6-2022

Building a supply chain for emergency: A case study of Kingfa's mask supply chain

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BUILDING A SUPPLY CHAIN FOR EMERGENCY: A CASE STUDY OF KINGFA'S MASK SUPPLY CHAIN

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SINGAPORE MANAGEMENT UNIVERSITY

2022

Building A Supply Chain For Emergency: A Case Study of Kingfa's Mask Supply Chain

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Submitted to Lee Kong Chian School of Business
in partial fulfillment of the requirements for the Degree of
Doctor of Business Administration

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2022

I hereby declare that this Doctor of Business Administration dissertation is my original work and it has been written by me in its entirety.

I have duly acknowledged all the sources of information which have been used in this dissertation.

This Doctor of Business Administration dissertation has also not been submitted for any degree in any university previously.

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10 June 2022

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Li Nanjing

Abstract

In case of emergency such as pandemic or earthquake, there are usually surge demands for some necessary products, which are usually far more than available production capacities thus it is necessary to quickly build more production capacities. However, building production capacities is not just building production lines but to constructing whole supply chains, from raw materials and equipment sourcing, manufacturing flow lines to demand management.

To quickly construct a supply chain for fulfilling such emergency demands is very challenging both theoretically and practically. This thesis aims to develop a model of supply chain construction for emergency demand and identify the critical success factors for constructing the supply chain for emergency.

Based on the theoretical framework of supply chain processes and elements, we develop a model for constructing the supply chain for emergency demands. With this theoretical framework, the case of KF company's facemask project and the construction process of such an emergency supply chain is analyzed, where manufacturing flow, materials and equipment sourcing and supply relationship management are discussed in depth. The construction of KF's facemask supply chain in Chinese context during COVID-19 pandemic is

very successful and several critical success factors are identified, including maintaining good relationship with stakeholders, strong organizational ability and efficient execution of strategic decisions, owning core technology for the products of the supply chain, and responding to demand quickly.

The model for constructing for constructing the supply chain can be employed for dealing with interruptive situations and the critical success factors may be useful in similar scenarios.

Keywords: Supply Chain Construction; Emergency Demand; Manufacturing Flow; Strategic Sourcing; Critical Success Factors; Case Study

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Acknowledgement

I would like to express my deepest gratitude to my thesis advisors Professor Lim Yun Fong from Singapore Management University and Professor Wan Guohua from Shanghai Jiao Tong University, for their continuous support, patient, encouragement, immediate knowledge and valuable feedbacks throughout the course of this thesis. I also would like to thank Professor Wang Hai for his valuable feeback and comments on this thesis.

I am profoundly grateful for all my professors, teaching assistants and fellow classmates at Singapore Management University, whose intellect has inspired me tremendously. Thank all faculty members and friends who help me along the journey!

Last but not least, I want to thank my loving wife and daughter, without whose unconditional support I could not have taken this journey.

Li Nanjing

10th June, 2022

Chapter 1 Introduction

1.1 The Outbreak of COVID-19 in Early 2020

The first case of unexplained pneumonia was reported in Wuhan, Hubei Province on 8 December 2019[1]. On 7th January 2020, China tentatively named the virus that triggered the outbreak as 2019 novel coronavirus (2019-nCoV), and pneumonia caused by this virus was called novel coronavirus pneumonia[2]. On 20th January 2020, the National Health Commission included the pneumonia in second category of statutory infectious diseases, and managed according to the first category, 30 provinces across the country activated a level 1 response for epidemic prevention and control[3]. On 4th April 2020, the global number of newly confirmed COVID-19 cases exceeded 100,000 on a single day, bringing the cumulative number of confirmed cases to more than 1.2 million. As of 16 May 2020, the global COVID-19 death toll has exceeded 300,000, with nearly 4.4 million confirmed COVID-19 cases worldwide and more than 4.31 million outside of China. Its transmission speed and fatality rate far exceed that of SARS in 2003, affecting over 200 countries worldwide (shown in Figure 1-1).

[1] 12 月 8 日:湖北武汉出现了首例不明原因肺炎病例。-抗击新冠肺炎大事记-2019 专题 (stdaily.com)

[2] 2019 新型冠状病毒_百度百科 (baidu.com)

[3] 国家卫健委：新型肺炎纳入乙类传染病 按甲类防控 (baidu.com)

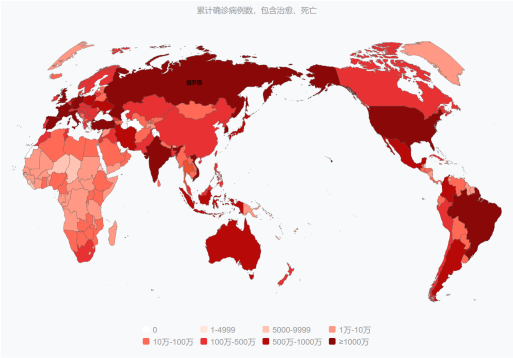


Figure 1-1 Global COVID-19 Epidemic Situation Map

2019-nCoV epidemics are characterized by high infectivity and insidiousness. The source of infection is mainly confirmed cases of novel coronaviruses and asymptomatic infections, and they are infectious during the incubation period; Epidemiological features. (1) Source of infection: The main source of infection seen so far has been patients with Covid. Asymptomatic infected persons may also be the source of infection. (2) Route of transmission: Respiratory droplet and close contact transmission are the main routes of transmission. Aerosol transmission is possible with prolonged exposure to high aerosol concentrations in a relatively closed environment. As novel coronaviruses can be isolated in faeces and urine, attention should be paid to faecal and urinary contamination of the environment resulting in aerosol or contact transmission. (3) Susceptible population: The population is generally susceptible.

The uncertain pathogenesis of novel coronavirus pneumonia, the diverse transmission routes, and the general susceptibility of the population have led to a high epidemic intensity of 2019-nCoV, which is highly susceptible to

outbreaks, epidemics, and pandemics. Since the outbreak of the new corona-virus, variants of the novel corona-virus strain have been identified and reported in many places around the world. China has always adhered to the general strategy of "prevention of external importation and internal rebound" and the general policy of "dynamic zero"[4].

Masks are an important line of defence against respiratory infections and can greatly reduce the rate of novel corona-virus infections. Wearing a mask is one of the most effective means of physically blocking the virus and reducing the risk of novel corona-virus infections (Wang, et al., 2020). Therefore, strengthening personal protection and wearing masks scientifically is one of the most effective measures to effectively reduce the risk of transmission, prevent the spread of the epidemic and reduce cross-infection among the public, and it is also the simplest, most convenient and most cost-effective prevention and control measure.

1.2 The Market of Medical Masks Overview of Medical Masks During the Epidemic

As personal protective equipment, masks play a key role mainly in human respiratory protection. In 2019, China produced approximately 5 billion masks, accounting for approximately 50% of the world's production[5]; the sudden

[4] 毫不动摇坚持“动态清零” 慎终如始做好疫情防控 (baidu.com)

[5] 报告图文详解中国口罩产能分布：去年口罩产量超 50 亿只，短期供给不足有三大原因 (baidu.com)

outbreak of novel coronavirus has prompted demand for a range of products for protection against the disease, including forehead temperature guns, masks, goggles, gloves and protective clothing, etc. The phased "mask shortage" has led to an explosive growth in demand. The situation of the new coronavirus-infected pneumonia epidemic remains very serious, and the demand for protection against the epidemic has kept masks in a state of continuous rush. According to statistics[6], China will produce more than 300 billion masks in 2020, of which about 224 billion will be exported, accounting for more than 90% of global production from January to July, especially from March to May as strategic epidemic prevention materials.

The surge in demand for masks led to an extraordinary shortage of medical supplies such as masks, which were out of stock in various online and offline channels, and the situation of "one mask is hard to find" is still fresh in people's minds, as the supplies needed to resume work and production across the country and the world were not available[7]. Because of the shortage, the price of masks skyrocketed, and as a result, masks instantly became a profitable industry. Due to the large number of enterprises joining the production of masks, the domestic production capacity of masks has been multiplied in a short period of time, and the supply of masks has been significantly relieved. The Ministry of Industry and Information Technology (MIIT) introduced on February 3rd that the daily

[6] 2020 年中国出口口罩 2242 亿只 相当于为全球每人提供近 40 只 (ctei.cn)

[7] 抢购口罩就像银行挤兑 应依靠国家力量增加供给 (baidu.com)

production capacity of domestic masks at that time was 20 million pieces; by March 1st, MIIT introduced that the daily production capacity of domestic masks had reached 120 million pieces. And on April 5th, data from the General Administration of Customs showed that from March 1st to April 4th, China exported 3.86 billion pieces of masks alone, plus no less than 4 billion pieces for domestic sales, the monthly production capacity of domestic masks reached a staggering 7.5 billion pieces, with a daily production capacity of 250 million pieces[8]. This is a 12.5-fold increase in the production capacity of domestic masks in just two months. Of course, the masks produced are all different and of varying quality. The quality of many masks cannot meet the standards for medical masks, and they cannot meet the needs of epidemic prevention. The key reasons for this are the immaturity of the equipment, the substandard quality of raw materials and the substandard environment of the production plant, which cannot match the surge in production capacity within a short period of time.

The commonly-used masks (shown in Figure 1-2) can be divided into three categories: medical masks, common gauze masks and industrial dust masks. Among them, medical masks can be divided into disposable medical masks (YY/T0969-2013), medical surgical masks (YY0469-2011) and medical protective masks (GB19083-2010). The product standards corresponding to

[8] 揭秘口罩日产量破 1 亿：近 3000 家企业增产转产_凤凰网 (ifeng.com)

different uses are different. Medical masks are Class II medical devices in China and must be approved before they can be listed.

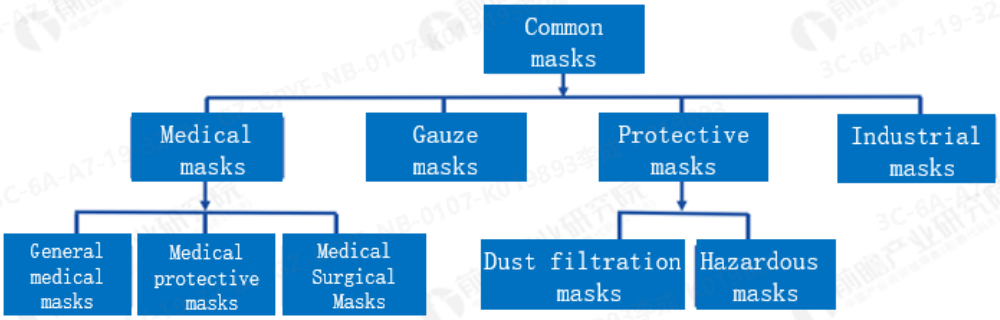


Figure 1-2 Classification of Commonly-used Masks

The procurement of raw materials, manufacturing, packaging and marketing of medical masks are regulated by the Medical Device Product Regulations and the Medical Device Quality System. The human, mechanical, material, the legal and environmental aspects of the manufacturing process are critical to the final quality of the product and its compliance with standards and regulations.

From product design to listing as a commodity, common medical masks will go through product design and development, product registration and certification, product mass production, and product marketing.

For enterprises producing medical grade masks, the primary thing is that the production environment must reach the 100,000 clean workshop purification level (shown in Figure 1-3) and at the same time needs to meet the requirements of GMP. The drug regulatory administration conducts an audit to confirm the

trial production site of the enterprise, and after the declared information and site audit are passed, a medical device production license is issued before production can be carried out. After the production environment is up to standard, the requirements for equipment, process and raw materials in product design and development are equally important.

Figure 1-3 Class 100,000 Cleaning Workshop

The masks produced by the company need to meet the GB2626-2019 standard for respiratory protective equipment, the YY0469-2011 standard for medical surgical masks and the national standard GB19083-2010 for technical requirements for medical protective masks published by the National Standardization Administration Committee.

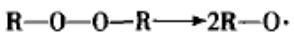
After the necessary production environment and other hardware conditions are in place, the BOM for the production of masks must be determined before submission for review and formal production. finally, the technology and quality department is the main focus, around the company's existing resources,

to develop a product technology roadmap in line with the company, the formation of product process technology manual, the development of production-related material BOM. at the same time, the need to assist production to develop SOP The operation protocols will translate technology into visual quality control points.

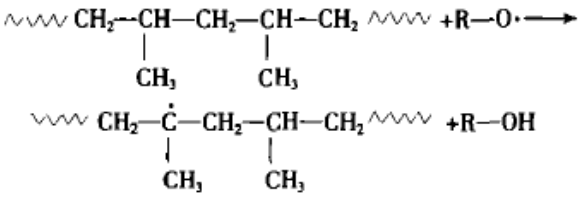
The mask generally consists of a melt-blown fabric, a non-woven fabric, a mask strap and a nose clip. The core body is a hamburger-like structure (shown in Figure 1-4) consisting of a spun-bond layer (Spun-bond), a melt-blown layer (Melt-blown) and a spun-bond layer (Spun-bond. The spun-bond and melt-blown layers are produced from a special polypropylene material by means of a non-woven fiber forming technique. The outer layer is usually a waterproof layer, consisting of spun-bond or hot-rolled non-woven fabric with pore sizes that can intercept particles of larger sizes and prevent external droplets from entering the mask. The inner layer is the moisture-absorbing layer, which is made up of ordinary spun-bond, needle-punched or hydro-entangled non-woven fabrics, ensuring moisture-absorbency and skin-friendliness and comfort.

Figure 1-4 The Core Raw Materials and its Structure

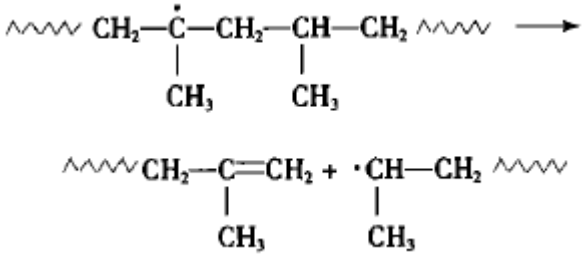
As the heart of the mask, the melt-blown fabric is an ultra-fine electrostatic fabric with a fiber diameter of 0.5 to 10 microns. The raw materials are melt-blown polypropylene and melt-blown electrostatic master-batches, the basis of which is a modified polypropylene material with ultra-high fluidity, which was in extremely short supply during the epidemic. The raw material for melt-blown non-woven is polypropylene which is first decomposed into free radicals by peroxide, which then attack the polypropylene molecular chain, taking away the hydrogen atoms from the polypropylene molecular chain and breaking off to obtain smaller molecules. The process is as follows, peroxide decomposition.



Attacking polypropylene molecular chains



Polypropylene molecular chain breakage



The ultra-high flow polypropylene is prepared with a reduced molecular weight and a narrower molecular weight distribution, combined with low odour technology to obtain a high quality meltblown polypropylene speciality. While the polypropylene fibers are extruded through the die spout holes, they are

blown into fine filaments for drafting using high speed hot air, from which ultra-fine fibers are formed and coalesced on the receiver device, which relies on its own bonding to become a non-woven fabric. It is not possible to directly meet the requirements of medical masks, and the melt-blown fiber material needs to be electrically charged to capture the aerosols in the new corona-virus with electrostatic forces. Electrostatic adsorption is the capture of New Corona-virus droplets (aerosols) by the coulombic force of the charged fibers. The principle is to use the charged charge capture on the surface of the filter material fibers to be able to capture the capturing ability of the particles, with increased charge density and greater adsorption and polarisation of the particles. The nano electrostatic electret technology makes the melt-blown non-woven fibers permanently charged and valid for several years. Due to the increase in the number of charges, the filtration efficiency reaches 99% filtration performance without any change in respiratory resistance, better virus prevention and better protection for the user. However, the availability of meltblown fabric material is extremely difficult in the event of an epidemic, making it even more difficult to obtain a qualified product with quality assurance.

Mask manufacturing and molding equipment. Medical mask production generally requires manufacturing processes such as mask forming, pressing, edge cutting, ear strap spot welding, nose strip line lamination and packaging. As the key production equipment for medical masks, the level of automation, stability and supply of the mask machine directly determine the output and

quality of the mask products. The mask machine may not be a high-tech product, but it also has a perfect industrial chain. Why is there an urgent shortage of mask machines and what is the difficulty? First, the supply chain of parts needed for the mask machine is not smooth. A mask machine (shown in Figure 1-5) involves more than 1,000 parts and ingredients, most of which need to be reprocessed.

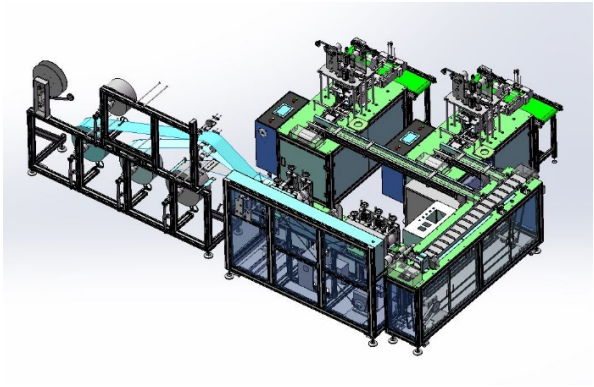


Figure 1-5 Schematic Diagram of the Mask Machine Structure

A few parts that seem common actually involve basic industrial categories such as petrochemicals, chemicals, textiles, machinery, metallurgy and electronics. If combined with related production equipment, and will involve material processing, machinery manufacturing, electrical control, pneumatic components, ultrasonic bonding, automatic packaging. Among them, the most sought-after core component is the ultrasonic welding machine. At the very beginning, the upstream spare parts have not yet fully resumed, how to find all the supplies needed, is the most headache for mask machine manufacturers.

Second, the difficulty of production technology and quality control. The mask machine is delivered late, and the delivery may not meet the production standards. Many companies urgently switch to the production of mask machines, but after all, they are "amateurs" and need to spend more man-hours. Technology is not in place, also led to buy back only to find that some of the parameters of the mask machine, performance does not meet the standard, leading to chaos in the industry. A small mask, but involves several small and large industrial chain, without a sufficiently complete and sufficient capacity of the supply chain, it is difficult to achieve mass production in a short time, to achieve the goal is almost impossible to complete.

