Literature Review

The need for physical distancing and having limited human interaction due to the COVID-19 pandemic has resulted in a shift from traditional face-to-face to virtual activities globally in several domains of life. This includes but is not limited to education, work and conferencing. The United Nations Educational, Scientific and Cultural Organization (UNSECO) reported that globally, there were over than 1.3 billion students in 186 countries who were unable to attend school (2020). It was also reported by the American Community Survey that prior to the pandemic, fewer than 6% of Americans worked primarily from home, however, by May 2020 this increased to 35% of the employed workforce which is about 48.7 million people. This demand has fostered the implementation and use of many technologies which have been vital in helping mitigate the impacts of the pandemic on humans. Conferencing is one of the areas which shifted virtually because of the pandemic. This is a gathering of people with a common interest or background, who meet to learn about and discuss issues, ideas and work that focus on a topic of mutual concern. (Rabinowitz, n.d.) Web conferences utilize collaborative technologies and services to facilitate such meetings remotely. Participants are able to have discussions over the internet using technologies including video conferencing, VoIP calls, document sharing software, digital whiteboards, cloud-based platforms and chat forums. Before this shift, online meetings were less preferred when compared to face-to-face meetings. However, individuals and organizers have been noticing some of the benefits of virtual conferences. Despite the urge to of wanting a return to normality, the question is posed of whether conferences should continue in a virtual format remains. Or should a hybrid model consisting of both face-to-face and virtual meeting components be established? A report on virtual science

conferences claimed that “shifting to an online platform has opened many doors for budding scientists and has established a path toward inclusivity.” (Estien, 2021) The two main mediums of online conferences are synchronous and asynchronous. Synchronous conferences are online meetings that occur in real-time, where communication, interaction and collaboration among participants are simultaneous. The format of synchronous conferences usually comprises of a fixed start time and more formal procedures. Asynchronous conferences on the other hand do not take place in real-time. There is usually a delay in communication and feedback. An example of this is using email. Nonetheless, these meetings still have a list of participants along with a purpose or agenda. This is largely beneficial to persons in different time zones.

Lyndsay describes online conferences as a “cost-effective way to bring together a group of geographically dispersed people.” The economic advantage of online meetings is one of the main factors responsible for the reconsideration of the format of conferences. Online conferences are cheaper and more cost effective for both participants and conference organizers. Thale Jarvis, the chief scientific officer at Keystone Symposia claims that the cost of the virtual conferences for attendees is less than 10% of a destination conference (Jarvis). Expenses associated with face-to-face conferences include travel, transportation, accommodation, visas, and conference fees such as registration. Travel costs specifically increase with geographical distance, making it more expensive for persons from further geographically distanced countries to attend. While majority of the costs stated above are eliminated in online conferences, other expenses such as purchasing computers, running high-speed networks and cloud computing subscriptions have to be evaluated. A study on the economic evaluation of an advanced video conferencing system for cardiac multidisciplinary team meetings provided a cost

analysis of running a conventional multidisciplinary team meeting when compared to a video conferencing multidisciplinary team meeting. The total cost of the conventional face-to-face meeting was £106 525.34 while the video conferencing was £54 392.50, thus representing a cost saving of 48.9% (Dulai). From this study it can be seen that the cost savings of video conferencing were very high. This is applicable to scientific conferencing since they share a similar format. A more in-depth analysis of the estimated financial costs and savings for individuals who participated in the Supporting Deaf People Conference in 2008 was done. The face-to-face meeting was hosted in the United Kingdom, and the average cost per participant living outside of London was estimated to around $2505.05 USD. This figure takes into account the airfare, taxi fare from and back to the airport, hotel accommodation and conference registration. Similar to the previous study, this makes online conferencing highly cost-effective for participants. Not only do the participants save money, but also conference organizers as they do not have to print materials for participants, obtain a physical venue as well as cover the travel expenses of speakers. Furthermore, finances may be a barrier for persons in low-income households and countries, making it difficult for them to attend conferences.

