

**Thesis**

**Topic: Effects of national policies on cooperation among global innovation networks on  
vaccine innovation during the COVID-19 pandemic**

**Victor Akintayo Ogunbolu**

**Master of Science in International Business, HEC Montreal**

**Submitted to: Ekaterina Turkina**

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## Abstract

## Table of Contents

<b>Abstract</b>	<b>1</b>
<b>Table of content</b>	<b>2</b>
<b>1. Introduction</b>	<b>4</b>
<b>2. Literature review</b>	<b>8</b>
<b>2.1 National Policies in Response to Covid-19 Pandemic</b>	<b>7</b>
<b>2.1.1 National Policies: As a tool for the public good</b>	<b>7</b>
<b>2.1.2 National Absorptive Capacity: A moderating factor</b>	<b>10</b>
<b>2.1.3 Differences in National Policies</b>	<b>13</b>
<b>2.2 The Role of GIN in the Pandemic</b>	<b>14</b>
<b>2.2.1 Value creation by firms (Networking)</b>	<b>14</b>
<b>2.2.2 The Global Innovation Network Structure and Analysis</b>	<b>17</b>
<b>2.2.3 Effects of Covid on GIN (Socioeconomic cost-benefit on GIN)</b>	<b>19</b>
<b>2.3 The divide between National Policies and GIN</b>	<b>21</b>
<b>2.3.1 The covid-19 pandemic: The Reason for further cooperation</b>	<b>21</b>
<b>2.3.2 Governments' Responses to COVID-19</b>	<b>24</b>
<b>2.3.3 Removing/Dealing with the Barriers to Global Innovation Networks (GIN)</b>	<b>28</b>
<b>3. Methodology</b>	<b>32</b>
<b>4. Analysis</b>	<b>35</b>

<b>4.1 Case Study: China and US Policies during the Covid-19 Pandemic</b>	<b>35</b>
<b>4.1.1 Policy Effects on Socioeconomic Life</b>	<b>36</b>
<b>4.1.2 Policy effects on COVID-19 vaccine innovation</b>	<b>42</b>
<b>4.1.2.1 Virus Sequencing</b>	<b>43</b>
<b>4.1.2.2 Vaccine funding</b>	<b>44</b>
<b>4.1.2.3 Vaccine research &amp; development:</b>	<b>46</b>
<b>4.1.2.4 Vaccine Production Distribution</b>	<b>47</b>
<b>4.1.2.5 Vaccine authorization/approval:</b>	<b>48</b>
<b>4.2 The RICTA Model</b>	<b>51</b>
<b>4.2.1 Relativity</b>	<b>51</b>
<b>4.2.2 Investability</b>	<b>53</b>
<b>4.2.3 Complexity</b>	<b>54</b>
<b>4.2.4 Trialability</b>	<b>55</b>
<b>4.2.5 Adaptability</b>	<b>56</b>
<b>4.3 Outcomes of COVID-19 Response</b>	<b>57</b>
<b>4.3.1 Increased Investment in Innovation</b>	<b>61</b>
<b>4.3.2 Increased Participation of Firms in middle-income Countries</b>	<b>62</b>
<b>5. Discussion</b>	<b>54</b>
<b>6. Conclusion</b>	<b>60</b>
<b>References</b>	<b>64</b>

## INTRODUCTION

The COVID-19 pandemic, spurred on by the new coronavirus SARS-CoV-2, began in the last quarter of 2019 and spread swiftly to affect the whole world. The pandemic has significantly impacted social, economic, and public health, resulting in millions of fatalities. Since COVID-19 was discovered in Wuhan, China, at the end of 2019, the virus has spread worldwide (WHO, 2019). COVID-19 has brought dire consequences to the economy and different aspects of life. No one was immune to the virus, so it became very infectious.

The World Health Organization (WHO) declared a pandemic in March 2020 due to the disease's fast human-to-human transmission and subsequent rapid worldwide expansion (WHO, 2020). There were significant constraints on healthcare materials, hospital accommodations, and medical personnel due to the increase in COVID-19 cases that put pressure on the healthcare systems of many nations (WHO, 2020). This made it essential to find strategies to stop the virus's spread and provide efficient therapies and safety precautions (Badawi & Vasileva, 2021). Due to bans and other limitations, the pandemic caused significant economic hardship for businesses and individuals (Badawi & Vasileva, 2021). The pandemic's containment efforts, including travel bans and social isolation policies, profoundly affected routine, worldwide trade routes and businesses (He et al., 2021).

The development of vaccination was a vital technique to stop the virus's spread and save lives globally from fatal sickness. The most feasible approach to reducing the pandemic's effects was thought to be the creation of safe and effective vaccinations (WHO, 2019). Although creating a vaccine usually takes years, the urgency of the situation demands exceptional speed, and the epidemic generated a new kind of international cooperation among scientists, researchers, pharmaceutical corporations, and governments (Badawi & Vasileva, 2021). Due to accelerated

regulatory processes, some COVID-19 vaccines acquired emergency use authorization or full clearance at record speed (WHO, 2020).

Countries worldwide responded differently to the pandemic by rolling out countless/thousands of national policies, considered one of the most extensive global social experiments, to address the crisis, hoping it would work out well (Cheng et al., 2020). Some of these affected the global innovation networks.

Barnard and Chaminade (2011) defined the Global Innovation Network (GIN) as a “globally organized web of complex interactions between firms and non-firm organizations engaged in knowledge production resulting in innovation.” Innovations play a significant role in discovering the vaccine for the virus and other prevention strategies to contain the crisis. The knowledge and resources needed to birth these innovations are not found in a single location (Acemoglu et al., 2016), which is why actors in the Global Innovation Networks (GIN) must be able to conduct their business unhindered to produce needed innovation that will help in solving the crisis, especially in a knowledge-intensive sector like vaccine production.

It is essential to examine the impact of the policy responses on GIN in the healthcare sector to be better prepared for future pandemics and solve other challenges of a global nature. This brought about my reasoning as to what model of internationally acceptable guidelines would meet the needs of all stakeholders irrespective of their contexts and eliminate barriers to the activities of GIN when there is an urgent social cause. Against this backdrop, this thesis is set to understand how national policies during the COVID-19 pandemic affect the global health innovation network. Can countries use the same policy model to manage a pandemic or issues in their domain so differently? Are policies moving towards convergence or divergence? In answering these

questions, we shall be looking at the problems in different jurisdictions that influence the effectiveness and efficiency of innovative works across the globe.

This work contributes to three broad strands of literature: first is on policy mitigating COVID-19, another is on collaborative innovation network theory, and lastly, socioeconomic geography. There are studies on COVID-19 policies concerning managing international borders (Lee et al., 2021), limiting unintended consequences (Su, 2021), and cost-benefits (Cheng et al., 2020). Also, there are several studies on innovation networks concerning social impact (Leite, 2022), innovation networks challenges (Jialu et al., 2021), global connectedness (Turkina & Van Assche, 2018), strategies in knowledge-intensive business (Doloruex et al., 2019) being innovation-driven and for economic gain (Hurmelinna-Laukkanen & Natti, 2018), dynamic interaction of big and small firms (Gay, 2014) to mention a few.

Existing research pays more attention to the dynamics of the innovation systems, policy outcomes (Cheng et al., 2020), and policy effectiveness in a typical setting (Carracedo et al., 2020, Caiazza et al., 2021, Su, 2021) but as the “unannounced” challenges bedeviling our mother earth are increasing in frequencies and complexities, so is the need for increased knowledge intensity through collaboration to manage the myriads of these challenges and little is known about the interrelationship between emergency policies introduced in different jurisdictions and GIN whose work is very critical and essential in crisis management.

This is documentary research; it makes use of official documents as a data source (Bowen 2009). Their quality of evidence on public relations and societal meanings makes them a vital consideration, and of course their relevance to this research work is thoroughly verified. Using an analysis of secondary data and a case study approach affords the opportunity to dig deep into

context under review and overcome challenges that come with digital research. Information is sourced primarily from databases, online, and data available in the public, open-access repository.

The remaining part of the study is organized as follows: The next section presents the literature review, tracked by the methodology; we proceed to the analysis section, then our discussion section, and finally, the conclusion.



## LITERATURE REVIEW

Experience from the COVID-19 pandemic has shown the world that globalization and interconnectedness have imposed on us some shared commonalities and vulnerabilities and the need for us to be better prepared for future global emergency crises (Carracedo et. al 2020). This chapter aims to understand the ideas on the impact of national policies on global innovation networks (GIN) in the health sector leading to vaccine development in the face of the pandemic and the possible approaches for virus eradication through knowledge production. We would also examine issues in different jurisdictions that affect their national health policy. The focus of this analysis is based on literature relevant to our research path conducted under three main sections: (a) a review of the effects of national health policies in response to the pandemic, (b) the contributions/role of GIN during the pandemic, and (c) bridging the gap between national policies and GIN.

### **2.1 National Policies in Response to Covid-19 Pandemic**

The section shall examine countries' adaptability measures during the pandemic and their goals, capacity, and policy differentials observed among nations. The scholarly thoughts analyzed are conducted under three subsections for clarity and to keep it under the scope of the study.

#### **2.1.1 National Policies: As a tool for the public good**

National health security or general health and safety issues during the pandemic can be classified as a public good (collective sound or social good) (Oakland, 1987). National policies can serve as a tool to create or nurture public interests in a supportive atmosphere to protect citizens (Pellegrin, 2017). Following the COVID-19 outbreak, several billions of dollars of taxpayers' funds were

spent on projects like vaccine innovation, social innovation, and improving or expanding digital and health infrastructure, to mention a few by different governments around the world, even staunch critics or those that generally oppose governments' spending soft pedal to cooperate with those in power to resolve the crisis in the interest of (Firey, 2020). It is, therefore, important to state that public support is essential for policy acceptance and implementation, and a policy must be people-centered to achieve its purpose (Su, 2021).

Pellegrin (2017) states that public health policy can create opportunities and incentives. When COVID-19 was declared a pandemic, the US government initiated a program called Operation Warp Speed (OWS) to expedite action on the development, manufacturing, and distribution of COVID-19 vaccines (US Department of Health and Human Services, 2020); this eliminates financial challenges that generally come with vaccine research and development by supporting multiple vaccine technology, it encourages mass production and upgrades to logistical infrastructure for distribution. This serves as a motivation for drug manufacturers to innovate. Many national and regional governments worldwide (Canada, UK, EU, etc.) introduced similar measures, which helped in the quick discovery of vaccines for the virus and widened the knowledge scope and opened up other possibilities that couldn't have been imagined (Cross et al., 2021).

Another paramount importance of health policy is that it can set conditions and mandates that protect the public (Pellegrin, 2017). Dataset from 198 countries' policy action reveals that governments across the world rolled out one of the highest known numbers – over 13,000 - of policy experimentation in less than five months after the virus was first reported (Cheng et al., 2020); they include lockdowns, travel restrictions, international trades restrictions, risks communications, quarantine, social distancing, hand washing, testing requirements, use of

personal protective equipment, mask mandates, vaccine mandates among many others with the good intentions of quickly containing the virus and keeping people safe.

How governments responded to the crisis affected public health results locally and globally (Cheng et al., 2020). When WHO announced on January 30, 2020, that the COVID-19 virus was of international concern, the body advised against trade and travel restrictions. Some international legal scholars criticized some countries that ignored the advice and implemented regulations, and industrial players of sectors impacted by the measure, like aviation, as they argue that there is no justification for taking such action and are not acting in the good of the public interest (Lee et al., 2021). According to Lee, when the pandemic became more severe, governments of countries that delayed the adoption of the restrictive measures were also criticized for their slow or weak response, and authorities that removed or relaxed restrictive measures quickly were accused of easing restrictions too early. So, the timing of policy implementation must be correct to serve the public's interest.

