

Chapter II

Case Study: Background and Problem Analysis



2.1 Business Overview

Hard disk drive (HDD) business is currently under the oppressive economics situation, which can be described in the way that there is excessive supply in the market and fluctuation of customer demand. The HDD industry has witnessed dramatic structural change and strong competition in the last few years, with increased levels of consolidation and restructuring activity taking place in the industry. The merger of Maxtor and Quantum took place in 2001. In 2000, Seagate split into two parts, with the hard drive group becoming a private concern. Technology of hard disk drive is rapidly developed in order to correspond with future technology. As a consequent, HDD competition is one of the toughest businesses at this moment. The HDD industry has been plagued by falling profit margins and consolidation has enabled disk drive manufacturers to benefit from economies of scale and more cost effective manufacturing. Such consolidation, however, does cause concerns that the HDD market is being left with too few vendors; a situation that can lead to supply shortages in the future and that could impact the HDD industry's growth into new markets. Low profit levels are already making it difficult to undertake the capital investment required for advances in technology and to break into new and emerging markets. Moreover, customers are growing more sophisticated and price sensitive and tend to have less manufacturer brand sensitive and more accepting of reseller brands and generics. Fluctuating customer requirements and competitive forces are putting more pressure on marketing and are demanding superior marketing strategy and tactical execution. Case studied company objective is to meet customer requirement, on time delivery, service levels and achieve the responsiveness level. To achieve the objective, case studied company is required to meet customer requirement, on time delivery, service levels and achieve responsiveness level. To meet the mentioned objectives, it is highly dependent on company ability to effectively react to dynamic demand and uncertainty environment.

2.2 Company Background

Case studied company is the hard disk drive (HDD) manufacturing factory. The manufacturing facilities will incorporate leading edge manufacturing technologies for assembly and testing of case studied company's high performance and high capacity products. The products, which are high technology hard disk drives, can be categorized as three main groups:

1. 1 " HDD Products: Digital Camera compatible
2. 2.5 " HDD Products: Laptop Computer compatible
3. 3.5 " HDD Products: Desktop Computer and Server compatible

Hard Disk Drive (HDD) is a leading storage device for computer and other computerized systems. There are four main dominators in HDD manufacturing: Seagate, Maxtor, Western Digital, and Hitachi.