Another challenge associated with in-person conferences that affects participants from international countries is visa bureaucracy. Riddle describes visa bureaucracy as equally burdensome to financial barriers and states that "obtaining a visa to travel to a host country can be a humiliating process, in particular when individuals are considered potentially dangerous' immigrants." (Ridde, 2008) Different countries have various requirements for obtaining a visa such as invitation letters, proof of financial support during the trip and purchased airplane tickets which could make the process more complex. Long processing and wait times can pose problems for persons wanting to attend conferences as it may result in delays. This problem has aggravated

during the COVID-19 pandemic due to the closure of embassies worldwide as well as change in operation days and time. Also, visas are not guaranteed to applicants, and there is a possibility of visa denials under strict visa and immigration laws in certain countries. Therefore, online conferences eliminate all the red tape and excessive bureaucracy associated with obtaining a visa for persons living in international countries.

Bolander describes academia as carbon intensive (Bolander, 2021). He makes reference to a study done at Université de Montréal, the largest university in Montréal, Canada, to gain a greater understanding of the environmental footprint caused by the transit of academic and student at a large university. He acknowledges that academic mobility is a vital part of research and field work, but explains that this is often done at the expense of the environment. From a sample of 703 students and faculty, the average travel distance for work and research was found out to be 8,525 kilometers per person per year. For professors, the average distance was over 33,000 kilometers per person per year. After calculations were done, professors had a carbon footprint of 10.76 T CO2 per year and international and exchange students had a footprint of 3.85 T CO2 a year. The article points out that majority of this travel is done by airplane. The United States Environmental Protection Agency states that electricity, transport and heat are the largest sources of greenhouse gas emissions from human activities. (Sources of Greenhouse Gas Emissions) Thus, another advantage of online conferences over in-person is the potential for reducing carbon footprint which is the total amount of greenhouse gases emitted into the environment by human actions. Face-to-face conferences encourage a lot of traveling both by air and ground and therefore are responsible for a considerable amount of greenhouse gas emissions. Due to the travel restrictions and lockdowns since the start of the pandemic, human behavior has changed, resulting in significant reductions in carbon emissions. The International Energy

Agency estimated an 8% reduction in carbon dioxide emissions as a result. (Gabbatiss, 2020) While virtual conferences have the potential to reduce carbon emissions especially from travel, considerations have to be taken in about how much electricity and energy will be used by computers and other online conference related technology. However, it is expected that they produce far less than in-person. Thus, the option of using solar energy to produce electricity is a viable option. One study estimated that the emissions per participant of persons flying to the location of the conference was 2.21 metric tons or 2201 kg (Anderson, 2009). This also included ground travel and hotel emissions. Another study on the emissions of virtual conference revealed that the conference generated 1324 kg of carbon dioxide emissions, which is just over half of the emissions released by in-person conferences (DeWeerdt, 2021). Thus, it can be inferred that online conferences produce a lower climate impact.

Online conferencing has the potential to promote greater attendance than traditional face-to-face meetings. In addition to cost and visa availability which were stated previously, online conferencing accommodates persons with commitments such as family and jobs or busy schedules that would not allow them the time to travel for face-to-face meetings. Roos explains that there are persons who are not able to travel to attend scientific conferences because of financial, health, family or job-related reasons. He states that being able to participate in conference with having to travel "creates the opportunity to extend conference attendance to larger audiences at minimal additional cost as well as reducing the financial and time burden of travel-related expenses (Roos)". Langin provides a real-life illustration of how this virtual option has the potential to make attending a conference easier for a physics professor in Germany, who would like to attend and is the co-chair for the Materials Research Society meeting, but has a

one-year-old child at home. Virtually participation will enable her to find the right balance between work and family.