### **2.1.2 National Absorptive Capacity: A moderating factor**

Absorptive capacity is the ability of an entity to recognize and utilize resources acquired from its environment (Sultana & Turkina, 2021; Cohen & Levinthal, 1990). It reflects how an entity can assimilate information to innovate or adapt to changes. This concept is commonly associated with firms and their innovativeness; its application also comes across different branches of social sciences (Caiazza et al., 2021; Omorede, 2020; Llopis et al., 2015), it also has a cognate relevance in the national context. A nation's absorptive capacity is a function of its knowledge and resources; these dependent factors are neither local nor global (Acemoglu et al., 2016) but are available in

different parts of the globe (Turkina & Van Assche, 2018), and they make a big difference between rich and developing nations.

In the pre-pandemic era, many national policies on health centered on managing the sector sustainably, that is, working resources to deliver optimum health services to citizens while mitigating environmental health hazards and keeping future projections in view (Chernozhukov et al., 2020). They opined that most developed nations invested more in innovation toward preventing prevalent diseases, which made it possible to reduce the pressure that healthcare facilities undergo. Developed countries have eradicated many diseases, especially infectious diseases, by investing in public healthcare and implementing proper policy measures. Some of these measures include maintaining a clean environment, waste management, and vaccination for any disease that threatens the public's health.

There has been much education on health issues, especially on nutrition and other health promotion practices, and the focus of government policies in healthcare for developed countries was on innovation and preventing non-communicable diseases, especially those emanating from issues of lifestyle (Hrytsiuk & Sak, 2021). They were also creating capacity for conditions that would reduce deadly illnesses such as cancer, which had been on the rise globally for a while (Hantrais & Letablier, 2020), and the concern of lifestyle diseases, which required a holistic approach that was more preventative. However, developing countries have been stemming from cases of infant mortality. There has been a quest to improve their absorptive capacity in health facilities, health professionals, and systems networks to increase access to healthcare services for their citizens. In many developing countries, citizens travel long distances to access healthcare services from government services. Many of these facilities need to be equipped, or healthcare services are unaffordable for most citizens (WHO 2020).

During the pandemic, most governments lacked preparedness for conditions that can cause a massive sudden stretch of their resources. In most countries, there was minimal capacity for intensive care units, considering only a few governments had anticipated a time when so many patients would require such services simultaneously as the COVID-19 pandemic (Wang & Alexander 2021). Many African countries that relied on foreign medical products were scrambling for alternatives when export restrictions were imposed on their essential supplies during that critical period (WTO 2020). While some rich countries like Qatar were able to turn to a local agency that improvised ventilators speedily and PPEs, among others (Ruhde & Singh, 2020), developing countries need more capacity. Very few nations like the US, China, and EU have the ability for highly knowledge-intensive medical products like vaccine development; worse still, some developing countries do not have the necessary supply chain infrastructure like cold-chain logistics and storage management, quality assurance, and IT resources, among others that the vaccines donated to them by COVAX required to administer them properly (Andersen et al., 2021). Therefore, the quality of a nation's absorptive capacity moderates the formulated and implemented policies. While third-world countries were thought to need more preparation, the pandemic showed how developed nations could not handle such a spontaneous health crisis (CRS report, 2020). The absorptive capacity of any country serves as a moderating factor for the type of policies that will be introduced (Andersen et al., 2021).

### **2.1.3 Differences in National Policies**

Policy changes society, and the rate of change depends on the societal context (Su, 2021). (Durand, 2018) In her book on marketing, globalization refers to differences in countries' contexts as distances. She categorized the differences into four groups: administrative distances, eco-techno distances, sociocultural distances, and geographic distances. The manner in which Covid-19

policies were implemented during the pandemic shows that spaces are still alive in many respect, for instance, for geographic reach – many countries restrict movement from countries with high covid-19 incidences, EU countries ease border restrictions to member countries only at a point in time before the rest of the world, for sociocultural distance – less attention to vulnerable groups (e.g immigrants in Qatar, seniors in Canada, UK, Blacks in the US), India relaxed movement restrictions and allowed for religious gatherings (religion is not a criterion in many countries for easing movement) which spiked up covid-19 infections to an unprecedented height (Su, 2021), for eco-techno distance – poor logistical infrastructure present a challenge for vaccine distribution that requires a cold chain, many poor countries relied on donation of vaccines from international communities (Durand, 2018, pg 81; Anderson et al., 2021), the healthcare cost burden is born by a different entity in different countries, for administrative distances - administrative powers are highly decentralized in some countries than others, differences in products standards, (Durand 2018, pg 81). Administrative space includes political, legal, legislative, organizational structure, and bureaucratic differences. Political factors influenced policies greatly during the pandemic (Cheng et al., 2020), and to what extent depends on the situation and the people in authority. For instance, former US President Trump’s administration has a different perspective on the Obamacare Act, a health policy introduced by his predecessor in the US. While both may be rooting for the same public good, their approach to achieving results differs (Chernozhukov et al., 2020).

However, from an epidemic and pandemic perspective - due to virus pathogenesis, population characteristics, medical and technological infrastructure, and communication availability - evidence from previous research indicates that effective policy in one context may not be effective in another (Cheng et al., 2020). Cheng et al. (2020) also argue that administrative structure and

political factors are primarily responsible for differences in policy formulation among world nations. The form of government in a jurisdiction affects the depth or scope of consultation before implementation. For instance, in federating states like the US- power is shared between regions and central government- policies can be made at the sub-national levels, which differ significantly from the main guidelines. More comprehensive consultations are expected on matters of public interests in democratic settings than in a unitary state of China where power is concentrated at the center. Decisions can be made quickly by very few individuals. These factors are familiar with the distances and absorption capacity challenges identified above.

Countries designed their national policies to protect their citizens and the public good. It is evident during the pandemic that their policies have some commonalities but vary significantly in implementation, and that is due to peculiarities in their jurisdiction. Understanding the differences in national contexts will help identify which policy needs to be standardized and which can be adapted by a country due to its context. It will help to develop a formidable global policy response to future threats with limited or unintended consequences. The following section will review the Global Innovation Network (GIN), a significant contributor during the crisis.

## **2.2 The Role of GIN in the Pandemic**

Barnard Chaminade (2011) defined the Global Innovation Network (GIN) as a “globally organized web of complex interactions between firms and non-firm organizations engaged in knowledge production resulting in innovation.” Three main characteristics of GIN based on scholarly articles reviewed will be discussed further.

### **2.2.1 Value creation through firms networking**

The modern world thrives on knowledge. The complexity and dynamism of the body of knowledge make it difficult to define its distinctiveness due to variances in factors that influence it, such as cultural, economic, and policy (Dell'Anno & Diu Giudice, 2015). Individuals, firms, and institutions seek knowledge that adds value to their offerings to remain relevant and keep up with changes in our dynamic world. Previous research suggests that incremental expertise in a field gives birth to more innovation in the same area (Acemoglu et al., 2016); for instance, the adenovirus vaccine technology is a product of two decades of research development (Cross et al., 2021). Also, innovation in a field can be complemented by discoveries in other areas (Liu et al., 2021); an example is biotechnological advancement, which has drastically reduced the time to complete virus sequences, usually from a few months to a few days.

Innovation is driven through formulation or interaction with many ideas, which can be internal or external. Organizations invest in research and development yearly to create knowledge that will add value to their offerings regarding qualities or make them more affordable through increased efficiency in their operation. The increased complexity of scientific and technological know-how and the quest for knowledge with limited resources compelled organizations to seek external collaboration (Turkina & Van Assche, 2018; Gay, 2014). Doloreux et al. (2019) research reveals a positive relationship between innovation types and openness to external ideas.

The concept of organizations' absorptive capacity plays a vital role in transforming ideas into innovation; without the necessary capacity, knowledge will be lost. Some countries returned COVID-19 vaccines donated to them due to the absence of cold chain infrastructure needed to deliver them safely in their distribution channel (Anderson et al., 2021). The internal capacity must



be considered before introducing a policy. Absorptive capacity must be developed at both individual and organizational levels (Doloreux et al., 2019) to attract a global solid FDI network (Sultana & Turkina, 2020) since funding plays a significant role in acquiring and maintaining the resources needed to transform the innovation to commercial value.

Value creation or innovation is critical in solving most human problems, especially in times of crisis. For instance, innovations in some modern military warheads and artillery were developed during the World Wars. Also, the discovery of COVID-19 vaccines in less than a year is born out of human ingenuity. So, it is essential to allow unrestricted access to the body of knowledge that will help create solutions to teething and future global challenges.

Knowledge and resources are not located in a spot (localized) or available everywhere (globalized) (Acemoglu et al., 2016) but are available in specific locations around the world. They must be tapped into to boost local innovation performance (Turkina & Van Assche, 2018), so firms must establish international linkages to increase their competitiveness.

### **2.2.2 The Global Innovation Network Structure and Analysis**

The location of interrelated and allied firms in proximity is defined as a cluster (Turkina & Van Assche, 2018; Porter, 1998). The GIN ecosystem comprises educational and research institutions that provide the skills and entrepreneurship activities funders that provide access to critical financial needs. These institutional establishments offer the necessary support, mobility of resources, and interpersonal networking, among other factors. Clusters are innovation-centric, and firms in groups easily access a pool of resources- both human and capital, information, and cheaper support services- downstream and upstream of their operations, customers, and many more to achieve competitive advantage. All the knowledge and resources needed to innovate are not

available in a location – localized (Turkina & Van Asche, 2018; Acemoglu et al., 2016; Wolfe & Gertler, 2004).

On the other hand, knowledge and resources are only available in some places (globalized), meaning they are not equitably distributed worldwide, as pointed out by (Acemoglu et al., 2016). In contrast, knowledge and resources are available in different parts of the world, in clusters mainly, and they are distributed equally and have an extra depth of knowledge (Turkina & Van Assche, 2018; Mudambi, 2008). For this reason, organizations focus on their core competencies and seek external cooperation to access knowledge or resources they lack, so they need international collaboration.

Turkina Van Asche (2018) stated that the ability to tap into foreign locations' knowledge depends on a cluster's structural embeddedness. Similarly, Jialu et al. (2021) argue that organizations with a high level of creativity stand a better chance of getting a valued collaborative partner in the network. The knowledge for the covid-19 vaccine development is highly intensive; the major covid-19 vaccine developers are well embedded in some of the most advanced biopharma clusters in the world (New York - Pfizer, Moderna – Massachusetts, Cambridge/Oxford – AstraZeneca); this enabled them to the entire network of production facilities, funding institutions, institutional support, supply chain infrastructure, and many more.

International collaboration blossomed to an unprecedented level among scientists in GIN in the biopharma and biotech sector during the COVID-19 pandemic in a bid to find a solution to the crisis, like information sharing on risk communication and prevention, data sharing on covid-19 virus genome sequencing (WHO, 2020), covid-19 vaccine development, covid-19 test kits development among others which many lives from the casualty figures.

Also, a rise in innovative international/institutional platforms was observed pre-pandemic; they are non-governmental, not-for-profit organizations set up to address specific issues among GIN. The Global Initiative on Sharing Avian Influenza Data (GISAID) is an excellent example. Due to media publicity given to human fatalities caused by influenza in January 2006, this consortium emerged within the scientific world; they created a platform that enhanced public sharing of influenza data in a verifiable and transparent manner, which the traditional method does not present (Diamond & Pierson 2020). This was a big boost for vaccine developers during the pandemic as the body facilitated the release and publishing of the COVID-19 virus sequences (WHO 2020). The organization was formally launched in May 2008 at the sixty-first World Health Assembly; since then, it has received tremendous cooperation from WHO member states and other contributors to the body of knowledge whose concerns have been addressed (GISAID website 2022).

The crisis impacts GIN's activities in several ways, but their contribution was tremendous, hence the need to discuss their socioeconomic impact.

### **2.2.3 Effects of Covid on GIN (Socioeconomic cost-benefit on GIN)**

Carracedo et al. (2020) describe the pandemic as an unforeseen problem that has affected all facets of the globe and existence, leading to some sought of globally accepted new and compulsive behaviors, revealing obsolete productive sectors and the need for less dependence on external agents, as well as an emerging new consumer market, and making virtual business ultimately gaining global ground, which triggers innovation dynamics leading to increase demand for research and development by most hit organizations.