It can be said that if we can solve the supply problem of meltblown cloth and mask machine in the early stage of the epidemic, we will directly take the initiative and can benefit to the maximum. The urgent shortage of meltblown cloth and mask machines, coupled with the disruption of the supply chain during the epidemic led to the inability to expand the production capacity of masks, and as the key prevention and control materials of the epidemic, all origins were strictly controlled, making procurement more difficult. It was extremely important to establish an emergency supply chain with strong capacity to ensure the completion of the set target.

How to make full use of the company's resources in terms of procurement strategy? In the process of building the supply chain, information flow is also very important to ensure the consistency of information flow, and each node

department of the supply chain needs to share information in a timely manner according to the project progress to ensure the linkage and integrity of the supply chain and maximize the production capacity of masks.

Mask Quality Standards and Medical Device Registration. The product listing of medical masks needs to be launched after the design and development is completed, after the assessment by the supervision department and the internal strict quality inspection. The masks produced by the enterprise need to meet the GB2626-2019 standard for respiratory protective equipment, the YY0469-2011 standard for medical surgical masks, and the GB19083-2010 standard for technical requirements for medical protective masks issued by the National Standardization Administration. In the formulation of enterprise internal control standards, the production process, procurement material standards, inspection and storage standards, etc. must be formulated around the relevant product quality standards. In order to ensure the supply of key medical materials, the supervision department has implemented a series of effective measures for mask products. For example, the green channel for emergency approval, emergency filing and product access standards and specifications, etc.; at the same time, it is necessary to quickly establish a quality evaluation process, and products (shown in Figure 1-6) can be released and allowed to be listed.

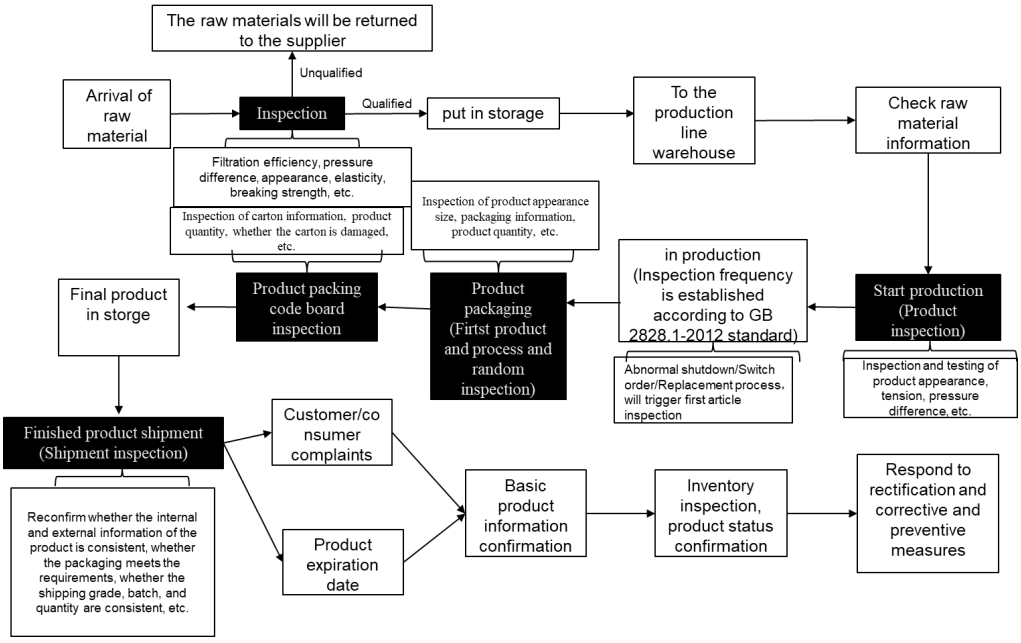


Figure 1-6 Mask Quality Management Process

After preparing the technology, equipment, raw materials and product development, a sufficient number of staff is required. The production of masks is a labor-intensive industry. How to quickly form a team, involving recruitment, training, scientific management and incentive policies, is the key to the rapid formation of combat effectiveness and team efficiency, and is also an important test in the emergency supply chain.

1.3 Introduction to KF Company

KF is founded in 1993, one of the most famous new materials company focusing on the R&D, production, sales and services of new high-performance chemical materials, providing new material solutions to create a safer, more comfortable and convenient human life. KF is committed to solving the

increasingly serious environmental problems of mankind, actively responding to the challenges brought about by changes in the global living environment, promoting the continuous improvement of the human living environment through a balanced relationship between economy, environment and society, achieving sustainable development and creating a better life. The company's revenue for 2019, 2020 and 2021 is $29.2 billion, $35 billion and $40.2 billion, respectively.

(i) Major Operations

The main business of KF is the R&D, production and sales of new chemical materials, including seven categories of modified plastics, environmentally friendly high-performance recycled plastics, fully biodegradable plastics, special engineering plastics, carbon fibers and composite materials, light hydrocarbons and hydrogen energy and medical and health polymer products, which are widely used in the automotive, household appliances, electrical and electronics, communications and electronics, new infrastructure, new energy, modern agriculture, modern logistics, rail transportation, aerospace, high-end equipment, medical and health industries. The company has established strategic partnerships with many well-known enterprises at home and abroad. At present, the company is one of the world's most complete enterprises in the new chemical materials industry, and the largest and most complete modified plastics manufacturer in the Asia-Pacific

region. In the fields of completely biodegradable plastics, special engineering plastics and carbon fibers and composites, the company's product technology and product quality have reached international advanced level. The company has gradually upgraded from a single modified plastic to a variety of new chemical materials around polymer materials, and its product structure has been continuously extended to the high-end and high value-added direction of the industry.

(ii) Major Business Models

As new chemical materials involve a wide range of plastics due to varying customer and market demand, and the performance of different products varies greatly, product selection and processing require strong expertise, the company's business model is to provide cost effective and customized material solutions to customers in various industries through a global leading technology research and development platform and a well laid out global marketing network.

Procurement mode: The mode is mainly through the establishment of strategic cooperative relationships with leading domestic and international industry suppliers, vigorously promote the localization of raw materials, and make comprehensive use of various procurement modes such as centralized procurement, forward contract procurement, global procurement and long-term contract procurement to ensure a stable and safe supply of raw materials.

Production model: The production model is mainly based on the "sell-to-produce" approach, i.e. customers submit orders for product performance and functional requirements, and the Company organizes the production, inspection and delivery of products based on market conditions, raw material and product inventories and plant conditions. Sales model: The sales model is mainly oriented to market trends and customer needs, and provides customers with cost-effective customized material solutions through a global leading technology research and development platform and a well-defined global marketing network. At the same time, as customized material solutions involve a wide range of plastics and the performance of different products varies greatly, product selection and processing require strong professional knowledge, therefore, the Company needs to provide comprehensive technical support services to downstream customers while selling products.

(iii) Core Competencies

(1) A corporate culture that unites talent.

The company has created a value-sharing-based incentive system - the "cake theory". The system focuses on combining the development of the company with the personal interests of employees, so that the core talents of the company can share the benefits of the company's growth. Adhering to the concept of "working together, growing together and getting rich together", the company constantly innovates and continuously improves its talent incentive

mechanism to suit different stages of corporate development. In addition, the company emphasizes the realization of customer value and incorporates the core value of "value creator-based" into its corporate culture. In recent years, the company has implemented a job target responsibility system to decompose the company's targets to each key position, guiding and motivating employees to pursue the achievement of targets in order to obtain optimal benefits. The job target responsibility system fully affirms the value of each position and each employee, and motivates employees to create benefits for the company through their personal efforts and realize their personal value, ultimately achieving a win-win situation for both employees and the company. The company's value-sharing philosophy has attracted a large number of outstanding talents, and currently the company has 109 doctors, 795 masters and 2,089 bachelors, of which nearly 40% graduated from famous universities.

(2) Three-dimensional driven R&D system

The company adheres to the R&D concept of "independent innovation, leading technology and product excellence" and has built a "13551" R&D system (1 central research institute, 3 international R&D centers, 5 sub-technology centers, 5 chemical and new materials incubation bases and 1 national industrial innovation center). The company has gradually formed a three-wheeled R&D platform driven by technology research, industry research and product research. In order to bridge the common technologies between modules, the company has established the Institute of Technology, which

includes the Institute of Sustainable Development Technology, the Institute of Flame Retardant Technology, the Institute of Interface Technology, the Institute of Material Life Technology and the Institute of Polymer Synthesis. The Institute of Technology uses projects as a grip to systematically address key common technologies for various products and improve the efficiency of technical research. The company strengthens its research capabilities in the industry and has set up an industry research department with industry research modules for automotive, home appliances, 5G and consumer electronics, rail transportation and electric tools, green packaging and medical health, as well as corresponding technical support and service modules, with the key common technologies of the industry as the research direction, keeping abreast of industry development and cutting-edge technology applications, and providing professional and overall solutions for industry customers. The company has set up a product research and development department based on product categories and material applications to conduct customized product development based on customer needs, grow with customers and provide them with competitive products. In addition, the technology R&D platform also has a process equipment department and an intellectual property office. The Process Equipment Department focuses on processing technology and equipment to improve product quality and processing efficiency and provide customers with stable quality products. The Intellectual Property Office manages intellectual property rights through patent layout. The company has applied for a total of

4,447 domestic and foreign patents, including 3,201 invention patents, 622 utility model patents, 34 design patents, 368 PCT patents and 222 foreign patents, making the number of patents obtained among domestic manufacturing enterprises at the top level.

(3) Global collaborative marketing network

The company adheres to the marketing concept of "order is order, contract is boss" and builds a global collaborative marketing network around customer needs. In the marketing center, we have formed a trinity of regional, customer and industry customer service system. In the regional dimension, we have set up a global collaborative service network in China (five domestic bases in the south-east, north-west and central), India, the United States, Europe and Malaysia, adhering to the service concept of rapid response, and responding to customer needs at the first time. In the customer dimension, we have set up key account managers to implement refined management, take customer needs as the starting point, study customer demands in depth and provide customers with overall solutions. In the industry dimension, we set up industry managers to deepen the work in the niche areas, taking the industry demand as the starting point, and marketing industry managers work with technical industry experts to study the direction of industry development and industry demand, and provide overall solutions for the industry.

(4) Global supply chain platform

The Company has adopted a global sourcing strategy and established long-term, stable and mutually beneficial strategic partnerships with its upstream supply partners, resulting in significant advantages in quality, delivery and price of raw materials. In 2021, when the supply and demand in the industry is tight, the company relies on its strategic partnership with upstream core suppliers and its global coordinated production and logistics system to ensure production and customer delivery to the greatest extent, which has won the recognition of many large customers and enhanced the company's market competitiveness.

(5) Products and services with high quality

The company always pays great attention to quality, actively responds to the national strategy of high-quality development, insists on serving customers as the focus of attention, adheres to the quality concept of "standard-based enterprise, quality-strong enterprise, customer first", and based on the framework of the excellent performance model, combines the management systems of ISO9001, IATF16949, ISO14001, ISO45001, IECQQC080000, ISO/IEC17025, ISO50001, ISO10012, etc. to form the "rigid-flexible quality management model with value creation as the core" with KF's characteristics, so as to realize the "five high quality development strategy" of high quality of customers, high quality of products, high quality of supply chain, high quality of operation and high quality of employees. In recent years, the company's quality management has been widely recognized and acknowledged by the industry, and has been awarded the honors of AAA China Quality and Integrity

Enterprise, National Advanced Enterprise for Implementing Excellent Performance, Guangdong Provincial Government Quality Award, Jiangsu Provincial Governor Quality Award, Guangzhou Mayor Quality Award, Suzhou Mayor Quality Award, etc.

(IV) Outstanding Industry Influence

KF plays an important role in many standardization technical committees, such as the National Technical Committee for Plastics Standardization and the Technical Committee for Circular Economy Standardization, etc. In 2009, KF assumed the secretariat of the Sub-Technical Committee for Modified Plastics of the National Plastics Standardization Committee, and currently participates in nearly 20 technical committees (TC), sub-technical committees (SC) and working groups (WG). The company has more than 30 national-level TC, SC and WG members and more than 10 Guangzhou standardization experts; it has taken the lead in drafting and participating in drafting and publishing 9 international standards, and has developed and published more than 130 national standards, industry standards, local standards and group standards. kf has taken the lead in formulating and publishing more than 40 national standards, covering areas such as flame retardant, reinforced, anti-static, recycled material modification and degraded plastics, which basically cover KF's core products. By collecting and collating a large number of Chinese national standards, industry standards, ISO standards and American Society for Testing and

Materials (ASTM) standards in the field of modified plastics, the Modified Plastics Sub-Committee Secretariat has compiled the Modified Plastics Standards Manual which has a wide influence in the industry.

Chapter 2 Theoretical Framework for Supply Chain Design

2.1 The Structure of A Supply Chain

A supply chain is a logistics network consisting of suppliers, manufacturers, warehouses, distribution centers and distributors. A complete supply chain should include suppliers (raw material or replacement parts suppliers), manufacturers (processing plants or assembly plants), distributors (agents or wholesalers), retailers (marketplace, department stores, supermarkets, specialty stores, convenience stores and grocery stores) and consumers.

The supply chain is a network chain structure, consisting of core enterprises' suppliers, suppliers of users' suppliers, and users of users. An enterprise is a node, and the relationship between node enterprises and node enterprises is supply and demand. Supply chain is characterized by complexity, dynamics, user demand driven, and crossover. The supply chain (shown in Figure 2-1) has the characteristics of complexity, dynamic, driven by user demand and intersectionality (Croxton, et al., 2001).

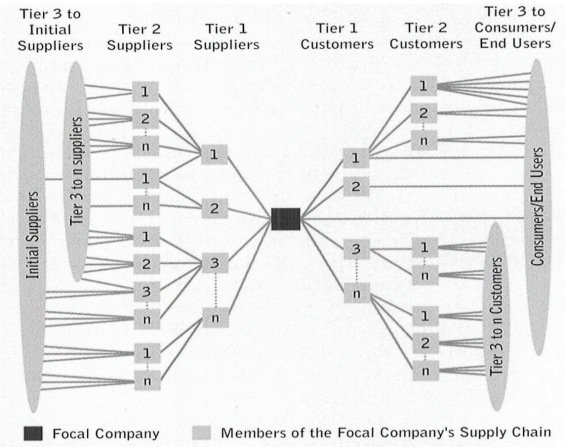


Figure 2-1 Supply Chain Network Structure

2.2 Eight Key Components of A Supply Chain

Supply chain management is increasingly seen as a key business process in the network of business management organizations. Although the advantages of using process management and supply chain approaches are widely recognized, there are still issues that need to be clarified in using process management and supply chain approaches: which processes to consider, which contain sub-processes and activities, how processes interact, and the relationship between traditional approaches, etc. Keely et al. (2001) describe the eight basic supply chain processes identified by the members of the GSCF from the strategic and operational levels, as well as the internal mechanisms of the processes and the mechanisms of interaction between the processes.

According to Keely et al. (2001), the definition of supply chain given and used by the Global Supply Chain Forum is that supply chain management is a key business process that is integrated from end users through the synergy between the source suppliers that provide products and services and information that adds value to customers and shareholders. Global Supply Chain Forum members have defined eight key processes within a supply chain network that can be performed within and outside an enterprise. Keely et al. (2001) extended the one-sentence summary summarized in previous research results to sub-processes and the details of activities that comprise the supply chain process, in order to provide theoretical support and practical guidance for supply chain management.

The eight basic components of supply chain management are:

- Customer relationship management
- Customer Service Management
- Demand management
- Order fulfillment management
- Manufacturing process management
- Purchasing and supply management
- Product development and commercialization
- Returns management

These eight key components of supply chain management (shown in Figure 2-2) run through the entire supply chain and can be deconstructed in all business areas that an enterprise operates, including marketing, manufacturing, procurement and logistics, as shown in the figure below. The utility of these key components can be seen in every business area, but the organic integration of these eight key components cannot be simply covered by a single business area.

While all business management in each supply chain should consider these eight key points together, the importance of each component and the specific activities it covers will certainly vary. Sub-processes and activities are distilled and summarized from the operations management processes of manufacturing enterprises located in the middle of the supply chain. Each process can be described at a strategic and operational level. At the strategic

level, it is mainly the process establishment and strategic management of each process, and the subsequent operation and execution plan provides a guiding blueprint. These are the key starting points for an enterprise to collaborate with other enterprises in its supply chain. From the operational point of view, the strategic plan is realized through the actual execution after the process is established. As shown in the figure below, subprocesses and activities together constitute the eight key components and interactions between process, intelligence, and key members of the supply chain (Croxton, et al., 2001).

