SKU LEVEL PERFORMANCE EVALUATION IN THE STEEL SUPPLY CHAIN

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ABSTRACT

ACME Steel United States (ASUS) currently uses a simple method of evaluating SKU level performance, Activity Based Margin. The activity component is only considering the variation in the amount of warehouse residence time and impact on cost/margin. All of the other components use a standard costing methodology. Product data is collected from multiple processing plants within the corporation's U.S. operations. Randomly sampled products are used to apply leading practices. This paper evaluates leading practices, and determines whether the current method should be changed and/or include other factors. The results support using SKU profiling by velocity for monitoring and proactively evaluating SKU level performance over what is currently used, resulting in a significant cost savings.

Keywords: SKU Level, Steel Supply Chain.

INTRODUCTION

Effective inventory management requires accurate forecasts for stock-keeping units (SKUs), especially for the strategic ones for companies' operations. A stock-keeping unit (SKU) is essential to efficiently managing the inventory levels of an organization. The SKU is a unique identifier that indicate details about a product and its variations within a particular inventory management system. Proper SKU level management is a significant indicator of the success or failure of an organization (Bartholdi & Hackman, 2008).

According to the World Steel Association, steel is the world's most important engineering and construction material. It is used in almost every aspect of our lives (including automotive, household appliances (air conditioning unit, washers/dryers, refrigerators, etc) and healthcare. As these finished goods are very different, there are more than three-thousand steel variations to fit the various use cases. Steel is produced all of the world, with the top five countries producing over 100 million metric tons of steel in March 2020 alone. However, the largest steel-producing country is China, which constantly produces more than nine times the amount of steel as the next largest country (India). Because of this, it is no surprise that the steel industry was impacted by the COVID-19 pandemic and greatly contributed to the disruptions seen since the declaration of the pandemic. It is interesting to note, however, that China produced almost seventy-five million metric tons of steel in February 2020, but that was not the record low; the record low amount of steel produced by China was in November 2021 when they produced less than seventy million metric tons, which corresponds with the large Delta-variant outbreak China battled around that time (Dhoka & Choudary, 2013).

In addition to lockdowns and COVID outbreaks impacting the amount of steel that could be produced, the steel industry also encountered a change in demand as a result of the COVID-19 pandemic. When people around the world were forced to stay home (and/or limit the amount of outside interactions they had), their energy shifted inward. There was a spike in demand for

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steel that was caused by Do-It-Yourself (DIY) projects and grill/home appliance purchases (Anderson International 2021). That combined with transportation and logistics challenges caused extreme delays for consumers. In turn, prices for steel increased more than three-hundred percent between March 2020 and December 2021. The price increases externally impacted consumers, but internally impacted bottom lines and predictions for the amount of working capital needed to operate (Gates, 1999).

ACME Steel United States (ASUS) currently has over 8,000 finished SKUs, a $156 million dollar working capital investment. There are three business units in the organization. Each business unit enjoys unique dynamics driven by the needs of the market and capability of the supply system. ASUS currently uses a simple method of evaluating SKU level performance that is the same for all areas. Should the evaluation method be changed and should it differ by area and include other (Kofler et al., 2011).

The current "*leading practice"* within ASUS for SKU performance evaluation is *"Activity Based Margin per ton".* The activity component is only considering the variation in amount of warehouse residence time and impact on cost/margin. All the other components use a standard costing methodology. There is a better methodology for monitoring and proactively evaluating SKU level performance than what is currently used.

SKU profiling by velocity is a simple but profound method that classifies inventory based on picking size and by frequency of picking, incorporating aspects of SKU profiling and SKU velocity. This research focus on optimizing the inventory management system for ASUS using SKU Profiling by Velocity. This research investigates a data-driven multiperiod inventory replenishment problem with uncertain demand and vendor lead time (VLT) with accessibility to a large quantity of historical data.

