

IMPROVING AND OPTIMISING SPARE PARTS INVENTORY MANAGEMENT

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Introduction

With increasing market globalisation, the spare parts logistics in Asia-Pacific region has prospered to achieve high business margin for corporate profits. Managing spare parts inventory is challenging. Organisations are realising the higher customers' expectations on quality and prompt after-sales support to ensure spare parts availability. This is mainly because end customers hope to extract the maximum value from products by extending products' lifecycle.

In order to satisfy customers, organisations need to deliver the right products, in right quantities and the right conditions, to the right place at the right time for the right customer at the right price. However, there will be tremendous cost implications when organisations try to improve the current supply chain to transport and stock spare parts in a more efficient, reliable and timely manner. Figure 1 shows a detailed flow of the continuous sequence of stock replenishment and reduction to meet demand.

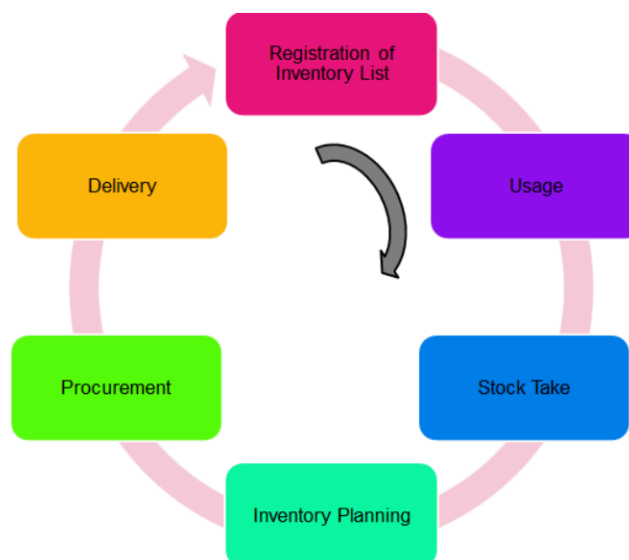


Figure 1: Basic Spare Parts Management Flow

Global Part Centre Singapore (GPCS) is an after-sales division of Company A, a printer manufacturing company. This company aims to progressively emerge to gain and retain end-customers through competitive advantage.

Current Spare Parts Management

GPCS spare parts are delivered in two modes. The first mode is to deliver spare parts under warranty service for repair. Whenever end customers (consumers) purchased printer from Company A, there will be a warranty contract binding Company A to provide free replacement of spare parts for a limited period. Once the printer becomes faulty, end customers will send it for repair at respective service centres. Some repair will require replacement of spare parts so service centres will purchase them from GPCS.

The second mode of delivering spare parts is for after warranty purposes. When end customers send their out-of-warranty printer for, they are required to make payment for the replacement of spare parts and services. It is important to ensure spare parts availability for both under warranty and after warranty repair because it can boost the confidence of end-customers to retain and attract new customers.

Using demand forecasting system and liaising closely with the world-wide service centres; GPCS calculates the quantities to procure spare parts from both in-house and original equipment manufacturer (OEM) suppliers. At any time, there will only be one supplier for each SKU.

When the stocks arrive at the warehouses, GPCS will allocate the necessary quantities to customers by issuing 3rd Party PO in SAP to instruct the warehouses to pick and pack stocks for delivery.

In GPCS, there are both make-to-service and make-to-stock replenishment methods. The critical orders need to be satisfied immediately will be fulfilled with spare parts make-to stock. Replenishment quantities for make-to-stock can be derived by adding safety stock quantities to the multiplication of GPCS forecasted future demand quantities and lead time. The less critical maintenance orders can be satisfied with make-to-service spare parts where customers provide a fixed lead time and GPCS will not plan safety stocks. Some examples of make-to-service spare parts are user manuals and software CD-ROMs. The reason for not stocking safety stock for user manuals is because paper can obsolete fast by turning yellowish and delivery key performance index (KPI) will improve given that customers provide a fixed demand lead time. Inventory management in GPCS is much more complex as it involves conflicting objectives across various organisation segments and tentative nature of supply and demand.

