



# Derivation of Recommendations for Action for Sustainable Development in the Light of the COVID-19 Pandemic

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## Abstract

With the outbreak of a pandemic due to the SARS-CoV-2 virus, the present paper gives an overview of the impacts that this unprecedented situation has had on the environment, the economy and society so far. It will be explained in the paper in what way modeling and simulation helps to understand and to forecast the spread of disease by focusing on compartment models and agent-based models. The presentation of the extent of the consequences in the form of a literature review and the following derivation of recommendations for action highlight the weaknesses of the current economic system. In this respect, the key finding of the research showed that society would be more resilient towards crises like COVID-19 with a regionally and long-term oriented economy that puts social equity and environmental protection first. Therefore, political leaders must rethink the way business is done and should use the crisis as an opportunity to unite the rebuilding of the economy with sustainable development. Models and simulations can assist in finding an appropriate action plan.

**Keywords:** Coronavirus; COVID-19 impacts; sustainable development; resilience; modeling and simulation

## 1. Introduction

For most of today's world population, the SARS-CoV-2 virus and the hereby induced pandemic represent an unprecedented situation. Shops and schools had to close, and people must socially distance or work from home. Due to a reduction in economic activities, economists expect the largest economic downturn that has ever been experienced (Elmers and Martens, 2020). On the one hand, an economic downturn is good news for the environment, but it was shown that more pollution has been reached in other areas of the crisis management on the other hand. Since the COVID-19 pandemic is still ongoing, this paper gives insight into the indirect effects on the environment as

well as the direct effects on the economy and society that have been caused until completion of this work. The role of simulation for analyzing and forecasting the impact of the disease will also be emphasized. Models and simulations are presented which help to assess epidemics and to derive mitigation plans.

The economy makes use of the society and is dependent upon nature for production factors. In line with the three pillars of sustainability – the economy, environment, and society – the present paper aims at answering the research question in what extent the current economic system is resilient towards crises like the COVID-19 pandemic. After the presentation of the impacts and the models, recommendations of action for businesses and policy makers will be stated which illustrate how the crisis could have been handled better



and what necessary conclusions for the economic system as well as sustainable development should be drawn. Hence, the goal of this paper is to depict the current impacts of the pandemic on sustainable development and to make suggestions on how the effects would have been mitigated if the economic system had been more aligned towards sustainable development efforts.

## 2. Literature Review

Numerous studies about impacts of the Coronavirus have been published so far. Each study focuses on a specific research area regarding the environment, the economy or society. Thus, the present paper combines all pillars of the triple-bottom-line principle as it is important to equally consider these for sustainable development.

### 2.1. Indirect Effects on the Environment

So far, the COVID-19 pandemic has had positive as well as negative effects on the environment. On the one hand, travel restrictions, lockdowns and the reduction of economic activities have led to a decrease in fossil fuel consumption which involved fewer greenhouse gas (GHG) emissions being emitted into the atmosphere. Motor vehicles and air traffic account for approximately 72% and 11% of the transport sector's GHGs, respectively. As an example, Germany was only able to achieve its climate goals for the past year due to the Coronavirus (Rueter, 2020). Likewise, the air quality has improved in many places all over the world because of less air pollution. China alone achieved to cut NO<sub>2</sub> and CO levels by almost 50% with the shutdown of heavy industries (Rume & Islam, 2020). Moreover, by scaling down the economy, less noise pollution has been created which disrupts animal ecosystems and humans (Zambrano-Monserrate et. al, 2020).

From an economic perspective, less shipping transport has also contributed to the reduction in GHGs as well as marine pollution. In developing countries, for example Bangladesh or India, untreated industrial wastewater gets often discharged into aquatic ecosystems. Due to the cessation of industrial activity, the Ganges River in India showed significant improvements in water quality. Besides that, the overall water consumption for industrial processes was decreased as well as solid waste which causes water and soil contamination. Furthermore, travel restrictions within the tourism industry have resulted in cleaner beach areas (e.g., Thailand or the Maldives) and the purification of water bodies because of the elimination of littering, swimming, or water sports (Rume & Islam, 2020).

