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The influence of global crises on reshaping pro-environmental behavior, case study: the COVID-19 pandemic

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HIGHLIGHTS

• The effect of COVID-19 pandemic on the pro-environmental behavior is investigated.
• The pandemic has led to an increase in people's knowledge about the environment.
• The pandemic has positively affected individuals' subjective norms and attitudes.
• The role of perceived behavioral control has been influenced by the pandemic.
• The relationship between intention and pro-environmental behavior is strengthened.

ABSTRACT

As a profound crisis capable of threatening human well-being as well as existence, the COVID-19 pandemic can be considered as an awakening experience which may lead to the promotion of environmentally responsible behaviors in the society. In the present research, an extended form of the Theory of Planned Behavior has been applied to examine the moderating effect of COVID-19 pandemic on pro-environmental behavior mechanism in Iran. To evaluate this effect, a 5-scale Likert questionnaire was designed comprising of 28 questions in 7 sections of information and concerns about COVID-19, environmental knowledge, subjective norm, attitude, intention, perceived behavioral control and pro-environmental behavior. According to the results, the pandemic has led to an increase in people's knowledge about their environment and has positively affected individuals' subjective norms, or the perceived social pressure to get involved in environmentally friendly actions. Individuals' attitude to perform pro-environmental behaviors has also increased as a result of this incident. Moreover, the role of perceived behavioral control over environmental actions has been influenced by the pandemic situation and the COVID-19 crisis has positively influenced the relationship between intention and pro-environmental behavior.

Keywords: Pro-environmental behavior, COVID-19, Intention, Theory of Planned Behavior

1. Introduction

The emergence of many global crises threatening the health and environmental security of nations as well as endangering the existence of various life forms can be traced in unsustainable development and destruction of the environment. Findings of many researches warn that the negative human induced impacts on natural systems such as pollution, habitat destruction, landscape alteration, biodiversity loss, introducing exotic species, etc. can lead to a significant increase in the activity of pathogens and the emergence of various diseases that severely threaten human life (Weiss and McMichael, 2004; Patz et al., 2005).
The outbreak of COVID-19 virus in Wuhan, China, in December 2019, and its subsequent global spread, has left human society with serious health concerns as well as serious challenges in many aspects of life (Severo et al., 2021). Our knowledge about the origin and transmission mechanism of this virus to humans is still very limited. However, as the evidences suggest, it most probably has a zoonotic source (WHO, 2020), which makes factors such as global warming and habitat destruction plausible to perform a role in this phenomenon. This probability is believed to be a serious indication of succeeding pandemic events (Vidal, 2020) and the vulnerability of human society towards them.

Moreover, the constant changes in people's behavior throughout the world in response to this novel situation have made it really difficult to deal with uncertainties and challenges caused by the COVID-19 pandemic (Chater, 2020). Since such critical situations affect people's lifestyle and everyday choices, understanding the individual's decision-making and preventive measures will be very challenging (Onwezen et al., 2013). Uncertainty and confusion are two factors that accelerates fear, stress, panic, and anxiety and provides a basis for dramatic changes in social behavioral patterns (Robinson and Smith, 2020). A considerable state of confusion in human interaction with nature has also been witnessed during the pandemic. The likely animal origin of this virus has caused fear from and discomfort to deal with animals, even pets, which in many cases have been abandoned or even killed during quarantine (Parry, 2020). In addition, the precautionary and preventive measures have influenced mobility behaviors, resulting in less willingness to use public transportation and shifting to unsustainable mode of mobility (personal cars) (Przybylowski et al., 2021). The improper disposal of face masks, over exploitation of single-use plastics and over-consumption of water for sanitary purposes along with the production of larger volumes of health-care waste are other environmental consequences of the pandemic (Dharmaraj et al., 2021) directly related to human behavior. However, besides the negative side, the profound social and ecological consequences of COVID-19 pandemic have affected the people's contemplation about the necessity of environmental conservation and protection (Mi et al., 2021).

The pandemic showed that novel approaches, adaptive management strategies, transparency and easier access to reliable information are essential to deal with the consequences of unexpected threats to human and the environment (Yilmaz and Osborn, 2020). Behavioral science has proven to be extremely helpful in understanding why people act against their own long-term benefits and environment (Attwood, 2021). In this context, understanding human behavior as a driving force in creating man-made or accelerating natural crises is very important. If people feel responsible and committed to the environment, they will act more environmentally friendly (Harland et al., 2007).