Lazarus et al. (2020) corroborated that the pandemic has affected lives and livelihoods and that it is an issue of public health, and policy formulation from local authorities is one of the most widely used tools to respond to the crisis. Gupta et al. (2020) findings unveil that the local authorities reacted by contributing funds for research such as creating a vaccine or cure or prioritized program and informing research institutions of the internationally available funding for the studies on the virus. Furthermore, institutions were guided and supported to succeed in acquiring such funds. Local authorities realize that funding will be critical to help research institutions develop innovative solutions that would address challenges posed by the virus. These academic scholars all find that local authorities set apart special funds and grants to allocate to private research institutions and partners to come up with solutions to the pandemic, realizing that a lack of funding will be a barrier to helping research institutions develop a vaccine or cure or a solution to the virus. Nonetheless, this may suggest that different countries adapt to a model based on their context.

Paunov (2010) discovers that the Global Financial Crisis (GFC) of 2008 caused significant innovation project discontinuations due to financing constraints and that younger firms and those depending enormously on foreign firms and markets stopped ongoing innovation investments, whereby access to public funding, by contrast, prevented such discontinuations. A similar pattern repeated itself during the pandemic. Zuo et al. (2020) found that several innovation projects were negatively impacted across many sectors; projects involving external collaboration and introducing new products to markets were delayed as attention was focused on navigating the crisis. According to Zou et al. (2020), the dispute between the US and China also forces firms to invest more in R&D innovation. Meanwhile, the rapid digitalization of operations enabled some firms to withstand the challenges and allow IT firms to profit from increased demand for their services. Biopharmaceutical and biotechnological firms also benefited from increased investment

in innovation to develop diagnostics, protective equipment, and vaccines that would save lives. All these suggest the impact of COVID-19 on GIN. More so, the rate of recovery from the global crisis may depend on understanding which sector was most hit by the problem and the state of the innovation investments to enable the formulation of efficient post-crisis recovery policies.

### **2.3 The divide between National Policies and GIN**

Before considering the impact of various government responses towards mitigating the effects of the COVID-19 pandemic, it is essential to investigate the background to grasp its footprints on the global economy, the health sector, and GIN.

This section analyzes the need for cooperation, how policies constitute barriers to GIN activities during the crisis, and how international institutions play a role; this understanding will help GIN to foster knowledge production, thereby meeting the needs of all stakeholders irrespective of their context and to be better prepared to tackle present or future challenges as further delays to solutions to issues of global concern due to technological lock-in in each country could result in devastating human casualties and severe economic consequences.

#### **2.3.1 The covid-19 pandemic: The Reason for further cooperation**

The WHO defines an epidemic as a disease outbreak consistently present in a regional or geographical area, while a pandemic is when a disease outbreak cuts across international boundaries. COVID-19 was declared a pandemic by the world body on March 11, 2020. The pandemic had its unique characteristics, which compare differently to the previously known crises the world has witnessed, like the 2003 SARS outbreak and the 2009 HINI flu.

It is important to note that the World Health Organization (WHO) declared SARs as an epidemic in February 2003; it is also a coronavirus but was contained enough to avoid being classified as a pandemic (Kopecki et al., 2020; LeDuc & Barry, 2004). According to Welsh J. (2020), when the 2009 H1N1 swine flu outbreak was declared a pandemic, some scientists believed there was insufficient evidence for such an action and criticized WHO's decision as premature; this contributed to the delay in announcing COVID-19 as a pandemic to allow for evidence gathering. However, the organization was criticized for not declaring it a pandemic earlier. Recognizing that the potential for global pandemics has increased over time is essential, thus presenting a unique challenge like COVID-19 (Lazris & Rifkin, 2021). The world has become a global village in the 21<sup>st</sup> century; transport has become more effective, and the movement level of goods and people has become more rapid. Therefore, a disease could spread quite far before it is identified. Also, the global population has increased significantly, thus making it even more challenging to control the virus (Lazris & Rifkin, 2021). For instance, in Wuhan, China, where the virus was first spotted, it spread quickly because of the population density (Zuo et al, 2020). Most places within the city were crowded, and considering the spread mode, the transmission rate was rapid.

The infection rate after the emergence of the COVID-19 virus is the underlying challenge that was recorded. For instance, the US has recorded over one million deaths from the onset of the pandemic, according to the USAFacts.org report of 2022. The mortality rate associated with the pandemic is overwhelming (USA Facts, 2022). None of the previous diseases mentioned above have recorded such a human catastrophe and have been able to attain the total deaths on a global scale that have been orchestrated in the US jurisdiction alone in this 21<sup>st</sup> century. As a result, the COVID-19 pandemic had a higher mortality rate per infected individual than any earlier diseases of comparison.

The public healthcare systems of different countries were overwhelmed by the pandemic, especially in curtailing its spread. Once available needs became inaccessible or restricted, the race to solve the problem became dire. As the mortality rate for virus-infected individuals rises, it poses a severe challenge to innovators worldwide to devise solutions to curtail the virus. The shortage of specialized equipment or cures to treat infected individuals in many countries was the ultimate factor that brought the issue to the fore. The need for the provision of personalized protective equipment for healthcare professionals and the public, in general, became the underlying factor causing the cost of offering treatment to patients during the pandemic to attract high medical expenses (Nie & Elliott, 2020).

A UN report (2004) on global health initiatives called for actions that are not limited to preventing or treating diseases but also provide global defense against natural disease outbreaks and bioterrorism that can be very costly to human lives. However, the warning was ignored (Welsh J., 2020). The same call was echoed by some G7 leaders in 2015 about the Ebola outbreak. According to Welsh J. (2020), many competing national policies are witnessed in the global space during the pandemic regarding trade, PPEs, and vaccines, to mention a few. The two countries with the biggest economies traded blame against each other. The US blamed China for the pandemic and for withholding information at the early stage of the pandemic and decided to put its interest first rather than supporting global response to combat the crisis. China on the other hand saw it as an opportunity to extend its global influence after condemning the poor US leadership response to the crisis. According to Welsh, experience from the global response to the pandemic reveals some factors that greatly influence global health security: political interests of the advanced countries, the cost of health security, and institutional effects of health security. These factors ensure global

efforts are tilted towards favored interventions and not necessarily the ones with high human casualties.

The issues above call for a rethink on how to strengthen global cooperation on many fronts, among which is to facilitate the activities of scientific and technological innovators rather than polarizing them through political and personal interest. By this, global action would not only be preventative but also responsive and inclusive. WHO, in its March 30, 2021, report, is set to adopt an all-of-government and all-of-society approach to improve the global health architecture in areas such as research and data sharing, worldwide production and distribution of public health treatment products such as diagnostics and PPEs, vaccines, medicines are a step in the right direction.

### **2.3.2 Governments' Responses to COVID-19**

Although the pandemic has the potential to cause even more significant harm, most governments have been able to control it to a greater extent due to collaborative efforts across the globe and various policy experimentations. Governments rolled out countless policy instruments to mitigate the effects of the Covid-19 pandemic. Innovation plays a critical role in this regard. However, the experience during the pandemic shows that implementing a national health policy meant for the public good can have flaws or result in unintended consequences (Su, 2021). Let us discuss some guidelines that help contain the spread of COVID-19 and how they affect the global innovation network.

First is a lockdown, which is the restriction of all non-essential movement. It is the most widely used measure to contain the spread of COVID-19; data from our world data website indicates that over 90% of countries adopted lockdown measures at one time or another, either at the national or sub-national level, to curb the spread of the virus. Carracedo et al. (2020) believe that globalization



and interconnectedness are the primary stimulus for the global reach of COVID-19. He further argues that the vulnerability of the bedrock of economies in the twenty-first century, which depended on a globally connected value chain, has been exposed by the lockdown imposed by authorities and that nearly all offshoots of human activities were affected by the lockdown, which resulted in a steep decline in consumption. This may explain the socioeconomic cost (unintended consequences) of COVID-19, which does not benefit GIN, as consumption, which is the request for GIN, will be reduced to country-based requirement innovation, such as a specific model of adapting to a pandemic. Markard et al. (2015) buttress this point by stating that policy intervention focusing on a country might neglect the contribution of GIN.

Furthermore, the effects of the lockdowns on the public include an increase in mental health issues, a rise in domestic violence, and the collapse of many business activities - such as SMEs - that cannot be run from home (Caiazza et al., 2021), among others. The unprecedented global rate of adopting lockdowns during the COVID-19 crisis was also ideally not focused on the encroachment of human rights; it was informed of the need to manage the COVID-19 pandemic from being a disaster that is increasing fatalities to the public. The government must protect the public from preventable fatalities, even when it involves restricting some ordinary people's rights. However, the lackluster response from the crowd was the major challenge the US faced in curbing the severity of the pandemic (Gharpure et al., 2021). Finding the right balance between managing a problem of national emergency and feeling that the government is infringing on public rights and freedom is not a decision that comes easy.

Secondly, in the quest to contain the spread of the virus, movements were restricted both locally and across international boundaries. Travel restriction is another very effective strategy adopted during the pandemic to control the transmission of the virus (Hantrais & Letablier, 2020).

International travel bans were implemented when the infection rate escalated, causing some countries' economies to nearly halt. (Chernozhukov et al., 2020). For instance, many countries halted flights from China at large to their countries to reduce the chances of importing viral infections into their country. This was received with mixed feelings as the level of disease has never been equal across all nations. Countries with lower levels of infection tried to protect their citizens by restricting or banning travel from countries with high incidences of COVID-19 infection.

The restriction of international travel by countries devastated some industries, like tourism, hospitality, entertainment, sports, aviation, and many more. Only a few economic activities can be run from home; therefore, when people are not going to work, their business lags significantly. At the same time, a good number also collapses, and when they are shut down, there would be no motivation to innovate. If movements had been allowed to continue more freely, it would have been quite challenging to control the spread of the virus up to date. The graph of infections rose in a sigmoid manner, thus allowing governments to prepare quite well for possible eventualities.

Thirdly, international trade policy was a visible phenomenon during the crisis as a diverse mix of international trade policies, such as trade liberalizations or trade controls, were implemented (Santi et al. (2020). According to Santi et al., trade-related policies significantly increased as COVID-19 cases rose initially, and trade policies targeted toward medical supplies and personal protective equipment almost tripled that of food and agricultural products. Some countries apply a different mix of import liberalization or import restriction and export restrictions or export liberalization; some apply just a single policy while others do not, so trade instruments application is heterogeneous across the nations of the world.

The dataset on food and agricultural products released by WHO 2022 shows that half of the export restrictions applied during the pandemic are from G20 nations, while most import liberalization policies are from poor and heavily dependent countries.

As the coronavirus outbreak spreads worldwide, countries must secure essential supplies to prevent the spread and keep their citizens safe. The supply chain was disrupted due to the movement restrictions and increased demand for medical supplies on the global stage, such as PPEs, ventilators, and masks, whose demand surged thirty-fold, according to Statista (2022). Major exporting countries of essential medical products restricted the exportation of these items and ramped up production because they could barely meet their local demands; this drew huge criticisms worldwide, especially from countries that hugely depend on them to meet local needs.

A similar occurrence happened immediately after the COVID-19 vaccine discovery. The exportation of vaccines was restricted initially in some jurisdictions that hosted the production facilities, and vaccine developers could not fulfill their obligations on time to their foreign customers, that is, delivery of vaccines when due (Su, 2021). This action can weaken trust among nations and have multiplier effects on GIN. However, some innovators in countries with scarcity take advantage of the situation and create substitute products, especially products with a low intensity of knowledge like PPEs and ventilators, among others (Ruhde & Singh, 2020), this is positive for innovation but may encourage country-specific innovation.

