Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

CHAPTER 10

Underlining the Role of Data Science and Technology in Supporting Supply Chains, Political Stability and Health Networks During Pandemics

INTRODUCTION

In a period of just 4 months, the global landscape had been overturned by the coronavirus, which was not seen as a threat in the initial stages when reports from started trickling from Wuhan, China. In fact, for almost 2 weeks after it was reported on December 31, 2019, it had only affected 41 people and had not spread to any other regions, or outside the city of Wuhan. For this reason, even the World Health Organization hesitated to identify it as a Public Health Emergency of International Concern (PHEIC) (WHO, 2020c) and as global pandemic (Branswell, 2020). But when it started to spread, first to neighboring regions, and to more parts of the China, and finally, to regions far and wide, it caused unprecedented panic and fears. Worse still, the number of infections started to increase exponentially, with substantial numbers of deaths in different parts of the world. By the end of 4 months, the disease, which was later renamed to COVID-19, had infected over 3 million people and killed over 215,000, with most of the deaths witnessed in the most developed regions and countries (Sullivan et al., 2020). Worse still, it had sparked fear and panic on governments prompting them to institute some measures with far-reaching impacts on societies, economies, the political sphere, and also the environment.

For the first time in history, numerous countries had instituted lockdowns in their countries (Barry and Jordans, 2020; Bermingham, 2020), imposed border restrictions, banned noncitizens or permanent residents from their countries, and grounded transportation networks. There have been also total suspension of flights, on both domestically and internationally (Pham, 2020), and unprecedented use of security forces in different countries to impose those measures. Economies across the globe have been halted, with only a few sectors, more so those providing essential services allowed to perform. The measures have also been accused of disrupting of supply chain (Cohen, 2020; OECD, 2020; Shwartz, 2020), thus prompting wide-scale scarcity of basic things including medical supplies that have been in great demand in different parts of the globe.

Socially, the emergence of COVID-19 brought unprecedented pains, fears, agony, and disarray as people, in their thousands, and millions are hospitalized, others separated with their loved ones forever. In worse-case scenarios, in areas with high daily death rates, deaths from hospitals were buried in mass graves with relatives void of the opportunity to say good bye. The devastation has been even worse on those who traveled outside their countries, and with lockdowns and restricted transportation, people have had to remain displaced until such measures are eased or lifted. The measures that have been imposed in different countries have also seen unprecedented impacts on livability, especially in urban areas where people are forced to remain indoors, with limited supplies (Nkengasong and Mankoula, 2020; Wearden and Jolly, 2020), with no social interactions, and with pressures from loss of jobs and source of their livelihoods. Such have prompted social strives, where in different parts of the globe such as in India, the United States, and Germany, residents of some towns called for lifting of lockdowns and other restrictions. Such issues were arising when the United Nations' World Food Programme had warned that the effects of COVID-19 would result into increase in the

Surveying the Covid-19 Pandemic and Its Implications. https://doi.org/10.1016/B978-0-12-824313-8.00010-3

number of acute hunger, affecting more than 265 million people globally (Anthem, 2020).

Politically, as the COVID-19 situation escalated, more political tensions were built. For instance, countries have been seen trading accusations as to the responsibility that each has played in escalating the situation. Others such as China have been accused by countries such as the United States, Germany, the United kingdom, Spain, and even France of having mishandled the situation and failing to share conclusive information and data in time to allow others to prepare (Bronstad, 2020; Pleasance, 2020). On other occasions, the United States has been blamed for instituting measures such as banning European travelers into the United States, also for banning exportation of medical supplies and other issues (Larsen and Gramer, 2020). In fact, with no immediate end on sight for this pandemic, there were fears that the tension may even escalate to dangerous heights, warranting interventions of international bodies.