Pro-environmental behavior mechanism is shaped and influenced by several determinants. At individual level, knowledge, values, attitudes and at social sphere norms, incentives, barriers, and behavioral setting are worth to mention (Roser-Renouf and Nisbet, 2008), Factors such as attachment to a place (Daryanto and Song, 2021), coping with environmental degradations (Hunter, 2021) and eco-friendly behavior intention (Yoon et al., 2021) are also believed to influence this mechanism. Jans (2021) suggests that community or bottom-up initiatives, that are developed and obtained in a group perform a significant role in shaping individuals' intentions to protect the environment. Some studies emphasize that environmental-friendly behaviors and intentions can be cultural matters (Chwialkowska et al., 2020; He and Filimonau, 2020). It is also proven that access to information can positively influence pro-environmental behavior and increase environmental knowledge (Liu et al., 2021).

Recent studies suggest that COVID-19 pandemic can be considered a significant turning point with profound influences on the public considerations of environmental protection. Using the affective events theory Mi et al. (2021) demonstrated the positive influence of public cognition of emergency of the COVID-19 case on boosted pro-environmental behavioral intention.

Prasetyo et al. (2020) applied an extended form of the Theory of Planned Behavior (TPB) integrated with Protection Motivation Theory (PMT) to determine the factors that influence the perceived effectiveness of preventive measures against COVID-19. According to the results, the perceived severity and vulnerability were directly affected by the understanding of the COVID-19, which themselves indirectly influenced the intention to follow, and this variable directly affected the actual and adapted behaviors.

Lucarelli et al. (2020) examined the potential influence of COVID-19 on the pro-environmental behavior using the Theory of Planned Behavior in the context of climate change. They concluded that greater awareness of interconnectedness between the pandemic and climate change resulted in higher intention and boosted pro-environmental behavior.

According to literature review, numerous studies have been conducted about the influential factors on pro-environmental behavior such as individual psychological variables (values, environmental awareness, subjective norms and personal identity and control beliefs) (Gkargkavouzi et al., 2019; Mi et al., 2021; Ru et al., 2018; Young et al., 2015), demographic and sociological characteristics (age, gender, educational facilities) (Li et al., 2019; Meyer, 2015) and social norms (Sun et al., 2018). However, little research has focused on the change in human behavior patterns to more supportive and environmentally friendly behaviors as one of the important and effective factors in reducing the impacts and probability of future environmental crises, especially during the incidents of natural and human disasters (Iviées, 2019). Works of Deng et al. (2017) and Wu et al. (2020) examined the impact of disastrous situations such as climate change on individual's environmental attitudes and behavioral tendencies, relating to events that the adverse consequences of which have not yet been fully experienced, and thus their perceived vulnerability and perceived severity are still incomplete. The present paper is one of the few studies that highlights the impact of unexpected global crises on the individuals' pro-environmental behaviors. The findings can provide an invaluable insight for policymakers and planners to turn emergencies situations such as the COVID-19 pandemic into an opportunity to promote pro-environmental behaviors and build up innovative behavioral incentives to be used to drive public support for environmental initiatives.

2. Theoretical framework

As an uncontrollable crisis capable of threatening human well-being as well as existence, we assume that COVID-19 pandemic can be an awakening turning point which may lead to the promotion of environmentally responsible behaviors. Various psychological models are available to examine the human behavioral mechanisms, among which the Theory of Planned Behavior (Lynne et al., 1995; Trumbo and O’Keefe, 2005; Tal et al., 2006; Bayard and Jolly, 2007; Clark and Finley, 2007; Wauters et al., 2010; Liobikienė et al., 2021; Zhang et al., 2021) has been chosen as the theoretical basis in the present research. This theory has been applied by several researchers examining the factors influencing the human behaviors in environmental context (Hu et al., 2021; Ahmadi et al., 2021; Singh et al., 2021).

An integral part of TPB is pro-environmental behavior, which is defined as a type of action that intentionally looks for minimization of the adverse impacts of human interventions on natural and man-made environment (Kollmuss and Agyeman, 2002). Several studies have attempted to identify the factors influencing pro-environmental behaviors (Kollmuss and Agyeman, 2002; Harland et al., 2007; He and Filimonau, 2020; Chwialkowska et al., 2020; Jans, 2021). However, there is still an incomplete understanding of the mechanisms and the interaction of psychological variables to constitute such interactions. According to Li et al. (2019), determinants of pro-environmental
behaviors can be classified into two main categories: external variables, such as social norms, cost and convenience, and personal sphere including demographic and psychological characteristics (Gkargkavouzi et al., 2019). Although early studies mainly examined demographic and external factors to discover the mechanism of pro-environmental behavior, lately psychological factors were found to be the most influential drivers on pro-environmental behaviors (Botzetazias et al., 2015).