The World Bank estimates that globally, approximately 15 percent of the world's population which is more than one billion people have disabilities (Raja, 2016). These impairments include visual, hearing, physical, psychosocial, intellectual, neurological and speech. This World Bank report also explains how one's educational and employment opportunities is affected by these disabilities and states that "the employment rates of persons with disabilities are a third to half of the rates for persons without disabilities." Information and communications technology (ICT) has been identified as one of the solutions to address the barriers that persons with disabilities face. Online conferences have the potential to make it easier for persons with disabilities like sensory and physical impairments to participate in conferences. In traditional face-to-face meetings, the main forms of communication are written or verbal communications. This can make it difficult for persons with disabilities to participate in conferences. Thus, the ability of the technology used in online conferences to delivery content of the meetings in multiple formats and through various media makes it easier for these individuals to participate. For example, persons with visual disabilities can use speech synthesis technology such as text-to speech conversion to get access to print material as well as screen magnification and audio-visual media. Another example is that online conferences can accommodate individuals with hearing disabilities through open captions, subtitles and instant text messaging for communication. Persons with physical disabilities such as loss of mobility directly benefit from online conferences as they could remain at home and still attend. (Raja, 2016)

Online conferences promote diversity and equality by accommodating persons who would otherwise not attend face-to-face conferences. Tulloch, from her analysis of 30 ecology and conservation conferences, found that 40% of the conferences were held in locations where laws and societal norms discriminate against people of minority genders or sexual orientations. She also discovered that only half of the events had codes of conduct that promote equity, diversity and inclusion. Virtual conferences are capable of creating an environment that is safe for everyone, and free from discrimination. Conference organizers and moderators are also charged with the responsibility of managing virtual meetings in a way that creates a level playing field for all participants. A guide on increasing inclusiveness in virtual meetings claims that "studies show that women, people of color, and other underrepresented groups are often silenced, interrupted, dismissed, or talked-over at twice the rate of their colleagues. Exclusion from conversations is also a major issue faced by persons of marginalized groups. In explaining the difference between diversity and inclusion, McGrath states "not everyone attending a meeting feels empowered to share their best ideas or offer opinions they feel the group may not want to hear" (McGrath, 2020). In addition, persons from minority groups often face financial issues which hinder them from participating in conferences. "Individuals from ethnic minority groups, historically excluded groups, particularly low-income and first-generation students, lack the resources and financial stability to attend and afford the expenses associated with scientific conferences." (Estien, 2021) The absence of costs associated with in-person conferences such as travel, accommodation and registration in online conferences play an integral role in eliminating this financial barrier for persons in minority groups.

While online conferences have promising benefits for the research communities, there are some drawbacks that need to be taken into consideration. Macon states that one of the

limitations of virtual conferences is the “feeling of disconnection” associated with “interacting with small images of people on a screen” (Macon). He said that this is exacerbated when participants mute their microphones and turn off their cameras. The lack of a captive audience makes it difficult especially for moderators who face uncertainty about whether persons are actually paying attention. Furthermore, the lack or absence of non-verbal communication that are present in a face-to-face environment such as visual and auditory cues can result in misunderstandings due to wrong interpretations and cause problems in the communication process. More time and effort from conference moderators and organizers is needed to carefully form messages and other types of communication, to ensure misinterpretations do not happen. They also have to check in with participants to make sure they are in sync with the group (Roos)

Another issue that can directly affect an online conference is poor internet quality and speed. Roos states that “a virtual conference is at the mercy of the quality of an internet connection.” Good internet speed is vital to the smooth flowing of an online conference, and an unstable connection can lead to disturbances, communication break down and
This is specifically important for synchronous conferences where live videos are being streamed and many people may be using the same network, apps and virtual conference room simultaneously. To alleviate this problem, higher-speed internet connections will be needed and subsequently a more expensive internet plan for additional bandwidth.

Computer hardware and software are prone to technical issues and failures, and this also affects the running of virtual conferences. A recent example of this is in 2020, when a four-hour outage of one of the most commonly used web conferencing programs, Zoom, disrupted meetings and classes around the country (Shaban). Virtual conferences are dependent on such videoconferencing tools as well as productivity tools, and they are affected by downtime of any

of those services. Conference organizers often hire tech support staff to deal with problems of this nature. Organizers of the Photonics Online Meetup conference shared that in they "enlisted the help of IT support at the University of Southern California to accommodate multiple speakers from many locations and to facilitate the connection between a large number of participants while minimizing technical risks" (Reshef). The technical support staff also provide training for conference attendees and speakers who may be
who unfamiliar with the software and platforms. While this is an additional expense for conference organizers, Reshef asserts it is probable that a lot of these technical issues and problems in using the technology will be overcome as persons get use to virtual events.