While the emergence of COVID-19 had severely impaired the global systems, it however, exposed the importance and power of modern technologies in helping address events such as pandemics. For instance, in the first stages of the outbreak of this virus, when the Chinese scientists and authorities and the WHO were trying to identify the virus (WHO, 2020d), and whether it could have impacts beyond Wuhan, a tech startup named BlueDot was able to detect that the world was facing an outbreak, which may end up having global impact. Using real-time data from different sources such as airlines ticketing and numerous news outlets, it made the prediction 9 days earlier, before the WHO made the announcement (Allam et al., 2020; Bowles, 2020). On the same, Allam et al. (2020) highlighted that there was also another startup named Metabiota that correctly predicted that the outbreak would spread to the neighboring regions in a matter of time, and a week later, the prediction came true as Japan, Thailand, Singapore, and others that had been noted as potential target for the outbreak confirmed their first cases. Besides those, even when countries went on lockdown, the use of technology became even more apparent, as devices such as drones, robots, sensors, smart helmets, and thermal detectors were widely used for different purposes such as delivery, identifying potential coronavirus virus cases and other purposes (WHO, 2020b). Technologies such as artificial intelligence (AI), machine learning, natural language processing, and big data have also been instrumental in some countries in implementing quarantines, in search for vaccines and drugs and in helping reduce further spread of the virus.

After such success on the use technology, it is incumbent upon different stakeholders in the global sphere to invest more resources in ensuring widespread of the same in different sectors; as going forward, the global systems will require a concerted effort to restore. For instance, in the economic front, there are signs that the world may be headed for a recession and that would have far-reaching impacts not only on the economies (Africa Renewal, 2020; Statista, 2020a, 2020b; Stephanie and Gerstel, 2020; Wang, 2020; Wearden and Jolly, 2020) but also on the environment. On this, with the use of technologies in sectors such as agriculture, manufacturing, energy production, and building and construction, it would be possible not only to revive the economies but also to void impacts on the environments. By ensuring continuity of the strides already made in different sectors, more so the environmental, the world may escape the dangers posed by climate change and others that are related to environmental sustainability (Allam and Jones, 2019). With that background, this chapter will concentrate on discussing the role of technology and data science in supporting supply chains, economies, and political sustainabilities.

MANAGING PANDEMICS WITH DATA SCIENCE AND TECHNOLOGY

The occasional occurrence of pandemics in the world is not unusual from a historical perspective. Since time immemorial, humans have had to contend with these, but, fortunately, most of those remained local, especially due to a number of factors. First, the global population has been played a significant part in the spread of pandemics, and in earlier days, population were relatively smaller and people were sparsely distributed. Secondly, the interaction between different groups of people from different countries and regions was limited as transportation infrastructures were not well developed, until recently. Also, urbanization was not as pronounced as it is today, and this played a key role in preventing widespread. Today, things are extremely different, as the population has already increased to 7.6 billion people, and it is projected to reach a high of 8.5 billion by 2030 and to 9.7 billion by 2050 (UN, 2019). Furthermore, technological advancement is at all-time high, and this has made interactions, communication, transportation, and research among other things more robust and efficient. These modern facts have made it possible for pandemics to be widespread and devastating. Therefore, in the case of infectious diseases like the COVID-19, it is not surprising that they spread quite fast and impact

numerous people and sectors in a short period of time. For instance, by the time of writing this chapter, the coronavirus had spread to over 212 countries, infecting over 3 million people and killed over 215 people. It had also started to spark some political and economic tensions, besides impacting greatly the social aspects in every part of the globe.

The technological advancement, however, cannot be overlooked on the lens of facilitating spread, but its greatest strength has been in controlling and preventing further spread and devastations. For instance, during the Spanish flu outbreak (1918–20), where technology was rudimentary, over 50 million people lost their lives (Martini et al., 2019). However, as technology continued to advanced, including in the medical fields, the succeeding pandemic such as the 2002–03 severe acute respiratory syndrome (SARS) spread was effectively contained, and it only spread into 26 countries and only infected 8000 people over that period. Even other outbreaks such as the middle east respiratory syndrome (MERS) (CDC, 2019), Ebola (Wojda et al., 2015), Zika (Kazmi et al., 2020), and influenza like the swine flu (Aris-Brosou et al., 2017) that have broken out did not have devastating impacts as compared with the Spanish flu. In fact, even the HIV that emerged in the 1970s, and is still present to date, has well been managed due to availability of technologies (The, 2017). Despite that, these have had some significant impacts on social and economic frontiers, which cannot be overlooked and which demand even further advancement in the medical field to help with the identification of outbreaks before they spread.