Lack of knowledge has been introduced as a fundamental barrier to positive environmental behaviors. van der Linden (2015) believes that environmental behavior has a significant positive relationship with the level of individual understanding of environmental problems. Put differently, sufficient knowledge makes people more willing to participate in environmental activities (Enfield and Mathew, 2012). Deliberate actions to protect the environment without sufficient knowledge on related issues or methods are believed to be uncommon (Lyons and Breakwell, 1994). Therefore, acquiring adequate knowledge is a necessary but not the only prerequisite for the occurrence of environmental behaviors.

One of the most well-known psychological variables in this mechanism is environmental attitude, which represents a combination of beliefs about the environment (Enfield and Mathew, 2012). It indicates the degree of commitment and support of the individuals to the environmental issues (Abdollahazadehgan et al., 2013). Attitude can be interpreted as a kind of lasting desire in a person to support people, environment and the world (Sultan, 2013) that generates a pleasant feeling about caring for the environment so that the person actively participates in the protection of nature (Mitchener and Jackson, 2012). Many studies have displayed a significant relationship between knowledge about the environment and the attitude towards it (van Birgelen et al., 2011; Araghi et al., 2014). In other words, people with a positive environmental attitude are more willing to perform for pro-environmental behaviors (Zsöka et al., 2013; Davison et al., 2014; Vlahakis et al., 2014).

There are several recognized theories which explain environmentally friendly behaviors, among which the Theory of Planned Behavior (TPB) has been widely used to examine the complex behavioral mechanisms. Based on this theory which was initially formulated and introduced by Ajzen (1991), a person’s behavior is to some extent shaped and influenced by a number of dominant drivers including attitude, subjective norms and perceived behavioral controls. As a matter of fact, the theory of planned behavior is a conceptual extension of the Theory of Reasoned Action (TRA) previously developed by Ajzen and Fishbein (1977), based on which, every human’s behavior is shaped by the attitude or the degree of internal evaluation of the desirability. Subjective norm is defined as “the social pressure perceived whether to perform or to avoid a certain behavior” (Ajzen, 1991). In other words, attitude is an intrinsic factor referring to an individual’s evaluation of a behavior, while subjective norms are about other people’s remarkable opinions that influence the individual’s decision. Another influential factor in this mechanism is the perceived behavioral control, which is the degree of ease or difficulty of performing a behavior for an individual.

Although knowledge does not always have direct impact on the occurrence of a behavior, it is capable of strengthening mechanisms that facilitate behavioral changes (Frick et al., 2004).

Based on the Theory of Planned Behavior, attitude, subjective norms and perceived behavioral control can boost an individual environmental attitude and encourage environmental behavior.

In this research we extended the Theory of Planned Behavior assuming that “knowledge and information” and “experiencing a global crisis” can potentially affect the mechanism of adopting pro-environmental behaviors. Based on this assumption, the hypotheses of the research are as follows:

**H1.a1.** There is a positive relationship between knowledge about the environment and intention.

**H1.b1.** Environmental subjective norms are directly related to intention.

**H1.c1.** Perceived behavioral control is directly and positively related to individuals’ environmental intention.

**H1.d1.** Environmental attitude has a significant direct influence on increasing environmental motivation.

**H1.e1.** Environmental intention has a positive and significant effect on the occurrence of pro-environmental behavior.

Little research has yet been conducted on the changes in environmental behavior patterns during critical and emergency situations (Ivlevs, 2019). Employing the theory of planned behavior, Bronfman et al. (2021) identified subjective norms, knowledge level and perceived behavioral control as influential variables in adoption of preventive measures against COVID-19. Based on the Protection Motivation Theory, Bashirian et al. (2020) found that people were more motivated to perform protective and preventive behaviors when facing threatening events. In other words, preventive behaviors can reduce the probability of further threats by reducing the risk of taking no action (Hung et al., 2013). Crisis recognition is also believed to directly affect perceived vulnerability and perceived severity, both of which have significant indirect impacts on intention to follow which itself has a significant influence on adaptive behavior (Prasetyo et al., 2020). Researchers believe that basic knowledge about the causes of crises can positively influence public perceptions, which makes training and providing valid knowledge to the society a significant measure in preventing the forthcoming catastrophic events (Balkhy et al., 2010; Johnson and Hariharan, 2017) through enhancing preventive behaviors and personal protection (Lucarelli et al., 2020; Bronfman et al., 2021). Deng et al. (2017) and Wu et al. (2020) also demonstrated significant positive effects of climate change on environmental attitudes and behavioral preferences of individuals. But the question is whether crises like COVID-19 will distract people from environmental behaviors. Lucarelli et al. (2020) believe that the COVID-19 pandemic has not weakened the structural relationships of components of pro-environmental behaviors. Conversely, greater awareness of the interdependence between COVID-19 and climate change has reinforced both environmental intention and behavior. Based on the Affective Events Theory, recognizing disturbing events can stimulate emotional reactions to the factors influencing the occurrence of these events, and promote environmental behavioral motivation (Mi et al., 2020).