On the other hand, the increased use of disinfectants can cause ecological disparities when other organisms than the targeted virus are killed (Rume & Islam, 2020). Similarly, to combat the SARS-CoV-2 virus in

drinking water, the excessive chlorination of water affects human health negatively (Zambrano-Monserrate et. al, 2020). The pandemic outbreak has also brought along a huge increase in medical waste since hospitals must treat a rising number of patients. As an example, the city of Wuhan generated 240 tons of this type of waste daily which was 190 tons higher than the normal waste volume. The use and incorrect disposal of personal protective equipment (e.g., face masks, hand gloves etc.) by people all over the world drives the waste piles up even more. Moreover, lockdowns and limited mobility made consumers shop more online and, therefore, household waste has increased due to packaging material. In addition to that many countries have temporarily suspended their recycling activities to minimize viral infections in recycling centers. Consequently, landfilling has grown (Rume & Islam, 2020; Zambrano-Monserrate et. al, 2020).

The beforementioned examples prove that the Coronavirus pandemic has impacted the environment in a positive and negative way up until now. It is assumed that the positive developments only last short-term because studies forecast that with the easing of restrictions emissions will begin to grow rapidly again (Dörre, 2020). Society will have to deal with negative environmental consequences for a long time after the pandemic, if they are not treated properly now (Zambrano-Monserrate et. al, 2020).

### 2.2. Direct Effects on the Economy and Society

Compared to the environmental impacts that have mainly been repercussions due to the shutdown of commercial activities, the COVID-19 pandemic has had more direct effects on the economy. Most businesses were not prepared to deal with contact restrictions and to work remotely which is why the crisis highlights the importance of a corporate culture that is open to digitalization and change as well as employees with digital expertise. While some companies are hit hard, e.g., the stationary retail trade, the tourism industry or the gastronomy, others have been benefiting since the start. Especially online shops gained from changes in consumer preferences. As an example, the online retailer Amazon expects record profits because people shop more online. The quick spread of disease did not give businesses time to adjust to the situation. As a result, many industries suffer collapse in demand or are unable to render their services, followed by short-time work and dismissals. It is expected that companies with a high digitalization level can cope more easily with the crisis (Wintermann, 2020; Burgos and Ivanov, 2021). Similarly, the pandemic has shown that a lot of analog procedures are being maintained although digital processes like home office structures could prevail more strongly. In Germany, only 14% of the working population worked from home in November 2020, whereas 27% did so in April 2020 (Kohlrausch, 2021).

However, a study has shown that 56% could potentially work remotely (Alipour et. al, 2020).

Moreover, complex economic interdependences and globalization are an additional burden to sustain business activities. Global supply chains make companies dependent on supplies from other countries. However, while economic activities slow down all over the world, so does the speed of imports and exports. Many companies that operate worldwide engage in vertical supply chains and offshoring by seeking lower production costs in foreign countries. This is a result of an economic system that focuses on growth and profit maximization whilst disregarding its contribution to environmental degradation (OECD, 2020). Although productivity gains can be achieved this way, COVID-19 has revealed that this system is not resistant to crises, and it made many capitalistic driven companies to seek state aid for financing contribution (United Nations, 2020). However, not every country can afford stimulus packages for stabilizing the economy. Especially countries in Africa and South America suffer from a drop in raw material prices and they are highly dependent on commodity exports (Ravallion, 2018). The Coronavirus caused the steepest slump in gross domestic product (GDP) compared to the global recessions in 1991 and 2009. The United Nations estimates that COVID-19 will decrease the global gross national income by one trillion US dollars (Ellmers and Martens, 2020).

At the same time, the pandemic highlighted the importance of the healthcare sector. However, privatization and capitalism led to the underfunding of this sector which weakened its resilience (Dörre, 2020). This can be explained by the attached importance to the GDP and its role as an instrument for measuring wealth and progress of a country. Obviously, the GDP is increased faster and more strongly by manufacturing products (Frey et. al, 2020). The disruptions caused to global supply chains have thereby unsettled financial markets and caused currency instability and serious liquidity shortages in many developing countries. As a result, the pandemic has intensified the velocity of capital flight (United Nations, 2020). Therefore, it was proven that sustainability-oriented businesses and investments are more resilient towards crises because equity funds with a long-term view and a focus on environmental, social and governance criteria performed better during the first quarter of 2020 than those with short-term orientation (Reuter, 2020).