2.2.1 Hard Disk Drive Manufacturing Process Overview

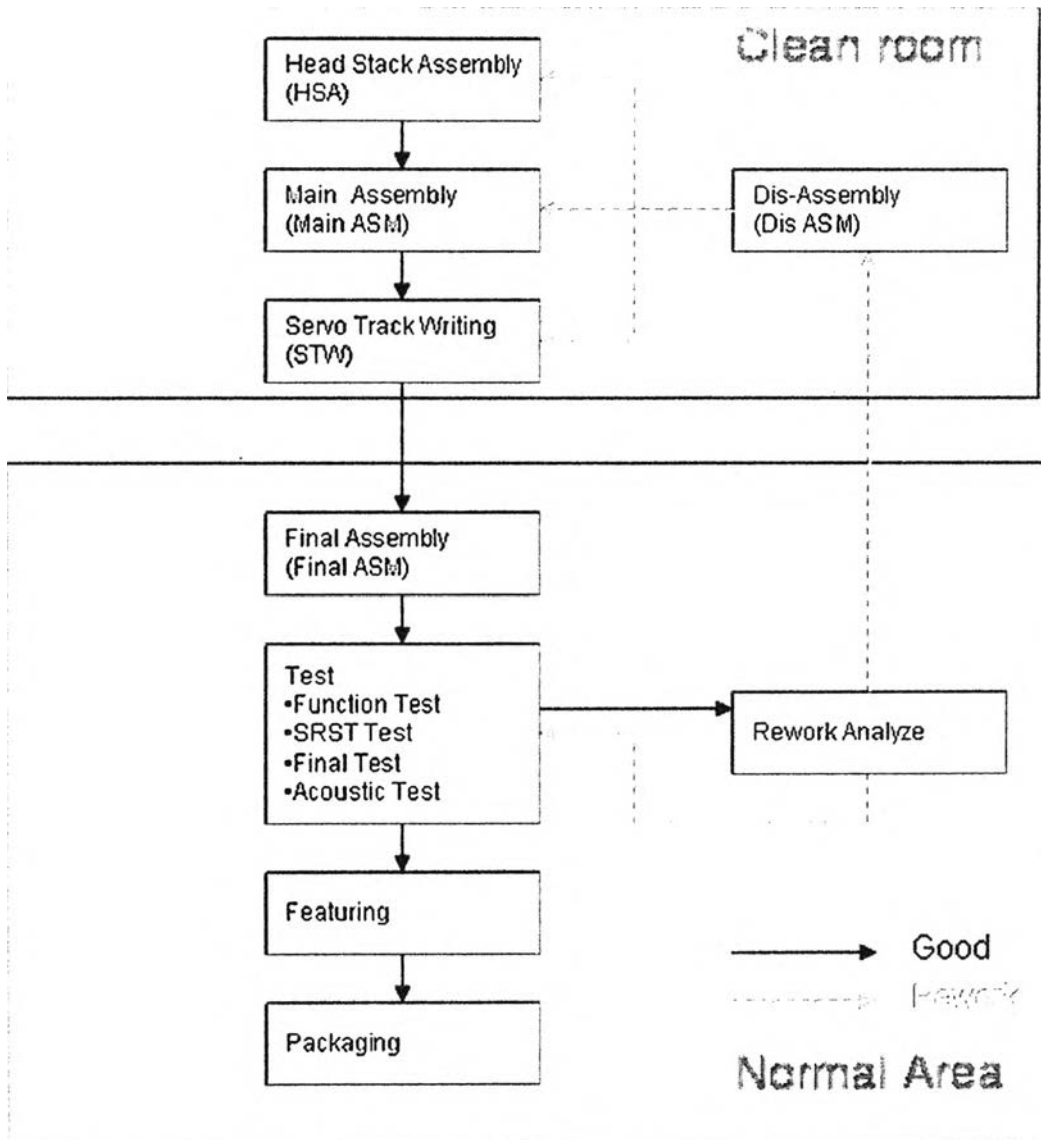


Figure 2.2.1 Hard Disk Drive Manufacturing Process Flow

The process of Hard Disk drive manufacturing consists of nine major processes and the processes are as follow:

- 1) Head Stack Assembly (HSA): This is the first stage of HDD assembly wherein the Head Gimbals Assembly is mounted on the tips of actuator blocks. Assembled with flexible printed circuits, coil and unit bearing.

- 2) **Main Assembly (Main ASM):** Main Assembly is where the required number of disk media is determined and stacked onto a DC motor separated by spacer rings. Head insertion is the process where the Actuator Assembly bearing the MR Heads is matched with the Spindle Assemble carrying the Disks. The two assemblies are combined carefully positioning the head in between disks. The combined assemblies are then mounted on a base with matching cover to complete the Disk Enclosure (DE).
- 3) **Servo Track Writing (STW):** STW process consists of two major stages. The first stage writes the master servo pattern on all disks. The second stage writes the proper servo pattern on all disks surface by referring to the master.
- 4) **Final Assembly (Final ASM):** Printed Circuit Board Assemble (PCBA) Mounting is the first process done outside the clean-room. This is where the PCBA is installed on Disk Enclosures to complete the Hard Disk Drive
- 5) **Test:** Hard Disk Drive is subjected to a series of function and reliability tests to ensure its superb quality. Function tests are conducted to calibrate the basic functions of the HDD. Moreover, the drives are subjected to a 24-hour Self-Running Test at high temperature. The drives are also subjected to 4-corner tests where varying conditions of high and low temperature and maximum and minimum voltage are simulated.
- 6) **Featuring:** Featuring is the process which, upload the customer's data into actual HDD units according to customer's requirement.
- 7) **Packaging:** The HDDs are packed and sealed with the highest standard of quality. The drives are stored in a temperature and humidity controlled environment and handled with utmost care to preserve its quality.
- 8) **Rework Analyze:** The HDDs that failed out from the series of test will be identifying the physical problem by Rework Analyze process. After the

problem identification, the reworked HDD will be transfer to proper process in order to rework it.

