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APPLYING THE OODA AND PDCA MODELS IN ORDER TO ENHANCE THE AGILITY AND ADAPTABILITY OF GOVERNMENT TO WIN THE COVID-19 WAR: LESSONS LEARNED FROM TAIWAN

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ABSTRACT

Public administration has been challenged and tested by the novel coronavirus (COVID-19). Sluggish responses to the crisis have caused death, economic impacts, and unexpected consequences. This paper aimed to apply the models of Observe (O), Orient (O), Decide (D), and Act (A) (the so-called OODA loops) and Plan (P), Do (D), Check (C), and Act (A) (the so-called PDCA cycle) in order to increase the agility and adaptability of a government in combating COVID-19. This article carried out an analysis of Taiwan's anti-COVID-19 response as the case study. Various sources of information were cumulatively collected and analyzed so as to describe the situation. It found that Taiwan's response to the crisis suggests that an agile and adaptive approach can control COVID-19 and alleviate its impacts. Applying the mentioned models and operating three key operations, including technology-driven operations, public information and communication, and public participation, can help us understand why and how Taiwan can obtain its success. This paper will help guide governments in building their capacity resilience by taking lessons from Taiwan's successful measures and adjusting the key strategies to match the country's context and changes resulting from the contagious virus. With the present dramatically changing and uncertain world, governments need to confront unknown unknowns. Consistently searching for alternative approaches to manage uncertainties and complexities should be taken into account in preparation for future complex problems.

Keywords: Agile government; adaptive government; OODA; PDCA; COVID-19

1. INTRODUCTION

COVID-19 is a humanitarian disaster since it is a so-called black swan event-rare, unpredictable, and catastrophic (Moon, 2020; Stephens, 2020). The severe crisis is now not only COVID-19 itself but also its uninterrupted impacts despite its early stage. With a dramatic increase in the volatile, uncertain, complex, and

ambiguous situations surrounding this pandemic, governments must act urgently and employ stringent measures despite the uncertain conditions (Hoda, 2020). The Covid-19 pandemic highlights the difficulties of government crisis responses; countries are using different approaches based on their laws, culture, technological constraints, and experiences. As we can currently observe that while the situation in some countries is getting better, many countries are severely experiencing the crisis and its consequences, particularly showing critical flaws in their socio-economic systems. According to the scale, size, and speed of the enigmatic outbreak and its obvious effects, public administration is undeniably being tested (Moon, 2020). It is forcing governments to rethink and redesign their culture, values, and capabilities in terms of managing and containing the complexity of the pandemic issues and preparing for the uncertainty of the waves of the virus's impacts. Governments thus need to think both quickly and in the long-term in order to deconstruct the problem quickly.

The experiences from Taiwan's successful efforts to combat COVID-19 (Huang, 2020) suggest an "agile and adaptive approach" that can control the pandemic and its effects effectively without locking down its economy (Moon, 2020; Janssen and van der Voort, 2020; Hoda, 2020; Manantan, 2020). In using an agile and adaptive approach, a government needs to be proactively prepared to deal with changes all the time, not just in terms of increasing government capacity, but also increasing the "speed of effective response and management" (Moon, 2020; Janssen and van der Voort, 2020) in order to fit various situations for survival. Employing an agile and adaptive approach in making decisions and implementing measures ultimately determines the number of COVID-19 cases in countries. Following the status quo is not a choice. A country that is slow to catch up with COVID-19 and its effects will be faced with unexpected consequences. Based on the effective management of the country, it may be easy to find out what Taiwan has done effectively. But what is behind their story? Why has Taiwan handled the virus outbreak more effectively? What are their thinking and management processes?. Importantly, since being a government requires systematic procedures, how has Taiwan performed an agile and adaptive approach? This paper aims to discuss the agile and adaptive approach of Taiwan to the COVID-19 crisis and to explore the management methods that we can apply and support, as such approach to making decisions and responding to COVID-19. From this, some lessons can be learned from Taiwan for other countries that are facing and combating the outbreak.

2. WINNING THE COVID-19 WAR BY USING AN AGILE AND ADAPTIVE APPROACH

Different approaches have been proposed to fight COVID-19. According to Moon (2020), and Bethune and Korinek (2020), some countries use a herd immunity approach, which requires that about 60% of the population become immune from infection, or vaccination, such as the United Kingdom, Japan, Sweden, while some use an aggressive approach (i.e. lockdowns), such as China, Thailand, Norway, Denmark, and Finland. Some countries that use the first approach soon changed their track and went into nationwide lockdown because of worsening situations, such as the United Kingdom (O'Grady, 2020), Netherland, France, and Italy (Moon, 2020). However, even though the aggressive approach seems to be effective, it can cause severe and long-lasting economic contraction such as economic recession and joblessness. Different from the two approaches above, an alternative approach that seems more to be effective is the agile and adaptive approach that can help to control the pandemic and still maintain economic and societal benefits. One of the so-called "agile nations" (Hoda, 2020) that has pursued this approach effectively is Taiwan (Manantan, 2020; C.-L. Lee, 2020), which is now recognized as a successful model that other countries can learn from.

The concepts of agility and adaptability are quite similar, but they are not the same (Janssen and van der Voort, 2020). An agile government refers to "primarily working practices and methods that facilitate quick responses" (Janssen and van der Voort, 2020). The so-called agile approach first occurred in software engineering work and was later applied to organizational theory. Its defining hallmark rests on the capability to respond quickly to changes in situations while embracing constant evaluation or feedback. In contrast, adaptation is "an iterative process of creating changes in a system" (Omarovaa et al., 2012). An adaptive government, which originated from evolutionary theory and later was widely accepted by various sciences, refers to "the adaptive ability to deal with complex societal issues when facing a major, and disruptive change through involving many stakeholders, diverging interests and uncertainty about the actions to be taken" (Janssen and van der Voort, 2020). The adaptive approach focuses on the capacity to go along with changing situations. The ability to adapt to or fit a changing environment is necessary for survival. While agility is mainly related to the speed of the response within a given structure, adaptivity signifies systematic change throughout a government. However, both approaches focus on managing and responding to uncertainty and changes in situations. Agile and adaptive approaches work together and support each other. As Mergel et al. (2018) proposed their relationship, agile governance is an "organizational culture and methods of collaboration to

achieve a higher level of adaptiveness." A government can manage dynamic situations with a timely response and in ways that fit changes. The size, speed, and uncertainty of the COVID-19 outbreak have led to no single best way to cope with the complexity of the outbreak, but it requires the agile and adaptive management to respond to changes (Moon, 2020; Janssen and van der Voort, 2020; Stephens, 2020). Many counties have adopted agile and adaptive approaches within a surprisingly short time.

Taiwan, one of the best-accepted examples, has provided strong evidence on how an agile and adaptive approach can present concrete solutions in combating current and post-COVID-19 (Manantan, 2020; Huang, 2020). When dealing with the fast-changing situations of COVID-19 in order to effectively handle the epidemic, we need to begin early and do it immediately. After meticulously reviewing the management literature, it can be seen that the management models that subscribe to the idea of speed and a fitting response to changes are the OODA loop and PDCA models. These correspond to successful agile and adaptive approaches that call for speed and appropriate management, both in making decisions and in taking action. The OODA loop is useful for decision-makers and implementers so that they can respond to dynamic situations with agility and quickly (Naidoo, 2020). The idea of the OODA loop was proposed by Clayton (2020), Naidoo (2020), and Candelon et al. (2020) to apply to the crisis management for COVID-19 and to develop an adaptive approach in complex organizations (Omarovaa et al., 2012). In order to make quick responses to the crisis, the quality of decision-making may be compromised because of speed, but this model can provide a way to increase the quality of decisions. Further, for a government, this crisis requires systems thinking with a clear agenda regarding the outcomes (Stephens, 2020). The PDCA model is useful for governments to operate a systematically adapting governance process with quality process management and improvement. The rotation and relationship of the models will support the agile and adaptive approach to seek ways to constantly develop and solve problems. This paper focuses on identifying and applying these two models, which can support organizational agility and adaptation in dealing with the COVID-19 crisis. The proposed framework was drawn using examples from Taiwan. Moreover, the key operations in fighting against the COVID-19 crisis will be discussed.