LITERATURE REVIEW

As described by May, Atkinson, and Ferrer, ABC classification assumes different names depending on the criticality criterion considered to rank SKUs. For example, by choosing average unitary cost as the classification basis, ABC takes the name of 'HML analysis', in which SKUs are divided into High, Medium, or Low-cost spare parts. Alternatively, when the ABC classifies spare parts based on demand-related criteria (e.g. average demand, coefficient of variation of demand, or number of withdrawals in DCs), we meet the 'XYZclassification' where X are critical SKUs, Y the moderately critical ones, and Zthe non-critical ones. Finally, when the ABC is carried out using criteria related to impacts from spare part unavailability on a system's functioning, it is called 'VED classification' and classifies SKUs as V – vital, E – essential, and D – desirable.

FSN Analysis

A widely-used method in inventory management is FSN analysis. With this analysis, inventory items categorized into fast (F), slow (S) and non-moving (N). This is done by preparing a list of items and calculating their unit cost, annual demand, annual usage and arranging the items in decreasing order by their annual demand. Next, the percentage of annual demand and cumulative percentage of annual demand is calculated for each item. Once that step

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is completed the inventory items can accurately be categorized into fast (F), slow (S) and non-moving (N) items. F-class items have a stock turnover ratio greater than 3 and the item is an item used heavily. S-class items have a stock turnover ratio between one (1) and three (3) and is used minimally compared to F- class item. Furthermore, N-class items have a stock turnover ratio below one (1). The main objective of this analysis is to minimize the inventory cost such as material cost, turnover cost and labor cost of the company.

XYZ Analysis

XYZ analysis is a strong analysis method to aid in controlling inventory levels in an organization. XYZ analysis classifies inventory items according to variability of demand. X items show very little variation of demand over time, therefore future demand can be reliably forecasted. Y items show some variation but variability can be predicted to an extent over time a specified time period. The factors that affect Y items are usually seasonality, product lifecycles, or economic factors, thus making it more difficult to forecast demand than the X items. The last classification are Z items. Z items have the most variation, making it relatively impossible to forecast demand.

For XYZ analysis to be efficient, it's vital to understand and apply an appropriate time span for assessing demand volatility. For example, if demand for items is seasonal, computing volatility over a month may not be appropriate. Alternatively, where product lifecycles are short, computing the volatility of items with sporadic demand could mean stocked items become obsolete. The benefits of this analysis method are that it improves accuracy of forecasting, helps determine the adequate service level of the organization and reduces stock outs significantly.

Conversely, the drawbacks of XYZ analysis is that the method defines the predictability of the demand among the items. This can become a problem because if, the demand of the product varies significantly, the inventory will be severely affected. Another drawback of this analysis is the categorization of new products. The XYZ method analyzes the variation of demand, which indicates that the company requires data and knowledge to forecast its demand. If a new item is presented, the items are most often placed in the class creating inaccurate results for the category and potentially increasing costs.

SKU Profiling

SKU profiling is a process in which an order fulfillment operation seeks to understand the behavior of its inventory. Proper profiling maximizes space utilization by determining what type of slot is best suited to a particular product. An item’s slotting unit dimensions are then evaluated relative to each slot type’s dimensions to ascertain which slot type(s) can accommodate products with the least amount of space left over in the slot type. Slotting recognizesthe positions, opening dimensions, weight limitations, product grouping, item slotting unit dimensions and weight, item picking unit dimensions and weight, among other factors, to profile and sequence items down the pick path. Changing an item from one slot type to another and/or rearranging its orientation with

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different facings and stackings to align with the product items flow out of the facility can help speed picking, optimize space utilization and reduce replenishment costs.

SKU Velocity

Another method that is widely used to identify characterizing factors of products is SKU velocity. SKU velocity is analogous to FSN analysis in that this practice classifies items by the speed at which an item moves from the warehouse to out of the warehouse. SKU velocity refers to the quantity and frequency of the SKU picked over a designated time period. SKU velocity allows a company to identify the fast, medium and slow movers which, allows each item to be placed in the proper storage medium. High velocity SKUs can then be placed in a readily accessible area for more efficient picking and replenishment. Furthermore, SKUs can be organized according to seasonality or specials promotional opportunities. Thus, applying SKU velocity significantly increases the efficiency of a warehouse's inventory practices and elevates the organization as a whole (Kumar et al., 2017).