Individuals may behave differently towards the environment based on their personal understanding of the COVID-19 crisis. Therefore, we assume that those who are more sensitive, informed, and concerned about the causes of COVID-19 pandemic, are more likely to engage in pro-environmental behaviors. In other words, having information and sensitivity about global crises such as COVID-19 create a positive influence on the level of knowledge, attitudes, perceived behavioral control and ultimately motivation of individuals and provide a basis for promoting pro-environmental behaviors in society. Given that moderating variables can influence and reshape the relationships between the main variables, in this study, COVID-19 is considered as a driver that can possibly affect the relationship between knowledge, attitude, intention, subjective norms, perceived behavioral control and the occurrence of environmental behavior. In order to investigate the influence of this moderating variable the following hypotheses are proposed:

**H2.a2.** More sensitive and concerned People about COVID-19 pandemic are more informed and motivated about environmental issues.

**H2.b2.** More sensitive and concerned People about COVID-19 pandemic possess higher subjective norms and environmental attitude.
H2.c2. A positive relationship between perceived behavioral control and environmental intention is expected from more sensitive and concerned people about COVID-19.

H2.d2. A positive relationship between environmental attitudes and environmental intention can be found in more sensitive and concerned people about COVID-19.

H2.e2. More sensitive and concerned people about COVID-19 pandemic show a higher positive relationship between behavioral motivation and the occurrence of pro-environmental behavior.

The theoretical framework of the present research has been developed as Fig. 1. According to this figure, since the coronavirus is most likely of natural origin, in addition to uncontrollable variables such as climate change and unknown natural factors, its roots can be traced in human unsustainable interactions with the environment through pollution, land use change, habitat degradation and biodiversity destruction. In addition, the COVID-19 pandemic crisis itself produces and accelerates environmental consequences such as reduced quantity and quality of water, increased waste production and environmental pollution. In other words, in such circumstances, not only the destructive activities of human beings can lead to crises and catastrophic events, but also the occurrence of these crises creates aggravating negative impacts on the environment. Therefore, witnessing and experiencing this vicious cycle may lead to a perceived need for changing such behavioral patterns and prevent their destructive consequences.

![Theoretical Framework Diagram](image-url)
3. Methodology

This investigation is a cross-sectional survey conducted in Iran, based on a quasi-experimental research design in which random sampling technique is used for the statistical population in February 2021. As the country was still at a critical period of controlling the pandemic experiencing limited communication and lockdown, data collection was conducted through an online survey, which has become a popular manner during the pandemic era (Nair et al., 2020; Algahtani et al., 2021). The web-based questionnaire was designed in Google platform in Persian language, maintaining the anonymity of the respondents. Data collection phase was accomplished using Systematic Random Sampling technique, by circulating the survey link through different popular social networks in Iran (i.e., Telegram, WhatsApp, and Instagram).

A pilot test including 34 filled questionnaires was executed and the Cronbach's alpha was calculated as 0.974 which indicated the high degree of reliability. Using the Cochran's formula, the sample size was determined 385 with the marginal error of 0.05. Also, the result of KMO test used to measure the adequacy of sample size was 0.89 indicating a suitable volume of sample for the path analysis.

Table 1 demonstrates the population composition and distribution of the survey sample, according to which 32.4% of the respondents were male and 67.6% were female. The majority of the sample (37.1%) belonged to below 20 age group. 55.3% of the total number of the sample experienced Corona disease infection, which consisted of 56.4% of male and 54.8% of the female respondents.