In Figure 2, the production lead time refers to the time required by supplier(s) to source raw materials and produce according to Purchase Order (PO) requirements. The production lead time for each spare part varies. This is due to the necessity to ensure clean room (a controlled environment with lowest level of pollutants) availability for clean parts production, acquiring of new moulds or kitting of child parts (Dekker, 2013). Transportation lead time is the duration needed to bring spare parts from a stock location (e.g. suppliers' premises) to service network (e.g. warehouses) and service centres (e.g. GPCS' customers). Depending on the mode of transport and geographical distances, ocean transportation lead time can take up to a month to reach end customers. One of the important deciding factors to determine which warehouse to stock the spare parts is dependent on the total lead time required from the point where GPCS issues SPR to fulfilling the customers' orders.

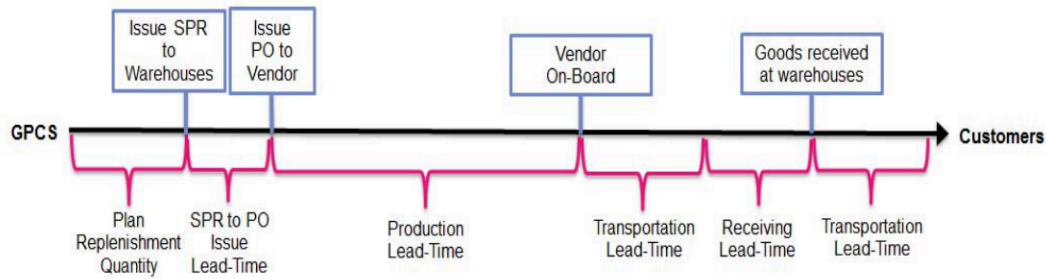


Figure 2: GPCS Spare Parts Process Flow Map

More than 50% of GPCS' sales orders cannot be fulfilled in a month. GPCS like other organisations across the industries is looking for ways to fulfil their commitments to customers by improving response time.

To achieve perfect order fulfilment, GPCS must deliver spare parts with complete and accurate documentation without delivery damage. This is often very difficult to achieve in practice as demand is uncertain. For instance, spare part failures are dependent on the cannibalism of other spare parts and how users use and maintain the printers. Especially when the dependence relation is unknown and there is no accurate information, these uncertainties will cause erratic demand and have an immediate impact on spare parts inventories. The tentative nature of unpredictable supply and demand is shown in Figure 3.



Figure 3: Tentative nature of unpredictable supply and demand

Therefore, it is necessary for service centres to provide quick repair of a product or system that is faulty. To guarantee a high service level, spare parts need to be stocked appropriately at some points in the supply chain

Scope of this Study

As shown in Figure 4, the main scope of this project will focus on the replenishment planning for spare parts within GPCS to ensure stocks availability to Company A's (multi-national company, MNC) service centres world-wide. The replenishment planning is on the upstream of the supply chain.

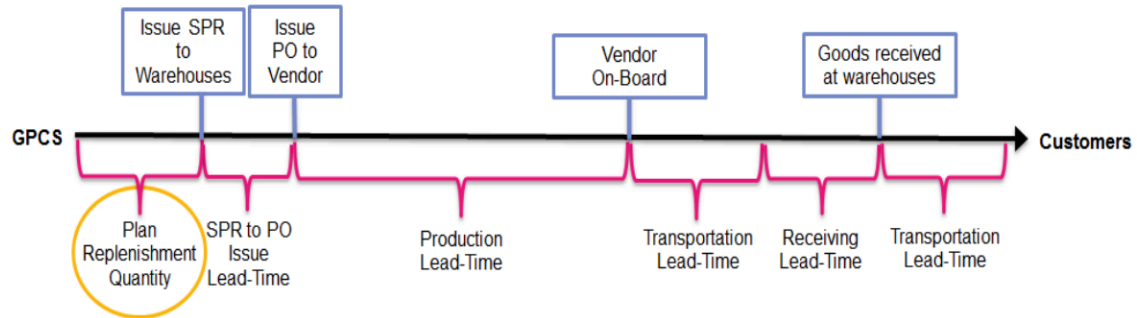


Figure 4: Scope of study in GPCS' Spare Parts Process Flow Map

Challenges

Often an unexpected event like customers being awarded a contract with government agency or some big companies can completely turn GPCS planning upside down because of the higher service standard required. This is because both parties would usually enter a contractual agreement with GPCS promising to deliver spare parts within a certain timeframe known as time-based service level. The first reaction is for GPCS to increase safety stock. However, this project aims not only to increase the safety stocks but propose solutions during replenishment planning to improve spare parts availability and customers' satisfaction.