One of the most novel ways of ensuring that future outbreaks can be contained is widespread application of data computation and analysis (Allam and Jones, 2020), which already, as discussed in the previous section, was instrumental in making predictions about the outbreak and spread of COVID-19 by BlueDot and Metabiota. In other fields such as climate change, the application of predictive technologies has been widely used, and these have had significant impacts in helping promote discourses on climate sustainability, emissions reduction, and the need to adopt alternative energy production (Allam, 2020a, 2020b). While the use of technology is being promoted, it is not meant to debase the role of other players in the medical world, but such would supplement the efforts, by making the work of investigators, pharmacists, researchers, and others even more pronounced and with far-reaching outcomes. It would also help in hastening processes, making decisions, collecting data, and reducing human errors in interpretation of said data, thus reducing misdiagnosis and other such issues that have occasionally been witnessed in the medical field (Allam et al., 2019). Such benefits are made even more robust by the availability of diverse data sources, data collecting technologies, and different data sharing platforms. For instance, with the increase of Internet infrastructures, now supporting even 5G in some regions (O'Mahony et al., 2019), and with the availability of numerous smart, mobile devices such as phones, drone, wearable technologies, and cameras, data generation and sharing is becoming pronounced. Similarly, the increase in number of social media platforms (Cinnamon et al., 2016), increased online news outlets, and mobile Apps among others are helping in generating unprecedented amounts of data (Allam, 2020b). The use of such Apps has earlier been used, especially during the 2010 Haiti earthquake and the cholera outbreak in the same country where health professionals collaborated with telecom companies such as Digicel (largest telecompany in the country) to track the movement of people. This allowed for optimal resource management and also in deployment efforts of those offering different forms of assistance (Bengtsson et al., 2011; Lu et al., 2012).

Even in the current pandemic, there is evidence of widespread use of technologies, besides what BlueDot and Metabiota did. In different parts of the globe, governments, telecoms, and startups have been seen to develop different Apps and online tools such as trackers that have helped in tracking and mapping the spread of the disease (Porterfield, 2020; Voa Student Union, 2020; Wakefield, 2020b). For instance, in South Korea, it is reported that they developed a platform that allowed security and health personnel effectively impose quarantine and would warn them whenever individuals were flaunting such measures (Park, 2020). Computation technologies were also widely used in China to combat the spread of COVID-19 (Chaturvedi, 2020), and even as it continued to spread in other countries, we have seen rival tech companies such as Apple and Google collaborating to make tracking tools to aid in effective mapping and tracking of the spread of the virus (Apple, 2020). By tapping on these technologies, there are possibilities of enriching the available database such that even in the future, it would be easier to address emergencies of whatever nature. On this, the most promising thing with the use of data computation technologies is that data from different spheres could be collated and analyzed to reach an informed conclusion. This is how BlueDot company made the prediction through the use of a wide expertise network as it hosts a rich expertise base comprising of meteorologists,

software developers, data scientists, ecologists, geographers, epidemiologists, veterinarians, and others, thus allowing them to make informed conclusion, which are inspired by insights from the diverse backgrounds (BlueDot, 2020a, 2020b). Going further, even post-COVID-19, the role of computation technologies will continue, especially in reevaluating the policy responses, and hence help different stakeholders to identify areas of weakness and how such could be strengthened in case of similar future major disruptive events.

