



# COVID-19 and dynamics of environmental awareness, sustainable consumption and social responsibility in Malaysia

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## Abstract

Despite a profound evidence of the human unsustainable behaviours' impact on the environment, stark disparities prevail on this narrative especially in the context of the current epidemiological situation ushered by the COVID-19. The ongoing pandemic is a global public health concern due to its sagacious impacts on environmental sustainability, social responsibility and people's quality of life. This study primarily focuses on analysing the impact of COVID-19 (COV) on the environmental awareness (EA), sustainable consumption (SC) and social responsibility (SR). Additionally, we aspire to investigate the impact of demographics of generations and religion on the proposed nexus in this study. The data was collected from 700 participants of different age groups and religious backgrounds in Malaysia, and structural equation modelling (SEM) was used to analyse this data and test the hypotheses. The findings indicate that COVID-19 has a significantly positive impact on EA, SC and SR, and the generations and religiosity moderate the relationship between COVID-19 and its impact on sustainable behaviours. This study contributes to analyse the difference in the perception of EA, SC and SR among the people that eventually will stimulate the scientific reasoning among the governments, policymakers and scientists to develop a holistic framework to combat unprecedented event such as COVID-19 and ensure the authentication of sustainable environment and exceptional quality of life. The policymakers in Malaysia may use the findings of this study to inspect the social and environmental aspects of the people during the transformation events.

**Keywords** COVID-19 · Pandemic · Environmental awareness · Sustainable consumption · Social responsibility · Malaysia

## Introduction

COVID-19 is an infectious disease caused by SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2), initially identified in China's Hubei (Wuhan) district in late December of 2019 WHO World Health Organisation (2020). The World Health Organization (WHO) declared it a global pandemic on 11 March 2020; as of 13 December 2020, it has affected 218 countries and territories with more than 72.07 million confirmed positive cases and 1.61 million

deaths WHO World Health Organisation (2020). Scientists across the world have used several epidemic and mathematical models to predict and warn the precipitous increase in fatality rate due to the outbreak of unmitigated virus (Adam 2020; Nawaz et al. 2020). However, these reputable models are not applicable for developing countries as these offer limited explanation and guidance to the policymakers about the spread of COVID-19 infection and mitigation strategies Nawaz et al. (2020). Instead of relying on reputable models, developing countries managed to mitigate the spread of the virus through rapid governance response, continuous surveillance of the pandemic-affected areas and integration of various resources such as health, education, defence and media Nawz et al. (2020). Nonetheless, the predictions of distressing and unconventional models forced governments around the world to immediately impose stringent containment measures such as restriction of movements; social distancing; closure of schools, businesses and public places; cancellation of major events; prohibition of large public gatherings; and closures of national borders (Asayama et al. 2020). Meanwhile,

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environmental and social behaviours during this epidemic situation have created a huge panic among the general public which needs to be addressed on immediate basis (Huo et al. 2021a). The disasters like COVID-19 notoriously pose serious economic and environmental impacts that may surpass the capacity of the affected countries to compete with the use of their assets (Huo et al. 2021b).

While the draconian containment measures are keys to halt the spread of COVID-19 infection, there is an ongoing debate in the world whether to characterise the emergence of COVID-19 as a “black swan” or a “black elephant” (Friedman 2020). COVID-19 and the climate change are described as a twin crisis in the Anthropocene which marks an era of significant changes in the global environment due to the unsustainable human activities (Asayama et al. 2020; Markard and Rosenbloom 2020). The recent studies have highlighted that containing the COVID-19 infection through systematic planning and synergistic approach will subsequently help to address and resolve the climate issues (Galbraith and Otto 2020; Peters 2020; Steffen et al. 2020). Despite striking disparities among the researchers, unarguably, it is projected that COVID-19 ushers a great prospect to advance the climate agenda, particularly in addressing the broader transitions in production and consumption patterns (Cohen 2020; Rosenbloom and Markard 2020). Particularly, based on the current health crises, the significance of environmental pollution is a major concern for public health as these can incur numerous neurological disorders (Iqbal et al. 2020a).

The global jurisdictions have launched a range of economic recovery programmes to mitigate the economic shocks ushered by COVID-19. These programmes largely focus on addressing the unemployment and cushion the core industries. However, these programmes have woefully neglected the climate issues which increase the risks of dire consequences of human actions on the environment. A profound example in this regard is the policy and assessment report submitted on March 2020 by the German Council of Economic Experts as an advisor to the officials which did not cover any aspect of sustainability or climate (GCEE, 2020). To add fuel to the fire, governments are prone to provide financial support as a pandemic response for the carbon-intensive industries underpinning the support for status quo trajectories. In the USA, the Trump administration appeared to bail out the fossil fuel industry (Krugman 2020) and the Canadian government has contemplated a similar stance (Fife et al. 2020). It is well-established that the changes in political assessment matrices of local officials help in decentralising the environmental effects (Wen and Lee 2020). Additionally, a recent study has found that policymakers’ lack of organisational capacity and effective policy response to COVID-19 crises management may generate negative effects on the public health as well as the economic system (Coccia 2021). Therefore, it is necessary to investigate the economic and environmental policies in the

South and Southeast Asian countries as the region is struggling to achieve sustainable development goals, and designing relative environmental policies may help in addressing the environmental and existing health crises (Sharma et al. 2020).

Scientists, health professionals and researchers have collaborated to identify COVID-19 implications on humans and the environment. Despite an established evidence of a deep connection between health issues and environment, the world continued to ignore this nexus and respond accordingly to the ongoing pandemic (Lodeiro et al. 2021). Globally, a common response to the ongoing health crises is escalating anxiety and helplessness among people. Zhai and Du (2020) found that people have developed mental health issues due to the pandemic that include panic attacks and anxiety (Blake et al. 2020). Insomnia is also classified as a common reaction to COVID-19 which is increasing the consumption of psychotropics and alcoholic beverages to curb the feelings of isolation and the fear of losing infected family members. The perpetual implications of the pandemic are yet to be classified; however, sagacious and prevalent social changes in production, consumption and environment are expected to occur in the future (Sarkis et al. 2020). The production of household and hospital waste significantly increased during the COVID-19 crises. The production of medical waste of Wuhan hospital increased from 50 to 240 tons per day during the pandemic (Zambrano-Monserrate et al. 2020). COVID-19 has a significant impact on the reduction of nitrogen dioxide (NO<sub>2</sub>) in the Chinese climate, initially started near Wuhan due to a lockdown and businesses closure and eventually spreading in the entire country Wang and Su (2020). The safety measures imposed in the wake of COVID-19 has protected people from getting infected from the virus as well as has a positive impact on the environment.

Furthermore, in several developed countries, economic recovery plans designed under the umbrella of COVID-19 largely focus on trade protection and have ignored energy efficiency issues (Wang and Wang 2020), whereas a profound evidence exists on the reduction of carbon emission through improved energy intensity (Zhao et al. 2020). Hence, we argue that focusing on energy conservation and responsible consumption will reduce carbon emission even after the COVID-19 pandemic.

Different generations perceive environmental awareness and sustainable consumption differently and represent a range of organisational and social behaviours (Ghosh et al. 2021; Severo et al. 2018). This will transform economic conditions in a region (De Guimaraes et al. 2014; Severo et al. 2017), environment (Dorion et al. 2012) and the quality of life which alternatively represents a triple bottom line approach. Similarly, a better religious participation leads to better emotional health and the emergence of COVID-19 is expected to strengthen the people’s faith (Kowalczyk et al. 2020) that may exceptionally impact on the environment. The findings of past

studies provide a sufficient evidence of religious beliefs driving better environment conservation behaviour. Based on the settings of the current study, it will be interesting to explore whether people from different religious backgrounds in Malaysia represent different environmental behaviour while stranded in the midst of the current pandemic.

The results of different studies and surveys conducted in Western cultures prove that religious beliefs drive individuals' environment conservation behaviour (Hagevi 2014; Minton et al. 2015; Morrison et al. 2015). According to the United Nations Environment Protection Programme (UNEP), spiritual leaders of different religions address and agree on environment as a creation of God and encourage its followers to protect the environment to represent a global solidarity, ethical moral and spiritual commitment

The analyses of recent studies show that social block of COVID-19 positively influence Tunisian consumers' food and waste awareness, attitude and behaviours (Jribi et al. 2020). Ironically, persuasive social commitments, governance frameworks and businesses have suppressed the sustainable production for the past three decades and the concept of SC is struggling to seek attention (Cohen 2019). Nonetheless, the emergence of COVID-19 provides the window of opportunities to advance the transitions in sustainable consumption (Cohen 2020).

This research highlights a theoretical research gap in the midst of a natural experiment such as COVID-19 and its interaction with EA, SC and SR among the generations of different religious beliefs. Precisely, we focus on investigating what is the influence of the COVID-19 pandemic on EA, SC and SR among the generations of different religious associations in Malaysia? The recent studies have confirmed the impact of COVID-19 on EA, SC and SR of generation (Severo et al. 2020). There is convincing evidence in the literature about the consumption patterns of consumers and the possible threats posed on the planet and the human welfare (Frick et al. 2020), and the emergence of COVID-19 and recent expansion of science, technology, development of industrial and economic activities have convinced consumers that the climate change is an intransigent concern (Evensen et al. 2021; Senapathi et al. 2021). Building upon the theoretical research gap, this research will contribute to investigate the difference in the perception of EA, SC and SR among people of different ages and religious backgrounds during COVID-19. Rationally, this will stimulate scientific reasoning among the governments, policymakers and scientists to design a holistic approach to combat unprecedented epidemiological event such as COVID-19 while authenticating sustainable environment and exceptional quality of life.

The remaining study proceeds as follows: the "Theoretical framework" section outlines the literature review and theoretical framework. The "Data and methods" section discusses the research methods, the "Empirical results" section highlights

the major findings and discusses these findings, and the "Discussion and conclusion" section presents the conclusion and implications.

### Current situation of COVID-19 in Malaysia

The first positive case of locally transmitted COVID-19 in Malaysia was reported on February 03, 2020, in an individual who returned after attending a meeting held between the Chinese delegates (Ahmad 2020). On March 04, 2020, there was a sudden increase in the number of cases originated from the cluster of case number 26, who had actively attended five large gatherings and had a travel history to China Abdullah et al. (2020). The situation was further intensified on March 11, 2020, when International Health Regulations (IHR) Malaysia discovered that a Bruneian individual was tested positive after attending a large religious gathering held in Selangor, Malaysia Abdullah et al. (2020). As of December 15, 2020, there are more than 84,846 positive COVID-19 cases and 419 deaths in Malaysia and the Centres for Disease Control and Prevention has categorised Malaysia as a high-risk country (level 4) Centres for Disease Control and Prevention (CDC) (2020). The Malaysian Ministry of Health (MoH) demonstrated exceptional readiness to minimise the outbreak of the COVID-19 infection. MoH ensured to screen individuals at key entry points by placing thermal scanners throughout the country (Md Shah et al. 2020). The Malaysian government and MoH coordinated to improve the capacity of its hospitals to control and treat the COVID-19 patients. MoH proposed that the government impose nationwide Movement of Control Order (MCO) to restrict people movement and contain the spread of the infection (Nadzir et al. 2020). The MCO prohibited and limited the operations of several private and public sector organisations including closure of educational institutions such as schools and universities, day care facilities and shopping complexes. Moreover, mass gathering was also prohibited and stringent measures were imposed on travel, tourism and recreational activities. The government announced a generous RM250 billion stimulus packages (PRIHATIN) on March 27, 2020, to cushion struggling micro, small- and medium-sized firms (Md Shah et al. 2020).

### COVID-19 impact on sustainable consumption and production in Malaysia

Malaysia is touted as an example of a successful developing country having a well-documented environmental policy which significantly addresses issues of cleaner production and resource efficiency (Adnan 2015); therefore, such economic developments are expected to contribute to reduce environmental pollution in the country (Iqbal et al. 2020a). However, the main issue in maintaining the sustainability of

resources and reducing the environmental pollution is excessive consumption of natural resources which are highly subsidised and underpriced by the government (Lee 2005). Malaysia aspires to achieve Target 12.2 of goal 12 through sustainable management and efficient use of natural resources by 2030 Department of Statistics Malaysia (DOSM) (2020). The consumption of natural resources among the general public is relatively high as compared to the recommended use of resources by the United Nations. Malaysians have fair levels of environmental awareness and actively represent conservation behaviour; ironically, the awareness is largely cost and convenience driven (Mei et al. 2016). Globally, consumers' consumption patterns were reshaped due to the implementation of lockdowns and its consequences following the wake of COVID-19 (Borsellino et al. 2020; Mathios et al. 2020). Many countries experienced massive stock piling of food products that may compromise the future of sustainable consumption. This will incur an extra burden on crumbling Malaysian agricultural sector whose 40% production relies on import from other countries (Adnan and Nordin 2020).