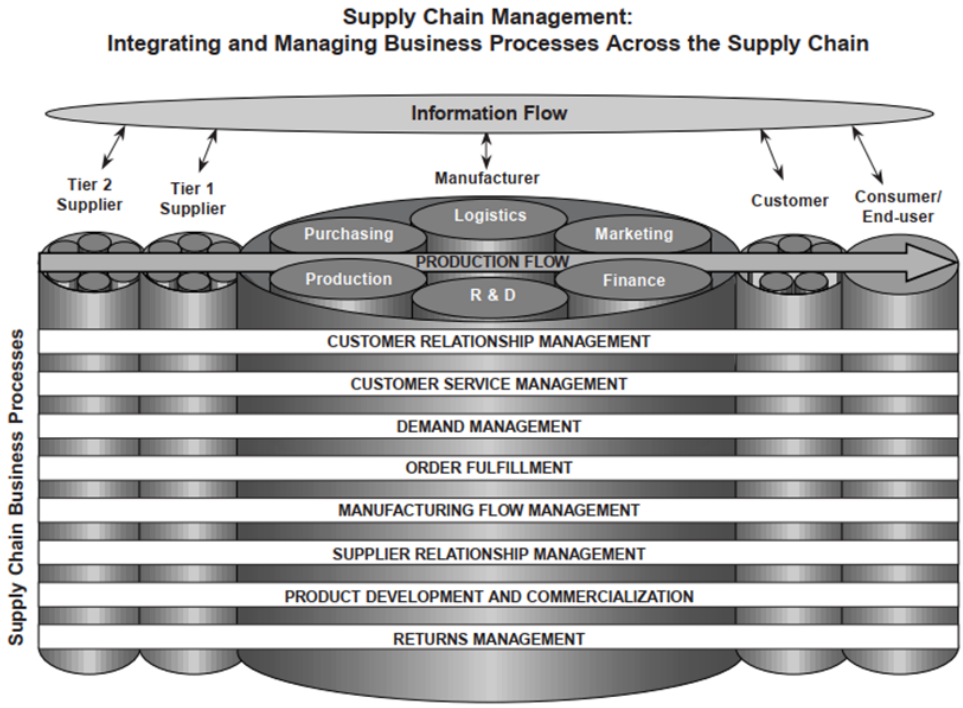


Figure 2-2 Supply Chain Management Process

The customer relationship management process provides a framework for the development and maintenance of the relationship between enterprises and

customers. Key customers and customer groups can be identified as the target of the enterprise's business objectives through the method of management. Customer teams tailor product and service agreements (PSA) to meet the needs of their target customer groups. The account team often works with key accounts to optimize management processes, reduce demand volatility and non-value-added activities, and quantify the profitability of individual accounts and the impact of the company's financial position on the customer through performance reports.

Customer service management determines the impression left by the enterprise to the customers. Real-time information such as product availability, shipping time and order status is provided to customers through production and logistics departments of enterprises. Customer service management is the implementation link of product and service agreement (PSA).

The demand management process needs to balance customer demand and enterprise supply capacity. It includes demand forecasting and its coordination with production, purchasing and distribution. The demand management process needs to coordinate all business activities that require manufacturing capacity. Requirements management also involves planning and executing transition plans when operations are disrupted.

Effective order performance management requires the cooperation of production, logistics and marketing. Enterprises should develop good

partnerships with key members of the supply chain to fully meet customer needs and reduce total delivery costs.

Manufacturing process management processes involve manufacturing and establishing line flexibility to serve market needs. Manufacturing equipment necessary for manufacturing processes, construction and implementation of manufacturing management flexibility, are included in the manufacturing process management process.

Supplier relationship management is the process of defining how an enterprise communicates and cooperates with its suppliers. Vendor relationship management can be thought of as the mirror image of customer relationship management. Just as an enterprise needs to develop its relationship with customers, it also needs to cultivate its relationship with suppliers, develop close relationships with a small group of suppliers and maintain traditional relationships with other suppliers.

Product research and development is very important for the sustainable development of enterprises. An important breakthrough point of enterprise achievement is to develop new products quickly and effectively to market, time to market is critical. With the shortening of product life cycle, it is necessary to promote and market the right products in a shorter time range to ensure the competitiveness of enterprises.

Effective return management is a key part of supply chain management, which can ensure enterprises to maintain continuous competitiveness and constantly explore new growth points.

2.3 Key Issues in Emergency Demand Supply Chains

In the current consumer economy, where products are updated and iterated more quickly, it is a dilemma for business operators to quickly convert business opportunities into corporate profits when they arise. In addition, when extreme events occur, companies are able to react quickly to produce products that respond to special events and minimize the level of risk. The emergency supply chain is built on the premise of rapid response, and through the efficient operation of the supply chain, products can be completed quickly and efficiently to solve immediate emergencies. The emergency supply chain system is a standard process management idea that will take supply chain management as the essence and raise the supply chain quickly to the height of emergency, which can create products quickly to meet market demand and achieve social or economic benefits in a shorter period of time through the operation of the supply chain.

Contingency supply chain will be facing uncertainty and the urgency of demand. It can be understood as a supply chain established temporarily in response to major emergencies or the urgent need to meet market demand, by rapidly establishing upstream and downstream network relationships with the

core enterprise as the centre, to obtain products that can meet demand and can quickly realize the commodity attributes of the product.

Table 2-1 Pros and Cons of Building An Emergency Supply Chain for Masks

Advantage	Disadvantage
Turning passivity into initiative and resuming work and production	Supply risk
Seize business opportunities quickly and profitably	Cost risk
Familiar with and set up fast consumable supply chain system to C-end	Inventory risk
Enter the medical device industry	Post-epidemic overcapacity

While all business management in every supply chain should consider these eight key points at the same time, some of these points are particularly important for the construction of emergency supply chains in the eight elements. The key components of emergency demand supply chain management are:

- Manufacturing process management
- Supplier relationship management
- Requirements management

2.3.1 Manufacturing Process Management

At the strategic level, the goal of manufacturing process management is to make decisions about meeting customer demand with respect to the necessary manufacturing infrastructure. This process begins with a review of the business strategy from the marketing, logistics, manufacturing, and purchasing perspectives, a sub-process that involves interaction with customer relationships

to identify possible opportunities and challenges in manufacturing technology to make the manufacturing process work. Incompatibilities between manufacturing processes and market characteristics can negatively impact business performance. In addition, the business plans and corporate strategies need to be considered along with environmental regulations. It is important to note that manufacturing strategy and business strategy are inextricably linked. The goal of the second sub-process is to determine the degree of flexibility of the manufacturing system. The inputs to this sub-process are manufacturing capabilities and constraints such as minimum lot sizes and turnaround times, the degree of worker specialization required for manufacturing, quality standards and quality control. Product development and commercialization as well as order fulfillment provide inputs to this sub-process. The team needs to make decisions about manufacturing or sourcing strategies, such as which manufacturing activities are strategic and therefore cannot be outsourced. These decisions guide the supplier selection for supplier relationship management and ultimately the direction of the partnership. In the final activity of this sub-process, the team needs to estimate capacity growth based on market strategy and business plans. The degree of flexibility determines the boundaries of push and pull. The customer's willingness to wait after an order is placed and customer service goals further limit the degree of manufacturing delay in the supply chain. Delayed commitments benefit the supply chain, but may result in longer lead times. The extent to which a company defers manufacturing and

logistics activities depends on product design, so product development and commercialization provide input into the design of push-pull boundaries. To determine push-pull boundaries, the team also needs to separate order production from inventory production in the supply chain. Push-pull boundaries help make decisions about inventory points in the supply chain that serve manufacturing facilities, distribution centers, and customers. These replenishment points, also known as decoupling points, allow downstream departments in the supply chain to operate independently of upstream departments. These decisions made in sub-processes need to be coordinated with the supplier relationship management team, as push and pull boundaries affect interactions with suppliers. Likewise, you need to work with the order fulfillment management team as you consider lead times and inventory constraints. The next sub-process is targeted at identifying manufacturing constraints and requirements to determine supply chain capabilities. Supplier and supply development strategies have a significant impact on supply chain coordination. The team should design communication mechanisms that maximize synergies between all activities with minimal management costs and establish quality standards for each part of the manufacturing process. This can provide input to supplier relationship management on which suppliers are included in the supplier development program. In the next sub-process, the team makes decisions about manufacturing capability and translates the capability into information that can be delivered to the customer. For example, minimum

turnaround times and minimum economic lots are the result of manufacturing capability design. The effectiveness of the strategy needs to be achieved through communication and understanding throughout the organization. The manufacturing process and customer relationship management teams also need to discuss possible PSA characteristics and areas where improvements can be made. Capacity estimates need to be communicated to the demand management, order fulfillment management, and returns management teams. In addition, the customer service management team needs to obtain order acceptance rate information. In the final sub-process, the team needs to develop the metrics system and send it to the CRM team. These measures estimate the efficiency of the manufacturing process, which may include turnaround time, inventory levels, and product quality.

At the execution level, the manufacturing process looks like internal company operations management, but the process also requires the coordination of internal operations management with external supply chain activities. In the first sub-process, the team needs to plan manufacturing routes and speeds, which involves translating inputs from the demand management side into resources and production plans to create a master production schedule. The team needs to consider the capabilities of the manufacturing equipment. This sub-process needs to interact with demand management to prioritize manufacturing and supplier management in order to confirm the priority of the suppliers and obtain their resource commitments. The next step is to develop a manufacturing

and materials plan. The team needs to develop detailed capacity plans and multi-stage demand plans. Interaction with customer relationship management and supplier relationship management extends this sub-process to other parts of the supply chain. Manufacturing planning and control includes developing the overall manufacturing plan, developing detailed material and capacity demand plans, and executing these plans. Second, capacity and demand need to be synchronized. Inventory includes raw material inventory, subassembly inventory, and packaging inventory at different levels. This step requires input from the demand management side and the order fulfillment side, then delivers the results to the customer service side. The final step in manufacturing process management is performance evaluation, not only by tracking and reporting on recorded metrics to the customer relationship management and supplier relationship management teams, but also by analyzing product quality and tracing the original cause of quality issues. The manufacturing process management team is responsible for finding solutions to quality issues, which also requires cooperation with the supplier relationship management teams, product development teams, commercialization teams and returns management teams.

2.3.2 Supplier Relationship Management

At the strategic level, the output of supplier relationship management is the development of reasonable PSAs for the definition and classification of the

different relationship levels. To achieve this, the team needs to first review the business strategy, manufacturing strategy, and sourcing strategy and identify the product and service components that are critical to the business today and in the future. With these key components that drive decision making, the team can develop supplier classification criteria. Criteria may include, but are not limited to, supplier profitability, value-add and stability, scarcity and importance of purchased parts, complexity and compatibility of supplier performance, volume sourced from suppliers, maximum volume obtained from suppliers, supplier culture of innovation, and expected level of supplier quality. The team needs to decide which criteria to use and how to apply them to suppliers. A classification scheme is needed to guide the identification of key suppliers and the classification of other suppliers. A special PSA for critical suppliers, a standard PSA for general suppliers, and a standard PSA for each type of general supplier. for critical suppliers, the team needed a set of decision criteria for the level of customization. They need to consider the cost and quality of different differentiation options and choose the correct level of differentiation. It is important to design a system of supplier management metrics through which the impact of integration on the supply chain can be seen. These indicators should concern the mutually beneficial impact of suppliers and companies. The value of supply chain management can be demonstrated by profitability analysis and the optimization of supplier management can be demonstrated by supplier cost or profitability reports. Win-win is important in supplier relationships.

Without win-win, there is no incentive for two-way cooperation, so in supplier management, it's necessary to show suppliers the bilateral benefits of optimization and improvement

At the executive level, supplier management implements PSA plan at the strategic level. first, a classification program is implemented to identify key suppliers and classify other suppliers, including an analysis of each supplier's impact on corporate profitability and quantification of each supplier's impact indicators based on appropriate criteria. Each key supplier has a supplier management team, and each group of other suppliers has a team. Each team consists of a team manager and team members from multiple functions. Each team needs to fully understand the role of each supplier in the supply chain and capture potential optimization for the suppliers to increase sales, reduce costs, and improve service. Next, PSA requires negotiations with suppliers that require constant communication, planning and improvement. Once a consensus is reached with the supplier on the PSA, implementation will begin and there will be daily interaction with the supplier to monitor progress and performance. The last and most important part is also the performance evaluation.

2.3.3 Demand Management

The demand management of the supply chain is user-centered, taking the user's needs as the starting point, focusing on evaluating and managing user needs, and trying to use this information to make production decisions to

achieve an activity that maximizes utility according to users. The uncertainty of emergencies leads to extremely high uncertainty in the quantity and type of emergency material needs. Changes in disaster conditions, disaster losses and other factors make the demand for emergency supplies time-varying.

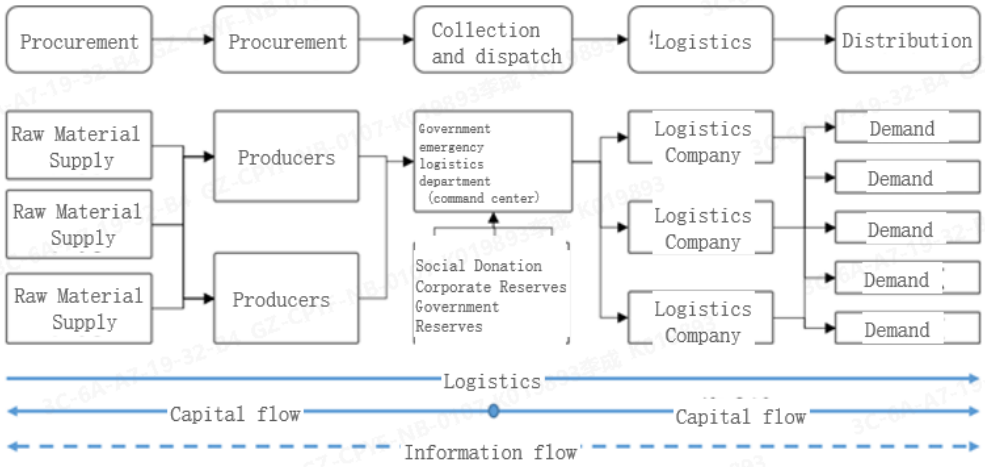


Figure 2-3 Information Flow between the Supply and the Demand

The supply chain is around the core enterprise, through the control of information flow, logistics, and capital flow, starting from purchasing raw materials, making intermediate products and final products, and finally sending the products to consumers through the sales network. Suppliers, manufacturers, distributors, retailers, and end users are connected into a whole functional network chain structure (shown in Figure 2-3). It is not only a logistics chain, information chain, and capital chain connecting suppliers to users, but also a value-added chain. Materials in the supply chain increase their value due to processing, packaging, transportation and other processes, bringing benefits to related companies. Any unsmooth information in the supply chain may lead to

inaccurate information, unidentifiable real demand, and amplification of supply chain demand variation. Common manifestations are as follows:

(1) Demand forecast revision refers to demand amplification when members of the supply chain use their direct downstream order data as market demand signals. When the supply chain is pushed upwards, the volatility of demand follows an increasing trend, often referred to as the "bullwhip effect".

(2) Order batch decision Order batch decision refers to two phenomena, one is periodic order decision, and the other is order push.

(3) Price fluctuations reflect a commercial behavior – Forward Buy. It is due to some promotional methods, such as price discounts, quantity discounts, free tickets, etc.

(4) The shortage game refers to such a phenomenon: when the demand is greater than the supply, the rational decision is to allocate the existing inventory supply in proportion to the user's order quantity. At this time, in order to obtain a larger share of the ration, the user deliberately exaggerates its order demand, and when the demand cools down, the order suddenly disappears.

Chapter 3 KF's Emergency Supply Chain Construction

The establishment of an emergency supply chain focuses on emergency and rapidity. The KF mask project is centered on customer needs, focusing on the design, development and mass production of medical masks, and transforming products into commodities as quickly as possible, which is the key work of the emergency supply chain construction process.

3.1 Supplier Relationship Management

3.1.1 Device Assurance Strategy

In the early stage of the epidemic, the supply of meltblown cloth and mask machines can be solved, which will directly take the initiative and maximize the benefits. The urgent shortage of meltblown cloth and mask machines, coupled with the interruption of the supply chain during the epidemic, made it impossible to expand the production capacity of masks. As the key prevention and control materials for the epidemic, all origins have been strictly controlled, making it difficult to purchase. How to build an emergency supply chain with strong capabilities to ensure the completion of the established goals is extremely important. KF fully utilizes the company's resources in terms of procurement strategy, uses government-level relationships to quickly find suppliers, strengthens communication, and ensures the continuation of production by locking key materials. In the process of building a supply chain, it is also very important to strengthen the timely update of information flow to ensure the

consistency of information flow. All departments in the KF mask project supply chain share information in a timely manner according to the project progress to ensure the linkage and integrity of the supply chain, using special personnel to follow up, ensuring the progress of mask machine assembly and entering the factory, and laying a foundation for maximizing mask production capacity.

3.1.2 Material Support Strategy

Material support strategy is to simplify the process, repaid response to the raw material procurement. After the material parameters are determined, a procurement plan is required, which needs to consider the urgency of the first batch of material demand and the supply cycle of the later material production. Due to the special situation of the epidemic period, the process cannot be established according to the push or pull supply chain model, and procurement is planned according to market demand. Therefore, the initial procurement strategy is to purchase materials around large orders and allow lead time for second and later turnaround orders. After completing the selection of materials and suppliers, there is the confirmation of matching the samples and produced goods. Due to time urgency, samples are not sent and confirmed according to the traditional process, and the confirmation of samples needs to be completed using the Internet and innovative processes. At the same time, after the order is placed, the delivery time must be guaranteed. To achieve the fastest arrival of goods, in the selection of transportation methods, it needs to have a strong

control of logistics. To grasp the timely delivery, and in order to more quickly to the goods, the logistics mode of transportation can be changed at any time.

KF's procurement strategy has been adjusted accordingly. First of all, the decision-making level directly with the procurement and technology rapid decision-making, including supplier research and selection, pricing and business negotiations, contract evaluation, procurement payment, on-site office on-site solution, so that each procurement needs to achieve same-day closure, greatly enhancing the efficiency. At the same time, the daily tracking process to avoid track of abnormal changes and react quickly; arrange for dedicated personnel to follow up on shortage of materials to ensure the timeliness of goods; provide necessary logistics support to control logistics information and control the arrival progress at the same time.

The successful implementation of the raw material procurement strategy is due to KF's advantages in scale, financial resources and human resources, and also KF's reputation accumulated in the industry chain, coupled with an agile and efficient decision-making, execution and tracking mechanism, thus giving play to its own competitive advantages and guaranteeing the supply of raw materials.

3.1.3 Flexible Procurement Strategy

Shortage of raw materials results in increasing prices. In the production of masks, the melt-blown fabric is the scarcest raw material. There are three layers

in disposable medical masks. The front and back layers are spunbond nonwoven fabric. The middle layer is melt-blown fabric, which is also the key layer of medical masks. Due to the high production threshold and long production period, there are few domestic melt-blown fabric manufacturers in China. It is reported that the price of melt-blown fabric rose 20 times during the epidemic. "I have a mask production line, but cannot find melt-blown fabric" has become a common issue in the production of masks. Many mask manufacturers even had to shut down production temporarily. Moreover, it is difficult to find the components for the mask production line, especially the key components. Due to the low rate of resumption of work during the epidemic period, as well as logistics and transportation difficulties, key components cannot be quickly acquired. The adequate supply of raw materials or equipment has become an important part of the supply chain.

