

The Development of Surgical Mask Industry: Chance of COVID-19

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Wenzao Ursuline University of Languages, 2021

Abstract

Due to COVID-19, the mortality rate in various countries is rising rapidly. Most countries bought the products of epidemic prevention, people maintained social-distancing in public place, rarely went abroad, and had online class or meetings. Since the mask is one of the epidemic prevention materials, Taiwan has become the second largest countries which produced the mask in the world. The purpose of this study is to understand the advantages of Taiwan's mask industry by the diamond model after the COVID-19 outbreak. I used the qualitative research method, the in-depth face-to-face interview, to interview the mask companies/factories. However, most mask companies/factories are too busy to take my interview. Afterward, I changed the research method to content analysis which I collected the mask information from the news media and government-related websites.

My data analysis illustrated the diamond model to comprehend the advantages of the surgical mask industry after COVID-19 outbreak. In the diamond model, there are six key elements: factors conditions, the demand conditions, the supporting from related industries, competition, structure and rivalry of firms, government, and chances. There are four main findings in this research. First, the chance of the external factors of Taiwan surgical mask industry indicated the growth of production. Second, the government of the external factors of Taiwan surgical mask industry showed the pro and con of government intervention in mask market. Third, related and supporting industries of the changing strategy of Taiwan surgical mask industry prior to and after COVID-19 clarified the surgical mask industry chain from upstream to downstream. Forth, the firm strategy, structure and rivalry of the changing

strategy of Taiwan surgical mask industry prior to and after COVID-19 showed us the market concentration and the mask issues of illegal policy. Therefore, I divided all the current problems that I observed the surgical mask industry into good and bad effects. The good effects are the adequate raw materials and equipment of mask and the production of masks is rising rapidly to satisfy the domestic demand. Before the COVID-19 outbreak, Taiwan's daily production of masks was 1.88 million; after the COVID-19 outbreak, Taiwan's daily production of masks has exceeded 20 million. Taiwan's mask production has grown 10 times. In addition, masks made in Taiwan are helping various countries. However, the bad effects are importing the counterfeit masks which from other countries, producing masks privately and selling on the market which violated the mask policy.

Keywords: surgical mask industry, COVID-19, diamond model, content analysis.

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INTRODUCTION

Background

At the end of 2019, an un-known virus broke out in Wuhan, Hubei province, China and the virus spread quickly to other countries become a global issue. The World Health Organization (WHO) called an official name of COVID-19. Globally, Thailand, Japan, South Korea, Singapore, Malaysia, France, Canada, Australia, Germany, the United Kingdom, the United States, and 111 other countries have reported COVID-19 cases. Most of the confirmed cases were locally transmitted cases outside of China¹. Almost the world was suffering from COVID-19, such as: epidemic infection, preventive measures, economic impact, unemployment rate, epidemic prevention materials, shortage of face masks... etc. After the COVID-19 outbreak, many affected countries-imposed export controls and sought ways to improve domestic output. Accordingly, the World Health Organization (WHO) and USA government has been advising social distancing, staying indoors, and some basic protective measures are staying hygiene by washing your hand frequently or cover mouth and nose with tissue or elbow when coughing and sneezing².

During the COVID-19 pandemic in 2020, the face masks have become one of the most indispensable of the protective equipment. The sudden growing demand on face mask has made the number of available face masks become insufficient³. Although the World Health

¹ Huai-Liang Wu et al., "Face Mask Shortage and the Novel Coronavirus Disease (Covid-19) Outbreak: Reflections on Public Health Measures," *EClinicalMedicine* 21 (2020): 2 (7-11).

² Yihui Goh et al., "The Face Mask: How a Real Protection Becomes a Psychological Symbol During Covid-19?," *Brain, Behavior, and Immunity* (2020): 3 (63-65)

³ Thien Luan Phan and Congo Tak-Shing Ching, "A Reusable Mask for Coronavirus Disease 2019 (Covid-19)," *Archives of Medical Research* 51, no. 5 (2020): 455(29-30).

Organization recommended that only positively confirmed patients should wear medical masks to mitigate COVID-19 transmission⁴, we wear the face mask to protect ourselves and to prevent the spread of infection to others. There are a few countries produce the face mask in the world; for example: China, Taiwan, South Korea, Australia, France ...etc. Both China and Taiwan supplied face masks to many countries after COVID-19 outbreak. In order to supply a large amount of face mask, it needed enough raw materials and machine tools to produce. Because of COVID-19, Taiwan's masks have made more countries knew Taiwan; the masks made in Taiwan have also gained international popularity and Taiwan also known as the second largest mask manufacturer in the world.

Motivation

As of March 15, 2020, data from World Health Organization (WHO), more than 153,517 confirmed cases of coronavirus disease 2019 (COVID-19) and 5735 deaths have been reported from 143 countries⁵. According to information from Taiwan Centers for Disease Control (CDC), there was only 7 people death by COVID-19. Since the face mask industry was originally a small and labor-intensive industry, and I am interesting about the face mask industry in Taiwan could become the second largest country of producing face masks. Taiwan had previous experience in controlling and preventing outbreaks. From hard learned lessons of severe acute respiratory syndrome (SARS) in 2003 (with 346 confirmed cases, 73 deaths), Taiwanese understood that this was a serious matter⁶. In that time, people also wore face masks. At that time, every family

⁴ Toan D Huynh, "The More I Fear About Covid-19, the More I Wear Medical Masks: A Survey on Risk Perception and Medical Masks Uses," *medRxiv* (2020): 2 (25-26).

⁵ Yhu-Chering Huang, Ping-Ing Lee, and Po-Ren Hsueh, "Evolving Reporting Criteria of Covid-19 in Taiwan During the Epidemic," *Journal of Microbiology, Immunology, and Infection* 53, no. 3 (2020): 413(4-8).

⁶ Chia-Rong Hsieh, "Putting Resiliency of a Health System to the Test: Covid-19 in Taiwan," *Journal of the Formosan*

stocked up face masks, and face masks were sold out of stock. Also, Taiwan's government learned from its 2003 SARS experience and established a public health response mechanism for enabling rapid actions for the next crisis⁷. Due to the experience of SARS, Taiwan has also done enough measures to prevent the COVID-19.

Faced with COVID -19, people urgently need the face masks also the manufacturer must supply a large number of surgical masks in a short time, manufacturers must also increase the resources of labors, raw materials and equipment. At the same time, the government has intervened in the economic market and controlled the price, export and sale of masks. It also required Taiwan Machine Tool & Accessory Builders' Association to cooperate with the government and built up "National Face Mask Team" to produce the surgical mask and fight COVID-19. To ration the supply of surgical masks for Taiwanese, the government restricted the surgical masks to be exported before June 1st and in order to get the equal amount of masks for every citizen the government implemented the mask-rationing plan that everyone purchased limited the number of face masks with NHI IC card tracking their purchase history in every week⁸. The main task for national face mask is to increase the number of face masks to 20 million pieces in short-term epidemic prevention. As far as I am concerned about the face mask industry because of the impact of the COVID-19 on many countries. To know about how the mask companies/factories made a piece of surgical mask, the impact of the Taiwan mask industry on the epidemic, and the impact of government intervention on the mask industry.

Medical Association 119, no. 4 (2020): 884(3-6).

⁷ C. Jason Wang, Chun Y. Ng, and Robert H. Brook, "Response to Covid-19 in Taiwan: Big Data Analytics, New Technology, and Proactive Testing," *JAMA* 323, no. 14 (2020).

⁸ Mei-Ling Chen, "Ban on Surgical Mask Exports, Domestic Retail Sales Lifted June 1 in Taiwan," *Taiwan Today* May 28, 2020

Research Purpose

After COVID-19 outbreak, the status quo of Taiwan's mask industry, the changes in the operation of Taiwan's mask industry, the supply chain of the mask industry and the basic introduction of surgical masks. I hope to use this to study and understand the current circumstances of the mask industry in Taiwan. I use the structure of the diamond model, to understand the competitive advantages of Taiwan's mask industry.

Research Questions

1. What are the conditions for surgical mask industry to have advantage in domestic market?
2. What happened to surgical mask industry in Taiwan with the external factors?
3. What did surgical mask companies/factories change the different strategy after COVID-19 outbreak?

Contribution

There are three points to show this research's contribution. First, the current situation of the surgical mask industry in Taiwan nowadays. Second, to understand the production process of the surgical masks and the basic materials of surgical masks. Third, to use the diamond model to understand the advantages of the mask industry in Taiwan.

Limits

1. When I search the word of face mask that show the different kinds of information about the face mask; for example, the face mask for skincare, the face mask for party or the performance to wear. Moreover, there are different kinds of face mask. For example: N95

face mask, Activated Carbon face mask...etc.

2. Since the COVID-19 is a global issue, I don't have enough time to comprehend what happened in each country

Delimits

1. I search the surgical or medical face mask that can get more accurately news, journals and information about medical treatment.
2. After the outbreak of COVID-19, Taiwan became the world's second largest country producing masks, so I focus on the main country of producing the face mask. At the same time, the quality of masks and the government's system to control masks have surprised many countries. In this study, I only focus on surgical and medical face mask.

LITERATURE REVIEW

The Definition of Surgical Mask

According to the regulations of the Republic of China Food and Drug Administration, the surgical mask used to prevent microorganisms, body fluids and particulate between patients and medical staff⁹. The surgical mask is disposable with ear loop, nose clip and combines three layers of non-woven fabrics. The surgical mask is suitable for people with respiratory symptoms, hospitals, movie theaters and other closed, unventilated places, during the epidemic of new influenza virus, medical personnel, laboratory personnel and livestock farm staff¹⁰. The surgical masks are required to be tested before sale on the market to ensure that the masks can block the epidemic. There are Bacterial filtration efficiency, Differential pressure, Sub-micron particulate filtration efficiency, Resistance to penetration by synthetic blood, Flame spread¹¹.

The Three-Layer of The Surgical Mask

The surgical mask has three layers of non-woven fabric. The material of the innermost layer is ES Bicomponent Non-woven Fabric and absorbs moisture from the users' breath, the middle material layer is Melt-Blown Non-woven Fabric and acts as a filter that prevent the virus into the surgical mask and the outer layer is PP Spunbond Non-woven Fabric and repels water and other liquids¹².

⁹ "Guidelines for Quality Management of Medical Face Mask Manufacturing Plants," ed. Taiwan Food and Drug Administration (2019), 4(1-3).