Figure 5 shows the different departments of GPCS seeking to increase or decrease inventories. Though each has differing viewpoints, they share the same goal of achieving better profitability.

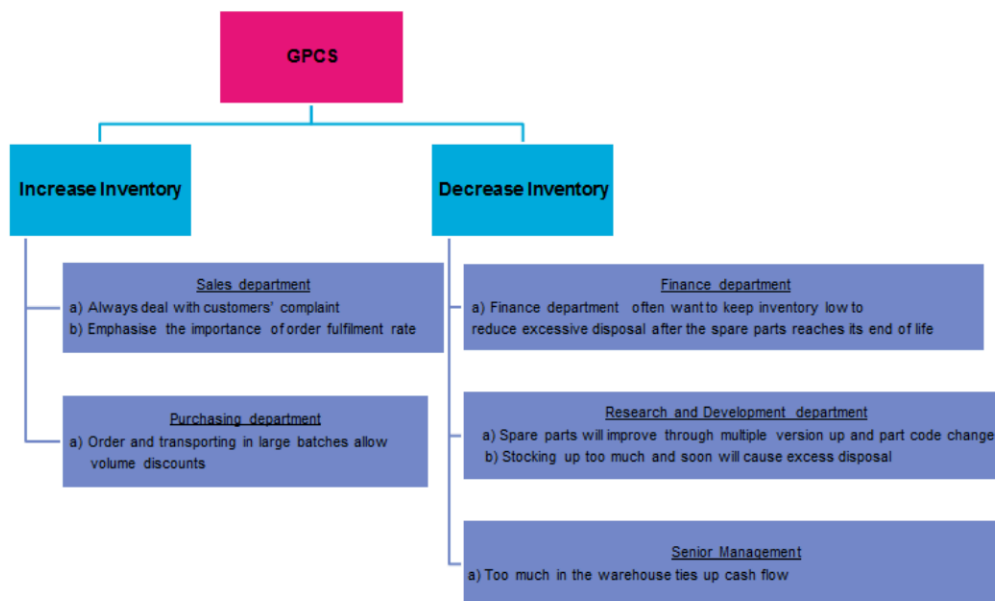


Figure 5: Conflicting Objectives in GPCS

Hit Rate

Hit rate is a form of performance measure indicator for order fulfilment. It is defined as the percentage of meeting customer orders within the time window (Wheatley, 2014). Figure 6 shows the increasing GPCS hit rate and decreasing outstanding sales orders. Figure 7 shows the decreasing stock amount at GPCS warehouses. Comparing Figure 6 to Figure 7, an increasing "hit" ratio is achieved at a lower stock amount. This implies GPCS is keeping the right spare parts for higher stock turnover.