(1) Full realization of resource sharing

The demand for masks in China has increased greatly, but due to the shortage of raw materials and personnel, the production capacity of masks was impacted. Almost all traditional mask manufacturers were requisitioned by the government and gave priority to local residents. During the special and emergency period, KF could only look for cooperation with basic qualified suppliers, but KF volunteered to provide the core equipment and papers, and the KF team was responsible for disassembling and assembling to share the mass production plan.

(2) Formation of resources and cross-system coordination

In the raw material supply stage, KF keeps communication with suppliers on material information at all times. KF collaborates with suppliers to complete supply progress and discusses solutions to abnormal problems with suppliers. For example, if the masks production machine lacks wheel steel, the company will mobilize resources to purchase round steel to support suppliers. If the single-screw extruder in the melt-blown fabric production machine is out of stock, the company will complete procurement with the assistance of the supply chain resources. If the melt-blown fabric machine does not have a single screw extruder, the company will organize its own supplier to finalize the supply. In addition, the coordination of the order management enables to create the upstream and downstream linkage, which can also promote the connection of the technical, financial, production, purchasing, logistics, and legal departments. It is to daily set up the shipment plan estimate the arrival, as well as update arrival information and future arrival plan daily, which help to avoid abnormal changes in the quick response. KF arranges dedicated staff to follow up on shortage goods to ensure the timeliness of goods supply; while controlling logistics information, KF provides necessary logistics support to control the delivery schedule. KF is using this series of methods to ensure the timely delivery of products. In addition, in the case of the shortage of domestic supplies, KF also applies the global synergy supply chain with the overseas subsidiaries working together to develop raw materials.

(3) Streamlining processes and responding quickly

Policymakers actively synchronize the information on procurement, technology, and the market. They research and select suppliers to introduce suppliers quickly in a short period. They participate in market research for masks, gloves, technology, and procurement suppliers. With the comprehensive analysis of the historical data on suppliers' market share, product quality, production scale, performance, and manufacturing capacity. Eventually, after obtaining supplier information, and supplier audit presentations, policymakers will make a final decision in one day.

(4) Strict risk prevention and control

To prevent quality risks, one is the management of hazardous chemicals, small base will start the trial plan, and then promote to the group, as required to establish a standardized storage and transportation management and mechanism for hazardous chemicals. In order to guarantee the on-time arrival of suppliers, and ensure timeliness, KF appropriately liberalizes the quality management of some products from suppliers to satisfy the rapid installation and production. KF's technical department independently developed substandard products and arranged its own supply chain to manufacture high-standard replacement products according to the equipment requirements. Finally, the SRM system was used to control supplier qualifications. For cost risk control, KF implemented a price classification procurement mechanism through daily

rolling cost calculations to achieve cross-departmental information sharing across the departments of technology, marketing, purchase, and planning.

(5) Guarantee of company platform and organization

Firstly, KF is large in scale with strong capital. With its own advantages in financial, material and human resources, KF has a clearer market positioning in the process of supply chain construction, thus giving play to its competitive advantages. Secondly, KF creates the upstream and downstream business chains and obtains the resources of suppliers of ear loops, non-woven fabrics, and mask nose strips by exchanging the melt-blown material. Finally, KF set up a special team to fully mobilize the enthusiasm and focus through the project management.

3.2 Manufacturing Process Management

For manufacturing companies, the development of new products is a routine task, but for new products across industries, in addition to technical and quality support, the certain production qualifications and production conditions are important in order to meet the five elements, namely human, machine, material, methods, and environmental conditions, shown in figure 3-1. In addition, the purchasing department can quickly provide the raw materials needed for production, which can ensure the production of new products. However, it should be noted that the procurement of materials urgently needed leads to a lower probability to have worthy exchanges. The purchasing

department even needs to face the quality issues of scarce materials. Therefore, it seems simple to make the procurement, but cannot buy the needed materials; under this situation, some procurement strategies and methods need to be established. For the KF medical mask project, it intends to illustrate the following chart (shown in Figure 3-1) in the Case Study.

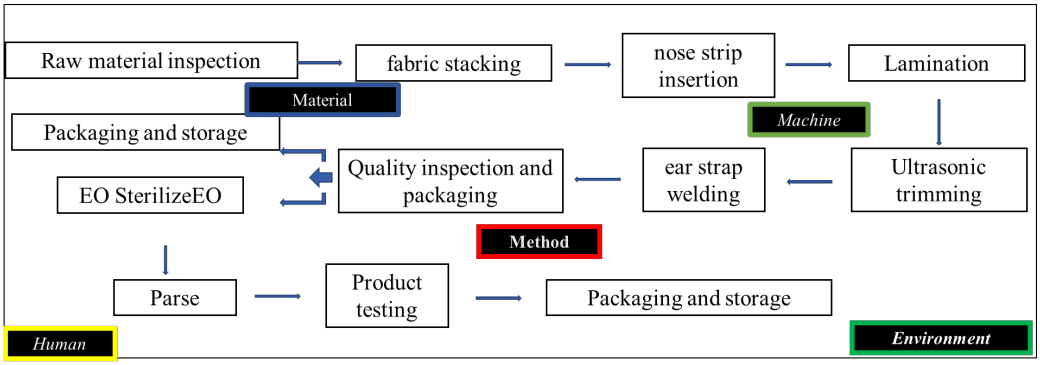


Figure 3-1 Manufacturing Process

Human resources. KF quickly built up an efficient, competitive, centripetal and goal-oriented team. The core team in the emergency supply chain contains the staff who recognize the company culture, with loyalty to the company, strong resistance to stress, and strong execution.

Machine. KF quickly obtained automatic mask production equipment and achieved the mass production capability. Mask production lines are non-standard equipment, with little space in the industry and insufficient technical talent and supply chain capabilities of equipment suppliers. KF Searched for equipment suppliers at the forefront of manufacturing strength to ensure a lower limit of equipment capacity. KF purchasing, technical, and equipment personnel

finished the decision-making during the site visits. They break through the bottlenecks with the KF group strength including human resources, finance, engineering, and technology after the communication and difficulties investigation. KF is good at integrating group strength, assigning professional equipment purchasing teams, decentralizing authority, and executing and providing timely feedback on abnormalities according to the equipment supply plan. Reaching a consensus to share the resource and benefit with equipment suppliers, the equipment suppliers are responsible for technical drawings and components supply, while KF is responsible for disassembling and assembling machines.

Material. The quality and supply of raw materials determine whether masks can be produced by qualified standards. Raw materials for masks include non-woven fabric, melt-blown fabric, ear loops, nose bridge strips, and packaging. The quality of raw materials plays a decisive role in masks (medical device products); KF produces its own melt-blown fabric, while other raw materials suppliers have a huge capacity, but the quality is worrying. The supply chain team advocates cooperating with large factories and up-scale suppliers with quality assurance.

KF operates the comprehensive assessment based on production capacity, quality, and supply capacity; for suppliers with higher quality (Qingyuan Yitong), assist them in production expansion and upstream raw material supply. For suppliers with large production capacity, arrange quality residency to assist

in improving quality. In special periods, barter (melt-blown material for non-woven fabric) was a way to jointly boost capacity with other suppliers. Based on the platform of KF, the suppliers with strong supply capacity and familiarity signed long-term strategic cooperation in priority.

Emergency materials are produced to reduce the loss of unexpected events. The first thing is to ensure the quality and technical parameters of the products can be applied to solve the problem to the maximum. The practical value is more important than the external apperance. Therefore, by being familiar with the national and industry technical standards of the products, we can quickly break through the technical barriers by using our own advantages to form products with corporate characteristics and bring them into mass production under the premise of ensuring quality. The focus on technical quality is the core of the emergency supply chain.

Law. KF needs to ensure product quality, product qualification, and product circulation legal compliance at all times. Internal and external legal compliance includes quality control of the product itself, product registration inspection, and compliance with sales of goods at home and abroad. Insisting on quality as the priority, KF combined 28 years of manufacturing and quality management experience, detailed quality specifications, and quality execution standards for incoming materials, processes, and finished products. KF strengthens the level of automation in the manufacturing process to reduce quality problems that may be caused by manual labor. KF focuses on the

training of front-line employees to enhance quality awareness with the clear Rewards and punishments policy. Technical and regulatory department personnel understand professional knowledge, including medical device regulations, domestic and international implementation standards, and import/export compliance, with close communication with agencies, customs and drug regulatory authorities.

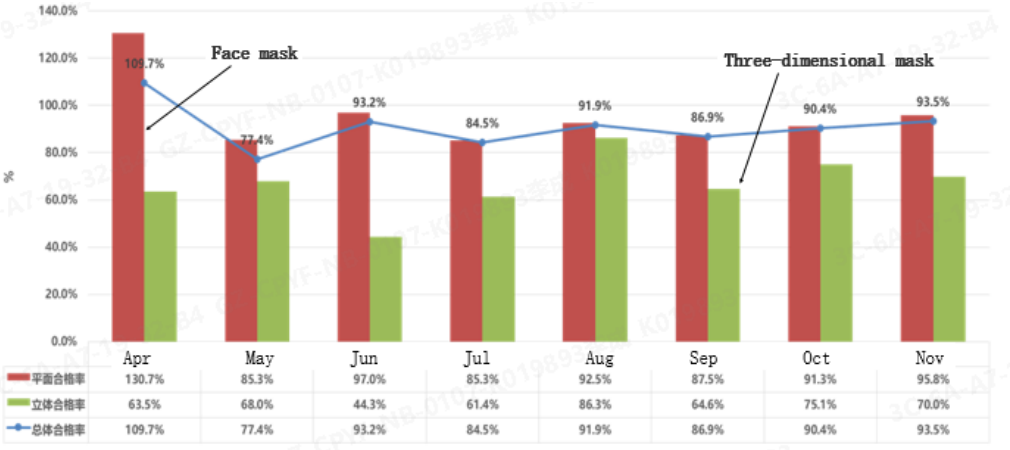


Figure 3-2 Qualified Rate of Masks

As shown in Figure 3-2, thanks to targeted management, the qualified product rate of products have achieved good results;

Maintaining high quality is a major challenge in the mass production process. The customers of KF are mainly large domestic and foreign medical material distribution companies, whose quality requirements for masks are relatively high. In the order completion process, professional third-party inspecting agents are invited to inspect the goods. Facing the pressure from customers, KF has been researching and accumulating while figuring it out.

Through continuous and meticulous improvements in the aspects of equipment, process and operation, KF's masks have achieved a high level in the industry and have been praised as the first in quality delivery performance in most of European countries.

Environment. KF quickly built the plants, laboratories, and workers' dormitories to meet the production of medical masks by working overtime. Medical masks are regarded as Class II medical devices. Products are required to be produced in Class 100,000 clean rooms. At the same time, the products need to be equipped with R & D and testing laboratories, including performance and microbiological testing. KF combined with internal and external resources. The external professional construction team and the company's internal engineering team to work jointly to determine the target. KF invited professional testing and third bottle evaluation agencies to the timely assessment of the environment. KF must ensure the capacity based on the equipment setup and the construction progress match the delivery target progress. Combined with the platform supply chain, KF ensure that all materials and resources needed for the delivery process are matched; set up additional incentives to reach the delivery target.

3.2.1 Building A Core Team

Efficient execution and effective team building determine the success or failure of the project. KF has established a top-down and centripetal team in a fast and orderly manner with the strength of the whole company.

(1) The chairman and the general manager are personally in charge of core team building. KF executives lead by example and make timely decisions. They personally visited the site to supervise and guide the frontline work. They communicated and dealt with the two issues of masks marketing and manufacturing in the WeChat meeting every night.

(2) Activate the following functions involving the cadre of each department. Selecting core cadre personnel from production, quality control, and financial departments to be responsible for the construction of each module of the project, as well as selecting sales, marketing, scientific and technical talents with a full understanding of company culture and management to support the grassroots management, coalescing the internal strength of the project team and motivating the staff.

(3) Establish a cadre of high-level professional talents. Select management cadres with rich professional knowledge reserves and strong knowledge span from the company to establish a solid cadre for the project team.

(4) KF establish the external talent referral program. Recruit a group of new talents with professional knowledge and market acumen from the society,

and give full play to their professional knowledge and skills, mobilize subjective initiative. They become another strong cadres team for the project.

3.2.2 Optimizing the Process and Respond Quickly

The production process is decentralized, and the team leaders and managers closest to the site make quick decisions on site matters and select and encourage capable and clear-thinking people to be the site decision team personnel. There are 3000-5000 people in the main production of the mask factory because they are all newly recruited from the society with differences in personal experience and personality, high mobility, and difficulty in forming tacit teamwork. and they need to establish a rapid integration mechanism, which places very high requirements on production management. KF took advantage of the group's talent advantage to deploy more than 300 cadres from bases across the country to fill the front-line management of mask production. About 150 of them were graduates from universities and colleges recruited in the past three years, and large numbers of high-quality talents from "985/211" colleges and universities. By the approaches of short-term training, incentive orientation, and elimination of the fittest, they quickly took up the responsibility of production grassroots management and became the cadre of mask production grassroots team leaders.

Regarding the selected grass-roots production cadres, the target is divided into all levels and the tasks are decomposed into groups and machines. The

target achievement of each group is notified on a daily basis, summarized on a weekly basis, and stimulated on a monthly basis. Mobilization of highly qualified personnel with high learning ability and high independent innovation can identify and solve problems in a timely manner and continuously improve. Establish an orderly front-line team management mechanism. The production grassroots team forms 1+6+X division of labor principle, 1 team leader + 6 host operators + a number of operators for division of labor. The clear division of labor for machine operation and grassroots management supervision responsibilities, supplemented by special training, ensure the stable and efficient operation of the mouthpiece production (shown in Figure 3-3).

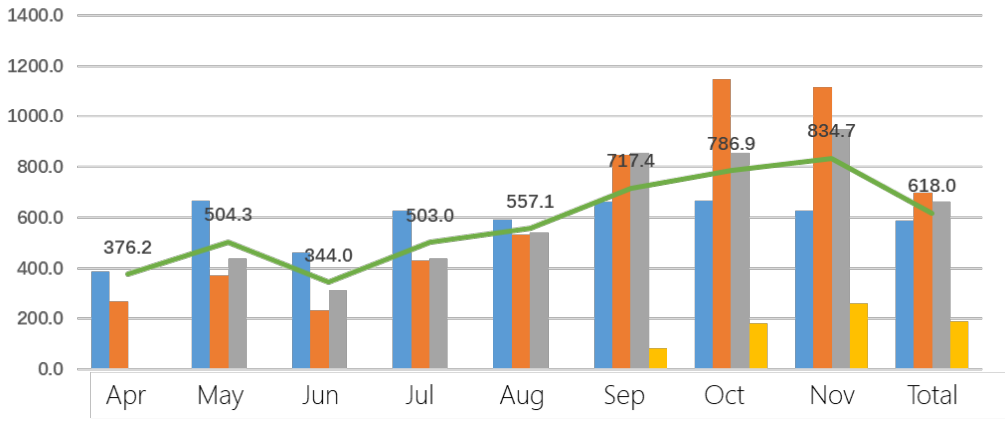


Figure 3-3 Efficiency per Capita Continues to Improve (unit: piece/hour)

3.2.3 Team Building

KF, as a "cross-industry" manufacturer of masks, had no experience in mask production and faced great difficulties; KF took various approaches to go out and come in to quickly solve the problems of mask production.

First of all, KF completed the construction of an efficient core team and an efficient personnel management and operation mechanism.

(1) Mobilize the high-quality human resources into the production of mask factories. KF has always attached importance to school recruitment and has a large number of high quality talents from "985/211" universities. The company's emergency mobilization group will recruit more than 300 fresh graduates to join the mask factories production after 1 to 3 years of employment. They ecome the main operator of more than 400 mask machines and the cadre of the leader of the mask workshop.

(2) Establish a management mechanism for the front-line team, the front-line production personnel is the key personnel to implementing R&D concepts into actual products, so the management of front-line teams is very important. By comparing and studying the manufacturing project team, this paper proposes the principle of +X/+6 machine operation division of labor, 1 foreman/shift leader + 6 host hand operators + several shop section division of labor model. It clearly defines the division of machine operators and grassroots implementation of management and supervision responsibilities. KF establishes a series of plans to improve special training capabilities to ensure smooth and efficient operation of mask production.

(3) Carry out flexible personnel recruitment. The manufacturing of epidemic prevention products such as masks is labor-intensive and requires a large number of workers (shown in figure 3-4). On one hand, KF, mobilized

professional talents from various domestic and foreign molecular companies to ensure that the mask production lines and related processes are in order. On the other hand, KF concentrated professional and technical personnel in higher education institutions, while mobilizing labor companies across the country to carry out labor dispatch and helped the Internet platform to recommend ways to recruit production operators to effectively guarantee personnel supply (shown in Figure 3-4).

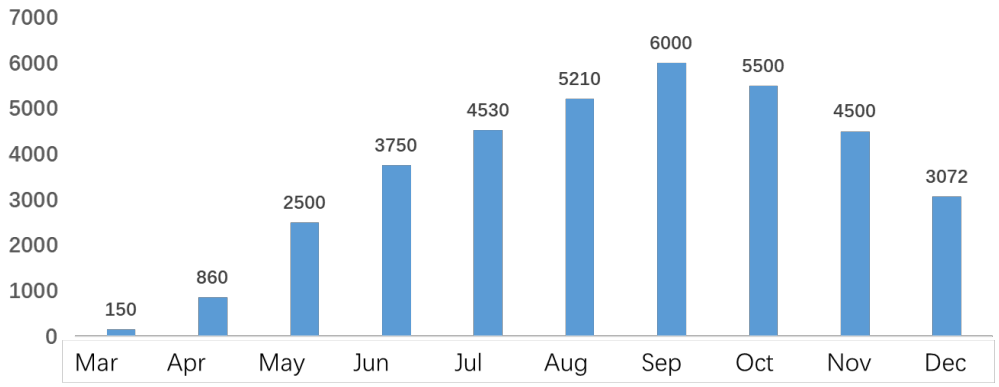


Figure 3-4 The Number of Recruited Workers

KF chose a group of competent cadres from the group as the core team for mask production. All of these people came from the KF group. They were familiar with the company's culture and system and worked well with the company's decision-making and mask construction project team. The disadvantage was that they were not familiar with the mask industry and did not have enough experience.