The fourth point is on risk communication; Government authorities use different means to communicate the risks associated with the virus to their populace. They educate them about the virus and give regular updates on how to take precautions and be safe. They also partnered with WHO, which offers updates on the level of risk on various issues regarding the virus. For instance,

the WHO has kept engaging health professionals to suggest the best ways to treat patients and ensure they are safe (WHO, 2020), as the virus does not discriminate against the people it infects. One of the lessons along the learning curve is not to discriminate against any group when it comes to risk communication; it was an eye-opener for some national governments regarding the need to carry everyone along and that no group of individuals should be left out during a pandemic. According to Ruhde & Singh, (2020), the Qatari government's attention was primarily on its citizens at the start of the pandemic; the country played host to a segregated population of immigrant workers whose numbers almost quadrupled that of their national. While they effectively contained the spread among their citizens, the outbreak spiraled out of control among the segregated population of workers, which in turn put the lives of their citizens at risk. The country then mobilizes its national resources to intervene before subduing the whole country. Even the most developed countries like the US and Canada, among others, experience a similar situation where the vulnerable groups recorded the highest casualty figures; this triggers a lot of social innovation actions to respond to the crises, e.g., creating awareness in different languages, virtual health treatment, or assistance among others (Lazris & Rifkin 2021).

Lastly, compulsory vaccination or making vaccination passports a license to unrestricted movement is one of many other government policies that were very controversial during the pandemic. At the same time, some leaders believe that vaccination of all citizens is the best way to get out of the problem, thereby trying to make it unavoidable so that everyone can get vaccinated; some citizens believe that the government is violating their rights and that movement restrictions are discriminatory against them. Pushbacks from some individuals and groups were recorded in different parts of the world against governments' continued regulation of movements, notably the "Freedom Convoy of 2022" in Canada.

### **2.3.3 Removing/Dealing with the Barriers to Global Innovation Networks (GIN)**

Policies are crucial instruments that can determine the scale of cooperation between players to ensure that public healthcare is advanced sufficiently. During the height of the COVID-19 season, different nations introduced several policies that suited their national interests. Some policies on health matters yielded unintended consequences as described above (e.g., the liquidation of many SMEs and a decline in consumption, which motivated innovation due to lockdown measures). Some have flaws that negate the spirit of good global citizenship (e.g., the US refusal to participate in the COVAX initiative, a worldwide effort to coordinate and finance international vaccine program development in 2020, but rather focus on America (Cohen, 2020)).

The COVID-19 pandemic caused the need for radical measures in vaccine research that were essential for managing the pandemic. Vaccine developers such as Oxford-AstraZeneca, PfizerBioNTech, and Moderna leveraged international cooperations, external partners, and open-sourcing information to develop and produce high-quality vaccines that helped reduce the fatalities recorded during the pandemic (Bargain & Aminjonov, 2020). The cooperation of the Oxford Research Institute and AstraZeneca was facilitated through the policies upheld by the US and UK jurisdictions (US Centers for Disease Control and Prevention, 2021; Bargain & Aminjonov, 2020). While this is positive for GIN, the ensuing projection of policies during the pandemic significantly influenced the cooperation models among various global innovation network actors outside GIN's interests. For instance, the relationship between CanSino and its Canadian partner, the National Research Council of Canada, dated back to 2013 and was quashed in 2020. Both organizations announced their collaboration on COVID-19 vaccine development on May 12, 2020 (Govt of Canada, 2020), but the partnership ended due to the refusal of the Chinese customs to allow

samples to be sent to Canada for trials; the Chinese government involvement is believed to be for a political reason.

Further, when a nation's policy is against the interest of other countries, for instance, banning or restricting the export of essential goods in critical needs like the pandemic, the nations at the receiving end will scramble for alternatives that will land them into safety (Su, 2021). To safeguard their national interests or minimize their dependencies/ vulnerabilities in the foreseeable future, the nations at the receiving end might also enact policies that might be country-specific and not be in the interest of GIN and may further weaken trust and cooperation among global nations, which is the foundation for solving other global challenges (CRS report, 2020). Now that the crisis is reasonably contained and vaccines have been developed, we are entering a geo-political era and must be more prepared to overcome the future situation (RAPS 2022). Knowledge creation is crucial in solving problems, especially in crisis periods like COVID-19; it is imperative to allow unhindered/unrestricted networking among global innovators to tackle a global crisis in which the knowledge requirements might not be readily available in a single location.

It is established that the national policies of an economy would continue to influence the dynamics of cooperation enacted among innovators of jurisdictions that embrace the cooperation deal or not. Thus, the existence of administrative factors (policies) that inhibit the work of GIN.

It is necessary to establish policies critical in managing urgency and creating a universal solution to problems once they occur respectably. The covid-19 is an eye-opener to how interconnected countries are and why there is a need to re-examine current policies to develop a standard approach to managing an international crisis like the pandemic. Carracedo et al. (2020) believe adapting quickly to new requirements will be essential for survival. International bodies and authorities

should focus on helping organizations introduce tech and social innovation to recover. Therefore, it is necessary to recognize what approach countries can adopt to achieve meaningful success over the future pandemic.

### **Conceptual Framework**

The literature review provides an overview of the relevant subjects of discussion to our research path. While it is the government's priority to mitigate the effect of the pandemic in their jurisdiction, it is equally essential to pave a smooth way for the activities of the global health innovators to strive at the same time, for they create value that may be knowledge intensive. Their products are crucial in mitigating the effect of a "pandemic-like" disaster. However, shortcomings observed in national policy experimentations during the pandemic indicate a gap, which we expanded on and suggested a way forward.

In the analysis section, we presented

1. A case study to examine two countries whose policies on socioeconomic life and vaccines have significant effects that transcend their borders. A country's policies can rubbish the preparedness of even some of the most advanced economies in crisis. When it comes to knowledge-intensive solutions, no country can be an island.
2. The RICTA model illustrates the complexities surrounding the global network structure of vaccine innovation, which is knowledge-intensive, very costly, and attracts limited pre-pandemic investment but can be very effective in containing the crisis.
3. The outcomes of the first part of our analysis. This is the highlight of our research; it provides an insight into how nations respond and the opportunities or contributions that abound.

On this basis, we make a case in our discussion for the convergence of policies to further enhance global innovative practices and exploit the best human ingenuity to safeguard humanity from our present and future shared vulnerabilities.



## **METHODOLOGY**

The nature of this research is a secondary approach (desk-based study), that is, the use of data from a variety of existing compilations of information to address our research question (Wickham, 2019). Engaging the use of secondary data sources entails a combination of scholarly articles on theoretical models and conceptual frameworks and published academic literature such as textbooks and journals. Gray literature such as newspaper articles, research papers, NGO reports, conference proceedings, and archival data repositories were also engaged. I compiled a large volume of data from the websites of the Canadian government, World Health Organization, Coronanet, Ourworldindata, United Nations Organization, and World Bank, among many others, using Search Engines and Online bibliographies and processed them to arrive at a reasonable submission. These materials help answer the research questions as they provide more comprehensive information and allow the blend of more relevant studies whereby investigations are made from all the necessary and appropriate views of available evidence essential to explore, blend, and analyze the research questions and to draw on the conclusion and recommendation from the findings.

Some criteria for selecting this literature and excluding other pieces were based on the source and integrity. The authors' credentials in management, health, economics, and financial development partly guided whether the information is trusted. More consideration was also given to arguments supported by evidence such as case studies and historical materials and to objectivity, that is, whether the works of literature are fair and impartial in treatment or judgments. Finally, it looks at the value of the arguments and conclusions of the literature, if convincing, and if it has significant contributory views to understanding this paper's topic. These criteria help to draw on varying viewpoints and set the scene for disentangling complex patterns of the impact of COVID-19 on GIN.

In a bid for successful research, a case study was considered in the health sector. The pandemic has shown that investing in quality health infrastructure makes sense from economic and social perspectives. The proposed countries shall be China and the United States. The choice of these countries is a result of their policy approaches to addressing the pandemic and their contextual differences, which represent a liberal society and a conservative society. Both countries are top-ranked manufacturers of medical products of all categories, and their share of contributions to the global innovation network is among the largest in terms of both capital and human investment. The virus emanates from China, but the US recorded the highest incidence of the virus, while they both struggled to contain the spread, the policies of the two largest economies during the peak of the crisis had a far-reaching effect on the activities of GIN that is looking for solution to the problem and global well-being.

Also, the COVID-19 vaccine discovery analysis will be considered; vaccines are knowledge-intensive products and one of the results of GIN. The birth of this innovation is crucial in managing the pandemic.

The case study approach offers unique richness in studying complex issues while retaining the holistic characteristics of real-life events (Charles-Cole, 2011, pp.17-28). It specializes in providing ‘thick descriptive’ information (whether investigating a single subject or small groups) based on specific contexts that can give research results a more human face as it is often associated with a location, such as an organization or a community (Naami & Mikey-Iddrisu, 2013). Therefore, this case study will seek an in-depth understanding of COVID-19 policies on GIN, their barriers, and their benefits in the health sector both socially and economically to fine-tune ways of work and encourage knowledge production to meet acceptable models to adapt to global pandemics.

Although the research proposes to dig deep into pieces of literature, the nature of the research type, which is desk-based, often centralizes on a specific problem or place where results may not apply to other sites. As well as the fact that the research may benefit from a less extensive sample size questionnaire given that the COVID-19 crisis has changed ways of work. It enforces social distancing and stay-home policies imposed by the government as a way of mitigating the pandemic. Also, the research may be affected by internet services as the majority operate via this medium, which may result in bandwidth congestion and slow internet connectivity. In addition, I would have benefited from colleagues who, when physically together, could share ideas face to face and discuss on a longer note. More so, issues of academic dishonesty and plagiarism may arise, and to overcome these, efforts have been made to ensure that research sources are appropriately cited.

## ANALYSIS

### 4.1 Case Study: China and US Policies during the Covid-19 Pandemic

#### Case Description

China and the United States are the two nations that drew massive attention during the pandemic; in the case of China, the COVID-19 virus was first detected before spreading to other parts of the world. The world looks to them for information about this virus when it becomes a global concern. Besides the virus pathogenesis, China is the largest exporter of manufactured goods; the country is also one of the top seven leading exporters of medical products and the largest exporter of personal protective equipment, which was in critical demand to control the spread during the pandemic. Also, the country introduced a range of measures during the pandemic, such as policies on risk communication, lockdown, and nationalization of the PPE supply chain (export restriction). To mention a few, these policies not only affect China but have a multiplier effect on other countries. The nation hosted Sinopharm and Sinovac, makers of the BBIBP and Coronavac vaccines. Both are among the top-tier COVID-19 vaccines given emergency authorization by WHO and many other countries.

Similarly, the United States (US) policies significantly impact locally and other countries. The country has the largest pool of advanced resources in terms of human and capital, which is crucial in creating a vaccine needed to control the pandemic. The US hosted Pfizer, Moderna, and Johnson & Johnson head offices, makers of the Comirnaty vaccine, Spikevax, and Janssen vaccine, respectively. They are top-tier COVID-19 vaccines given emergency authorization use by WHO and received the most significant number of emergency authorization use by countries. The nation is also the largest exporter of medical products; the country is host to several specialized and

knowledge-intensive firms and organizations in the diverse health field. They have advanced and sophisticated innovation clusters that are well embedded and very influential in the global innovation networks with access to tremendous resources. They also host many industrial and service sectors, among the world's most extensive.

However, the strategic position of these two nations in the world makes their policies critical in the dynamics of the global innovation space. This makes these nations a perfect selection for a case study analysis.

## **Case Analysis**

### **4.1.1 Policy Effects on Socioeconomic Life**

Several factors largely influenced the management of the coronavirus pandemic by China and the US. First is the governance style in both jurisdictions. China runs a communist system of government, governance in China is more of an authoritarian manner, and power is concentrated in a few hands at the center. It is easier and quicker for them to make decisions, unlike the United States, which is democratic, and power is shared between the center and state governments, meaning more comprehensive consultations are often considered before making a policy. When the national government makes a policy during the pandemic in China, there is zero tolerance for non-compliance to the measures taken by the administration. However, in the context of the US, policies introduced at the national level are sometimes challenged by the regional governments or the public in court if not wholly ignored, slows down policy implementation, and aggravates the devastating effect of the crisis. We examine the four measures introduced in both contexts and how they affect them.