¹⁰ Xin-Hong Shen, "Taiwan Face Mask Application Market and Development Situation," Industry & Technology Intelligence Service(ITIS).Table. 1

¹¹ KP Chellamani, D Veerasubramanian, and RS Vignesh Balaji, "Surgical Face Masks: Manufacturing Methods and Classification," *Journal of Academia and Industrial Research* 2 (2013): 322.Table 2

¹² Goh et al., "The Face Mask: How a Real Protection Becomes a Psychological Symbol During Covid-19?," 2(50-53).

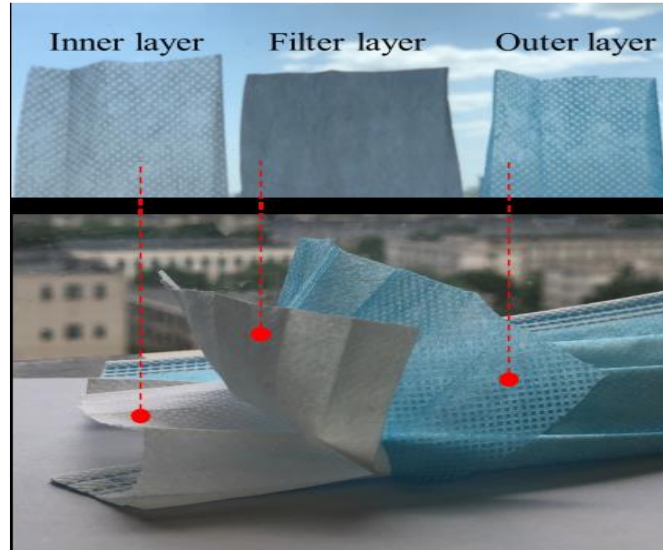


Figure 1. The Three-Layer of The Surgical Mask¹³

Surgical Mask Industry in Taiwan Current Situation

Masks are very daily product in Taiwan. The Surgical mask is also called a ‘procedural’ or ‘medical’ mask¹⁴. When a new type of influenza or epidemic broke out in the past, the government not only reminded people to wash their hands frequently, but also strengthened protective measures to wear masks. Mask manufacturers will also produce or import more masks during special periods. The COVID-19 outbreak caused a shortage of face mask in different countries world because some countries didn’t produce masks¹⁵. The surgical mask is produced using fabric forming technology as woven, non-woven and knitted. However, most of the surgical face masks are made up of non-woven¹⁶. Surgical mask can provide 85% to over 99%

¹³ Dan Wang et al., "Can Masks Be Reused after Hot Water Decontamination During the Covid-19 Pandemic?," *Engineering* (2020): 5. Figure 2. (a) Photographs of the triple-layer structure of a typical surgical mask


¹⁴ Goh et al., "The Face Mask: How a Real Protection Becomes a Psychological Symbol During Covid-19?."

¹⁵ Weixing Hao et al., "Filtration Performances of Non-Medical Materials as Candidates for Manufacturing Facemasks and Respirators," *International Journal of Hygiene and Environmental Health* 229 (2020).

¹⁶ Chellamani, Veerasubramanian, and Balaji, "Surgical Face Masks: Manufacturing Methods and Classification,"

effective protection and avoid spreading of transmission diseases¹⁷. Taiwan's overall surgical mask industry chain is divided into the raw materials produced by non-woven industry of the upstream: raw materials of three-layer non-woven, melt-blown non-woven fabrics; surgical mask machines and mask equipment factories manufactured by the machine tool industry in the midstream, and downstream surgical mask factories purchased raw materials and equipment produced various types of masks and tested and comply with Taiwan's regulations. Finally, surgical mask is sold to the market through various stores, pharmacies and online platforms.

Table 1. Supply Chain of Surgical Mask Industry

Upstream: material of surgical mask	 <p data-bbox="722 1339 1255 1373">The Three-Layer Structure of The Mask¹⁸</p>
-------------------------------------	--

321(40-41).

¹⁷ Ibid., 321(20-22).

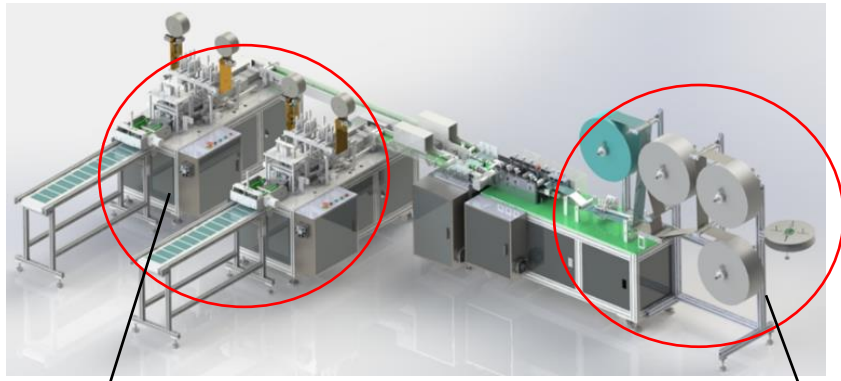
¹⁸ Di Liu, "The Inventor of the Life-Saving N95 Mask and Electrostatic Cloth Material, the Unknown Inventor in Taiwan-Dr. Peter Tsai," (Taiwan Nonwoven Fabrics Industry Association, 2020).figure 2. The three-layer structure of the mask, the middle layer is the main protective layer

Middlestream: machine tool of surgical mask



Face Mask Making Machine¹⁹

Downstream: buildup of surgical mask, sell on market



Surgical Mask Production Line²⁰

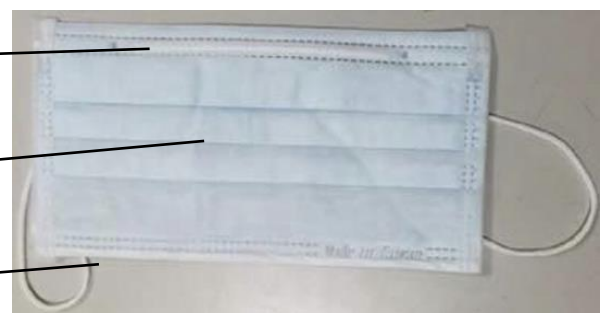
Make the round elastic band and plastic nose clip into the surgical mask

Combine three layers of non-woven fabric

Plastic Nose Clip

Three-Layers of Non-Woven

Round Elastic Band/Ear-loop



A Surgical Face Mask²¹

¹⁹ TRM-Top Rank Machinery Inc., "Tr-983 Automatic Inner Ear Loop Making Machine."figure 1. TR-983 automatic inner ear loop making machine

²⁰ Sarem Machinery, "Surgical Mask Production Line."

²¹ Phan and Ching, "A Reusable Mask for Coronavirus Disease 2019 (Covid-19)," 2.Figure 2. (A) A surgical face mask

Diamond model

Michael Porter, who is an American academic, offered a model that allows examining why some states are more competitive and why some industries within states are more competitive than others are²². In the diamond model have six elements: Factor conditions, Demand conditions, Related and supporting industries, Firm strategy, structure, and rivalry, Government, and Chance. Government, and Chance are two external factors. Therefore, market changes may also be affected by external advantages, disadvantages or national policies. The following is an explanation of the six elements.

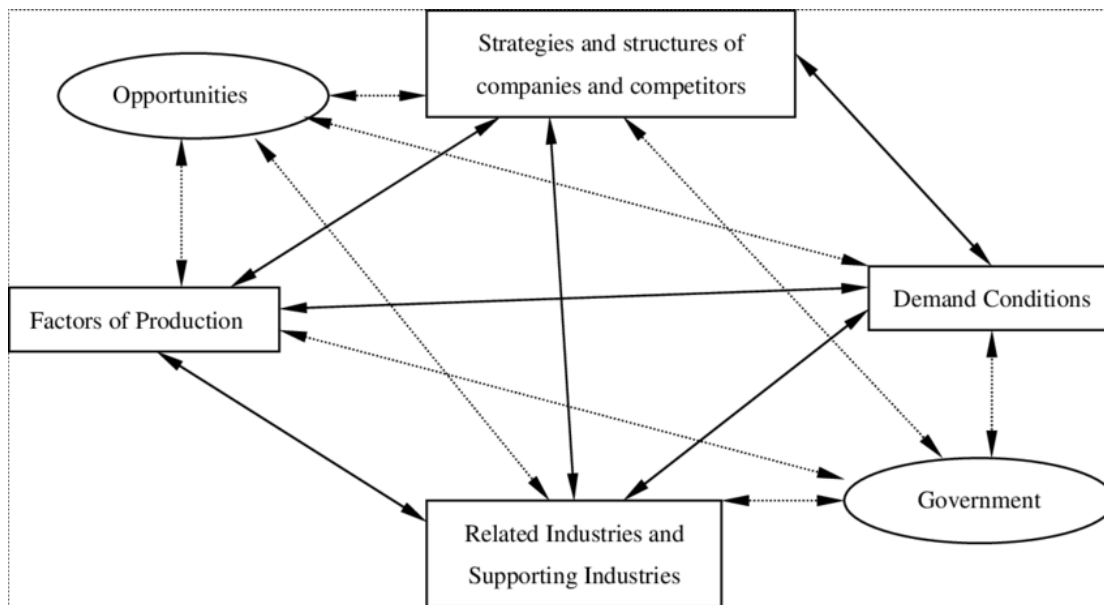


Figure 2. Michael Porter Diamond Model

Source: Michael E. Porter, *The Competitive Advantage of Nations*

²² İsmail and Doğan Bakan, İnci, "Competitiveness of the Industries Based on the Porter's Diamond Model: An Empirical Study," *International Journal of Research and Reviews in Applied Sciences* 11 (3) (2012): 441(8-9).

The factor conditions distinguished into five types. There are human resources, natural resources, knowledge resources, capital resources and infrastructure²³. Human resources refer to the labor that assists in production, the skills of professionals, or the cost and hours of labor. Natural resources mean that some countries are very rich in natural resources, having abundant plants and animals, water, minerals...etc. For example: The Middle East is rich in oil resources. Knowledge resources refer to technology, market development, data, etc. Capital resources means that the amount of capital and capital cost of the industry, of capital and capital cost of the industry, such as: equipment capital, labor cost, plant capital... etc. Infrastructure refers to maintain the foundation for the normal operation of the industry, including the transportation system, the communication system.