HEALTH DIGITAL INFRASTRUCTURES AND DATA CRUNCHING

Following the numerous technological interventions initiated to combat the COVID-19 pandemic, it is now evident that technology, especially related to data storage, data processing and sharing is part of the backbone of the health industry. This has been given the impetus by the happening in the technological sphere where much effort has been made in improving data collection methodologies, with the use of smart devices gaining traction. In regard to data storage, developments have been made significantly, where research is being performed to see whether it could be possible to store such in human genomes or proteins such that, in the future, unlimited amounts of data could be stored. In regard to data processing, as noted earlier, the medical field would benefit even further through the upcoming advancements in AI-driven tools, the advancement in machine learning technologies, and also the improvement in big data technologies. With these technologies, it will be possible to process vast amount of data, in real time and from diverse sources as noted earlier; hence, the insights and conclusion drawn from such will have far-reaching impacts.

This far, in the medical field, with such technologies, there is evidence that it is now possible to perform noninvasive surgeries that reduce fatalities and also reduce healing time for patients, and such have proven beneficial (Elrod, 2014), especially during this period of COVID-19. Others such as the 3D printing are gaining traction, especially in address complex medical issues, especially those requiring implantation of biomedical devices. According to Javaid and Haleem (2020), 4D printing is offering the possibility to have relatively smaller implant devices at the comfort of patients. In the case of COVID-19, already, with the available data, researchers have estimated and predicted the various case scenarios that different countries would face, especially in terms of fatality and recoveries, and infection, hence allowing all involved parties to prepare (Giordano et al., 2020; Tokars et al., 2004). For instance, in the United States, using such computation, it was estimated that country may have an approximate death toll of 200,000 and have millions affected. And already, the number of infections in the country has clocked over 1 million (Cole et al., 2020).

When those technologies and many others are complemented by data computation, the medical field can be made to benefit even further, and already, market of those devices and the number of companies investing in the medical fields are increasing. In particular, with the notable achievements and recognition that data processing startups have gained over this period of COVID-19 following the correct predictions made, the market for smart devices will continue to grow even further. On this, before the emergence of the pandemic, it had been projected that the number of Internet of things (IoT)–supported devices in the health industry would reach a total of 30 billion devices by 2020 and 75 billion devices by 2025 (Digital Information World, 2020), thus pushing the device market to US$534.3 billion (Fortune Business Insight, 2019). Mordo Intelligence (2019) undervalues the market and argues that it will increase to a high of US$172.46 billion by 2025 from a high of US$55.5 billion report in 2019. But in both predictions, it is true that the growth in the market is relatively high, at a compounded annual growth rate (CAGR) of more than 20% each year. Mordo Intelligence (2019) credits such increase in number to factors such as the improvement in accuracy and connectivity that such devices have made possible in the healthcare sector and also the emergence of big data in healthcare such that any amount of data that such could generate would be stored and processed without fear of lack of storage.

With the world focusing on statistical modeling for data gathering from the increasing COVID-19 cases, and solutions driven from processing that data, it means that solutions derived may also be technologically driven. In fact, even as governments, scientists, agencies, individuals, and other stakeholders intensify the search for a vaccine and drug for this disease, already, as noted earlier, technological processes have managed to assist in reducing the spread of the virus. For instance, the example cited in the previous section about the use of mobile platforms in the Republic of South Korea to enforce quarantine is proof that technology holds a sizable share in bringing to an end the coronavirus menace and that of future pandemics. It is worth noting that using technology, the Chinese authorities managed to identify the coronavirus genome sequence and posted the same on a public database

where it could be accessed by all accredited researchers (ECDC, 2020). Within no time, labs across the world had access to this, and they managed to clone it (Scott et al., 2020). Through such public platforms, those labs shared information and data on all the experiments that failed, helping reduce repetition, and they are also helping researchers on areas to focus (Ramiah, 2020). In other cases, through statistical modeling, organizations, including the WHO and others, have been able to develop dashboards that are helping to track the spread of coronavirus, and these are providing people with real-time updates on what is happening across the globe (WHO, 2020a). Similarly, using these modeling, especially those that are AI driven, China managed to diagnose thousands of coronavirus cases, as these could read through thousands of CT scans in a record time with an accuracy level of over 96% (Ramiah, 2020). This helped reduce time and also ease the pressure on the radiologists who were already overwhelmed due to the fast rates at which cases were being confirmed and hospitalized. An article posted in the University of Copenhagen website (UoC, 2020) explains that AI will, in such cases, go ahead to predict the patients who may urgently be in need of ventilators, depending on severity of their case.

