Impact of COVID-19 Pandemic on International Research Collaboration: A Pilot Interview Results

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Abstract: While the COVID-19 pandemic had a significant negative impact on the world economy, international research collaborations were disrupted by problems like hiring freezes, stopped lab and fieldwork, delayed research infrastructure, health effects, and restricted travel. This study aims to identify the most critical indicators with the highest relevance to explain the overall impact of the pandemic on international research collaboration. For this purpose, it uses a pilot interview conducted through the Zoom platform at a public research university in the U.S. The interview included six questions designed to reveal the impact of the pandemic on international research collaboration and its indicators. Thirty participants from different departments were interviewed. The findings of this study reveal the most important indicators for the overall impact of the pandemic on international research collaboration. The results can help design research programs, particularly those involving international collaboration, to reduce the adverse impacts of such adverse conditions.

Keywords: International research collaboration, Covid-19 pandemic, Critical indicators

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Introduction

The COVID-19 pandemic, a major global health crisis in the past century, has led to severe disruptions at socio-economic levels. Analyzing the impact of this pandemic on international collaboration is crucial for designing effective interventions and promoting a more interconnected and resilient global research community (Bogle, 2020; Lee & Haupt, 2021). While the entire world economy faced significant challenges due to the pandemic, issues such as hiring freezes, halted lab and fieldwork, delayed research infrastructure, socio-cognitive health

effects, disruptions in the flow of international students, and restricted travel have especially hindered international research collaborations (Gewin, 2020; Radecki & Schonfeld, 2020; Recio & Colella, 2020).

Since the early 1990s, both developed and developing nations have witnessed a substantial increase, around 10- and 20-times respectively, in scientific publications produced through international collaboration (Gewin, 2020). Approximately 25% of the total global scientific publications are the result of international partnerships, contributing to higher citation rates and more significant societal impacts worldwide (Gewin, 2020; Lee & Haupt, 2021; Miroudot, 2020). However, the momentum of this collaborative trend was significantly impeded by the COVID-19 pandemic, (Liu et al., 2020; Miroudot, 2020) which disrupted travel, face-to-face interactions, lab work, fieldwork, hiring, and the flow of international students, as noted by various sources (Bogle, 2020; Brandon-Jones et al., 2014; Gewin, 2020; Radecki & Schonfeld, 2020; Recio & Colella, 2020). This disruption not only hampered the progress of shared scientific discoveries, especially in the context of international research, but also posed challenges to the national capacity to continue providing a skilled workforce (Bogle, 2020; Boroughani et al., 2023a; Brandon-Jones et al., 2014; Gewin, 2020).

Figure 1 illustrates data from the United Nations World Tourism Organization regarding the percentage of destinations worldwide reporting various travel restrictions in 2020 (Buitendijk et al., 2020; Fry et al., 2020; ICC, 2020; NSB, 2020; Sy et al., 2020; UNWTO, 2020c). The comparison of international student enrollment in 2020 and 2019 is depicted in Figure 2 (UNWTO, 2020e). The adverse effects on international research collaborations encompassed cost overruns, limitations in human resources, and the closure of research facilities, leading to reduced opportunities for research and training for underrepresented minorities (Bogle, 2020; Boroughani et al., 2023b; Radecki & Schonfeld, 2020; Recio & Colella, 2020; Xodabande et al., 2023).

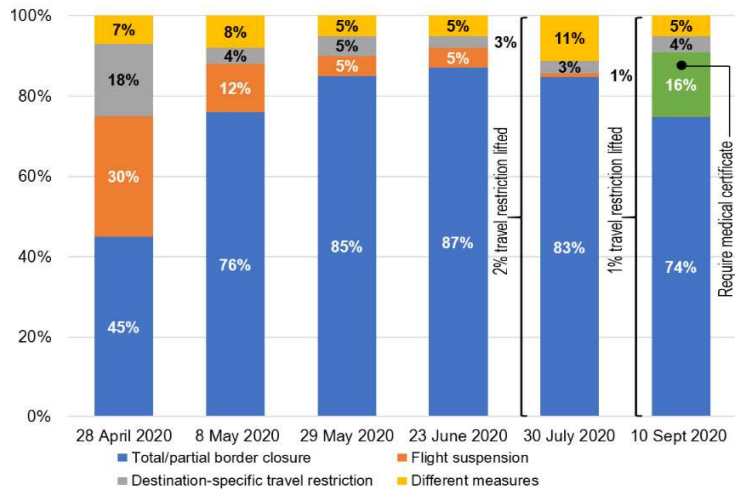

Figure 1. Global travel limitations (percentage of destinations)

