CHAPTER 47

Pandemic and Epidemic Risk Management

THE COVID-19 PANDEMIC AND ITS CASCADING EFFECTS have left a lasting mark on all industries and sectors. While the root causes, sources, and drivers of the pandemic will be discussed in great detail in countless forums in the coming time, our aim in this chapter is to discuss the management of its consequences, with a focus on business continuity, in the context of risk management.

There has been much conversation about black swan events, which have such low probability that they cannot be predicted and are, effectively, unforeseeable. Nassim Nicholas Taleb[1] popularized the theory of the black swan, which assigns the "black swan" label to events that come as a surprise and are hugely impactful.

In the case of COVID-19, one may well argue that this was foreseeable and not a black swan event. Taleb has called COVID-19 a "white swan"—that is, an event that is an eventuality with estimable impact.

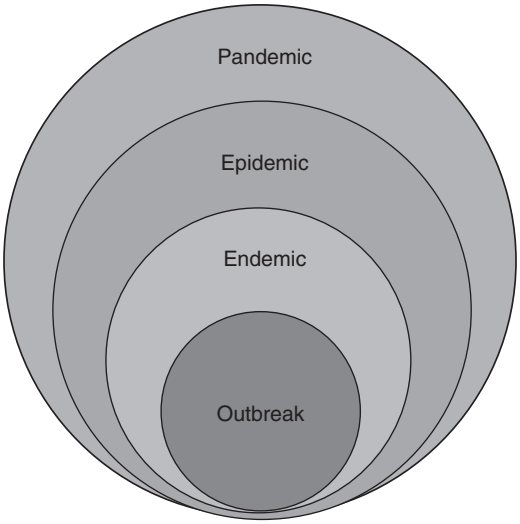
Indeed, a related coronavirus had earlier reared its head with Middle East respiratory syndrome (MERS-CoV) in 2012, 2015, and 2018 and severe acute respiratory syndrome (SARS-CoV) from 2002 to 2004. The modus operandi of virus genesis was the same in these two cases as it was for the SARS-CoV-2, which is by zoonotic spillover (i.e., transmission of a pathogen from a vertebrate animal to a human).

Zoonotic spillover is an arduous process in which the virus mutates, selectively adapting to intermediate and final hosts. Despite multiple barriers and low probabilities of spillover events, two-thirds of human viruses have spilled over, including HIV (chimpanzee, green monkey, and sooty mangabey), Ebola (bat), Marburg filovirus (bat), and H1N1 (swine). H1N1, which first appeared in 1918 causing the disease then known as the Spanish influenza, has had at least 18 outbreaks since then with one as recent as 2020 in India.

Despite such repeated occurrences and a large body of knowledge on infectious diseases, why has the effect of SARS-CoV-2 been so disastrous? Was this risk truly an

1. Nassim Nicholas Taleb is the author of the 2007 book *The Black Swan*, which has been described by *The Sunday Times* as one of the twelve most influential books since World War II.

FIGURE 47.1 Contexts based on the spread of a disease.



unforeseeable black swan? The answer lies in risk management—or rather the lack of it, which transformed this local outbreak of SARS-CoV-2 into a crippling pandemic.

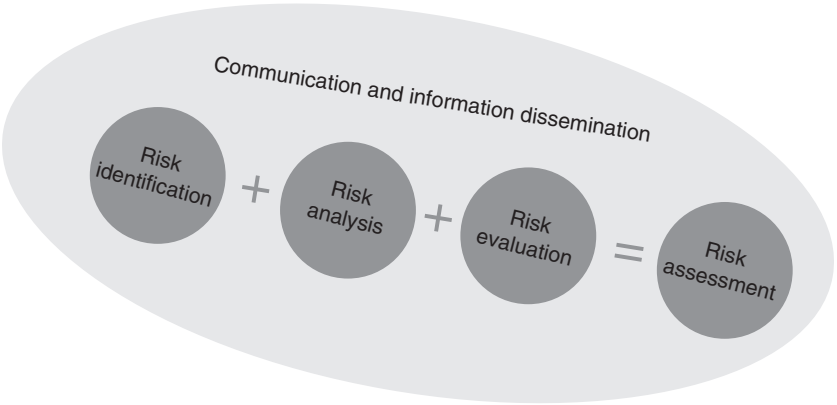
Let us start by setting the context of risk management. In epidemiological risk management, there are four contexts (see Figure 47.1):