As shortly mentioned before, the Corona pandemic imperils many jobs, thus causing unemployment. According to the International Labour Organisation, 81% of the global workforce has been affected directly or partly by lockdowns since the beginning of disease spread (Dörre, 2020). In this context, social inequality rises because poorer countries cannot tackle the crisis the same way as richer countries due to the lack of financial resources and political stability in most low-

income countries (OECD, 2020). Moreover, in countries like the United States as well as in many African or Asian countries, workers on sick leave are legally not entitled to continued payment of wages. Likewise, in countries with a major informal sector and, therefore, a missing social security system social injustice increases. This sector is especially hard to be taken care of because it is not included into public policies. Moreover, self-employed workers and daily laborers are concerned about job insecurity. The crisis also exacerbates gender inequality and presents a particular challenge for disabled or older people. For example, most of the care personnel is female in many countries, thus being exposed to a greater risk of infection. Many women also only work part-time to reconcile family and professional life (Ellmers and Martens, 2020).

Furthermore, the United Nations (2020) emphasized that if more effort had been put into the realization of the Millennium Development Goals (MDG) and the Sustainable Development Goals (SDG), the economy and society could have been able to manage the crisis better. For example, with a stricter pursuit of the MDG and SDG, the economy and health care services all over the world would be less exclusive. In addition, the continuing pandemic is currently seen as a barrier to the pursuit of the 2030 Agenda for Sustainable Development as well as the Paris Agreement (United Nations, 2020).

### 2.3. The Role of Simulation for Resilience

Modeling and simulation can be used to investigate different what-if scenarios of complex phenomena. Thereby, it can help to analyze the impacts of the ongoing Corona crisis. Firstly, by examining and forecasting the spread of disease and the effects it entails. Secondly, by ascertaining appropriate countermeasures that would help to keep negative repercussions as little as possible (Araz et. al, 2013). As the Corona crisis represents an unprecedented situation for most of the global population and especially for today's policy makers, it is vitally important to find models that help decision makers to take profound decisions. Concerning this, modeling and simulation functions as a tool which contributes to the understanding of the crisis by emulating situations and different scenarios. Hence, simulations can be used to develop appropriate strategies theoretically that might prove to be effective in practice. By doing so, pandemic impacts can be mitigated because simulations help to evaluate the efficiency of current control measures and suggest more appropriate interventions to control the virus, e.g., lockdown, hospital capacity, school closures, resource management, staffing etc. (Currie et. al, 2020; Mahmood et. al, 2020). Brydges et. al (2020) describe simulation as a crucial tool for adjusting to occurring changes elicited by a pandemic. While simulations are an important tool in crisis management it is

important that lessons learned from simulations are adopted, and that the associated changes are made as soon as possible following the simulations to be effective in practice (Reddin et al., 2021). Moreover, simulations fed with real data provide a key tool for increasing the reliability of the derivations regarding the impacts of COVID-19 on sustainability. In this respect, more data-driven quantitative methods are needed as the majority of current research on sustainability impacts of COVID-19 is based on qualitative methods (Ranjbari et al., 2021).

In order to evaluate the impact of a novel crisis situation like COVID-19 properly, the timing for executing the simulation is of high importance. For example, the availability of a sufficient number of trained staff must be taken account of during the first of the four phases in crisis management: Mitigation, preparedness, response and recovery (Altay & Green, 2006; Amideo et al., 2019). Likewise, the distribution of resources should be managed in an early stage and before an epidemiological peak to evade shortages. Therefore, modeling and simulation can be used to react to changes in demand and to make predictions about how the pandemic will develop (Currie et al., 2020). In a later stage, knowledge gained can be used to assess the impact of the crisis on society's mental health due to feelings of depression, health concerns or subsistence threats. Thus, to simulate the effectiveness of possible support measures. Besides, in more general humanitarian settings, modeling and simulation can be used to evaluate the distress and related emotions experienced by the affected population in response to crises and, therefore, evaluate the effectiveness of the response (Drakaki and Tzionas, 2021). Furthermore, simulation can be used to work out a global vaccination strategy by identifying what group of people should be getting the first shots (Currie et al., 2020).

