IMPROVING INVENTORY TURNOVER IN A FIBER OPTICS MANUFACTURING PROJECT

by

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Abbreviation definition

FTTH – Fiber To The Home

SAP - An enterprise resource planning software developed by the German company SAP SE

FIS – Factory information system, a production activity and inventory information tracking system

VTR – The name of company discussed in this case study

TCS – Total customer satisfaction, a managerial position in VTR Penang

MI5K – MI5000 XM, a fiber optics modulator

MOQ – Minimum order quantity

KPI – Key performance indicator

BI – Business intelligence

TQM – Total quality management

SPC - Statistical process control

Kaizen – A Japanese word refers to a continually improvement and standardization practice

Abstrak

Masalah lebihan stok atau inventori yang tinggi adalah merupakan salah satu faktor yang menggangu kestabilan operasi dalam sebuah kilang pembuatan gentian optik iaitu VTR Penang. Kajian kes ini adalah berdasarkan masalah lebihan stok atau inventori dalam sebuah projek gentian fiber yang baru dilancarkan di VTR iaitu projek-MI5K. MI5K adalah projek pembuatan gentian fiber yang memerlukan pengkhususan yang tinggi dalam kuantiti yang rendah. Sasaran kitaran pusingan inventori adalah sebanyak 60 hari sedangkan kadar prestasi yang sebenar adalah 82 hari. Kajian kes ini dimulakan dengan memahami proses kerja yang sedia ada termasuklah sistem yang digunakan untuk membantu perniagaan VTR Penang. Masalah seperti kurangnya kepintaran integrasi system perniagaan, produk yang tidak menetapi tahap kualiti yang dikehendaki, masa yang panjang untuk memperbaikin dan menganalisis punca masalah, pembelian bahan mentah secara berlebihan dan kekurangan bahan mentah dibincangkan dalam kajian kes ini. Untuk memahami dengan lebih lanjut punca sebenar masalah, kajian secara terperinci dan komprehensif dilakukan dengan kaedah menemubual dan menggunakan analisis seperti atau “fishbone” atau gambarajah tulang ikan, Pareto analisis dan “Benchmarking” analisis. Tujuan sebenar kajian kes ini adalah untuk mengenalpasti langkah terbaik untuk memperbaiki proses pengurusan inventori bagi mencapai sasaran kitaran pusingan selama 60 hari.

Abstract

High inventory has been one of the unstable operation factors in fiber optics manufacturing projects in VTR Penang, a contract manufacture. This case study looks into the particularly high inventory turnover days issue encountered in a newly launched fiber optics project-MI5K project in VTR. MI5K is a high mix low volume manufacturing project with 60 days inventory turnover target， however the actual performance is 82 days. The study begins with understanding the existing workflow together with the business intelligence system. Current issues such as lack of business intelligence system integration, high reject rate, long failure analysis lead-time, and material over purchase and shortage were discussed. To further understand the potential root causes of those issues, a comprehensive analysis is performed using interview, fish bone, Parato, Benchmarking analysis tools. The goal for this case study is to find out the possible solutions to improve the inventory management process in order to achieve the 60 days target.

Executive Summary

Mr. Paul is the TCS manager of MI5K project in VTR Penang. MI5K is a manufacturing project servicing a leading fiber optics component maker. He recently discovered that the inventory turnover days of his project is 82 days in average. He knows that this is an issue because the target that management set to him is 60 days.

The objective of this case study is to find out the possible root causes leading to the high inventory turnover issue and provide recommendations to improve the situation.

The study begins with reviewing current business model of MI5K. It starts with planner planning needed materials for one year base on the forecast given by customer, and uploads the information into SAP system and trigger buyer to purchase materials. Buyer creates the purchase order in SAP and inform vendor to deliver materials. When the material arrive in VTR, warehouse will load the information of the received material into SAP, production will then transfer the materials into production and begin the assembly process until raw materials are assembled to become a finish good and hand over back to warehouse and prepared for delivery to customer.

Four areas are looked into to discover the detail of inventory related issues. 1. Lack of integrated information in the business intelligence systems used in MI5K SAP and FIS. 2. High and unstable failure rate during production processes. 3. Failure review process is taking too long. 4. Material over purchase or shortage.

Interview has been performed to the related people from planning, purchasing, production, engineering, as well as the TCS manager. Followed by a fish bone analysis that identifies the potential root causes may contribute to the high inventory issue. Root causes are identified and grouped into four categories, Man, Method, Machine, and Material. For Man related root causes are lack of skill and knowledge, improper mindset used had contributed to high failure rate. Material shortage has led to the rest of materials being idling in warehouse. Method related root causes such as key performance indicator were not suitable for failure rate control; product design limitation can cause high failure rate as well. Lastly, the limitation of SAP system and limited machine capacity from machine category is contributing to the issue too.

These potential root causes are grouped and weighted based on the re-occurrence times of the same root cause in those 4 main issues. Through a Parato analysis to identify the root causes that has higher severity level. The current practices of higher contributors are benchmarked against the practice in Total Quality Management and Lean Manufacturing to understand the performance gaps.

Base on the analysis, this paper recommends MI5K to fully utilize the FIS and build up the missing link between SAP and FIS system, re-establish KPI to have production team owns all inventories staying at production floor, including failure inventories to build up a closed loop system for failure inventory recovery. Implement Total Quality Management can help to raise the quality mindset for everyone. For those un-controlled root causes such as design limitation, material shortage caused by customer not able to

deliver, it is suggested program manager to realize the detail impact and communicate to customer to gain some deserved composition.