- 9) Dis-Assembly: Dis- Assembly process is the process which located in Clean-room and the major function is to tear off the defect part from the HDD before sending to the next appropriate process.

From the figure 2.2.1, there are two material flows, one is the good units and another is the reworked units. The failed unit from the series of test process will instantly transfer to Rework Analyze process in order to analyze the cause of defect. After analyzed, the cause of the failure and the reworking process will be identified. Finally, the failed units will again transfer to the identified process in order to rework until rework units become finished good.

2.2.2 Supply Chain Management Overview

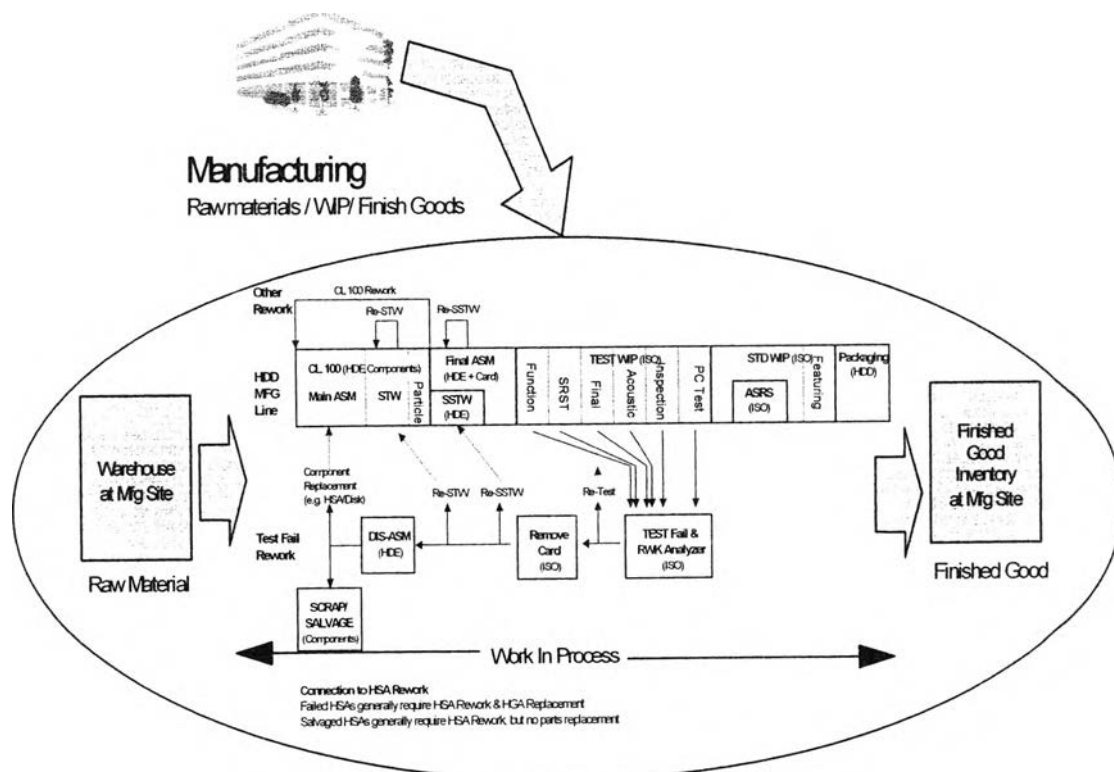


Figure 2.2.2 Supply Chain Management

From figure. 2.2.2, type of inventory in supply chain management of case studied company can be virtually categorized as three items:

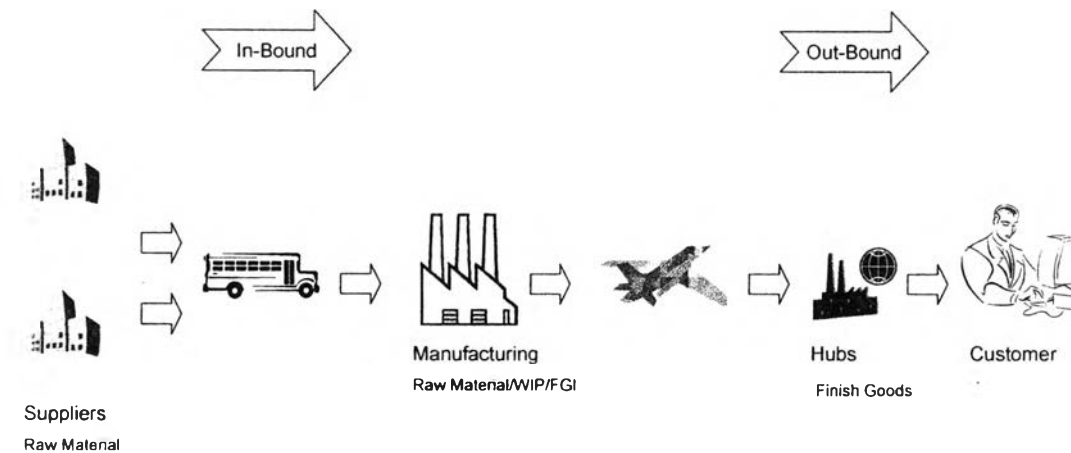


Figure 2.2.3: Logistics Flow of Hard Disk Drive Manufacturing

1. Raw Materials: case studied company's suppliers can be categorized to two major groups; one is the local supplier, which are located in Thailand and another one is oversea supplier, which are located outside Thailand. Raw materials will become case studied company's inventory after case studied company received raw materials to warehouse and some raw materials will be requested to pass the incoming inspection from Component Engineering department.
2. Work In Process (WIP): WIP is started right after raw materials transfer to manufacturing assembly line. In hard disk drives manufacturing, there are nine major processes and the lead-time of each product are quite different, it depends on the manufacturing design of each product.
3. Finished Goods: In case studied company's supply chain management, finished goods inventory exist in three areas, which are manufacturing area, in-transit area, and logistics center hubs. Case studied company's Logistics center hubs were established based on geography.

Inventory can be easily explained as the stock of any item or resource used in an organization. Inventory is one of the riskiest decision areas in supply chain management. Commitment to a particular inventory diversity and subsequent market allocation in anticipation of future sales represent the supply chain management. Without the proper diversity of inventories, marketing problems can be developed in revenue generation and customer relations. Additionally, material requirement planning and inventory management are critical to manufacturing operations. Raw material shortage can shutdown the production line or require modification of production schedule, which in turn, introduces added expense and potential of finished inventory shortage. Just as shortages can shut down disrupt planned marketing and manufacturing operations, overstocked inventories can also create problems. Overstocks increase cost and reduce profitability through added warehousing, capital tie up, deterioration, excessive insurance, added taxes, and obsolescence. Inventory is the focus of two conflicting corporate objectives: maintain inventory large enough to provide good customer service and smooth plant operations, and small enough to limit the financial investment and risk.

2.3 Problem Analysis: Existing Situation

To analyze the problem for existing situation, element of part supply are required to examine both separately and cooperatively.

2.3.1 Element Check list

Before start developing the material management system, all elements concerning with material are suggested to be checked. There are eight categories for element check list.