3. THE INTEGRATION OF THE OODA AND PDCA MODELS

As mentioned above, Observe (O), Orient (O), Decide (D), and Act (A) or the OODA loop was developed by Colonel John Boyd, a legendary fighter pilot, strategist, and instructor in the United States Air Force in early 1993 (Boyd, 1995). It was developed from the situation when enemies used advanced aircraft and weapons. During that time, fighter pilots needed to observe the presence of enemies, orient their direction, decide whether to attack or avoid the threat, and then follow that decision by acting immediately. The loops consist of four main steps: observing the environment, orienting it in order to determine strategies, deciding on the proper strategy, and acting on it. Boyd viewed the entire "loops" as "an ongoing, multi-faceted cross-referencing process" to deal with rapid change (Boyd, 1995). The OODA loop is a chain of independent actions among actors, which can be enemies or opponents in a situation of conflict or competition, and their environment is the flow of information. The agility in Boyd's ideas is another aspect of conflict or competition. If we are faster than our opponents, we can change the situation and we can move forward faster in the direction that matches the real world, even when a situation is ambiguous, confusing, and rapidly changing. Decision-making takes place in repeated loops of OODA (Richards, 2004). Agile practitioners often refer to this model when faced with rapidly changing situations and when they must make decisions and act quickly (Omarovaa et al., 2012). With the situations of COVID-19, using the OODA Loop as a guiding principle allows for the continual adaption to action plans in order to beat COVID-19 (Naidoo, 2020; Candelon et al., 2020). For Taiwan, the government has realized that they are at war and regard COVID-19 as the inevitable enemy that Taiwan needs to overcome (L. Chen, 2020; Huang, 2020). In this article, the OODA model is used to explain how the Taiwanese government has responded to tackling this invisible enemy.

Plan (P), Do (D), Check (C), and Act (A) is an iterative and repetitive method for continuously improving processes or products. It was developed from the Deming wheel in 1951 (Moen and Norman, 2010). The cycle includes four steps: planning possible solutions, doing or testing a solution, checking the results, and acting on the standardized solution as well as returning to the planning step once the results are found to be unsatisfactory. The cycle focuses on preventing the recurrence of errors by establishing standards and by continually revising those standards. In Deming's eyes, the PDCA is an improvement process through tackling problems, finding solutions, reducing defects, and focusing on the process itself. In terms of COVID-19, it can be applied to crisis management. With the unpredictable conditions surrounding COVID-19, the PDCA can be applied in order to standardize nursing practices, improve the quality of health services, and increase patient survival from the severe coronavirus disease (Chen et al., 2020; Li et al., 2020; Wei et al., 2020). It enables real-time planning, execution, inspection, and improvement since it is not an end-to-end process. Additionally, the

PDCA has been proposed by the International Civil Aviation Organization (2020) to be an application for aviation safety risk management during the pandemic (International Civil Aviation Organization, 2020). At this moment, the PDCA, which may not be a new concept in terms of management studies, would seem more relevant to ensuring an effective approach for organizations to fight COVID-19, to controlling and continuously improving governmental process and services, and to planning a return to a new working normality.

For Taiwan, the government has established a series of prevention measures and quarantine systems based on the 2003 severe acute respiratory syndrome (SARS) experience. At that time, Taiwan faced the SARS crisis alone and suffered a great loss. The current measures are now seen as benefitting the approach to the COVID-19 pandemic (L. Chen, 2020). Joseph Wu, Taiwan's foreign minister, mentioned that "at the time Taiwan was hit very hard and then we started building up our capacity dealing with a pandemic like this" (CNN, 2020). A series of measures have been prepared for the worst situation. Chen, the health minister, warned that people should not be complacent. He stated that "local transmission is inevitable. We must make preparations as though we are facing a more serious situation" (Kyodo, 2020). The purpose of a series of COVID-19 measures in Taiwan is to make the best preparations for the worst, although some measures may not be implemented yet, for example, a lockdown measure. Although Taiwan has avoided lockdown measures, the government has still prepared such measures for the worst situations. Presently, these measures have not been implemented but are planned to be instituted (Taiwan News, 2020). Preparation is a must in dealing with the pandemic based on the situation. When a situation of a crisis changes, measures will be changed accordingly. Taiwan has a tradition of making the best preparations for any changing situations.

As mentioned, the PDCA is not an end-to-end process but is a continuous improvement cycle. The Taiwanese government has a series of prevention measures and virus control systems, and the government has implemented appropriate measures and has carried out simulation exercises for some measures on a small scale. The government has also monitored and explored the results to learn and improve their measures. Then, any inappropriate measure will be adjusted, improved, or even abandoned so as to be able to implement the appropriate measure on a large scale. The cycle of the PDCA will be run again and again until the problems have been solved. In addition, as epidemic control must take into account the changing circumstances, the ODDA loop model, which is a model of decision-making in an urgent situation, is included to describe Taiwan's management in solving and controlling the epidemic together with the PDCA model. In order to get ahead of the COVID-19 crisis, using the OODA loops and PDCA cycle will help us make quick decisions and congruous responses with continuous quality improvement. Taiwan has presented what is possible when observation and action are minimized, for example. By applying the two models, a government will be able to respond quickly and continuously to changes in the rapidly and severely changing environment. The frequent iterations of the cycles will increase the learning rate, which is the basis for preparing for rapid changes and for taking quick actions. Figure 1 presents the integration of the two models to support the agile and adaptive approach. Each phase will be discussed by providing the experiences from Taiwan as the example.

During the first phase, "Observe (O)" is the essential ability to find out something new and evidence of crisis occurrence in order to raise questions on what is happening, and to continuously track changing occurrences in order to adjust the reference scenario as needed (Candelon et al., 2020). What is going on around and within a country is noticed in this phase. Regarding Taiwan, Dr. Lo Yi-chun, an infectious disease expert and the deputy director-general of Taiwan's Centers for Disease Control (TCDC) interviewed by TIME, stated that Taiwan began to know about the occurrence of the virus after his coworkers working in the media monitoring unit found and traced social media posts about an unknown cause of pneumonia in Wuhan. He was alerted by his colleagues at 6:30 a.m. on December 31, 2019.

Later, the original posts were quickly gone but screenshots had been still discovered. Dr. Lo found something suspects from the doctors' messages and reports of a laboratory that they had found patients with a mysterious type of pneumonia in Wuhan (Watt, 2020). On that day, he and his colleagues immediately asked for more information from Beijing and the World Health Organization (WHO) based on the International Health Regulations mechanism. At around 1:30 p.m. on the same day, 27 cases of the mysterious pneumonia were announced by the Wuhan Municipal Health Commission. These cases were related to the seafood market. Wuhan's investigations stated that there was "no clear human-to-human transmission." Afterward, the WHO reported the existence of an unknown cause of pneumonia in Wuhan on December 31, 2019. Taiwan did not wait to have clear evidence that the disease had human-to-human transmission. According to Joseph Wu, Foreign Minister interviewed by TIME (Watt, 2020), "we were not able to get satisfactory answers either from the WHO or from the Chinese CDC, and we got nervous and we started doing our preparation." They immediately stepped up precautions on the same day. Taiwan recognized the crisis early since they had a bad experience with a severe acute respiratory syndrome (SARS) outbreak in 2003 (Wang et al., 2020). The island thus began operating health screening and implementing strict surveillance for all flights for passengers traveling from Wuhan beginning December 31, 2019.