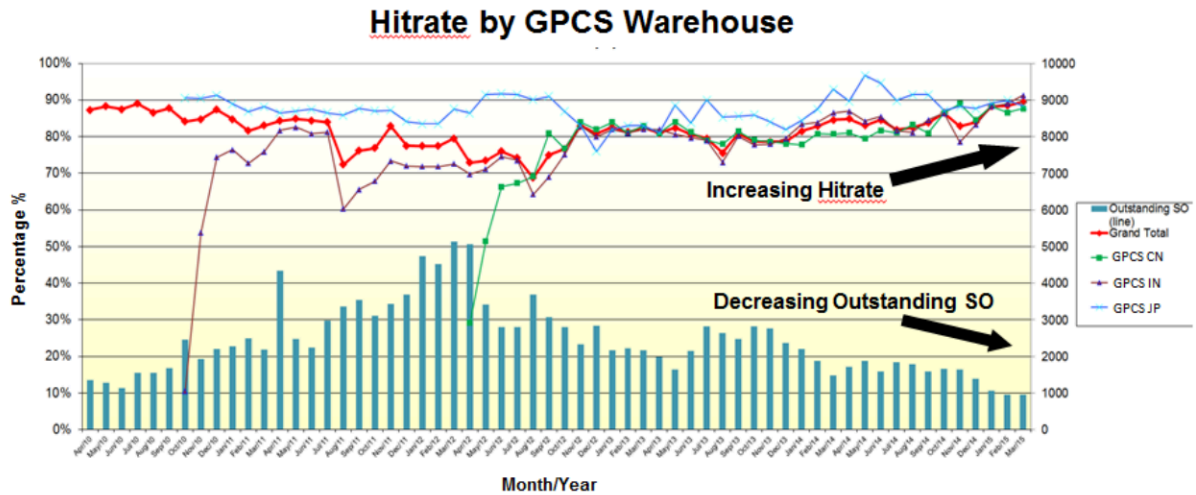


Figure 6: Hit rate by GPCS Warehouse

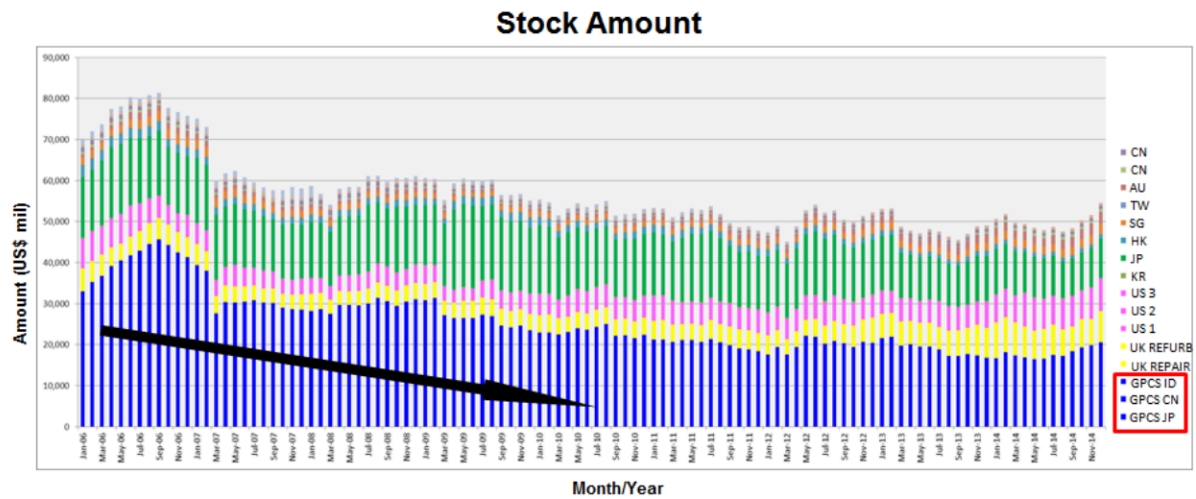


Figure 7: Stock Amount by GPCS Warehouse

Improved Inventory Policy

In order to efficiently compete in the market, GPCS is reviewing its inventory management to concentrate on areas to produce significant and short-term results (Wintle & Patch, 2003).

Safety Stocks

The current stocking policy in GPCS is based on product categories. Among the different product categories, GPCS can focus on part classification with high volume and low hit rate (Figure 8).

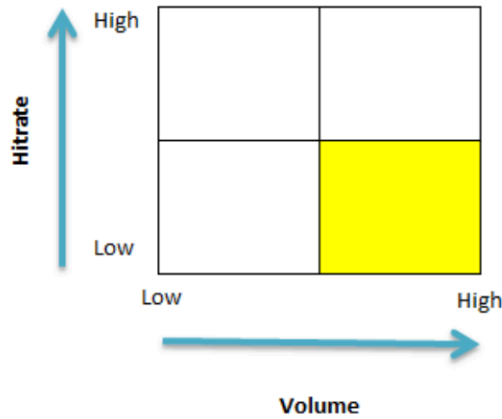


Figure 8: Matrix of Hit rate and Volume

As shown in Figure 9, the Pareto Analysis identified 20% of the part classifications to represent 80% of the sales. Having GPCS to spend time to focus on these 20% can produce 80% of the results. The top 20% of the part classifications are namely mainboard, I/S supply assy/ unit, panel and printer mechanism.