### Environmental and social impacts of COVID-19

The outbreak of COVID-19 resulted in humanity retreating indoors and the natural world rumbling out liberated. Several notorious and dirty waterways and rivers around the world started to look clean, the air quality improved, the smog and haze disappeared and open spaces filled with wildlife (Saadat et al. 2020). Apparently, global lockdowns in the wake of the coronavirus ushered numerous positive effects on the environment. Several local and domestic environmental reporting bodies such as NASA (National Aeronautics and Space Administration) and ESA (European Space Agency) reported positive changes in environmental quality induced by COVID-19 after compiling the recently published data (Khan et al. 2021). Additionally, empirical studies have also confirmed the reduction in air pollution levels during the pandemic such as the amount of nitrogen dioxide (NO<sub>2</sub>) and black carbon (BC) reduced by 50% in Barcelona, Spain Tobias (2020). Carbon emission in China reduced by 25% during the lockdown, that is, about 1 million tons lower than the last year's emission (Wang and Su 2020). Similarly, in Malaysia, particulate matter (PM<sub>2.5</sub>) reduced by 58.4% during the MCOs (Abdullah et al. 2020).

Whereas unpropitious ramifications of COVID-19 on the environment include hefty amount of domestic and medical litter generated by hospitals during the diagnosis and treatment of large number of COVID-19-infected patients (Zambrano-Monserrate et al. 2020), the cluster of studies conducted during COVID-19 on energy management found that effective and efficient energy management and CO<sub>2</sub> emission are a serious problem (Iqbal et al. 2020b). Different studies have confirmed the increase in environmental waste during

the pandemic, such as in China, medical waste per day jumped to 240 metric tons during the pandemic (Saadat et al. 2020), 550–600 kg/per day of medical waste in India (Somani et al. 2020) and 206 ton/per day of medical waste was produced by hospitals in Dhaka Rahman et al. (2021). In Southeast Asia, approximately 154–280 metric ton medical waste was produced by hospitals in Manila, Kuala Lumpur, Hanoi and Bangkok during the first phase of the pandemic (Rume and Didar-UI Islam 2020). Similarly, established quarantine policies across the world increased online shopping and consumers demanding home deliveries which eventually increased the household waste (Somani et al. 2020). Even though recycling of waste is an authentic method to reduce pollution, save energy and conserve natural resources (Ma et al. 2020), yet, countries were forced to postpone its recycling initiatives to reduce the spread of the virus. Many recycling facilities were shut down in nearly 46% cities in the USA, the UK, Italy and many European territories as these were perceived as one of the hotspots of spread of infection (Somani et al. 2020). The intensive use of disinfectants on the roads, commercial and residential places to exterminate the COVID-19 virus may kill non-targeted beneficial species that resulted in ecological imbalance (Rume and Didar-UI Islam 2020).

The pros and cons of the COVID-19 pandemic and its impact on the environment are comprehended better in the territories most affected by the virus such as China, the USA, India, Brazil, the UK, Italy and Spain (Praveena and Aris 2021). Therefore, studies on the impact of the pandemic on the environment particularly on environmental behaviours such as awareness, consumption and social responsibility are relatively scarce and are confined to certain local scales in the Southeast Asian region (Ash'aari et al. 2020; Dang H-A and Trinh 2020; Li and Tartarini 2020; Stratoulis and Nuthammachot 2020; Tosepu et al. 2020). Hence, our study attempts to bridge this theoretical gap and documents an empirical evidence about the impact of the COVID-19 pandemic on the environment and social behaviours. The following section advances further discussion about the impact of COVID-19 on the environment and different environmental behaviours of consumers of different ages and religious backgrounds.

### Theoretical framework

#### COVID-19 pandemic and psychological and emotional consequences

The literature has extensively documented the psychological and emotional health disruptions caused by major stressful events on individuals (Ghodse and Galea 2006; Smith et al. 2019). Primarily, the researchers and scientists have focused

on preventing the transmission of COVID-19 and vaccine discovery (Rathod et al. 2020). However, the aftermath of the current crises, especially mental health issues, could be devastating that may range from health-related anxiety and life and global uncertainty (Yao et al. 2020) to effects on lives due to mandatory social distancing, self-isolation and quarantines (Bedford et al. 2020; Memish et al. 2020). The findings of recent studies reveal that COVID-19 and its containing measures are developing negative psychological disorders, post-traumatic stress symptoms, confusion and anger among people (Rathod et al. 2020). Brooks et al. (2020) analysed the stressors in quarantine and concluded that quarantine duration, fear of infection, frustration, boredom, lack of supplies and information, financial loss and stigma are the major stressors.

### COVID-19 pandemic and environmental awareness

The pandemic has resulted in serious economic shocks that may negatively impact on the human and organization environmental response (Hallema et al. 2020). This will constitute further challenges on environmental awareness and the water consumption patterns which are cardinal to water efficiency and policy execution designed to address the rising water scarcity issues Gomez-Llanos et al. (2020).

Recently, the air pollution has come under limelight, as the improvement in air quality, reduction in environmental noise and cleanliness of beaches is associated with the emergence of the COVID-19 pandemic (Zambrano-Monserrate et al. 2020). The restriction of movements and travel bans have reduced the carbon dioxide emission by 0.3% which is achieved for the first time after a decade (Tahir and Batool 2020; Rugani and Caro 2020), whereas the negative aspects of the pandemic are increased wastes, reduced recycling and increased contaminated public spaces (Zambrano-Monserrate et al. 2020). These are the serious consequences of the pandemic and there are large disparities among the scholars whether the emergence of COVID-19 will have a positive or destructive impact on the environment and the public environmental awareness.

Fattorini and Regoli (2020) highlighted that the number of COVID-19 cases had a significant impact on the air quality of 71 provinces in Italy which confirms that chronic exposure to contaminated environment provides a breeding ground for the spread of the virus. Pirouz et al. (2020a) coherent findings further affirm that climatic conditions and population density play a major role in increasing COVID-19 cases. While Sarkis et al. (2020) highlighted that the emergence of COVID-19 positively impacts the environment which will result in significant reduction in air pollution. Regardless of COVID-19 emergence, domestic plants and gardens are considered a significant contributor to improve climate conditions, enhance public awareness and shape market trends (Sofa and Sofa 2020). These findings provide a profound evidence about the potential of domestic gardens to trigger sustainable use

and conservation of natural resources at a small scale and help in shaping self-efficiency, sustainability and improved environmental awareness.

However, the positive aspects of COVID-19 on the environment are temporary and serve as a guideline for the societies to transform their lives El Zowalaty et al. (2020). Indeed, COVID-19 has emerged as a new paradigm to engage the public to represent a better environmental behaviour and enhance their environmental awareness which will help in achieving long-term sustainable environmental goals (Sarkis et al. 2020; Cohen 2020). The proceeding argument leads us to propose H1;

**H1:** COVID-19 (COV) pandemic has a positive impact on environmental awareness (EA).

### COVID-19 pandemic and sustainable consumption

Jribi et al. (2020) found that during the COVID-19 pandemic, a notable positive behavioural change occurred among the people for the food purchase, food waste, storage and the consumption of leftover food. Moreover, the dependence of developing countries on external supply chains has restricted the access to food supplies which has resulted in serious economic, social and consumption issues (Grinberga-Zalite et al. 2021). However, the restriction of movements and the socioeconomic conditions of people during the pandemic might have contributed more in representing this particular behaviour in contrast to environment protection behaviour. While the restriction of movements faced by the public drastically affects their economic and social fronts, it is also expected to positively impact on natural environment (Muhammad et al. 2020).

The policymakers continue to struggle in mitigating the emission of greenhouse gases and protection of groundwater from contaminants, microbes and pathogens to transform the environment (Ali et al. 2021; Hua et al. 2021a). However, the positive environmental changes at the COVID-19 epicentres were confirmed by the National Aeronautics and Space Administration (NASA) and European Space Agency (ESA) in Wuhan, Italy, Spain and the USA where the environmental pollution declined by 30%. A few other studies conducted in India and China found a convincing evidence of a significant decline in the concentration of nitrogen dioxide (NO<sub>2</sub>) during the pandemic (Wang and Su 2020; Shehzad et al. 2020). Collivigneri et al.'s (2020) findings also indicate a significant reduction in the concentration of environmental pollution and sulfur dioxide (SO<sub>2</sub>) in the urban areas of Milan primarily due to the decline in vehicles achieved by imposing restriction of movements. Lal et al.'s (2020) findings concluded that the concentration of NO<sub>2</sub>, carbon monoxide (CO) and the optical aerosol depth has declined at the majority of COVID-19-affected areas. Another study in California found that

COVID-19 and environmental pollutants such as PM<sub>10</sub>, PM<sub>2.5</sub>, SO<sub>2</sub>, NO<sub>2</sub> and CO are strongly interconnected encouraging regulators to consider promoting environment friendly policies as the reduction in environment pollution can be achieved by minimising the quantity of environmental pollutants (Bashir et al. 2020).

Simultaneously, the existing scenario of COVID-19 serves as a model to handle future pandemics and indicates a dire need to develop a sustainable model to cater to the future needs (Hsu et al. 2020). The imposed safety measures such as quarantine has shifted consumers' purchasing methods to online shopping and the changes in preference to the delivery of goods at their homes. The stark rise in household consumption is increasing the organic waste as well as inorganic waste through the food and goods obtained using online shopping channels (Zambrano-Monserrate et al. 2020).

During these unprecedented circumstances, the concept of sustainable consumption has gained eloquent popularity as the existing situation indicates a climate change which is frequently used as a shorthand to describe global sustainability issues (Asayama et al. 2020). The concomitant fluctuations in consumers' sustainable behaviours drive organisations to exhibit capacities of environment friendly and safe entities through recycling of materials, variations in business model and reduction in fashion trends. Hence, achieving efficiency, sustainable consumption, recycling of materials and disposing domestic solid waste legitimises the welfare of a domestic society (Lo and Liu 2018).

The quality of environment, inputs and natural resources is deteriorating in the technologically driven economies due to the excessive energy consumption (Rauf et al. 2020). Yet, enhanced consumption of renewable energy and financial development bolster safe environment. According to Liu and Song (2020), food production by utilising minimal water resources and the efficient use of water needs to be addressed on immediate basis, particularly in the areas suffering with long droughts and impoverished ecosystem. Recently, the deforestation has gained an alarming momentum due to the increase in wood consumption reinforcing sustainable management of forests to address the transformations in distributing consumer goods and resources and maintain the equilibrium between the consumption and supply (O'Brien and Bringezu 2017).

Consequently, the situation created by COVID-19 highlights that the sustainable development will provide a roadmap to create an acceptable and favourable future for the upcoming generations Pirouz et al. (2020a, 2020b). The needs of future generations can be fulfilled through global sustainable policies (Cohen 2020) and through the conservation of natural resources (Severo et al. 2018). The proceeding argument leads to propose H2 which is as follows;

**H2:** COVID-19 (COV) pandemic has a positive impact on sustainable consumption (SC).

## COVID-19 pandemic and social responsibility

The outbreak of COVID-19 has united together and the mutual coordination between the societies has improved. These egregious crises mandate social distancing and significant behavioural changes to authenticate the facilitation of sustainable projects, supply and production (Sarkis et al. 2020). Other social implications of the pandemic are the changes in learning methods at schools to ensure social distancing to minimise the infection rate (Signori et al. 2018).

As the world was struck by COVID-19, territorial governments have imposed emergency measures such as restriction of movement, physical social distancing, sanitization of public places and socioeconomic restrictions to contain the spread of the virus De Bruin (2020). The consumption and production patterns of the society are a grave threat to the protection of environment and social responsibility. Therefore, minimising the consumption and production volumes is essential to restructure the prevalent socioeconomic settings (Bengtsson et al. 2018)

The pandemic has revealed the underlying chronic social illness of the societies as marginalised, and vulnerable people in low- and middle-income territories are facing perennial social consequences (Chattu and Yaya 2020). The existing circumstances necessitate taking effective socially responsible actions to warrant the success of newly improvised economic developments and governance frameworks (Sarkis et al. 2020). The social and economic policies designed to curb the effects of COVID-19 are yet to address the moral and ethical issues (Tisdell 2020). Therefore, there is a danger of increase in vulnerabilities of marginalised communities and mistrust among societies which will push these people to double jeopardy (Kelley et al. 2020). The regulators need to ensure the inclusion of social issues of gender violence and underpaid workers while designing public health intervention policies which will be conducive to the central pledge of sustainable development goals: "leaving no one behind".