AI-based machine learning and natural language processing have also been employed in health facilities in other countries with huge success rates (Wright, 2020), thus providing hope in the fight against the spread of the virus, and finally, finding a cure for the disease. But its most promising use, in respect to fighting the COVID-19 pandemic, is its ability to crawl through the data pertaining to the 15,000 approved drugs already on the market and make predictions from over 8 million possible pairs or over 10.5 billion triple-drug combinations. But with AI-powered technologies, researchers predict that possible combination of drugs; whether a part or triple that could go to human trials would take only few weeks. And, already, companies such as Healx (Earley, 2020), Exscientia (Exscientia, 2020), Scipher Medicine (Wakefield, 2020a), and others are also in advanced stages of proposing possible drugs that could be repurposed and be tried as cures for COVID-19.

Outside the hospital environment, as noted in the previous chapters, giant corporations such as Apple, Google, Alibaba, Tencent, and others have been seen to develop Apps and platforms that provide data sharing platforms, and such have helped in mapping areas where cases were spreading faster and where people could get help and get tested. All the data collected from these platforms and numerous others that are actively being used elsewhere across the globe would remain its usefulness, even post-COVID-19, but this will require a superior statistical modeling tools to manage the increasing magnitude of such data. In this case, therefore, it will not be farfetched to employ the services of AI-driven technologies such as machine learning, natural language processing, and others such as big data that have already proven capable of delivering quality statistical results in real time and with high levels of reliability.

THETECHNOLOGICAL BACKBONE AND GLOBAL STABILITY

During the period where C0VID-19 has engulfed the world and brought almost everything at a standstill, the role of data processing and sharing is not only being hailed in the health sector but also seen to be critical in other spheres such as the economy, society, and the environment. In the economic sector, there is much that the emergence of the coronavirus has prompted, especially with restriction on movements, grounding of transportation and lockdowns. Firsts, as noted by the International Labour Organization (ILO, 2020), these measures meant to assist the health sector have transformed the way a majority of people work. On this, a portion of the workforce has managed to continue working from home via teleworking, or through other means. But a majority of the population, especially those in the informal sector, have had their routines greatly disrupted, with a majority globally already filling for unemployment claims. For instance, in the United States, in about 6 weeks, from March to April 2020, over 30 million people filled unemployment claims (Jones, 2020), higher than the December 2008 recession where 11.1 million people filed similar claims (Department of Labor, 2009). Such happenings have increased economic pressures on families, forcing them toward seeking family relief, and other social support systems to see them through the period of aforementioned restrictions. With the disruptions in the labor market, Mahler et al. (2020) used data processing to showcase that the estimation on issues such as global poverty will tilt upward, whereas, in the absence of the coronavirus, this year (2020), the global poverty rate would have followed the projected historical trend that showed that it could decrease. But now, with the available data from over 166 countries on those locked down, those losing their jobs and the disruption on other economic areas, it shows that the pandemic will

push the poverty by around 0.5% higher from 2019 rate, and 0.8% higher from what had been predicted earlier (Mahler et al., 2020). Data processing has also been used during this period to predict that the current health crisis could lead to a recession, where some experts argue that already, the recession has already started in the United States (Stewart, 2020).