Gooding claims that the pandemic has "increased inequality of internet access around the world" (Gooding, 2020). This is supported by a UNESCO report which reveals
that 54.8%, which is just over half of the world, still has no connection to the internet. With so many regions globally out of the reach of digital technology, virtual conferences are not available or accessible to many persons. Not only is this disadvantageous to low-income and developing countries, but is still an issue in developed countries. A Pew Research study reports that about 24% quarter of adults in the US with household incomes below $30,000 a year say they don't own a smartphone and about 43% or four-in-ten adults with lower incomes do not have home broadband services or a 41% desktop or laptop computer. Without addressing these inequalities in technology, a shift to online conferences will exclude several persons which directly opposes one of the goals of many conference organizers, that is, to promote diversity and inclusivity.

Given the numerous benefits of virtual conferences, conference organizers are reconsidering the format of future conferences. Reshef asserts that there have been no

meaningful changes in the format of conferences over centuries. Conferences normally follow the traditional in-person format, where speakers make their presentations to an audience sitting before them. He compares this model to that used by the Royal Society which was created in 1660, and is "the oldest national scientific society in the world and the leading national organization for the promotion of scientific research in Britain," according to Britannica. This success of the in-person format of conferences have made conference organizers and the academic community reluctant to switch to an online format, despite its increasing use over the years. However, he claims that academic travel has been posing negative impacts on personal lives such as a work-life balance as well the environment. This along with improvements in technology and internet connections have opened a door for a "paradigm shift enabled by modern teleconference solutions." However, from early 2020, the Covid-19 pandemic has impacted in-person meetings and coerced a shift to virtual conferences. As a result, many conferences were cancelled, rescheduled to a future date and replaced by virtual meetings. Online conferences successfully provided a platform for researchers and scientific communities around the world to continue holding meetings. A Nature poll of over 900 readers who after a year of viewing and participating in online research presentations, shows that the majority of survey respondents (74%) think that scientific meetings should continue to be virtual, or have a virtual component, after the pandemic ends. Remmel states that conference organizers now have the duty of "considering logistically and financially how to blend the best of both worlds by incorporating virtual elements when in-person meetings resume" (Remmel).

Langin said that many persons in the US are choosing to continue with virtual meetings and that a handful of organizations are planning hybrid meetings, which encompasses both a physical location and for virtual venue. She refers to hybrid meetings as a significant undertaking

and explains that it often requires two planning teams as well as greater expense. However, she reiterates the following statement from Nate Wambold, the director of meetings and conferences for the American Anthropological Association (AAA), to show that many persons are optimistic about the future of hybrid meetings - “We're going to take the best of both worlds and try and smash them together in a way that makes sense.” Conference organizers now have the responsibility of coordinating these hybrid meetings in a way that is beneficial to them and participants. The success of this new format of conferences will have a impact on how meetings will be held in the future.

Conference organizers of The Society for Mathematical Biology and the European Society for Mathematical and Theoretical Biology were some of the many groups who put together virtual conferences over the past year. Amber Smith, one of the organizers, outlined that one of her goals was for the meeting as close as possible to an in-person meeting. Using online workspaces and virtual event coordinators they aimed at having a model incorporating “socializing, networking, and mentoring, hearing talks, seeing posters, and visiting the meeting’s corporate sponsors.” This was successfully done through webinars, Q&A sessions with speakers via video chat, audio, chat and as well as a public forum for further discussion of unanswered questions. Achakulvisut believes that both online and in-person conferences will be used in the future, and the number of attendees at online conferences might be high. The reasons for this assumption is that there are many people around the world who are unable to attend conferences in-person because “if the conference is somewhere hard to get to—because of visa restrictions, distance, expense, or something else.”

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