Element Check List

Customer Ordering Characteristics	
Order Timing Order Size Delay in Order Processing Order Cycle Order Type	
Demand Patterns	
Variability Ability to Forecast Demand time frame Any Dependent Demand Substitution Demand History	
Supply Situation	
Supplier name Lead Time Reliability Flexibility Ability to Expedite Supply Commit (after demand send) Minimum Orders Discount (Volume, Freight) Availability Alternate Part Receiving Inspection Supplier and Transportation Lead Time Inventory Turnover	
Cost Factors	
Acceptable Stock Out Carrying Costs Expediting	
Nature of Product	
Repairable (Rework or Reused, and Number of Time of Rework) Part Cost Safety Stock Scrap Ratio	
Other Issues	
History of Shortage History of Expediting Customer Service Target	

Figure 2.3.1 Element Check List

2.3.1.1 General Details

1. **Part Number:** Unique alphanumeric designation for part. Normally, part number length is about 10 to 20 range but not over than 30. Part number may combine a coding sequence which represents characteristics of each part.
2. **Part Name:** Part name is a shorten version of part description. Generally, engineering established the standard part name in order to identify part purchase for specific supplier.
3. **Part Description:** Specific description of part should be consistent with part name to make easy understanding. Again, engineering established the standard format for part description.
4. **Commodity:** A commodity is any homogenous item which identify for the same understanding among companies. Commodity is a generic term covers a wide range of items which logically grouping of inventory based upon user defined characteristics.
5. **Part Characteristic:** Parts may have a variety of specific characteristics which serve to further differentiate them from other parts. Characteristics include length, width, height, diameter, and electrical properties, etc. All parts cannot be identified by the same standard character.

2.3.1.2 Customer Ordering Characteristics

1. **Order timing:** Order timing means the period of time when company issues the purchase order to suppliers. Order timing can be daily, weekly, monthly, or yearly depends on agreement between company and suppliers.
2. **Order Size:** Order Size means the size of each order which also depends on lot size, agreement with suppliers, and order methodology.

Lot size can be easily explained as the quantity of an item to make or buy at one time. Lot size depends on economy of scale, quantity discount and, delivery efficiency. Lot size is one of the factors that need to be considered thoroughly since it relates to cost of ordering and cost of storing. Inappropriate lot size certainly incurs unnecessary cost.

3. Delay in order processing: Order processing means the system to create, cancel, or modify the purchase order. This item is the check list to examine the problem of order processing that caused the delay of order processing.
4. Order Cycle: Order cycle sometimes called replenishment cycle. Order cycle refers to the time between orders of a specific item. The calculation method for order cycle is to divide the order quantity by the annual demand and multiplying by the number of days in the year.
5. Order Type: Type of order for each part supply for instance Purchased Order or Scheduled Agreement.

2.3.1.3 Demand Pattern

1. Demand Variability: Demand Variability means the inconsistency of the demand in certain period. Variation can be tracked by using tracking signal. A tracking signal can be used to monitor the deviation trend of actual demand from forecast. This provides a numeric value that can be compared to a reference value or range centering on zero.

$$\text{Tracking Single} = \frac{\text{Running Sum of Forecast Errors}}{\text{Mean Absolute Deviation}}$$

2. Demand time frame: Demand within the time frame is accumulate to determine the total order quantity. Time frame quantity is commonly used with system which sum and review demand using bucket. Bucket can be daily, weekly or monthly depend the requirement of company.

3. Ability to forecast: Ability to forecast means that the given demand has an accurate promised date and correct type of requirement.
4. Demand History: Demand history is a chronological record of demand broken down into forecast periods. The amount of historical data depends on the nature of the business. From the study, slow moving items are required to account more demand history in order to create an accurate model of the demand.
5. Any dependent demand: Apart from independent demand, there is another demand so called dependent demand. Dependent demand is the demand of lower level of BOM which generated from independent demand. Therefore, dependent demand is not a forecast quantity but the calculated number.
6. Substitution: Substitution means the replacement of part supply by another part supply either from the same supplier or other suppliers.