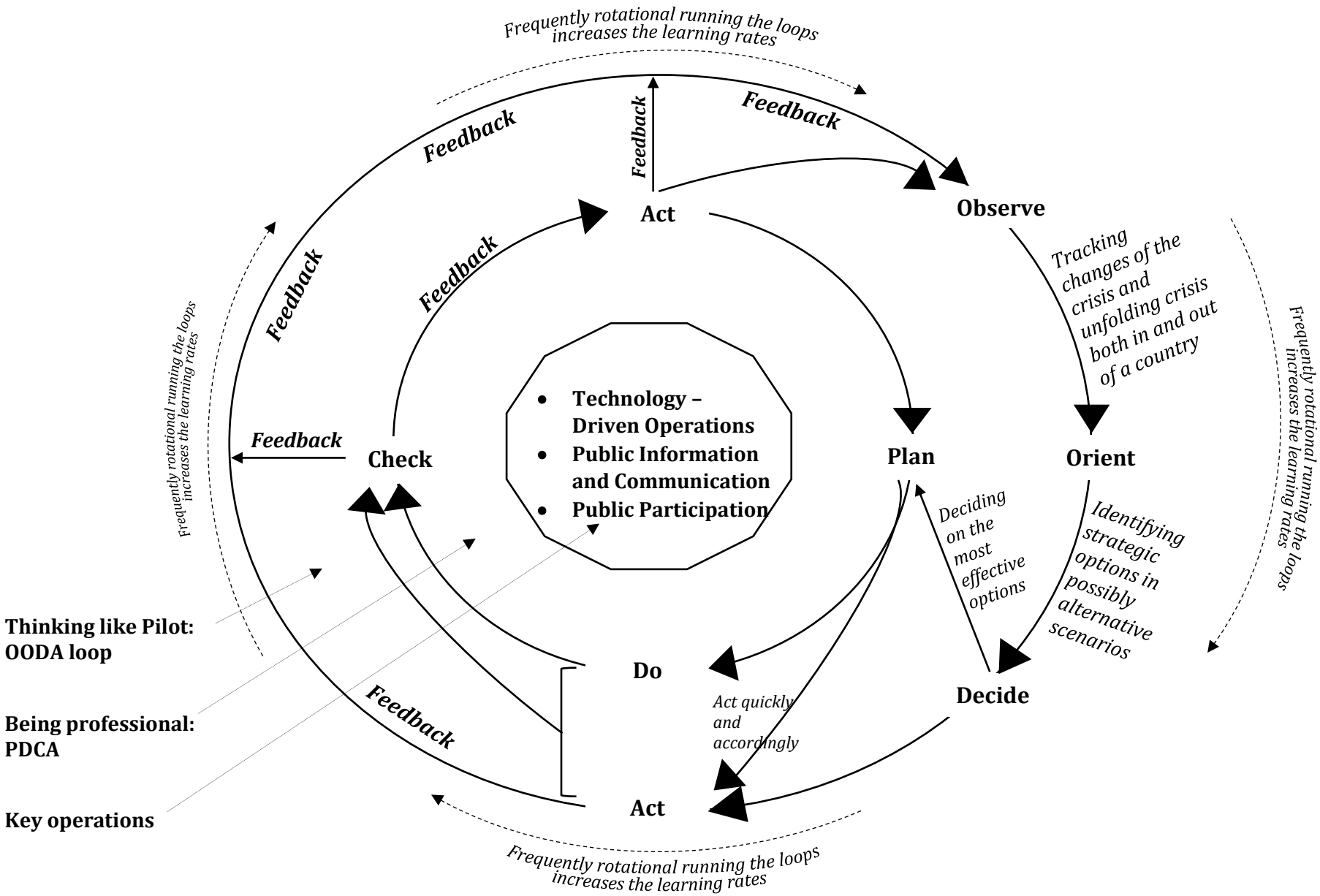


Figure 1: The Integration of the Two Models to Support the Agile and Adaptive Approach in Combating COVID-19

From January 13 to 15, 2020, health experts from Taiwan, Hong Kong, and Macau visited Wuhan and discovered a family cluster that appeared to indicate the human-to-human transmission of the virus (Watt, 2020). They warned the Chinese government and the WHO. After a few days, a top expert of the Chinese government confirmed the spread between humans can occur. Also, the WHO stated on January 19, 2020, that "human-to-human transmission was taking place in Wuhan" (World Health Organization, 2020c). Taiwan's immediate actions showed that they were aware of the worst cases that could occur although the Chinese government and the WHO failed to perceive Taiwan's early warning, as stated by Taiwan's Vice President Chen Chien-jen, an epidemiologist-turned-politician (Watt, 2020). Taiwan is still self-reliant in seeking information about diseases and solutions to problems. Lo Yi-chun, the deputy director-general of TCDC and interviewed by TIME, stated that "by not having full membership status, Taiwan kept thinking, well, we must have missed important information. That actually gave us that urgency and anxiety that we should be protecting ourselves much better by searching all the necessary social media … and not just rely on WHO's goodwill or other countries' goodwill to share information with us" (Watt, 2020).

Observation is a divergent activity that should be broad and profound by listing diverse and unrelated observations. Looking backward on information helps the government determines the path of the crisis and understands the underlying factors that may cause the crisis in the future. Further, looking forward - warning indicators helps a government to detect weak signals in a changing environment (Candelon et al., 2020). Taiwan has proactively continued to observe and sought for new relevant information on COVID-19 and its effects. In order to be able to manage relevant forward information, Taiwan required tourists to fill out an online health declaration form before departure or upon arrival so Taiwan could separate tourists according to the risk of infection at immigration (Y. N. Lee, 2020). In general, there are conditions for the analysis of data for our decisions, or we wait for more information before making a decision. However, during this crisis, time was at a premium. Not making decisions can also be considered an act. We can learn from other countries that have the highest number of COVID-19 infections, such as Italy, the United States, France, the United Kingdom, or Germany, for example, that the crisis may be more intense if we do not act immediately on the situation. However, a quick response needs to be balanced with long-term planning and impacts. During the crisis of COVID-19, safety and survival of life are the first priorities, but a government must be aware of both the medium and long-term effects of COVID-19 as well. In particular, the epidemic has exposed inequality and many hidden issues in both public health and socio-economic situation. Support and remedies for growth as well as solutions for such issues after the crisis must be actively prepared (Naidoo, 2020).

The phase of "Orient (O)" refers to the identification of strategic options in possible alternative scenarios. Without the orientation phrase, Boyd indicated that all observations were meaningless. Orientation represents the "images, views, or impressions of the world" (Boyd, 1987) that are shaped by a complex set of factors. He viewed the detailed components of orientation as "a complex set of filters and shaping mechanisms of genetic heritage, cultural predispositions, personal experience, and knowledge" (Boyd, 1995). We act by following how we perceive the world, not how it is. According to Candelon et al. (2020), this phase is especially crucial since a government must be aware of weak spots in its systems, implementations, plans, and contexts ahead of time. A government needs to think carefully about possible scenarios, including extreme ones because strategic responses can be followed by those possibly defined scenarios. In this phase, the precedent of SARS 2003 in Taiwan fueled their skepticism. The island badly suffered during the SARS outbreak because the Chinese authorities had tried to conceal information. The painful lessons caused the Taiwan government to jump into action and their citizens were highly alerted early once the unknown pneumonia occurred (Watt, 2020). At the end of 2019, when there were indications of a new type of respiratory illness, Taiwan identified its strategic options: beginning to monitor incoming passengers from Wuhan, tracing, quarantining, and operating related preventive measures so as to protect against potentially infected passengers and crew departing from Wuhan (C.-L. Lee, 2020). In January, travel restrictions were introduced, and quarantine protocols were established for high-risk passengers and crew (Ing-Wen, 2020). Clear responsibility was assigned throughout the government in terms of prevention and containment including on-ground responses and detection, health treatment, and quarantines.

Although we cannot have insights into what scenarios the country made, one thing that we can see quite clearly in Taiwan is its quick response and action in the worst-case scenario if the disease could be transmitted human-to-human. However, there was a framework of relevant scenarios regarding the COVID-19 crisis introduced by the Boston Consulting Group (BCG) that we can learn from, including four scenarios (Candelon et al., 2020). For each scenario, indicator examples of each that should be regularly updated and monitored are presented in Table 1. First, the public health situation should be assessed during the period of severity and geographic spread of the outbreak through employing data metrics, such as active case reports, patient cases in intensive care, and the current availability of treatment. For Taiwan, the government established a national testing network by including testing facilities in the northern, central, southern, and

eastern parts of the island. Their testing capacity is currently up to 7,166 specimens per day through using test kits that show the result within 4-6 hours. In addition, although there are currently 53 detection institutions, the government continues to expand its viral detection capacity. More importantly, Taiwan has speeded up the research and development of test reagents and rapid test kits as well (Ministry of Health and Welfare, 2020).

Table 1: Indicator Examples of COVID-19 Crisis Scenarios

Scenarios	Early-warning indicators	Macro indicators	Underlying factors
Public health	• Disease trajectory in other countries	• Active cases • Daily increase • Patients in intensive-care units	• % of population aged 65+ • Doctor/health workers/ hospital beds per 10,000 people • Adult mortality rate
Macroeconomic	• % recovery in airline flights • % recovery in electricity use • % recovery in traffic congestion • % of work resumed	• Stock market trends in the country • Quarterly GDP growth vs 2019 • Unemployment rate • Government financial support • Bankruptcies	• Pre-crisis GDP • Public debt as % of GDP • % of workers in small and medium-sized enterprises • % of informal economy
Business–specific demand	• Top product categories in searching and selling online • Top online search terms • Web traffic by e-retailer and product category • Social media discussion about products • High demands for medical supply – masks.	• Monthly sales • Market share • Correlation of demand with GDP	
Government measures	• (in case of lockdown) Estimated lockdown end date	• Lockdown status • % of population under lockdown • % of factories closed by order • % of mandated point-of-sale closures	

Alternative Strategies

Source: Adapted from Candelon et al. (2020)

Orientation is essential since the ways we observe, decide, and act are shaped by it. In the unpredictable context of the COVID-19 crisis, developing scenarios may tend to be lost in unnecessary details and wrong precision. Fundamentally, a government may use the above framework as a guideline. Importantly, possible scenarios should be updated frequently by checking various real-time indicators (Candelon et al., 2020). Scenarios should be considered together with indicators' assumptions that determine the evolution of the crisis. Following such scenarios, strategic responses should be driven by possible scenarios. Thinking about strategies or measures to combat COVID-19 may mean that the measures may slow the spread of the contagious virus, but will drastically reduce economic activities. Based upon the possible scenarios, the relief packages of alternative strategies of health, economic, and social aspects have to be built and introduced based on signs, reliable evidence, and science in time. For example, supportive measures are required for (i) those that have been infected, (ii) those that have health screenings, (iii) those that are struggling financially in business, or (iv) those that have lost their jobs (Hoda, 2020). The built scenarios will be used as the basis for decision-making.