Orcutt et al. (2020) concluded that COVID-19 has transformed public behaviour and people have become socially more aware. The large-scale social campaigns of food and clothing distribution and provision of personal protective equipment and medications evolved in many countries (Al-Reyaysa et al. 2019; Francis and Pegg 2020; Khan et al. 2020; Tekleab et al. 2020). The institutional campaigns focus on helping large and socially vulnerable communities and encourage these communities to prioritise assisting the marginalised people, children, elders, drug addicts, homeless, refugees and migrant workers.

**H3:** COVID-19 (COV) pandemic has a positive impact on social responsibility (SR).

## Moderators effect

This study proposes age and religion as the moderators of the nexus between COVID-19, EA, SC and SR. The studies have shown that older people are at a higher risk of COVID-19 infection and perceive it as a major threat to their health, personal and financial situation (Schaeffer and Rainie 2020; De Bruin 2020). The recent studies have documented an evidence of differential gender-related epidemiology in the SARS-CoV-2 infection and found that males are at higher risk of getting infected as compared to the females Ghosh et al. (2021). The analyses of past pandemics such as Ebola and Zika have also revealed different gender- and age-related impact of viruses Ghosh et al. (2021). Furthermore, comparative model of different courses of epidemic in China and the rest of the world has confirmed that difference in immune response to viral infection—innate and adaptive immunity—plays a major role in getting infected from the virus which also confirmed that geographical locations and patients' health conditions respond differently to COVID-19 (Dimaschko et al. 2021). Similarly, in the context of environmental behaviour, age plays a major role in different environmental attitudes and behaviours (Wiernik et al. 2013). Generally, older generations are more likely to represent environment preservation and conservation of energy and resources (Wiernik et al. 2013). Older individuals are also described as more thrifty consumers due to their association of being an agent of positive change Wahl et al. (2012). This study predicts that different generations, X (Baby Boomers), Y (born between 1965 and 1981) and Z (born after 1981), perceive EA, SC and SR differently. COVID-19 affects differently on certain age group which leads us to infer that older individuals perceive COVID-19 differently and are likely to represent higher EA, SC and SR.

**H4a:** *Generations moderate the relationship between COV and EA.*

**H4b:** *Generations moderate the relationship between COV and SC.*

**H4c:** *Generations moderate the relationship between COV and SR.*

The results of different studies and surveys conducted in Western cultures prove that religious beliefs drive individuals' environment conservation behaviour (Hagevi 2014; Minton et al. 2015; Morrison et al. 2015). According to the United Nations Environment Protection Programme (UNEP), spiritual leaders of different religions address and agree on environment as a creation of God and encourage its followers to protect the environment to represent a global solidarity, ethical moral and spiritual commitment. The role of spirituality in clinical practices is well-documented (Best et al. 2015), particularly the ability to cope with disease and recovery after hospitalisation. The recent study shows that COVID-19 has

a positive impact on individuals' religious beliefs as people started to become religiously more attached by performing frequent prayers (Kowalczyk et al. 2020). Therefore, we expect that individuals' religious attachment due to COVID-19 will lead to higher EA, SC and SR; hence, it is proposed that:

**H5a:** *The religiosity moderates the relationship between COV and EA.*

**H5b:** *The religiosity moderates the relationship between COV and SC.*

**H5c:** *The religiosity moderates the relationship between COV and SR.*

The theoretical framework of this study is illustrated in Figs. 1 and 2. These figures outline the theoretical model with variable impact (Fig. 1) and variable impact with operationalisation of the model's construct (Fig. 2).

## Data and methods

The overall approach adapted in this study was quantitative and descriptive research, through a self-administrated survey questionnaire (khan et al. 2019). This adapted approach is valid as it allows the researchers to estimate the complex path models with latent variables and their relationships (Khan et al. 2019). The questionnaire comprised of two sections, A and B. Section A contains the demographic information of the respondents' gender, age, religious background, education level, occupation and income. Section B contains 20 items related to the four variables of COVID-19 (5 items), environmental awareness (5 items), sustainable consumption (5 items) and social responsibility (5 items). The respondents were provided with a 5-point Likert scale option ranging from strongly disagree (1) to strongly agree (5) to respond on the items under this section. The questionnaire was designed and validated in consultation with four doctors who were expert in the thematic area of medicine and environment. The questionnaire validation method used in this study is vigorously used by several studies in the thematic areas of medicine and environment (Pélissier et al. 2017; Biasutti and Frate 2017; Bouman et al. 2018). The questionnaire was originally designed in English using simple and easily understandable language and was also translated to Malay to ensure the diversity in sample collection.

The data was conveniently drawn through a non-probability sampling technique from 700 participants of different age groups and religious background in Malaysia. A total of 750 samples were distributed through social networking platforms (WhatsApp, Facebook, Instagram and LinkedIn) and e-mail. The snowball sampling technique was used for the circulation of the research questionnaire. This sampling technique of circulating questionnaire through social

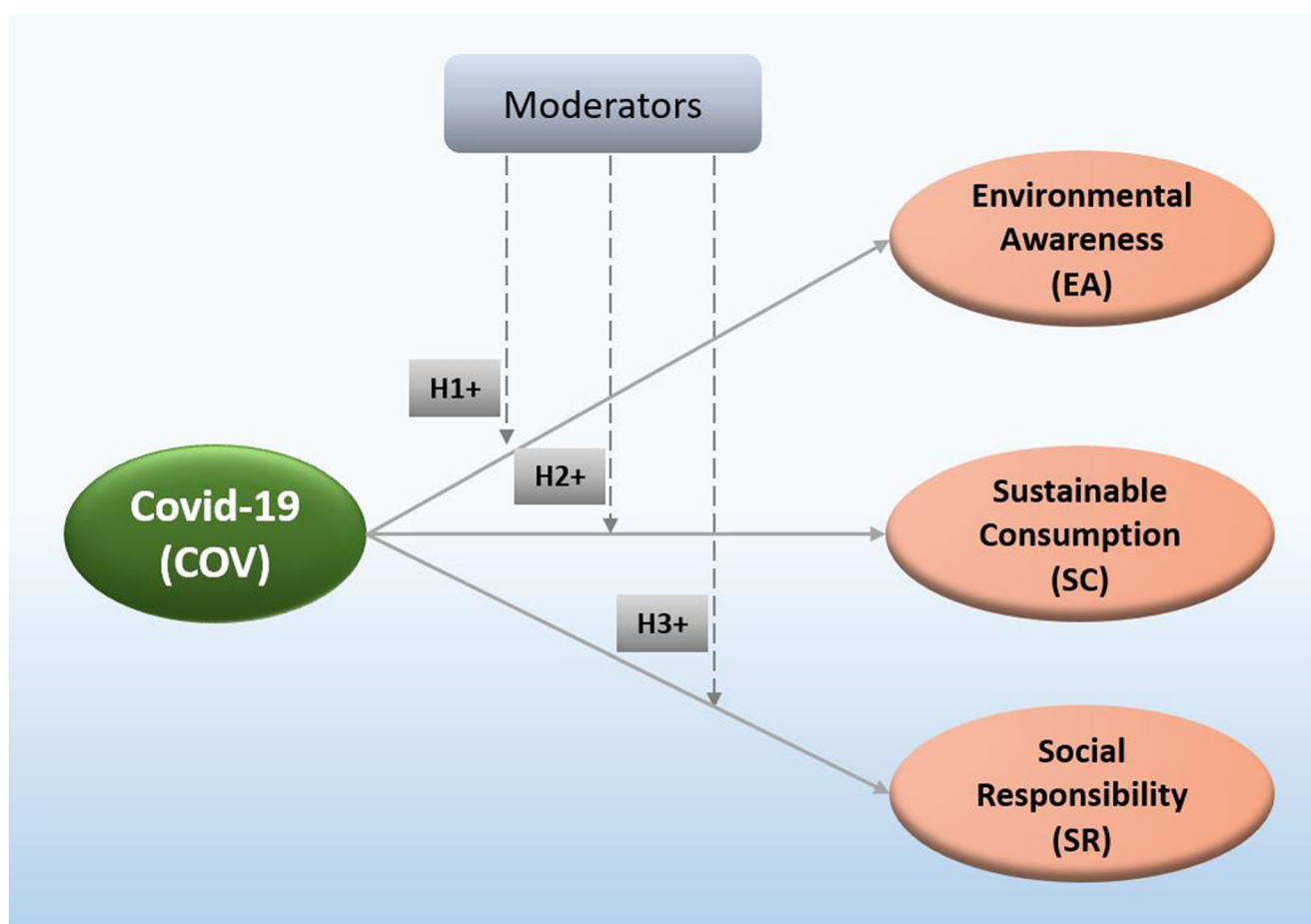


Fig. 1 Proposed theoretical model

media platforms was an appropriate method during this pandemic which ensures the effectiveness in data collection as well as achieving randomness and diversity of respondents (Lee and Spratling 2019). The questionnaire was circulated between August 17, 2020, and August 30, 2020, in Malaysia. The respondents returned 717 samples showing the return rate of 95.6%. In final data analysis, 17 cases were excluded as these samples were found incomplete resulting in 700 valid cases to be considered for final data analysis. The collected samples exceed the threshold of more than 200 to 400 valid cases as 700 valid cases were obtained representing 35 respondents per variable (Kline 2016).

The validity and reliability of the observable variables is outlined in Fig. 2 which describes the overall methodology in this study. Figure 3 explains the normality and observability of the variables, constructs validity, correlation between the assumption variables, quality estimation of the measurement model through structural model and the effects of moderators of generations and religiosity. Past studies of Fornell and Larcker (1981), McDonald and Marsh (1990), Byrne (2010), De Guimaraes et al. (2016) and Severo et al. (2020) have

rendered a similar approach which justifies the approach adopted in this study.

This study adopted an innovative research methodology by deploying the constructs of observable variables combined with a situation represented by significant changes (COVID-19). This study verifies the direct impact of COVID-19 on EA, SC and SR (Fig. 3). Alternatively, it provides the details of statistical analysis method to the academicians and the scientific community. This will allow other researchers interested in using structural equation modeling (SEM) to adopt the rigorous methodological approach, statistical tests, SEM application and the assessed parameters for the validation of data and testing of hypothesis outlined in this study.

The collected data was analysed using SEM using SmartPLS which comprised different statistical analysis and procedures to examine the dependence relationship between the constructs Hair Jr et al. (2013). SEM is considered an ideal approach to test the hypotheses of dependence relationships and correlation, and to estimate the moderating variables' impact on multigroup variables (Long et al. 2017; Cai et al. 2019) as SEM provides an accurate estimation of the