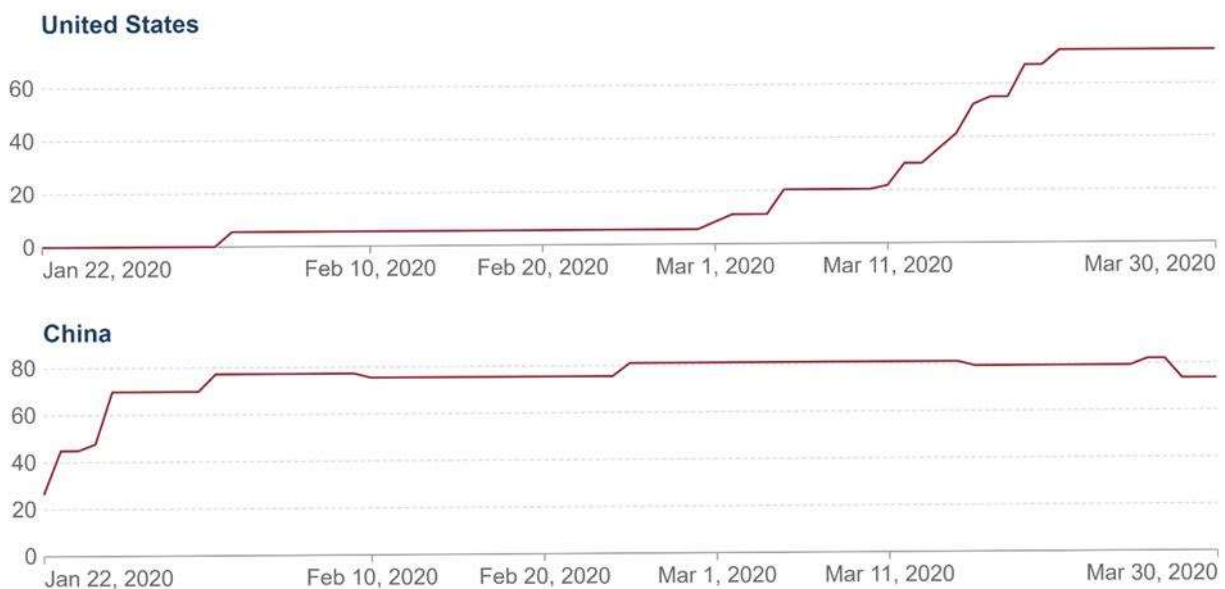
**i. Lockdown:** Lockdown is one measure widely introduced during the pandemic; the measure was much more stringent in China, and the citizens cooperated, but, in the US, despite raising a less rigorous standard at various subnational levels, their government still encountered the challenge of compliance to the measure by the populace.

## COVID-19: Stringency Index

Our World in Data

The stringency index is a composite measure based on nine response indicators including school closures, workplace closures, and travel bans, rescaled to a value from 0 to 100 (100 = strictest).

■ Non-vaccinated ■ Vaccinated ■ Weighted average of vaccinated and non-vaccinated



Source: Hale, T., Angrist, N., Goldszmidt, R. et al. A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker). Nat Hum Behav 5, 529–538 (2021). <https://doi.org/10.1038/s41562-021-01079-8>  
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Fig 1: Lockdown Stringency Level during Covid-19 Pandemic

Figure 1 is a graphical illustration of the highest level of stringent lockdown measures in any part of the two countries under review within the period of ten weeks (Jan 22 to Mar 30)- seven weeks before the time COVID-19 was declared a pandemic by WHO and three weeks after that date, out of 100 which represents the highest stringency level, China score 75+ throughout the period while US stringency level rose from meager 5.5% to just a little above average a week after a pandemic

was declared. The US recorded 299,951 COVID-19 cases and 3,299 deaths per million, whereas China, where the virus was first detected, recorded 208 COVID-19 cases and four deaths per million (Worldometer, 2022). This supports some arguments that the early introduction of strict lockdown measures and not lifting them too soon is most effective in controlling viral transmission/spread. Countries may resort to this measure to curtail the future viral spread. It is essential to make adequate preparations by putting in place modalities that will minimize the burdens or consequences of this policy on the people- healthcare cost, mental health- economy, healthcare personnel, essential service workers, and global innovation network. This has also created opportunities for innovations that will minimize physical contact in healthcare administration.

**ii. International travel restrictions:** These were widely adopted measures when COVID-19 was declared a pandemic. Countries quickly ban or restrict international movement from nations with a high incidence of covid-19 virus or its variants during the pandemic.

International travel ban/restrictions					
Country	May 31st, 2020, ms/rank	Dec 31st, 2019, ms/rank	Dec 31, 2018, ms/rank	Dec 31st, 2017, ms/rank	Dec 31st, 2016, ms/rank
China	56/39	80/63	75/60	63/65	56/67
US	80/18	171/3	165/3	158/4	155/3

Table 1: own elaboration based on Passport Index (mobility score/ranking)

Table 1 shows the global mobility score (gms) for China and the US four years prior to the detection of the virus and five months later. Both countries’ indexes have been on an annual

increase from the 2016 year-end to the 2019 year-end, but China's index slid by 24 gms at the end of May 2020 due to the COVID-19 pandemic while the US slid sharply by 91 gms during the same period. Due to China's ability to control the spread of the virus, even though the coronavirus was first discovered in its territory, its GMS did not decline steeply like the US, whose cases and mortality rate almost spiraled out of control.

One of the oldest health measures in protecting local public health is through the health screening conducted on migrants (Macpherson & Gushlak 2017). The US government recognized the fact that new entrants into the country might have had exposure to some health risks that could affect the local community health or pose personal health challenges, but the screening is limited to refugees and visa immigrants. The current policy exempts citizens and legal residents of the country who travel outside and re-enter the country from health checks, and this loophole in the policy became the leeway for the COVID-19 pandemic to spread into the nation. As international travel restrictions were implemented across nations of the world to control the spread, some experts argue that banning international travel from a country because of a crisis could result in negative consequences as the nation could be isolated further economically thereby compounding its economic woes. For instance, where aviation, travel, or tourism revenue contributes significantly to the GDP, a country may be tempted not to disclose the risk in its domain as quickly as possible for fear of reprisal.

**iii. International trade policies:** China and the US implemented export restrictions especially on essential items like PPEs at the early stage of the global pandemic. According to the CRS report (2020), when COVID-19 became a significant health concern in China, the government assumed control of domestic manufacturing and distribution of essential medical products and mop-up stocks in the global market, all for local use. They also refused to grant an export license to the



Canadian partner of CanSino Biologics; both are collaborating on developing a COVID-19 vaccine, among other measures (Statistics Canada 2020). The US government followed in a similar direction when the COVID-19 crisis was declared a pandemic by restricting exports of PPEs; manufacturers were expected to prioritize local demands before other countries. A similar pattern was observed in the distribution of COVID-19 vaccines; export restriction was introduced in the US at the initial stage when the vaccine was discovered. However, some of their export control measures are short-lived in the face of severe criticism as they revert to liberalizing their exports.

	country	export value (\$)	share of world medical exports (%)	med equipment	med supplies	medicines	PP products
	World	995.8	100	14	17	55	14
#2	US	116.6	12	25	29	35	12
#7	China	51.6	5	19	22	10	49

Table 2: own elaboration based on WTO 2019 medical exports

Table 2 shows elaboration from the World Trade Organization (WTO) 2019 medical report that China and the US control 17% of global medical exports, which is significant, especially in the crisis period. During the global supply shortage, a country like Qatar was able to take advantage of the situation and developed local capability more so in products with less specialized knowledge, like PPEs and ventilators, among others (Ruhde & Singh, 2020). This is positive for innovation and the countries to avoid overdependence on foreign nations, but this could encourage country-specific innovation.

**iv. Risk communication:** The management of COVID-19 information in China was described as secretive by some experts and was regarded as a factor that helped play down the severity of the negative impact of the pandemic on the jurisdiction (Chernozhukov et al., 2020). Even though they have some information about the virus that they could have updated the international community with, the genome sequence of the virus was not released on time until a trusted ally in WHO engaged the government intensively to seek their cooperation before the virus sequences were approved for publication. Meanwhile, in the US, misinformation about the COVID-19 virus and COVID-19 vaccines contributed mainly to developing conspiracy theories that lack scientific merits and later vaccine hesitancy. The US prioritizes the interest of its populace, that is, putting American interests first, and shows little interest in global cooperation until they reach a comfortable position. Fig 4 shows a risk communication matrix designed to elaborate on the effectiveness of the countries under consideration.

Communication Matrix		Insights	
		China	US
1	Adapting communication to the local context	Primary – Due to the low level of diversity	Complex - due to high diversity
2	training spokespersons for effective communication	Basic - limited info sources and are controlled	Complex - multiple uncontrolled sources of info
3	combating sources of misinformation and disinformation	Essential - Zero tolerance due to administrative style	Complex- tolerance due to the system of administrative (foi)
4	improve data-sharing infrastructure and methodologies	Secretive - data are micromanaged	Openness - a fair level of transparency
5	engage organizations working with at-risk groups	Basic – limited	Mild – some form of engagement
6	developing a shared language based on feedback that will resonate with people of different beliefs	Basic	Complex
7	adopting bidirectional communication	Basic – uses a top-down approach	Mild – some element of bidirectional communication

Table 3: own elaboration based on Overton et al., 2021 report.

#### 4.1.2 Policy effects on COVID-19 vaccine innovation

Containing the COVID-19 virus is a collective responsibility of all and sundry. Every nation that has successfully curtailed the virus benefited from the contributions of other entities in one way or another across the globe; for instance, during the pandemic, WHO became the rallying point for many countries for information about the virus. The benefits derived from external collaboration vary significantly in form and scale, such as information sharing, resources, personnel, and other forms of assistance. The same goes for the innovation that brought about Covid-19 vaccines.

Before COVID-19, it was a general belief among medical experts that vaccine development usually takes years before it is approved for emergency use.

Contrary to that belief, the COVID-19 vaccine discovery was made less than a year after the time the first COVID-19 case was recorded; this was made possible due to extensive collaboration among various stakeholders, which was visible during the innovation process that brought about COVID-19 vaccines for public consumption. The vaccine developers leveraged the partnership to gain more knowledge and support in all stages of the COVID-19 vaccine innovation.

This case study analyzes the impact of policies on five stages - virus sequencing, research funding, vaccine development, vaccine production, and vaccine approval - of vaccine innovation during the pandemic to better understand the interconnectedness of GIN and how government policies affect the linkages.

**4.1.2.1 Virus Sequencing:** This is the first step to developing a vaccine that fights disease. Genome sequencing is a process used by scientists to determine the genetic material in an organism or virus, how it is changing, and how the health of the public may be affected (US Centers for Disease Control and Prevention 2022); this process can take weeks or even last for months. Identifying and releasing the virus sequences are essential for developing vaccines or possible antivirals and test kits. Prompt release of virus sequences enables scientists to swing into action and come up with a solution that will mitigate the effect of the virus, so every single minute counts in the face of human casualty. According to TIME's journal (2020), an order from China's topmost health authority on January 3, 2020, prohibits the publication of information related to COVID-19. Even though some labs have processed the virus sequences, they were not allowed to be published. The bravery of Prof Zhang, who completed the COVID-19 virus genetic sequence on

January 5, 2020, made public on the Virological.org website (an open public platform) on January 11, 2020, was commended by peers. WHO also confirmed on its website the official receipt of genetic sequences from China on the same date, which was made public; this was made possible after a series of discussions. China denied any cover-up and emphasized that the country was trying to verify the information before it would be made public to avoid the repeats of criticisms that greeted the 2009 swine flu, which WHO declared a pandemic. However, many experts believed it was unnecessary based on virological evidence. However, time confirmed the submission of Zhang's work on January 5, 2020, to the US National Center for Biotechnology Information (NCBI). Still, it takes days or weeks for the agency to review the submission, which is a significant administrative encumbrance in securing a solution to a debilitating virus on their part. In times of crisis, time is of the essence, and access to vital information that would enable various actors in GIN to come up with a solution should not be delayed because of political interests or administrative bureaucracies that do the public no good.