The following phase is to "Decide (D)." This refers to making a decision on the most effective strategies. Once the facts and scenarios are listed, decisions will be made. Decisions are a convergent activity among what we observe, orientate, and a few key decision-points that may be the patterns of what we see or the hypothesis we initiate from the orientation phase. A decision-maker needs to ask him/herself whether a decision needs to be made now, or if decisions should be prioritized. If pushing decisions to the future, the decision-maker needs to return to the first and second phase in order to obtain new and current information and to generate a new orientation. Taiwan made a quick decision with the most effective options. Further, since they acknowledged the pandemic, they also sent fact-finding teams including health experts, to Wuhan in order to investigate what was taking place. Once the team returned and found human-to-human transmission, they decided to jump into careful action monitoring passengers arriving from Wuhan and taking the history of people traveling from Wuhan (Watt, 2020). Regarding the information released out of China, Taiwan is always alert and vigilant. Dr. Lo, interviewed by TIME, stated that "that helped us to safeguard our people from being affected by the first wave of the epidemic…" (Watt, 2020). The decision of the Taiwanese government was wisely made based upon the context. For example, to decide whether to carry out mass testing, Taiwan learned that the efficacy of mass testing was not as high as other countries with large-scale infected communities. The first priority implemented by Taiwan was to block and prevent the appearance of community infection. A scrupulous pandemic investigation makes it possible to accurately identify each case that needs to be tested (Ministry of Health and Welfare, 2020). In addition, Taiwan made early decisions on other measures such as wearing a mask, closing borders, banning exports of face masks, and increasing mask manufacturing domestically. These efforts were generated by the top levels of the Taiwanese government.

The fourth phase is "Plan (P)." After making a decision, selected strategies need to be more identified and elaborated on step by step. In addition, the predicted results of each strategy should be indicated. More importantly, a government needs to acknowledge that the COVID-19 crisis and the measures that they take will have not only short-term impacts but also long-lasting impacts. A government needs to think forwardly about both short-term and long-term impacts. Taiwan proactively thought about and developed its plans even before they discovered the first infected person on January 21, 2020 (Ing-Wen, 2020). Anti-COVID-19 plans were formulated by the Taiwan Centers for Disease Control (TCDC) based on Taiwan's experiences with past epidemics, including SARS, the Middle East Respiratory Syndrome (MERS), Ebola, Avian influenza A (H7N9), and Zika outbreaks (Sheng, 2020). The plans consist of two phases including "preparedness" and "contingency planning" depending on the epidemic situations of the country. The "preparedness" phase was activated when suspected cases were been reported in neighboring countries. All of the preparedness strategies are presented in Table 2. Taiwan has carried out these measures in order to control and protect itself against potentially infected flights departing from Wuhan beginning on December 31, 2019 (Ing-Wen, 2020). The "contingency planning" phrase is further activated during an ongoing and spreading epidemic. It includes nine strategies as presented in Table 2.

To implement the anti-COVID-19 plans, the Central Epidemic Command Center (CECC) was established on January 20, 2020, to take responsibility for dealing with COVID-19. The center issued more than 120 measures during the 5 weeks after its establishment, averaging 3-4 measures per day. Later, the CECC announced anti-epidemic measures which included (i) entry control (i.e. traveling from China was prohibited only business travel from Hong Kong and Macau was exempted); (ii) exit control (i.e. all exits were prohibited except under exceptional circumstances); (iii) quarantine measures (i.e. four measures: independent health management, at home quarantine, at home isolation, and mandatory isolation); (iv) medical supply control (i.e. prohibiting the export of masks, increasing mask manufacturing, allocating sufficient masks to people, and managing nearly 1,000 available rooms for negative pressure isolation); and (v) social distancing (i.e. wearing a mask was a must in public, and taxi in Taiwan could refuse to carry passengers if they did not wear a mask, and clubs and ballrooms were suspended) (C.-L. Lee, 2020). In addition, for alleviating the impacts of COVID-19, the Taiwanese government introduced many measures for such purposes at the end of March, including (i) several supportive tax measures (i.e. deferral of tax payments for affected companies and individuals, and corporate income tax reduced by 200% for salary expenses); (ii) support measures for employment (i.e. subsidy training programs, salaries, and corporate process safety and health equipment); (iii) stimulus measures for the economy (i.e. deferral of principal repayments or extended loan for companies and individuals, deferral of card payments without penalty and interest for individuals); and (iv) control measures for customs (i.e. prohibiting the export of masks, controlling the export of fever thermometers, and temporarily adjusting the importing of masks and undenatured alcohol) (KPMG International, 2020). Table 2 presents the major measures of Taiwan's government in fighting COVID-19 and its impacts. However, although Taiwan made numerous plans, those plans were adjusted and improved in order to fit new situations.

Table 2: Taiwan's Measures in Responding to the COVID-19 Crisis

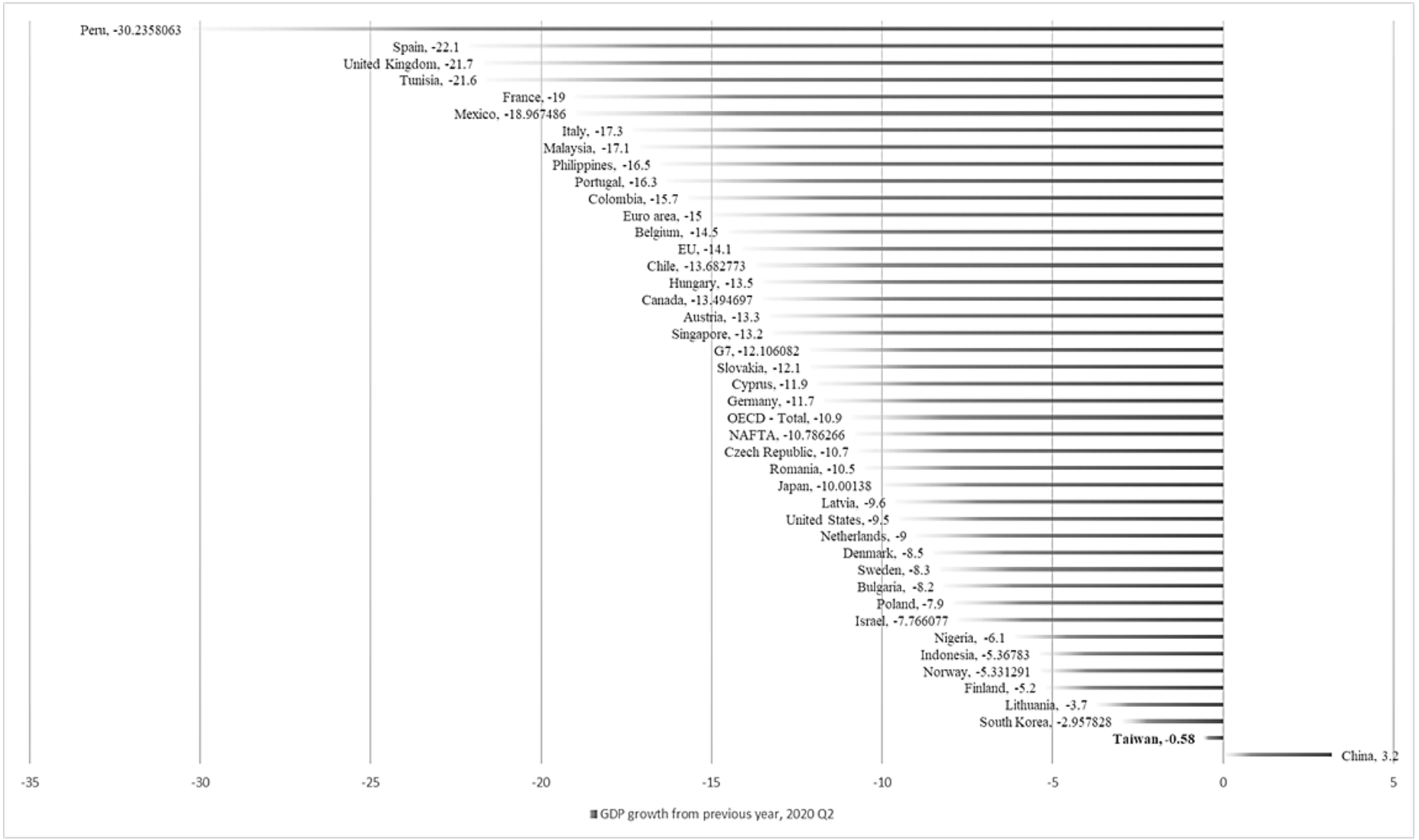
Phase I	**Phase II**		
Preparedness	**Contingency plan**	**Anti COVID-19 measures**	(i) entry control
(i) continuous epidemiological surveillance and risk assessment			(ii) exit control
(ii) implementation of border quarantines	(ii) tightening border quarantines		(iii) quarantine measures
(iii) inventory checking of medical supplies and equipment	(iii) perfecting the Healthcare system		(iv) medical supply control
(iv) strengthening risk communication	(iv) allocation and management of medical supplies and equipment		(v) social distancing
(v) enhance testing and diagnostic capabilities			
	(vi) developing international collaboration	**Alleviating COVID-19's impacts**	(i) Tax measures
	(vii) epidemiological investigation		(ii) Employment measures
	(viii) community-based epidemic prevention		(iii) Economic stimulus measure
	(ix) constant risk communication		(iv) Customs measures