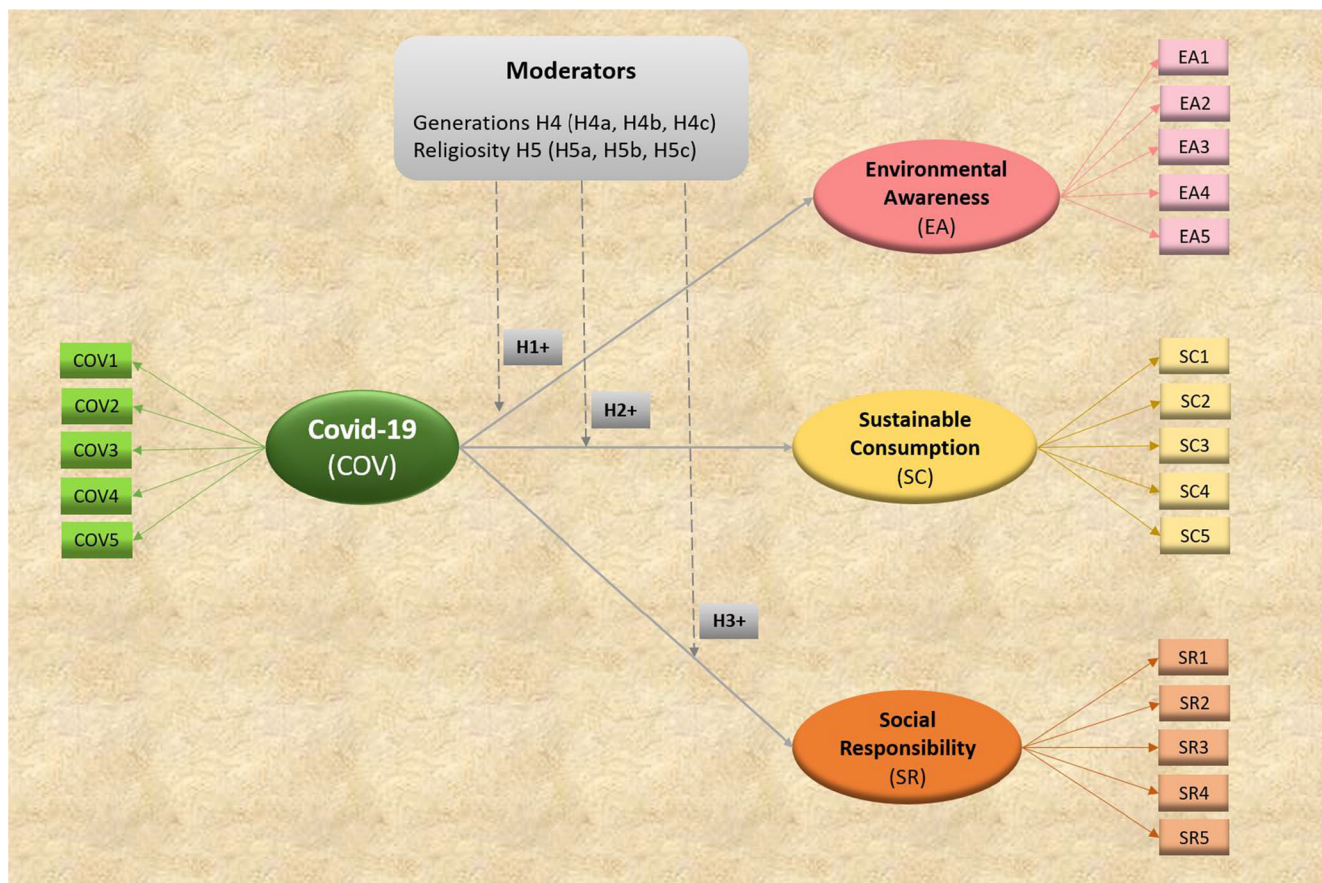


Fig. 2 Operationalised theoretical framework

measurement and structural model (Jin et al. 2019; De Guimaraes et al. 2020).

## Empirical results

### Descriptive statistics

The descriptive statistics of the respondents are reported in Table 1. The majority (56.71%) of the respondents were male, females were 41.57% and other genders were 1.71%. The Baby Boomers (above 57 years) were 11.28%, generation X (between 40 and 56 years) was 60.85% and generation Y (between 18 and 39 years) was 27.85% of the samples received. The respondents had different religious associations; the respondents were Muslims (38%), Christians (15.14%), Buddhists (21%), Hindu (22.57%) and others (3.28%). In terms of education, about 52.57% respondents had a bachelor degree which leads us to predict that most of the respondents had a fair understanding of the questionnaire. Most (52.57%) of the respondents were employed in government sector and the majority (41.42%) was earning between RM3,001 to 5,000 per month. The further details of the respondents’ characteristics are outlined in Table 1.

### Reliability and normality

The reliability and normality of the research instrument is measured by estimating Cronbach’s alpha, KMO, Bartlett’s test of sphericity, variance explained and composite reliability. The results of these tests are disseminated in Table 2. The results indicate that most of the statements of the questionnaire have exceptional reliability as the Cronbach’s alpha and KMO for the multivariables (COV, EA, SC and SR) are above the threshold value of 0.70 except for KMO of COV that is slightly below (0.684) the acceptable reliability benchmark. This shows that the statements related to COVID-19 variable can be further improved; however, researchers decided to retain these statements due to their theoretical contribution as it is researchers’ exclusive decision (Hair et al. 2013). The constructs of the model adequately explain the variance in the variables as the values of variance explained is greater than the threshold of 50%.

### Model fitness analysis

The correlation between the questionnaire statements is estimated by explanatory factor analysis (EFA). The findings of EFA are presented in Table 3. The variance explained for the

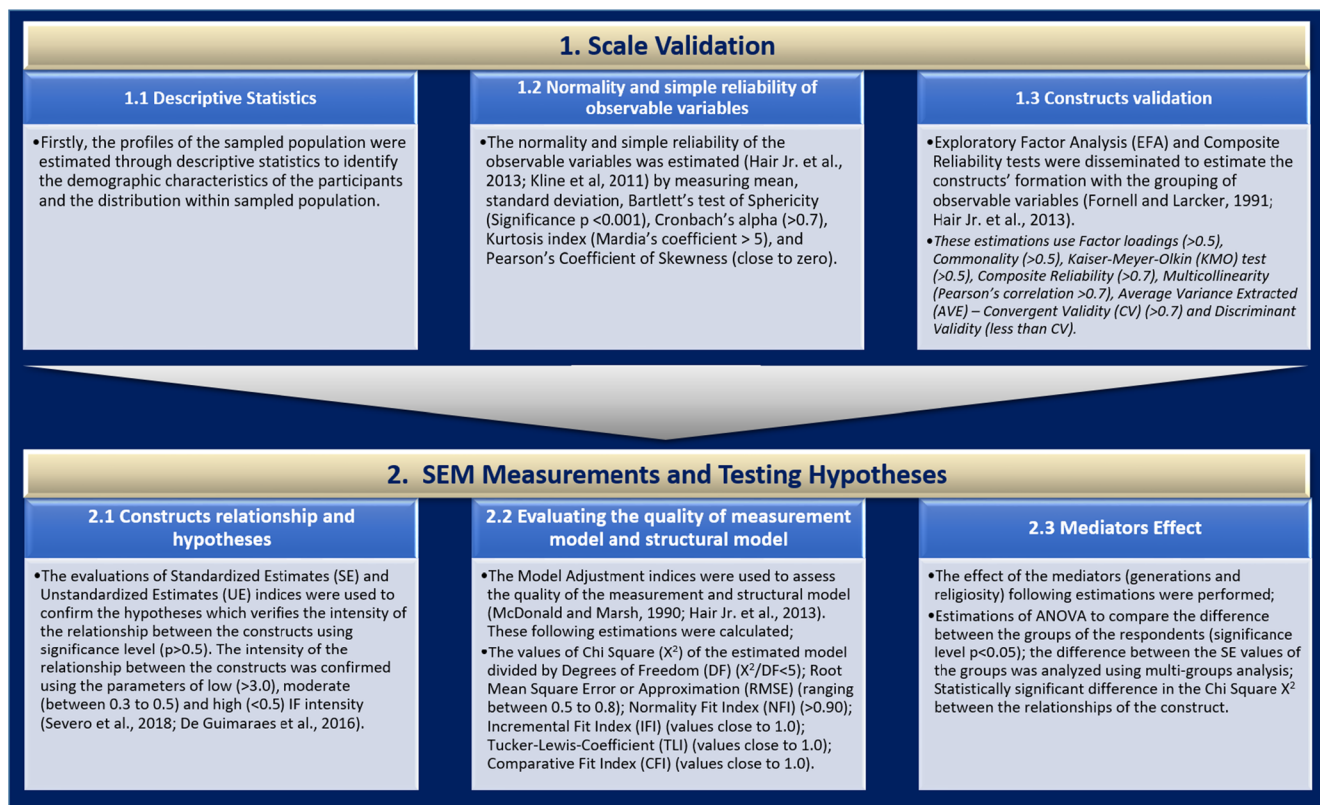


Fig. 3 Statistical analysis method

variables is above 50% criteria (Table 2) and the factor loading for each item except (COV4, EA3, EA5, SC4, SC5, and SR5) is higher than the acceptable criteria of 0.70 (Table 3). Additionally, the respondents have a fair understanding of most the statements as the mean values for each construct (COV, EA, SC and SR) are greater than 3.0 (Table 3). The standard deviation results further confirm that the variance in the response for each construct is low as the values of standard deviation values were below 1 (Table 3). The model fitness criteria are assessed by estimating composite reliability, KMO, multicollinearity (Pearson correlation) and average variance extracted (AVE). The values of composite reliability and KMO are greater than the AVE (Table 2) which proves that the model does not suffer from the multicollinearity issues and it is suitable for further analysis.

We dropped the weak items in the model (factor loading  $< 0.7$ ) and reformed SEM analysis. The results indicated (Table 4) a significant improvement in the AVE of the COV variable as the factor loadings satisfy acceptable criteria (Hair et al., 2014).

### Hypotheses testing

The hypotheses were tested by estimating the standardised and unstandardised path coefficients of integrated model. The results of the path coefficients are disseminated in

Table 5. The results of both standardised and unstandardised path coefficients are positive and statistically significant. The relationship between COV/EA shows that highest intensity representing the positive and significant impact of COVID-19 on environmental awareness. These results confirm that H1, H2 and H3 are accepted. The quality of the measurement and structural model is verified by estimating adjustment indices.

The quality of the measurement and structural model is evaluated by estimating the indices shown in Table 6. The values of the NFI, IFI, TLI and CFI are coherent with the recommended criteria (Bollen 1989; Bentler and Bonett 1980; McDonald and Marsh 1990; Hair Jr et al. 2013).

### Moderators (generations and religiosity) effect

The moderators' (generations and religiosity) impact on the relationship between the constructs is evaluated by estimating the SE and chi-square difference. The values of generations and religiosity's SE and chi-square difference are positive and significant (Table 8). The SE and chi-square difference is higher for Baby Boomers as compared to the other two generations (Table 7).

For the religiosity, SE and chi-square difference for the Christians shows relatively higher difference as compared to the other religious association of the respondents (Table 8).

**Table 1** Demographics of the respondents

Demographic characteristics	N	%
Gender	397	56.71
Male	291	41.57
Female	12	1.71
Others	700	100
Total		
Age	82	11.71
18–28	113	16.14
29–39	207	29.57
40–49	219	31.28
50–56	79	11.28
Above 57		
Religion	266	38.00
Muslim	106	15.14
Christian	147	21.00
Buddhist	158	22.57
Hindu	23	3.28
Others		
Education	63	9.00
High school	128	18.28
Diploma	368	52.57
Bachelor degree	121	17.28
Master degree	20	2.85
Doctorate degree		
Occupation	149	21.28
Student	273	39.00
Government	203	29.00
Private	75	10.71
Self-employed		
Income (RM)	85	12.14
Below 1500	189	27.00
1501–3000	290	41.42
3001–5000	117	16.71
5001–10000	19	2.71
Above 10, 000		

The results in Tables 7 and 8 confirm that the null hypotheses H4a, H4b, H4c, H5a, H5b and H5c are accepted.

The ANOVA test result measures the averages of the interferences of generations and religiosity with the responses. The ANOVA test results presented in Table 9 indicate a significant difference in the mean values of all constructs (COV, EA, SC and SR). Baby Boomers have a

relatively high mean values (2.782) compared to generation X and Y which indicate that they are facing the relatively higher brunt of COVID-19 crises. This result is consistent with recent studies of Gosh et al. (2021) and Dimaschko et al. (2021) which confirmed that COVID-19 has a different impact on different ages, genders and geographical due to prevalent differences in innate and adaptive immunity. While in the context of EA, generation Y has the highest (2.893) mean value which confirms the higher environmental awareness for generation Y. SC’s mean values are higher for generation X which indicate the higher tendency among this generation towards sustainable consumption of resources during COVID-19. SR’s mean is higher for Baby Boomers indicating that older generations are socially more responsible in contrast to others. The means for religious affiliations do not highly deteriorate among the respondents of different religious backgrounds which confirm that all the religions are equally affected due to the COVID-19 outbreak. EA mean value is higher (2.879) for the respondents with Muslim religious affiliation which indicate higher environmental awareness among Muslims during COVID-19. SC mean value is comparatively high (2.978) for the Christians confirming relatively enhanced perception among them for the sustainable consumption of resources. SR mean value is higher (2.798) for the respondents associated with Hinduism representing the possibility of a better socially responsible behaviour among them during COVID-19.