In conclusion, the mass production mindset should not be used in a fiber optics manufacturing projects where there're too many uncertainties occurring. A more integrated and lean model can help VTR to become more flexible in facing new challenges.

1. Introduction

Mr. Paul is the TCS Manager for VTR Penang. He is managing the MI5K project, a manufacturing service project servicing to a world leading fiber optics component maker. This is the second fiber optics project he handled,

One day, the finance manager Mr. Joe went to see him, “Hi Paul, I need to talk to you about cash.” “Cash? Joe you are the owner of cash of our company, why do you come to me?” Paul asked. Joe sits down and continued, “Yes, I know, we want to take some cash to invest into a project expansion, there’s one customer pushing very hard on us to expand our product line capacity for our multi-meter project. The problem is, now we don’t have enough cash, therefore I was asked by my boss to search among our projects to see if there’s extra cash being held as inventory. And your project is the winner of all, do you know that you are holding enough inventory for you to running almost one quarter without any purchase.” Paul said, “ I know we are running at a bit high inventory, but that’s always like that since I run fiber optics project many years ago. We need certain level of inventory to sustain a healthy service level, customer will certainly not happy when delivery is often not met, but since you brought this up, let me take some time to look into this, I will get back to you as soon as I can on how we can help to free up more cash from our project.” “Looking forward to your proposals.” Joe left the office as he spoke.

Paul started wondering how to tackle this problem, based on his 20 years of working experience in manufacturing industry as well as 5 years in fiber optics industry; he knew

that the inventory turnover issue was always fluctuating in manufacturing projects, especially for fiber optics projects. This MI5K is a new project that launched in the beginning of this year. Before it, there had been 2 fiber optics projects run in VTR, and he was managing the second project that ended last year. The inventory levels of these 2 fiber optics projects were fluctuating up and down. The average inventory turnover days for the first project were around 68 days and the second one was as short as 31 days. Each project has its uniqueness due to the different nature of the products. Usually when the product has more complex, long assembly processes and high quality requirement that is more difficult to meet will potentially lead to a longer inventory turnover days. For example, the first fiber optics project was a 10Gb optical modulator that has a total of 26 process steps inclusive of 5 testing processes, the total cycle time needed to complete the manufacturing processes is 12 days, such complex manufacturing flow lead to the inventory turnover days as high as 68 days. The second project was a total opposite; it was an optical laser project where there are only 9 process steps and 1 test step with the cycle time of 3 days. As a result, the second project managed to maintain an overall turnover performance of 31 days. As for this project, there’re 17 steps, how does inventory turnover perform in this project?

Paul then begins with looking into the historical inventory level. Knowing this project is still quite new; it just finishes the production line setup early this year, the mass production stage started in May. The data in earlier start up stage may not indicates the actual performance, thus Paul pulled the data from May onwards.

Data shows the inventory of MI5K was about RM9.4Millions in May 2014, and then dropped to RM7.3Millions in June, after that, it growth back to RM10Millions again in August.

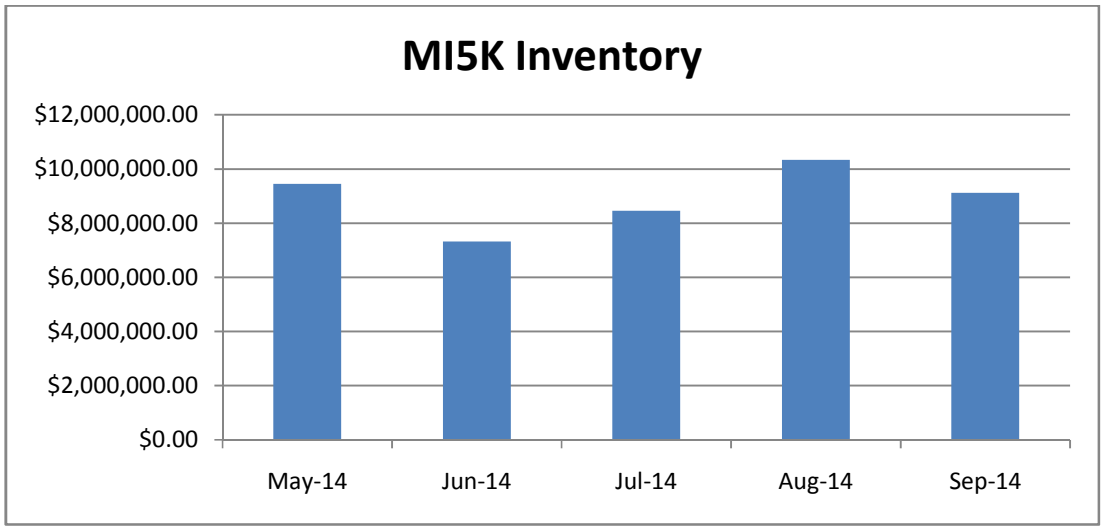

Figure 1.1 MI5K inventory level since January 2014, source: VTR internal material

To understand the impact of inventory to profitability, the "inventory turnover days" concept was used. The "inventory turnover days" is the figure reflects the average days that needed to sell the inventory. It is calculated based on the formula below:

(Average inventory of the month/Cost Of Goods Sold per year)*365

The inventory turnover days of MI5K product line is as below:

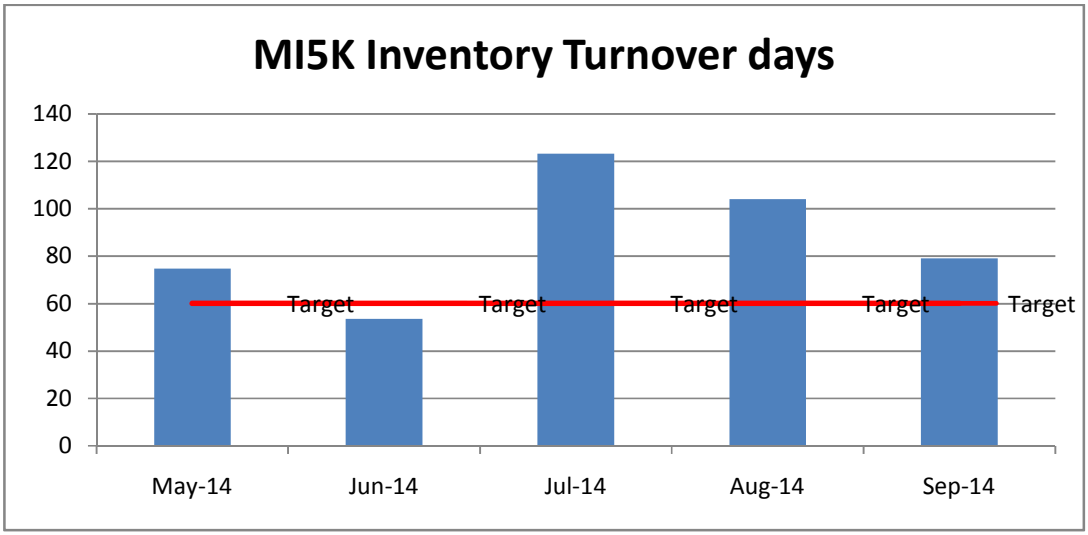

Figure1.2 MI5K inventory turnover days, source: VTR internal material

As shown in figure 1.2, Over the 5 month's period, 4 out of 5 months are failing to meet the target. The best month was in May with 54 days, but it was then shoot up to 123 days in June, double against the target. The average turnover in 2014 is 82 days, till far away from the target of 60 days.

VTR higher management has set the target of 60 days for inventory turnover. Previously there was no target set for the fiber optics project because VTR is lack of experience in the optical industry. But after gaining some experience from the last two projects, management felt that it is necessary to have a benchmark for inventory control. Therefore they set the target by refereeing to the historical performance of previous projects. As described earlier, the average inventory turnover days for the previous two projects were 68 days and 31 days with respective complexity in terms of numbers of process steps as well as cycle time. Taking into consideration of the complexity of the MI5K project, with

total 17 steps and cycle time of 5 days, such figure falls into the middle range. Base on this comparison, management has decided to set the target to 60 days.

Project Name	Total Process Steps	Cycle time	Actual Inventory turnover days	Target
Optical modulator	26	12	68	NA
Optical laser	9	3	31	NA
MI5K	17	5	82	60

Table 1.1 Inventory turnover comparisons among projects

To have a further understanding of the impact of the inventory data, Paul tried to compare the turnover days against the total assembly and test processes cycle time, in other word the throughput time of MI5K production.

By comparing the existing inventory turnover data against the throughput time, it is obvious that 82 days of inventory turnover is unreasonable. How can the inventory stay in the factory for 82 days while the production process only takes place 5 days? This can also be understood as the average inventory on hand is enough to sustain the line for 16.4 cycles (82 days divided by 5 days).

Never the less, the data speaks the truth. This is the reality, and the issue is obvious. In addition, Top management has only given Mr. Paul 3 months to overcome this issue and release the cash from the inventory, so that VTR has the cash to support the other project's expansion, It's now the time to investigate and understand what is actually causing this issue, and four research questions have been identified here:

1. What is the current production system?

2. How does the system support inventory reduction?

3. Why does MI5K inventory fluctuating at a high level?

4. Why do new materials continue feeding into production when there's already RM9Millions of inventory on hand?

2. Industry background: Fiber optics Manufacturing

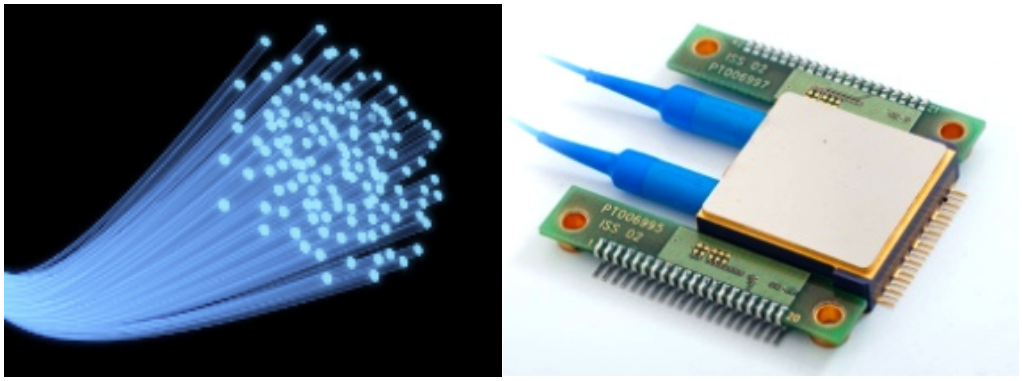

Figure 2.1 Fiber optics products

Fiber optics is well known in the telecommunication. It is a method of transmitting information from one place to another by sending pulses of light through an optical fiber. Because its high transmission data rate and low installation cost as compare to traditional cable, fiber optics communication has rapidly grown to replace the electrical transmission network since 1990s.