The disruptions in the economic sectors have not only prompted challenges on the economic front butalso raised concerns on the security sector, especially with countries seen to short-circuit and ban the exportation of health equipment of other countries. These have raised fears of lack of transparency, thus affecting global collaboration on the fight against the virus. In particular, the issue of data on infections, deaths, and medical supplies has sparked political tensions between different countries, even prompting accusations on independent bodies such as the WHO (Sevastopulo and Manson, 2020). The need for transparency on data sharing on COVID-19 has thus been emphasized by different global organizations like the United Nations (UN), World Bank, and others (The World Bank, 2020). According to The World Bank (2020), data transparency not only would help in reducing political tension and win over the coronavirus but is also prerequisite in weathering down the economic shocks affecting the global economy, especially by helping enhancing trust in governments, hence promoting investments especially post-COVID-19.

In a bid to ensure that the issue of transparency, especially on the origin and the outbreak of the virus, is established, countries such as the United States have been seen to establish fact-finding committees, whereas others such as Germany, Sweden, and Australia are considering doing the same in due course (Amaro, 2020). The need for reverse engineering as reported in an article posted in Nature Medicine (Oppmann, 2020) is warranted by the lack of collaboration, especially by the Chinese, whom the European Union (EU) chief, Ursula von der Leyen, said need to be involved in the investigation of the origin of the virus, so that more understanding on the origins can be uncovered, leading to better preparations for future pandemics (Amaro, 2020). The first such reverse engineering was performed by researchers at Peter Doherty Institute for Infection and Immunity in collaboration with Royal Melbourne Hospital and University of Melbourne where a copy of virus was grown in the lab from samples from an infected patient (Reuters, 2020). The need for participation of as many parties as possible is to elucidate the real origin of the virus, and issues that have raised numerous theories, where the United States claimed that it may have originated from a virology laboratory in Wuhan, China (Stanway, 2020; Borger, 2020; Law, 2020). China strongly rejected this theory and is also backed by the WHO, which warned against blaming individual countries for the virus outbreak and spread since this would jeopardize the steps already in place to stop its spread (Pérez-Peña and McNeil, 2020).

The availability of diverse institutions, governments, and laboratories and hospitals participating in the fact finding about the coronavirus does not only offer hope and possibilities of gathering data across a diversity array of networks and regions, but also their findings would facilitate efforts of finding a cure for the virus. The identification of the genome sequencing of the virus, for instance, is a positive in the search for vaccines, and drugs, especially noting that these genome sequences are deposited in the public databases, where all researchers can access them. The same are also submitted to the "Global Initiative on Sharing All Influenza Data" (GISAID) platform. As noted earlier, despite the controversies that are associated with the source of the virus, knowing the actual source would not only hasten in the development of the vaccine and cure but also help in winning back confidence of numerous stakeholders, whom, to this far, have shown dissatisfaction on how the whole issue of the pandemic has been managed. Winning the confidence of everyone will help in further collaboration efforts in eliminating the virus, unlike the scenario where individual country is seen to be looking inwardly and applying their own policies, trials, and test, and treating information from other countries with suspicion.

DATA-DRIVEN CITIES AND NETWORKS FOR FUTURE RESILIENCE

While the exploding demand for data-driven solutions at this particular period is all geared toward overcoming the spread and impacts of the coronavirus, this may spark and reignite the need for smart cities concepts, which peaked in 2015 (Allam and Newman, 2018; Allam, 2018). In the current dispensations, most of the digital solutions that cities across the world have been observed to be concentrating on is the health sector with the aim of containing any incidence of coronavirus, especially to prevent further spread (Allam et al., 2020; Allam and Jones, 2020). On this front, numerous devices and technologies, such as state-of-the-art thermal imaging sensors, smart helmets with sensors, use of drones, robots, and mobile phone applications have been in use in this period to help in