While international collaborations in developed nations were significantly impacted, developing countries experienced the most severe consequences (Bogle, 2020). Global research partnerships play a crucial role in

addressing skill shortages in advanced economies like the United States and the United Kingdom, fostering shared scientific progress with developing nationss (Lee & Haupt, 2021). However, there is a lack of understanding on how to enhance the resilience of international collaborations, particularly in the face of global crises such as the COVID-19 pandemic (Bogle, 2020; Gewin, 2020). Lee and Haupt (2021) caution that very few studies have examined international collaborations during a global crisis, emphasizing the need for more research dedicated to comprehending how catastrophic disruptions impact research partnerships.

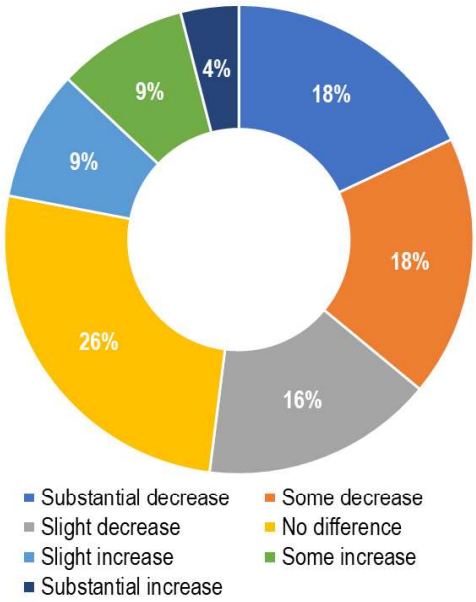

Figure 2. The enrollment of international students in 2020 compared to 2019

It is crucial to adapt the way scholars engage in global research to effectively address similar potential situations in the future (Liu et al., 2020). A comprehensive comprehension of how the pandemic has impacted ongoing global research collaborations is essential for identifying gaps in research and infrastructure. This knowledge will inform present and future international research programs. The present study serves as the initial phase of a larger project that involves collecting and synthesizing time-sensitive qualitative and quantitative data from ongoing international research projects. The aim is to elucidate significant gaps, propose interventions, and highlight opportunities for international collaboration. To be specific, the findings presented in this paper are derived from a pilot interview conducted as part of the initial stages of the broader research endeavor. The objective of this paper is to investigate the key indicators that reflect the overall influence of the pandemic on international research collaboration.

Methodology

This paper represents the results of a pilot interview conducted at a public land-, sea-, and space-grant research university in the U.S. The Zoom interview included six questions (ee Table 1). The websites of several

departments were searched for multilingual/multicultural professors, post-docs, and research assistant Ph.D. students. The potential participants were invited for the online interview, among which 30 participants completed the interview. First, Cronbach's alpha was applied to check the reliability of the indicators. Next, quantitative and qualitative analyses were used to describe the basic features of the collected data.

Table 1. Pilot interview questions

Q_1	Which challenges, conflicts, and limitations caused by COVID-19 has the research team faced?
Q_2	How have these issues caused by COVID-19 impacted the research process and outcomes of this project?
Q_3	Which changes and interventions have you explored because of COVID-19 in this project to address these issues?
Q_4	How have these changes and interventions explored because of COVID-19 impacted the overall research quality?
Q_5	How has the pandemic affected the project budget, schedule, and health and safety of your team?
Q_6	Which opportunities could be exploited to enhance sustainability of global research during the pandemic?

Results

The first question asked participants about challenges, conflicts, and limitations caused by COVID-19 that their research team faced. The most frequently mentioned issues were under the following categories, respectively: conflicts (N=35), challenges (N=24), and limitations (N=8). In addition, under each category, the responses could be classified in 11 different subcategories. Among challenges, the issues regarding data collection were the most frequently mentioned ones. The participants addressed conflicts related to communication, interaction, collaboration, and connection more than other conflicts. In addition, limitations regarding lab work were the most frequently mentioned issues under limitation category. Additionally, issues related to data collection, lab work, and education/training were the most frequently addressed issues in total (see Table 2).