When it comes to managing SKU performance, there typically is not a one size fits all solution. Putting all inventory into one material handling technology limits your ability to effectively manage inventory. For the most efficient inventory management strategy, one should mix and match the storage and retrieval technologies with the characteristics of the SKUs. Both methods of SKU level management stated above are heavily used within the industry but, one technology or practice alone is not enough to properly characterize inventory. SKU profiling by velocity incorporates both leading practices into one robust and inclusive strategy.

SKU Profiling By Velocity

SKU profiling by velocity begins with categorizing inventory by pallet, case or piece and SKU velocity whether that be fast, medium, slow or very slow. The inventory is then cross- referenced by the time associated with picking each of these parts against their order frequency. This creates a visual graph that simplifies the process of SKU optimization. The nextstep is to categorize the products by applying an adjusted 80/20 rule. The most dramatic improvements in SKU management will come from applying solutions to entire categories of products, as opposed to improving the movement of just a few SKUs (Ikiz & Utma, 2023).

The 80/20 rule states that 80% of the picks commonly come from 20% of the inventory. This rule must be adjusted because if you focus your picking optimization efforts solely on the fast movers (20% of your inventory) you ignore 80% of your facilities floor space and picking labor demands. The cost of order picking is estimated to be as much as 55% of the total warehouse and DC operating expense. Therefore, if you neglect the order of picking and the travel associated with a product you dismiss over half of the facility's direct labor activities. SKU profiling by velocity ensures that order of picking and frequency of picking are both being applied by out the facility to avoid substantial costs. The third step is to mix & match technologies by SKU Velocity. This step involves matching the requirements of the inventory category to the best technology using criteria such as storage

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density, flexibility, by put, productivity, accuracy, inventory control and ergonomics (Silver, 1981).

By correlating the specific benefits of each type of technology with the inventory classified in the first step, it becomes relatively easy to determine which technologies will meet the picking needs of each category. Therefore, the SKU profiling by velocity method successfully classifies SKUs by size and order frequency to give the optimal storage method for a facility.

A case study was performed highlighting the impact of SKU Profiling Velocity performed on Kubota's part distribution center in Ontario, Canada. Kubota's parts center utilizes a pick and pass strategy with three picking zones. Six horizontal carousels from Kardex Remstar manage the fast-moving SKUs; four Shuttle XP VLMs from Kardex Remstar house the medium moving SKUs, and the slower moving SKUs, are stored in hi-bay shelving. Since then, Kubota's center automated parts distribution center has doubled productivity and recovered 83% floor space with an improved order picking strategy. The utilization of the SKU Profiling Velocity is a powerful strategy that takes the best qualities of two leading practices, further improving efficiency and reducing the cost associated with inventory control.

Inventory management can make or break a company. Often, inventory is the largest item in a organization's balance sheet, therefore issues with inventory management can cause extreme losses for a business. This also means that proper inventory management can become a core competency for a successful company. In the next sections, SKU profiling by velocity in the ASUS Sutner Sheet Plant is performed.

METHODOLOGY

ASUS – Sutner conversion plant created a name for itself as a global steel packaging supplies manufacturer. The Sutner Sheet Plant has become ASUS' largest converter and has solidified itself as a leader in the field. By applying SKU profiling by velocity, the importance ofresearching this method further is demonstrated.

The first step when creating a methodology applicable to a specific facility or process, begins with identifying all the information available and transforming that data into actionable information. The data for the Sutner Sheet Plant was formatted to show the products used solely in the conversion segment of the company. Next, the products were researched to determine the size, weight, storage and handling properties of each SKU in the facility.

This provides the information necessary to determine the correct profiling for each SKU. After identifying the factors related to SKU profiling, the sales data was analyzed for each SKU in this segment to ascertain the frequency at which the product is sold each month Figure 1. By identifying the frequency of each product (SKU velocity) and the SKU profile, the inventory can be properly organized to meet the best needs of the facility. Once the data is completely organized and sorted, SKU profiling was applied by velocity on the information. For the basis of this analysis, six SKUs were randomly selected and assumed that these six products comprise the entire warehouse. By selecting a variety of products, one could determine how each product should be placed in the warehouse to exercise the most effecting picking process. Beginning with SKU velocity, align each product by the

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sales frequency per month. The frequency was determined by dividing the quantity of SKUs by the number of months that it represents (i.e. 28,924/15 = 1,928).