Initially, fiber optics communication started with implementing on backbone network between countries, or between main domestic cities, for example: undersea fiber between Japan and US, or between San Francisco and New York. As the industry develop and cost of manufacturing lower down, fiber optics network expand further to reach more areas such as medium and small cities, in year 2006, the FTTH concept (Fiber To The Home) had even began to reach the end user's house directly. For example, Malaysia's major Internet service provider such as Maxis, Celcome, Astro had already been offering fiber optics broadband to condominiums, housing areas or individual consumers.

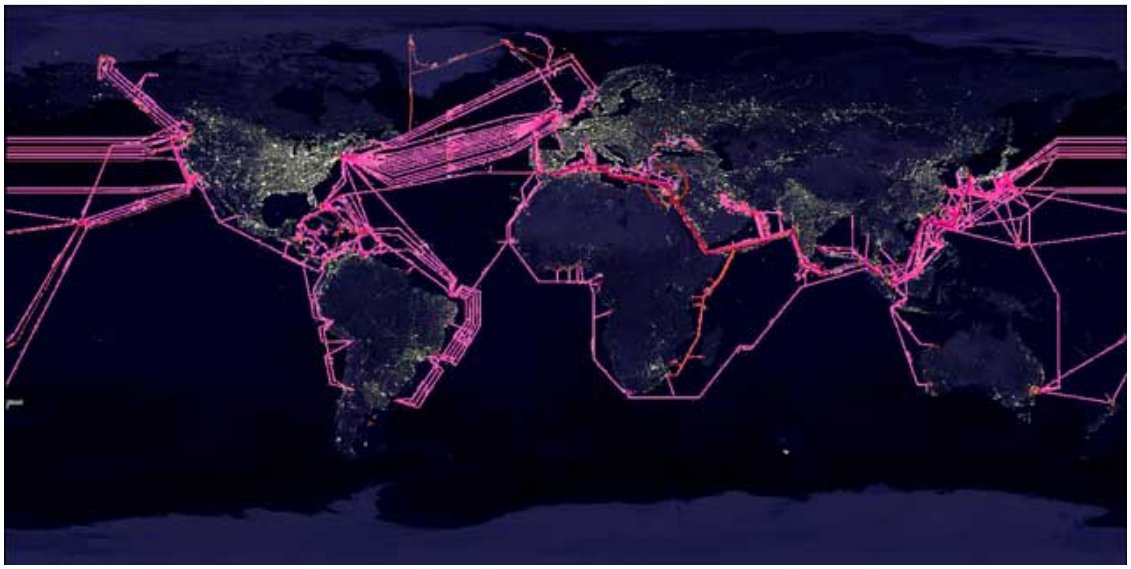

Figure2.2 Existing Fiber optics network around the world Source: The Fiber Optic Association, 2013

There're list of companies who manufacture fiber optics components, namely JDSU, Finisar, Oclaro, Oplink etc. Early in the 1990s, before the dot-com bubble burst in 2000, most of the companies had their manufacturing in Europe and the US, as the premium-selling price is able to support the high manufacturing cost. But after year 2000, the selling price dropped tremendously, most of the companies suffered with high lost, and began to move their assembly and test manufacturing to Asia to optimize their profitability. So far, most of the fiber optics manufacturing plants are located in South East Asia, such as China, Thailand and Malaysia.

The major competitors of VTR in fiber optics zone come from China, namely Neophotonics, Oclaro, Sanmina-SCI are located in Shenzhen, and Finisar, Fiber-home are located in Shanghai and Wuhan respectively. Other than China, there's also a well-known contract manufacture in Bangkok Thailand that focus in fiber optics name is Fabrinet. Fabrinet has been offering manufacturing services to the major OEMs such as Oclaro,

JDSU and so on, it's business model is quite similar to VTR. Therefore, Fabrinet is considered to be the closest competitor in fiber optics manufacturing service.

3. Company background: VTR Penang

VTR Penang is one of the key companies that had been deeply involved in fiber optics manufacturing services. Since year 2002, VTR Penang has been providing Engineering and Manufacturing services for 3 customers from fiber optics industry. These customers are leading fiber optics components makers, and the products which manufacturing in VTR are key components for long-distance (above 10km) telecommunication systems, namely tunable lasers, modulators, and receivers. VTR serves these customers as a contract manufacture, the technologies, and products specifications, assembly processes and as tests solutions are designed and defined by customer. VTR adds value through stream lining process flow, optimizing capacity and equipment utilization, maximizing throughput. In terms of supply chain management, VTR takes over the front-end supply chain system from customer, which includes raw material ordering, and stocking, material quality assurance (MQA), as well as reverse logistics (customer returns).

There are also many other projects running in VTR Penang, servicing customers from different industries, for example, there is a SMT projects providing printed-circuit-board assembly manufacturing service for multiple customers, including other projects within VTR that needs PCBAs, there's an instrument assembly project building test instruments for one of the world's largest test instrument maker, there's a medical devices that help customer making the implanted medical components. Of cause, the fiber optics project – MI5K is one of those projects running in VTR Penang as well.