Table 2. Challenges, Conflicts, and Limitations Caused by COVID-19

Issues	Challenge	Conflict	limitation	Total
Travel ban	3	5	0	8
Data collection	10	3	1	14
Field work	1	1	0	2
Lab work	7	2	4	13
Equipment provision, personnel recruitment	2	5	0	7

Issues	Challenge	Conflict	limitation	Total
Funding, expense	0	2	0	2
Educational, training	0	3	0	3
Communication, interaction, collaboration, connection	0	8	2	10
Remote work	0	3	1	4
Political/administrative response	1	2	0	3
Emotional	0	1	0	1
Total	24	35	8	67

The second question asked participants how the issues caused by COVID-19 impacted the research process and outcomes of their project. More than half of the participants (56.67%) believed that their research was negatively affected but continued. 30% of mentioned that their research was adapted to the new conditions and continued. The rest of participants said their research were completely stopped or postponed (Table 3).

Table 3. Impact of the issues Caused by COVID-19 on research process.

Participant	Researched completely stopped/postponed	Researched was negatively affected/slowed down, but continued	Research was adapted and continued
P_1			✓
P_2			✓
P_3			✓
P_4		✓	
P_5		✓	
P_6			✓
P_7	✓		
P_8		✓	
P_9	✓		

Participant	Researched completely stopped/postponed	Researched was negatively affected/slowed down, but continued	Research was adapted and continued
P_{10}			✓
P_{11}		✓	
P_{12}		✓	
P_{13}		✓	
P_{14}		✓	
P_{15}		✓	
P_{16}		✓	
P_{17}		✓	
P_{18}		✓	
P_{19}			✓
P_{20}		✓	
P_{21}		✓	
P_{22}		✓	
P_{23}		✓	
P_{24}			✓
P_{25}		✓	
P_{26}	✓		
P_{27}			✓
P_{28}	✓		
P_{29}		✓	

Participant	Researched completely stopped/postponed	Researched was negatively affected/slowed down, but continued	Research was adapted and continued
P_{30}			✓
Total	4	17	9

On the other hand, more than half of the participants (56.67%) believed that the issues caused by COVID-19 did not impact the outcomes of their projects. 30% of the participants believed that the issues had negative impact on their project outcomes and 10% of them mentioned that the impact of the issues caused by COVID-19 on their project outcomes was unclear. Only one of the 30 participants believed that the issues caused by COVID-19 had a positive impact on their project outcomes, and they got better outcomes (Table 4).

Table 4. Impact of the issues Caused by COVID-19 on project outcomes

Participant	Unclear	Not affected	Negative	Positive
P_1		✓		
P_2		✓		
P_3			✓	
P_4		✓		
P_5			✓	
P_6				✓
P_7			✓	
P_8		✓		
P_9	✓			
P_{10}		✓		
P_{11}			✓	
P_{12}		✓		
P_{13}			✓	

Participant	Unclear	Not affected	Negative	Positive
P_{14}		✓		
P_{15}		✓		
P_{16}		✓		
P_{17}			✓	
P_{18}		✓		
P_{19}		✓		
P_{20}		✓		
P_{21}			✓	
P_{22}		✓		
P_{23}			✓	
P_{24}			✓	
P_{25}	✓			
P_{26}	✓			
P_{27}		✓		
P_{28}		✓		
P_{29}		✓		
P_{30}		✓		
Total	3	17	9	1

The third question asked participants about changes and interventions they explored in their projects to address the issues caused by COVID-19. Most participants (83.33%) mentioned that they explored some changes and/or interventions and only 3.33% said that they did not explored any changes or interventions. In addition, 10% of them talked about changes/ interventions that they would or might explore in the near future in their projects to address the issues caused by COVID-19 (Table 5).

Table 5. Changes and interventions explored to address the issues caused by COVID-19

Participant	Explored	Would be explored	Might be explored	No changes/interventions
P_1			✓	
P_2		✓		
P_3	✓			
P_4				✓
P_5	✓			
P_6	✓			
P_7	✓			
P_8	✓			
P_9	✓			
P_{10}	✓			
P_{11}	✓			
P_{12}				✓
P_{13}	✓			
P_{14}	✓			
P_{15}	✓			
P_{16}	✓			
P_{17}	✓			
P_{18}	✓			
P_{19}	✓			
P_{20}	✓			

Participant	Explored	Would be explored	Might be explored	No changes/interventions
P_{21}	✓			
P_{22}				
P_{23}		✓		
P_{24}	✓			
P_{25}	✓			
P_{26}	✓			
P_{27}	✓			
P_{28}	✓			
P_{29}	✓			
P_{30}	✓			
Total	25	2	1	2

