Improvement of Kanban Inventory System Management

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Abstract *— An increase in scrap of Kanban inventory has been reported in a medical device company. The main causes of the reported condition are the lack of visibility of inventory levels and inadequate execution of firs-in-first-out practices in the shop floor. The processes regarding the release and allocation of the product manufactured per three product families were evaluated. An inventory tool that allows information to flow from the release of material to Kanban Area to the requisition conducted at downstream operations was implemented. This significantly improved the prioritization of work-in-process based on expiration risks.*

Key Terms *— Lean Manufacturing, Waste, Overproduction, Just-in-Time (JIT).*

INTRODUCTION

A business unit pertaining to a medical device company manufactures sub-assembly (SA) product codes pertaining to three product families, which are supplied as critical components to a variety of manufacturing lines. The sub-assembly product codes are denominated as critical components due to their time-sensitive nature per material composition. Therefore, these products have an established shelf-life requirement of 16-weeks per product specification. Work in process (WIP) material is properly identified with labeling material that includes variable information regarding the lot number, SA product code and expiration date prior to being allocated to the designated Kanban area per product family.

The business unit has a high inventory level of WIP material which requires to be allocated and consumed in the manufacturing of finished goods work orders (WO). Per current manufacturing practices, the prioritization of material consumption in a first-in-first-out (FIFO) manner is solely based on personnel performance regarding the assessment of the physical inventory availability when addressing service request per finished good demand. The lack of information regarding the traceability of WIP material, as well as constraints based on expiration date, has led to the disposition of inventory as scrap due to the shelf life of the SA being surpassed prior to consumption.

The medical device company has the need to reduce costs associated to inventory scrap. Current practices regarding the assessment and management of the Kanban inventory do not assure the prioritization of material consumption in a first-in-first-out manner based on expiration risks. Having an inventory tool helps improve the manufacturing and consumption by giving the manufacturing shop floor visibility of upper and downstream demands of SA inventory volume, as well as mitigating expiration risk based on the prioritization of WIP material through information regarding the date of manufacturing.

LEAN MANUFACTURING

Manufacturing is defined as the activity of adding value to raw material through the change of their fit, form and function, and supplying the resulting product to the end customer [1]. The means by which the product transformation is accomplished consist of the combination of five elements identified within the manufacturing process regarding storage, delay, transportation, processing, and inspection of the materials [1]. The only element that adds value in manufacturing is processing, nonetheless, material movement and inspection are necessary periods required in the processing of materials in some degree. The remaining elements referring to storage and delay, which can be defined as stagnation periods, are considered wasteful elements.

The main source of wastes in the manufacturing process are associated with overproduction and excessive inventory, which can be based on either a continual production regardless of the amount of WIP at the downstream process or the development of a safety stock to mitigate the impact of raw material shortages when producing finished goods. There are two fundamental principles to achieving an ideal material flow; these are to create a pull system method for which only the amount required for downstream process is produced, and to level production to supply the different product codes required as a cycle stock by selecting the appropriate batch size.

To identify and eliminate the distinct forms of waste regarding stagnant periods in the manufacturing process, the just-in time (JIT) continuous improvements tool is implemented. JIT system is fundamentally a pull system, in which a preceding process produces the required number of units to replace the quantity consumed by a subsequent process [2]. The product demand in this type of system is transmitted by means of an information tool denominated as Kanban. There are two main physical identifications that can be implemented in the Kanban system for information recollection regarding material flow in the following two aspects referring to material withdrawal and production [3]. Thus, the implementation of an efficient Kanban system yields a higher output with lower inventory; thus, reducing the manufacturing costs which can be associated with production process variation by controlling one of the variables, referring to material.

Inventory is a necessary response to system variation so that production rate can be maintained [2]; thus, through a Kanban system an optimum inventory level is maintained to provide the manufacturing work center flexibility and responsiveness to address changes in product yield and demand. In principle, the objectives of a Kanban system are to simplify daily control for production and to improve production capabilities from a long-range point of view [2].