Besides social and economic impacts, simulation can also be used to study effects on the environment. As an example, a multi-scale chemistry-transport model was used for India regarding changes in emission and pollutant concentrations due to industrial shutdowns. The findings endorsed to implement stricter environmental regulations as significant reductions in pollution were identified. Hence, policy makers should tighten laws to maintain environmental improvements that have been realized through COVID-19 (Dumka et al., 2021).

In addition, simulation models project outcomes for different intervention strategies which can contribute to choose from the most suitable managerial activities for sustainable development. In the literature, two simulation types are highlighted: First, compartment models (CM) which analyze causalities and, second, agent-based modeling (ABM) that focuses on interactions between individuals of a population and how behavioral changes would affect future outcomes (Ranjbari et al., 2021). With ABM, the most realistic simulation is achieved when contact patterns, medical conditions and other demographic data are known.

Then, conclusions can be made about transmission rates (Nsoesie et al., 2012). Moreover, multi-agent system (MAS) is a modeling and simulation tool that has been used effectively for decision support in order to address complex problems in various fields. In a MAS, individual agents are local decision makers that interact, communicate, and cooperate with each other in order to solve complex problems which could have not been solved by individual agents (Drakaki et al., 2018). MAS has so far been used to investigate COVID-19 spread (Yyklyuk et al., 2021).

Since COVID-19 has had tremendous effects on global trade and supply chains (SC), it is worthwhile to address one more simulation technique. Discrete-event simulation (DES) subdivides an overall system into several steps. Global SC are complex structures, and the Coronavirus outbreak has disrupted 94% of the Fortune 1000 businesses. Since health crises come under supply chain risks, DES can help to evaluate implications for global supply chains and to work out plans for risk mitigation on the short-term or even risk preparedness on the long-term. By doing so, policy makers can be assisted in finding answers to disruption and recovery time or appropriate policies (Ivanov, 2020). One of the main findings of Ivanov's (2020) simulation was that global SC perform best during a pandemic when the different production stages in the SC recover in sync. Furthermore, lengthy disruptions to facilities and demand downstream the SC (e.g., distribution centers) deteriorate performance considerably for the following reason: While production and transportation cost arise for upstream facilities (e.g., producers), there is no revenue without buyers downstream the SC (Ivanov, 2020).

This paper focuses on CM and ABM as they are most frequently used to analyze spread of disease and to derive mitigation plans (Dalgıç et al., 2017; Araz et al., 2013). With ABM, there are various research focuses that are worthwhile for closer consideration. Tatapudi and Das (2021) have used ABM to investigate the impact of full or partial reopenings of schools in the US. They found that for pandemics from viruses with similar characteristics as for SARS-CoV-2, it might be useful to keep the schools open with a modest campus safety protocol and in-person attendance below a certain threshold. Additionally, Ferguson et al. (2006) have examined general approaches for state intervention to keep the impacts of a pandemic as low as possible. The authors elaborated their data basis with information from past pandemics, namely the Spanish flu, the avian H5N1 infection as well as the SARS epidemic in Hong Kong. They used ABM to compare levels of infection between the US and the UK. They concluded that quarantining and case isolation reduce infection levels effectively, whereas school closures can minimize peak attack rates but not overall attack rates. The latter depends on transmission rates in schools, e.g., if they amount to around 50-60%, which used to be high during past pandemics. This can also be transferred to workplaces which is why various social environments

must be looked at. Compared to school closures, absenteeism in workplaces cause higher economic cost but both ease the burden on the health system. In addition, only very high effectiveness of limitations on border crossing and travel restrictions within the country can delay the spread by a few weeks (up to 6 weeks in the US). Their comparison of the US and the UK has shown that epidemic peaks tend to begin earlier in smaller countries (Ferguson et. al, 2006).

ABM can also be used to find an effective vaccine allocation strategy. Logically, an extensive vaccination coverage has the highest success rate in eradicating contagion (Liu et. al, 2015), especially because “[v]accine stockpiled in advance of a pandemic could significantly reduce attack rates even if of low efficacy” (Ferguson et. al, 2006, p.448). Similarly, clinical cases should be treated with antivirals as soon as possible for which stocks for approximately half the population size are needed. In general, simulations can make use of data from past pandemics, but each virus is individual and needs to be studied separately (Ferguson et. al, 2006).