Source: Adapted from Sheng (2020), C.-L. Lee (2020) and KPMG International (2020)

At present, the COVID crisis is continuing around the world amid 19 vaccination efforts, and Taiwan is still working on a number of virus control measures. Although the results of each measure have not yet been evaluated in terms of how effective they are, it cannot be denied that Taiwan's management of the COVID 19 solution has been overall successful and recognized around the world. Currently, as a result of implementing the virus control measures, 639 cases of the infection have been reported in Taiwan and only 7 deaths as of November 28, 2020 (Johns Hopkins University, 2020). In terms of economic impacts, careful planning of economic stimulus and remediation measures helps to build the confidence of both domestic and foreign investors to continue their business activities. Likewise, Taiwan supports its people to normally consume. With its proper economic measures, Taiwan is one of the countries where the virus has slowed economic growth (GDP) at only -0.58 percent in the second quarter of 2020, lower than in the same period in 2019, and very little compared to many countries (Eurostat et al., 2020), as presented in Figure 2. However, the evaluation of each measure should be further studied.

The fifth phase is "quickly and accordingly act." "Act (A)" from the OODA loop and "Do (D)" from the PDCA here could take place during the same phase. Basically, Act (A) in the OODA loop refers to the testing of selected decisions by an implementation (Boyd, 1995). According to Boyd (1995), "the results of which produced more observations that were then fed back and compared to expected observations. Actions either prove or disprove the validity of the decision." In this sense, the meaning of "Act" is similar to "Do (D)" in the PDCA, which refers to carrying out the plan in a trial on a small scale and measuring the results of the trial. The actions from both the OODA and PDCA should be performed quickly and decisively. For example, in order to decide whether to carry out mass testing, the CECC analyzed community prevalence rates, and the sensitivity and specificity of the test methods, the analysis of cost-benefits, and other scientific evidence in order to conduct precise strategic tests for effective disease prevention and control (Ministry of Health and Welfare, 2020). Moreover, the Taiwanese government has prepared a series of measures for worst cases, although its situation has not yet reached that point. The government has launched a simulation exercise, for example, a lockdown measure. The New Taipei city, a municipality surrounding Taiwan's capital, launched a lockdown simulation of 21 days in order to prepare for a worsening-case situation that may arise from the country's epidemic (Taiwan News, 2020). Hou You-yi, the city mayor, mentioned that 21 days consisted of a 14 day virus incubation period and 7 days for people to recover from the infection. This simulation exercise is a tool to improve preparedness for the worst situations of the pandemic, and it offers an opportunity to explore and identify gaps and weaknesses in resource allocation, planning, and procedures.Specific roles and responsibilities are also clarified for responsible organizations. Furthermore, it provides an opportunity to train staff to be ready to respond to the worst situations (European Centre for Disease Prevention and Control, 2014).

Figure 2: The Percentage Decline of GDP in the Second Quarter of 2020



Source: Eurostat, OECD, and individual statistics agencies. (2020)
Note: China gained positive growth in Q2 after a fall of 6.8% in Q1.

Additionally, in order to carry out such responses, the management of the current crisis in Taiwan regarding COVID-19 depends on the democratic process of the legislature. No public agencies have been shut down; the Parliament and courts are still working well despite the health crisis. Online meetings will be considered when necessary (C.-L. Lee, 2020). In order to deconstruct and respond to the complex problem quickly, the TCDC announced the activation of the CEEC for Severe Special Infectious Pneumonia on January 20, 2020, three days before the Wuhan lockdown on January 23 (Taiwan Centers for Disease Control (TCDC), 2020b) in a timely manner in order to formulate policies integrating resources from various sources, coordinating across ministries and government agencies, coordinating responses to outbreaks from all private and social sectors, and managing epidemic prevention measures, such as establishing quarantine protocols for high-risk travelers (Watt, 2020; Manantan, 2020; Huang, 2020). With the proactive decision of the Taiwan government, the CECC as a team responding to the disease was at first a level 3 governmental unit and then was upgraded to level 2 on January 23, and to level 1 on February 27. This indicates that the prevention against COVID-19 was a significant mission. Being the first-level governmental unit, the CECC has been able to integrate resources from various ministries efficiently and to invest heavily in controlling the spread of the disease (C.-L. Lee, 2020). This pointed to the comprehensive power of the CECC under the law to be implemented in a planned and coordinated manner. Proactive prevention strategies and measures have been adopted by the CECC. This can be explained in terms of the organization and its functions as a first-level organization, which results in the centralization of authority in the fight against the epidemic. There is a clear tendency for centralization and local authorities to be very limited. The consultation meetings of cross-agency command centers and experts have been held under this power.

The sixth phase is “Checking (C).” According to the idea of the PDCA, “Checking” refers to analyzing the results of the trial or what has been implemented, verifying what has improved in terms of processes or results, and considering implementing it on a broader scale. Continuously checking measures and analysis of the success of Covid-19 management needs to be carried out and predefined criteria for this checking should be included. Taiwan intends to regularly monitor its operations by making changes based on surrounding situations, listening to expert’s opinions, analyzing data, etc. For example, the CECC continually checks and updates the “Recommendations for COVID-19 Case Definition, Specimen Collection, and Diagnostic Tests” in order to ensure that national testing criteria are correlated with the most up-to-date epidemiological investigations. Moreover, physicians and experts are asked to immediately report cases that cannot be excluded for COVID-19 for testing (Ministry of Health and Welfare, 2020). Another example is entry control and medical supply control, which have been implemented and adapted to fit the existing environment (C.-L. Lee, 2020). Since the end of 2019, Taiwan has carried out the checking and monitoring of people from Wuhan. Then, expanding the target population with a history of travel to China was recommended by experts’ opinions during the expert consultation meeting held by the CECC. All passengers from Wuhan and China have been checked for both severe special infectious pneumonia and all pneumonia case. This broadens the surveillance scope and identifies suspected cases (Taiwan Centers for Disease Control (TCDC), 2020b). Further, the COVID-19 crisis is spreading around the world, and Taiwan began to prohibit foreigners from entering the country and did not allow any transit airline passengers to enter the country (Taiwan Centers for Disease Control (TCDC), 2020c). Figure 3 shows the timeline of the adaptive entry control operations.

Similar to medical supply control, from January 13 to 15, 2020, health experts from Taiwan, Hong Kong, and Macau visited Wuhan and discovered a family cluster that appeared to indicate “human-to-human transmission” of the contagious virus (Watt, 2020). However, on January 14, 2020, the WHO tweeted that “there was no clear evidence of human-to-human transmission.” Then, on January 19, 2020, the WHO reported: “there was evidence of limited human-to-human transmission” (World Health Organization, 2020c). On January 20, 2020, a top Chinese pulmonologist clearly confirmed that the virus was capable of spreading between people (Watt, 2020). After two days, the WHO definitely affirmed the announcement.