2.3.1.4 Supply Situation

1. Lead times: Lead time is one of the most important parameters in MRP. In this case, lead time means lead time after purchase order released until the receiving of part supply or supplier lead time. Long lead time is possible to reduce the accuracy of forecast. In general, lead time is the amount of time from the point at which you determine the need to order to the point at which the inventory is on hand and available for use. Normally lead time should include the following details
 - i. purchase order or work order including approval steps
 - ii. time to initiate
 - iii. time to notify the supplier
 - iv. time to process through receiving and any inspection operations

2. Reliability: Supplier Reliability is very important for improving supply chain. Supply visibility from reliable supplier will definitely support company on forecasting. Supplier performance can be used as a tool to measure supplier reliability. Supplier reliability can be improved by using variety of solutions. Reducing the supply complexity, employing strategic sourcing solutions, improving supplier quality by business intelligence tool can also assist the company on this issue. However, company needs to select the suitable tool and level of detail. Basically, at the commodity level, suppliers need to be focused on cost, quality and delivery. For company that, have one or two strategic suppliers, process improvement may make more sense.
3. Flexibility: Supplier flexibility can be measured by the responsiveness of supply once the demand has been changed, sometimes called changeover flexibility. Another flexibility related to changeover flexibility is volume flexibility, the ability to produce whatever volume the customer needs. To increase the supply flexibility, Vendor managed inventory (VMI) is an alternative solution to assist the improvement. VMI is a partnership solution allowing company to responsible on replenishment of inventory. Meanwhile, the supplier is responsible for the inventory and is obligated to maintain a high fill rate of inventory. Theoretically, the implementation of VMI will be beneficial for both parties. The supplier gets more business and reaps the financial rewards of just-in-time inventory, which in turn reduces labor and warehousing costs. However, the difficulty of VMI implementation is VMI is taking time to pay for itself. Another difficulty of VMI is for small company which cannot compete with bigger competitor.
4. Ability to expedite: Actually, supplier lead time includes backlog, cycle time, and normal shipment time. There are some constraints on expediting order which are manufacturing lead time and availability of components. Expediting lead time provides and indication of lead time



which may be possible if the company is willing to pay extra expenses for urgent shipment.

5. Minimum Orders: The smallest order quantity which party, supplier and customer, agree together.
6. Discount (volume, freight): Suppliers usually encourage company to place and purchase large order by offering quantity discounts. If company places the larger quantity than a specified price break quantity, supplier will reduce the unit price of the part for the company. However, company is required to elaborately calculate the optimum purchased order due to unit cost may be lost by accruing higher inventory holding cost. There are two types of discount one is all units discount and second is increment discount. All units discount mean if the order purchase is larger than price break quantity, then all units will get the discount. Increment discount means if the order purchase is larger than price break quantity, only those units over price break quantity will get discount.
7. Availability: Supply availability means there always part supply available once the company is requested from supplier.
8. Alternate Part: When the primary part is shortage, alternate part will be selected and allow to be used. Normally, alternate part tends to be more expensive than the primary parts. Alternate part is quite difficult to manage and plan effectively since the shortage always occur unexpectedly.
9. Receiving Inspection: Receiving Inspection is checking that the goods or services are in a satisfied condition according to the prior contract. The receiving inspection would typically different from each component depend on supplied material criteria. The amount of inspection should be compatible with the risk or inconvenience.

Detailed inspection is always performed on major component due to the rectification could be expensive and time-consuming.

10. Supplier and transportation Lead time: Time duration from Order released to supplier to receiving material at company.
11. Inventory turnover: Inventory Turnover is a measurement of basic efficiency to indicate how many times a company's average inventory is sold during a period of time, which can easily explain as how quick a company sells the products.

$$\text{Inventory turnover} = \frac{\text{Cost of goods sold}}{\text{Average amount of inventory}}$$

Low turnover is a sign of inefficiency and can be implied that inventory in company is hardly produce and sell out to customer.

2.3.1.5 Cost Factors

1. Stock out: Stock out means the number of part supply shortage. Company should determine the acceptable percentage of stock out.
2. Carrying costs: Carrying costs is the cost for holding inventory from the received date to disposed date.
3. Expediting costs: The cost of extra expenses that company is required to pay for any urgent shipment.