The changes and interventions explored by the participants could be divided into 9 major categories including:

1. Change in experiment, such as, changing experiment location, simplifying experiment, making experiment online, changing the sample size, and replacing experimental work with simulation work.
2. Using different methods/ tools, such as, using online tools/ platforms, software simulations, and online behavioral testing
3. Online interaction, such as, using google drive and online meeting platforms
4. Remote work
5. Change in materials procurement, such as, using alternative sources, and overpaying for materials
6. Change in recruitment, such as, recruiting post-docs instead of doctoral students
7. Following new regulations/ rules, such as, wearing masks, and complying social distance
8. Working harder to achieve efficiency
9. Change in results, for instance, preparing hypothetical papers instead of experimental ones

The fourth question asked participants how the explored changes and interventions impacted their overall research quality. One-third of the participants considered the impact on their research quality as negative. For instance, they mentioned that the changes and interventions impacted their research quality, efficiency, data and personnel quantity, budget, original plan, timeline, and mental health negatively, or the research became less

enjoyable. 30%, one-sixed, 10%, and 10% of them addressed the impact as either negative or neutral, neutral, unclear, and positive, respectively (Table 6). The positive impacts included improved quality as a result of working harder due to uncertainty, creative thinking, and spending more time on research methods.

Table 6. Impact of the explored changes and interventions on

Participant	Unclear	Negative	Neutral	Positive
P_1		✓		
P_2		✓	✓	
P_3		✓		
P_4		✓		
P_5		✓	✓	
P_6		✓		
P_7		✓		
P_8		✓	✓	
P_9	✓			
P_{10}		✓	✓	
P_{11}		✓	✓	
P_{12}			✓	
P_{13}		✓	✓	
P_{14}		✓	✓	
P_{15}		✓		
P_{16}			✓	
P_{17}		✓	✓	
P_{18}				✓

Participant	Unclear	Negative	Neutral	Positive
P_{19}		✓		
P_{20}			✓	
P_{21}		✓		
P_{22}				✓
P_{23}	✓			
P_{24}		✓		
P_{25}	✓			
P_{26}		✓		
P_{27}			✓	
P_{28}		✓	✓	
P_{29}				✓
P_{30}			✓	
Total	3	19	14	3

The fifth question asked the participants how the pandemic affected their project budget, schedule, and health and safety of their team. 43.33% of the participants mentioned that their project budget was not affected or they were unaware of the affect. 23.33% and 20% believed that their project budget decreased, and increased, respectively. The rest mentioned that the impact of the pandemic on their project budget was still unclear (Table 7). In addition, most participants (73.33%) believed that the pandemic made their schedule longer (Table 8). Unsurprisingly, two-third of the participants reported that the pandemic affected the mental health of their team (see Table 9).

Table 7. Impact of the pandemic on project budget

Participant	Unclear	Increase	Decrease	Other
P_1				✓

Participant	Unclear	Increase	Decrease	Other
P_2		✓		
P_3			✓	
P_4		✓		
P_5				✓
P_6				✓
P_7	✓			
P_8		✓		
P_9				✓
P_{10}		✓		
P_{11}				✓
P_{12}				✓
P_{13}				✓
P_{14}				✓
P_{15}			✓	
P_{16}		✓		
P_{17}		✓		
P_{18}				✓
P_{19}			✓	
P_{20}	✓			
P_{21}	✓			
P_{22}			✓	

Participant	Unclear	Increase	Decrease	Other
P_{23}			✓	
P_{24}				✓
P_{25}				✓
P_{26}				✓
P_{27}	✓			
P_{28}			✓	
P_{29}				✓
P_{30}			✓	
Total	4	6	7	13

Table 8. Impact of the pandemic on project schedule

Participant	No change	Unclear	Longer	Shorter	Other
P_1	✓				
P_2			✓		
P_3			✓		
P_4			✓		
P_5			✓		
P_6			✓		
P_7	✓				
P_8			✓		
P_9			✓		
P_{10}					✓