Demand conditions: reflect to local customers demand or criticize the quality of products and services, and companies will use this to improve and at the same time strengthen the competitiveness of domestic companies/market, while the Upstream, midstream, and downstream of the industrial chain have to working together and produce demand to satisfy the market and consumers.

Related and supporting industries: the production of this product requires raw material supply, machine production, processing, packaging goods... etc. Therefore, the support of upstream, midstream and downstream are needed to manufacture products.

Firm strategy, structure, and rivalry: The country's culture, the number of companies, current situation of industry or external factors will affect the prosperity of the industry and

²³ Saban Esen and Hande Uyar, "Examining the Competitive Structure of Turkish Tourism Industry in Comparison with Diamond Model," *Procedia - Social and Behavioral Sciences* 62 (2012): 624(39-40).

increase the existence of many competitors²⁴.

Government: government is one of the necessary elements that make the diamond model complete. The government can provide the resources needed by the industry and intervene in the free market and policies when necessary.

Chance: chance is the other of the necessary elements that make the diamond model complete. Chance is a kind of external factor that also appears out of the blue, which may lead to advantages for some and disadvantages, and will change the country's industrial current situation and competition. For example, industrial innovation, exchange rate impact, global demand... etc²⁵.

Among the four main elements in diamond model, the key to creating an industrial competitive advantage. There will always be some unavoidable variables and national policies, which will cause the industry change accordingly, to stabilize the advantages and expansion opportunities in the market.

Summary of Literature Review

To sum up, the literature review has briefly described the definition of surgical masks which also called medical mask. Then, the three-layer of the surgical mask also mentioned the most important part of masks: melt-blown non-woven fabrics. Next, in the current situation of the surgical mask industry in Taiwan, I showed a table of supply chain of surgical mask industry that all the materials and equipment needed for masks by photos. At last, the six aspects in the diamond model could observe surgical mask industry that showed the effectiveness of analyzing whether the mask industry has a competitive advantage.

²⁴ SHENG-YANG JIANG, "The Application of Porter's Diamond Model on Advantages of Taiwan Game Industry." (2019).

²⁵ Ming-Cheng Yeh, "A Study of the Competitive Strategy of Lcd Industries : From the View of the Diamond Model" (2013), 17(34-35).

METHODOLOGY

Research Process

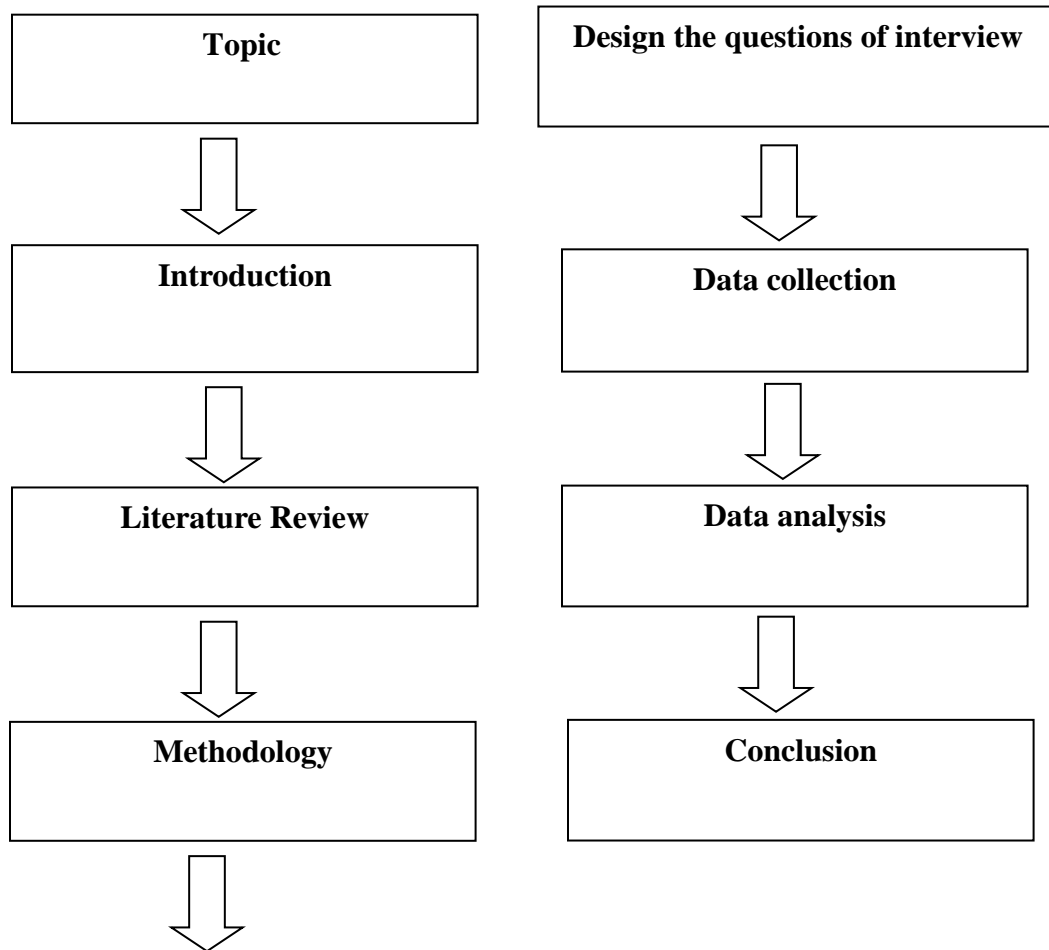


Figure 3. Research Process

This research is mainly to observe the different changes after COVID-19 in the surgical mask industry and will use the diamond model for further analysis. At the beginning, the researcher must collect a lot of information and read the literatures to formulate the motivation and purpose of this research. Next, researcher began to structure the study methods and processes. Finally, the researchers collected the secondary data and followed the diamond model to analyze the surgical mask industry in Taiwan.

This research would be designed by literature review and content analysis. In literature review, it provides the definition of Diamond Model and the information of Taiwan surgical mask industry. It brought about the previous researchers to have basic understanding and background to realize this research for reader. In content analysis, the researcher would collect the secondary data and analyzed from the news about the Taiwan surgical mask industry, face mask, COVID-19, policies of mask, mask diplomacy, etc.

Research Method

1. Content analysis: in this study, I have to collect the secondary data to follow up the news of face mask and COVID-19, some journal articles of face mask and COVID-19 closely.

Resource of Data

When conducting this research, the chance of face-to-face interviews was extremely small. 78 face mask factories/companies have been contacted; however, only one accepted interview and the other one agreed to accept interview, the rest of companies refused my request. Most of the reasons for the refusal were because the government started to requisition the mask on September 24th, 2020, and they didn't have extra time to interview. Moreover, the researcher sent e-mails to the interviewees, and then contact with them to inform the content and purpose of the e-mail. If the company didn't received e-mail after a week, the researcher would contact companies again. Unfortunately, the researcher could not have more companies agree to accept interview in October; hence, the researcher decided to only take content analysis as her research method to do her study.

Research Instrument

Therefore, the researcher kept collecting the secondary data. The researcher collected the

secondary data on the news in Taiwan. Also, because of COVID-19 pandemic, a lots of news and reports are abundant and available, such as the demand of mask, business opportunities of mask, the government policies about the restricting the mask be exported, the requisitioned the mask from factories, the mask-rationing plan, mask diplomacy, national face mask team, the fake mask, importing mask and the price of mask...etc. The researcher's job is to collect, review, and then analyze the content of news and reports according to research design and theoretical framework.

DATA ANALYSIS

This study analyzes the various elements of Taiwan's surgical mask industry based on Porter's diamond model of surgical masks and explores the competitive advantages of Taiwan's surgical mask industry today. Therefore, according to the diamond model, the data is divided into six main elements, factors conditions, demand conditions, related and supporting industries, firm strategy, structure and rivalry, chance, and government, for sorting and analyzing.

The Conditions of Surgical Mask Industry in Taiwan

In this section, I am going to answer my 1st research question: What are the conditions for surgical mask industry to have advantage in domestic market? There are two parts to explore the conditions of surgical mask industry in Taiwan, demand conditions and factor conditions.

Demand conditions

As mentioned in literature review, the demand conditions are mainly to understand the current situation of the industry and the needs of the domestic market and consumers.

When Taiwanese people usually used the masks, they wanted to keep warm, and which is more in demand in winter. Also, when they rode motorcycles to avoid the air pollution. As for industrial masks, it is related work to avoid dust-proof use²⁶.

According to a questionnaire on a website of Everyday Health(早安健康): Everyday Health conducted a questionnaire survey on whether Taiwanese people had the habit of “wearing masks” even there is no epidemic. In this questionnaire about 11,000 netizens responded and

²⁶ Zong-Xian Li, "Taiwan's Battle for Masks in 2020: The Total Population of 23 Million Needs to Increase Daily Production to 10 Million.," *BBC* 2020.

found that nearly 60% of them have the habit of wearing masks. As many as 37% wear masks every day. Therefore, the main reasons for wearing masks are "poor air quality", "riding a motorcycle" and "avoiding germs." People who work in medical care must wear masks every day in Taiwan²⁷.

Factor conditions

As mentioned in literature review, factor conditions covered human resources, natural resources, capital resources, knowledge resources, and infrastructure. These functions are the main comparative benefits or relative abundance of the factor condition, which can allow countries to derive the advantages and disadvantages of competition in trade with other countries.

The human resources required by the mask industry including the mask machine technician and mask production line packer. Mask production line packer is busy counting the number of masks every day to ensure the quality of each piece of mask; the work of mask machine technician, they observed the operation of the machine, and ensured the machine has enough raw materials and stable mechanical equipment²⁸.

The natural resources of the mask industry include non-woven materials, plastic nose clip, and ear loop and mask machine. Taiwan's mask materials are sufficient, and the quality of the masks is good. The raw materials for making masks which needed non-woven fabrics, plastic nose clip, and ear loop on sides of the mask. Moreover, mask machine and equipment are mainly to combine the materials into mask²⁹.

²⁷ "3 Reasons Taiwanese Love to Wear Masks," *YAHOO* 2020.

²⁸ Chun-Feng Zhang Meng-Lan Xu, Zhong-Yi Xie "6/1 the Free Sale of Masks Resumed. Manufacturers Recruit Personnels on a Large Scale.," *CTS NEWS* 2020.

²⁹ Jia-Qing Wang, "Medical Masks That Have Not Expired Will Cause Accidents If They Are Not Used. The Bad Habits That Need to Be Avoided Most.," *China Times* 2020.