METHODOLOGY

Production Volume per Product Family

Current manufacturing shop floor Kanban designated areas were evaluated and information regarding the lot number, sub-assembly product code, lot size, date of manufacturing and expiration was gathered as part of this activity. In conjunction to this assessment, a Voice of the Customer (VoC) exercise was conducted with the area supervisor and team leaders to identify value adding information required for the development of the inventory tool. Once these activities were completed, the Kanban inventory tool was developed and populated with the data recollected.

Per the evaluation of the Kanban inventory, it was identified that SAs pertaining to Product Families Y and X are manufactured at a higher volume than SAs pertaining to product Family Z. As shown in Figure 1, for Product Families X and Y, production work orders are generated monthly. For these product families the SAs manufactured enter a greater inventory hold period when compared to SAs pertaining to Product Family Z, which are manufactured at a lower frequency.

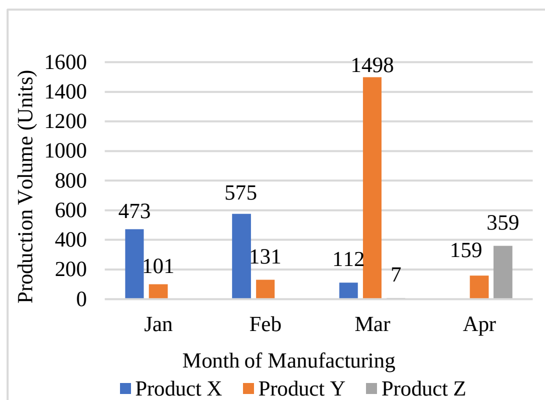

Figure 1
Production Volume per Product Family per Month

Figure 2 represents SA inventory availability at the end of the month of April 2022. Inventory level of Product Family Y corresponds to 1,889 units distributed in the manufacturing of eight different product codes and 30 lots. Inventory level of Product Family X, the 1,160 units are distributed in the manufacturing of four different product codes and 19 lots. Furthermore, inventory level of Product Family Z corresponds to 366 units distributed in the manufacturing of three product codes and four lots.

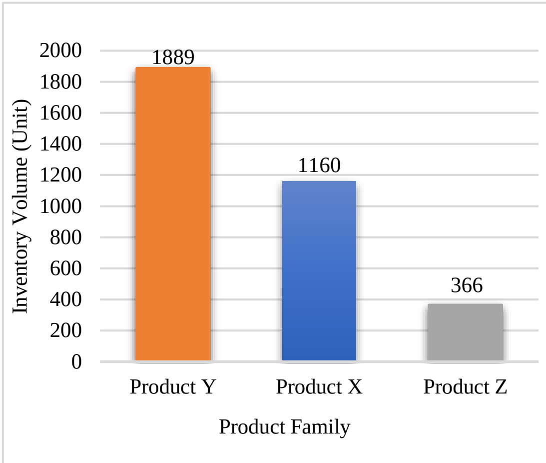

Figure 2
Sum of Inventory Units per Product Family

Production Assessment: Pristine and Non-Pristine Inventory Management

Current manufacturing process of the SAs per the critical operation of unit formation can yield visual defects for which material manufactured must be allocated to alternate smaller finished good products to maximize unit consumption and reduce units scrapped. As part of the manufacturing process, prior to the release and allocation of material to the Kanban inventory storage, unit inspection and segregation is conducted and material is allocated within two categories, regarding pristine and non-pristine units. Figure 3 gives a representation of the yield of non-pristine units; furthermore, Figure 4 gives a representation of the yield of pristine units per the manufacturing process for each Product Family.

Per the analysis of non-pristine inventory, as shown in Figure 3, the yield of visual defect on SA product codes is observed to be consistent; furthermore, the production volume identified as non-pristine on a monthly basis is greater for product codes pertaining to Product Family X in comparison to the other two product families. Per the assessment conducted for Product Families Y and Z led to the identification that these two product families share the same critical operation, which comprises the transformation of the raw material into the finished sub-assembly product code. Product Family X is subjected to different variable as the manufacturing work step differs in the equipment used for processing.