Nsoesie et. al (2012) combined ABM with a sensitivity analysis to analyze how certain parameters and their adjustment affect transmission dynamics of pandemic influenza. This way decision makers can modify their action plan. For example, some of the results showed that epidemic dynamics can be predicted by the mean of an incubation period only and age-dependent transmission hinges heavily on the mean infectious period (Nsoesie et. al, 2012).

CM using differential equations are also a common modeling technique in epidemiology. Araz et. al (2013) simulated a disease spread of the H5N1 avian virus with deterministic CM in which compartments are indicated as susceptible (S), exposed (E), infected (I) and removed (R) for different disease states. Then, members of the population were allocated to each compartment to establish a pandemic preparedness plan for school closures. This is especially challenging because policy makers must be able to assess the impacts of this approach and offer alternatives if school is cancelled. The authors concluded that “the sequential closure and re-opening with a specific decision rule gave the best compromised solution in terms of minimizing the total number of infections and providing minimal educational discontinuity.” (Araz et. al, 2013, p.572) This provides decision makers with valuable time in managing a health crisis when peak attacks are decreased (Araz et. al, 2013).

Silva et. al (2020) used a similar but new approach with ABM using the Susceptible-Exposed-Infected-Recovered (SEIR) model for evaluating social distancing strategies and their impact on transmissibility and the economy. The authors investigated “[s]even different scenarios of social distancing interventions [...]: (1) do nothing, (2) lockdown, (3) conditional lockdown, (4) vertical

isolation, (5) partial isolation, (6) use of face masks, and (7) use of face masks together with 50% of adhesion to social isolation.” (Silva et. al, 2020, p.1) ABM is an appropriate tool because it can simulate a society as a dynamic system. According to their findings, a combination of face masks and partial isolation is considered as more enforceable from a practical point of view. A (conditional) lockdown leads to high economic costs and restrictions on people’s movements but would achieve the best results for the spread of disease. In this case, government intervention is necessary to support citizens and the economy financially (Silva et. al, 2020).

It is worth to compare different models for the epidemiological research focus. Even if the same recommendations can be deduced from different models, Dalgıç et. al (2017) have proven that strategies derived from ABM would have led “to 70% decrease in total cost and 34% reduction in the number of infections compared to the strategies derived by using the compartmental model.” (Dalgıç et. al, 2017, p.1) The reason for this are presumptions and parametrization within the models. Their research focused on identifying vaccination prioritization for determining vaccine allocations strategies. By looking more closely into an influenza pandemic and hypothetical households with different age groups, both models suggest vaccinating school children (aged 5 to 18 years) first (Dalgıç et. al, 2017).

### 3. Methodology

In order to answer the research question - how resilient the present economic system is towards crises like COVID-19 - this paper aimed at presenting impacts of the pandemic on the environment, economy and society in the form of a literature review. For this reason, qualitative as well as quantitative data was examined to also achieve the goal of the paper: To depict the present extent of the crisis and what society can learn from it. This information was based on secondary data only and extracted from books, reports and journal articles that can be found on Elsevier, Google Scholar, SpringerLink and ResearchGate. Since the Corona crisis is a new research area, this approach helped to gather information about the effects of the crisis and to identify their interrelationships. Hence, the literature sources were qualitatively reviewed based on value-added content in order to demonstrate major impacts.

With the findings from the literature review, recommendations for action for businesses and political leaders are derived in the discussion since it was made clear that the current economic model does not consider risks like the Coronavirus pandemic well enough. For this reason, the system even intensifies the effects.

This paper faces certain limitations because the disadvantages of qualitative methods include lower

objectivity and findings that are strongly influenced by the chosen academic literature. However, the research for this paper included German and English literature, whereby a greater extent of the literature review was achieved. Moreover, the paper focused on global impacts following the triple-bottom-line principle which enhances the value and variety of the findings.