KF has taken various approaches from internal and external experience to quickly enhance the shortage of mask manufacturing management. Firstly, during the construction of the mask factory, the production cadres were selected to go to professional mask enterprises to learn and understand the manufacturing process. On the basis of external experience learning, KF applied and optimized it with its own characteristics to lay the professional foundation of KF's mask manufacturing technology and process (shown in Figure 3-5). At the same time, KF outsourced the top professional company in medical device manufacturing system construction and aseptic workshop management in South China to regularly review KF's production and guide the improvement, making KF's mask production management rapid progress.

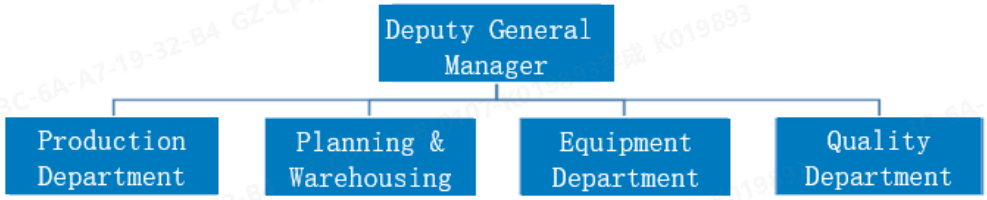


Figure 3-5 Internal Structure of Operating Departments

The mask is not complicated from the product aspect, but the whole industry chain resources such as equipment, raw materials, packaging, and production are indispensable. In the case of an epidemic outbreak, the resources of all parties are grabbed by the whole society, while many manufacturers lack the ability to enter this industry. From January 2020, the whole market was in a

mess. KF focused on the front section of the raw material market and did not enter the mask industry at the first time. In March 2020, KF started to make decisions to enter the mask market, while the competitors are everywhere in the market. How to organize the construction and operation of the mask factory systematically. There was a huge challenge.

The establishment of the mask factories required the internal integration of resources from marketing, R&D, equipment, production, purchasing, logistics, quality control, and other departments. The external integration of customers, equipment suppliers, raw material suppliers, logistics suppliers, and government regulatory inspection, these tasks needed to be effectively organized in a short period, and all parties had to be mobilized to coordinate arrangements and carry out actions within the same goal. KF has extensive experience in new product development and new project construction. Therefore, KF decided to move forward with a project-based approach.

The key of the success of the project is team building. Only the right selection of the team can effectively undertake the project tasks. On the mask project, the chairman and the general manager of KF personally are in charge of the front-line management. The execution is led by example, timely decision-making, on-site supervision, and in-depth front-line guidance, to solve the relevant problems.

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project, the chairman and the general manager of KF personally are in charge of the front-line management. The execution is led by example, timely decision-making, on-site supervision, and in-depth front-line guidance, to solve the relevant problems.

3.2.4 Implementing Special Incentives

KF implements the incentives for equipment commissioning personnel. Mask production relies heavily on equipment, and the improvement of the OEE of equipment is crucial to the qualified yield of masks. The motivation of equipment commissioning personnel needs to be fully mobilized. Set up special incentives for equipment commissioning personnel, including new machine commissioning award and production increment award. Incentives for production personnel, Mask production capacity is directly related to production operators, and a special production increment award is also set up in addition to the normal salary to encourage more production output.

Table 3-1 The Summary of Special Incentivess

Production target (10,000 pieces/class)	**Equipment staff (yuan/class)**	**Production staff (yuan/class)**
<1.5	0	0
1.5-2.0	75	38
2.0-2.5	175	88
2.5-3.0	325	163
>3.0	525	263

Through the way of over-production incentives, KF mobilizes the front-line staff to work actively and effectively to improve the production capacity of masks.

3.2.5 Plant Construction (Cleaning Workshop)

The construction of the mask factory is an important part of the mouthpiece project. In March 2020, KF had 26 factory buildings in its Qingyuan base, each with an area of 6,000-20,000 square meters. In order to complete the construction work of the mask workshop in the shortest time, 2 buildings of the factory and 2 buildings of the warehouse were selected for rebuilding, thus solving the problem of the factories. Medical masks belong to Class II medical devices, and the production environment needs to be carried out in a clean workshop of Class 100,000 or above. Under the time urgency as well as the high standard construction requirements, the safe and clean mask production environment faced heavy challenges. The construction period was tight. The task was tough. The project involved many professions, difficult cross-construction coordination, and there was a shortage of construction materials. Facing the difficulties and challenges, KF's mask project team cracked them one by one and completed the production environment construction problems on time and in quality, providing a safe and clean environment for mask production.

KF identified the construction supplier for the workshop renovation on March 16 and signed the construction contract for the first mask factory. The

first mask factory was divided into three units for step-by-step construction. After working day and night, KF started to complete the first unit of the No.1 mask factory on March 23, the second unit was put into use on April 5, and the third unit was put into use on April 10. All of them were put into use as scheduled. In this process, making good progress control was a heavy difficulty. In order to complete the construction successfully, KF's project team, led by the engineering minister, worked on-site, coordinated on-site, and scheduled the processes in an orderly manner during the construction process. They worked continuously for 24 hours, overcame various difficulties in material procurement, construction plan, operation process, epidemic protection, etc., and finally reached the construction goal.

3.3 Demand Management

For enterprises, the continuation of production cannot be guaranteed if a good product cannot be transformed into a commodity and circulated in the market, so the emergency supply chain also needs to pay attention to the sales process. In different stages, the strategy of sales is different. In the preparation stage, there is no product, so sales need to cooperate with the technical quality to propose market demand so that the designed products can meet the market to the maximum extent. In the response period, due to the emergency properties of the product, resulting in an overdemand of products, sales need to rationalize market demand and assist production to finalize the planning management. In

this case, the production can be fast and orderly. In the improvement period, it needs feedback on the use of the product in the emergency supply chain. In the improvement period, sales need to give feedback on the use of the products to each part of the emergency supply chain and improve the supply chain by solving the pain points of customers. Therefore, in the sales part of the emergency supply chain, it is necessary to promote the optimization of the supply chain while ensuring the transformation of products into commodities to achieve social attributes.

3.3.1 Identifying True Demand

The emergency security activities in the emergency supply chain are inherently uncertain. In order to reduce the uncertainty in the emergency supply chain, it is necessary to make demand forecasts and try to clarify the "demand fog" in the emergency supply chain. The emergency support department must firmly establish the concept of "emergency support demand as the center", as shown in Figure 3-6, strengthen the contact with emergency demand units and individuals during normal times, understand the demand information in time, analyze the potential demand, and strive to provide the best emergency materials and emergency services to the final security object in the shortest time.

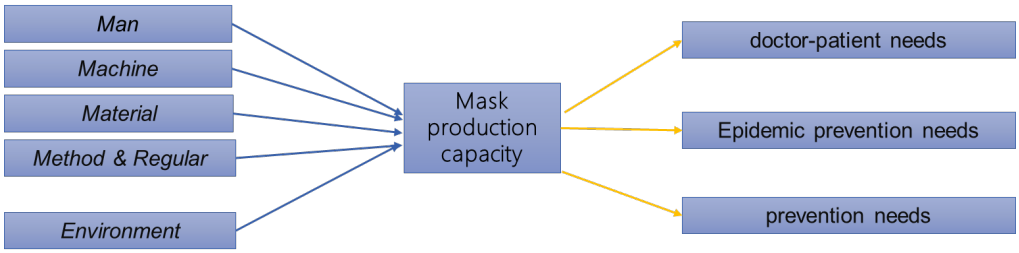

Figure 3-6 The Relationship between Production, Supply and Marketing

Demand Management: How to identify real demand and achieve the orderly planned supply? The epidemic leads to a crazy supply-demand relationship, which often triggers a series of pseudo-demand and demand illusions. It is common that many real demands are repeated many times and turn into the demands with exponential increase number, and finally become "verbal or digital demands". Effective identification of real demand can avoid blindly expanding supply; it is necessary to reasonably plan production scheduling and supply chain resource dispatching within the scope that the emergency supply chain can bear, based on demand management and situation judgment.

On the morning of May 2020, the company received the demand form including the delivery date and inquiry of 1 billion medical masks order. On that afternoon, company B received the same form, and the next day company C also received an inquiry, so the same order demand in three days, the real demand for 1 billion medical masks became close to 8 billion digital demand. As the result, each manufacturer cannot identify the real demand. Each manufacturer was unable to identify the real demand, and each of them actively

went to compete for it by low price and stock preparation, which resulted in a big loss for these mask manufacturers.

As one of the largest manufacturers of masks, KF's emergency supply chain capacity was also greatly tested. With 28 years of manufacturing experience, KF divided demand identification into three categories: (1) end-customer demand: combined with the platform resources own supply capacity, active source-seeking to find end-customers with real demand, commonly found in manufacturing large customers, government and bidding demand, belonging to the prevention demand; (2) distribution, channel merchant demand: identify well-known distributors and channel merchants in the mask industry, pay attention to market demand changes, and strive to (3) demand from traders: during the epidemic, traders are the most active and their demand is hard to distinguish between real and fake. For trade customers, it is necessary to distinguish between good and bad and identify risks, especially when the supply exceeds the demand and the value of goods is high, which belongs to epidemic prevention demand.

The “Bullwhip Effect” (shown in Figure 3-7) is a high-risk phenomenon prevalent in supply chain management, which can lead to unreasonable supply-side fluctuations compared to the real demand, thus affecting marketing, supply and production, and even causing chaos in the whole supply chain. The “Bullwhip Effect” leads to overreaction to market changes. When market demand increases, the capacity of the entire supply chain increases more than

the increase in market demand, and the excess is accumulated in the form of inventory at each node of the supply chain. Once the demand slows down or grows negatively, a large amount of capital and products will be accumulated in the form of inventory, resulting in poor capital turnover of the whole supply chain, affecting the good operation of the supply chain and even leading to the closure of enterprises, especially small enterprises at the end of the supply chain.

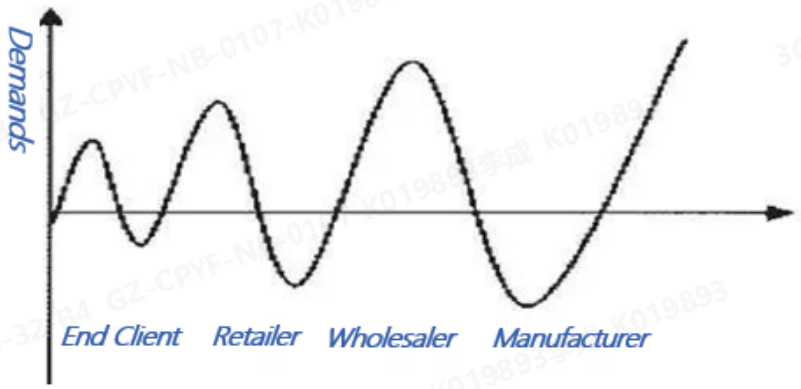

Figure 3-7 The Bullwhip Effect of Demand

Below is the monthly production and sales volume of KF's medical masks in 2020 (shown in Figure 3-8).

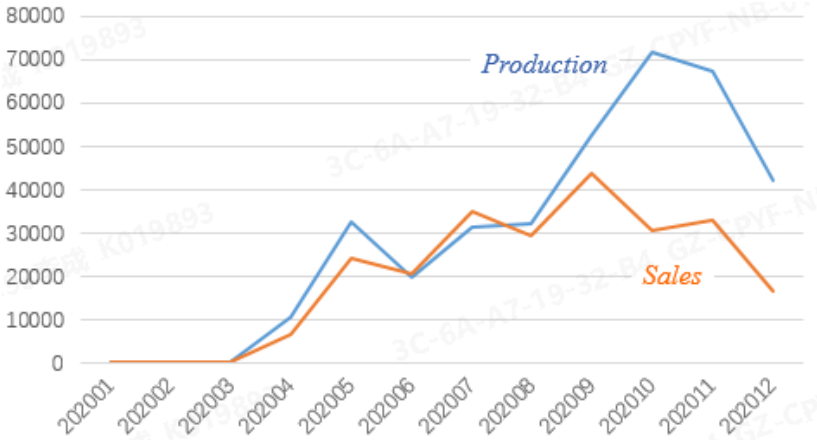

Figure 3-8 KF Mask Production and Sales in 2020

As shown in Figure 3-8, it shows when medical mask supplies are relatively scarce in the month (202033-202008), the monthly production and sales equivalents and trends fluctuate over time. The trend lines are close to overlap, which is because the outbreak of the epidemic at home and abroad during this strong-demand period. At the same time, demand from both domestic distribution, overseas trade was close to actual demand, but from September onward the production was much larger than actual sales, indicating a problem in managing demand. This is because small changes in consumer market demand are magnified one level to manufacturers, first-tier suppliers, sub-suppliers, etc. For example, a slight increase of 5% in demand forecast for the mask market may translate into 10% for first-tier traders, and 20% for manufacturers. In short, the further back in the supply chain need to manage greater the change in demand. Changes in demand translate into inventory levels, and accordingly, inventory changes follow a similar pattern. Prices and supply and demand have changed dramatically at this point.

From the whole production and sales trend line in 2020 can be seen, it is the typical bullwhip effect trend line, which means that in 2021 in the validity of medical mask products need to spend more energy and resources to inventory. As shown in figure 3-9 below, it can be seen that the inventory risk generated in 2020 has been accompanied by 2021. At the end of 2021, the inventory was reduced to a manageable range, into a healthy operating range. As illustrusted

in Figure 3-9, the production and sales volumes in 2021, the inventory risk created in 2020 stays with 2021, only bringing it down to a manageable level by the end of 2021.

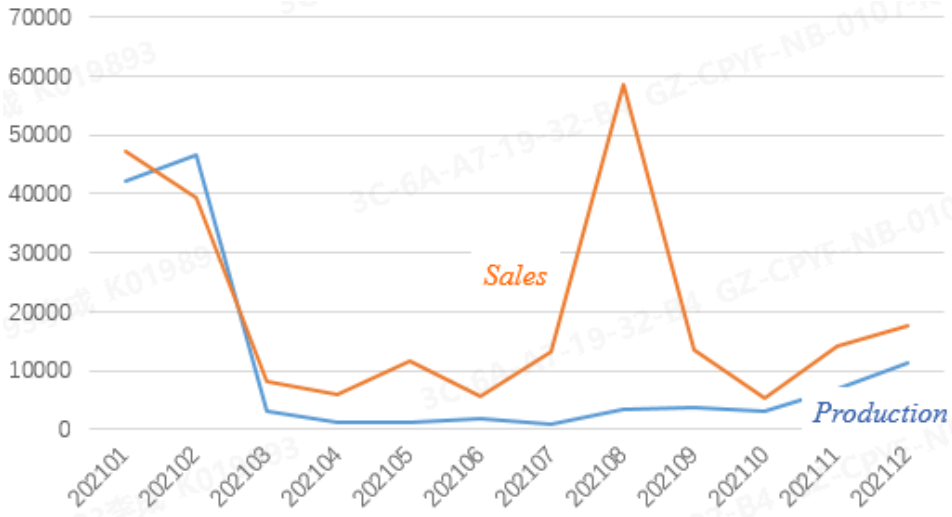

Figure 3-9 KF Mask Production and Sales in 2021

3.3.2 Meeting Regulatory Requirements

At the beginning of the epidemic outbreak in 2020, medical masks classified as Class II medical device product categories surge in demand and become strategic materials. The quantity of market-qualified, legal-compliant products in the market cannot meet demand. In order to speed up the mass production of medical masks and rapid market launch. In order to further improve the prevention and control of COVID-19 infection of epidemic, as required by the medical equipment emergency approval, combined with the 《Guangdong Provincial Drug Administration Office on the adjustment of the first level of response during the implementation of special management of medical masks and other prevention and control of urgently needed devices》.

On March 7, 2020, the Drug Administration issued a "medical masks, medical Protective clothing and other epidemic prevention and control of urgently needed equipment emergency approval application guidelines", and asked the subordinate units to actively deal with the emergency approval application guidelines for publicity, orderly guide enterprises to apply for emergency approval.

Emergency filing and approval process is as follows. The applicant to apply for emergency registration, shall submit the registration declaration information to the provincial Drug Administration. The applicant shall submit an application for registration of quality management system verification within 2 working days after the acceptance of registration. The applicant shall establish a quality management system and maintain effective operation, with the appropriate production equipment, personnel, sites, with production management and quality control capabilities, retain the appropriate records. Supervision department shall organize on-site inspection within 2 working days from the date of receipt, review department in the organization of on-site inspection within 5 working days after the completion of the technical review, approval department in the technical review and quality management system verification are completed within 3 working days after the completion of administrative approval. It can be seen that each link is leading and racing with time, and Class II medical devices (medical masks) in the normal registration filing process and time up to about six months long, as compared in Table 3-2.

Table 3-2 The Comparison of Domestic Registration Cycles of Medical Masks in Normal vs in Emergency Situation

(Emergency)	(Normal)
Acceptance (1 working day) - registration review (5 working days for technical document review), physical examination (7 working days arrangement) - registration review (1 working day for leader's reply) - certificate making (1 working day)) - to apply for a production license (5 working days), **the cycle is about 20 working days in total;**	Acceptance (5 working days) - registration review (at least 35 working days for technical document review), physical examination (arrangement within 1 month of submitting technical documents) - registration review (5 working days for the leader's reply) - certificate making (5 working days) - apply for a production license (10 working days); **the normal cycle is at least 85 working days;**

The above table shows that at the beginning of the epidemic of COVID-19, as for, whether the qualified medical masks can access to the market depends on how soon the government and regulatory authorities the epidemic emergency policy which release the production capacity for the medical masks. It is the key factor to open the medical mask emergency supply chain. KF timely set up by the technical-oriented special product certification registration and regulatory research team to play an irreplaceable role in the introduction of products.