Indicates the fastest products were the 8 ½ x 11 products, followed by the 8 ½ x 14 product and concluded with the 11 x 17 products. This finding is extremely important when organizing the warehouse because it allows the facility to store high-velocity SKUs in a readily accessible and ergonomically friendly area for ease of both picking and replenishment.

FIGURE 1
DISPLAYS THE SALES FREQUENCY OF EACH SKU PER MONTH

Now that the SKU frequency has been determined, SKUs were categorized into fast movers, medium movers, slow movers and very slow movers. Thus, products can be easily recognized and moved into a particular location upon arrival, making the process between inventory managers and warehouse employees more seamless.

SKU Classification

SKU Movement

Sumter Sheet Plant (SKU Quantity in Tons)

SKU	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Total	Frequency
14242	1,575	1,753	2,330	1,701	2,184	2,470	2,079	1,575	2,498	2,620	2,194	3,614	987	1,260	84	28,924	1,928
19228	-	-	-	-	91	2,708	3,907	2,740	3,257	2,775	3,102	3,005	3,252	3,284	389	28,510	2,592
88369	-	-	-	-	-	-	-	-	-	-	639	495	297	514	595	2,540	508
14250	-	-	-	-	-	-	-	-	-	-	32	179	136	316	14	678	136
13161	34	83	16	-	-	-	-	-	-	-	46	155	62	30	3	429	54
95333	93	65	49	2	3	3	-	4	-	-	-	-	-	-	-	219	31
Total	1,609	1,836	2,346	1,701	2,275	5,178	5,986	4,315	5,755	5,395	6,013	7,448	4,734	5,404	1,085	61,300	

FIGURE 2
CLASSIFIES THE SKUS INTO CATEGORIES

It is important to note that ASUS should not focus solely on the fast movers when optimizing picking activities. As stated above, the cost of order picking is estimated to be as much as 55% of the total warehouse and DC operating expense Figure 2. That's because the travel time to pick the SKUs accounts for over half of a facility's direct labor activities. Thus, if ASUS followed the ABC method and focused only on the fast movers (top 20%) they would ignore 80% of the picking demand and facility floor space (Tarn et al., 2003).

At the Sutner Plant, ASUS primarily utilizes the pallet system. All pallets are built off thesheeters on the palletizer, shrink wrapped and stored in the finished goods warehouse by stackingpallets on top of each other (no racking system). As shipments are scheduled, full finished pallets are picked and loaded into railcars or trucks. Since, ASUS already employs a pallet system the organization should determine the ideal location for each product. According to the SKU velocity method, the organization should arrange the products from fastest movers to very slow movers. By doing so ASUS will optimize the pick speed and improve the process of loading and unloading railcars/trucks substantially.

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Once the products are classified by SKU velocity, the process moved to the profiling aspect of the method. This entails determining how to store each product effectively. Implementing SKU velocity will undoubtedly improve the inventory management processes of ASUS, applying SKU profiling to this method solidifies this strategy. The inventory should continue to be ordered from the fastest to slowest movers but, does not account for the storing, dimensions and weights of the products. Figure 3 displays the dimensions and weights for each of the products.

Sumter Sheet Plant									
SKU	MaterialDesc				GradeDesc	Sheets	Carton	Paper Weight (lbs)	Carton Weight (lbs)
14242	STP RED20	#D V145STD 08	1/2X11	S	STAPLES COPY PAPER	500	5000	20	200
19228	MEMMRK 20	#D V145STD 08	1/2X11	S	MEMBERS MARK	500	5000	20	200
88369	HP ECO 18	#D V154CLOK08	1/2X11	S	HP ECOSMART	500	5000	20	200
14250	STPCOPY20	#D V145STD 08	1/2X14	S	STAPLES COPY PAPER	500	5000	20	200
13161	GLOBLHB20	#D BW92STD 11	X17	S	GLOBAL OFFICE HB	500	2500	20	200
95333	ECONO9220	#D V145STD 11	X17	S	ECONOSOURCE	500	2500	20	200