2.3.1.6 Nature of Product

1. Repairable: Repairable is an ability to be rework or reused and number of time of rework.
2. Part cost: Part cost is a standard cost for each part.
3. Safety stock: An inventory quantity which planned to have for in the case of future uncertainty.

4. Scrap ratio: Scrap Ratio is a percentage added to the normal part supply requirement in order to compensate manufacturing loss.

2.3.1.7 Other Issues

1. History of shortage: The historical data of shortage situation that company had faced. The history of shortage shows the number of time and quantity of part supply that had been insufficient and may caused the production line down in the past.
2. History of Expediting: The historical of data of part supply expediting that company had expedited through the supplier in the past. Part supply expediting can be described as a near future part supply problem, however, it can be solved by urgent delivery of part supply. Urgent delivery of part supply means that supplier was requested to deliver the part supply earlier than the promised date. History of expediting sometimes came from dramatically demand change, manufacturing process yield problem, or inaccurate MRP result, etc.
3. Customer service targets: Customer service targets can be in several forms. They include on time delivery to customer, buffering against uncertainty, and meet customer requirement. The example of customer service targets are as follow:
 - i. Quality Level: The largest quantity of defectives in a certain sample size that can make the lot definitely acceptable.
 - ii. Responsiveness: Responsiveness is the criteria to measure the flexibility of suppliers to react according to dramatically demand change.
 - iii. Service Level: In theory, target of company is to minimize the part supply shortage situation. Part Supply shortage cost money from lost sales, lost customers, and costs of back order. Therefore, company should carry sufficient safety

stock so the cost of carrying the extra inventory plus the cost of part supply shortage is a minimum. In HDD market, customer service is a major competitive tool and part supply shortage cost is very expensive. Theoretically, part supply shortage is quite difficult to identify and service level is a management decision and company marketing strategy. From the study, it was shown that the chances of a part supply shortage is directly proportional to the frequency of reorder which mean more often of stock is reorder, the more often there is a chance of part supply shortage.

2.3.2 Cause and Effect Diagram

The cause & effect diagram was invented by Kaoru Ishikawa, whose expertise in quality management. The objective of cause and effect diagram is to explore all the potential or real causes that result in a single effect. Causes will be determined according to their importance or detail. From this process, it can help to search for the real root causes, problem area, and eventually compare the relative importance of different causes. The cause and effect diagram are normally arranged into four major categories. For manufacturing, there are four items which are manpower, methods, materials, and machinery. For Administration and service, there are four items which are equipment, policies, procedures, and people.