After this information was affirmed, although Taiwan had put in place inventory checking of medical supplies and equipment, they quickly made the decision and quickly took action to prohibit the export of N95 masks and surgical masks beginning on January 24, 2020 (C.-L. Lee, 2020), a day after Wuhan was locked down. Taiwan was able to get ahead of a possible mask shortage (Farr and Gao, 2020). In order to prevent panic buying, the government closely monitored the market and controlled the distribution of masks. Moreover, the

Ministry of Economic Affairs coordinated with private medical-supply companies so as to increase production capacity for masks and surgical masks on January 30, 2020 (C.-L. Lee, 2020). In order to effectively distribute masks, a distributing rationed mask system was invented and supported by the cooperation among technology experts, pharmacies, and convenience stores. Since February 6, 2020, masks have been available for hospitals and the public at a fair price. The joint efforts of all public and private sectors in partnership were recognized as "Team Taiwan," which enabled the country to manage the situation and to donate necessary supplies to other seriously affected countries (Ing-Wen, 2020). The timeline of the adaptive medical supply control is presented in Figure 3.

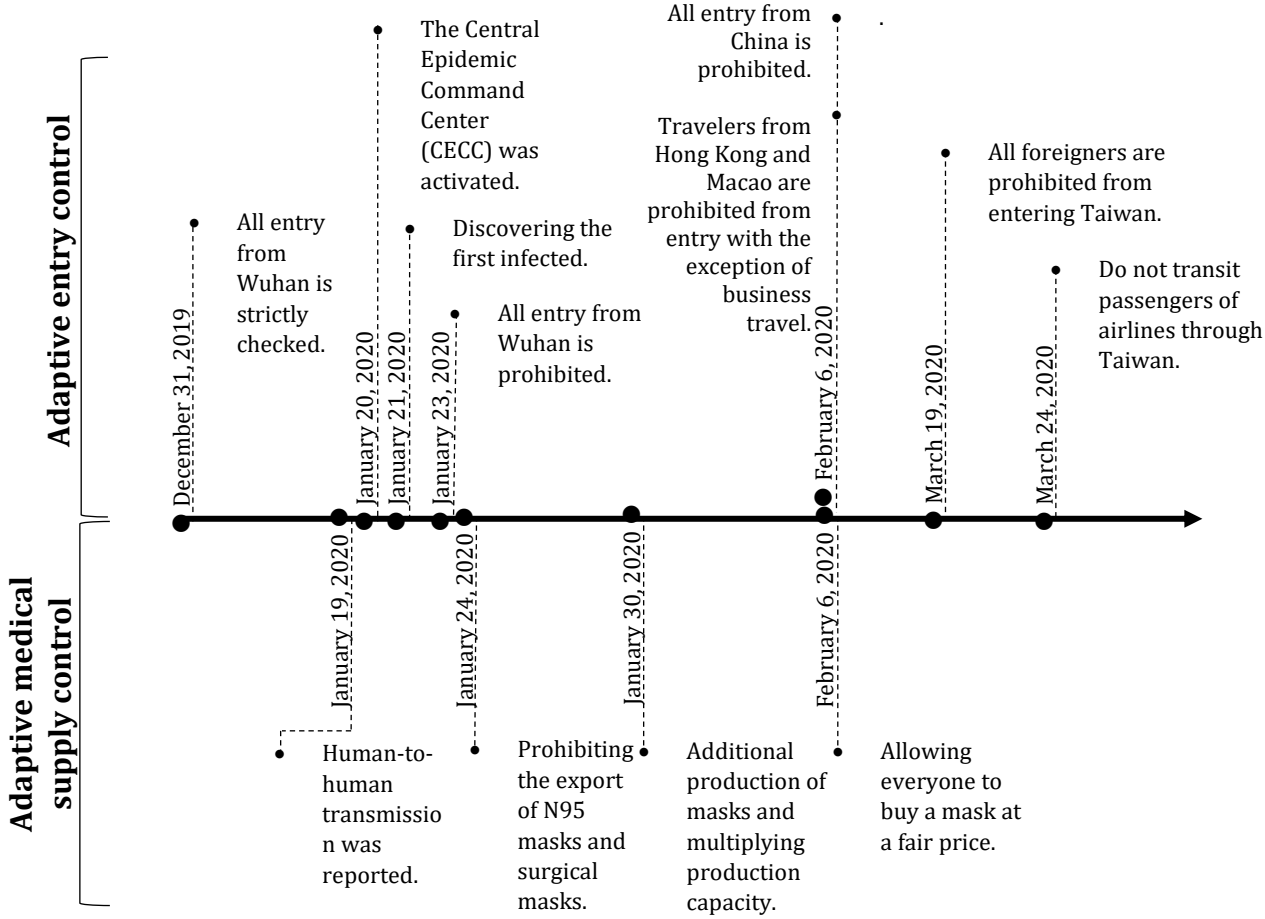


Figure 3: The Adaptive Entry Control and Medical Supply Control Implemented by Taiwan

The following phase is "Act (A)." This stage of the PDCA refers to implementing the changes that have been verified and improved, updating the operating procedures, and ensuring that the new measures are working. Examples are presented in Figure 3. After the checking phase, where the measures should be matched with the existing situation, this phase should also be carried out quickly. For example, the anti-COVID-19 measures of Taiwan that have been implemented since the end of 2019 have been improved to fit the current situation. After discovering the first infected person on January 21, 2020, Taiwan has carried out a rigorous investigation in order to track the history of travel and contact of all suspected patients. This strict escalation helped to isolate and contain the contagious disease within the infected community before a mass outbreak would expand to other areas. During this situation, all private and social sectors, such as businesses, apartments, buildings, and so on, began body temperature checking and monitoring, and disinfecting within their areas following the government's suggestions. Additionally, the government has supplementarily disinfected in public spaces (Ing-Wen, 2020). It has also implemented what was planned and has re-strategized the plans to fit the new situations. Continuous improvement has been achieved by improving weaknesses and strengthening the strengths identified by means of investigation, emergency operations, and simulations.

While implementing the phases "Do or Act," "Check," and "Act" above, "Feedback" needs to be perceived invariably since it represents practical information results that are essential to the next rotation of

the loops or cycles. Boyd later recognized the importance of the feedback that should be included in the loops. Feedback loops demonstrate the ability of circuits or systems to use their output as inputs as part of the adaptive process (Omarovaa et al., 2012). The OODA and PDCA should be repeated as often as needed with new information or observations from the results of previous actions. Uncertainty should be admitted so that any new input will not get lost in outdated assumptions. Current and accurate information needs to be kept. Additionally, a government needs to be prepared to be wrong and to make adjustments. Being agile and adaptive, it is possible to acknowledge when new information comes along. In this particular pandemic, the COVID-19 crisis is like a chess game that changes randomly and fluctuates around the board (Clayton, 2020). Tightening the OODA Loop and PDCA would support the making of impactful decisions more rapidly. The available information and new information should be processed, and the pros and cons of alternatives should also be indicated and weighed. The interventions should be prudent, effective, and acceptable since there are no best and worst measures during the crisis.

4. KEY OPERATIONS: TECHNOLOGY-DRIVEN OPERATIONS, PUBLIC INFORMATION AND COMMUNICATION, AND PUBLIC PARTICIPATION

One of the best healthcare systems in the world is in Taiwan, with strong research capabilities and transparent information actively shared between key governmental agencies (Ing-Wen, 2020). Taiwan's response to the containment of the COVID-19 virus was not only quick but was also highly efficient and effectively supported by allocating $2 billion to all measures of anti-COVID-19 and impact alleviation (Kyodo, 2020). However, although Taiwan is recognized as a successful country in tackling COVID-19, there are various assumptions about the factors that may play a role in the success of the outbreak control, such as geographic features. Although there is still no empirical evidence to prove whether they are the factors affecting the success or failure of the epidemic response, this issue should be discussed as follows.

Being an island may be noticed as one of the factors that make it easier for Taiwan to manage and control the spread of COVID-19. However, there are still many other islands that continue to face and suffer from this epidemic. For example, Australia, which is an island and has a current population of 25,623,236 as of November 28, 2020 (Worldmeter, 2020a), has similar conditions to those in Taiwan, which is also an island and has a current population of 23,834,487 as of November 28, 2020 (Worldmeter, 2020b). With these similar conditions, while Australia has 27,874 confirmed cases of infection and 907 deaths, Taiwan has 639 cases and 7 deaths as of November 28, 2020 (Johns Hopkins University, 2020). Moreover, if being an island is like a control variable in handling COVID-19, border closure and lockdown measures should also be like control variables since they can refer to mandatory geographic quarantines and mandatory recommendations, such as prohibiting citizens from leaving their country, blocking foreigners from anywhere from entering the country, restrictions on traveling to other regional areas, place closures (i.e. schools, universities, shopping malls, restaurants, etc.), and restrictions on people gathering. Considering these factors, why do so many countries or island nations still face epidemic control problems? In the case of Taiwan, the island is one of the most at-risk areas for transmission from China, yet Taiwan has avoided locking down the country. In particular, despite the spread of the disease, Taiwan has still allowed investors and travelers from other countries to enter the country on the condition that passengers have to strictly adhere to Taiwan's measures. Within the country, Taiwan citizens are also allowed to live normally under prevention measures. If there is any community area at risk of infection, it is declared as a disease control area without announcing a lockdown.