Participant	No change	Unclear	Longer	Shorter	Other
P_{11}			✓		
P_{12}					✓
P_{13}			✓		
P_{14}			✓		
P_{15}			✓		
P_{16}			✓		
P_{17}			✓		
P_{18}			✓		
P_{19}			✓		
P_{20}			✓		
P_{21}		✓			
P_{22}			✓		
P_{23}			✓		
P_{24}			✓		
P_{25}			✓		
P_{26}					✓
P_{27}			✓		
P_{28}			✓		
P_{29}	✓				
P_{30}				✓	
Total	3	1	22	1	3

Table 9. Impact of the pandemic on the health and safety of team

Participant	Positive COVID test results	Mental health issues	Other
P_1			✓
P_2			
P_3			✓
P_4			
P_5			✓
P_6			✓
P_7		✓	✓
P_8		✓	✓
P_9		✓	✓
P_{10}		✓	✓
P_{11}	✓	✓	
P_{12}			✓
P_{13}		✓	✓
P_{14}	✓	✓	✓
P_{15}		✓	✓
P_{16}			✓
P_{17}		✓	✓
P_{18}		✓	✓
P_{19}	✓	✓	
P_{20}		✓	✓

Participant	Positive COVID test results	Mental health issues	Other
P_{21}		✓	
P_{22}			✓
P_{23}		✓	
P_{24}		✓	✓
P_{25}	✓	✓	
P_{26}		✓	✓
P_{27}		✓	✓
P_{28}		✓	✓
P_{29}		✓	✓
P_{30}			✓
Total	4	20	23

The sixth question asked the participants about the opportunities to be exploited to enhance sustainability of global research. The responses grouped into three main categories: technological opportunities, modifying research solicitations/ RFPs, and modifying methodologies/methods. Technological opportunities addressed data collection, communication, conferences and networking, and tools, while modifying research solicitations/ RFPs included IRB, health, technology, and standard. On the other hand, modifying methods/methodologies addressed conferences and networking, communication, planning, data, training, technology, flexibility, and humanity. The category with the highest frequency was modifying methodologies/methods followed by technological opportunities (see Table 10).

Table 10. Opportunities to enhance sustainability of global research

Participant	Technological opportunities	Modifying research solicitations/RFPs	Modifying methodologies/methods
P_1	✓		
P_2			✓

Participant	Technological opportunities	Modifying research solicitations/RFPs	Modifying methodologies/methods
P_3		✓	
P_4	✓		
P_5	✓		
P_6			✓
P_7	✓		
P_8	✓		
P_9			
P_{10}			✓
P_{11}		✓	
P_{12}	✓	✓	
P_{13}		✓	
P_{14}		✓	✓
P_{15}	✓		
P_{16}			✓
P_{17}			✓
P_{18}		✓	✓
P_{19}			✓
P_{20}			✓
P_{21}			✓
P_{22}			✓

Participant	Technological opportunities	Modifying research solicitations/RFPs	Modifying methodologies/methods
P_{23}			✓
P_{24}	✓		
P_{25}		✓	✓
P_{26}	✓	✓	
P_{27}			✓
P_{28}	✓		✓
P_{29}			✓
P_{30}	✓		
Total	11	8	16

Conclusions

According to the findings, the predominant issues stemming from COVID-19 fell under the conflicts category. Issues related to data collection, laboratory work, and education/training emerged as the most critical issues overall. Although the issues caused by COVID-19 had a predominantly negative impact on research, they did not directly influence the research outcomes. In many instances, efforts were made to address these issues through various changes and interventions. These changes and interventions encompassed nine major categories: altering experiments, utilizing different methods/tools, adopting online interactions, implementing remote work, modifying materials procurement, adjusting recruitment processes, adhering to new regulations/rules, intensifying efforts for efficiency, and change in results. Notably, these explored changes and interventions had a detrimental effect on the quality of one-third of research projects. Additionally, the pandemic led to increased budgetary requirements for one-fifth of the projects and predictably extended timelines in most cases. The pandemic also had a negative impact on individuals' mental health. To enhance the sustainability of global research, potential opportunities fall into three main categories: technological advancements, adjustments to research solicitations/requests for proposals, and modifications to methodologies/methods, with the latter being the most promising category.

The results uncover the primary factors indicating the comprehensive effects of the pandemic on international research collaboration. Nevertheless, it is essential to acknowledge certain limitations. The participation in the

pilot interview was not restricted to individuals engaged in active international projects during the pandemic. The study focused on specific departments within a U.S. public land-grant research university, and involvement was confined to members of multilingual/multicultural teams. Consequently, the findings are constrained to the particular sample employed in the pilot study.

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