screening and providing contactless diagnosis against the virus. Even postcoronavirus, such technologies will still remain relevant, as they also will be part of numerous other IoT devices that are seen to be increasing, as the demand for smart solutions increases. On this, even before the emergence of coronavirus, the demand for smart cities, as expressed by Mordor Intelligence (2018), was growing, and this had catalyzed the demand for IoT devices, which, by 2019, were only 26.66 billion devices and had been projected to reach a high of 75.44 billion devices by 2025, as the application of smart cities concept continued. Besides this, the global market for the IoT solutions had reached a high of over US$212 billion by 2019, and the projections were that it would cross US$1.6 trillion by 2025 (Liu, 2019). According to Horwitz (2019) from Cisco, currently, the number of IoT-connected devices globally is over 31 billion, and she also predicts that they would increase to over 75 billion devices by 2025, especially due to improvement in areas such as Internet connectivity where many cities will have the 5G services by then. As those devices increase, the smart cities market will also continue to grow, and as Smart Cities Association (2020) report showcases, it will improve from the 2019 $622 billion valuation to over US$ 3.48 billion valuation by 2016.

On the above, though the outbreak of COVID-19 may have somehow halted the attention on application of the smart cities concepts that different cities were piously pursuing, its management is seen to be prompting new legislations aimed at enhancing tech solutions to contain the spread, and most of these will survive postvirus. Their enactment, therefore, does not only address the virus, but in the future, they will also add to the existing ones on urban livability, and ultimately, they will lead to better urban and policy decisions. In particular, those policies have formulated to guide in restricting movements, instituting guidelines, and containing the transport sectors, and others will have a positive bearing in the future in ensuring issues such as traffic congestion, supply of basic services, and provision of securities and other issues are maintained. This will be based on the increasing data that different cities are generating those measures that have been placed to contain COVID-19. For instance, Das (Philip James) explains how the University of Newcastle is using smart technologies to track the adherence to social distancing measures in Newcastle, and after analyzing the massive data (capturing over 1.8 billion individual events), the conclusion is that the sensors being used were able to give real-time data on how people were responding and also identified areas and issues prompting bottlenecks. On this, as noted by Allam and Jones (2020), one of the issues that has appeared prominently in the course of containing the spread of COVID-19 is the nationalistic approach, in decision-making where each country has been observed to look inward, with little regard to the plight of its neighbors. Such an approach would be counterproductive in a smart cities concept, as the devices installed need to communicate with others within the network to ensure synchronization of data and information, hence reading to informed decisions and insight drawn after data analysis.

With lockdowns, it has been evident that urban livelihood was to be negatively impacted, and in no time, this came to pass, with citizens in a number of cities in different countries protesting. This situation in cities is largely blamed on the haphazardly formulated policies that were mechanically enacted with little consideration of the negative impact that they would draw on locals. In most cities, despite the high population and density, government was seen to delay in implementing measures that would allow them to manage early detection, which would eventually help to reduce the number of local transmissions that prompted the lockdown. However, the blame is not all on government, for it also took time before it was established that the virus could be transmitted from one person to the other. Therefore, in most cities, the lockdown came when local transmission had already spread. But while that is the case, local governments had the capacity to learn, especially by analyzing data of cities such as Wuhan, which was affected first, and see how cases were spreading quickly and thus prepare effectively, especially by formulating restrictions measures that are more flexible, while being effective, for locals. Such would have sufficed, as most urban cities are characterized of high-density and high-rise buildings, where during total lockdown, people would feel trapped, where Grant (2020) supports that the planning of such leaves only a little or no open spaces where people could move out for recreation. But with prior planning, as was observed in France, people had opportunities to walk out, albeit under very strict conditions. But while things have been complicated by lockdowns, one take-home after the COVID-19 is the need for intelligent urban planning principles, and this could be achieved by promoting decentralization, of some services, especially those that could be done achieved remotely as advised by Shenker (2020). Already, this has been happening in this era of COVID-19, where some people have been able to work from home via live telecommunicating. There has also been a widespread use of digital transactions such as use of mobile

money transactions, which could help in decentralizing the financial services.

While the future postcovid is still uncertain, there are clear indications that the technological revolutions that were brought about to address it will remain as a legacy. There will be calls, soon enough, for communities, cities, and regions will use this momentum to craft more resilient fabrics while keeping in mind societal and economic equity in the process.

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