The knowledge resources of Taiwan's mask industry are about industry technology and industry development. Taiwan's non-woven and machine tool industries are mature, and the quality of the masks produced is also quite good. The types of masks sold in Taiwan have different functions such as N95 masks, medical and surgical masks, activated carbon masks, cotton or gauze masks and general paper masks³⁰. In 2020, the main demand in the Taiwan market is mostly for surgical masks³¹. Some masks companies have their own brand and they made different colors of the mask also follow the trend to design the appearance of the mask. Some companies also strengthen the function of materials in masks, so that consumers can choose different masks either higher performance or wear more comfortable masks³².

The capital resources of the mask industry include the cost of machine tool, raw materials, packaging, and transportation, the salary cost of employees, and the basic expenses of the company/factory³³.

The External Factors of Surgical Mask Industry in Taiwan

In this section, I am going to answer my 2nd research question: What happened to surgical mask industry in Taiwan with the external factors? There are two parts to explore the conditions of surgical mask industry in Taiwan, chance and government.

Chance

³⁰ Shen, "Taiwan Face Mask Application Market and Development Situation".

³¹ "Carefully Choose Mask Manufacturers to Use the Headquarter's Conditional Gift Mask Production Machine to Produce Masks," Ministry of Economic Affairs, https://www.moea.gov.tw/MNS/populace/news/News.aspx?kind=2&menu_id=41&news_id=88847.

³² Hong-Yi Xiao et al., "The First Line of Epidemic Prevention: Technological Development of Masks and Protective Clothing," Industrial Technology Research Institute, <https://www.materialsnet.com.tw/DocView.aspx?id=43900>.

³³ Xian-Yi Lin and Zheng-Jie Zhang, "Miniature Masks Are Always Factory. Reduce Costs to Play the International Cup," *YAHOO* 2020.

As mentioned in literature review, chance is external and unpredictable factor, but the impact is not necessarily bad, and it may also form an opportunity.

Due to the COVID-19 outbreak this year, many industries have been greatly affected, and many companies have also closed. On the contrary, masks and other protective related products are busy producing and supplying them at home and abroad. Countries with abundant resources and technologies for masks are more advantageous.

Growth in Production Line of Masks

Before the COVID-19 outbreak, Taiwan's daily production capacity is 1.88 million masks, and the maximum production capacity is 2.44 million masks³⁴. COVID-19 has triggered the panic buying of masks. Even if it is to fulfill the needs of Taiwan's 23 million people, it still needs to rely on imports. The main import country of masks is China. For the past few years, Taiwan has imported about 300 million to 400 million pieces masks (about 90% are from China), which has showed that Taiwan is highly dependent on China³⁵.

After COVID-19 outbreak, it also joined the 92 new production lines of the national mask team. On March 2nd, the Ministry of Economic Affairs stated that the daily production capacity of masks reached 8.2 million pieces³⁶. At the end of May, the daily output of masks reached 20 million pieces³⁷. From June 1st, the export of masks began to be opened. Mask manufacturers not only could sale the masks on domestic market, but also exported the masks to help other countries. According to statistics from Customs Administration, the quantity of the imported

³⁴ Yi-Lun Ye, "The Problem of Mask Chaos Is Import!," *Voicet tank* 2020.

³⁵ Yi-Jing Pan, "Controversy of the Ban on Export of Masks Spreads That 90% of Imported from China.," *CNA* 2020.

³⁶ Jian-Qi Feng, "Ministry of Economic Affairs: Daily Production of 8.2 Million Masks. The Number of Real-Name Systems Increases Every Week.," 2020.

³⁷ Tzu-Ti Huang, "Taiwan to Produce 19 Million Face Masks Daily by Next Month.," *Taiwan News* 2020.

masks is about 134 million from January to June in 2020³⁸. Among them, 110 million masks are from China, accounting for more than 80% the masks. Even if the government avoided selling low-quality masks in domestic market and started to control medical/surgical masks in July³⁹, but China is still the main importer. For medical/surgical masks, the import ratio is as high as 90%.

In September, the government strengthen controlled on the import of masks again owing to the situations of fake masks. From September 16th, the new policy of imported masks will be controlled. medical or non-medical mask should first apply for an import permit from the International Trade Bureau of the Ministry of Economic Affairs, regardless of the transportation of sea and air, express delivery and postal parcels. After applying for a medical device license or consent document and passing the import inspection, only import medical materials and equipment by Food and Drug Administration of the Ministry of Health and Welfare⁴⁰.

Commercial Opportunity

On June 1st, masks returned to the market mechanism. The few manufacturers observed the business opportunities of masks as a marketing product and expanding reputation of companies for making masks and people have brand trust in masks⁴¹. Mask manufacturers co-brand with brands and celebrities, such as: a company called: China Surgical Dressings Center Co., Ltd. (中國衛生材料生產中心股份有限公司)⁴², they have designed more than 50 mask styles. The

³⁸ Xing-Yi Guo, "Taiwan Imported 134 Million Masks in the First Half of the Year. 80% Are from China.," 2020.

³⁹ "Border Inspection of Medical Masks Officially Launched on July 7," Ministry of Health and Welfare, <https://www.mohw.gov.tw/cp-4630-54684-1.html>.

⁴⁰ Bi-Hua Xu, "Customs Administration: Imported More Than 20 Million Masks since the New System Control on September 16," *Economy Daily News* 2020.

⁴¹ Ling-Ming Hong, "Sell 2,000 Boxes of Masks Every Minute! R&R Medical Corporation Pink Mask Sold Out," *SET News Channel* 2020.

⁴² "The News of Csd Mask," CSD, <https://www.csd.com.tw/news>.

styles are not limited to blue, green or white, from single color, printed patterns to digital printing designs⁴³.

Boutique masks which is China Surgical Dressings Center Co., Ltd. (中國衛生材料生產中心股份有限公司) cooperate with BVLGARI and the mask only for VIP members of BVLGARI. This is the first time for China Surgical Dressings Center Co., Ltd. to become an international boutique⁴⁴. Taipei Fashion Week co-brand with mask manufacture China Surgical Dressings Center Co., Ltd. In response to COVID-19, Taipei Fashion Week has also cooperated with China Surgical Dressings Center Co., Ltd to print and manufacture limited edition masks with a sense of fashion. Each person can receive one piece, with a daily limit of 200 pieces⁴⁵. China Surgical Dressings Center Co., Ltd. designed Double Ten National Day masks and cooperated with 22 channels. China Surgical Dressings Center Co., Ltd. announced that as long as the public completes the message under the fan page of 23 channels (including China Surgical Dressings Center Co., Ltd. 's fan page) before 23:59 on Double Ten, they will have the opportunity to get a "limited edition National Day mask"⁴⁶.

Government

As mentioned in literature review, government is an external condition. The government will control the market in a reasonable situation, but the length of time will also cause the market to be intervened by the government.

⁴³ "Turn Masks from Medical Materials into Collections of Fashionable Accessories. The 73-Year-Old Csd Created a Legend.," *Liberty Time* 2020.

⁴⁴ Peng-Min Cai, "Csd Expands Its Overseas Market Layout. Hand in Hand with Bulgari to Move Towards an International Boutique.," *CNA* 2020.

⁴⁵ Ruo-Yu Jian, "Taipei Fashion Week Is Here! Join Hands with Csd to Push Ultra-Fashion Masks, Limited to 200 Pieces Per Day.," *Sanlih E-Television* 2020.

⁴⁶ Yi-Rong Lin, "Leave a Message before 23:59! Csd's Golden Orange "National Day Masks" Will Be Given for a Limited Time. Csd Cooperates with 22 Channels.," *Business Today* 2020.

Government Intervention in The Mask Market

Before COVID-19 outbreak, mask is a free market in Taiwan. The prices and sales channels of commodities are determined by the manufacturers themselves, and the government didn't intervene in control. After the outbreak of COVID-19, the Taiwanese government has implemented policies, which are restricting the export of masks, the amount of requisitioned masks, the mask prices, and the mask-rationing plan⁴⁷.

The reason for restricting the export of masks is to stabilize domestic supply first. The government announced that the export of masks made of textile materials (excluding paper, sponge materials and gas masks) is controlled on January 24th⁴⁸. Although the export of masks is strictly controlled, in order to take care of Taiwanese which working on abroad, people are allowed to send masks overseas. Passengers could bring the masks out of the country with a maximum of 5 boxes for each person (50 pieces per box) from January 30th⁴⁹. People will be allowed to send masks to family members overseas, and 30 masks can be sent every two months from April 9th⁵⁰. Starting from June 1st, the masks could be exported. Also, it is also open for people to send masks overseas without any application⁵¹.

⁴⁷ Po-Chih Chen, "The Economics of Government Intervention in the Mask Market," *Taiwan Institute of Economic Research* 43, no. 4 (2020).

⁴⁸ "Epidemic Prevention Items Import, Fast Customs Clearance and Export Control.," Ministry of Finance, <https://www.mof.gov.tw/multiplehtml/9fe8e125b1104b118f17a99a73b49e36>.

⁴⁹ "Passengers Are Restricted to Carry out of the Country with Masks, with a Limit of 250 Per Person," Ministry of Health and Welfare, <https://covid19.mohw.gov.tw/ch/cp-4822-53520-205.html>.

⁵⁰ "The Ministry of Economic Affairs Reminds Four Procedures for Sending Masks to Relatives Abroad.," The Bureau of Foreign Trade, MOEA, <https://technews.tw/2020/03/31/4-step-of-send-masks-overseas/>.

⁵¹ "Sending Masks to Relatives Abroad Is Fully Open from June 1st," Bureau of Foreign Trade, <https://www.trade.gov.tw/Pages/Detail.aspx?nodeID=40&pid=695614>.

The government requisitioned all general medical and surgical masks produced by domestic mask factories (approximately 4 million pieces per day) started from January 31st⁵². The government subsidized mask manufacturers to provide mask machines, but they needed to fulfill the conditions and specifications that each manufacturer applied for a mask machine with the government, and each mask machine needed to produce at least 5 million pieces of masks, 1.2 million pieces are given to the government free of charge, and 3.8 million pieces are used for expropriation. every week produced 700,000 pieces⁵³. These machines could be left to the factories, and those machines that do not fulfill the conditions will be handled by the government. Starting from June 1st, the formulated number of 8 million pieces per day would be requisitioned⁵⁴. Starting from September 24, domestic medical masks must embossed with "MD" and "Made in Taiwan" fully requisitioned and supplied to the channels mask-rationing plan for sale⁵⁵. The government originally planned to fully requisition masks by the end of October because the number of masks is sufficient; therefore, the fixed requisition of 8 million pieces per day will be resumed from October 15th. At the end of September, it was originally announced that the masks embossed with 'Made in Taiwan MD' was fully levied. As the production capacity of masks was enough, it became a fixed requisition⁵⁶.