GISAID, an NGO fully recognized and supported by WHO, is one the brightest ideas that came up in 2006 after the SARs 2003 epidemic; it encourages the sharing of information on influenza among experts globally after having addressed concerns of individual nations in respect of publishing information on public health sites (WHO 2020). This body contributed to expediting discussion with Chinese authorities, which led to the official release of the virus sequences and further cooperation by the government. Sharing the virus sequences is widely believed to have expedited steps toward vaccine discovery as most vaccine developers are active on global platforms (Mallapaty 2022). Therefore, the role of non-business actors and transnational institutions in overcoming or reducing the national barriers described above is significant, many

countries rely on them for information and see them as more trusted and dependable allies when it comes to entrenching trust among nations for the common global good (Welsh 2020).

**4.1.2.2 Vaccine funding:** The contribution of private and public partnerships in providing or harnessing much-needed resources to drive innovation is significant (Cross et al, 2021). The global research and innovation forum convened by WHO in February 2020 included funders whose contributions to making money available for the research work are of great importance (WHO 2021). Considering the urgency and huge funds required to drive this process, firms do not have them readily available, and it will take a longer time or not if they are to mobilize more resources on their own, thereby slowing down the pace of their innovation process and eventually when the vaccine will become available (US Dept of Health and Human Services 2020). From this standpoint, many nations and regional governments make funds available to fill the void for vaccine developments and other noble innovations besides regular contributions from charitable organizations, public-private partnerships, and venture capitalists.

According to Cross et al. (2021), because of the public spending in this direction, many individuals, groups, and organizations advocated for equal access to the COVID-19 vaccines. They criticized vaccine developers for making a fortune out of it. The US NIH spent over \$17.2B in two decades preceding the COVID-19 pandemic on research related to vaccine technology, which is the groundwork for many vaccine technologies today (Cross et al. 2020), this is besides the vast resources expended by individual vaccine developers over the past decades on research & development. Therefore, appropriating a reasonable amount to compensate for the one-time effort might be difficult, especially when determining the fair price for the vaccine. According to Cross et al. (2020), AstraZeneca's vaccine price includes a 20% markup despite its pledge to make it available at cost earlier in the days of the pandemic. Lower-income countries have also been found

to be paying more for vaccines generally than rich countries, even though billings of countries for vaccines have been confidential. These ethical issues further widened the gap in countries' vaccination. They led to the call for global equitable distributions and intellectual property waiver to allow mass production, which vaccine developers and governments of some rich nations are against.

There are so many disparities in the published figures of funding reported due to a lack of transparency in reporting research funding. However, funding sources during the pandemic are mainly government agencies, Oxford-AstraZeneca over 97% from government and charitable funding (Cross et al., 2021), and PfizerBioNTech received over \$1.5B grant from German and US governments for the development and supply of the covid-19 vaccines (McCarthy, 2021; Griffin & Armstrong, 2020). Funds provided for innovation and research sometimes carry certain conditions. Initially, PfizerBioNTech decided against taking funding from the US Operation Warp Speed (OWS) program because of its rules, though it backtracked on that decision months later. The issues and policies around vaccine funding could cause distrust and hinder further cooperation among nations, with harmful or unintended consequences on the work of GIN. More efforts are ongoing by the International Health Regulations (IHRs) to improve vaccine funding reporting.

**4.1.2.3 Vaccine research & development:** When the Trump administration constituted Operation Warp Speed (OWS) with a viable vaccine mandate among other targets, some considered it too ambitious, but, in less than a year, they were able to deliver on their promise (Diamond et al., 2020). The knowledge that drives vaccine innovation is incremental. It builds on past experiences. Vaccine development is knowledge-intensive, capital-intensive, and requires years of capacity building to come up with one. These factors have created a wide gap between the advanced economy and the less developed ones looking forward to catching up through knowledge transfer.

Very few countries possess the resources and absorptive capacity to make things happen within a short time. The failure rate for vaccine developments is 94%, so many private individuals are skeptical about investing in this kind of venture.

The CoviShield vaccine was a product of over two decades of investment in research and development into chimpanzee adenovirus-vectored vaccine (ChAdOx) technology at Oxford University, UK, before British-Swedish AstraZeneca acquired it in April 2020 (Cross et al., 2020). Long-term planning and investment make developing the most affordable COVID-19 vaccine possible. Also, external partnering by Pfizer of the US with BioNTech of Germany was out of the need for Pfizer to leverage BioNTech mRNA vaccine technology to produce the Comirnaty vaccine. Over a decade of investment in research and development of mRNA vaccine technology makes this possible; R&D investments cover from vaccine sequencing to development, clinical trials, production, distribution, and continuous improvement of the vaccine to combat new variants. More firms are specializing in their core strength, that is, where they will derive a competitive advantage over others due to the limited availability of resources for research and development; this trend is reinforcing the importance of external partnering in high knowledge-intensive sectors, and especially to firms that are embedded in advanced global innovation clusters (Turkina & Van Assche, 2018) like vaccine development. Many unscientific decisions also influenced clinical trials of vaccine candidates. In contrast, many are subjected to a peer review process, while others are carried out secretly, drawing criticism from professionals worldwide.

**4.1.2.4 Vaccine production distribution:** The lockdown measure that was in force during the pandemic disrupted the supply chain. Some host nations to COVID-19 vaccine production facilities adopted trade measures that restricted the exportation of urgently needed vaccines until local demand has been satisfied. For instance, the former US President signed an executive order



on December 8, 2020, prioritizing vaccine shipment to Americans first, which sparked controversy in several jurisdictions worldwide (Cohen 2020). This spurred developers to rethink their production and distribution strategies as political decisions impacted their contracts with foreign customers.

So, even though vaccines are essential for mitigating the pandemic, where a firm locates its production facilities can be a game changer for its going concern or growth strategy. However, there were many collaborations between vaccine developers and owners of other production facilities; there were also increased investments in the modernization of production facilities in some places, enhancing their capacity to scale up production and easing tension among customers. Oxford-AstraZeneca partnered with foreign firms in India, Italy, UAE, Japan, South Africa, and so on to produce their vaccine (Pfizer website 2022, Cross et al., 2021, Cohen 2020). PfizerBioNTech Comirnaty vaccine was produced in the US, Germany, Ireland, Belgium, and Croatia. Pfizer has ten local production sites in the US and over thirty in other parts of the world (Pfizer website 2022).

COVID-19 vaccines are transported, distributed, and stored in a regulated condition. This necessitated further investments in the upgrade of supply chain infrastructures (Andersen et al, 2021). Reputable firms are contracted to handle the transportation and distribution of the vaccine stock, but there were some initial delays due to inadequate preparedness (Govt of Canada 2020). This led credence to improve collaboration with upstream and downstream actors to deliver consumers a safe and effective product efficiently (Andersen et al, 2021).

There has been improvement in the standardization of trade rules since the World Trade Organization (WTO) was formed in 1995 and global supply chain management. However, rules

have been circumvented by introducing administrative encumbrances majorly because of political reasons (WTO 2020).

#### **4.1.2.5 Vaccine authorization/approval:**

It is common knowledge that vaccines can have adverse reactions on the human body, even causing irreparable damage to the functioning of the system if the chemical composition is not correct or in the right proportion or if the vaccine is not administered or stored correctly, that is why clinical trials are usually conducted in three phases and results subjected to administrative and peer review to minimize if not eliminate the consequences before the emergency use authorization is granted (Diamond & Pierson 2020). Historically, it usually takes a few to dozens of years to develop, unlike COVID-19 vaccines developed in less than a year.

The announcement of the COVID-19 vaccine discovery brought great relief to the world. However, it was greeted with skepticism in some jurisdictions because of the timeline of the discovery, mixed messages about vaccine candidates from developing nations, lack of transparency surrounding some clinical trials, beliefs, religion, or state of diplomatic ties with the country of origin (COO) among other factors which intertwined with different political interests (Gharpure et al, 2020). For instance, the US clarified that vaccines made in China and Russia will not be accepted in the US and vice versa.

All things being equal, approval for the emergency use of vaccines is based on scientific criteria set by national or regional governments or international institutions like WHO, which we witnessed during the pandemic.

Vaccine/Developer	COO-Country of Origin	Countries with Strained Diplomatic Ties with COO - (Vaccines were not approved in the jurisdictions)
Comirnaty/PfizerBioNTech	US/Ger	Russia, China, North Korea, Venezuela
Spikevax/Moderna	US	Russia, China, North Korea, Venezuela
Corovac/Sinovac	China	US, Canada, EU
Convidicea/CanSino	China	US, Canada, EU
BIBP-Cor/Sinopharm	China	US, Canada, EU

Table 4: own elaboration based on RAPS 2022

Table 4 shows that some countries did not approve vaccines developed in nations with which they have strained diplomatic ties; the decisions are either political or borne out of nationalistic pride and did not serve the interest of the global public. This has many implications; first, if a less effective means/vaccine is administered in a region, the virus may be suppressed but gain momentum after a while with further economic losses and human casualty for the nation and the whole world. The current rise in COVID-19 cases in China is attributed to the low effectiveness of domestic COVID-19 vaccines administered in the country by some scientific experts (CBC News Dec 26, 2022) - which was not proven when writing this thesis. Secondly, the effort and resources that go into the work of GIN on vaccine development can be undermined based on political misinformation and senseless pride. Finally, to safeguard the public interest and avoid vaccine hesitancy, vaccines are usually subjected to peer reviews and clinical trials at the developmental stage, and the field results obtained are cross-examined by the regulated authorities and network of its partners before being given emergency approvals. There were concerns due to

a lack of transparency around clinical trials run by some vaccine developers, which gave more room for critics to doubt their quality and slowed down their global acceptance.

The increase in COVID-19 variants posed a severe challenge to the developed COVID-19 vaccine's efficacies; for example, an Israeli study found Comirnaty to be ineffective against the South African variant, and South African experts also found Covishield to be ineffective against the South African variant. The blood clot controversies surrounding the AstraZeneca vaccine and the Janssen vaccine, among many other arguments, have negative consequences on GIN as they bolster the idea of vaccine hesitancy, which requires a joint effort to address (Wang & Alexander 2021, Lazarus et al. 2021). Despite the criticisms surrounding the COVID-19 vaccines, evidence gathered so far from actual use is firmly in support of the COVID-19 vaccines, and the efforts of the vaccine developers and the global health innovation network, in general, have not only yielded fruits but are also commendable (WHO 2021).

#### **4.2 The RICTA Model**

Based on the analysis carried out in the cases analyzed above, I developed the RICTA framework Figure 2 to illustrate the international dimensions that characterize innovators' global networks and better understand the issues involved. RICTA can be leveraged to develop cooperation models among countries and enhance the activities of GIN. This conceptual framework is related to each other.

**RICTA**-Relativity, Investability, Complexity, Trialability, Adaptability

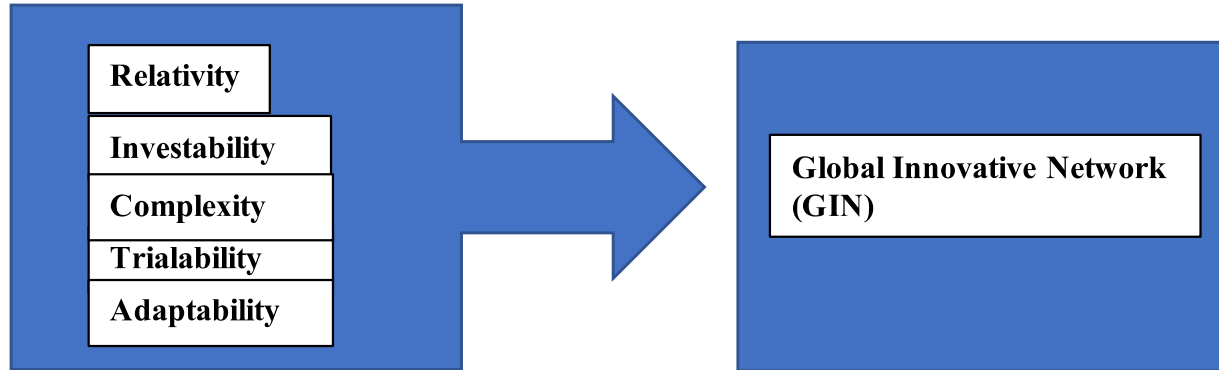


Figure 2: The RICTA Model

The RICTA conceptual framework was initially designed to analyze the literature reviewed and address the research questions, which will help to understand how national policies affect GIN in the health sector during the pandemic. This conceptual framework is related to each other.