FIGURE 3
SHOWS THE DIMENSIONS AND WEIGHTS OF THE PRODUCT LISTED

Though the dimensions are different, the weights are all the same. Furthermore, ASUS usesa pallet system, thus variety of sizes won't play a huge role in the storage and handling of each product. Therefore, further research was needed to determine how they should be ordered. I found that the HPES (88369) had different storage requirements than all other products, ultimately changing where it should be placed in the warehouse. HPES customers require GMA pallets – the pallets are different sizes so they do not fully utilize the bays. Therefore, if ASUS used just the SKU velocity some of the efficiency would be lost because it doesn't account for the storage and handling aspect of inventory management. Without knowing more detail of the Sutner Sheet plant one cannot specify an exact location for the HPES product but, it should be noted that placing the product in the same location as the other 8 ½ x 11 products would lessen the efficiency of the plant. Once you've successfully determined which inventory goes into which storage technology, consider the minor enhancements you can make within each category. This includes but is not limited to adding pick to light technology, upgrading the inventory management software, adding bar code scanning, integrating a hoist for heavy lifting.

A technology that can be applied to improve the processes at ASUS is the pallet flow rack. A pallet flow rack is deep lane rack in which the shelving is slanted and lines with rollers, so that when a pallet is removed, gravity pulls the remainder to the front. This allows pallets to be put away from one side and retrieved from the other, preventing the storage and retrieval operations from interfering with one another (Vickers et al., 2019).

LIMITATIONS

The limitations of SKU Profiling Velocity are: (1) The strategy doesn't account for the sales value of the products; (2) Products must be closely watched due to changes in

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product frequency (seasonality); and (3)The warehouse must be moved in accordance to frequency changes to maintain efficiency. However, there are numerous benefits, including but not limited to the following: Improved warehouse efficiency; Increased floor spacing; Improved picking frequency; Adjustments to seasonality can be made; Indicates the sales frequency of each product; Improved order processing; Improved inventory management; Reduced holding and stock out costs.

CONCLUSION

SKU Profiling Velocity is an inventory management strategy that ASUS should consider. The implementation of SKU Profiling Velocity will undoubtedly improve the inventory and SKU management by creating a more efficient warehouse, picking and order process. Having the abilityto quickly categorize and sort inventory according to frequency and behavioral characteristics streamlines and simplifies the warehousing activities for managers and employees. This method can reduce the costs with little investment because the improvement will come from better use ofthe assets already on hand.

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REFERENCES

Bartholdi, J.J., & Hackman, S.T. (2008). *Warehouse & Distribution Science: Release 0.89*, 13.

Dhoka, D.K., & Choudary, Y.L. (2013). XYZ inventory classification & challenges. *IOSR Journal of Economics and Finance*, *2*(2), 23-26.

Gates, B. (1999). Business@ the speed of thought. *Business Strategy Review*, *10*(2), 11-18.

Ikiz, A.K., & Utma, G.H. (2023). Combined forecasts of intermittent demand for stock-keeping units (SKUs). *World Journal of Applied Economics*, *9*(1), 1-31.

Kofler, M., Beham, A., Wagner, S., Affenzeller, M., & Achleitner, W. (2011). Re-warehousing vs. Healing: strategies for warehouse storage location assignment. In *3rd IEEE international symposium on logistics and industrial informatics*, 77-82.

Kumar, Y., Khaparde, R. K., Dewangan, K., Dewangan, G. K., Dhiwar, J. S., & Sahu, D. (2017). FSN analysis for inventory management–Case study of sponge iron plant. *International Journal for Research in Applied Science & Engineering Technology (IJRASET)*, *5*(2), 53-57.

Silver, E.A. (1981). Operations research in inventory management: A review and critique. *Operations Research*, *29*(4), 628-645.

Tarn, J.M., Razi, M.A., Wen, H.J., & Perez Jr, A.A. (2003). E-fulfillment: the strategy and operational requirements. *Logistics Information Management*, *16*(5), 350-362.

Vickers, A.J., van Calster, B., & Steyerberg, E.W. (2019). A simple, step-by-step guide to interpreting decision curve analysis. *Diagnostic and prognostic research*, *3*(1), 1-8.

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