As VTR is a contract manufacture, the business model among projects is quite similar. Customers come to VTR with product design prototypes and manufacturing specifications, such product usually have been manufactured by customer in house to prove its manufacturability, however, as technology developed, the product competition increases, product life cycle become shorter, some customers choose to launch their new products directly into VTR's production with the new product introduction carry on simultaneously. Once the agreeable price and specification of the product has been achieved between customer and VTR, VTR will start purchase material that meets customer's requirement, store them in the factory warehouse, and train the production team to be equipped with knowledge to build the product. Production will start when there's a work order placed by customer. During the production, labors, materials, and utilities are induced and consumed to support the production work. During production stage, customer would provide certain operational support, including technical support to resolve production defects, operation planning to provide demand forecast and work order tracking. At the end, there will be 2 types of outputs, finish goods and wasted been generated, Finish goods will be shipped to customer to gain profit and wastes will be scrapped off from system as the manufacturing lost.

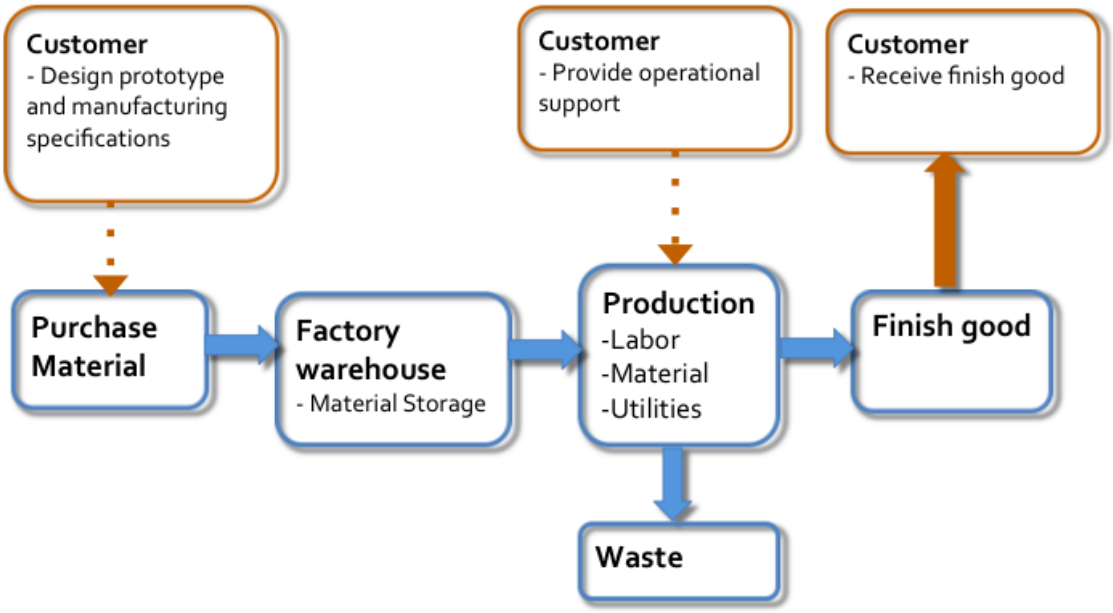

Figure 3.1 VTR'S manufacturing model overview, Source: VTR internal document

Although the business model is almost similar across all projects running in VTR Penang, there is still a major difference, which is the product volume and mix. Most of the projects are known as high volume and low mix where customers' industries have relatively large market base, for example, one of the product produced in test instrument project is hand held multi-meter, a meter that is widely used around the world, and there's not much variety in terms of functionality that enable the production maintain a low level of product mix and high level of output. Another example is the medical devices, which is a product that directly used by consumer, thus the market size is even larger than the hand held multi-meter.

The MI5K project however, is unique among all the projects in VTR Penang, This project manufacture fiber optics components that is known to be low volume. In addition, different customers requires the components to have different functionality in terms of

operating parameters, such as wavelength, power, input current and so on, as a result, the level of mixture has increase.

3.1 VTR's Mission and core values:

Most organizations has Vision & Missions, which is presented to all stakeholders to understand what is the short term or long term goal the organization is pursuing, in order to align the interest among the stakeholders. VTR's mission is to be a strategic global partner for success by providing best-in-class technology services, products and solutions. It stated that VTR is aiming to be successful only through providing services to other organizations, which position it as a purely Business-to-Business service provider.

3.2 Service offer

VTR does not make products in its own brand, it provides services other companies. Customers to help them reduce cost by outsourcing part of their value chain to VTR, for example, manufacturing, by doing so, they can release the pressure of holding fix capital such as, inventories, facilities, and headcounts to sustain manufacturing. VTR takes over the manufacturing from customer and reduces the overall manufacturing cost by utilizing its own shared resources, such as factory facilities, HR, Logistics; in the end create a win-win business partnership for both VTR and its customers. In the end, customers gain more competitive advantage by focusing their resources on their R&D and marketing, VTR earns many through manufacturing service charges.

The types of services that VTR offers contain 3 main categories： Design Service, Manufacturing service, and supply chain service. First category Design service refers to designing new product, new manufacturing capability for customers, such as mechanical systems design, electronics system design, software design product test development and so on.

The second category is manufacturing services, including high-volume products and high-mix, low-volume products. VTR's service covers multiple types of product segments in light industries such as print circuit board assembly (PCBA), fiber optics assemblies, full electronic product assemblies and so on. VTR's service covers from the very beginning of the manufacturing stage: new product introduction until mass production. The company in this case study is from the manufacturing service category.