### Discussion and conclusion

The findings indicate that COVID-19 has ushered serious social and psychological disorders; however, people are optimistic that in the near future, an effective medical intervention will help in resolving the current health crises. Additionally, people strongly believe that the COVID-19 campaigns will help in reducing the spread of infection rate. This finding is encouraging the regulators in Malaysia to organise more public health campaigns which will authenticate the effectiveness

**Table 2** Normality and reliability test results

	COVID-19 (COV)	Environmental awareness (EA)	Sustainable consumption (SC)	Social responsibility (SR)
Cronbach’s alpha	0.703	0.751	0.796	0.813
KMO	0.684	0.748	0.716	0.760
Bartlett’s test of sphericity	4265.0719*	3574.0630*	2907.0573*	3043.0631*
Variance explained	71.56%	76.60%	69.82%	72.16%
Composite reliability	0.745	0.793	0.849	0.876

\*Significance level  $p < 0.001$

**Table 3** Results of varimax rotation (factor loadings of observable variables)

Observable variables	Factor loadings	Communality	Mean	SD
COVID-19 (COV)				
COV1) The COVID-19 worries me about the future life	0.765	0.710	3.113	0.8232
COV2) My social behaviour has changed after seeing people affected from COVID-19	0.797	0.712	3.432	0.8001
COV3) The large number of COVID-19-related deaths has scared me	0.812	0.734	3.876	0.9836
COV4) I am hopeful that in 2020 there will be an effective vaccine for COVID-19	0.531	0.580	3.648	0.8103
COV5) The prevention campaigns for COVID-19 will reduce its infection rate	0.746	0.600	4.098	0.8510
Mean 3.633; SD 0.8645				
Environmental awareness (EA)				
EA1) I have learned to separate the increase of organic and recyclable waste due to COVID-19	0.722	0.736	3.129	0.8130
EA2) I have reduced the consumption of water during the COVID-19 as water is a limited environmental resource	0.850	0.740	5.813	0.9567
EA3) I am more worried about the natural resources for the future generations during the COVID-19	0.428	0.711	3.584	0.8032
EA4) I have noticed the reduction in air pollution during the COVID-19	0.811	0.769	5.222	0.9456
EA5) I am more aware of the environmental impacts on the planet during the COVID-19	0.549	0.542	3.753	0.8745
Mean 4.300; SD 0.9247				
Sustainable consumption (SC)				
SC1) My consumption habits have become more sustainable during the COVID-19	0.841	0.712	2.456	0.9856
SC2) I have started to buy more environmentally friendly products during the COVID-19	0.814	0.787	3.639	0.9302
SC3) I have reduced the production of waste by prevention, reuse and recycling during the COVID-19	0.764	0.707	3.209	0.8903
SC4) The atmospheric gases (CO <sub>2</sub> ) causing the greenhouse effect are reduced during the COVID-19	0.369	0.421	2.845	0.6063
SC5) The deforestation and loss of biodiversity is reduced due to the COVID-19	0.384	0.580	3.269	0.6182
Mean 3.083; SD 0.8385				
Social responsibility (SR)				
SR1) I have become more sensitive to social vulnerability issues during the COVID-19	0.759	0.740	3.750	1.3857
SR2) I have started to donate food and clothes during the COVID-19	0.731	0.712	4.305	0.8404
SR3) I have started to provide financial help to needy people and organizations during the COVID-19	0.750	0.730	4.110	0.8402
SR4) I have started to consume products/services from socially responsible companies during the COVID-19	0.795	0.760	4.509	0.9595
SR5) The COVID-19 contributes to welcoming socially vulnerable people.	0.584	0.682	3.802	0.6274
Mean 4.095; SD 0.9047				

of MCOs as well as will help in containing the spread of the COVID-19 infection. This result also corroborates the findings of Rahman et al. (2021) which encourage governments and organisations to organise more public health campaigns to enhance awareness among the younger generations (Y and Z) for a comprehensive pandemic control. This finding has also confirmed that COVID-19, besides physical health crises, is

affecting the socioeconomic circumstances of the people and escalating mental health issues (Blake et al. 2020; Zhai and Du 2020).

The results of the hypotheses (Table 4) confirm that COVID-19 has a significant and positive impact on the constructs of EA, SC and SR reinforcing the impact of COVID-19 on people sustainable behaviours. Recently, people have

**Table 4** CSR and AVE loadings of indicator variables

Constructs	Measurements	Factor loading	Variance	Error	SCR	AVE
COV	COV1	0.72	0.64	0.24	0.89	0.73
	COV2	0.78	0.79	0.17		
	COV3	0.75	0.83	0.12		
	COV5	0.79	0.76	0.26		
EA	EA1	0.86	0.86	0.25	0.94	0.82
	EA2	0.89	0.90	0.12		
	EA4	0.88	0.93	0.09		
SC	SC1	0.75	0.85	0.23	0.85	0.85
	SC2	0.74	0.77	0.28		
	SC3	0.78	0.76	0.26		
SR	SR1	0.75	0.79	0.25	0.83	0.74
	SR2	0.73	0.76	0.39		
	SR3	0.78	0.98	0.06		
	SR4	0.92	0.75	0.05		

**Table 5** Integrated model test result-hypothesis testing

Hypotheses	Constructs	Integrated model	
		SE <sup>a</sup>	UE <sup>b</sup>
H1	COV → EA	0.816	9.472
H2	COV → SC	0.725	8.564
H3	COV → SR	0.714	8.708

\*Significance level  $p < 0.001$

<sup>a</sup> Standardized estimate (SE)

<sup>b</sup> Unstandardized estimate (UE)

become more concerned about the socio-environmental issues and started to consume environmentally sustainable products as evidenced in the findings of the high intensity between COV/EA. This finding confirms that people environmental awareness and concerns about climate change have improved due to the current situation of COVID-19 and the consumption patterns have become more sustainable which may mark the transition of sustainable consumption and reduction in air pollution (Cohen 2020; Evensen et al. 2021; Sarkis et al. 2020). Alternatively, a significant increase in household and medical waste has occurred during COVID-19 which draws the regulators’ attention to design policies to improve environmental awareness among the people and develop a better

treatment and disposal mechanism for the medical waste. This will also help in implementing radical changes in sustainable consumption behaviour requiring consumers’ support which will lead to the acceptance of consumption policy Gwozdz et al. (2020).

Moving on to the results of the relationship between the COV/SR, it is evident that COVID-19 has a significantly positive impact on the social responsibility; however, its intensity is relatively lower compared with the intensities of the other constructs (Table 5). The public appears less concerned about the rising social issues of social vulnerabilities especially people in the rural poor areas are the most affected due to COVID-19. This finding diverges from the study of Orcutt et al. (2020) concluding that COVID-19 has improved people behaviour and social awareness. This finding encourages the regulators and general public to organise more social campaigns to distribute, food, clothes, medicines and personal protective equipment during this pandemic (Al-Reyaysa et al. 2019; Francis and Pegg 2020; Khan et al. 2020; Tekleab et al. 2020).

The results (Tables 7 and 8) determine that generations and religious affiliation have a significant effect on the relationship between COV/EA, COV/SC and COV/SR. The difference in the behaviour of generations results in exhibiting different environmental behaviour, especially during the current

**Table 6** Model adjustment test results

Cronbach’s alpha*	Bartlett’s test of sphericity*	AVE*	Composite reliability*	KMO	DF	RMSEA	NFI	IFI	TLI	CFI
0.853	25817.424	0.562	0.887	0.864	35.2	0.047	0.071	0.823	0.814	0.849

\*Significance level  $p < 0.001$  for all the observed variables

**Table 7** Multigroup test results (moderating effect of generations)

Hypotheses	Relationship	Baby Boomers SE <sup>a</sup>	Generation X SE <sup>a</sup>	Generation Y SE <sup>a</sup>	Chi-square difference P
H4a	COV → EA	0.856	0.897	0.821	***
H4b	COV → SC	0.885	0.810	0.747	***
H4c	COV → SR	0.954	0.869	0.911	***

\*\*\*Significance level  $p < 0.001$

<sup>a</sup> Standardized estimate (SE)

scenario, Baby Boomers appear to be more conservative and concerned about the quality of life and environment (Severo et al. 2020). This finding is consistent with Eastman et al.'s (2020) study concluding that future concerns among the seniors result in sustainable behaviours. In the context of religious association, all religions have an equal perception towards the threats of COVID-19 and encourage their followers to protect their surrounding environment. This finding corroborates Kowalczyk et al.'s (2020) study confirming that people's religious beliefs have strengthened due to COVID-19 that will also lead to environmentally sustainable behaviour.

Similarly, the impact of other demographic variables such as gender, education level, occupation and income on the constructs is presented in Fig. 1. The mean

difference for the females is high and significant confirming that females are more affected due to the current situation of COVID-19. This finding corroborates the policy report of United Nations Least Developed Countries Portal (UNLDCP) (2020) representing that COVID-19 has escalated the domestic violence and marginalisation against women. Moreover, females exhibited relatively higher EA, SC and SR confirming that their behaviour is more environmental-friendly as compared with other genders. The mean values of all the educational construct are positive and significant showing that regardless of educational level, COVID-19 has affected people equally and it equally impacts on EA, SC and SR. For the occupation and income level, mean values are relatively

**Table 9** Test results of the mediators of generations and religiosity

Constructs	Generations		Religious affiliation	
	Groups	Mean values	Groups	Mean values
COVID-19 (COV)	Baby Boomers <sup>a</sup>	2.782	Muslims <sup>a</sup>	2.784
	Generation X <sup>a</sup>	2.746	Christians <sup>a</sup>	2.779
	Generation Y <sup>a</sup>	2.713	Buddhists <sup>a</sup>	2.781
			Hindu <sup>a</sup>	2.777
			Others <sup>a</sup>	2.778
Environmental awareness (EA)	Baby Boomers <sup>a</sup>	2.870	Muslims <sup>a</sup>	2.879
	Generation X <sup>a</sup>	2.885	Christians <sup>a</sup>	2.842
	Generation Y <sup>a</sup>	2.893	Buddhists <sup>a</sup>	2.848
			Hindu <sup>a</sup>	2.870
			Others <sup>a</sup>	2.877
Sustainable consumption (SC)	Baby Boomers <sup>a</sup>	2.903	Muslims <sup>a</sup>	2.942
	Generation X <sup>a</sup>	2.908	Christians <sup>a</sup>	2.978
	Generation Y <sup>a</sup>	2.901	Buddhists <sup>a</sup>	2.964
			Hindu <sup>a</sup>	2.972
			Others <sup>a</sup>	2.830
Social responsibility (SR)	Baby Boomers <sup>a</sup>	2.780	Muslims <sup>a</sup>	2.788
	Generation X <sup>a</sup>	2.744	Christians <sup>a</sup>	2.768
	Generation Y <sup>a</sup>	2.749	Buddhists <sup>a</sup>	2.751
			Hindu <sup>a</sup>	2.798
			Others <sup>a</sup>	2.727

<sup>a</sup> ANOVA significance level  $p < 0.001$

**Table 8** Multigroup test results (moderating effect of religiosity)

Hypotheses	Relationship	Muslims SE <sup>a</sup>	Christians SE <sup>a</sup>	Buddhists SE <sup>a</sup>	Hindu SE <sup>a</sup>	Others SE <sup>a</sup>	Chi-square difference <i>p</i>
H5a	COV → EA	1.012	1.168	0.983	1.084	0.826	***
H5b	COV → SC	0.884	0.878	0.843	0.828	0.839	***
H5c	COV → SR	0.836	0.847	0.822	0.802	0.781	***

\*\*\*Significance level  $p < 0.001$

<sup>a</sup> Standardized estimate (SE)

higher and significant for the private sector employees with low income. This finding is consistent with the technical report of United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) (2019) demanding regulators to consider the inclusion of vulnerable and socially marginalised societies in the rural poor areas while designing financial support policies during the COVID-19. Table 10 presents the summary of the major findings of this study.

The findings tested and supported through the hypotheses can help in analysing the impact of COVID-19 on EA, SC and SR. The demographic variables of age, religion, gender, education, occupation and income are significantly affected during this pandemic which will result in different environmental behaviours among the Malaysians. This study indicates that the worsening economic conditions have ushered stark social consequences for the vulnerable people escalating health and environmental issues.

Our study contributes to the literature focusing on consumers’ environmental behaviour. Precisely, it has empirically analysed the difference in perception of environmental awareness, sustainable consumption and social responsibility among the consumers of different ages and religious backgrounds. Another contribution of this study is the measurement model represented as a theoretical model. The proposed framework validated through the normality, reliability tests and its internal consistency

can help in developing the matrices to inspect the socio-environmental behaviour during the transformational event such as COVID-19.

The researchers have disseminated a special consideration for the validation of the proposed model through normality, variability, reliability and AFE tests; however, the research instrument of this study is a major limitation as the triangulation (respondents’ opinion) was the only efficient source of data. The method of data collection may result in common method variance (CMV) and halo effect (wrong generalisation); however, the researchers have tried to overcome these issues by evaluating the multivariate outliers which will help in minimising CMV. Another limitation is associated with the data collection through snowball sampling technique which may result in similar respondents’ characteristics. The sources of data collection through the social networking platforms will ensure randomness and diversification of the respondents.

The future studies may consider investigating the impact of COVID-19 on socio-environmental behaviours, eco-innovation, corporate philanthropy and how the pandemic interacts with the people’s quality of life. COVID-19 is not just a public health emergency, it is a colossal opportunity to address and resolve the social, environmental and economic issues which will transform societies and people mutual interaction and human interaction with the environment and ensure resilient economies.