3.3.3 Satisfying Customers' Demand

The needs of the market and customers are always the core. Medical masks have strict executive standards and market access conditions. The results of various studies and experiments have shown that medical masks have better barrier protection against particles such as COVID-19, germs and mist compared to general protective masks, and are also in the greatest market demand. From product development, production to delivery, the whole emergency supply chain will experience a greater challenge. Only through continuous communication (shown in Figure 3-10), feedback and information sharing can we identify real needs, make production, supply and marketing information symmetrical, and meet customer needs at the first time.

Figure 3-10 Communication among Supply, Production and Sales

3.3.4 Risk Management

Risk is uncertain but objectively exist at the same time. Wherever there are supply chain activities, there will be risk. Supply Chain Risk Management refers to the systematic identification, assessment, and quantification of potential supply chain disruption risks, with the aim of controlling the occurrence of risks and reducing the negative impact or loss of risks.

Uncertainty in the supply chain refers to a situation where the characteristics and state of things cannot be adequately and accurately observed, measured and foreseen when the time factor is under consideration. In the process of cooperation between supply chain enterprises, there are various factors that generate internal uncertainty and external uncertainty. Uncertainty in the supply chain generally comes from the following aspects.

(1) There is uncertainty from supply chain links. There are many reasons for not being able to supply on time, such as transportation problems, suppliers' own supply problems, etc., which can cause the failure to deliver within the promised lead time, and this uncertainty can appear in every link of the supply chain.

(2) There is uncertainty from the production process. Uncertainty in the production process comes mainly from equipment broken, temporary shortages of key personnel, and out-of-stock downtime caused by supply chain links. The difficulty also lies in the fact that the reliability of the production systems of multiple companies in the supply chain is at different levels, sometimes varying widely.

(3) There is uncertainty from customer demand. Adequate supply leads to diversification of demand and unstable consumer base. Customers have a lot of choices and can easily switch from one product to another. The complex and coordinated operation of the supply chain relies on perfect planning control, and the preparation of the plan comes from the forecast of demand. Uncertainty of

demand can easily cause chaos in the whole supply chain. There are two types of supply chain risks:

Chain reaction caused by shortage. As the business between the supply chain partners is closely related, and each partner is desperately trying to reduce inventory due to the pressure of their own operating costs. As a result, the shortage of individual nodes may cause disruption of the whole supply chain operation, or disrupt the normal schedule of the whole supply chain. The consequence may be the loss of customers due to order postponement or the exponential increase in the operating cost of the whole supply chain due to the contingency measures taken, resulting in a decrease in market competitiveness. Analysis of the loss of customers due to order extensions is necessary. If the shortage occurs in the manufacturing chain, the distribution chain as the direct victim of the loss of customers, although there is no fault for the manufacturers, they will also innocently bear the loss due to reduced orders.

Chain reaction will be caused by false demand. Due to a false demand signal generated by the client, in the process of spreading along the supply chain gradually amplify. When the clients bring any signal of the demands, the multiplying inventory will occur, because the rational response of enterprises is to increase inventory to eliminate uncertainty. Eventually, this inventory cost will also reduce the competitiveness of the supply chain, and \ make each member suffer losses This effect is called "bullwhip effect".

There are three steps to control and reduce the risk in the supply chain: before, during and after. These three steps are interlinked to make the risk management system more complete and become a complete closed loop (shown in Figure 3-11).

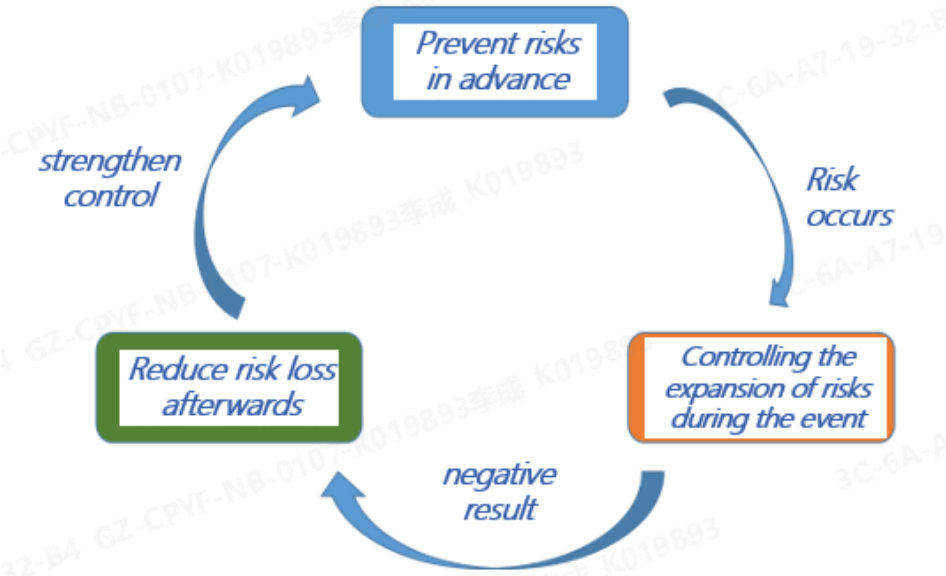

Figure 3-11 Closed Loop of Risk Management

For the KF mask project, the response to risks in the emergency supply chain is mainly based on its own business model, combined with the supply and demand of medical masks under the epidemic and the bullwhip effect, for the identification and prevention of risks is the most important. The general process of its operational risk prevention is shown in Figure 3-12.

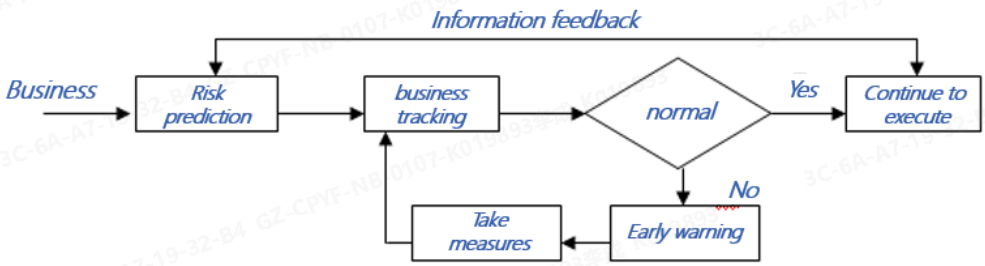

Figure 3-12 Risk Identification and Prediction

For various risks and their characteristics, different preventive measures should be taken. The prevention of risks can be considered at the strategic and tactical levels. The main measures are as follows.

(1) Develop multiple supply channels, multi-region supply channels, and strengthen the inspection and evaluation of suppliers.

In order to ensure stable product supply, multiple supply channels should be developed in the supply chain, and it is not suitable rely on a single supplier. Otherwise, once that vendor has problems, it will inevitably affect the normal operation of the whole supply chain. At the same time, when there is dependence on certain supply materials or products, geographical risks should also be considered. For example, war can interrupt the supply of raw materials in certain regions, which will inevitably cause a crisis if there is no supply from other regions. In addition to establishing multiple regions and multiple suppliers, each supplier situation must be tracked. If establish a long-term supply chain partnership with suppliers that is trustable, cooperative, and open to communication, it needs to first analyze the competitive market environment. The purpose is to find out for which product markets to develop supply chain

partnerships to be effective, and must know what the current product demand is, and what the types and characteristics of products are, in order to confirm the needs of users, to confirm whether there is a need to establish supply chain partnerships. If supply chain partnerships have been established, to confirm the need for changes in supply chain partnerships based on changes in demand. Also analyze the current situation of existing suppliers, analyze and summarize the problems in the enterprise, and make a full investigation of the supplier's performance, equipment management, human resource development, quality control, cost control, technology development, user satisfaction, delivery agreement, etc. It is likely to be a factor that affects the security of the supply chain. Once a supplier is found to have problems, the supply chain strategy should be adjusted in time.

(2) Establishing strategic partnerships.

Supply chain enterprises want to achieve the desired strategic goals. Objectively, supply chain enterprises are required to cooperate and form a win-win situation of sharing profits and risks. Therefore, establishing a close partnership with other \ companies in the supply chain becomes a very important prerequisite for the successful operation of the supply chain and risk prevention. Establishing a long-term strategic partnership requires, first of all, members of the supply chain to strengthen trust. Secondly, the exchange and sharing of information among members should be strengthened. Thirdly, a formal

cooperation mechanism should be established to realize benefit sharing and risk sharing among the supply chain members.

(3) Strengthen information exchange and sharing, establish multiple information transmission channels, and prevent information risks.

Information sharing among enterprises in the supply chain can improve the synergy and operational efficiency of the supply chain operation on the one hand, and on the other hand, it is conducive to the timely detection of potential risks in the supply chain, so as to win valuable time for risk avoidance and early remedial action. With the rapid development of economy, social division of labor is becoming more and more detailed. The relationship between manufacturers-consumers-suppliers is becoming more and more complex, and the role of each enterprise in the supply chain is becoming closer and closer, and the interaction between them is accelerating. Therefore, the supply chain enterprises should establish the sharing of inventory information, available sales information, order information, planning information, end-customer demand information and historical information, and cargo transportation status information, so that the enterprises in the whole supply chain can be agile and quick to respond to market demand. At the same time, the supply chain enterprises should also eliminate information distortion through mutual information exchange and communication, so as to reduce uncertainty and reduce risk.

(4) Establish the leading position of core enterprises.

The enterprises in the supply chain cannot be on an equal footing because of the different resources they possess, such as financial strength, R&D capability, and brand value. In fact, the supply chain is also a network chain formed around the core enterprise, not simply a chain from the supply chain to the user. Since the supply chain is a community of interest with close business ties, the leadership role of the core enterprise is conducive to maintaining strong pressure for improvement throughout the supply chain, thus improving the synergy and operational efficiency of the supply chain and reducing the risk brought about by it.

(5) Establish a core supply chain.

There are always key resources in any supply chain, i.e., those with high technological content, those that play a key role in determining the quality of the supply to the end user, and those that are in short supply. The core company is able to form its leadership position, in large part because it holds many key resources. If the core enterprise cannot hold all the key resources, it should strengthen the relationship with the enterprises holding some of the key resources, and form a strategic partnership with them to form a core supply chain, which is essential to reduce the risk of the supply chain. Especially when two or more supply chains compete for the same resources, it is particularly important to establish and maintain such relationships. For example, a PC manufacturer can not ensure the normal supply of CPU, or a car factory can not ensure the normal supply of engine will be in a very awkward situation.

Generally speaking, this relationship can be strengthened through mergers, equity participation or mutual exchange of equity.

(6) Daily management of risks.

Competitive enterprises are always facing risks, so the management of risks must be persistent, and establish an effective risk prevention system. To establish a set of early warning evaluation index system, when more than one of the indicators deviate from the normal level and exceed a certain "critical value", the need to issue an early warning signal. The determination of the "critical value" is a difficult point, because the critical value deviates from the normal value is too large, it will make the early warning system before the arrival of many crises to issue a warning signal; while the critical value deviates from the normal value is too small will make the early warning system to issue too many false signals. y must be based on the specific distribution of various indicators, choose the indicator can make the error The threshold value that minimizes the ratio of false signals for that indicator must be chosen based on the specific distribution of the indicators.

(7) Establish emergency handling mechanism.

Supply chain is a complex system with multiple links and multiple channels, and it is easy for some unexpected events to happen. In supply chain management, it is necessary to be fully prepared for the occurrence of unexpected events, and to establish a certain emergency response system for various unexpected situations that may occur in the process of cooperation from

various aspects and multiple levels. After the early warning system makes a warning, the emergency system timely emergency treatment of urgent and sudden events, for some accidental but destructive events, the enterprise should develop contingency measures in advance, develop a workflow to deal with emergencies, and establish a contingency team. In this way, through the emergency response system, the risk of various unexpected situations arising in the supply chain cooperation can be defused and the actual loss brought about by it can be reduced.

Chapter 4 Case Analysis

In this chapter, case analysis is used to further illustrate how KF construct the emergency supply chain (Yin, 2014). According to scientific guidelines and case demonstrations, the focus is on evidence and data analysis, which greatly improves the success rate of emergency supply chain construction in the project.

4.1 How did KF Construct the Facemask Supply Chain?

As the company with the most complete variety of modified polymer materials and products in the world, relying on the four national R&D platforms and technical R&D strength, combined with 28 years of manufacturing and supply chain integration capabilities and accumulated platform advantages. The decision-makers of KF attach great importance to judging the situation, actively respond to the call of the country and keep up with the dynamic demand of the market. We have made a decisive strategic decision and put forward the daily production capacity target of 40 million masks, quickly opening up the whole industrial chain of melt-blown polypropylene special material, melt-blown polypropylene non-woven fabric and medical masks. Decision makers are bold and decisive in judging the situation, and the ability of emergency supply chain also gives decision makers confidence.

The outbreak of COVID-19 in January 2020 led to an explosion in demand for materials and products such as melt-blown polypropylene special materials -- melt-blown polypropylene non-woven fabrics -- and medical masks. On the one hand, KF company undertakes social responsibilities, in order to alleviate

the extreme shortage of epidemic prevention materials in China, to promote the resumption of production and work in China, and to reduce the harm of the epidemic to more people. From January 2020, the company decided to devote all efforts to produce special breathable film materials for medical protective suits and melt-blown polypropylene materials for medical masks to meet the growing demand of epidemic prevention materials in China. Since February 2020, the company has rapidly expanded to the downstream, taking advantage of the company's supply chain capabilities and platform advantages, and combining with the cooperation of the R&D department, process equipment department and engineering department, the company has rapidly completed the construction of 100,000-class workshop, equipment assembly, in-plant installation and debugging, and accelerated the completion of the whole industrial chain of melt-blown materials, melt-blown cloth and medical masks.

On February 1, 2020, the company requested five domestic production bases to quickly complete the modification and commissioning of melt-blown polypropylene extrusion production machines. With the joint efforts of all departments, the technical scheme design, pilot test verification, equipment transformation and mass production evaluation were completed in 10 days. The melt-blown polypropylene special material with high fluidity, narrow molecular weight distribution and low odor has been successfully developed and mass-produced. After one month, the daily output of melt-blown polypropylene special material has exceeded 2,000 tons, more than half of the total market

supply, and the annual total production and sales are about 170,000 tons. According to the development trend of the situation, from February 22 to March 1, the company completed the formula development of melt-blown nonwoven products for masks and the planning, installation and commissioning of the first 3.2 meters wide Melt-blown nonwoven production line of Germany Reifenhauser in only 9 days. After that, one equipment will be installed and debugging every seven days. By the end of March, the daily production capacity of melt-blown cloth will be 25 tons, which can produce 25 million medical masks per day, making China one of the largest melt-blown nonwovens suppliers of medical masks in China. In order to further promote the resumption of production and work, ensure the supply of qualified medical masks in the market and meet the demand of the whole industrial chain. The mask project was approved on March 16. Relying on the advantages of the whole industrial chain and emergency supply chain of protective materials, mask factory construction, mask machine technical plan and qualified medical masks were completed in 15 days. In order to rapidly increase production capacity of mask products, the capacity of the emergency supply chain was greatly utilized to maximize energy through collaboration with manufacturers. On March 18, the first medical mask equipment was delivered to the factory. On April 5, qualified medical masks were offline and capable of shipment. With the changing global epidemic situation and market demand, 100 million masks were produced on

May 1. In mid-June, the daily production capacity reached 40 million medical masks, making it the world's largest supplier of masks.

Table 4-1 Important Nodes of KF's Mask Project

Date	**Milestone of KF Mask Project**	**Important Events**
March 16	Publish the decision on the construction of mask factory	The mask project was officially launched
March 18	The first mask has been developed	
March 20	The first batch of mask production materials are set together	
March 23	The renovation of the first clean workshop was completed	
March 25	The first qualified plane mask is produced	Mask project put into operation
March 27	The first qualified three-dimensional mask production	
April 30	A total of 100 million masks were rolled off the production line	
May 3	Daily production of flat face masks reached 8.5 million per day	Production of flat face masks peaked
May 22	Daily production of stereoscopic masks reached 7.2 million per day	Production of three-dimensional masks peaked
June 29	The mask production line has reached 400 sets, with a total production capacity of 20 million yuan per day	The mask factory construction project has been completed

KF's strategic decision and the establishment of emergency supply chain quickly built the whole industrial chain of melt-blown polypropylene special materials, melt-blown nonwovens and medical masks, quickly filling the huge gap in the demand for epidemic prevention materials during the epidemic. By

2020, China will provide more than 170,000 tons of polypropylene melt-spray special materials, 1,900 tons of melt-spray cathode master batches and 34,000 tons of polyethylene special materials for breathable film, capable of producing more than 200 billion masks and 500 million medical protective suits, and producing and selling more than 4 billion medical masks, greatly alleviating the shortage of core materials for epidemic prevention and control. It has made a major contribution to China's and the world's anti-epidemic efforts. KF also successfully turned crisis into opportunity and realized leapfrog development.

4.1.1 Identifying and Pre-positioning Suppliers

KF has excellent experience in identifying and prepositioning suppliers, considering the implementation of fast and effective purchasing strategy for mask equipment. Modern mask production has been fully automated production, so as to achieve mass and low-cost production of masks. It is understood that the cost of medical plane masks is 0.1 yuan per mask every year. But without modern and efficient automated mask production equipment and appropriate raw materials, this cost is impossible to achieve. On the other hand, when the demand far exceeds the supply, mask machines and raw materials are scarce. Only the effective implementation of procurement strategy can get through the supply chain.