#### 4. Results and Discussion

The literature review has made obvious that the present economic system is not resilient towards crises like Corona. The economic model even exacerbates its consequences. Hence, it must promote sustainable development more. There are different reasons to this. Firstly, the COVID-19 crisis has highlighted how important digitalization is for the economy. Therefore, its development should be driven forward more strongly and consistently. This applies to any kind of sector so that all industries can benefit from possible efficiency gains. The Corona crisis has shown that it could have been handled better from the beginning with a higher level of digitalization. For example, home schooling, remote work, and digital communication. In this context, even a few digital upgrades are sufficient sometimes, e.g., digital food delivery services for the gastronomy or pick and collect services for the stationary retail. Especially the health care sector would benefit from digital technologies. Hence, countries should invest more into research and development about digital technologies and future business models should already implement digital characteristics. In general, corporate culture must be eager for change and continuous learning since the digital age accelerates change incessantly. Accordingly, home office structures could become a standard as they allow greater time flexibility for employees, especially families.

These findings can be well transferred to the promotion of automation so that economies can regain autarky. Complex supply chains have aggravated the economic impacts of COVID-19. With more self-sufficiency and a local character of business interdependences, companies could become more resilient to crises. This can be achieved through closer relationships with stakeholders. In addition, lowering global transport routes can represent a potential for emission reduction. It must be assured that the environment also benefits from more local markets. Similarly, these aspects address the need for a more circular economy. Less resources would be needed, and the concept of a closed-loop system is less sensitive to crises because the economy will be less dependent on external factors outside the circle. From an epidemiological point of view, this was also proven by ABM because only a very effective border control would reduce transmissibility significantly (Ferguson et. al, 2006). The movement of goods and people contribute to the spread of disease which affirms the gain from a regionally oriented economy. Firstly, from a health perspective and, secondly, from an economic point of view when the

direct economic impacts of COVID-19, including a health crisis as a supply chain risk, are being enumerated once again. The SC in a regional economy is much shorter whereby risks are easier to detect, assess, mitigate, and control.

In this respect, national governments can use the current situation to build back better or perhaps bounce forward with resilience building. Environmental laws must remain effective because especially polluting industries would benefit from a suspension. The exclusion of polluting companies from stimulus packages should even be considered. While businesses with a short-term profit orientation can help to increase the GDP fast again, new instruments that measure progress and wealth must be considered. Economic strength should be valued after the well-being of employees, environmental improvements, and overall resilience towards crises. Besides, social safety net policies have been identified as recovery policies in the context of the GDP growth loss caused by COVID-19 (Azomahou et al., 2021). Now would be the time to invest in a greener and more sustainable economy and governments should reconcile financial aid with its long-term impacts, thus its role for the climate crisis. If political leaders only focus on the management of the Corona crisis now, they will still have to face climate issues afterwards. This also applies to the SDG and MDG.

In this regard, the modeling examples illustrated the importance of models and simulations for the management of a health crisis and to derive action strategies. The latter need to be adjusted from time to time. Most importantly, weaknesses regarding the economy, society, and the environment can be revealed and studied in depth. For example, simulations on environmental improvements and degradation can develop realistic scenarios to highlight areas with specific need for action. The necessity for acting can be reinforced with a crisis that stresses the relief of the environment during an economic shutdown and intensifies existing environmental problems. Moreover, modeling and simulation reveals the vulnerability of different societal groups during the pandemic and can be used to evaluate the spread of disease for various social environments (Haqiqi and Horeh, 2021). Hence, policy makers gain insights on what group to take care of first and what could help to improve their situation long-term. This way they could promote social equity. The same applies to the economic point of view. Some businesses and professional groups have been hit harder than others (Wintermann, 2020; Burgos and Ivanov, 2021). As an example, many artists have been without a job for more than a year now. Modeling can analyze how to support these kinds of groups best during an ongoing pandemic and how to distribute stimulus packages. In summary, models and simulations highlight areas for government intervention because governmental decisions can still effectuate the most regarding the three pillars of sustainability and sustainable

development.

In general, the COVID-19 crisis has revealed that the “business as usual” behavior should not be continued. It is obvious that the positive environmental impacts were not achieved consciously and that there will be rebound effects when the economy picks up speed again. In order to change the economic structure, strict objectives and business models that internalize sustainable development are necessary. Hence, environmental, social, and corporate governance should become a standard just like long-term risk planning.