The price of masks has also changed. Before the COVID-19 outbreak, the price of a mask was about NT\$2-3. However, the price of masks might also be lower than NT\$2 in different

⁵² Yi-Fong Su et al., "Masks and Medical Care: Two Keys to Taiwan's Success in Preventing Covid-19 Spread," *Travel Medicine and Infectious Disease* (2020).

⁵³ Xin-Yun Wu, "Mask Manufacturers Complain That They Have Not Been Requisitioned and Cannot Be Sold. The Ministry of Economic Affairs Is Issuing Requisition Letters," *CNA* 2020.

⁵⁴ Jian-Qi Feng, "The Export of Masks Is Lifted. Three Key Points of the Ministry of Economic Affairs," *China Times* 2020.

⁵⁵ "The Full Requisition of Double-Stamped Masks Will Resume the Quota Requisition in Advance from October 15th.," Centers for Disease Control, MOHW, <https://www.mohw.gov.tw/cp-4626-56042-1.html>.

⁵⁶ "The Full Requisition of Masks Was Released in Advance. People Can Commercially Available Buy Masks Embossed with 'Made in Taiwan Md' from 10/15," *Radio Taiwan International* 2020.

channels or different countries produced⁵⁷. From January 28th to 30th, each person could only purchase 3 pieces of masks, and each piece of mask was NT\$ 8⁵⁸. From February 1st, price of a mask reduced from NT\$8 to NT\$6, maintaining the limit of three pieces masks for each person⁵⁹. The mask purchased from the mask-rationing plan is NT\$5 each piece⁶⁰. Market trading resumed on June 1st, and masks could be bought and sold freely. The price of one mask is about NT\$ 5 to NT\$ 7 per piece, and price of the mask-rationing plan still maintained NT\$5⁶¹.

The main purpose of mask-rationing plan is to control the number of masks for the people buy and avoid storing the masks. There are 3 different channels to obtain the masks by mask-rationing plan. From February 6th, mask-rationing plan 1.0, each person was allowed to purchase two surgical masks every seven days with their own NHI card⁶². Starting from March 12th, the mask-rationing plan 2.0 added online channels to pre-purchase masks⁶³. People could log in to the platform through NHI card, citizen digital certificate, or pre-order by the NHI Express APP. From April 30th, mask-rationing plan 3.0 that people could resume getting masks and pre-purchase masks at convenience stores⁶⁴.

National Face Mask Team

⁵⁷ YU-SHAN FAN, "Taiwan Masks Are the Cheapest in the World? Uncover the "Real Price"." *SET News* 2020.

⁵⁸ Jie-Ling Chen, "The Government Immediately Releases 6 Million Masks a Day, One Person Is Limited to 3," *United Daily News* 2020.

⁵⁹ Yuan-Hong Zhang, "Taiwan Masks Start on 2/1, and the Price of Masks Is Reduced to Nt\$6 Each. The Price of Chinese Masks Has Soared Wildly," *Chinese Television System* 2020.

⁶⁰ Peng-Min Cai, "Free Buying and Selling Masks Cost Less Than Nt\$5. The Industry Clamored Unreasonably.," *CNA* 2020.

⁶¹ Sh-Rui Wu and Meng-Chieh Hsu, "The Price Has Gone Up! The Cosmeceutical and Pharmacy Masks Cost Nt\$50 to 100 Per Box since Last Week.," *TVBS* 2020.

⁶² "Mask-Rationing Plan 1.0 Are Sold on the Road, and People Hold Their Health Insurance Cards to Purchase at Special Pharmacies," <https://covid19.mohw.gov.tw/ch/cp-4822-53560-205.html>.

⁶³ "The Mask-Rationing Plan 2.0. Trial Operation Online Pre-Order from March 12," Taiwan Centers for Disease Control, https://www.cdc.gov.tw/Bulletin/Detail/I93JyhKzaG5hHmhcls5_HQ?typeid=9.

⁶⁴ "Compare Mask-Rationing Plan 1.0, 2.0, 3.0," National Health Insurance, https://www.nhi.gov.tw/News_Content.aspx?n=FC05EB85BD57C709&s=D50166BA3B48BD2A.

When the government announced that it would increase the production line of masks, the machine tool industry initiated the national face mask team⁶⁵. Everyone worked together to make face mask machines and increase production lines of mask, while the government invested a lot of money in raw materials, face mask machines and equipment and the soldiers from Ministry of National Defense to support the mask factories for producing the masks. Mainly task to solve the demand of masks and produce a lot of masks in the least time in Taiwan⁶⁶. The national face mask team is composed of the government, the machine tool suppliers, the mask raw material suppliers (non-woven fabric factories), 24-hour overtime mask manufacturers, and precision machinery research & development center⁶⁷. On January 30th, the government requisitioned all general medical masks and surgical masks produced from the domestic mask factories⁶⁸. On January 31st, the government invested in the addition of 60 production lines to increase the total daily production capacity of 6 million pieces⁶⁹. In February, government started the mask-rationing plan and requisitioned with the mask companies/factories to complete weekly production lines⁷⁰. Increasing the production of the national face mask team, Taiwan could produce 9.2 million pieces masks in a day, which can reach the maximum daily output of 10 million in March⁷¹.

⁶⁵ Pei-Jun Huang and Xin-Fang Li, "The National Team of Masks Strives to Produce 10 Million Pieces Per Day. The Government Invested 200 Million Yuan to Build a Mask Production Line.," *Liberty Times* 2020.

⁶⁶ Song-Yi Zhou, "Mission Impossible! The National Face Mask Team Handed over 92 Production Lines in 40 Days. How to Do It?," *MANAGER today* 2020.

⁶⁷ Li-Yan Qiu, "Taiwan's Mask Miracle: These 80 Companies "Work Together" to Produce 10 Million Pieces Per Day.," *Global Views Monthly* 2020.

⁶⁸ "All General Medical Masks and Surgical Masks Produced by Domestic Mask Factories (Approximately 4 Million Pieces Per Day) Will Be Requisitioned and Distributed by the Command Center.," Ministry of Health and Welfare, <https://covid19.mohw.gov.tw/ch/cp-4822-53522-205.html>.

⁶⁹ Yu-Yang Liao, "The Government Will Fund 60 New Mask Production Lines. The Daily Production Capacity Reaches 10 Million Pieces.," *CNA* 2020.

⁷⁰ "The the Mask-Rationing Plan for Selling Masks Will Start on February 6, and People Can Buy Them with Nhi Cards.," Centers for Disease Control, <https://www.mohw.gov.tw/cp-16-51286-1.html>.

⁷¹ Jian-Qi Feng, "The Average Daily Production of Masks This Week Is 9.2 Million Pieces. Minister of Economy: The

On March 20th, with a daily production capacity of 10 million pieces, the Ministry of Economic Affairs has instructed to add another 30 production lines, and the daily production capacity can be increased by another 2 million to 3 million pieces⁷². In just three months, the national mask team added 92 production lines and gradually moved towards the goal of 20 million pieces⁷³. Started from June 1st, masks could sale on the market, but the government considered the problem of price of masks, so the mask-rationing plan policy still continued to operate, and the price will remain at a reasonable NT\$ 5 each piece mask. moreover, the national face mask team continued to requisition masks (8 million masks are provided daily for the government's fixed requisition)⁷⁴. From September 24th, in order to prevent masks made from China mixed with masks made from Taiwan, the surgical/medical masks must be embossed with "MD" and "Made in Taiwan" on the outer layer of the mask⁷⁵.

Mask Diplomacy

COVID-19 has brought a heavy attack to the world. Many countries couldn't fulfill their demands for epidemic prevention supplies. Taiwan also continued to face the threat of COVID-19. However, when domestic supplies were relatively sufficient, Taiwan reached out to help other countries, including North America⁷⁶, Latin America and the Caribbean, Europe, Asia-

Highest Challenge Is 10 Million Pieces.," *China Times* 2020.

⁷² Cheng-Zhong Wang and Quan Gu, "An Additional 30 Mask Production Lines Were Added. Daily Output Will Exceed 12 Million Masks," *CNA* 2020.

⁷³ Long-Qi Su, "The Output of Masks Has Greatly Improved. Ministry of Economic Affairs: The Daily Maximum Has Reached 20 Million Masks.," *ibid*.

⁷⁴ Yi-Feng Lu, "The Export of Masks Will Be Officially Opened on June 1st! The Number of Requisitioned Daily Was Reduced to 8 Million Tablets. The "Mask National Team" Will March Internationally Next Month.," *The Storm Media* 2020.

⁷⁵ Jie-Ling Chen and Yi-Jun Qiu, "The Requisition for Double-Stamped Masks Was Restored. The Full Expropriation Will End Early on October 15th.," 2020.

⁷⁶ Ching-Tse Cheng, "Huge 'Taiwan Can Help' Ads Appear in New York's Times Square," *Taiwan News* 2020.

Pacific and Africa. Taiwan gave the masks, epidemic prevention supplies and technologies, showing the spirit of "Taiwan Can Help, and Taiwan is Helping!"⁷⁷.

On April 1st, President Tsai Ing-Wen donated 2 million masks to the United States, 7 million masks for EU countries, and 1 million masks for diplomatic countries; hoping to fight against COVID-19 with other countries⁷⁸. On April 15th, Ministry of Foreign Affairs donated 80,000 pieces of medical masks to four Pacific diplomatic countries including Palau, Marshall, Nauru, and Tuvalu⁷⁹. In addition to donating medical-grade masks, Taiwan also donated clinical diagnostic kits and infrared thermometer. On April 17th, Taiwan government donated 2 million masks to Japan⁸⁰. On April 24th, Taiwanese businessman: Kuo Hua Trading Company Ltd.(國華台灣食品公司) donated 80,000 masks to teachers and students in Vancouver⁸¹. On the same day, Ministry of Foreign Affairs donated 300,000 pieces of medical masks to Vietnam⁸². Because the supply of melt blown non-woven fabrics for making masks is insufficient. On April 29th, Ministry of Foreign Affairs donated 500,000 pieces of medical masks to Canada⁸³. On May 26th, Ministry of Foreign Affairs donated 100,000 masks to Magen David Adom (以色列紅大衛盾會)⁸⁴. On June 30th, Taiwan government donated 50,000 surgical masks to Kuwait⁸⁵.