To evaluate the effects of the COVID-19 pandemic on pro-environmental behaviors a questionnaire was designed comprising of 28 questions in 7 sections of sensitivity and information about the pandemic, environmental knowledge, subjective norm, attitude, motivation, perceived behavioral control and the occurrence of pro-environmental behavior. The questionnaire rated the responses using a 5-point Likert scale ranging from “strongly disagree” to “strongly agree”, that were later translated to quantitative measures, allocating 1–5 scores to each scale respectively (Likert, 1932; Boone and Boone, 2012).

The variables and criteria used to design the questionnaire used in the present investigation are summarized in Table 2.

3.1. Measurement model analysis

To evaluate the Goodness-of-Fit index of the designed model, reliability, internal consistency and validity were used (Ho, 2013). As demonstrated in Table 3, for all the variables, Cronbach’s alpha was higher than 0.7 and composite reliability coefficient was higher than 0.7 that according to Fornell and Larcker (1981) indicate the internal reliably.

### Table 1: Survey sample characteristics.

| Variables               | Categories                          | Number | Percentage (%) |
|-------------------------|-------------------------------------|--------|----------------|
| Gender                  | Male                                | 125    | 32.4           |
|                         | Female                              | 260    | 67.6           |
| Age                     | <20                                 | 143    | 37.1           |
|                         | 20–35                               | 113    | 29.4           |
|                         | 36–50                               | 106    | 27.6           |
|                         | >50                                 | 23     | 5.9            |
| Educational level       | Below high school diploma           | 136    | 35.3           |
|                         | High school diploma                 | 27     | 7.1            |
|                         | Bachelor degree                     | 82     | 21.2           |
|                         | Graduate degree                     | 140    | 36.5           |
| Family income (Toman)*  | <3 million                          | 72     | 18.8           |
|                         | 3–6 million                         | 95     | 24.7           |
|                         | 6–10 million                        | 125    | 32.4           |
|                         | >10 million                         | 93     | 24.1           |
| Infection rate          | No                                  | 172    | 44.7           |
|                         | Yes                                 | 213    | 55.3           |

* Each US dollar is equal to 28,000 tomans.

### Table 2: Variables and criteria used to design the survey questionnaire.

| Variables                                           | Criteria                                                                 |
|-----------------------------------------------------|--------------------------------------------------------------------------|
| Concern and information about the COVID-19 pandemic  | Having concerns about the threat to human life and the future generations due to COVID-19. |
|                                                     | Having concerns about the number of people infected or dying from the coronavirus worldwide. |
|                                                     | Obtaining information and knowledge about the causes, modes of transmission and control ways. |
|                                                     | Obtaining information and knowledge about the consequences of COVID-19 on humans and the environment. |
| Knowledge                                           | Obtaining information and knowledge about the causes of environmental crises such as global warming, climate change etc. |
|                                                     | Obtaining information and knowledge about the consequences of environmental crises such as global warming, climate change etc. |
|                                                     | Obtaining information and knowledge about ways to prevent environmental crises in the future. |
|                                                     | Obtaining information and knowledge about the importance of the environment in the health quality of life of the present and future generation. |
| Subjective norms                                    | Feeling responsible to take actions to reduce environmental crises. |
|                                                     | Recognizing the responsibility to prevent natural disasters and maintain a healthy environment. |
|                                                     | Understanding the importance and necessity of compatibility with the environment. |
|                                                     | Understanding human vulnerability as a result of the emergence of environmental crises. |
| Attitude                                            | Understanding the impacts of an unhealthy environment on the occurrence of crises and pandemic situations such as COVID-19. |
|                                                     | Understanding the destructive consequences of human interference on the nature. |
|                                                     | Understanding the impact of unhealthy environment on the pandemic besides the potential of this crisis to create destructive effects on environmental factors. |
|                                                     | Understand the need to control and reduce destructive activities on nature to prevent future crises. |
| Intention                                           | Willingness to change the lifestyle to an environmentally friendly one as a result of observing the global problems caused by COVID-19. |
|                                                     | Willingness to adopt environmental protection measures in the wake of the pandemic. |
|                                                     | Increased motivation and efforts to reduce natural and environmental crises |
|                                                     | Increased motivation to learn and teach environmentally friendly methods to prevent future global crises. |
| Perceived behavioral control                         | Understand the importance of family, society and environmental health. |
|                                                     | Understand the need for global efforts and actions to achieve a healthy world. |
|                                                     | Understand the role of individuals in reducing the incidence of natural and environmental crises. |
|                                                     | Understand the importance of preserving natural resources and assets by a nation as a sign of that nation's culture and civilization. |
| Pro-environmental behavior                           | Making changes in individual and family lifestyles to provide a healthier environment. |
|                                                     | Taking necessary actions to reduce household waste production. |
|                                                     | Separation of household waste. |
|                                                     | Taking necessary actions to reduce water and energy consumption to minimize the negative effects of COVID-19 and prevent new crises in the future. |
validity of the variables, the Average Variance Extracted (AVE) was calculated. Based on Fornell and Larcker (1981), convergent validity exists when Average Variance Extracted (AVE) is higher than 0.5, and all AVE values were obtained greater than 0.5.