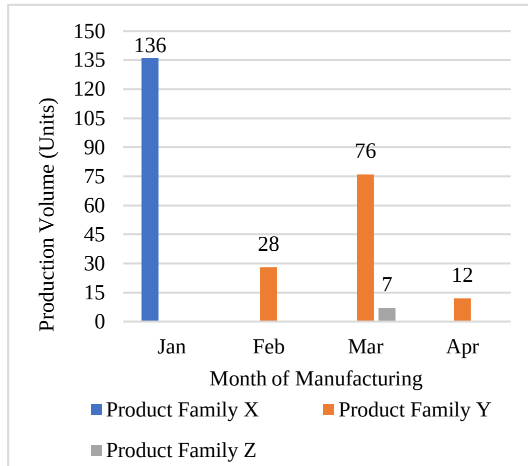

Figure 3
Sum of Non-Pristine Inventory per Product Family

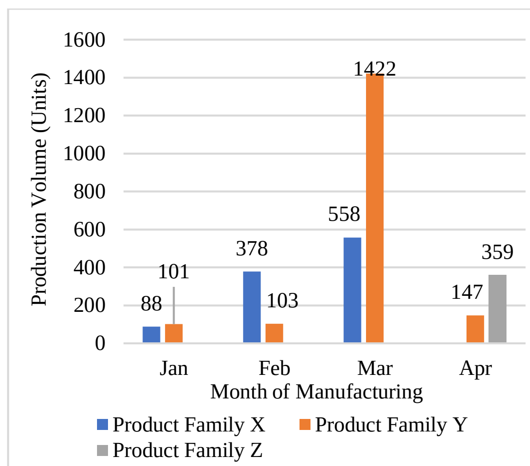

Figure 4
Sum of Pristine Inventory per Product Family

Further assessment was conducted for Product Family X manufactured during January 2022. It was identified that non-pristine units' generation is solely associated with SAX-1, as seen in Figure 5. SAX-1 is the largest size manufactured at the business unit being addressed.

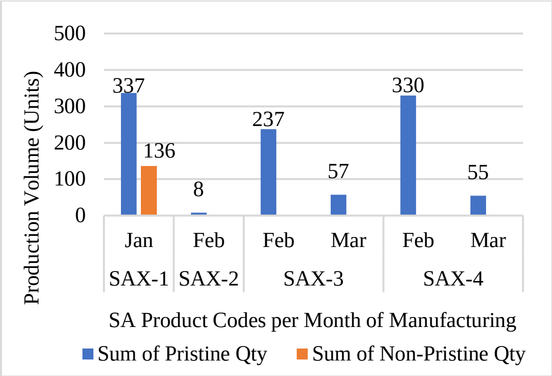

Figure 5
Inventory Assessment for Product Family X

Kanban System Assessment

Per the assessment of the manufacturing processes, it was identified that the staging of the sub-assemblies manufactured is not standardized between the three product families pertaining to the business unit. For Product Families X and Z, the entirety of the lot manufactured is segregated within a single polybag and identified with an inventory label containing variable information and a material withdrawal card. Based on the bill of material requirement of Product Families X and Z, one entire sub-assembly lot is consumed per each finished good work order regarding end item finished lot size.

For Product Family Y, one sub-assembly lot is greater in size than a finished good work order which has a bill of material with a smaller lot size. In order to address proper material allocation per the material requisition process of the finished good work order, the SA units manufactured identified as pristine are packed in polybags containing a maximum of twenty units each; each polybag containing a withdrawal card containing unit balance and variable information. The polybags of pristine SA pertaining to the lot assessed are placed within an identified and clean plastic bin, which is identified as well with an inventory label containing variable information and a material withdrawal card. The units categorized as non-pristine are segregated within a polybag, identified, and allocated into a separate Kanban area identified for these units pertaining to Product Family Y.

Based on finished good bill of material configurations, the standardization of SA lot storage configurations between product families is not required.

Results

Based on the information gathered, it was identified that there are designated Kanban storage areas for Product Family X and Product Family Y; nonetheless, there is no designated Kanban storage area for Product Family Z. This is due to the nature of JIT manufacturing conducted for product codes pertaining to Product Family Z which has low production rates; nonetheless, a higher output is yielded with lower inventory. For Product Families X and Y, there is a higher level of inventory which is not being readily consumed in downstream operations; thus, waste regarding overproduction and inventory were identified. In addition, based on the high inventory level of the product families aforementioned, it is suggested to increase the storage capacity of the Kanban areas pertaining to the product families by adding an additional three level storage cart.