⁷⁷ Keoni Everington, "Taiwan Donates 5 Mask Production Lines to Czech Republic," 2020.

⁷⁸ "Taiwan Continues "Epidemic Prevention Diplomacy": 7 Million Masks Will Be Donated to the Eu, 2 Million in the United States, and 1 Million in Diplomatic Countries.," *The News Lens* 2020.

⁷⁹ George Liao, "Taiwan Donates 80,000 Surgical Masks to Pacific Allies," *Taiwan News* 2020.

⁸⁰ YUN-YU CHEN, "Taiwan Donates 2 Million Masks to Japan to Fight Covid-19.," *ibid*.

⁸¹ YU-LI HU, "Taiwanese Businessmen Donated Masks Made in Taiwan. The Mayor of Ottawa Thanked Taiwan for the Donation.," *ibid*.

⁸² YUN-YU CHEN, "Taiwan Donates 300,000 Masks to Vietnam.," *ibid*.

⁸³ YU-LI HU, "Taiwan Presented Medical Masks to Canada.," *CNA* 2020.

⁸⁴ "Taiwan Donated 100,000 Masks to the Magen David Adom of Israel, Saying That Mit Is a Quality Guarantee.," *ibid*.

⁸⁵ JING-WEN HUANG, "Taiwan Donated Surgical Masks to Kuwait and Taiwan's Mask Diplomacy Got Well Received.," *Newtalk* 2020.

The Changing Strategy of Surgical Mask Industry in Taiwan Prior and After COVID-19

In this section, I am going to answer my 3rd research question: What did surgical mask companies/factories change the different strategy after COVID-19 outbreak? There are two parts to explore the conditions of surgical mask industry in Taiwan, related and supporting industries and firm strategy, structure and rivalry.

Related and supporting industries

As mentioned in literature review, the related and supporting industries is when the development of companies and the suppliers that could be stronger, and fully prepared than the competitors, that helped the industry have more competitive advantage in a competitive market.

The Surgical Mask Industry Chain

Owing to mask is one of the medical equipment, the researcher applied medical equipment industry chain to the mask industry⁸⁶. According to the introduction of the medical equipment industry chain, the surgical mask industry is divided into upstream, midstream and downstream. The upstream of medical equipment is mainly industry of the materials and machine equipment, while the upstream of masks is non-woven fabrics industry which produced the three-layer non-woven fabric and the machine tool industry which support to produce the face mask machines. Then, the midstream of medical equipment is manufacturing, while the midstream of the mask is

⁸⁶ "Introduction to Medical Equipment Industry Chain," Taipei Exchange, <https://ic.tpex.org.tw/introduce.php?ic=C200>.

medical and biotech industry which related medical materials and supplies manufacturing, other textile and products manufacturing, cosmetics manufacturing, rubber products manufacturing, or paper products manufacturing...etc. At last, the downstream of medical equipment industries are professional agents and distributors of medical equipment, while the downstream of masks are mainly medical-related hospitals, clinics, and pharmacies; physical channels and online platforms are also sold many types of masks.

Table 2. Industry Chain of Surgical Mask Industry

Upstream	Midstream	Downstream
machine and material	manufacturing and production	sales and distributors
non-woven fabrics industry and machine tool industry	medical and biotech industry	hospitals, clinics, pharmacies (main sales channels)

Source : website of industry value chain information platform (產業價值鏈資訊平台)

Price of Melt-Blown Non-woven Fabric

When masks returned to the market, the price changed of melt-blown non-woven fabric will have a direct impact on the price of masks. Compared with the price fluctuation of foreign melt-blown non-woven fabric, the price of domestic melt-blown non-woven fabric continued to rise after COVID-19 outbreak⁸⁷.

⁸⁷ " The Price of Melt-Blown Non-Woven Fabric Masks Made in China Collapsed. The Quality of Mit Masks Remains High.," CNA 2020.

In order to maintain the quality of masks and the willingness of non-woven manufacturers to supply goods, the government increased the price of the main raw material of masks: melt-blown non-woven fabric. Before COVID-19 outbreak, the price of melt-blown non-woven fabric was NT\$ 600 per kilogram⁸⁸. On August, the non-requisitioned melt-blown non-woven fabric returned to the market mechanism. The price of melt-blown non-woven fabric is NT\$ 500 to NT\$ 800 per kilogram; while the requisitioned melt-blown non-woven fabric price is NT\$ 330 to NT\$ 420 per kilogram, and the price increased by about 30%⁸⁹.

Price of Face Mask Machine

Before COVID-19 outbreak, there are only two mask machine manufacturers in Taiwan. Many companies from China invested in mask machines, and the price was half that of Taiwan after H1N1 outbreak⁹⁰.

Before COVID-19 outbreak, the price of mask machines in China was RMB 200,000 to 400,000 (about NT\$860,000 to NT\$1.72 million) After COVID-19 outbreak, the price of a face mask machine is NT\$ 3 million is paid by the government, but it is not given to the mask factories for free, and there were additional conditions⁹¹. Taiwan mask machines sold to various countries, and orders were full until September and the mask machine sold abroad is NT\$3.5 million⁹².

⁸⁸ Hong-Jun Yan, "Covid-19 Has Triggered a Competition in the Number of Major Domestic Mask Manufacturers. Motex Healthcare Corporation Produces Its Own Melt-Blown Non-Woven Fabrics.," *The Liberty Times* 2020.

⁸⁹ Yi-Jie Lin and Bo-Hua Zhuang, "The Price of "Melt-Blown Non-Woven Fabric", a Raw Material for Masks, Rose. Starting from October, the Price of Boxed Masks May Increase.," *Formosa Television* 2020.

⁹⁰ "More Than 20 Countries Have Designated Rescue, This Pair of Brothers Let Taiwan Mask Machine Shine.," *Tech News* 2020.

⁹¹ Money DJ, "Masks Will Be Open for Export. Who Will Benefit from Non-Woven Fabric Factories?," *WEALTH MAGAZINE* 2020.

⁹² Qian-Han Bi and Jing-Ying Huang, "Mit Shines! Taiwan's Mask Machine Orders Are over-Full and Sold to "These Countries",," *TVBS NEWS* 2020.

Firm strategy, structure and rivalry

As mentioned in literature review, the firm strategy, structure and rivalry related with the number of companies, domestic competition among manufacturers, and the pros and cons faced by external factors that would affect the industry's advantages. There will be differences between large enterprises and small and medium enterprises, and the company's production volume will affect its competitiveness in the market.

Distribution of Mask Industry in Taiwan

According to the list of mask manufacturers provided by the Ministry of Health and Welfare, there are a total of 80 mask manufacturers, 66 after deducting duplicates and no factory registration⁹³. The researcher collected 78 mask manufacturers, mainly located in New Taipei City in the north and Changhua County in the west. Most of the companies are mainly Medical Materials and Supplies Manufacturing, Non-woven fabric Manufacturing, and Other Textile and Products Manufacturing. There is also Cosmetics Manufacturing, Rubber Products Manufacturing, or Paper Products Manufacturing...etc.

Market Concentration of Mask Factories

Before COVID-19 outbreak, the mask industry didn't have obvious competitiveness. Masks are daily necessities that need to be replaced at any time, so manufacturers only needed to produce the quantity required by the market to fulfill the market.

⁹³ "The Mask Industry's Production Capacity and Immediate Production Capacity Requisitioned Masks in Batches. Up to 66 Mask Manufacturers Are Currently Being Requisitioned.," Ministry of Economic Affairs, https://www.moea.gov.tw/MNS/populace/news/News.aspx?kind=1&menu_id=40&news_id=88683.

After the COVID-19 outbreak, the production of masks in Taiwan had risen sharply, with daily production having exceeded 20 million pieces⁹⁴. Many manufacturers actively invested in the production of masks. In addition to the number of masks requisitioned by the government every day, it also included the output for domestic and foreign sales.

Among many companies that joined producing masks. Therefore, the market competition was relatively obvious. It was obvious that COVID-19 had the concentration ratio on the mask industry. The concentration of mask manufacturers is that the number of masks produced by each manufacturer depends on the concentration ratio of the four (CR4) largest manufacturers in the mask industry. The four mask manufacturers are in the mask industry, and their production volume is among the top four in the mask industry.

In this table showed that CR4 of the face mask industry after COVID-19 outbreak. According to the news that the researcher collected, the daily output of masks is about 20 million. According to the 78 mask manufacturers collected by the researchers, the top four mask manufacturers are Motex Healthcare Corporation(華新醫材股份有限公司), Kleaner Nicer Healthier(康那香企業股份有限公司), Universal Incorporation(恒大股份有限公司), Nanliu Enterprise CO., LTD (南六企業股份有限公司). These companies are all non-woven fabric manufacturers, so when producing masks, the raw material resources can be self-sufficient and need to increase mask machines to produce masks.

Motex Healthcare Corporation (Non-woven fabric factory, Medical equipment factory): Before COVID-19 outbreak, the daily output was about 200,000 masks. After COVID-19 outbreak, the production line increased from 11 to 17, and the daily output of mask increased to

⁹⁴ Yu-Xiang Wang, "Epidemic Prevention Can Also Be Very Fashionable! Take a Look at the Three Major Trends of "Post-Epidemic Wear"." *Global Views* 2020.

700,000 pieces after government funds are invested in a new mask machine. The output is expected to increase to 1 million in July⁹⁵. Due to the addition of 3 production lines of melt blown non-woven fabric in August, and the daily output of 5 tons of melt blown non-woven fabric in October would be able to produce 6 million masks⁹⁶.

Kleaner Nicer Healthier (Non-woven fabric factory, Medical equipment factory): At the end of January, 210,000 masks per day were produced. In February, two mask production lines are expected to be added⁹⁷. In March, there were 6 mask machines produced masks day and night, with an average daily output of about 800,000 pieces⁹⁸. In October, 16 mask equipment was added, with a daily production capacity of 4 million pieces⁹⁹.

Universal Incorporation (Non-woven fabric factory): In January, the 6 mask production lines could have a daily production capacity of 200,000 masks. It is estimated that another 6 production lines will be added. The overall production capacity can reach 400,000 masks without shutting down for 24 hours¹⁰⁰. In June, 15 mask machines could produce 1.4 million pieces per day¹⁰¹. They have increased 20~30 mask production lines, with a daily production capacity of 3 million pieces in October¹⁰².