The third category is supply chain management service. This service is mainly to address the customer's need of filling the gaps in their value chain or among their suppliers and customers. For example, VTR can help customers to manage their suppliers, build their logistics and distribution networks, or establish reverse logistics. While providing the supply chain service, instead of build a new network for each customer, VTR leverages its own globalized network and integrate together with Customer's supply chain network, by sharing resources across the globe, VTR provides supply chain services with a competitive cost.

3.3 MI5K, A High-Mix, Low-Volume manufacturing project

In MI5K project, the customer is a component maker in fiber optics industry who is specialized in making long haul fiber optic networks components. Long-haul optics refers to the transmission of visible light signals over optical fiber cable for great distances (10km above). As a result, the population of customer base is relatively small. Only a few telecommunication equipment makers in the world is purchasing these products, namely Cisco, Ericson, Huawei, Ciena and ZTE etc

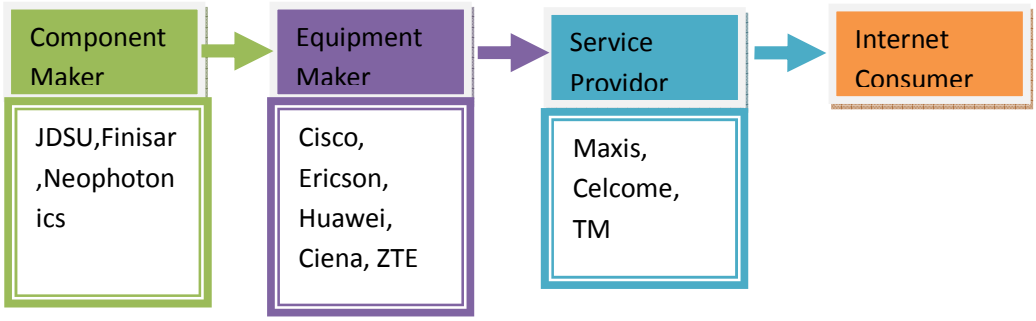

Figure 3.2 Fiber optics telecommunication value chain

Thus, the fiber optics component manufacturing is a typical small industry in terms of sales quantity. Even with a smaller customers base, component maker still need to extend their product varieties to meet different customer design applications. For example, JDSU's popular XFP tunable laser shipped 25,000 units from late 2009 till early 2011. The average shipment per month is around 1,600 units. Furthermore, there multiple models under XFP tunable laser to satisfy variable customer requirements, such as wavelength coverage, optical power level, connector types, the total models can be up to 20 plus. Which means under the 1,600 units shipped every month, each models only contains 80 pieces in average.

With the degree of product variation, the manufacturing project requires high flexibility to deal with variable issues such as demand fluctuations, material shortage, and quality system variation, all of these variations can lead to issues on sustaining the production line. Potentially, such manufacturing project may tend to keep more material stocks in order to meet the customer demand.

3.4 Organization Structure

VTR is organized as a shared value system where most of the common functional departments are working independently, such as IT, logistics, finance. There could be many different operations departments servicing variance customers, they work separately in the same factory, but those functional departments are shared among all operations. For each project, there is a TCS manager, TCS stands for Total Customer Satisfaction, his function is to engage with the customer to understand what the customer requirement is and aligns it with the internal team, on top of that, and the TCS manager also runs the operational activities of the project. The chart below shows the detail of organization structure of the MI5K project this case study is based on the issues encountered in MI5K.