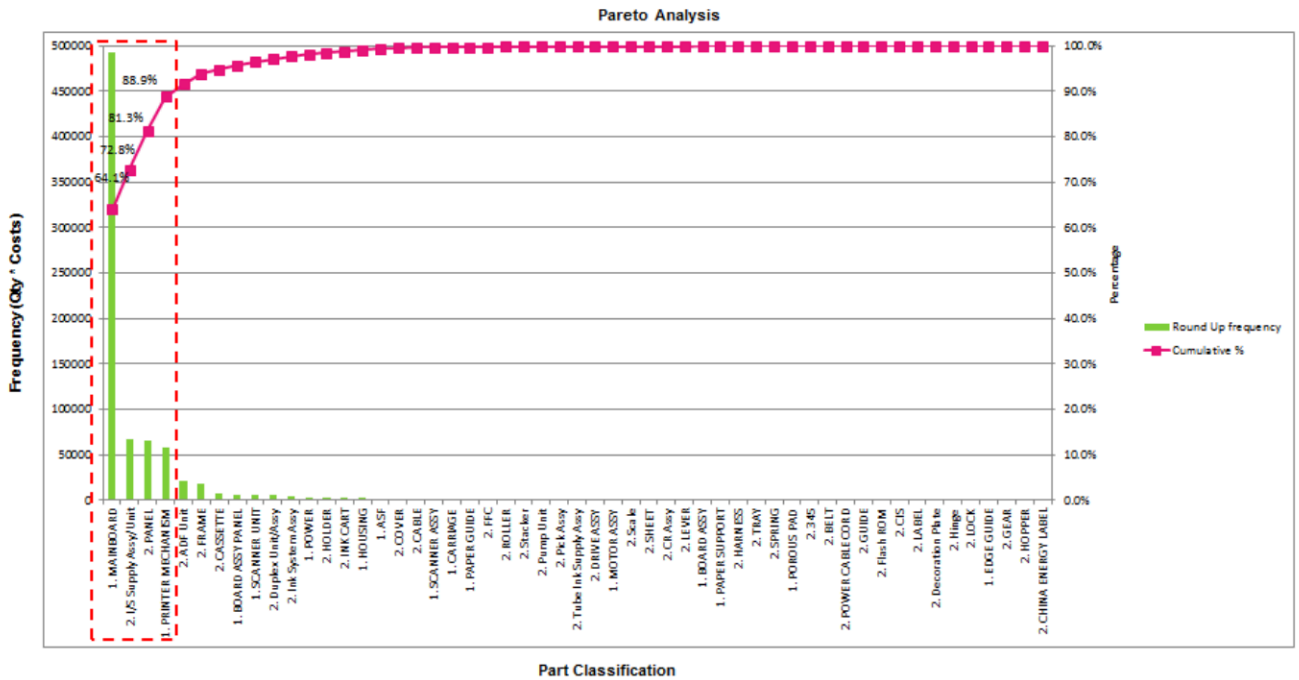


Figure 9: Pareto Analysis

Minimum stock quantities

Slow and recently introduced parts tend to have intermittent demand character and lead time is uncertain. Unlike moving parts, the re-order point for slow and recently introduced parts cannot be determined easily. This is mainly due to the insufficient sales history to generate forecast quantities. It is important to select the best inventory policy to improve customer service and reduce inventory holding costs.

Business Printers

Compared to other product categories, unit costs for Business Printers' spare parts are relative expensive and they will experience more frequent part change due to quality issues. The management of GPCS needs to consider the impact judiciously.

To avoid excess disposal due to minimum stock policy, the scope of targeted parts should shrink. For instance, spare parts which are created more than three years ago with no sales should be removed from the target part list. The reason for setting three years is because the printer should have already entered its mature stage in product lifecycle. If there is no sale within the three years, it simply reduces the probability of them having any demand in future.

Table 1 shows the average customers ordered quantities in the past one year. It shows the percentage of sales order (SO) lines that can be covered by the minimum stock quantities. For instance, if GPCS were to ensure that all Business Printer spare parts in the target list to have at least 10 pieces on-hand stock at all times, GPCS is expected to be able to cover 29.7% of total Business Printer sales order lines.