Per the implementation of the Kanban inventory tool developed, as shown in Figure 6, shop floor practices were assessed and structured through guidelines to ensure the proper prioritization of WIP material based on expiration risks. The inventory tool developed and implemented is to be accessed by manufacturing personnel executing the material release operation to enter information regarding the lot and product code manufactured, as well as the inventory transactions conducted regarding material classification as pristine and non-pristine, and expiration date.

Based on the manual entries conducted, the inventory tool provides a counter as a visual aid of days remaining for material consumption based on expiration risks. This inventory tool is accessed by team leaders and the area supervisor on a daily basis to assess the master manufacturing production schedule. The discussion of Kanban Inventory soon to expire material was incorporated into the daily forum held with Manufacturing Manager and Supportive Areas, such as Planning, Quality and Engineering.

Product Family X Kanban Inventory Manufacturing Line							
Lot Number	Item Number	Pristine Qty	Non-Pristine Qty	Date of Manufacturing	Expiration Date	Expiration Risk (Days remaining for inventory consumption)	Material Allocation Comments
PFX-22-1	SAX-1	0	136	1/21/2022	5/13/2022	20	
PFX-22-2	SAX-1	88	0	1/24/2022	5/16/2022	23	
PFX-22-3	SAX-1	78	0	1/24/2022	5/16/2022	23	
PFX-22-4	SAX-1	3	0	1/26/2022	5/18/2022	25	
PFX-22-5	SAX-1	168	0	1/26/2022	5/18/2022	25	
PFX-22-6	SAX-3	4	0	2/7/2022	5/30/2022	37	
PFX-22-7	SAX-3	61	0	2/8/2022	5/31/2022	38	
PFX-22-8	SAX-4	64	0	2/8/2022	5/31/2022	38	
PFX-22-9	SAX-3	55	0	2/9/2022	6/1/2022	39	
PFX-22-10	SAX-3	53	0	2/9/2022	6/1/2022	39	
PFX-22-11	SAX-4	63	0	2/17/2022	6/9/2022	47	
PFX-22-12	SAX-4	61	0	2/18/2022	6/10/2022	48	
PFX-22-13	SAX-4	61	0	2/20/2022	6/12/2022	50	
PFX-22-14	SAX-2	8	0	2/22/2022	6/14/2022	52	
PFX-22-15	SAX-4	18	0	2/23/2022	6/15/2022	53	
PFX-22-16	SAX-4	63	0	2/23/2022	6/15/2022	53	
PFX-22-17	SAX-3	64	0	2/25/2022	6/17/2022	55	
PFX-22-18	SAX-3	57	0	3/3/2022	6/23/2022	61	
PFX-22-19	SAX-4	55	0	3/3/2022	6/23/2022	61	

Figure 6
Representation of Inventory Tool Developed

CONCLUSION

The principles of Lean Manufacturing were implemented during the evaluation of current Kanban inventory system in order to maximize value adding activities. Per the evaluation conducted at the manufacturing shop floor, it was identified that in order to increase the efficiency of the current system, an information system was required in order to provide visibility of inventory levels, as well as shelf-life constraints regarding the lead time available in order to consume material in downstream operations. The inventory tool implemented ensures the prioritization of material consumption in a first-in-first-out manner based on expiration risks. A function displaying days remaining for material consumption in conjunction with a color guide were incorporated into the tool to provide a visual aid of soon to expire inventory.

In conjunction with the development and implementation of the inventory tool, guidelines were provided to the manufacturing personnel regarding the purpose and requirements of this prioritization tool, which was incorporated into the daily forum where business unit’s requirements for service, inventory and quality are discussed with upper and middle management personnel. It is recommended that the business unit maintains the discussion of SA Kanban Inventory to improve mix attainment per the generation of the required work orders and mitigate impacts based on pass due work orders based on changes in product demand.

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