The first is the mask machine. Mask machine is divided into plane mask machine and three-dimensional mask machine according to the type of mask. In

March 2020, a large number of equipment enterprises cross-production plane mask machine, but the quality of equipment is uneven. In view of this situation, KF company adopted the strategy of "horse racing" and signed conditional delivery contracts with a number of mask manufacturers, because the contracts were large enough and the deposit was large enough to attract the input of mask manufacturers. On the other hand, the time limit for qualified delivery shall be agreed. The mask machine shall meet the standards of on-site trial production before full payment can be made. According to this strategy, we reached cooperation intention with 5 suppliers, and finally 2 of them won the competition and won the super large order of 200 mask machines from KF Company. KF company also timely purchased mask machines from the competition of suppliers. As of March 2020, the manufacturing capacity and market supply capacity of three-dimensional mask machine equipment are obviously insufficient, and the technical difficulty of such masks is more difficult. Temporary manufacturers cannot break through the technical bottleneck, while the capacity of old factories is limited, basically meeting the needs of government allocation. In view of this situation, KF company adopted the cooperative production mode with mask machine equipment factory to solve the problem. After investigation, we selected an old factory in the industry and proposed that the mask machine factory draw the drawings and provide key parts. KF company assisted in the assembly and debugging of the equipment with its own technology and equipment, and built a mask machine equipment

factory in one week, increasing the production capacity of the other company from 2 sets/day to 8 sets/day.50% of the qualified mask machines, namely 4 machines per day, were sold to KF Company. Due to the decision making and fast execution of the top management, the supplier's ability was accurately judged and the agreement was reached quickly. Although the mask machine factory was skeptical at the beginning of cooperation, in front of the mask machine factory built by KF company in a week, the other party further opened up the embrace of cooperation.

Case: The mask project was approved on March 16, 2020. In the afternoon of that day, the Ministry of Industry and Information Technology and the National Development and Reform Commission provided information to search for mask machine suppliers and sort out the list of candidates. On March 17, the company's purchasers and technicians went to Dongguan to inspect TWO equipment manufacturers HY and KYD on site, and KYD was preferred. I have learned that the supplier is in the forefront of the industry in terms of technical level and equipment stability, but only 2 masks can be produced every day and only one mask machine can be supplied within three days, with limited capacity. On the afternoon of March 17th, after reporting the inspection results, the chairman personally led the procurement and technical team to KYD again and asked: 1. What are the biggest difficulties and bottlenecks at present? 2. What kind of person can make a mask machine? 3. Is there any idle factory nearby? On March 18, the Human Resources Department gathered nearly 300

equipment and technical personnel from each base and required them to arrive at the designated location in Dongguan on March 19.At the same time, the procurement personnel and the chief scheduler are required to be on-site, responsible for progress follow-up and assist in solving on-site problems; The engineering department leads the team to clean and paint the factory; Logistics including canteen, security guards and drivers in place; March 21, KF equipment and technical personnel to participate in on-site debugging, and determine raw materials and technical requirements agreement; On March 24th, the contract was signed and the goods were shipped; The new plant was put into use on March 28;By the beginning of May, 200 units with a daily production capacity of 10 million. In early April, I received an order of 100 million KN95, making a profit of nearly 500 million.

4.1.2 Assuring Specifications

Medical masks have strict implementation standards and market access conditions and therefore KF is obliged to assure specifications. According to the results of various studies and experiments, medical masks have better barrier and protection against novel coronavirus, germs and particles such as droplets compared with general protective masks, and they are also the most in demand on the market. From product development, production to delivery, the entire emergency supply chain will undergo a greater test.

As the core producer of KF, the core is how to convert the produced goods into valuable goods legally and legally. How to transform demand and organize production according to demand side requirements? In the manufacturing link of emergency supply chain, people, machine, material, method and environment are indispensable. Raw materials in place, quality must be qualified; The equipment is in place and running in good condition. Qualified production, quality, equipment and management personnel in place; The products are legal and qualified for shipment; The factory building is up to standard and the laboratory function is satisfied.

After determining the demand, the demander may have some additional and customized demands, such as customized packaging, customized mask logo, co-branding, shortened delivery time of expedited transportation, and demand exceeding supply capacity, all of which will bring direct pressure to the emergency supply chain. This includes challenges to the legality of regulations and products, challenges to logistics, which is already at the forefront of the epidemic, and challenges to the stability of process equipment. KF all adhere to the "order is the order, a contract is the boss" principle, to guarantee the legal products compliance conditions, set up the quality of surgical masks regulatory group, engaged in surgical masks product quality specification interpretation, domestic and foreign regulations and packaging management and global product import and export policy research, etc., all in order to ensure delivery as the goal. Set up a transport intelligence team at home and abroad to obtain

domestic and foreign epidemic control policies at any time, collect and process global epidemic trends, warehousing and transportation dynamic information, and establish strategic partnership with professional freight and logistics in advance. At the same time, we should strengthen interaction and communication with the customs, strengthen mutual discussion and communication on laws and regulations and policies, and timely sort out customs requirements and inspection links. For customers with less transportation resources, help customers solve logistics problems through platform resources.

After quick identification and determination of real requirements, according to the order requirements preset specifications and targets, fast identification and pre-positioning of suppliers. Including raw material suppliers, equipment suppliers, labor companies, regulatory consulting companies and construction teams and so on. We have unified external Windows, strengthened communication at every link of the industrial and supply chains, established a rigid communication mechanism within 12 hours, and provided timely feedback and sharing of work progress and information among the three parties.

(1) Clarify export standards of masks and obtain relevant product certification

Masks and other protective materials are becoming increasingly scarce because of the rapid spread of COVID-19 abroad. On the basis of ensuring domestic demand for masks, huge demand for masks is shifting from domestic

to foreign countries. Countries around the world have also introduced a number of policies and regulations on mask import in light of the epidemic situation and national conditions. In the past, KF did not enter the field of masks, nor did it collect relevant policies. Therefore, the collection and interpretation of mask import policies of countries around the world are almost from scratch. Therefore, for the overseas market, the most important issue for KF company is to understand the requirements of the target market/enterprise for mask products, as well as the relevant export clearance standards of the national export policy, to ensure that the products are qualified and meet the relevant standards and requirements, so as to facilitate the smooth export of the products.

Firstly, in-depth study of relevant requirements (product quality standards) on mask products at home and abroad, especially in Europe and America. Quickly apply for and successfully pass the important standards and requirements of relevant countries in overseas markets for mask products, such as CE certification in Europe and FDA certification in the United States.

Secondly, further study national policies, standards, certification of all kinds of mask products exported by customs, study relevant requirements, application procedures and required materials of national export whitelist, and prepare documents and applications jointly by relevant departments with caution. KF Whitelist should be applied for export declaration of all mask products.

Thirdly, go into the front end of production, guide and review mask packaging design, implement relevant standards and requirements such as mask packaging design, specification requirements and inspection certificate requirements into product production, and ensure that products meet customs clearance requirements and market/customer requirements.

(2) Implement customs policies and requirements to ensure smooth customs clearance of masks

During the epidemic, mask products are exported overseas as important anti-epidemic materials, which is closely related to politics. To support the global fight against COVID-19 and further strengthen the quality supervision of exported epidemic prevention materials and products, ministries and commissions of several countries have issued various policies on the export of masks. At the same time, as second-level medical products, customs inspection standards are strict, especially when masks are exported to Australia and passed Hong Kong Customs. This requires KF company to thoroughly study and strictly implement relevant policies and requirements, and clarify specific customs clearance operation rules, operating procedures and relevant materials. Due to the outbreak, the global demand for masks is urgent. Mask export and customs clearance policies are usually relatively new and numerous, and it takes time for people from all sides to digest and understand the policies. In a short period of time, therefore, will inevitably lead to different customs, different staff,

therefore, even in case of abnormal inspection, KF company first in policies, on the basis of in-depth reading through the interpretation of reasonable and effective standards related policies, effectively and efficiently explain the abnormal situation with the customs officers at the same time, through a variety of resources to solve the problem of abnormal collaborative communication support, efficiently and properly handle inspection abnormalities to ensure smooth customs clearance of masks. The enterprise's emergency supply chain also needs to pay attention to sales. The key to the enterprise's emergency supply chain sales is to ensure fast delivery of products. As shown in Figure 3-12, KF realized fast delivery of mask products through rapid capacity construction and strict control of production and manufacturing, and the cumulative product delivery rate reached 94.5%.

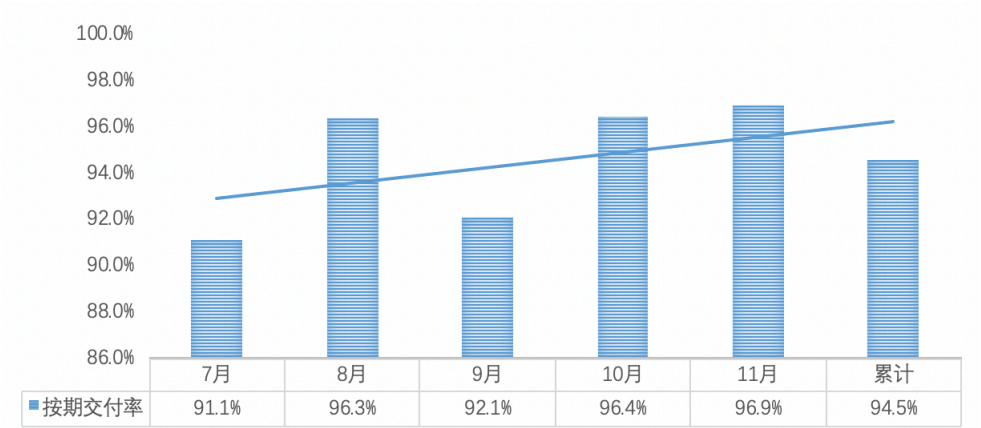

Figure 4-1 Fast Delivery during July-November 2020

4.1.3 Communication, Communication and Communication

For the success construction and management of the KF mask supply chain, improving supply chain communication is a vital step to building supply chain resiliency and mitigating procurement risks. The well communication lines across the supply chain enables managing supply chain disruptions and bottlenecks, avoiding stock shortages hitting your sales and profitability and maintaining high customer satisfaction levels. Successful practice has been made in the following nine aspects:

(1) Encourage transparency with procurement and sourcing teams

Poor communication across a supply chain network is often a consequence of the same problem being present internally. KF encourages internal supply chain leaders to improve their communication, and that of their teams with the supplier network will follow.

(2) Agree metrics with all providers and stakeholders

KF is always ensuring all stakeholders, from their internal teams to their provider and distributor network, are all on the same page is an easy win when it comes to communication. Whether setting metrics around lead time, supply chain sustainability, or optimization of a specific process, doing so is a vital step to enhancing communication and the entire supply chain operation.

(3) Manage entire supply chain proactively

KF is proactive and can have open discussions about potential supply chain issues, whether there's a potential warehousing problem on the horizon or need to look at outsourcing a process elsewhere. Taking this step also means suppliers feel comfortable about dealing with issues too. It's a win-win strategy.

(4) Embrace technology

Technology is vital to supply chain communication in the modern world. Things like traceability software can open communication lines while also providing a real-time overview of supply chain performance. Integrating supply chain software into existing ERP suite is also a positive step to take. Elsewhere, using communication technology like messaging tools can ensure a channel for priority communications that can't wait for a meeting or an email response.

(5) Prioritize suppliers and supplier relationships

KF makes efforts to nurture supplier relationships and take the time to schedule regular reviews, which are positive steps to building and maintaining rapport.

(6) Meet suppliers and distributors on a regular basis

Building on the last point, it's vital to regularly have scheduled meetings. The KF supply chain consists of many moving parts, so they try and get both

suppliers and key distribution partners together at least once a quarter, if not monthly. Modern technology enables easily facilitate meetings online.

(7) Standardize communications by knowing inventory

KF devotes to make every part in business have a working knowledge of the inventory, which helps communicate requirements to suppliers while also helping understanding shortages or bottlenecks.

(8) Ensure clear accountability for communications

KF creates a service level agreement type document that details, for themselves, suppliers, and distributors:

- Who stakeholders should communicate specific issues to
- Mutually agreed to timelines for a response and/or a resolution
- The escalation process in the event of no or an unsatisfactory response

(9) Respect suppliers and don't micromanage them

KF holds the belief that respecting suppliers extends to the management of suppliers and interactions with downstream suppliers. Improving internal processes is a fine line between collaboration and trying to micromanage and run suppliers' business.

In a word, better communication is to some extent equivalent to better supply chain management. By spend time evaluating how to improve

communication across the supply chain, assessing the necessity to streamline decision-making processes, finding new technology to use as a communication tool, the KF company gains a competitive advantage for their business and see a positive impact on their bottom line.

4.1.4 Arranging Partnership with Specialist Freight and Logistic Providers

KF prioritizes coordination all kinds of related resources to ensure efficient logistics and transportation, and successfully arrange partnerships with specialist freight and logistic providers.

During the epidemic, the logistics and transportation of mask products are facing great challenges due to the shortage of logistics and transportation resources due to the short delivery time of orders, large shipments, high delivery frequency and fierce competition for logistics resources. The following methods are mainly used to ensure the logistics of mask products.

Firstly, expand the resources of airlines, adopt the way of "aircraft package", realize the timely delivery of emergency orders by air. In order to realize the timely delivery of urgent orders, KF company expanded the export of gas mask products in South China, north China, southwest China, central China and other places through various resources and airline public relations. Combined with the characteristics of mask products, KF company cooperated with airlines to adopt heavy matching method, which effectively reduced the logistics cost of air transportation. For the urgent orders of large quantities of

mask products, we actively negotiate with foreign airlines and adopt the way of "charter flight" to break through logistics barriers.

Secondly, cultivate shipping company resources, adopt "grab ships", "clear cabinets" and other ways to ensure timely delivery. As party a's enterprise, the enterprise needs to ship company resources, "a ship is hard to find", "a tank (tank) is hard to find" phenomenon, in the case of Marine resources nervous, KF the company through the platform, network, resources, the relationship between the usual maintenance, etc., active coordination of the pearl river shipping company in qingyuan yard to place empty containers, and cooperation with south China other export company charter, The masks will be delivered as soon as possible and the delivery time will be effectively guaranteed.

Thirdly, expand land transport channels and develop china-Europe Freight train channels to ensure timely delivery of orders. With the deepening of the "nearest" policy, KF mask products of the company in the inland market share gradually increase, KF convenient and seize the opportunity, the company actively communicate with ZT freight forwarders for selection and introduction, KF mask used to meet the company products in the inland market order delivery request, we are working with freight forwarder at the same time, promote the starting point of Guangzhou as part of a central trains.

Fourth, coordinate all kinds of resources, timely and properly handle the abnormal situation in the process of logistics transportation. Most of KF's early orders for mask products were FOB or EXW. At present, the project team

actively communicates with the freight forwarder designated by the customer to ensure the smooth export clearance and delivery of the goods.

4.2 The Critical Success Factors

4.2.1 Speed, Speed and Speed: Speed Up the Process

(1) Fast and effective purchasing strategy for mask equipment

The first is the mask machine. KF adopted the strategy of "horse racing" and signed conditional delivery contracts with a number of mask manufacturers, according to this strategy, they reached cooperation intention with 5 suppliers, and finally 2 of them won the competition and won the super large order of 200 mask machines from KF. KF also timely purchased mask machines from the competition of suppliers. KF company adopted the cooperative production mode with mask machine equipment factory to solve the problem. After investigation, they selected an old factory in the industry and proposed that the mask machine factory draw the drawings and provide key parts. KF company assisted in the assembly and debugging of the equipment with its own technology and equipment, and built a mask machine equipment factory in one week, increasing the production capacity of the other company from 2 sets/day to 8 sets/day. 50% of the qualified mask machines, namely 4 machines per day, were sold to KF Company. Due to the decision making and fast execution of the top management, the supplier's ability was accurately judged and the

agreement was reached quickly. Although the mask machine factory was skeptical at the beginning of cooperation, in front of the mask machine factory built by KF company in a week, the other party further opened up the embrace of cooperation.

(2) Raw material purchasing strategy with simplified process and agile response

After the material parameters are determined, a purchase plan shall be made, which shall consider the urgency of the first material requirements and the later material production and supply cycle. Due to the particularity of the epidemic period, it is impossible to establish the process according to the push or pull supply chain mode, and the procurement plan is made according to the market demand. Therefore, the initial procurement strategy is to purchase materials around large orders and reserve turnaround time for the second and later double orders. After the selection of materials and suppliers, there is also the confirmation of samples, and the matching between the bulk goods produced by suppliers and samples. Due to the urgency of time, samples were not sent and signed according to the conventional process, and samples need to be confirmed through the Internet and innovative process. At the same time, after completing the order, we must ensure the delivery time and realize the arrival of goods in the most efficient way. In the choice of mode of transportation, we need to have strong logistics control ability and be able to grasp the timely

dynamic of materials. In order to faster arrival of goods, we can change the mode of logistics transportation at any time.

The raw materials needed for production were also in short supply at the height of the epidemic. KF's procurement strategy has also been adjusted accordingly. First of all, the decision-making level makes quick decisions directly with procurement and technology, including supplier research and selection, pricing and business negotiation, contract review, procurement payment and on-site office settlement, so that every procurement demand can be closed on the same day, greatly improving efficiency. At the same time, daily tracking of delivery and arrival, timely grasp abnormal changes, quick response; Arrange full-time staff to follow up the goods in short supply to ensure the timeliness of goods; Provide necessary logistics support and control the delivery schedule while controlling the logistics information. KF company is through this series of ways to ensure the delivery of raw materials on time.

4.2.2 Resources Exchange

(1) Fully realize resource sharing

Demand for masks in China has soared, but production capacity has been greatly affected due to shortages of raw materials and personnel. Almost all formal mask factories have been expropriated by the government, giving preference to local mask owners. During special and emergency periods, KF

company can only find suppliers with ordinary qualifications for cooperation, but KF Company volunteered to provide core equipment and transfer drawings, and KF team was responsible for disassembly and assembly, and finally realized mass production sharing.