From a societal view, companies must assume responsibility for their workforce. By doing so, they must respect the interests of all types of employment (e.g., part-time, temporary etc.). Firstly, they should provide necessary training opportunities to further their knowledge continuously. Secondly, employers need to improve job security, e.g., continued pay, and thirdly, companies must protect workers from potential health risks with additional hygiene precautions. The latter should especially be considered for employees without the option for remote work, whereas all other employees should be enabled to do so with proper ergonomic equipment. With regard to simulations, ABM can be used to investigate the risk of infection in different work groups in order to determine the need for protection. This is especially interesting when comparing transmissibility in so-called white-collar jobs and blue-collar jobs since low-skilled laborers tend to work in the latter and it is easier for white-collar workers to work from home. This would represent another possibility of generating more equality.

Simulation helps to understand a crisis better and to predict how it evolves. However, since SARS-CoV-2 is a new virus and the pandemic is still ongoing, it entails a level of unpredictability. The most recently discovered viral mutations of the Coronavirus demonstrate that models should have a short time horizon, be revised on a continuous basis as well as modified with new data, if necessary. Moreover, they should be checked whether they are universally or only locally applicable since the pandemic concerns the global population. Apart from this, it is highly recommended to use such models in order to recognize connections and make sound decisions for sustainable development.

The presented models have made clear how individual simulations are and how much their results depend on the investigated environment, the included dataset as well as on parametrization. It is crucial for the findings what is analyzed and where. Hence, it is difficult to transfer these results and interpret them for different social, environmental, or economic environments. This was exemplified with two different models of the same research focus but different outcomes and the comparison of outcomes of the same model in different countries. Similarly, derived mitigation plans can work for one actor but not for another which makes it

difficult to make general statements. A further aspect is the lack of data for some models. This is evidence by the fact that each epidemic is individual which makes it difficult to suggest specific simulations and models for the current Corona crisis, especially because it is a wide-reaching, global health crisis. However, decision-makers can learn from past epidemics and their models.

Lastly, managing the crisis requires a cooperative approach. Nations should collaborate and work together so that the Corona crisis will not aggravate issues in developing countries. Another key fact to remember is that joint action calls for an equal distribution of vaccine. When making plans for sustainable development it is important that decision-makers do not only look at it from a national point of view but rather an international one. The most effective approaches to fight a virus are antivirals and a vaccine (Ferguson et. al, 2006). However, rich countries tend to be in better positions regarding stockpiles of antivirals to treat infected people and the current Corona pandemic has shown that they secure vaccines for themselves. In a global context, this approach increases inequality. Driving sustainable development forward in one country is less effective when many other countries fall along the wayside.

## 5. Conclusions

The literature review emphasized the importance of keeping the triple-bottom-line principle in balance. By focusing on the environment, the economy and society, green businesses proved to be more resilient towards crises than capitalistic companies. However, especially large companies receive financial aid from governments due to their role for the present economic system. Nonetheless, it was made obvious that global supply chains are fragile. The present economic system is not resilient towards crises like Corona and should be reconciled with sustainable development more. To address this problem, economies need to become more circular and local, and align with high social and environmental standards. Governments can promote this transition through legal regulations and other political instruments. Modeling endorses the decision-making process because it simulates the possible scope and implications of an epidemic outbreak, thus deriving strategies for action. Therefore, they are a crucial tool for resilience-building efforts and sustainable development because they highlight strategic action areas for social equity, environmental protection, and economic support. With regard to COVID-19, it is difficult to recommend specific models due to the individuality of simulations and the virus as well as its global extent. Due to this, the pandemic affects many different social, economic, and environmental structures. However, models already developed during past epidemics can be used as reference.

Most importantly, it is imperative to rectify the

problem at source. Zoonotic diseases can occur more frequently with rising temperatures and the relationship between humans and animals. The reasons for this are the exploitation of animals for food, the consumption of animal products, livestock farming as well as wildlife trade. The Coronavirus will not be the last pandemic if habitat of other species gets intruded into and destroyed. COVID-19 has indicated that resources, especially in advanced industrialized countries, are available to manage a crisis. However, the climate crisis has not received the same attention for urgency yet. Decision-makers must administer to the climate crisis the same way so that we can look towards a more resilient, sustainable future.

For future research, a full impact analysis of the pandemic for a specific country regarding the economy, the environment and society can be conducted, though this would make most sense after the crisis. Epidemiological research, including simulation and modeling, will benefit from this data.

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