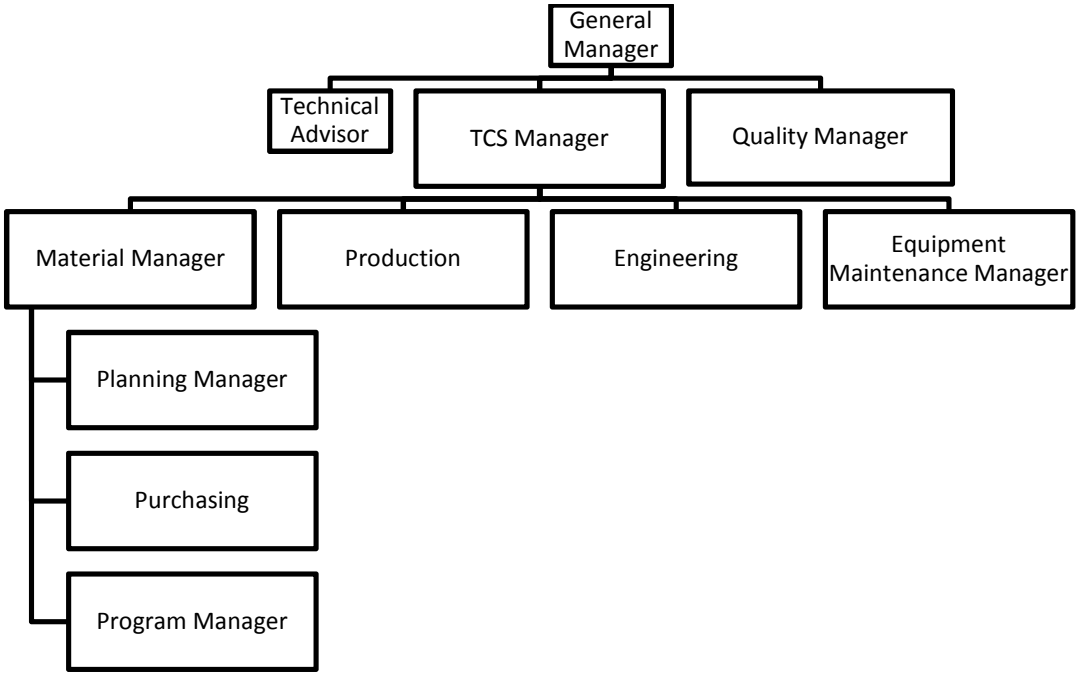

Figure 3.3 MI5K project Organization chart, source: VTR internal material

As shown in the organization chart, the top of the organization is the general manager of VTR Penang who supervises all projects in VTR Penang. Under MI5k project, there're are 3 key manager/technical advisor, the operational aspect is owned by TCS manager, the operation including production, engineering as well as equipment maintenance is own by different managers respectively, there's also a quality manager who oversees the quality system of MI5K project. Under TCS manager, there is a material manager in charge of material planning and purchasing, both of them work closely with the production team to ensure sufficient materials are supplied to sustain production, there's also a program manager who look after the cost control and pricing, the team under TCS manager basically covers supplier and customer engagement as well as daily operations. There's a production team which lead by production manager that runs the day-to-day

manufacturing activities of MI5K product, plus an engineering team and equipment maintenances team to provide technical assistance in terms of equipment trouble shooting, product and assembly, test failure analysis and so on.

In this organization, TCS manager, planning, purchasing, and production managers are highly involved day-to-day inventory planning and managing. Thus, in this case study, these are the targeted group of personal to conduct interview as well as documentation review. On top of that, Engineering related personal are also engaged to understand the issues encountered during production that may cause material or semi-finished products fail to meet the quality system requirement, and how engineering deal with those materials do.

4. Case issue: High inventory turnover days of MI5K production line

The business intelligence systems that adopted by VTR global group are SAP and FIS. SAP is a well know system which used globally especially on manufacturing industries. SAP system is used to track the resource planning and tracking of the company. All the material purchase, storage, finishes goods delivery, as well as scraps are recorded in the SAP system. For example, if buyer wants to place an order to vendor to purchase material, she will raise an order in the SAP that attach with an order number, this order will then be tracked and closed in the system until the material arrived from vendor. The detail of this purchase is stored in the SAP, such as price, quantity, vendor name, date and time of this purchase as well as the date when material arrived. The SAP not only will store the raw data, but also provide with tools to perform data analysis. For example, the inventory data shown in the introduction is acquired directly from SAP.

Like every other manufacturing projects, as shown in figure 4.1, the MI5K project begins operating with order forecast, at this stage, planner will usually work out a year-long forecast by getting the information from customer, once that has been confirmed, the planner will start to work on the list of required material to run production, those materials inclusive of key materials that are used to build into finish goods, such as laser chips and fibers, and also the supporting materials that consumed during production but won't become part of a product, such as gloves, papers, tools and so on. At least 8 weeks before production started, planner transacts the material requirement plan into business

intelligence system, as to allow sufficient lead-time for material purchase and delivery. Once the system receives the material requirement information from planner, it will then automatically trigger the buyer to start purchasing materials from Vendor. When buyer gets the information of needed materials from the SAP, she would first check the existing availability of those materials in house, if the in house materials are not enough, she will then start contacting available vendors for each material and check on availability and price. After compare among vendors, buyer starts to place orders to vendors that offer the most competitive price. After that, there will be a waiting period for the parts to be delivered to VTR. This period depends on the delivery lead-time set by Vendor, some vendor is able to deliver within a few days, and some may need weeks. When the materials arrive in VTR warehouse, the stock keeper will update the arrival information into the SAP system. Planner performs regular checking in the system for material availability, once all the materials are ready, production supervisor will be informed. Then materials will start load into the production floor and start the production processes. The productions activities start from step 5 in figure 4.1.After the production processes are completed and materials built into finish good. Production will transact in the system to convert materials into finish good.

The first production steps are assembly, where all related parts will be assembled together and become a semi-finished goods, subsequently, this semi-finished goods will go through several more steps such as soldering, second time assembly, splicing and so on. To become a complete finish goods. After that, the finish goods will undergo several testing process to verify the product performance before shipping to customer. During the

testing process, there' will be some defect products been generated, those products will be extract out from normal production flow and hand over them to the r engineers I