(2) Resource formation and cross-system coordination

In the stage of raw material supply, KF company kept communication with suppliers on material information, cooperated with suppliers to complete the supply schedule, and discussed solutions to abnormal problems with suppliers: for example, the mask machine lacked wheel steel, the company would mobilize resources to purchase round steel to support suppliers; The single screw extruder of melt-blown cloth machine is out of stock, and the company supplies resources to complete the purchase; The melt-blown cloth machine has not changed the net member, the company organized its own suppliers to complete the supply. In addition, through the coordination of order management chain, upstream and downstream linkage is realized to promote technology, finance, production, procurement, logistics and legal affairs. Make delivery plan and actual arrival on a daily basis, update arrival information and future arrival plan on a daily basis, grasp abnormal changes in time, and realize quick response. Arrange full-time staff to follow up goods in short supply to ensure the timeliness of goods; Provide necessary logistics support and control delivery schedule while controlling logistics information. KF company is through this

series of ways to ensure timely delivery of products. In addition, KF is developing raw materials jointly with its overseas subsidiaries through global cooperation in the face of a shortage of domestic supplies.

Chapter 5 Discussion and Conclusion

5.1 Theoretical Contributions

5.1.1 In Emergency: How to Construct A Supply Chain

Emergency demand supply chain refers to when a large scale incident (such as all kinds of serious natural disasters, public health events, etc.) occurs, the affected regional emergency fund, supplies, rescue and scheduling command guaranteed a multidimensional and multifaceted cooperation activities, its operating structure belongs to the system function nets chain structure, by the number of suppliers, the demand side, a dynamic supply chain that takes time efficiency as its core goal and can quickly respond to environmental changes. The emergency demand supply chain is characterized by uncertainty, rapid response, timeliness and elasticity.

The emergency supply chain aims at time efficiency and provides relief materials as quickly as possible. Therefore, in the construction of emergency supply chain, the principles of agility, dynamic, coordination, peacetime and wartime integration should be followed to ensure the flexibility of the supply chain, so that the material supply process can proceed smoothly. The implementation of emergency demand supply chain is a systematic project.

(1) Supplier relationship management

How to select the best suppliers and form strategic partnerships in emergency situations is crucial in emergency demand supply chain management.

In addition to technology, ability, quality and other factors, the selected suppliers should be able to help and come forward at critical moments. Reasonable pricing, normal profits, priority in supply, value long-term cooperation, not immediate interests.

(2) Manufacturing process management

The emergency supply chain can quickly form an excellent cross-departmental team, including manufacturing, technical, quality, procurement, etc., to focus on solving these problems encountered in the manufacturing process. The advantages of emergency manufacturing process management are mainly reflected in the discovery of flexible production technology, reducing the complexity of product manufacturing process; Innovation ability of products, processes and operating methods; Adopt flexible manufacturing strategies to achieve competitive advantage; Outsourcing part of the process or semi-finished products, finished products outsourced processing; Portability of production process, etc.

(3) Demand Management

Due to the suddenness and uncertainty of emergency demand, the demand for emergency supplies is also uncertain, and it is difficult for relevant teams to know the real demand in the first time. The current demand forecasting methods can be roughly divided into qualitative forecasting method and quantitative

forecasting method. Qualitative prediction methods mostly rely on intuition, experience and other judgments. Quantitative analysis method is a method to predict future demand changes by using certain mathematical models based on previous historical statistics and mastered data, which can be divided into causality model and time series model.

After the market receives feedback from the customer demand side, the emergency demand will be quickly transferred to the supply side. At this point, "bullwhip effect" is likely to occur. The most typical example is to use control theory to solve the problem of maximum supply quantity planning in the process of supply chain management, which effectively reduces the bullwhip effect on the corresponding management link. In addition, effective sharing of information resources can optimize many links of the whole organic linkage system of supply chain, disperses and weakens the adverse effects of bullwhip effect.

5.1.2 Key Success Factors

The core of KF's mask project success lies in its ability to quickly build an efficient corporate emergency supply chain and the key success factors can be summarized as follows:

- Benefit sharing with suppliers and stakeholders in emergency situations is a key element of the success of an emergency supply chain. That is, when sourcing equipment from suppliers and permit from government, it is critical to maintain

good relationship with them;

- Organizational ability and efficient execution are important resources and tools for emergency supply chain construction;
- The core technological ability is an important guarantee for solving the problem of stuck neck raw materials. In general, without core technologies, it is difficult to construct an effective and efficient supply chain in short time;
- Quick demand identification is an effective method to ensure benefits of an emergency supply chain.

5.2 Practical Implications

5.2.1 Applications in Similar Scenarios

As a reserve unit integrating R&D, production and sales of epidemic prevention emergency supplies, KF is the main supplier of epidemic prevention supplies and consumables in China. Two years of experience in constructing and operating the emergency supply chain has made us know that domestic enterprises are weak in responding to emergencies and the supply chain is not capable of bearing pressure. Meanwhile, the optimization of emergency supply chain is a continuous process, involving the optimization of product design, production process, procurement cost, etc. Design optimization occurs when consumers and competitors force a product to perform better after the initial launch, requiring continuous improvement. The optimization of the production process is due to the need to consider production efficiency and production cost

factors, including production process, production rhythm, quality control, etc., after the urgency is eased. The optimization of procurement costs includes the introduction of new suppliers, the replacement of new materials, etc. The reduction of product costs can better improve the market competitiveness of products. The core supply chain of medical masks as its core products under the epidemic situation explains what the company is doing well and paying the price, with the purpose of summing up experience and lessons and establishing a competitive supply chain and emergency supplies supply chain. The supply chain of medical masks is also taken as an example to show that the capacity of the emergency supply chain is very important for enterprises, society and the country in cases similar to epidemic emergencies. It determines the direction of public events, affects the survival of enterprises and affects the national development strategy. For the supply chain of medical mask supplies under the epidemic, an information collection and monitoring and prediction team should be established to quickly learn about the situation. Identify potential market demand and shorten lead time;(2) Increase network distribution points, improve supply chain distribution frequency, and shorten the distance with customers;(3) Because the demand frequency is very small (the demand per unit time is very unstable and difficult to predict) and the value is high, centralized or rolling inventory strategy is adopted. The inventory point does not need to be very close to the customer, but high-speed transportation can be selected to make up the space distance. All have strong demonstration significance.

Case sharing: The epidemic in Hong Kong in March 2022 was so fierce that the conventional supply chain was immediately paralyzed and supplies were urgently needed. In response to the epidemic in Hong Kong, KF successfully completed its mission by sending urgently needed supplies to Hong Kong at the first time. Thanks to KF emergency in the supply chain security principle of rolling stock, the 25 million accord with a country compulsive standard KN95 GB2626-2019 medical surgical masks masks and stock inventory, in the shortest possible time (3 days) by ministry hall, ZhongLianBan and the General Administration of Customs and other departments, complete the customs clearance and successively methods such as complete by land and sea transport supply, This buys time for the subsequent continuous supply capacity climb. After receiving the following clear demand (120 million KN95 and 80 million surgical masks in total), KF immediately organized human resources (including company employees and labor service companies), strategic raw material suppliers and other resources to complete the supply guarantee within the specified time, which is the result of KF's emergency supply chain capacity construction from 2020 to now. It directly reflects the importance of emergency supplies supply chain to the country, society and enterprises.

5.2.2 Lessons Learned and Improvement in the Current Supply Chain

Through the study on the emergency supply chain construction of mask production in KF Company, we believe that the enterprise emergency supply

chain system is very important. The enterprise emergency supply chain is the core ability of enterprises to cope with public emergencies, and it is also a magic weapon for enterprises to win when facing public emergencies. Through the example of KF's enterprise emergency supply chain, we preliminarily summarized the model framework of the emergency supply chain system:

Enterprise emergency supply chain system capability = F (strategy; Organizational security; Basic platform and production factor escort; Policy and cultural security), among them

Correct strategy: efficient strategy, be a contrarian during the epidemic, stick to the post and never retreat.

Organization guarantee: high-quality team, strong and efficient execution.

Basic platform and production factor escort. Global marketing platform; strong technology research and development, process equipment platform; procurement and supply chain platform support; land workshop, water, electricity, government relations and other production factors escort.

Policy and culture guarantee. Competitive incentive plan, value creator oriented corporate culture.

We analyzed the significance of establishing the emergency supply chain system in manufacturing enterprises and how to establish the emergency supply chain system. The practical value of the emergency supply chain in

manufacturing enterprises is exemplified by the mask in response to the pneumonia outbreak caused by COVID-19. At the same time, in the emergency supply chain system, the collection and analysis of information flow, big data analysis and intelligent manufacturing need to be further studied. Its fast response speed can promote its wider application and needs more in-depth research.

5.2.3 Questions for Follow-up Research

In emergencies, due to information asymmetry, channel hoarding caused a surge in demand, and buyers were in a state of skyrocketing prices to obtain greater discounts and a larger share of rations. shortage. As a result, the demand is seriously unreal, and the "bullwhip effect" of the supply chain is even more serious. This puts forward higher requirements for the demand management of emergency supply chain.

(1) During the state of emergency, the shortage of materials caused prices to skyrocket, and the demand increased infinitely. But the state of emergency will always end, and behind the skyrocketing prices and increasing demand is a cliff-like fall in prices and zero demand.

(2) Blindly following market demand When the window period ends, it will inevitably cause a large amount of inventory and loss of price.

(3) How to deal with the emergency demand game puts forward higher requirements for demand management.

(4) Controlling a reasonable inventory to meet the real needs of the emergency market is an important research topic.

In the current month: Production volume = Sales volume - Safety stock

The goal is to develop from Figure 5-1 to Figure 5-2.

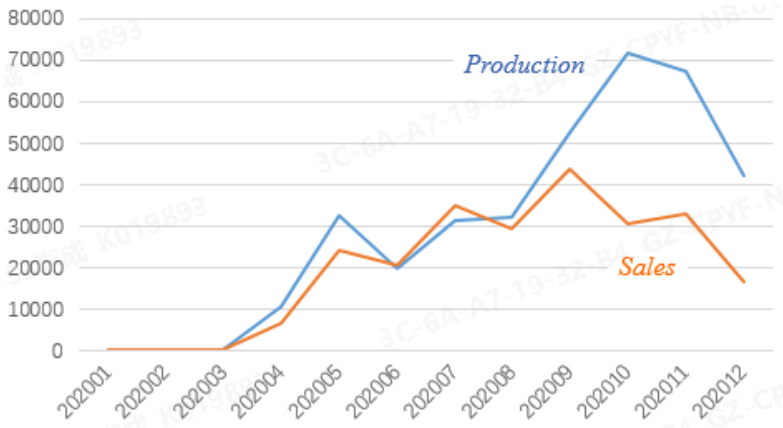

Figure 5-1 KF Mask Production and Sales in 2020

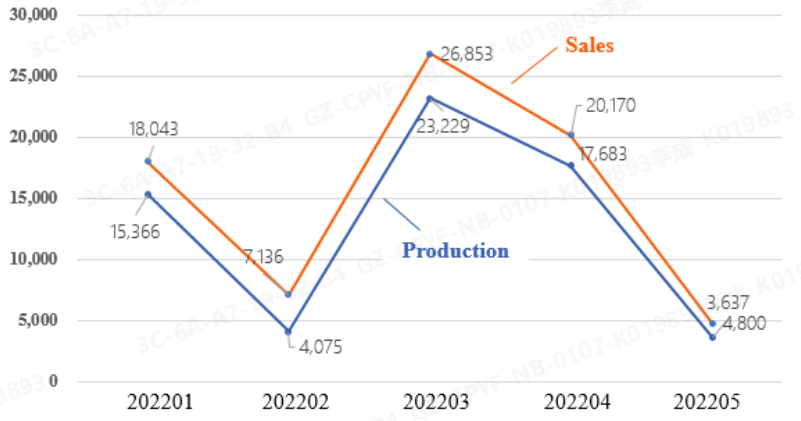

Figure 5-2 KF Mask Production and Sales in 2022

5.2.4 Thoughts on Supply Chain Strategy in the Post-epidemic Era

Under the influence of the new crown epidemic in 2020, the global political and economic landscape is undergoing great changes. Over the past 40 years of

reform and opening up, China's economy has undergone tremendous changes. In 1982, China's total GDP was 205.09 billion US dollars. By 2021, China's total GDP will exceed 17 trillion US dollars. During this period, the globalization of supply chains made China the world's second largest economy and the world's largest manufacturing country. However, in recent years, due to the combined effects of multiple factors such as anti-globalization, rising trade protectionism, and the new crown pneumonia epidemic, the safe and stable operation of the global supply chain has been severely impacted. It turns out that the success factors of the global supply chain, global resources, knowledge without borders, JIT strategy, service outsourcing, etc. have encountered major challenges. How to ensure the security of the supply chain and give play to the important role of the supply chain in economic development is an important issue that we must face and solve.

5.3 Conclusion

We have described and analyzed a case in which a supply chain for emergency demand was constructed.

We first develop a model for analyzing construction of the supply chain for emergency demands using the theoretical framework of supply chain processes and elements. We then describe the case of KF company’s facemask project and the construction process of an emergency supply chain. We then analyze its manufacturing flow, materials and equipment sourcing and supply relationship management in depth. KF’s facemask supply chain is so successful during Covid-19 pandemic, thus we identify several critical success factors

from this case. These include responding to demand quickly, building an effective and efficient team, building efficient production lines in short time, sourcing materials and equipment from the suppliers with guarantee and relatively low costs, and maintaining the supplier relationship.

The model for constructing the emergency supply chain can be employed for dealing with situations with interruptive supply and urgent demand, and the critical success factors may be useful in managing supply chain in scenarios with high risks and disruptions.

There may be shortcomings of this study. First, the conclusions are drawn from a single case, and may not be generalizable due to its timing and context; Second, the data collection is not complete thus there may be some missing facts and data that may influence the conclusions; Third, it is better to develop a specific theoretical framework to analyze the case of emergency supply chain construction. The current framework seems workable but to understand the deep relationship among the factors that influence the performance of an emergency supply chain, there still be a lot of future work.

References

Aboolian, R., O. Berman, J. Wang (2021). Responsive make-to-order supply chain network design. *Naval Research Logistics*, 68:241–258.

Anonymous. Fabric enterprises face difficulties in the production of epidemic prevention materials in the post-epidemic era. *China Textile Newspaper*. https://www.tnc.com.cn/info/c-001001-d-3700627.html

Blacharski D. (2020). The global supply chain in a public health emergency. https://www.supplychainbrain.com/blogs/1-think-tank/post/30973-the-global-supply- chain-in-a-public-health-emergency. Accessed March 8, 2022.

Burt, D. N., Sheila D. Petcavage (2010). *Supply Management* (8th ed.). McGraw-Hill.

Caunhye, A. M., X. Nie, S. Pokharel (2012). Optimization models in emergency logistics: A literature review. *Socio-Economic Planning Sciences* 46: 4e13.

Cohen, M. A., Hau L. Lee (2020). Designing the right global supply chain network. *Manufacturing and Service Operations Management*, 22(1): 15-24.

Croxton, K. L., S. J. Garcia-Dastugue, D. M. Lambert and D. S. Rogers (2001). The supply chain management processes. *International Journal of Logistics Management*, 12(2): 13-36.

Disney, S. M. , & Towill, D. R. . (2003). The effect of vendor managed inventory (vmi) dynamics on the bullwhip effect in supply chains. International Journal of Production Economics, 85(2), 199-215.

Goetschalckx M. . C. J. Vidal, K. Dogan (2002). Modeling and design of global logistics systems: A review of integrated strategic and tactical models and design algorithms. *European Journal of Operational Research* 143: 1–18.

Graves, S. C., Sean P. Willems (2005). Optimizing the supply chain configuration for new products. *Management Science*, 51(8):1165-1180.

Ji, G., & Zhu, C.. (2012). A study on emergency supply chain and risk based on urgent relief service in disasters. Systems Engineering Procedia, 5(1), 313-325.

Kopczak, L, R., M. E. Johnson (2003). The supply-chain management effect. *Sloan Management Review*, Spring 2003: 27-34.

Li, L. , Zhang, J. , Li, S. , & Qian, X. M. . (2011). Research progress of elastic nonwovens with meltblown technology. Advanced Materials Research, 332-334, 1247-1252.

M. J. Meixell, V. B. Gargeya (2005). Global supply chain design: A literature review and critique. *Transportation Research Part E*, 41: 531–550.

Novak, S., S. D. Eppinger (2001) Sourcing by design: Product complexity and the supply chain. *Management Science* 47(1): 189-204.

Sheffi Y. (2021). Enduring lessons from the COVID-19 pandemic. *Supply Chain Management Review*, March/April 2021: 6-7.

Sharifzadeh, M., M. C. Garcia, N. Shah (2015). Supply chain network design and operation: Systematic decision-making for centralized, distributed, and mobile biofuel production using mixed integer linear programming under uncertainty. *Biomass and Bioenergy*, 81: 401e414.

van Meighem, J., G. Allon. *Operations Strategy: Principles and Practice* (2nd Edition). Dynamic Ideas.

Wang. F. S., C. Zhang (2020) What to do next to control the 2019-nCoy epidemic[J]. *Lancet*, 395 (10222): 391-393.

Wang, Q., L. Shun (2020). Special report on mask industry: In-depth analysis of raw materials in the whole mask industry chain. *Research Report*, China Merchants Securities.

Yin. R. K. (2014). *Case Study Research: Design and Methods* (5th ed.). Thousand Oaks, CA: Sage.

刘胜兰. (2020). 新冠肺炎疫情全球大流行现状及应对. 中国发展观察(5), 5.

Liu S. (2020). The status quo of and the countermeasures for the global Covid-19 pandemics. *China Development Observations* (5), 5 (In Chinese).

牛兴荣, 焦琳, 钱辉, & 杨森. (2020). 常用口罩分类,检测标准及认可. 中国认证认可(6), 4.

Niu X., Jiao L., Qian, H., Yang, S. (2020). The classification, test standards and Qualification. *Chinese Qualification and Verification* (6), 4 (In Chinese).

王鹏, 叶丹, & 郑则广. (2020). 口罩在预防新型冠状病毒感染中的作用及其选择与使用. 广东医学, 41(9), 4.

Wang, P., Ye, D., Zheng, Z. (2020). The roles, choices and uses of the face masks in preventing Covid-19 infection. *Guangdong Medicine*, 41(9), 4 (in Chinese).