⁹⁵ Zhe-Hao Wu and Bo-Yang Xiao, "The Export of Masks Will Be Lifted. Motex Medical Equipment Estimates That the Business Opportunities Brought by the Epidemic Will Continue until the End of the Year.," *CNA* 2020.

⁹⁶ Yan, "Covid-19 Has Triggered a Competition in the Number of Major Domestic Mask Manufacturers. Motex Healthcare Corporation Produces Its Own Melt-Blown Non-Woven Fabrics.."

⁹⁷ Yan-Shou Yuan, "Fight the Epidemic Together! Kleaner Nicer Healthier Resumed Work Ahead of Schedule and Will Add 2 Production Lines.," *Commercial Times* 2020.

⁹⁸ Yi-Jing Pan, "All 92 New Mask Machines Went Online. Sprint to Produce 15 Million Pieces Per Day.," *CNA* 2020.

⁹⁹ Peng-Min Cai and Rong-Xiang Zhang, "Kleaner Nicer Healthier Expanded Its Production Line. In October, the Daily Production Capacity of Masks Was 4 Million Pieces.," *ibid*.

¹⁰⁰ Xing-Han Jiang, "The Government Buys Masks! The Stocks Ofuniversal Incorporation, Kleaner Nicer Healthier, and Nanliu Enterprise Co., Ltd Opened Daily Limit for Two Consecutive Days.," *Global Views* 2020.

¹⁰¹ Xuan-Yi Peng, "Mask Orders Are Fully Loaded. Universal Incorporation Continued Its High-End Operations in June.," *China Times* 2020.

¹⁰² Shu-Xuan Chen, "The Order Is Full until the End of the Year. Universal Incorporation'smelt Blown Non-Woven Fabric Production Capacity Was Ordered.," *Economic Daily News* 2020

Nanliu Enterprise Co., Ltd. (Non-woven fabric factory, Medical equipment factory): Nanliu Enterprise Co., Ltd. was no production of masks before COVID-19 outbreak, but the production capacity of non-woven fabrics was quite large, so Nanliu Enterprise Co., Ltd. was in response to the government's call¹⁰³. In September, there were 43 mask production machines to produce masks; however, the mask production staff was insufficient, and only 35 were able to go online¹⁰⁴.

Table 3. CR4 of Mask Manufactories

	Name of mask companies	Output	Percentage
1	Motex Healthcare Corporation	6 million pieces masks	30%
2	Kleaner Nicer Healthier	4 million pieces mask	20%
3	Nanliu Enterprise Co., Ltd.	3.5 million pieces mask	17.5%
4	Universal Incorporation	3 million pieces mask	15%
5	Other mask companies (about 74 factories)	3.5 million pieces mask	17.5%
Total	78 factories (researcher collected)	20 million pieces mask	100%

Resource: 7 news media websites: CNA(中央社), Commercial Times(工商時報), Global Views(遠見), China Times(中國時報), Economic Daily News(經濟日報), Liberty Times(自由時報), Wealth Magazine(財訊).

In this table of CR4, there are 4 companies which are the largest number of producing masks in Taiwan. First, the company that produced the most masks is Motex Healthcare

¹⁰³ DJ, "Masks Will Be Open for Export. Who Will Benefit from Non-Woven Fabric Factories?."

¹⁰⁴ Yan-Shou Yuan, "The Daily Production Capacity of Masks Can Reach 3.5 Million Pieces. Nanliu Enterprise Co., Ltd : To Be Taiwan's No.1," *Commercial Times* 2020.

Corporation. According to the latest information, Motex Healthcare Corporation could produce approximately 6 million pieces of masks per day. Therefore, 30% of the masks in Taiwan come from Motex Healthcare Corporation. Second, Kleaner Nicer Healthier could produce about 4 million pieces mask each day, and 20% of the masks in Taiwan come from Kleaner Nicer Healthier. Third, Nanliu Enterprise Co., Ltd. could produce 3.5 million pieces mask pieces mask each day, and 17.5% of the masks in Taiwan come from Nanliu Enterprise Co., Ltd. Forth, Universal Incorporation could produce 3 million pieces mask pieces mask each day, and 15% of the masks in Taiwan come from Universal Incorporation. At last, the other companies/factories could produce 3.5 million pieces of mask every day, and 17.5% of the masks in Taiwan come from those 74 companies.

The Mask Issues of Illegal Policy

Since the opening of the market to sell masks in June, many manufacturers have been able to supply domestic and foreign demand on their own. However, some factories privately produced masks and imported masks from other countries and led to many cases of fake mask in Taiwan. It also made Taiwanese people worried about the masks made in Taiwan. Also, the mask factories from national face mask team which has won glory for Taiwan has the same problem. There are also some mask factories that sold masks under the name of the national team or bought the mask boxes from the national face mask team and sold them in various channels.

National face mask team: Carry Hi-Tech Co., Ltd. imported the mask from China

According to the fake mask news that about Carry Hi-Tech Co., Ltd. (加利科技有限公司), also people called: Carry Mask. Carry Hi-Tech Co., Ltd. who is a member of the national mask

team in August imported 3.37 million masks made in China, relabeling and repackaging them as government-rationed and domestically manufactured face mask supplies. On September 3rd, Lin who is the owner of Taiwanese mask supplier Carry Mask admitted he had commissioned a company from China to produce the masks. The government announced that the purchase of masks with "Carry Mask" printed on them can be refunded and covered the administrative costs of the mask returned¹⁰⁵. A total of 535,900 pieces were recycled across Taiwan, with over 490,000 pieces in New Taipei City, followed by more than 20,000 pieces in Yilan County, and 8,860 pieces in Taipei City. It is estimated that the total recycling volume in Taiwan will exceed 5 million pieces¹⁰⁶. The government revoked Carry Mask. Carry Hi-Tech Co., Ltd.'s medical certificate, took back the mask machine distributed by the government to Carry Mask. Carry Hi-Tech Co., Ltd., and fined 2 million by the owner of Carry Mask. Carry Hi-Tech Co., Ltd.¹⁰⁷. On September 5, Carry Mask. Carry Hi-Tech Co., Ltd. announced that consumers who purchased Carry Mask can bring their invoices and products directly to the company for a refund or return to the place where they bought the products. The mask returned time is from September 9th to October 8th. Each piece would be refunded at NT\$5. The prosecutor convicted Lin of fraud and other crimes, but there was no need to detain him, and ordered NT\$3.5 million for security. According to Offenses of Fraudulent, Carry Hi-Tech Co., Ltd. carried a maximum five-year sentence; violated the Pharmaceutical Affairs Act that accepted and imported medical equipment provided for jail sentences of three years and fines of up to NT\$10 million¹⁰⁸.

National face mask team: Haw Ping Co., Ltd. imported the mask from China

¹⁰⁵ Keoni Everington, "Taiwanese Have 1 Week to Return Fake Chinese Masks," *Taiwan News* 2020.

¹⁰⁶ Ming-Xuan Zhang, "Carry Mask Who Mixed the Mask from China into the Mask-Rationing Plan, and More Than 530,000 Pieces Were Recovered on the First Day.," *CNA* 2020.

¹⁰⁷ Chellamani, Veerasubramanian, and Balaji, "Surgical Face Masks: Manufacturing Methods and Classification."

¹⁰⁸ Bin Fang, "The Person in Charge of Carry Hi-Tech Co., Ltd. Involved a Five-Year Sentence and Talked About the Case.," *The Liberty Times* 2020.

After the fake mask news of Carry Hi-Tech Co., Ltd., another one factory who is also joined the national face mask team, Haw Ping Co., Ltd. (豪品國際實業股份有限公司). The supplier of Haw Ping Co., Ltd. sold lower-cost masks which made from China and pretended to make from Taiwan for sale in the channel¹⁰⁹. Starting from June, imported Chinese-made masks will be used as masks and Taiwan-made medical-grade masks will be sold on their own channels¹¹⁰. Haw Ping Co., Ltd. had imported 7.18 million masks from China in August, and government found that the company had 3 million pieces mask in factory, while it had already sold more than 4 million to Taiwanese consumers¹¹¹. Haw Ping Co., Ltd. imported non-medical masks made from China but on the box using "medical masks" as outer packaging is sold, and Haw Ping Co., Ltd. sold the non-medical masks to distributors at a price of about NT\$5 or more (each imported mask costs about NT\$2 to 3) and about 2 million pieces mask were sold. Haw Ping Co., Ltd. has removed the fake mask, violated the Pharmaceutical Affairs Act and might be sentenced to imprisonment of up to 5 years, criminal detention, or a fine of up to NT\$20 million¹¹².

National face mask team: Jing Sing Technology Co., Ltd. privately increased production lines

On September 24th, Jing Sing Technology Co., Ltd.(淨新科技股份有限公司) was found to have privately produced medical masks. Although Jing Sing Technology Co., Ltd. has the license of legal medical equipment manufacturing, the factory is on the fifth floor, and privately set up 22 medical mask production lines set up 22 medical mask production lines on other floors.

¹⁰⁹ Pei-Chi Liang, Jhe-Hao Wu, and Evelyn Kao, "Another Taiwanese Manufacturer Accused of Selling Counterfeit Masks," *Focus Taiwan* 2020.

¹¹⁰ Liang-Yi Wu, "Haw Ping Has Mixed into Chinese Masks. Food and Drug Administration: Up to 5 Years Imprisonment, Fine of 20 Million," *The Liberty Times* 2020.

¹¹¹ Keoni Everington, "Company Sells 4 Million Fake 'Made in Taiwan' Masks from China," *Taiwan News* 2020.

¹¹² Wu, "Haw Ping Has Mixed into Chinese Masks. Food and Drug Administration: Up to 5 Years Imprisonment, Fine of 20 Million."

The owners of Jing Sing Technology Co., Ltd. violated the Pharmaceutical Affairs Act, and they were released on bail of NT\$300,000 and NT\$200,000¹¹³.