**Table 10** Hypothesis confirmation

Hypothesis	Description	Yes/no
H1	COVID-19 (COV) has a positive impact on environmental awareness (EA).	Accepted
H2	COVID-19 (COV) has a positive impact on sustainable consumption (SC).	Accepted
H3	COVID-19 (COV) Pandemic has a positive impact on social responsibility (SR).	Accepted
H4a	Generations mediate the relationship between COV and EA.	Accepted
H4b	Generations mediate the relationship between COV and SC.	Accepted
H4c	Generations mediate the relationship between COV and SR.	Accepted
H5a	The religiosity mediates the relationship between COV and EA.	Accepted
H5b	The religiosity mediates the relationship between COV and SC.	Accepted
H5c	The religiosity mediates the relationship between COV and SR.	Accepted

**Author contribution** Conceptualization: Q.A.; formal analysis: Q.A.; investigation: Q.A., H.Y. and S.P.; methodology: Q.A., A.S, Z.Z. and H.Y.; supervision: Z.Z. and A.S.; writing original draft: Q.A.; writing—review and editing: Q.A., S.P., H.Y., Z.Z. and A. S.

**Data availability** The datasets/materials used and/or analysed for the present manuscript are available from the corresponding author on reasonable request.

## Declarations

**Ethics approval** Not applicable.

**Consent to participate** I am free to coordinate any of the people involved in the research to seek further clarification and information.

**Consent to publish** Not applicable.

**Conflict of interest** The authors declare no competing interests.

## References

- Abdullah S, Mansor AA, Napi NNLM, Mansor WNW, Ahmed AN, Ismail M, Ramly ZTA (2020) Air quality status during 2020 Malaysia Movement Control Order (MCO) due to 2019 novel coronavirus (2019-nCoV) pandemic. *Sci Total Environ* 729:139022. <https://doi.org/10.1016/j.scitotenv.2020.139022>
- Adam D (2020) Modelling the pandemic: the simulations driving the world's response to COVID-19. *Nature* 580:316–318
- Adnan A (2015) Education for sustainable consumption in Malaysia: current policy, frameworks, implementation and governmental capacity, Chapter 2. Institute for Global Environmental Strategies:11–32
- Adnan N, Nordin SM (2020) How COVID 19 effect Malaysian paddy industry? Adoption of green fertilizer a potential resolution. *Environ Dev Sustain*. Available online <https://doi.org/10.1007/s10668-020-00978-6> (accessed on 22 November 2020)
- Ahmad D (2020) Situasi terkini jangkitan 2019-nCoV dan pengesahan kes baharu di Malaysia. Press release. Available online: [https://www.penerangan.gov.my/japenv2/wp-content/uploads/2020/02/Kenyataan-Akhbar-KPK-Situasi-2019-nCoV-4-FEBRUARI-2020\\_edited-2.pdf](https://www.penerangan.gov.my/japenv2/wp-content/uploads/2020/02/Kenyataan-Akhbar-KPK-Situasi-2019-nCoV-4-FEBRUARI-2020_edited-2.pdf) (accessed on 22 November 2020)
- Ali L, Nawaz A, Iqbal S, Aamir Basheer M, Hameed J, Albasher G, Shah SAR, Bai Y (2021) Dynamics of transit oriented development, role of greenhouse gases and urban environment: a study for management and policy. *Sustainability* 13:2536. <https://doi.org/10.3390/su13052536>
- Al-Reyaysa M, Pinnington AH, Karatas-Ozkan M, Nicolopoulou K (2019) The management of corporate social responsibility through projects: a more economically developed country perspective. *Bus Strat & Dev* 2(4):358–371
- Asayama S, Emori S, Sugiyama M, Kasuga F, Watanabe C (2020) Are we ignoring a black elephant in the Anthropocene? Climate change and global pandemic as the crisis in health and equality *Sustain Sci* 16:695–701. <https://doi.org/10.1007/s11625-020-00879-7>
- Ash'aari ZH, Aris AZ, Ezani E et al (2020) Spatiotemporal variations and contributing factors of air pollutant concentrations in Malaysia during movement control order due to pandemic COVID-19. *Aerosol Air Qual Res* 20:2047–2061. <https://doi.org/10.4209/aaqr.2020.06.0334>
- Baier D, Rausch TM, Wagner TF (2020) The drivers of sustainable apparel and sportswear consumption: a segmented kano perspective. *Sustain* 12(7). <https://doi.org/10.3390/su12072788,2788>
- Bashir MF, Bilal BM, Komal B, Bashir MA, Farooq TH, Najaf I, Bashir M (2020) Correlation between environmental pollution indicators and COVID-19 pandemic: a brief study in Californian context. *Environ Res* 187:109652. <https://doi.org/10.1016/j.envres.2020.109652>
- Bedford J, Enria D, Giesecke J, Ihekweazu C, Kobinger G et al (2020) COVID-19: towards controlling of a pandemic. *Lancet* 395:1015–1018
- Bengtsson M, Alfredsson E, Cohen M, Lorek S, Schroeder P (2018) Transforming systems of consumption and production for achieving the sustainable development goals: moving beyond efficiency. *Sustain Sci* 13(6):1533–1547. <https://doi.org/10.1007/s11625-018-0582-1>
- Bentler PM, Bonett DG (1980) Significance tests and goodness of fit in the analysis of covariance structures. *Psychol Bull* 88(3):588–606. <https://doi.org/10.1037/0033-2909.88.3.588>
- Best M, Butow P, Olver I (2015) Do patients want doctors to talk about spirituality? A systemic literature review. *Pat Educ Counsel* 98:1320–1328. <https://doi.org/10.1016/j.pec.2015.04.017>
- Biasutti M, Frate S (2017) A validity and reliability study of the attitudes toward sustainable development scale. *Environ Educ Res* 23:214–230. <https://doi.org/10.1080/13504622.2016.1146660>
- Blake H, Bermingham F, Johnson G, Tabner A (2020) Mitigating the psychological impact of COVID-19 on healthcare workers: a digital learning package. *Int. J. Environ. Res. Publ Health* 17(9):2997. 17. <https://doi.org/10.3390/ijerph17092997>
- Bodenheimer M, Leidenberger J (2020) COVID-19 as a window of opportunity for sustainability transitions? Narratives and communication strategies beyond the pandemic. *Sustain: Sci Pract and Pol* 16(1):61–66. <https://doi.org/10.1080/15487733.2020.1766318>
- Bollen KA (1989) A new incremental fit index for general structural equation models. *Sociol Methods Res* 17:303–316. <https://doi.org/10.1177/0049124189017003004>
- Borsellino V, Kaliji SA, Schimmenti E (2020) COVID-19 drives consumer behaviour and agro-food markets towards healthier and more sustainable patterns. *Sustain* 12(20):8366. <https://doi.org/10.3390/su12208366>
- Bouman T, Steg L, Kiers HAL (2018) Measuring values in environmental research: a test of an environmental portrait value questionnaire. *Front Psychol* 9:564. <https://doi.org/10.3389/fpsyg.2018.00564>
- Brooks SK, Webster RK, Smith LE, Woodland L, Wessely S, Greenberg N, Rubin GJ (2020) The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet* 395:912–920. [https://doi.org/10.1016/S0140-6736\(20\)30460-8](https://doi.org/10.1016/S0140-6736(20)30460-8)
- Byrne BM (2010) Structural equation modeling with AMOS: basic concepts, applications and programming, Taylor & Francis Group, New York
- Cai S, Long X, Li L, Liang H, Wang Q, Ding X (2019) Determinants of intention and behavior of low carbon commuting through bicycle-sharing in China. *J Clean Prod* 212:602–609. <https://doi.org/10.1016/j.jclepro.2018.12.072>
- Centres for Disease Control and Prevention (CDC) (2020) COVID-19 in Malaysia. Available online from: <https://wwwnc.cdc.gov/travel/notices/covid-4/coronavirus-malaysia> (accessed on 15 December 2020)
- Chattu VK, Yaya S (2020) Emerging infectious diseases and outbreaks: implications for women's reproductive health and rights in resource-poor settings. *Reprod Health* 17(1):1–5. <https://doi.org/10.1186/s12978-020-0899-y>
- Coccia M (2021) Effects of the spread of COVID-19 on public health of polluted cities: results of the first wave for explaining the déjà vu in the second wave of COVID-19 pandemic and epidemics of future