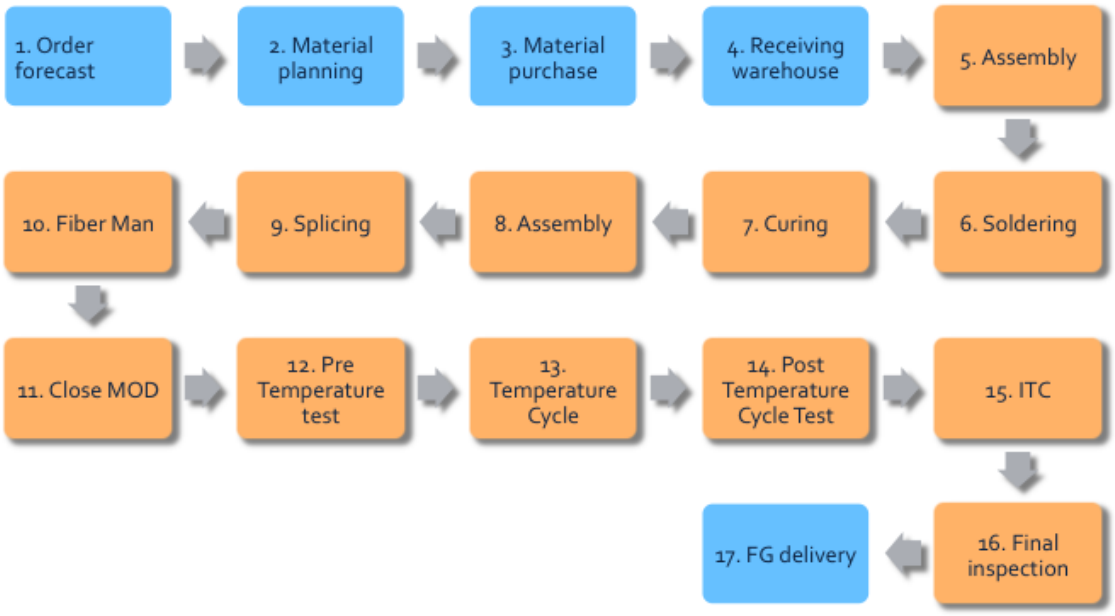

Figure 4.1 MI5K manufacturing process flow. Source: VTR internal material

There're a few area to look into to further understand the inventory issue. First are the business intelligent systems. Other than SAP, there's also another system call FIS, FIS stands for Factory Information System, its used to track the production status by product serial number, those tracking information includes date and time each process steps were performed, the quality testing records, operator handling records, if a product fails at certain process, FIS will capture the detail of the failures encountered as well as review and disposition given by engineers. Unlike the SAP that link to financial data, FIS only tracking base on product serial number and quantity, there's no pricing available, no record of each individual materials status. The data input of FIS is from the data entry performed by operators using their individual user id. For example, when the assembly

operator “A” perform his job, one of the assembly process for product “X”, he would first perform the “move in” transaction to that product serial number in FIS to tell the system that this product “X” is now under assembly by him. When the assembly job is done, he will then perform “Move out” transaction in FIS, this product will then move to next step in the system. By performing such transaction, the FIS system records the time operator “A” starts performing assembly work for product “X” and the time it is completed. When this product “X” completes all the production process steps, from step 5 to step 16 as described in figure 4.1. FIS will have the full history record of product “X” on each individual process steps. If this product failed during testing, operator will perform “on hold” transaction in FIS, and this product will then be “freeze” in FIS to prevent it from moving forward. Engineers will the review this failed product to see if it’s a true failure of a failure that is able to rework and place back to production. After engineer review, if it is a true failure a “Scrap” transaction will be performed by engineer to scrap off that product from system, if it is to be reworked, a “rework” transaction will be performed, or engineer will “release” the product if it is a false failure.

When the semi-finished goods failed meeting the quality system requirement, they will be kept aside and wait for engineers to verify, in some case the failures are valid and those affected samples will be scrape, but in other cases they are still reusable after some rework or retuning of the product. Engineers will perform a comprehensive analysis to find out whether those failures are able to rework. During the verification process, materials could be hold in the production floor, it is necessary to understand where are those inventory being hold, what form of materials are being hold, how long have they

been there. The objective is to find out the right owner of the holding inventory and the workflow of driving failure semi-finish goods to a closure: either to be re-used or scrappy.

The other area to look into is the material over supply or under supply that contributed to over inventories. In SAP system, all the required material to build each product has already been defined and recorded, the information does not only include the name and part id, but also include cost, available vendors, MOQ (minimum order quantity), lead time of delivery and so on. Whenever there's an order from customer to produce a product, planner is able to know what are the materials required and how long it takes for vendors to deliver the parts.

The existing quality management system in VTR is also one of the areas to explore. There is a quality team to monitor the quality performance of the projects; the quality team established quality criteria in the aspect of product quality inclusive of incoming materials and outgoing finish goods, and operation conformance quality against documentation, making sure operations being executed are comply to what is written in the documentation. For product quality assurance, there's incoming material quality assurance call "MQA" to perform checking on all incoming materials for supplier quality records, manufacturing data and expire date and so on. For operation conformance quality, there's a in process quality check call "IPQC" to perform a regular check through production line to see if operators are following that is described in the work instruction. Non-conformance report will be generated for each checking and forward to management and respective owners to improve. The quality ownership falls under quality department, where they are the one who detect quality issues and drive for improvements. Other

functional teams such as production and engineering plays the role in execution when quality teams come up with improvement requirement. They usually don't self-initiate quality improvement plans.

4.1 Lack of integrated information system

As mentioned, there're two systems tracking the material movement for the entire project, SAP and FIS, and each system only tracks a portion of the entire process flow. Figure 4.2 represents what are the process steps tracked under SAP and FIS respectively. The SAP mainly tracks the planning and material purchasing as well as incoming and outgoing logistics. FIS tracks from step 5 till 16, which is the process steps happening within the production floor. There's no over lapping of this two system, each process step is either only cover by SAP or FIS. These two systems work independently, they do not communicate to each other either. When the materials being move from step 4 warehouse to step 5 assemblies. Production team will reduce the affected quantity of materials in warehouse virtual locator and increase the same amount of materials in production virtual locator in SAP system, telling SAP that these materials are now being moved into production floor. Each of the virtual locator is a system representation an actual location that stores materials. After that, once those materials start loading into assembly process (step 5), production will create new products serial numbers in FIS and record the process information accordingly. From step 5 onwards until step 16, while the production works ongoing, FIS system will continue to track the production activities, whereas in SAP system, there's no update, while the materials are being assembled in the production, the latest up to date information in SAP is until unchanged at step 4, even though some of the