Summary (Business Printer)

Monthly SO Qty	Average Number of Part Codes (Monthly)	Average Number of SO Lines (Monthly)	Cumulative Number of SO Lines	Cumulative % of SO Lines
1-5pcs	118	150	150	17.2%
6-10pcs	66	109	259	29.7%
11-20pcs	69	124	383	43.9%
21-30pcs	25	72	455	52.2%
31-40pcs	14	57	512	58.7%
41-50pcs	7	20	532	61.0%
> 51pcs	67	340	872	100.0%
Total	366	872		

Table 1: Monthly Order Pattern (Business Printer)

The simulation results are shown in Table 2 to Table 4. According to the simulation results, the option of keeping minimum stock quantities at 20 pieces will allow GPCS to achieve the highest Delivery On Time (DOT) improvement of 5.9% at a moderate inventory amount increase of \$ 86908.82 and Days of Supply (DOS) improvement of 10 days. Moreover, it can cover approximately 43.9% of Business Printer SO lines per month. In option 1 and 2, the different minimum stock quantities are applied to parts based on its importance. For example, the most important spare parts will be assigned to minimum stock quantities of 20 pieces and the least important spare parts will be assigned to 5 pieces in Option 1.

DOT

	Jan'15	Feb'15	Mar'15	Average DOT %	
Business Printer DOT (Actual)	82%	75%	76%	77.7%	
Minimum Stock Policy	Jan'15	Feb'15	Mar'15	Average %	Improvement
Business Printer DOT Option 1 (min stock = 5pcs, 10pcs, 20pcs)	85%	77%	81%	81.1%	3.4%
Business Printer DOT Option 2 (min stock = 10pcs, 20pcs, 30pcs)	87%	79%	83%	83.0%	5.3%
Business Printer DOT Option 3 (min stock = 10pcs)	85%	78%	82%	81.8%	4.1%
Business Printer DOT Option 4 (min stock = 20pcs)	87%	79%	85%	83.6%	5.9%

Table 2: DOT Improvement for Introducing Minimum Stock Policy
(Business Printer)

Inventory Amount

Minimum Stock Policy	Actual	Increase by	Improved Final Inventory Amt
Business Printer Option 1 (min stock = 5pcs, 10pcs, 20pcs)	\$ 775,789.88	\$ 50,869.01	\$ 826,658.89
Business Printer Option 2 (min stock = 10pcs, 20pcs, 30pcs)	\$ 775,789.88	\$ 147,640.29	\$ 923,430.17
Business Printer Option 3 (min stock = 10pcs)	\$ 775,789.88	\$ 37,790.70	\$ 813,580.58
Business Printer Option 4 (min stock = 20pcs)	\$ 775,789.88	\$ 86,908.82	\$ 862,698.70

Table 3: Inventory Amount Increase for Introducing Minimum Stock Policy
(Business Printer)

DOS

Minimum Stock Policy	Actual (days)	Increase by	Improved Final DOS (days)
Business Printer Option 1 (min stock = 5pcs, 10pcs, 20pcs)	90	6	96
Business Printer Option 2 (min stock = 10pcs, 20pcs, 30pcs)	90	17	107
Business Printer Option 3 (min stock = 10pcs)	90	5	95
Business Printer Option 4 (min stock = 20pcs)	90	10	100

Table 4: DOS Improvement for Introducing Minimum Stock Policy
(Business Printer)

Conclusion

Due to the costs involved in holding inventory, it will aim to hold the minimum amount possible while still being able to satisfy orders from its customers. In this study, several stock increase simulation have been conducted for slow moving and recently introduced critical product categories like Business Printer to improve order fulfilment rate. Taking into consideration the DOT improvement and inventory amount increase, GPCS management is recommended to implement minimum stock policy of 20pcs for Business Printer. In order to achieve effective inventory management in the competitive changing demand market, it is important that GPCS conduct quarterly reviews on the minimum stock policy. Besides procuring parts from suppliers, GPCS can consider to buy back excess quantities from customers to reduce the overall inventory in Company A.

Strategic stock increase for minimum stock quantities have to be implemented in different phases so that it will not affect Company A's financial performance. Introducing the minimum stock quantities is not a one-time application. It needs to be reviewed regularly on a monthly basis. Minimum stock quantities may be adjusted according to market demand. Due to the time constraint of this project, GPCS should also consider to optimise the inventory level of the moving parts by studying the inventory situation further. Solution Effect Analysis can be used to check on the effects that the proposed solutions will cause. This ensures that having agreed on a solution will not cause another problem to occur.

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