- vital agents. *Environ Sci Pollut Res* 28:19147–19154. <https://doi.org/10.1007/s11356-020-11662-7>
- Cohen MJ (2019) Introduction to the special section: innovative perspectives on systems of sustainable consumption and production. *Sustain: Sci Pract Pol* 15(1):104–110. <https://doi.org/10.1080/15487733.2019.1703331>
- Cohen MJ (2020) Does the COVID-19 outbreak mark the onset of a sustainable consumption transition? *Sustain: Sci Pract Pol* 16(1):1–3. <https://doi.org/10.1080/15487733.2020.1740472>
- Collivignarelli MC, Abba A, Bertanza G, Pedrazzani R, Ricciardi P, Miino MC (2020) Lockdown for CoViD-2019 in Milan: what are the effects on air quality? *Sci Total Environ* 732:139280. <https://doi.org/10.1016/j.scitotenv.2020.139280>
- Dang HA H, Trinh TA (2020) The beneficial impacts of COVID-19 lockdowns on air pollution: evidence from Vietnam. Discussion Paper Series. IZA DP No. 13651.
- De Bruin WB (2020) Age differences in COVID-19 risk perceptions and mental health: evidence from a national US survey conducted in March 2020. *J Gerontol Ser B Psychol Sci Soc Sci* 18(76):24–29. <https://doi.org/10.1093/geronb/gbaa074>
- De Guimaraes JCF, Severo EA, Dorion ECH (2014) Cleaner production and environmental sustainability: multiple case from Serra Gaúcha Brazil. *Espa* 35(4):8
- De Guimaraes JCF, Severo EA, Henri Dorion EC, Coallier F, Olea PM (2016) The use of organizational resources for product innovation and organizational performance: a survey of the Brazilian furniture industry. *J Prod Econ* 180:135–147. <https://doi.org/10.1016/j.ijpe.2016.07.018>
- De Guimaraes JCF, Severo EA, Júnior LAF, WLB DC, Salmoria FT (2020) Governance and quality of life in smart cities: towards sustainable development goals. *J Clean Prod* 253:119926. <https://doi.org/10.1016/j.jclepro.2019.119926>
- Department of Statistics Malaysia (DOSM) (2020) Sustainable development goals indicators. Available online from: [https://www.dosm.gov.my/v1/uploads/files/4\\_Portal%20Content/2\\_%20Statistics/SDG/goals/Goal\\_12pdf](https://www.dosm.gov.my/v1/uploads/files/4_Portal%20Content/2_%20Statistics/SDG/goals/Goal_12pdf) (accessed on 15 November 2020)
- German Council of Economic Experts (GCEE) (2020) Die Gesamtwirtschaftliche Lage angesichts der Corona-Pandemie (The Overall Economic Situation in View of the Corona Pandemic). GCEE, Weisbaden
- Dimaschko J, Shlyakhover V, Iabluchanskyi M (2021) Why did the COVID-19 epidemic stop in China and does not stop in the rest of the world? (Application of the Two-Component Model). *SciMedicine* 3:88–99. <https://doi.org/10.28991/SciMedJ-2021-0302-2>
- Dorion ECH, Severo EA, Olea PM, Nodari CH, Guimaraes JCF (2012) Hospital environmental and residues management: Brazilian experiences. *J Environ Asses Pollut Manag* 14:1250018. <https://doi.org/10.1142/S1464333212500184>
- Eastman JK, Modi P, Gordon-Wilson S (2020) The impact of future time perspective and personality on the sustainable behaviours of seniors. *J Consum Policy* 43:275–294. <https://doi.org/10.1007/s10603-019-09440-1>
- El Zowalaty ME, Young SG, Jarhult JD (2020) Environmental impact of the COVID-19 pandemic—a lesson for the future. *Inf Ecol Epidemiol* 10(1). <https://doi.org/10.1080/20008686.2020.1768023>
- Evensen D, Whitmarsh L, Bartie P, Devine-Wright P, Dickie J, Varley A, Ryder S, Mayer A (2021) Effect of “finite pool of worry” and COVID-19 on UK climate change perceptions. *Proc Natl Acad Sci U S A* 118(3):2018936118. <https://doi.org/10.1073/pnas.2018936118>
- Fattorini D, Regoli F (2020) Role of the chronic air pollution levels in the Covid-19 outbreak risk in Italy. *Environ Pollut* 264:114732. <https://doi.org/10.1016/j.envpol.2020.114732>
- Fife R, Graney E, Cryderman K (2020) Ottawa prepares multibillion-dollar bailout of oil and gas sector. *The Globe and Mail* (March 20)
- Fornell C, Larcker DF (1981) Structural equation models with unobservable variables and measurement error. *J Mark Res* 17(1):39–50. <https://doi.org/10.2307/3150980>
- Francis NN, Pegg S (2020) Socially distanced school-based nutrition program feeding under COVID 19 in the rural Niger Delta. *Extract Indus Soc* 7(2):576–579. <https://doi.org/10.1016/j.exis.2020.04.007>
- Frick V, Matthies E, Thøgersen J, Santarius T (2020) Do online environments promote sufficiency or overconsumption? Online advertisement and social media effects on clothing, digital devices, and air travel consumption. *J Cons Behav* 20:1–21. <https://doi.org/10.1002/cb.1855>
- Friedman T (2020) We need herd immunity from Trump and the coronavirus. *The New York Times*, Available online from: <https://www.nytimes.com/2020/04/25/opinion/coronavirus-immunity-trump.html> (accessed on 15 November 2020)
- Galbraith E, Otto R (2020) Coronavirus response proves the world can act on climate change. *The Conversation* (March 19)
- Ghodes H, Galea S (2006) Tsunami: understanding mental health consequences and the unprecedented response. *Int Rev Psychi* 18(3):289–297. <https://doi.org/10.1080/09540260600709149>
- Ghosh B, Sarkar S, Sepay N, Das K et al (2021) Factors for COVID-19 infection that govern the severity of illness. *SciMedicine* 3:177–197. <https://doi.org/10.28991/SciMedJ-2021-0302-9>
- Gomez-Llanos E, Duran-Barroso P, Robina-Ramírez R (2020) Analysis of consumer awareness of sustainable water consumption by the water footprint concept. *Sci Total Environ* 721:137743. <https://doi.org/10.1016/j.scitotenv.2020.137743>
- Grinberga-Zalite G, Pilvere I, Muska A, Kruzmetra Z (2021) Resilience of meat supply chains during and after COVID-19 Crisis. *Emerg Sci* 5:57–66. <https://doi.org/10.28991/esj-2021-01257>
- Gwozdz W, Reisch LA, Thøgersen J (2020) Behaviour change for sustainable consumption. *J Consum Policy* 43:249–253. <https://doi.org/10.1007/s10603-020-09455-z>
- Hagevi M (2014) Religion and the environmental opinion in 22 countries: a comparative study. *Int Rev Sociol* 24(1):91–109
- Hair Jr JF, Black WC, Bardin BJ, Anderson RE (2013) Multivariate data analysis. Pearson New International Edition, 7<sup>th</sup> edition. Pearson Education Limited, New York
- Hallema DW, Robinne FN, McNulty SG (2020) Pandemic spotlight on urban water quality. *Ecol Process* 9:1–3. <https://doi.org/10.1186/s13717-020-00231-y>
- Hsu LY, Chia PY, Vasoo S (2020) A midpoint perspective on the COVID-19 pandemic. *Singap Med J* 61(7):381–383. <https://doi.org/10.11622/smedj.2020036>
- Abdullah NH (2020a) Situasi semasa jangkitan penyakit Coronavirus 2019 (COVID-19) di Malaysia. Press release. Available online: <https://kpkkesihatan.com/2020/03/04/kenyataan-akhbar-kpk-4-mac-2020-situasi-semasa-jangkitan-penyakit-coronavirus-2019-covid-19-di-malaysia/> (accessed on 20 November 2020)
- Abdullah NH (2020b). Situasi semasa jangkitan penyakit Coronavirus 2019 (COVID-19) di Malaysia. Press release. Available online: <https://kpkkesihatan.com/2020/03/11/kenyataan-akhbar-kpk-11-mac-2020-situasi-semasa-jangkitan-penyakit-coronavirus-2019-covid-19-di-malaysia/> (accessed on 21 November 2020)
- Huo C, Dar AA, Nawaz A, Javaria Hameed J et al (2021a) Groundwater contamination with the threat of COVID-19: insights into CSR theory of Carroll's pyramid. *J King Saud Uni Science* 33:101295. <https://doi.org/10.1016/j.jksus.2020.101295>
- Huo C, Hameed J, Nawaz A, Shah SAR, Albahser G et al (2021b) Scientific risk performance analysis and development of disaster management framework: a case study of developing Asian countries. *J King Saud Uni Science* 33:101348. <https://doi.org/10.1016/j.jksus.2021.101348>
- Iqbal N, Khan A, Gill AS, Abbas Q (2020a) Nexus between sustainable entrepreneurship and environmental pollution: evidence from

- developing economy. *Environ Sci Pollut Res* 27:36242–36253. <https://doi.org/10.1007/s11356-020-09642-y>
- Iqbal S, Bilal AR, Nurunnabi M, Iqbal W, Alfakhri Y, Iqbal N (2020b) It is time to control the worst: testing COVID-19 outbreak, energy consumption and CO<sub>2</sub> emission. *Environ Sci Pollut Res* 28:19008–19020. <https://doi.org/10.1007/s11356-020-11462-z>
- Iqbal A, Ahmed M, Ahmad S, Sahoo CR, Iqbal MK, Haque SE (2020) Environmental neurotoxic pollutants: review. *Environ Sci Pollut Res* 27:41175–41198. <https://doi.org/10.1007/s11356-020-10539-z>
- Jin J, Du J, Long X, Boamah KB (2019) Positive mechanism of foreign direct investment enterprises on China's environment: analysis of host country regulation and parent company management. *J Clean Prod* 227:207–217. <https://doi.org/10.1016/j.jclepro.2019.04.143>
- Jribi S, Ben Ismail H, Doggui D, Debbabi H (2020) COVID-19 virus outbreak lockdown: what impacts on household food wastage? *Environ Dev Sustain* 22:3939–3955. <https://doi.org/10.1007/s10668-020-00740-y>
- Kelley M, Ferrand RA, Muraya K, Chigudu S, Molyneux S, Pai M, Barasa E (2020) An appeal for practical social justice in the COVID-19 global response in low-income and middle-income countries. *Lancet Glob Health* 8(7):888–889. [https://doi.org/10.1016/S2214-109X\(20\)30249-7](https://doi.org/10.1016/S2214-109X(20)30249-7)
- Khan GF, Sarstedt M, Shiau W-L, Hair JF, Ringle CM, Fritze MP (2019) Methodological research on partial least squares structural equation modeling (PLS-SEM): an analysis based on social network approaches. *Internet Res* 29:407–429. <https://doi.org/10.1108/IntR-12-2017-0509>
- Khan M, Lockhart J, Bathurst R (2020) A multi-level institutional perspective of corporate social responsibility reporting: a mixed-method study. *J Clean Prod* 265:121739. <https://doi.org/10.1016/j.jclepro.2020.121739>
- Khan I, Shah D, Shah SS (2021) COVID-19 pandemic and its positive impacts on environment: an updated review. *Int J Environ Sci Technol* 18:521–530. <https://doi.org/10.1007/s13762-020-03021-3>
- Kline RB (2016) Principles and practice of structural equation modeling, 4th edn. The Guilford Press, New York
- Kowalczyk O, Roszkowski K, Montane X, Pawliszak W, Bajek A (2020) Religion and faith perception in a pandemic of COVID-19. *J Relig Health* 59:2671–2677. <https://doi.org/10.1007/s10943-020-01088-3>
- Krugman P (2020) Republicans don't want to save jobs – billions for oil, nothing for nurses and teachers *New York Times* April 13
- Lal P, Kumar A, Kumar S, Kumari S, Saikia P, Dayanandan A, Dibyendu A, Khan ML (2020) The dark cloud with a silver lining: assessing the impact of the SARS COVID-19 pandemic on the global environment. *Sci Total Environ* 732:139297. <https://doi.org/10.1016/j.scitotenv.2020.139297>
- Lee C (2005) Water tariff and development: the case of Malaysia. Working Paper No.117. Centre on Regulation and Competition. University of Manchester <https://doi.org/10.22004/ag.econ.30676>
- Lee J, Spratling R (2019) Recruiting mothers of children with developmental disabilities: adaptations of the snowball sampling technique using social media. *J Paed Health Care* 33(1):107–110. <https://doi.org/10.1016/j.pedhc.2018.09.011>
- Li J, Tartarini F (2020) Changes in air quality during the COVID-19 lockdown in Singapore and associations with human mobility trends. *Aerosol Air Qual Res* 20:1748–1758. <https://doi.org/10.4209/aaqr.2020.06.0303>
- Liu Y, Song W (2020) Modelling crop yield, water consumption, and water use efficiency for sustainable agroecosystem management. *J Clean Prod* 253:119940. <https://doi.org/10.1016/j.jclepro.2019.119940>
- Lo AY, Liu S (2018) Towards sustainable consumption: a socio-economic analysis of household waste recycling outcomes in Hong Kong. *J Environ Manag* 214:416–425. <https://doi.org/10.1016/j.jenvman.2018.03.029>
- Lodeiro C, Capelo-Martínez JL, Santos HM, Oliveira E (2021) Impacts of environmental issues on health and well-being: a global pollution challenge. *Environ Sci Pollut Res* 28:18309–18313. <https://doi.org/10.1007/s11356-020-10265-6>
- Long X, Chen Y, Du J, Oh K, Han I, Yan J (2017) The effect of environmental innovation behavior on economic and environmental performance of 182 Chinese firms. *J Clean Prod* 166:1274–1282. <https://doi.org/10.1016/j.jclepro.2017.08.070>
- Ma Y, Lin X, Wu A, Huang Q, Li X, Yan J (2020) Suggested guidelines for emergency treatment of medical waste during COVID-19: Chinese experience. *Waste Dispos Sustain Energy* 2:81–84. <https://doi.org/10.1007/s42768-020-00039-8>
- Markard J, Rosenbloom D (2020) A tale of two crises: COVID-19 and climate. *Sustain: Sci Pract Pol* 16(1):53–60. <https://doi.org/10.1080/15487733.2020.1765679>
- Mathios A, Micklitz HW, Reisch LA, Thøgersen J, Twigg-Flesne C (2020) Consumer policy in the age of Covid-19. *J Consum Policy* 43:433–435. <https://doi.org/10.1007/s10603-020-09461-1>
- McDonald RP, Marsh HW (1990) Choosing a multivariate model: noncentrality and goodness of fit. *Psychol Bull* 107(2):247–255. <https://doi.org/10.1037/0033-2909.107.2.247>
- Md Shah AU, Safri SNA, Thevadas R, Noordin NK, Abd Rahman A et al (2020) COVID-19 outbreak in Malaysia: actions taken by the Malaysian government. *Int J Infect Dis* 90:108–116. <https://doi.org/10.1016/j.ijid.2020.05.093>
- Mei NM, Wai CW, Ahmad R (2016) Environmental awareness and behaviour index for Malaysia. *Proc Soc Behavior Sci* 222:668–675. <https://doi.org/10.1016/j.sbspro.2016.05.223>
- Memish ZA, Ahmed QA, Schlagenhauf P, Dombia S, Khan A (2020) No time for dilemma: mass gatherings must be suspended. *Lancet* 395:1191–1192. [https://doi.org/10.1016/S0140-6736\(20\)30754-6](https://doi.org/10.1016/S0140-6736(20)30754-6)
- Minton EA, Kahle LR, Kim CH (2015) Religion and motives for sustainable behaviors: a cross-cultural comparison and contrast. *J Bus Res* 68(9):1937–1944. <https://doi.org/10.1016/j.jbusres.2015.01.003>
- Morrison M, Duncan R, Parton K (2015) Religion does matter for climate change attitudes and behavior. *PLoS One* 10(8):0134868. <https://doi.org/10.1371/journal.pone.0134868>
- Muhammad S, Long X, Salman M (2020) COVID-19 pandemic and environmental pollution: a blessing in disguise? *Sci Total Environ* 728:138820. <https://doi.org/10.1016/j.scitotenv.2020.138820>
- Nadzir MSM, Ooi MCG, Bakar MAA, Mohtar AAA et al (2020) The impact of movement control order (MCO) during pandemic COVID-19 on local air quality in an urban area of Klang Valley, Malaysia. *Aerosol Air Qual Res* 20:1237–1248. <https://doi.org/10.4209/aaqr.2020.04.0163>
- Nawaz A, Su X, Iqbal S, Zahoo H et al (2020) Validating a phenomenological mathematical model for public health and safety interventions influencing the evolutionary stages of recent outbreak for long-term and short-term domains in Pakistan. *Complexity* 8866071:9. <https://doi.org/10.1155/2020/8866071>
- Nawz A, Su X, Barkat MQ, Asghar S et al (2020) Epidemic spread and its management through governance and leadership response influencing the arising challenges around COVID-19 in Pakistan—a lesson learnt for low income countries with limited resource. *Front Pub Helath* 8:817. <https://doi.org/10.3389/fpubh.2020.573431>
- O'Brien M, Bringezu S (2017) What is a sustainable level of timber consumption in the EU: toward global and EU benchmarks for sustainable forest use? *Sustain* 9(5):812. <https://doi.org/10.3390/su9050812>
- Orcutt M, Patel P, Burns R, Hiam L, Aldridge R, Devakumar D, Kumar B, Spiegel P, Abubakar I (2020) Global call to action for inclusion of migrants and refugees in the COVID-19 response. *Lancet* 395:9–15. [https://doi.org/10.1016/S0140-6736\(20\)30971-5](https://doi.org/10.1016/S0140-6736(20)30971-5)
- Péllissier C, Dutertre V, Fournel P, Gendre I, Michel Vergnon J, Kalecinski J, Tinquaut F, Fontana L, Chauvin F (2017) Design and validation of a self-administered questionnaire as an aid to

