired inventories and hence can result in an overall cost reduction.

5.0 Data Collection

Data collection is that the process of compiling and evaluating information on variables of interest, it generally enables one to answer certain research questions, test hypotheses, and predict outcomes.

The data collection component of this project involved many attributes, which helped in building this model accurately. The attributes are explained intimately below.

Attributes

1. Merchant ID

When a vendor becomes a third-party seller on Amazon, they'll need their merchant ID for the Amazon Marketplace Web Service (MWS). The MWS is Amazon's integrated web service API that sellers use to exchange data on listings, payments, orders, and reports. The MWS has other functions still, all intended to assist sellers grow their business and seamlessly integrate listings, orders, and payment data into their business's existing workflows.

2. ASIN

ASIN stands for Amazon Standard number. It's a novel identity consisting of ten letters and numbers for a product that's assigned by Amazon.com. It's primarily accustomed identify a product within their product catalogue of billions of things.

3. Package dimensions

Package dimensions include the length, breadth, and width of a SKU.

Item package dimensions refers to the size of the individual unit. The size include the unit's packaging, like the individual box or polybag. The item, item package, and case can all have distinct weight and dimensions. FBA fees are supported item package dimensions. All dimensions are taken in inches for this project.

4. Package weight

It is the burden of a given SKU. One among the largest expenses involved in e-commerce is shipping. And one amongst the most factors that influences the value of shipping a product is its weight. Dimensional weight may be a calculation of a package's volumetric weight supported its width, height, and length.

5. Hazmat product

Dangerous goods are substances or materials that will pose a risk during storing, handling, or transporting because they contain flammable, pressurised, corrosive, or otherwise harmful substances.

6. Readily available order quantity

It represents the quantity of packages that are ordered and are yet to be shipped

7. In transit order quantity

The number of SKUs which are shipped, but not yet delivered.

8. Original order quantity

The sum of readily available quantity and in transit quantity gives the initial order quantity.

9. Total quantity

The total number of SKU's present within the warehouse excluding the orders.

10. Sellable and Unsellable quantity

When FBA shipments are shipped to Amazon fulfilment centres (FCs), each unit in your shipment are going to be inspected by Amazon associates to confirm they need arrived in sellable condition and within the correct quantity. If Amazon determines that an item has arrived in poor condition (e.g., packaging isn't any longer intact, item requires repair, has passed the expiration date, or there are signs of mould or corrosion), they'll deem it unfit purchasable, hence, "Unsellable." they're going to then set it aside for removal.

6.0 Data Modelling and Analysis

The end goal being evaluation and rating of suppliers/vendors of an inventory for its optimized management, we establish an initial analysis on the different parameters provided in the dataset followed by a brief description of its identity

For hypothesis testing, a crucial set of parameters are considered and their influence in optimized vendor managed inventory is evaluated

The following were prioritized for choosing of parameters:

1. Direct/Indirect influence
2. Occupied space in the inventory
3. Occupied time in the inventory per unit
4. Moving velocity of SKU's
5. Inbound/outbound rates of the units
6. Advertised quality in the product description page (PDP)

The parameters are first normalised to a score based on their weightage and their direct/indirect influence, and a range of scores along with the bandwidth cases is provided to uniformly quantify the final vendor optimization score

The normalised scores make up the model of vendor optimization score (VOS) which then evaluates individual parameters on an arithmetic scale to output a final score detailing the VOS

Parameter	Algorithm	Normalization of Score
Sell through rate	$\frac{\text{Total units shipped in 90 days}}{\text{No. of units in FBA in last 90 days}}$	0 – 10 : 50 11 – 25 : 100 25 – 75 : 200 > 75 : 350
Glance rate	The number of times customers visited your product detail pages.	0 – 1000: 10 1001 – 2500 : 50 > 2500 : 100
Avg days in Inventory	The average days a SKU stays in the inventory before being shipped/become unsellable	0 – 100 : 200 101 – 300 : 100 > 300 : 25
Density of product	The volume occupied by the SKU per kilogram of weightage (m ³ /kg)	0 – 50 : 50 51 – 100 : 150 >100 : 250
Units shipped in the last 90 days	The cumulative number of units shipped in the last 90 days	0 – 50 : 50 51 – 150: 100 >151 : 300

Although the normalization poses a degree of freedom to the rating, the final VOS is kept similarly deviated with appropriate weightage of the individual score, so that the scope of usage is widen for VOS.