1. A disease that spreads more than expected (i.e., with a greater than anticipated occurrence rate within a local range or population) is known as an *outbreak*.
2. When the disease starts occurring at a predictable occurrence rate within a certain area or within a certain population, it is known as an *endemic*.
3. When the disease spreads with a much higher than normal occurrence rate and affects a greater than anticipated population set, it is called an *epidemic*.
4. An epidemic that has spread to multiple countries and populations is known as a *pandemic*. The World Health Organization (WHO) defines a pandemic as "an outbreak of a new pathogen that spreads easily from person to person across the globe."[2]

Each of these disease classes demands a separate and specialized risk management approach. As the spread of the disease starts increasing, the level of maturity of systemic risk management proportionally increases. The challenge here is to dynamically adapt the risk management approach to contain the risk as the disease progresses upward from an outbreak toward a pandemic. Failure to manage risk and contain the spread using risk-driven mitigative measures at each step allows the severity of the harm from

2. C. Sibthorpe, "Coronavirus Pandemic: What Does This Mean - and What Happens Next?," *Sky News*, March 12, 2020, https://news.sky.com/story/coronavirus-pandemic-what-does-this-mean-and-what-happens-next-11955553.

FIGURE 47.2 The risk assessment process with special stress on communication and information dissemination.



the disease to increase proportionally as it progresses toward the epidemic/pandemic stage.

We will apply the principles learned in earlier chapters—specifically, the phases of risk management per ISO 31000:2018 as detailed in Chapter 22—to tackle pandemic risk management in this chapter.

It is important to understand that from a policy standpoint, a pandemic is a systemic risk, which means that it poses a threat to the entire system as opposed to individual components or entities. A system is characterized by interdependent components. As a pandemic rages, if the risk is not properly managed, the whole system can strain toward collapse due to cascading component-level failures (e.g., healthcare delivery strain). Systemic risks require an interdisciplinary approach for accurate classification, and the process begins with epidemiological characterization, which is the first step of risk identification. Figure 47.2 reiterates the three steps of risk assessment, staying true to ISO 31000:2018, which we will follow in this chapter. As can be seen, communication and information dissemination is of utmost importance in every step of infectious disease risk management. If critical information about the spread of the pathogen or its novelty is not disseminated on a timely basis, then other regions may not have enough time to set policy and define appropriate mitigative measures, which could lead to loss of life.

STEP 1: RISK IDENTIFICATION

The first step starts in the initial outbreak phase. Once an outbreak has been identified, it should be clearly recognized and described. In epidemiological terms, the strain of the pathogen must be identified to check for novelty of genetic matter and mode of transmission. The pathogenicity of the disease, which is its ability to harm the host, must be classified, and the host-pathogen interaction must be mapped out. Pathogenesis, which

refers to the manner of development of the disease when the pathogen interacts with the host, must also be clarified in this stage. The disease and its end points must be clearly described. On a higher level, the level of susceptibility of certain populations in terms of demographic parameters should also be identified in this stage—for example, the pathogen severely attacks children or people with certain organ insufficiencies or older adults within a certain age range. The information on risk identification must be communicated as early as possible to all applicable stakeholders and continual updates must be provided as the risk management process progresses.

STEP 2: RISK ANALYSIS

Risk analysis consists of assessment of the severity and occurrence of the disease. All concepts of risk analysis discussed in Chapter 25 also apply here.

First, when gauging severity, the pathogenicity (i.e., the ability of the pathogen to harm the host) is studied in terms of *virulence*, which is defined as the degree of pathology caused by the organism.