**4.2.1 Relativity-** This concept denotes the absence of standards of absolute and universal application of a phenomenon. Considering relativity against the research questions and literature reviewed, we observed a lack of compatibility between local authority pursuit for innovation and the global network, negatively impacting GIN. The aim and motivation are different in that GIN's motivation is finding a better way of profitably meeting needs or for a social cause (Leite, 2022). At the same time, local pursuits sometimes go beyond that to being embedded in satisfying political interests or nationalistic pride (Campbell, 2020).

The introduction of national policies continues to be a means by which innovation effort is channeled to meet political interest and entrenched local pride; this is due to persistent geopolitical

rivalry/tensions among countries of the world, which further complicates the establishment or compliance with standards resulting in administrative challenges for the GIN.

These administrative encumbrances come in different forms; they can restrict collaboration or truncate existing cooperation among GIN without recourse to the investment and effort that has gone into such a deal. A perfect example is that of CanSino Biologics of China and their Canadian partner; this triggers the fear that critical innovations such as vaccine development can be weaponized in times of crisis for cheap political gain at the expense of the world (Govt of Canada 2020).

One of the ways to overcome this challenge is through international institutional platforms, just as the GISAID was launched in 2008 to solve a problem and encourage the global sharing of influenza data and has been a success story, especially during the pandemic, helping in negotiation with Chinese authority for the immediate release of the covid-19 virus sequences. Its work can be expanded to cover other stages of vaccine development as international organizations are sometimes in a better position to strike a deal among countries that would limit the unintended consequences or flaws that the introduction of national policy in one country will have on GIN or other countries.

**4.2.2 Investability-** This idea indicates the potential or capacity for the quality of being attractive or profitable to invest in. Regarding the investability concept concerning the research questions and literature reviewed, it is discovered that sustainable fund and partnership investments are required to foster the research for vaccines linked to social and economic profitability (WHO 2020, US Dept of Human & Health Services 2020). Before the pandemic, most vaccine developers generated funds from raising capital, non-governmental organizations, charities, and donations

sources to fund research and development (Cross et al, 2021). The pendulum swung during the pandemic when various governments rolled out huge grants for innovation. For instance, multiple firms with different vaccine technologies were considered by the (OWS), but the ones that met predetermined criteria by the financier were selected for funding (US Dept of Human & Health Services 2020).

Investing in vaccine development is challenging because of the vast, required investment, very low probability of success, and usually a very long timeline. Potential vaccine developments in less and developing countries are often overlooked when it comes to funding in the international space because of their low capability, visibility, or embeddedness in the sophisticated global innovation clusters or simply for political reasons. If not for their government's support, Sputnik V from Russia faced the challenge of being promoted as a vaccine candidate, the same as vaccines from China.

Government funding and support are significant for firms in developing countries to enhance their absorptive capacity; they can support them through the instrument of national policies targeted towards this effort. The developers need to collaborate more within the network to increase their capacity and global visibility and attract investors.

Also, more established organizations can benefit from foreign funding sources and reject local sources if they are tied to conditionalities embedded in national policies that will have harmful or unintended consequences on their activities. Smaller firms can benefit from foreign investment sources if embedded in GIN.

**4.2.3 Complexity-** This characterizes the behavior of a system or model whose components interact in multiple ways and follow local rules, meaning there is no reasonable higher instruction

to define the various possible interactions. As the comparison of distances among nations increases, the complexity also increases for GIN in general (Durand, 2018, p. 78). In looking at the research questions and literature reviewed, innovation of a possible model to fight the pandemic has been a complex, different mix of vertical collaboration and horizontal collaboration strategies adopted on many intertwined issues and at different stages of the pandemic. Given diverse policies and other forms of support to aid innovation, the interplay of complexities involving legal, regulatory, competitive, and economic conditions, and the supply of technological and other types of contributions to innovation differs from jurisdiction to jurisdiction, these slow innovation and collaboration among researchers.

<i>Actors</i>	<i>Resources</i>	<i>Activities</i>	<i>Dynamism</i>
Firms	Expert Personnel	Sequencing	New Variants
Governments	Facilities	R & D	Field response/feedback
Funders	Knowledge creation	Clinical trials	Politics-policy changes/political influence
NGOs	Scien/tech know-how	Material Sourcing	Scientific /technological changes
Public	Capital-FDIs, VCs, Govts, NGOs, Charities	Production	
Innovators		Distribution	
		Data Mgt	

Table 5 : own construct of Global Innovation Networks for Vaccine based on reviewed data sources.

Table 5 is on COVID-19 vaccine development alone; many functional and cross-functional teams work on different issues such as sourcing general information about the virus, virus sequencing, vaccine technology, research and development, funding, clinical testing and trials, production, and distribution, dealing with national policies, and other regulatory requirements. The resources are scattered across the globe in variations. Some actors make things happen, and the activities and



times are subject to change. Each of these is impacted differently by many factors in each jurisdiction, which are discussed extensively with world nations before carving out a workable model that limits the unintended consequences of national policies introduced shortly.

**4.2.4 Trialability-** This refers to testing how potential adopters can accept innovation. Several national policy measures were introduced during the Global Financial Crisis (GFC) of 2008 by various arms of government institutions saddled with the responsibility to contain the crisis; scaling up the computerization and digitization of operations is one of the strategies adopted by firms which was well embraced because of increased adoption of ICT during the decade (Paunov, 2010). On the other hand, national policies during the COVID-19 pandemic are directed toward prevention, control, treatment, and vaccination efforts. Historically, vaccine adoption has always been done with severe caution because of the harmful effect of wrong chemical composition in the body and some myths and misinformation - most of which are out of sociocultural and religious beliefs - about vaccines (Overton et al, 2021). However, vaccine hesitancy has never been limited to a social class of people. Comparing the measures adopted during the 2008 GFC and the COVID-19 crisis, the effect of the previous is reversible/controllable if it does not work. However, the effect of a harmful vaccine could result in irreparable or irreversible damage.

According to the US Dept of Human & Health Services (2020), stakeholders are responsible for ensuring the safety of innovation before it is introduced to the public to avoid the negative consequences of a harmful product. At the same time, it is easier to adopt the measures introduced during GFC 2008 that cannot be said of the COVID-19 vaccine because of the speed at which it was introduced into the market. Secondly, some clinical trials/tests were conducted in a specific controlled atmosphere, but the real-life use results show some differences, which caused vaccine apathy among the public. Another factor that affects the trialability of the vaccine in a jurisdiction

is the liability(asset) of foreignness or the country-of-origin effect, this results from a lack of trust among nations of the world. The US government clarified that it will not accept, or support vaccines made in China (Cohen 2020). Vaccines adopted in each jurisdiction have some correlation with and can be traced to the friendly host nation of the vaccine developers (RAPS 2022). This political influence negates the spirit of global networking for innovation, which is why the role of international institutions is becoming increasingly important as a mediating point to overcome barriers and strengthen global trust and cooperation.

**4.2.5 Adaptability-** This concept refers to the capacity to be modified for a new use or purpose and the ability to adjust to new conditions. We live in a dynamic world as the virus replicates over time; they evolve in different forms due to copying error during mutation. Over fifty multiple variants of the COVID-19 virus have been detected, adding pressure on vaccine developers to continue seeking product improvement. The ability of vaccine developers to respond appropriately often comes with a wealth of experience with the virus and the availability of resources to make the necessary modifications. The absorptive capacity for continuous innovation to meet the rise in viral diversity will determine whether the product will stand the test of time or if the vaccine life cycle is cut short (Caiazza et al, 2021).

The system and structure of a firm can also influence its ability to adapt; big players sometimes are too slow to respond to innovative ideas generated that could bring desired changes because of their more often complex structure; this can be their undoing even though they have excellent capability to mobilize resources to implement changes if need be. On the other hand, smaller firms can be susceptible to new ideas and usually operate a flexible structure; they respond to changes faster even though they characteristically command minimal resources (Carracedo et al, 2020). Irrespective of size, firms strategically positioned in the global innovation networks can benefit

from such a relationship; smaller firms can obtain technical skills training and access to resources from the bigger ones, while the more prominent firms can generate innovative ideas from the smaller ones (Jialu et al, 2021). Firms must collaborate continuously to improve their capacity to adapt to changes in demand if they survive our changing world.

National policies can enable or hamper the ability of firms to adapt, whether the firm aims to enhance its internal capacity to adapt or to restructure and reposition its organization within the global innovation network. For instance, recent policies in some Western countries are not encouraging collaboration with Chinese companies. So, it is expedient to formulate policies in such a way that will promote healthy cooperation among innovation networks (Yang, 2021).

There has been a rise in international entrepreneurship platforms in the past two decades that focus on promoting cooperation and collaboration among firms, groups, institutions, and nations across the globe through sharing knowledge and resources (WHO 2020). In this view, adopting a joint front is necessary so that all countries can manage a crisis like the COVID-19 pandemic in such a way that national policies introduced in a jurisdiction will enhance the activities of global innovation networks or limit harmful or unintended consequences on the network's activities or other jurisdiction and can leverage the RICTA dimensions to create a model.

#### **4.3 Outcomes of COVID-19 response**

The study of the COVID-19 pandemic would help to reflect on global preparedness for a future health crisis to prevent humanity from unnecessary fatalities that could be avoided. Understanding the variations of the policies that different governments undertake in response to the pandemic is crucial to guiding the interests and responsibilities of all stakeholders toward managing other known or future challenges facing humanity. There is a lack of sufficient research and

understanding of how different countries behave, the consequences of their actions in the foreseeable future, and whether their policies concerning GIN are moving towards convergence or heterogeneity (divergence).

The pandemic issue requires a multifaceted approach to tackle it efficiently and effectively. The solution might not be available in a single location. However, with combined synergy among various stakeholders, they can come up with solutions that will have a far-reaching effect on the crisis, either in terms of containing the spread of the virus and mortality or minimizing the economic and social costs. Therefore, policymakers must consider national policies introduced during the crisis with a two-facet lens; the first lens will focus on removing barriers to GIN activities because of the benefits that will accrue to firms, nations, and people. The second lens will focus on supporting local peculiarities while minimizing or eliminating unintended consequences to local or foreign jurisdictions.

From the first lens perspective, the internationalization phenomenon has reduced the globe to a village in the context of business, travel, education, health, and even the dynamics of culture. Our needs are similar in many respects; we share some values and vulnerabilities like a pandemic. The introduction of national policies during a global crisis must consider minimizing, if not eliminating, barriers and encouraging the activities of GIN, whose innovations are significant in finding solutions to a crisis in which the whole knowledge and resources needed to achieve that purpose might not be readily available locally and which time is of the essence in terms of casualty figures or socioeconomic costs.

Therefore, the need for cooperation/collaboration between innovators in healthcare systems from different economies is to promote innovations and reduce the timeline at which the innovation

effect will kick in to contain the impact of the crisis efficiently and effectively, especially on knowledge-intensive innovations that do not need to be modified to provide a country-specific solution, examples of goods or service that serve or could serve the common purpose irrespective of jurisdiction are vaccines, vaccine passport for international travel, etc. Improving cooperation on policy differences among nations in preparation for a future pandemic, for instance, lockdown policies and trade policies concerning essential items could ease the barriers to GIN's activities. This openness towards a global approach to problem-solving will complement the national drive in the same direction.

This has the potential to save countries of the world a significant share of resources that, firstly, would have been spent on duplicating efforts in various jurisdictions if each nation were to pursue innovation independently. Secondly, saving each nation from the consequences of an extended timeline for innovation to occur, imagine the consequences if virus information or sequence is delayed. This will result in an extended vaccine timeline, prolonged lockdown, and increased socio-economic burden.