With the above criterion taken into consideration, the model can now evaluate the appropriate algorithm to provide a VOS on a bandwidth with the scales that are user defined with respect to the individual product category SKU.



The defined spectrum of VOS is defined as below the benchmark as VOS = 500 and an excellent optimizer with a VOS > 500 and a poor optimizer with a VOS < 500.

The final VOS is calculated as the aggregate of all the SKUs of the vendor in case of a multiple SKU engagement so that any one SKU does not affect the final score by extreme means.

Analysis of Vendors

Let us consider a few vendors and evaluate their vendor optimization score to conclude on their defined usage of inventory.

Vendor A

Vendor A is identified by the Unique Merchant ID: 1088720241, and its corresponding attribute tuples are provided in the below snapshot of the dataset. As we can clearly see, Vendor A deals with multiple SKUs that vary tremendously in the final VOS, hence the aggregate of all the SKU is considered for the vendor.

The total number of tuples were 75 data rows, and the aggregate VOS was found out to be 831.

Vendor B

Vendor B is identified by the Unique Merchant ID: 25652524605, and its corresponding attribute tuples are provided in the below snapshot of the dataset.

As we can clearly see, Vendor B also deals with multiple SKUs that vary tremendously in the final VOS, hence the aggregate of all the SKU is considered for the vendor.

merchant_id	Sell through rate	Normalised score for sell through rate	avg_days_in_inventory	Normalised score for avg days in inventory	glance_views_t90	Score for glance rate	Density of the product	Score for density	units_shipped_last_90_days	Score for units shipped	Vendor Optimized Score (VOS)
25652524605	246.25	350		200	13431	100	89.22602492	150	1480	300	1100
25652524605	52.30569948	200		200	14911	100	49.40041823	50	1182	300	850
25652524605	53.41269841	200	40.75	200	39684	100	43.54796396	50	2019	300	850
25652524605	0	50	40.75	200	39684	100	43.54796396	50	2019	300	700
25652524605	94.58128079	350		200		10	54.27640616	150		0	710
25652524605	31.34490239	200		200	50437	100	55.43662937	150	1920	300	950
25652524605	9.473684211	50		200	10259	100	20.50827822	50	1445	300	700
25652524605	2.253455142	50		200	17566	100	20.50827822	50	18	0	400

merchant_id	Sell through rate	Normalised score for sell through rate	avg_days_in_inventory	Normalised score for avg days in inventory	glance_views_t90	Score for glance rate	Density of the product	Score for density	units_shipped_last_90_days	Score for units shipped	Vendor Optimized Score (VOS)
193428294402	0	50	253.6666667	100	72	10	42.23997021	50	6	0	210
193428294402	0	50		200	167	10	296.1301993	250	0	0	510
193428294402	42	200		200	95	10	10.50444022	50	0	0	460
193428294402	0.1538461538	50	15.04878048	200	1664	50	296.1301993	250	63	100	650
193428294402	0.1704545455	50	245.5	100	45	10	42.66839573	50	2	0	210
193428294402	0.2052785924	50		200	136	10	45.02474227	50	3	0	310
193428294402	0.1550387597	50	20.33333333	200	292	10	7.771655082	50	7	0	310
193428294402	0.6774193548	50	63	200	237	10	7.771655082	50	4	0	310
193428294402	0.02898550725	50	15.04878048	200	1664	50	7.128183458	50	63	100	450
193428294402	0	50	289.5	100	225	10	35.15637464	50	1	0	210
193428294402	0.3076923077	50		200	29	10	8.674194148	50	0	0	310
193428294402	0.1286764706	50	109	100	645	10	46.16667414	50	4	0	210
193428294402	1.794871795	50	137.75	100	119	10	39.52938388	50	7	0	210
193428294402	0.03921568627	50	137.75	100	119	10	12.64087506	50	7	0	210
193428294402	0.1851851852	50	171	100	103	10	37.11291175	50	1	0	210
193428294402	0	50	77	200	167	10	32.45326457	50	3	0	310
193428294402	0.1927710843	50		200	100	10	42.36793867	50	0	0	310
193428294402	0	50	113.6	100	403	10	39.52938388	50	8	0	210
193428294402	0.08645533141	50		200	4	10	4.328389346	50	0	0	310
193428294402	0.1255230126	50	170	100	97	10	41.9928051	50	3	0	210
193428294402	0	50	157.5	100	111	10	16.22693891	50	3	0	210
193428294402	0.8915662651	50	54.64705882	200		10	23.89210716	50		0	310
193428294402	0	50	64.83333333	200	1008	50	15.86479469	50	37	0	350