The following parameters can provide an indication of the severity of the disease:

1. Case fatality rate: the proportion of symptomatic cases that lead to death
2. Available treatment sensitivity
3. Outcome classification according to the four clinical severities of asymptomatic, symptomatic but mild, severe/grave disease presentation, and death

Occurrence of the disease is the second dimension, which can be gauged using the following parameters:

1. Transmission rate, which is the number of cases an individual will cause during his or her infectious period. This can also be called basic reproduction number, effective reproduction number or rate, infectiousness, or infectivity.
2. Number of deaths or excess mortality (i.e., increase in mortality attributed to the organism under study).
3. Number of serious adverse outcomes.
4. Hospital admission rate and intensive care admission rate.
5. Generation time: the mean delay between the time of infection of an index case and the times of infection of secondary cases caused by the index case.
6. Serial interval: the average length of time between symptom onset of individual cases and the persons they infect.
7. Clinical attack rate (CAR): the proportion of the population that is symptomatically infected in a given time period. CARs can be calculated for different demographics, localities, and risk groups.
8. Incidence proportion: the proportion of people who develop a new disease during a specified time period. This may take the form of a Proportional Reporting Ratio (PRR), where appropriate.
9. Prevalence: the proportion of people who have a disease at a specific time.

10. Weekly influenza-like illness (ILI) or medically attended acute respiratory illness (MAARI) cases as a proportion of total clinic/hospital visits, or incidence rates.

Many other risk parameters are identified in Table 47.2. It is also helpful to incorporate, at times, a detection dimension in the risk assessment, which can include factors such as testing capacity and capability. This is important for novel viruses where testing approaches may not be universal and well deployed.

From the list of the above severity and occurrence parameters (sometimes detection or exposure can be included as well), the most relevant must be chosen for the next step of risk evaluation. When selecting the parameters, special attention should be paid to data accuracy, reliability, and integrity.

STEP 3: RISK EVALUATION

Many methods, depending on the required outcome, can be employed to evaluate the risk of disease. The visual risk tracker introduced in Chapter 33 can be used to perform a comparative evaluation and to benchmark the disease in order to get an idea about risk and response strategies.

For the COVID-19 pandemic, we can choose the following two parameters (out of the list mentioned in the earlier step) and chart them over similar parameters from other epidemics and outbreaks to assess comparative risk:

1. Severity parameter: case fatality ratio
2. Occurrence parameter: basic reproduction number (R_0)

A simple multiplication of severity and occurrence parameters is not sufficient in this case. Here lies the challenge of assessing risk for infectious diseases: the spread is complex and outcomes do not follow a common linear relationship.

The spread of the virus is a major contributor to the excess mortality and can be given a higher weight than the case fatality rate. Using this logic, let us form a risk equation for disease risk as:

$$\text{Risk} = (R_0)^3 \times \textit{Case fatality ratio} \tag{47.1}$$

Based on the parameters we have chosen and our chosen risk equation, it can be seen (in Table 47.1) that by placing stress on transmissibility, the worst-case risk of COVID-19 is the highest among the six infections.

Of note is the range between the best case and the worst case. While this highlights the importance of mitigative measures to contain the disease (better mitigations, lower risk), it also indicates the need for a higher level of analysis that can better quantify the uncertainty in a probabilistic manner. We will look at this in detail in the coming sections. It is also important to note that as an outbreak progresses, the data must be actively sought, and the integrity of the data set must be maintained.

TABLE 47.1 Disease risk assessment example.

		Transmissibility (R_0)		Case fatality rate		Total risk	
Disease	Virus	R_{0w} (worst case)	R_{0b} (best case)	C_w (worst case)	C_b (best case)	Best case	Worst case
SARS	SARS-CoV	4	2	10	9.5	76	160
COVID-19	SARS-CoV-2	5.5	1.4	15	2	5.488	2495.625
Ebola	EBOV	2.5	1.5	82	45	151.875	1281.25
Bird flu	H7N9	0.4	0.03	59	56	0.001512	3.776
MERS	MERS-CoV	0.69	0.35	40	20	0.8575	13.14036
Seasonal flu (U.S)	Influenza A/B	2.1	0.9	0.21	0.1	0.0729	1.94481