From the second lens, they have established that some characteristics are unique to individual nations, for instance, the level of scientific and technological know-how (absorptive capacity), supply chain infrastructure, and population demographics, to mention a few. Since these factors influence the policy introduced, it would be meaningless to introduce a national policy that a country cannot bear, for instance. Countries have the right to the flexibility required to adapt their policies to suit their local needs.

However, despite their right to make their laws, it is imperative, especially during a pandemic, to ensure that their actions do not negatively affect the well-being of other countries, as this may stir

political tension between them and weaken trust and cooperation between them. Also, consumption, the request for GIN, can be reduced to country-based requirement innovation, such as a specific model of adapting to a pandemic that harms GIN. Markard et al. (2015) buttress this point by stating that policy intervention focusing on a country might neglect the contribution of GIN. This may explain the socioeconomic cost of COVID-19, which does not benefit GIN in some sectors. Looking at the RICTA analysis above, how global politics is evolving, and its complexities, we can note that countries' policies will continue to be heterogeneous for the foreseeable future. However, because no nation is an island, we also witness increased cooperation leading to policy convergence.

Innovation is significant in crisis management; for instance, many innovations of major military artillery were developed during World Wars, and the development of COVID-19 vaccines in less than a year was born out of ingenuity that did not happen during the standard period and was critical to managing the crisis. The activities of innovators are essential, as well as the speed at which they deliver to limit the fatalities recorded. Since knowledge is not localized, innovation to solve a problem can be born in any part of the world or jointly birthed through collaboration between multiple firms. Therefore, developing a model that enables unrestricted access to global knowledge and resources and protects existing relationships against damaging national policies is imperative.

Based on the data reviewed during this research, we have identified three main impacts of the pandemic on GIN.

#### **4.3.1 Increased Investment in Innovation**

The pandemic has had tremendous detrimental effects on the global economy, considering the restrictions governments placed on economic activities to reduce the spread of the deadly virus, and economies are still recovering. While most of the impacts on the global economy have been negative, that has not been the case, especially when it comes to innovation in health management. Challenges present an opportunity for people to solve them, thus leading to innovation (Wang & Alexander, 2021). Consequently, innovation has risen since the Covid 19 pandemic, with the health sector being one of the greatest beneficiaries (Hantrais & Letablier, 2020). The pandemic caused so much pressure on the health systems, requiring innovative ways of dealing with this challenge. For instance, soon after the rise of the pandemic, hospitals began to experience challenges with space, hospital beds, ventilators, and personal protective equipment, among others (Hatter, 2020). All these challenges presented an opportunity for innovation. The period of the COVID-19 pandemic saw some tremendous innovations within the health sector. Individuals, firms, and institutions developed more affordable PPEs, ventilators, diagnostic kits, and virus sequencing equipment, among several social, technological, and scientific innovations to save lives, especially those of frontline health workers and patients.

Another reason for the increased investment in the health sector is the introduction of national policies in some high-exporting countries with very high negative impacts (unintended consequences) in other jurisdictions (Su, 2021). For instance, China is one country that introduced a hard lockdown. The country is a global leader in medical supplies, equipment, pharmaceutical ingredients, antibiotics, and other health-related products (Hrytsyuk & Sak, 2021). This measure hurt innovators' ability and motivation for production and continuous innovation because of the reduced consumption of many products at home and in importing countries. However, some countries rely on China to supply a significant share of their medical products. The disruption

caused to the global supply chain prompted some countries to reconsider their dependence on China's manufacturing and supply chain. As innovators in these importing countries are motivated to create alternatives, policyholders in these vulnerable economies were challenged to do more to encourage them to develop local substitutes to reduce their dependencies; even advanced economies like the United States are not left in this pursuit (He et al, 2021).

#### **4.3.2 Increased Participation of Firms in middle-income Countries**

Developing and middle-income countries are expected to play a significant role in GIN. This is contrary to what has been the tradition in these networks. The shift is due to the increasing innovation markets in less developed countries. The experience of many developing and third-world countries during the pandemic has spurred them to consider their overdependence on research and development from developed nations and charitable donations from more affluent nations. The pandemic makes many countries realize how vulnerable they are, and they are taking action to reverse the trend by increasing investment in building the national capacity of their health and other targeted sectors (Andersen et al, 2021 & Santi et al, 2020).

Governments are rolling out policies encouraging local talents and firms to collaborate with foreign institutions and clusters to expose them to advanced training, techniques, and technology to enhance the nation's absorptive capacity. For instance, some African countries have acquired the capacity to conduct virus sequencing, which was not the case before the pandemic. This is made possible through a public-private partnership, and the implication is that sequencing of any virus in the future can be conducted and released on time; this will support or speed up the work of other scientists working on the research and development of vaccines (Mallapaty, 2022). Some countries also try to set up vaccine manufacturing facilities and R&D. The government's



willingness to increase innovation in these countries and availability/access to cheap labor is expected to create a more conducive environment for their participation in GIN.

## DISCUSSION

This research examines the nation's public health policies during the pandemic, focusing on China and the U.S. policies and how they affect collaboration among innovators of health products, especially vaccine development in different jurisdictions.

This study contributed to the literature on global policies and network theories. We found that distance is still alive, as suggested by Durand (2018); the approach to managing public health in different countries varied due to their contextual differences. Cheng et al. (2020) stated that the previous research confirms that policy that works in one jurisdiction might not work in another jurisdiction, even in the face of a global emergency that requires an immediate solution like the pandemic; they also pointed out that public health policies rolled out during the crisis was shaped by the element of administrative structures and political interests rather than rational thinking that could benefit the global public citizens.

From the analysis, we examined how these differences add to the complexity and cost of effectively managing the problem in the event of a global crisis using the RICTA model and other examples. The absence of robust common standards and mechanisms of an international nature that could safeguard the global public interest is partly responsible for the scope of variation, as is evident in the vaccine innovation effort, which is of necessity but requires very high knowledge intensity. Several countries spent enormous resources that are not readily available to address the pandemic; a chunk of the limited resources spent could have been saved had they subscribed to an agreed global approach that would allow the global health innovators to carry out their activities unrestricted and the result shared equitably and justifiably for the good of the global public.

Global innovation networks are known for innovation. Innovation is critical when in dire need of solutions to a critical challenge such as the pandemic, where highly intensive knowledge and resources are required to stem the scourge of the virus. Doloreux et al. (2019) suggested a positive correlation between innovation and openness to external ideas. Turkina and Asche (2018) stated that knowledge and resources are available globally, and the network is structured in a way that it requires a free flow of information and interaction among various players in the network to generate knowledge production; that is why we are strongly making a case for unrestricted flow of their activities.

Also, Acemoglu et al. (2016) stated that resources are neither local nor global; the importance of this is that no nation is an island of knowledge and resources and is not in equal proportion among nations but instead concentrated across geographical locations of the world. Nations' absorptive capacities are also at different levels of development. They can be a limiting factor, but from the analysis above, with improved collaboration and increased investment in the health sector by low and middle-income countries, especially in sequencing, every nation could contribute towards a safer world. We can predict that most countries will be capable of conducting virus sequencing soonest; this will enhance global surveillance on new virus detection and reduce the timeline for the invention of diagnostic equipment/kits and cures for future viruses or disasters.

Thinking of the world as a global village and considering shared vulnerabilities imposed on us because of the acceleration of globalization does not only make economic sense but would help us to be better prepared against global emergency disasters if we intensify our efforts toward global health policy convergence for the good of the global public. Scholars, experts, professionals, and interest groups usually agree that policies should be people centered. Su (2020) pointed out that policies introduced in one jurisdiction can adversely affect another and provided some scientific

strategies to mitigate them. From the analysis, we expanded on why synchronizing global health policies would enhance the activities of global health innovators, mitigate barriers to scientific development, and prevent political leaders from using policies to truncate innovations that could be birthed because of political interests and national pride.

Now that the pandemic is under control and nations are trying to rejig their economy with political dexterity, it is imperative to strengthen trust, promote unity and cooperation among nations to solve other global challenges and be better prepared for future events. The lack of trust among national leaders of the world is unsettling global political space, and national governments may be tempted to continue to implement policies that support country-specific innovation to protect their political interests and those of the people they govern. The reality of the time is that no nation could remain an island in this global village. For this singular reason, there is a need for increased collaboration among nations on many fronts, leading to the convergence of policies even though political interests remain a clog in the wheels of this progress.

The increased convergence of national policies is essential because it is expected to affect GIN from different perspectives. First, the pandemic is expected to maintain or increase investments in GIN. Investments in GIN are known to reduce issues parallel to economic or other types of crises. However, the number of investments into GIN will depend on the degree of specific requirements and importance attached by local authorities. Innovation will still be regarded as an effective way to resolve problems/crises. They are considering that after the financial crisis of 2008, investments in innovation across the globe increased.

Also, developing countries are expected to play a significant role in GIN. This is contrary to what has been the tradition in these networks. The shift is due to the increasing innovation markets in

less developed countries. Again, the availability of expertise and resources in these countries and access to cheap labor are expected to create a more conducive environment for participation in GIN. The pandemic has also influenced middle-income and emerging countries to consider their overdependence on research and development from developed nations.

Finally, the impact of COVID-19 will be heterogeneous on GIN. Like in previous crises, GIN investments were reduced or increased depending on the industry. In this regard, the health sector will experience a high investment rate after the COVID-19 crisis to boost human capital and enhance investment profitability. In addition, COVID-19 will make innovations from GIN more customized to regional or local needs. Countries across the world have different needs. Thus, they demand innovations that address their unique circumstances. Innovation is easy to pursue when focused on a specific problem since the range of issues to address will be narrow.

## CONCLUSION

### **6.1 Firms:**

The distrust sown during the pandemic through policy introduction and manipulation, such as export restrictions, yielded some intended and unintended consequences for future cooperation among nations, which must be addressed. Despite this, during the Covid-19 pandemic, international collaboration boomed among scientists. The contributions of innovators across the globe during the pandemic are immense; the COVID-19 vaccine discovery is a testament to the fact that this kind of cooperation remains the best pathway to solving issues confronting Mother Earth; it is also an impetus to encourage greater participation by all firms to get involved in networking in their specific field. This avenue will expose them to various knowledge and resources unavailable locally and free them from technological lock-in and the scarcity/dearth of funds.

### **6.2. Policymakers:**

Now that the severity of the pandemic has subsided and COVID-19 vaccines have been discovered, we are exiting the period of scientific investigation and moving to the phase of geopolitics. It is imperative to bolster trust among world nations and encourage cooperation among countries. This is important to address the earth's teething challenges, such as climate change, other crises of global concern, or future problems. Kudos to the US lawmakers and German government that supported the idea of Peter Bogner in establishing GISAID in 2006 for knowledge sharing. More such cooperation should be encouraged on the international stage.

### **6.3 WHO:**

The role of multilateral institutions is essential; from experience, they have a better record and an edge in promoting issues of global interest better than what an individual country has achieved either directly or indirectly, for example, obtaining covid-19 virus sequencing from China so that scientist can begin work may not have been that easy or could have been delayed longer. Most nations relied on WHO for information and technical support during the pandemic. The organization also assisted many nations in their quest to boost their absorptive capacity in health, for instance, in virus sequencing. On vaccine development, just like the success recorded with GISAID, the organization can explore the dimensions analyzed under RICTA with respective stakeholders to define their challenges to find a suitable model for all parties. As globalization accelerates, there is every reasonable belief that no country would want to be left out. They will all continue collaborating, and national policies will drift towards convergence.

For instance, the organization can diffuse the fear of weaponizing critical innovation for political gain. We recommend an established scientific standard that would serve as a reference guide for researchers to access funding from the global community. These objective steps should be based on scientific merits.

- Limitations

National policies adopted by the government of every country differ in scope, length of period, categorization, measurement, and so on. This poses a challenge when comparing the data among countries. Index from sub-national levels diverge significantly from the national score, especially in federal countries. Also, we do not understand all the different languages, so it is not easy to understand or interpret some information. Finally, national policies are limited to those directly

related to the global innovators networking in the health industry; many other indirect ones are not considered. There is insufficient data for empirical analysis.

- Suggested topics for further research

The multi-nationality of a product increases its acceptability/approval or reduces the liability of foreignness.



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