merchant_id	Sell through rate	Normalised score for sell through rate	avg_days_in_inventory	Normalised score for avg days in inventory	glance_views_t90	Score for glance rate	Density of the product	Score for density	units_shipped_last_90_days	Score for units shipped	Vendor Optimized Score (VOS)
25652524605	246.25	350		200	13431	100	89.22602492	150	1480	300	1100
25652524605	52.30569948	200		200	14911	100	49.40041823	50	1182	300	850
25652524605	53.41269841	200	40.75	200	39684	100	43.54796396	50	2019	300	850

1	merchant_id	Sell through rate	Normalised score for sell	avg_days_in_inventory	Normalised score for avg days in	glance_views_t90	Score for glance rate	Density of the product (m3/kg)	Score for density	units_shipped_last_90_days	Score for units shipped in	Vendor Optimized Score (VOS)
2	107678864	0	50		200	12958	100	206.2859345	250	0	0	600
3	107678864	0	50		200	12958	100	206.2859345	250	0	0	600
4	107678864	0	50		200	12958	100	72.18473782	150	0	0	500
5	107678864	116.6666667	350		200	69670	100	72.18473782	150	0	0	800
6	107678864	21.98347107	100		200	8601	100	126.5616487	250	105	100	750
7	107678864	0	50		200	64438	100	128.2088422	250	266	300	900
8	107678864	27.99614644	200	625	25		10	15.15829392	50		0	285

1	merchant_id	Sell through rate	Normalised score for sell	avg_days_in_inventory	Normalised score for avg days in	glance_views_t90	Score for glance rate	Density of the product (m3/kg)	Score for density	units_shipped_last_90_days	Score for units shipped in	Vendor Optimized Score (VOS)
66	14796526702	0.1052631579	50		200	17	10	4068.248944	250	0	0	510
67	14796526702	0.0641025641	50		200	19	10	50.27240899	50	1	0	310
68	14796526702	0.0613496932	50	260	100	21	10	92.40740149	150	1	0	310
69	14796526702	0	50	246	100	5	10	55.36391157	150	1	0	310
70	14796526702	0	50	207	100	4	10	59.13415177	150	0	0	310
71	14796526702	0	50		200	2	10	40.14927098	50	0	0	310
72	14796526702	0	50		200	7	10	51.96330012	150	0	0	410
73	14796526702	0	50		200	40	10	44.38110794	50	0	0	310
74	14796526702	0.0636942675	50		200	11	10	44.38110794	50	0	0	310
75	14796526702	0	50	250	100	21	10	27.28649927	50	2	0	210
76	14796526702	0.0641025641	50		200	9	10	27.28649927	50	0	0	310
77	14796526702	7.865168539	50	190	100	7	10	34.26722372	50	1	0	210

The total number of tuples were 8 data rows, and the aggregate VOS was 782

Vendor C

Vendor C is identified by the Unique Merchant ID: 193428294402, and its corresponding attribute tuples are provided in the below snapshot of the dataset

As we can clearly see, Vendor C also deals with multiple SKUs that vary tremendously in the final VOS, hence the

aggregate of all the SKU is considered for the vendor.

The total number of tuples were 1021 data rows, and the aggregate VOS was 303.