Cause and Effect Diagram

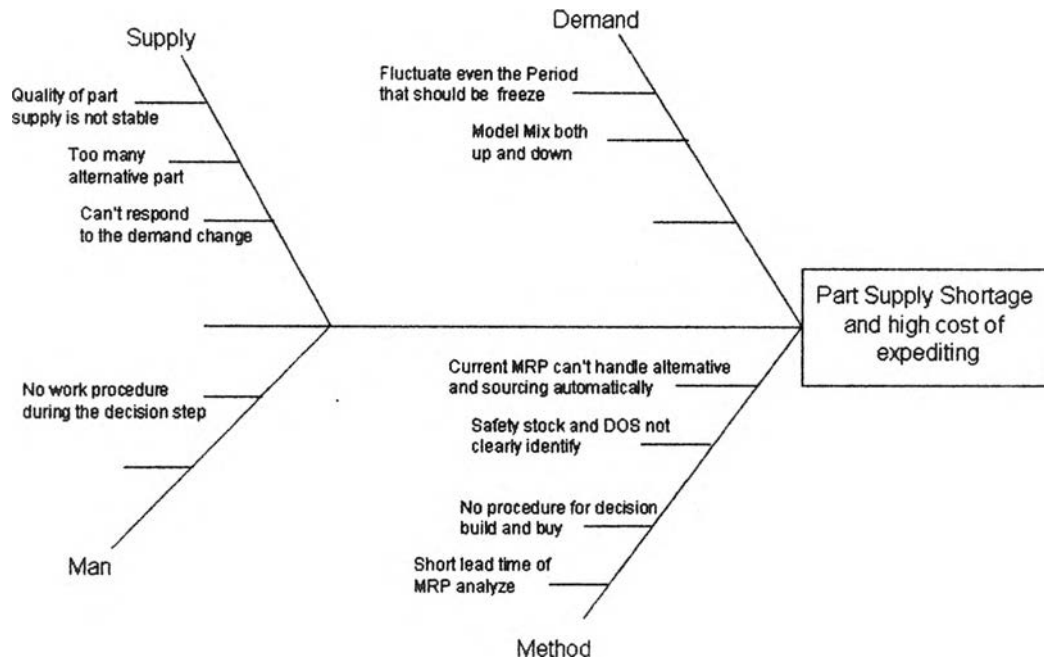


Figure 2.3.2 Cause and Effect Diagram

2.3.2.1 Summary of Cause and Effect Diagram

From above cause and effect diagram, causes can be categorized into four major items as follow:

1. Supply Problem

- i. Quality of part supply is not stable: From the element checklist, part supply of the case studied company seems to have slight problem of quality. However, quality problem is not a major concern according to historical data on number of part supply quality problem found.
- ii. Too many alternative parts: From the observation of BOM, there are too many alternative parts especially for HGA UP and HGA Down. There are more than 8 alternative parts available.
- iii. Failure to respond to the demand change: From the element checklist, the record of supplier responsiveness is considerably lower than the case studied company's target.

2. Demand Problem

- i. Fluctuate even the near period of planning horizon: Demand of the case studied company is significantly fluctuated even the close period of the demand. An increasing of demand is sometimes called demand upside in case studied company. From the historical data of demand change, most of the time it creates the part supply shortage particularly the shortage happens with the near term of the planning horizon.
- ii. Model mix both mix up and mix down: For the model change is sometimes the case studied company called it model mix up and mix down. Model mix up is when the total demand is not change only the demand switching from the low model to high model for example from Moraga Plus A model 1 to Moraga Plus A model 4. Changing from Moraga Plus A model 1 to Moraga Plus A model 4, it requires more part since the number of the model represents the number of HGA. Generally, model mix up in near period of planning horizon creates more part supply requirement and eventually effect on part supply shortage while model mix down create less problem comparing to model mix up and total demand change.

3. Method Problem

- i. Current MRP can't handle alternative and sourcing automatically: Current process of MRP is calculated and managed alternative part and supplier sourcing manually. The supplier sourcing is a time taking process and heavily relies on planner experience. Therefore, sometimes this process effect on the delay of MRP and like a chain reaction, supply request and supply commit process are continuously delay.
- ii. Safety stock and DOS are not clearly identified: From element check list, safety stock and day of supply are not clearly identified. This identification process is a duty of part planner and it also relies on planner experience.

- iii. No procedure for building and buying decision: Case studied company either buys HGA both up and down from supplier or produces it by themselves. The problem of case studied company is that there is no procedure of how to decide what to buy and what to build. As a consequent, sometimes HGA supply shortage especially in near period of planning horizon, low utilization of HGA production line, and long period of time for MRP and analyzing process.
- iv. Short lead time of MRP analyze: Since there are a lot of manual process such as supplier sourcing, safety stock and DOS identification, and build-buy decision, there is insufficient time for MRP analysis after MRP Process was completed.

4. Man

- i. No work procedure during decision steps: From the observation, the most time taking and required heuristic consideration are the manual process such as the supplier sourcing, safety stock and DOS identification, and build-buy decision got no procedure to support planner's decision.
- ii. High turnover of planner: From historical data, there was high turnover of part planner. Therefore, to have an experience planner who is familiar with the case studied company is difficult to find one.

2.3.3 Solution Concept

From the study, three are three strategies to be proposed as a solution concept for improve material management system for Hard Disk Drive Manufacturing.

1. Demand Policy for establishing MPS
2. Establish MRP system with HGA capacity
3. Establish Lot Sizing Technique and Scrap Allowance