Policies and action measures are beyond border control or lockdown since Taiwan realizes that they are not sufficient. The question is not what other countries are doing wrong, but how Taiwan has kept control of the virus with good results. Collaboration and joint efforts by medical professionals, government agencies, the private sector, experts in various fields, and the public as a whole have created a national defense against the virus. Reviewing what Taiwan has done well suggests three main operations combating COVID-19.

4.1 Technology-driven operations

The rapid spread and mystery of the pandemic are challenging, but it is unlocking the ability of humans to use technology to solve immediate problems. Combating COVID-19 has been made possible by integrating technology and data in Taiwan. Fundamentally, the health care system in Taiwan is digitized; all Taiwanese citizens have a health insurance card with a specific ID that all doctors and hospitals can use to access online medical records across the island's major medical centers in Taipei, Kaohsiung, Taichung, and other cities (Manantan, 2020; Taiwan External Trade Development Council (TAITRA), 2020a). In turn, the eight largest hospitals in Taiwan have shared information and test results diligently. This broad collaborative effort has enabled Taiwan to find better ways to fight viruses (Taiwan External Trade Development Council (TAITRA), 2020a). However, although Taiwan is fundamentally an open society (Huang, 2020), accessing and sharing data

are implemented under strict compliance with the Personal Data Protection Act (Manantan, 2020). During the COVID-19 crisis, transparency and authority are positively perceived in appealing to public support (Huang, 2020). With this well-implemented system, Taiwan has been capable of combating COVID-19 by utilizing technology to drive operations for such purposes that can be mainly divided into (i) entry and quarantine control, and (ii) risky areas and medical supply alert.

(i) Entry and quarantine control. Taiwan strictly requires that travelers traveling to the island complete an online health declaration form before departure or upon arrival so that they can be separated based on the risk of infection during the immigrating process (C.-L. Lee, 2020). Since the end of 2019, the National Health Insurance Agency (NHIA) and the National Immigration Agency have created a joint database that provides a risk assessment approach in identifying possible infections based on the 14-day travel history of foreigners and citizens traveling to Taiwan. Passengers' health information and travel itineraries are recorded by scanning QR codes upon entry to the island (Lin et al., 2020; S. Chen, 2020). Additionally, authorities are allowed to assess the integrated data provided by the national health insurance and immigration and customs databases in order to identify potentially infected or high-risk cases based on their travel history and symptoms. Those that are at high risk will be identified, be forced to self-quarantined, and be monitored through their cellphones.

This operation was a result of the SARS outbreak in 2003 where Taiwan leveraged its experience (Lin et al., 2020; Wang et al., 2020). In that year, the National Health Command Center (NHCC) was established. Since then, the information system first developed and managed by the NHCC has been integrated from multiple government databases that can gather real-time information to work together, such as the National Health Insurance (NHI), stockpile systems, the Taiwan National Infectious Disease Statistics System, and media reports. This information system has helped Taiwan's government to gather relevant early data on the COVID-19 outbreak in China and other countries in Asia. However, although the data that are integrated with digital systems are not designed to stop a pandemic, they are sufficiently agile to prevent and control the spread of the virus (Emanuel et al., 2020). Specifically, when medical supplies are limited, using data to identify high-risk people in order to test Covid-19 is therefore very useful. As researchers have reported (Wang et al., 2020), "Taiwan enhanced Covid-19 case finding by proactively seeking out patients with severe respiratory symptoms (based on information from the National Health Insurance database) who had tested negative for influenza and retested them for Covid-19." The availability of data to inspect patients or high-risk individuals has enabled the country to identify, test, track and isolate cases more efficiently.

More importantly, a 24-hour helpline chatbot was created through the collaboration of the TCDC and two tech companies-HTC and LINE (Ministry of Foreign Affairs Republic of China (Taiwan), 2020) in order to allow and support people to report their health status, as well as to provide suggestions for health prevention from the contagious virus. Additionally, Taiwan enforces quarantines with cellphone tracking. This changed policy as a result of the situation where the exemption from stringent quarantine, which began in January, was used for some business travelers from low-risk countries on June 22, 2020. Taiwan increased alternative travel restrictions and used geofencing technology for home quarantine systems. This system is now called an "electronic fence" or a "digital fence". The government will closely monitor the mobile signals of foreigners for 14 days. If anyone under mandatory quarantine leaves his/her dwelling or goes outside his/her designated quarantine site, there will be "warning sounds" that are sent directly to notify the police or local authorities for immediate detention. At the local level, partnering among the CECC, police agencies, local officials, and telecom companies supports local authorities in terms of checking quarantined citizens by calling them about their health status and sufficient basic daily supplies which they may bring to them if needed (Lin et al., 2020).

(ii) Risky areas and medical supply alert. The government uses artificial intelligence to control data and to create real-time digital updates in order to alert people in risky areas so that infections can be avoided (Broga, 2020; Wang et al., 2020). The private sector supports government COVID-19 measures by using data to create tools that help citizens get a clear and transparent picture of their private travel so that they can check if their travel history relates to risky areas. For example, a group of programmers and website developers managed by GitHub Inc. has developed a map-based code by using Google maps in order to detect the journey history of individuals. This provides web users with the ability to estimate whether they are in "red areas," where infected cases have been discovered, or have journey history-related such areas (Broga, 2020; Wang et al., 2020).

Moreover, in order to solve the controversy of the panic buying medical supplies, the Taiwanese government of Audrey Tang, Taiwan's digital minister, has delivered a live map of medical supplies for the entire island. A real-time updated mask map application was introduced by the government to provide real-time information on mask stocks and to help citizens find masks nearby (Farr and Gao, 2020). The application was collaboratively developed between the Digital Ministry and a group of entrepreneurs and hacktivists. The application was suggested on vTaiwan (https://info.vtaiwan.tw/), an open discussion platform, to create a

consensus on policy issues. Through vTaiwan as a virtual democracy platform and brainstorming site, the public and the government can communicate directly. Engaging the public in problem-solving increases the transparency of the policymaking process, builds trust in the national government, and even builds civic pride (Kluth, 2020). Consequently, the entire country voluntarily collaborates with the government to create a two-way interactive information network. This collective effort is the key to harnessing data-driven solutions (Manantan, 2020). With the increase in mask production and having real-time information about the mask inventory, the supply of masks is now sufficient to meet basic consumers' needs, and the public is allowed to buy a greater number of masks. In February, Taiwan instituted a rationing system that allowed citizens to buy two masks per week, then three masks per week and nine masks every two weeks since the production of the mask has increased from about 3 million per day to about 20 million per day (Taiwan External Trade Development Council (TAITRA), 2020b).

4.2 Public information and communication

The rise in the crisis is in part a result of the shortage of information, conflicting information, and information overload, which makes it difficult to know what and whom to be believed (Stephens, 2020). An inclusive communication strategy for COVID-19 must be implemented immediately through both digital and print channels that have sufficient frequency to create a clear understanding for audiences. Adequate frequency and transparent information is critical in building trust during the crisis. Taiwan has regularly, transparently, and accessibly communicated online (S. Chen, 2020) with the public for various purposes: (i) updating news on a daily basis, (ii) reassuring and educating the public, and (iii) fighting and correcting misinformation.

(i) Daily updating of news. Chen Shih-chung, Health Minister and the head of the CECC, was appointed by President Tsai Ing-wen to host daily news conferences to inform the public, to track the pandemic situation both within the country and other countries, and to announce relevant measures to fight COVID-19. Changes in governmental measures are announced and clearly explained ahead of time.

(ii) Reassuring and educating the public. Apart from the daily press, the government has improved health education and communication regarding for example how, when, and where to wear a mask, personal hygiene behaviors (such as frequent hand washing), the effects of mask hoarding, and promoting "Stay at home and do not attend public assemblies if you are sick" (Chang, 2020; Wang et al., 2020). The government communicates in many ways, for example online, via SMS, messaging apps, websites, and posting in visible locations such as bulletin boards, staircases, or elevators. In addition, television and radio stations are requested by the government to broadcast every hour about the spread of the virus, and the importance of personal hygiene behaviors, and wearing a mask. Importantly, the CECC has created plans to instruct schools, businesses, and factories to obtain a greater understanding of healthcare prevention (Chang, 2020).