Forged Trademark Mask Factory: Neng Siang Automatic Technology

On August 28th, Neng Siang Automatic Technology(能翔自動科技公司) is a counterfeit trademark of Jeng Guang Co., Ltd.(正洸股份有限公司). Neng Siang Automatic Technology(能翔自動科技公司) is a company operating detector of tire-pressure in Taoyuan. Because of increasing the demand for masks, Neng Siang Automatic Technology privately bought materials of mask and produced the masks and sold masks in physical or online store, such as "Shopee"(蝦皮購物). In order to increase sales of mask, use the name of the qualified company which is Jeng Guang Co., Ltd. and printed the type on the outer packaging which approved by the Ministry of Health and Welfare, and the mask is sold for about NT\$ 7 per mask. The police seized 30 boxes with counterfeit trademark of masks (50,070 masks) and 1 box of semi-finished masks (1,070 masks) at the factory¹¹⁴. The police transferred him to the Taoyuan District Prosecutor's Office for investigation on suspicion of violating the Trademark Act and Pharmaceutical Affairs Act¹¹⁵.

Imitating the name of a member of the national face mask team: FU DA corporation

On September 8th, FU DA corporation(富達實業社) purchased about 610,000 fake medical masks without the license for medical equipment, and then commissioned a printing company to

¹¹³ Wen-Ting Hou, "Jing Sing Technology Co., Ltd. Fined 2 Million Illegally, Whether They Have Flowed into the Market Is Still to Be Investigated," *CNA* 2020.

¹¹⁴ En-Hui Chen, "Taoyuan Police Cracked a Case of a Forged Trademark Mask Factory and Found 30 Boxes of More Than 50,000 Masks.," *Liberty Times* 2020.

¹¹⁵ Yu-Ke Zhang, "The Underground Mask Factory Imitates the National Team and Prints Its Own Approved Name.," *TVBS News* 2020.

use the name of Hung Wei Medical Consumable Co., Ltd. (宏瑋醫材有限公司) which is a member of the national mask team to print more than 20,000 outer boxes and sell them under fake names. The prosecutor believed that the person in charge of FU DA corporation was involved in fraud, forgery of documents, Pharmaceutical Affairs Act, etc., and that he has buried and destroyed evidence, colluded with people or witnesses, repeatedly committed fraud, and filed for detention in Nantou District Court Forbidden to see allowed¹¹⁶.

Imitating the name of a member of the national face mask team: Ham Bin Company

On September 11th, the underground mask factory of the Ham Bin Company (漢賓國際有限公司) faked the packaging boxes of Taiwan Pro-Level Papers International Co., Ltd (台灣優紙企業有限公司) which is the number of the national face mask team. It sold 750,000 pieces of fake masks and made an illegal profit of about NT\$5 million¹¹⁷. When COVID-19 outbreak, at the beginning of 2020, Ham Bin purchased boxed masks from the national face mask team manufacturer” Taiwan Pro-level papers” at first. After purchasing the machine and raw materials in May, it not only manufactured fake medical/surgical masks, but also copied the packaging boxes. Ham Bin Company purchased the mask machine could produce 4,800 pieces per hour. In the past two or three months, the counterfeit masks sold reached 750,000 pieces, and the profit was about 5 million¹¹⁸.

¹¹⁶ Po-Wen Hsiao et al., "Supplier Detained in Changhua for Allegedly Selling Counterfeit Masks," *Focus Taiwan* 2020.

¹¹⁷ Nian-Yu You and Xiao-Yi Zhang, "Fake Mit Mask and Disrupt Taiwan and Seize Underground Factories.," *China Times* 2020.

¹¹⁸ Mu-Chun Su, Po-Wen Hsiao, and Matthew Mazzetta, "Taipei Man Detained for Alleged Production, Sale of Counterfeit Masks," *Focus Taiwan* 2020.

Importing the mask from China: Team Power Healthcare Ltd.

On September 15th, Team Power Healthcare Ltd. (勤達醫療器材股份有限公司) imported the mask from China but labeled the mask from Malaysia. The police found about 60,000 masks in the factory which from China without obtaining an allowed permit. Team Power Healthcare Ltd. violated the Pharmaceutical Affairs Act and the Criminal Code. Team Power Healthcare Ltd. posted a new information of returning mask on its official website, saying that returned mask from China are accepted until October 7th¹¹⁹. The person in charge of Team Power Healthcare Ltd. paid NT\$800,000, and the associate paid NT\$400,000¹²⁰.

Two liar sold mask made in China: Chong Kuang Co., Ltd. and Income Instrument Co., Ltd.

On September 24th, Chong Kuang Co., Ltd. (崇光公司) imported non-medical masks from China, the mask box printed with medical masks, but inside the box are non-medical masks and sold the about 1 million pieces to medical equipment shops and mask distributors in various places: Income Instrument Co., Ltd. (英肯儀器公司), or online shop, and earned NT\$4 million. Chong Kuang Co., Ltd. imported 5.5 million masks from China in June, and collaborated with certified medical company in central Taiwan named Lih Yow (立佑企業公司), and to sign a fake business contract that allowed Chong Kuang Co., Ltd. to use the firm's brand on the packaging. However, Lih Yow said that contract was signed in 2018, and there were no issues with COVID-19 at the time. The owner of Chong Kuang Co., Ltd. committed the fraud, and policed considered the seriousness of this case, the owner would continue to be detained¹²¹.

¹¹⁹ Hung-Kuo Wang et al., "Supplier Investigated for Selling Falsely-Labeled Face Masks," *ibid*.

¹²⁰ Pei-Yao Shen and Hong-Guo Wang, "Team Power Healthcare Ltd. Involved Illegal Import Masks from China, and the Person in Charge Paid 800,000 Yuan in Guarantee.," *CNA* 2020.

¹²¹ Shi-Cheng Chen and Rui-Yan Cai, "Caught Another Fake Mask! Entering China's Counterfeit Masks Made a Huge Profit of 4 Million.," *Formosa Television* 2020.

At the same time, Chong Kuang Co., Ltd. sold some masks from China to Income instrument Co., Ltd. and the mask manufacturer printed on the label is Lih Yow. Income Instrument Co., Ltd. faked the mask box of the national face mask team, counterfeited the mask box of Chong Kuang Co., Ltd., and thought Chong Kuang Co., Ltd. is a legally manufactured medical manufacturer. The owner of Income Instrument Co., Ltd. released on bail of NT\$150,000, sold more than 200,000 masks and obtained an illegal profit of more than NT\$400,000¹²².

¹²² Mu-chun Su, Shwu-fen Wang, and Ko Lin, "Taichung Supplier Detained for Allegedly Selling Counterfeit Masks," *Focus Taiwan* 2020.

CONCLUSION

My research is about what happened to the face mask industry after COVID-19 outbreak in Taiwan. My data analysis showed that the six elements of diamond model are related to the research questions. Furthermore, there are four main findings in my research. First, the change in the external factors gave a developing opportunity to Taiwan surgical mask industry; Second, government in the external factors implied its control and influence on Taiwan surgical mask industry; Third, the related and supporting industries of the changing strategy showed a completed surgical mask industry chain in Taiwan; Fourth, firm strategy, structure and rivalry of the changing strategy demonstrated the market concentration of mask factories and the mask issues of illegal policy of surgical mask industry in Taiwan.

First, the change in the external factors gave a developing opportunity to Taiwan surgical mask industry. There are over 10 folds' growth of mask production, either the total amount of masks or the production line of masks. Taiwan's daily production of masks was about 1.88 million prior to the outbreak of COVID-19. The demand for masks due to the COVID-19 has risen and mask manufacturers have also increased their production to fulfill market demand to more than 20 million per day currently.

Second, government in the external factors implied its positive and negative influences on Taiwan surgical mask industry. Government asked to build up national face mask team and to ensure the mask production and distribution. Government policies also included the limiting export the mask, requisitioned the mask, the mask-ratioing plan, the price of mask, and transaction the mask. First, the government restricted the masks to be exported before June because fulfilling the domestic demand. Also, Taiwanese could send the masks for relatives in

other countries. Second, the government requisitioned masks every day for the mask-rationing plan from the mask manufactures which are the national face mask team. Then, the policy of mask-rationing plan is the public bought the equal quantity mask in every week. Third, government forbidden the mask factories sold the masks and rose the price of masks, so the government prohibited the sale of masks in the market before June. Owing to COVID-19, government need to content Taiwanese purchased large number of masks. The government cooperated with the national face mask team which built up by Taiwan machine tool & accessory builders' association. They spent 40 days to complete the production of 12 million masks and increase 92 mask production line. The production of masks in May also reached 20 million pieces.

Third, the related and supporting industries of the changing strategy showed a completed surgical mask industry chain in Taiwan. In this part mentioned the surgical mask industry chain who is the main upstream, midstream, and downstream; and related supporting industries. The main upstream is divided into the raw materials for masks: three-layer non-woven fabrics, and machines: mask machines; manufacturers of plastic nose clip and ear-loop for masks and the machine tool industry are related support industries. The main midstream is medical and biotech industry. The main mask manufacturer is medical equipment, and related manufacturers of masks are other textile and products manufacturing, cosmetics manufacturing, rubber products manufacturing, or paper products manufacturing...etc. The main downstream are the agents and the distributors of medical equipment, and the main places to sold mask are: hospitals, clinics, and pharmacies which are the medical-related ; the supermarkets and convenience stores are the related shops sold mask.

Forth, firm strategy, structure and rivalry of the changing strategy demonstrated the

market concentration of mask factories and the mask issues of illegal policy of surgical mask industry in Taiwan prior to and after COVID-19. In this part mentioned the market concentration of mask factories, and the mask issues of illegal policy. In the market concentration of mask factories mentioned that the CR4 of manufactories in table 3. According to the production line of mask from those factories that the four largest mask factories are Motex Healthcare Corporation(華新醫材股份有限公司), Kleaner Nicer Healthier(康那香企業股份有限公司), Universal Incorporation(恒大股份有限公司), Nanliu Enterprise CO., LTD (南六企業股份有限公司). The production volume of the four factories has reached 80%; most of the masks in Taiwan came from these four companies. In the mask issues of illegal policy mentioned that since the opening of the export and trading in June, more and more factories have been producing masks in private, counterfeit masks from the national face mask team, importing and selling fake masks. They want to get the profits and money by producing a large number of masks when the market demand still exists.

In conclusion, I utilized the competitiveness of the surgical mask industry from the six elements in the diamond model. Because of the COVID-19 outbreak, the surgical mask industry has shown its competitiveness advantages due to the collaboration between government and enterprises in Taiwan. The fantastic mask production is helping Taiwan, but also the rest of world. However, the market mechanism was intervened by the government so that we could see a few factories, which are seeing economic rents in a planned market, violated the policies related to masks by producing, selling, and importing the mask.

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