- detection of occupational exposure to lung carcinogens. *Public Health* 143:44–51. <https://doi.org/10.1016/j.puhe.2016.10.026>
- Peters GP (2020) How changes brought on by coronavirus could help tackle climate change. *The Conversation*, March 16. Available online from: <https://theclimatecenter.org/how-changes-brought-on-by-coronavirus-could-help-tackle-climate-change/> (accessed on 30 November 2020)
- Pirouz B, Shaffiee Haghshenas S, Pirouz B, Shaffiee Haghshenas S, Piro P (2020a) Development of an assessment method for investigating the impact of climate and urban parameters in confirmed cases of COVID-19: a new challenge in sustainable development. *Int J Environ Res Public Health* 17(8):1–17. <https://doi.org/10.3390/ijerph17082801>
- Pirouz B, Shaffiee Haghshenas S, Shaffiee Haghshenas S, Piro P (2020b) Investigating a serious challenge in the sustainable development process: analysis of confirmed cases of COVID-19 (new type of coronavirus) through a binary classification using artificial intelligence and regression analysis. *Sustain* 12(6):2427. <https://doi.org/10.3390/su12062427>
- Praveena SM, Aris AZ (2021) The impacts of COVID-19 on the environmental sustainability: a perspective from the Southeast Asian region. *Environ Sci Pollut Res Int* 6:1–8. <https://doi.org/10.1007/s11356-020-11774-0>
- Rahman M, Jhinuk JM, Nabila NH, Yeasmin TM et al (2021) Knowledge, attitude, and practices towards COVID-19 during the rapid rise period: a cross-sectional survey among public university students of Bangladesh. *SciMedicine* 3:116–128. <https://doi.org/10.28991/SciMedJ-2021-0302-4>
- Rathod S, Pallikadavath S, Young AH, Graves L, Rahman MM, Brooks A, Phiri P (2020) Psychological impact of COVID-19 pandemic: protocol and results of first three weeks from an international cross-section survey - focus on health professionals. *J Affect Disord* 1:100005. <https://doi.org/10.1016/j.jadr.2020.100005>
- Rauf A, Liu X, Amin W, Rehman OU, Li J, Ahmad F, Bekun FV (2020) Does sustainable growth, energy consumption and environment challenges matter for Belt and Road Initiative feat? A novel empirical investigation. *J Clean Prod* 262:121344. <https://doi.org/10.1016/j.jclepro.2020.121344>
- Rosenbloom D, Markard J (2020) A COVID-19 recovery for climate. *Science* 368:447–447. <https://doi.org/10.1126/science.abc4887>
- Rugani B, Caro D (2020) Impact of COVID-19 outbreak measures of lockdown on the Italian Carbon Footprint. *Sci Total Environ* 737:139806. <https://doi.org/10.1016/j.scitotenv.2020.139806>
- Rume T, Didar-UI Islam SM (2020) Environmental effects of COVID-19 pandemic and potential strategies of sustainability. *Heliyon* 6:04965. <https://doi.org/10.1016/j.heliyon.2020.e04965>
- Saadat S, Rawtani D, Hussain CM (2020) Environmental perspective of COVID-19. *Sci Total Environ* 728:138870. <https://doi.org/10.1016/j.scitotenv.2020.138870>
- Sarkis J, Cohen MJ, Dewick P, Schroder P (2020) A brave new world: lessons from the COVID-19 pandemic for transitioning to sustainable supply and production. *Resour Conserv Recycl* 159:104894. <https://doi.org/10.1016/j.resconrec.2020.104894>
- Schaeffer K, Rainie L (2020) Experiences with the COVID-19 outbreak can vary for Americans of different ages. *Pew Research Centre*. Available online from: <https://www.pewresearch.org/fact-tank/2020/06/16/experiences-with-the-covid-19-outbreak-can-vary-for-americans-of-different-ages/> (accessed on 21 November 2020)
- Senapathi V, Sekar S, Viswanathan PM (2021) Recent environmental geochemical trends in water and sediments—a framework on OSPRC. *Environ Sci Pollut Res* 28:18421–18422. <https://doi.org/10.1007/s11356-021-13496-3>
- Severo EA, Dorion ECH, De Guimaraes JCF (2017) Innovation and environmental sustainability: analysis in Brazilian metal-mechanic industry. *Int J Innov Sustain Develop* 11(2):230–248. <https://doi.org/10.1504/IJISD.2017.083286>
- Severo EA, De Guimaraes JCF, Dorion ECH (2018) Cleaner production, social responsibility and eco-innovation: generations' perception for a sustainable future. *J Clean Prod* 186:91–103. <https://doi.org/10.1016/j.jclepro.2018.03.129>
- Severo EA, De Guimaraes JCF, Dellarmelin ML (2020) Impact of the COVID-19 pandemic on environmental awareness, sustainable consumption and social responsibility: evidence from generations in Brazil and Portugal. *J Clean Prod* Available online from <https://doi.org/10.1016/j.jclepro.2020.124947> (accessed on 22 November 2020)
- Sharma R, Sinha A, Kautish P (2020) Examining the impacts of economic and demographic aspects on the ecological footprint in South and Southeast Asian countries. *Environ Sci Pollut Res* 27:36970–36982. <https://doi.org/10.1007/s11356-020-09659-3>
- Shehzad K, Sarfraz M, Shah SGM (2020) The impact of COVID-19 as a necessary evil on air pollution in India during the lockdown. *Environ Pollut* 266:115080. <https://doi.org/10.1016/j.envpol.2020.115080>
- Signori GG, De Guimaraes JCF, Severo EA, Rotta C (2018) Gamification as an innovative method in the processes of learning in higher education institutions. *Int J Innov Learn* 24(2):115–137. <https://doi.org/10.1504/IJIL.2018.094066>
- Smith EC, Holmes L, Burkle FM (2019) The physical and mental health challenges experienced by 9/11 first responders and recovery workers: a review of the literature. *Prehos Disaster Med* 34(6):625–631. <https://doi.org/10.1017/S1049023X19004989>
- Sofa A, Sofu A (2020) Converting home spaces into food gardens at the time of Covid-19 quarantine: all the benefits of plants in this difficult and unprecedented period. *Hum Ecol* 48:1–9. <https://doi.org/10.1007/s10745-020-00157-1>
- Somani M, Srivastava AN, Gummadivalli SK, Sharma A (2020) Indirect implications of COVID-19 towards sustainable environment: an investigation in Indian context. *Biores Technol Rep* 11:100491. <https://doi.org/10.1016/j.biteb.2020.100491>
- Steffen B, Egli F, Pahle M, Schmidt TS (2020) Navigating the clean energy transition in the COVID-19 crisis. *Joule* 4(6):1173–1141. <https://doi.org/10.1016/j.joule.2020.04.011>
- Stratoulis D, Nuthammachot N (2020) Air quality development during the COVID-19 pandemic over a medium-sized urban area in Thailand. *Sci Total Environ* 746:141320. <https://doi.org/10.1016/j.scitotenv.2020.141320>
- Tahir MB, Batool A (2020) COVID-19: healthy environmental impact for public safety and menaces oil market. *Sci Total Environ* 740:140054. <https://doi.org/10.1016/j.scitotenv.2020.140054>
- Tekleab AG, Reagan PM, Do B, Levi A, Lichtman C (2020) Translating corporate social responsibility into action: a social learning perspective. *J Bus Ethics*:1–16. <https://doi.org/10.1007/s10551-020-04447-y>
- Tisdell CA (2020) Economic, social and political issues raised by the COVID-19 pandemic. *Econ Anal Pol* 68:17–28. <https://doi.org/10.1016/j.eap.2020.08.002>
- Tobias A (2020) Evaluation of the lockdowns for the SARS-CoV-2 epidemic in Italy and Spain after one month follow up. *Sci Total Environ* 725:138539. <https://doi.org/10.1016/j.scitotenv.2020.138539>
- Tosepu R, Gunawan J, Effendy DS, Ahmad LOAI, Lestari H, Bahar H, Asfian P (2020) Correlation between weather and Covid-19 pandemic in Jakarta, Indonesia. *Sci Total Environ* 725:138436. <https://doi.org/10.1016/j.scitotenv.2020.138436>
- United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) (2019) Social outlook for Asia and the Pacific poorly protected. Available online from: <https://www.unescap.org/sites/default/files/publications/SDD-SP-Social-Outlook-v14-1-E.pdf> (accessed on 10 December 2020)
- United Nations Least Developed Countries Portal (UNLDCP) (2020) Policy brief: the impact of COVID-19 on South-East Asia.

- Available online from: <https://www.un.org/ldcportal/policy-brief-the-impact-of-covid-19-on-south-east-asia/> (accessed on 10 December 2020)
- Wahl HW, Iwarsson S, Oswald F (2012) Aging well and the environment: toward an integrative model and research agenda for the future. *Gerontologist* 52(3):306–316. <https://doi.org/10.1093/geront/gnr154>
- Wang Q, Su M (2020) A preliminary assessment of the impact of COVID-19 on environment - a case study of China. *Sci Total Environ* 728:138915. <https://doi.org/10.1016/j.scitotenv.2020.138915>
- Wang Q, Wang S (2020) Preventing carbon emission retaliatory rebound postCOVID-19 requires expanding free trade and improving energy efficiency. *Sci Total Environ* 728:141158. <https://doi.org/10.1016/j.scitotenv.2020.141158>
- Wen H, Lee CC (2020) Impact of fiscal decentralization on firm environmental performance: evidence from a county-level fiscal reform in China. *Environ Sci Pollut Res* 27:36147–36159. <https://doi.org/10.1007/s11356-020-09663-7>
- WHO World Health Organisation (2020) WHO characterizes Covid-19 as a pandemic-11 March. Available online from: [https://www.who.int/docs/default-source/coronaviruse/transcripts/who-audio-emergencies-coronavirus-press-conference-full-and-final-11mar2020.pdf?sfvrsn=cb432bb3\\_2](https://www.who.int/docs/default-source/coronaviruse/transcripts/who-audio-emergencies-coronavirus-press-conference-full-and-final-11mar2020.pdf?sfvrsn=cb432bb3_2) (accessed on 27 November 2020)
- WHO, World Health Organization (2020) World Health Organization WHO timeline – COVID-19 (2020) Available online from: <https://www.who.int/news-room/detail/08-04-2020-who-timeline%2D%2D-covid-19> (accessed on 22 November 2020)
- Wiemik BM, Ones DS, Dilchert S (2013) Age and environmental sustainability: a meta-analysis. *J Manag Psychol* 28(7/8):826–856. <https://doi.org/10.1108/JMP-07-2013-0221>
- Yao H, Chen JU, Xu YF (2020) Patients with mental health disorders in the COVID-19 epidemic. *Lancet Psychiatry* 7(4):21. [https://doi.org/10.1016/S2215-0366\(20\)30090-0](https://doi.org/10.1016/S2215-0366(20)30090-0)
- Zambrano-Monserrate MA, Ruano MA, Sanchez-Alcalde L (2020) Indirect effects of COVID-19 on the environment. *Sci Total Environ* 728:138813. <https://doi.org/10.1016/j.scitotenv.2020.138813>
- Zhai Y, Du X (2020) Addressing collegiate mental health amid COVID-19 pandemic. *Psychiatry Res* 288:113003. <https://doi.org/10.1016/j.psychres.2020.113003>
- Zhao L, Zhao T, Yuan R (2020) Factors driving the change of household CO2 emissions through 2040 in China: based on decomposition and scenario analyses. *Environ Sci Pollut Res* 27:36865–36877. <https://doi.org/10.1007/s11356-020-09706-z>

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