(iii) Fighting and correcting misinformation. The outbreak of COVID-19 has resulted in an immediate "infodemic". The infodemic is relevant to an "over-abundance of information-some accurate and some not-that makes it hard for people to find trustworthy sources and reliable guidance when they need it" (World Health Organization, 2020a). As the COVID-19 epidemic continues to evolve rapidly, communication about it must be investigated and monitored in order to detect misinformation, rumors, or information gaps as early as possible. The Ministry of Foreign Affairs of Taiwan has actively attempted to find, fight, and detect rumors and misinformation from news, online media, and cyberattacks (S. Chen, 2020). In addition, the Taiwan FactCheck Center and MyGoPen, Taiwanese fact-checking institutions and groups, also fastly check misinformation on the epidemic, which is mostly online, and correct it while distributing the correct information to the public (Broga, 2020; Wang et al., 2020). Accurate and trusted information is crucially needed in order to communicate "what is known and unknown, what is being done, and what will be acted" to the public through trusted channels (World Health Organization, 2020d).

4.3 Public participation

An adaptive approach utilizes capabilities and decision-making power from an internal and external organization as well as from both top-down and bottom-up approaches (Janssen and van der Voort, 2020). Overcoming COVID-19 requires the collective effort of every unit of society – individuals, communities, businesses, public agencies, and non-profit and international organizations. Their collective action needs to be harnessed (World Health Organization, 2020b). The Taiwanese government instructs the public on how to respond to COVID-19. Public participation was the focal point when the government found that local cases were spreading. According to the observed data of the "Central Epidemic Command Center (CECC)" (Chang, 2020), local cases with links to family and hospital groups have been recently confirmed. The number of cases in the country has increased more than imported cases. These unknown local cases represent the notification of a potential community spread. In order to prevent cluster infection and to enhance health and safety, the unit of individuals is the essential point. The government instructs the public to enthusiastically implement "hand washing or sanitation, respiratory hygiene, coughing etiquette, and staying at home when sick". Individuals on

the high-risk monitoring list must follow the disease control measures issued by the CECC in order to manage their health. Additionally, the government has activated a plan for strengthening community surveillance through creating a "map for community facilities" as a surveillance network, which now includes 161 facilities so that people can easily access evaluation and be screened specifically, and 52 hospitals that have been prescribed to treat patients with severe symptoms. Strengthening and confidence in community surveillance will reduce the burden on hospitals (Ministry of Health and Welfare, 2020).

Moreover, the private sector also plays a crucial role in combating the COVID-19. For example, the government together with Polstar Technologies, Inc., has rapidly developed an online real-time map of stores selling face masks, a so-called mask map. The Taiwanese government took only three days to discuss how to build the mask map through utilizing open government data and upgrading the maps with private developers. The applications could not have come out quickly without the government's quick decisions. Currently, real-time online maps support the government in terms of educating people about the availability of supplies. The public can check the availability of masks near their homes. The classification of adult and child masks is provided by a location detection page about which health centers provide masks, their distance from the person's residence, and the date and time of the updated information (Broga, 2020; Wang et al., 2020). In addition, the "Disease Containment Expert," a Line Bot system, was developed and launched jointly by the CECC, Line Taiwan, and HTC Corporation's healthcare unit DeepQ to support and track people in home quarantines. The CECC sends SMS messages daily to track the health status of people that are under home quarantine and isolation. In turn, these people can voluntarily and directly report their health status by replying to the SMS sent to health workers every day. Additionally, they can obtain relevant information and ask for suggestions by adding the Disease Containment Expert as a friend list (Taiwan Centers for Disease Control (TCDC), 2020a). Further, the Taiwanese government has collaborated with developers and the public to find out and develop anti-COVID-19 strategies through the online city hall (https://info.vtaiwan.tw/), where the public can discuss and participate in the policymaking process. In this way, the entire community voluntarily collaborates with the government to create network transparency information, which is the key to the successful strategy of "testing, tracing and isolating" for dealing with COVID-19 as well as boosting trust in the government (Su and Han, 2020).

In addition, all shopping malls, shops, restaurants, gyms, offices, and buildings provide hand sanitizing and screening of the temperature of people before entering buildings. People that do not wear face mask cannot enter any building (S. Chen, 2020). This is different from the West. Wearing a face mask in Taiwan has a less negative perception (Su and Han, 2020). It has become a cultural norm for various reasons, such as social responsibility when feeling uncomfortable, keeping one's face warm, or protecting oneself from air pollution. More importantly, since the SARS outbreak in 2003, the Taiwanese government and the public have learned that respiratory diseases cause damage, and wearing a face mask can be the first line of defense because it can reduce the risk of virus transmission (Su and Han, 2020). Adopting mask wearing for COVID-19 was implemented quickly. However, high penalties will be enforced if they do not wear a mask in a designated area, such as a subway (i.e. high-speed rail or various metro systems), and for breaking quarantine. Chen Shih-chung, Health Minister and the head of the CECC, announced that those that do not wear a mask in public transport will be fined between NT$3,000 (US$99) to NT$15,000 (US$496) for contravening the Communicable Disease Control Act (Strong, 2020). Even more aggressive, the use of social pressure has become a part of the culture in Taiwan, such as giving names and shaming people who do not wear masks in public transportation or are breaking quarantine early. People that do so may see their faces appear on social media apps (Farr and Gao, 2020).

Taiwan's collective efforts - public-oriented mentality and cooperation - have proved to be crucial in the nation's containment efforts in tackling COVID-19 in a more unified way (Huang, 2020). The experience of Taiwan demonstrates that when people are conscious that they are "at war" in the midst of a pandemic crisis, cross-sector collaborative governance can be successfully applied (Huang, 2020). Individuals must adopt healthy behaviors such as washing their hands, wearing a mask, providing a level of physical distancing, or staying at home when they feel sick. Communities must monitor and help each other so that there are adequate medical supplies and understanding of the pandemic, for example educating, protecting vulnerable groups, supporting health workers, tracking cases, and supporting physical distancing measures. Additionally, private companies may provide expertise and innovation to support COVID-19 responses and solutions (World Health Organization, 2020b).

5. CONCLUSION

Since COVID-19 is dramatically increasing volatile, unpredictable, complex, ambiguous, and catastrophic situations, public administration has been challenged and tested by the pandemic. The situations

surrounding public health and infection rates are changing rapidly. Additionally, the severity of the current crisis is unpredictable and will undoubtedly cause long-term consequences. New information, new regulations, and new plans are often announced. This disrupts the economic activities that a government must consider at the same time: how to help people, how to ameliorate unemployment and suffering companies, and how to manage a frustrating supply chain. The successful management of the COVID-19 crisis in Taiwan had required a lot of effort, collaborative action, and sagacity. Taiwan's response to COVID-19 has introduced agility and adaptability approaches that have been able to handle the crisis and mitigate its effects. Applying the concepts of the OODA, the PDCA, and three key executions, including technology-driven operations, public information and communication, and public participation, can help the country manage and control COVID-19 and reboot the socioeconomic growth in a short time.

Regarding the implications for other infected countries, the concepts, management practices, and measures implemented in Taiwan can help to slow down and control the epidemic. However, in addition to such smart and efficient management, experiencing traumatic losses from the SARS epidemic in the past has united enthusiastic Taiwanese and their highly accountable government to fight the epidemic this time. Taiwan's contextual factors regarding past experiences, high government accountability, and the unity of the Taiwanese have made the management of this COVID-19 crisis a noticeable success. These factors could therefore be both constraints and challenges for other countries in adopting the Taiwanese approach. Nevertheless, other countries may consider learning from the successful measures of Taiwan and adjust them based on the context of their own country. Measures for local epidemic preparedness, temperature monitoring, virus detection both for foreigners and citizens, and the enhancement of medical supplies and resources should be strengthened in order to manage and control the pandemic. Likewise, some countries that may be uninfected should be ready to respond to emergencies in a timely manner and should strengthen their ability to quickly detect COVID-19. In terms of public administration development, although COVID-19 is a harmful crisis, it has provoked and shattered the traditional values and practices of bureaucratic systems, which may have been thought to be impossible but can be done when we are in crisis and have to survive. The crisis has provided the opportunity to see and learn how public administration can be effective by applying agile and adaptive approaches within a short time span. However, since public administration is generally considered to be in a stable environment, we henceforth need to review public administration in the new context of uncertainty. Adopting new values and practices requires that both academics and practitioners help review important public administration issues, such as administrative capabilities, systems, values, and methods, as well as the redesign of future resilient public administration.

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