Vendor D

Vendor D is identified by the Unique Merchant ID: 25652524605, and its corresponding attribute tuples are provided in the below snapshot of the dataset.

As we can clearly see, Vendor B also deals with multiple

Vendor	VOS	Rank	Description
Vendor A	831	II	With a more than benchmark VOS, the vendor is quite moderately optimized with a more than benchmark inventory management
Vendor B	782	III	The vendor is closing to fall towards the benchmark although the VOS > 500, hence precautionary measures can be advisable to ensure optimization
Vendor C	303	IV	The vendor poorly optimizes the inventory with a VOS of 303, strongly recommending a change in the existing methods of Inventory Management
Vendor D	935	I	The Vendor best optimizes the usage of inventory with a VOS of 935, closing to excellence providing a maximum effectiveness to the Inventory

	C	AK	AL	AM	AN	AO	AP	AQ	AR	AT	AU	AV
1	merchant_id	Sell through rate	Normalised score for sell	avg_days_in_inventory	Normalised score for avg days in	glance_views_t90	Score for glance rate	Density of the product (m3/kg)	Score for density	units_shipped_last_90_days	Score for units shipped in	Vendor Optimized Score (VOS)
65	13702463402	0	50		200		10	50.67504824	50		0	310

SKUs that vary tremendously in the final VOS, hence the aggregate of all the SKU is considered for the vendor.

The total number of tuples were 21 data rows, and the aggregate VOS was 935

Vendor E

Vendor E is identified by the Unique Merchant ID: 107678864, and its corresponding attribute tuples are provided in the below snapshot of the dataset

As we can clearly see, Vendor E also deals with multiple SKUs that vary tremendously in the final VOS, hence the aggregate of all the SKU is considered for the vendor

The total number of tuples were 8 data rows, and the aggregate VOS was 530

SKUs that vary tremendously in the final VOS, hence the aggregate of all the SKU is considered for the vendor

The total number of tuples were 12 data rows, and the aggregate VOS was 318

Vendor G

Vendor G is identified by the Unique Merchant ID: 13702463402, and its corresponding attribute tuples are provided in the below snapshot of the dataset

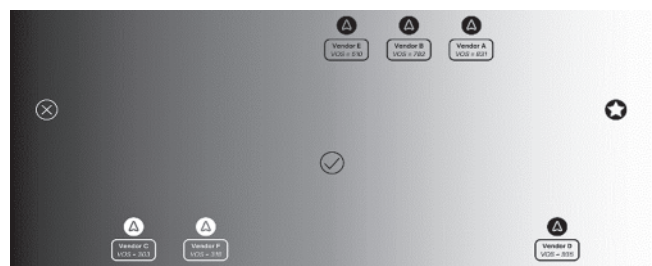
As we can clearly see, Vendor G deals with single SKU.

The total number of tuples was 1 data row, and the VOS was 310

Vendor F

Vendor F is identified by the Unique Merchant ID: 107678864, and its corresponding attribute tuples are provided in the below snapshot of the dataset

As we can clearly see, Vendor F also deals with multiple



7.0 Results

As mentioned in the previous chapters, the VOS scores are evaluated with the standard benchmark (VOS = 500), the relative scores are aggregated in the table above and the result is based on the individual VOS

The VOS is potentially used to determine the final audited quality of inventory management corresponding to the individual vendor/supplier

Since the supplier as whole organise and manages the inventory, an aggregated score is considered for the final conclusions

8.0 Conclusions

Vendors with a staggering VOS (>900) stands to be one of. The top optimized suppliers in the competition, hence potentially enjoying a wide spectrum of benefits and incentives from the organizations such as:

- Zero FBA storage cost
- Zero packing and packaging cost
- Prime deliveries with greater margins to suppliers

Vendors with an average VOS ($500 < \text{VOS} < 900$) stand just above the industry stated benchmark of 500, hence a set of precautionary measures shall be dealt to make sure their VOS does not steep further

A set of incentives can also be paved to encourage the vendors for the growth of their VOS

Vendors with a potential low VOS (< 500) stand below the profitability benchmark of the organization and penalties can be imposed to restrict the optimization leak

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