Convergent Validity was used to evaluate the validity of latent structures, indicating the degree to which the measures of the constructs assumed to be related theoretically, are actually related (Sarstedt et al., 2014). According to Table 3, the Maximum Shared Variance index (MSV) is lower than the Average Variance Extracted (AVE) value, which means an acceptable Convergent Validity. Heterotrait-Monotrait Ratio (HTMT) and the Fornell-Larcker criterion were also used to evaluate the Convergent Validity. If this index is lower than 0.85-0.9, it indicates and acceptable validity. Thus, Convergent Validity for all variables is acceptable and the root Average Variance Extracted of all research variables is greater than the correlation with other variables, which confirms the Convergent Validity based on the Fornell-Larcker method. Moreover, for all the variables of the research, the squared root of AVE is higher than inter-construct correlation indicating the existence of discriminant validity.

The data analysis flow of the research is presented in Fig. 2.

4. Results

4.1. Structural model analysis

Coefficient of Determination ($R^2$), Path coefficient ($β$ value), T-statistic value, Predictive relevance of the model (Q2) and Goodness-of-Fit (GOF) were used to analyze the structural mode. Table 4 shows the impact of attitude, knowledge, perceived behavioral control on intention and the relationship between intention and pro-environmental behavior.

As depicted in Table 4, there is a positive and significant relationship ($β = 0.296009$) between people's attitudes towards the environment and their intention to perform environmental behaviors. Also, the findings highlight a positive and significant relationship between individuals' knowledge about environmental crises and their intention ($β = 0.559846$). Given that the T-value is greater than 2.56, the results are significant at the level of 0.01. It can also be deducted that subjective norms have a significant positive impact on intention of environmental behaviors ($β = 0.38900$), for which 95% confidence level is obtained (Fig. 3).

Based on the results, perceived behavioral control has a positive and significant impact on promoting the intention of environmental behaviors ($β = 0.320055$) for which 95% confidence level is obtained. In other words, perceived behavioral control is playing a fundamental role in pro-environmental behavior mechanism. This is also correct for the relationship between intention and behavior. Based on the findings of this study, individuals' intention has a positive significant impact on the occurrence of pro-environmental behaviors ($β = 0.510$) and has a very high confidence level of 99%.

4.1.1. Evaluating the quality of the model

Q2 criterion evaluates the predictive relevance of the model. If the Q2 value is positive for a certain endogenous latent variable, it indicates the predictive relevance for this construct. To calculate this indicator, Blindfolding technique was applied which evaluates the quality of the model using CV-Redundancy and CV-Communality (Henseler et al., 2009).

As illustrated in Fig. 3, the positive numerical value of these indexes indicates the acceptable quality of the model. Also, GoF indicator was used for the overall measurement of the model. As shown in the figure, the value of GoF is higher than 0.36 which indicates strong quality of the model.

Another criterion applied for examining the structural quality of the model is R-squared or the coefficient of determination, which indicates the effect of an exogenous variable on an endogenous

![Table 3](image)

| No. | Variables                                      | 1     | 2     | 3     | 4     | 5     | 6     | 7     | Cronbach's alpha | AVE   | CR    | MSV   |
|-----|-----------------------------------------------|-------|-------|-------|-------|-------|-------|-------|------------------|-------|-------|-------|
| 1   | Concerns and information about COVID-19 pandemic | 0.718 |       |       |       |       |       |       | 0.8089           | 0.51598 | 0.7003 | 0.421 |
| 2   | Knowledge                                     | 0.534 | 0.879 |       |       |       |       |       | 0.9313           | 0.7721 | 0.9016 | 0.643 |
| 3   | Subjective norms                              | 0.562 | 0.593 | 0.761 |       |       |       |       | 0.8418           | 0.579  | 0.7452 | 0.471 |
| 4   | Attitude                                      | 0.514 | 0.423 | 0.656 | 0.838 |       |       |       | 0.9042           | 0.7028 | 0.8592 | 0.586 |
| 5   | Intention                                     | 0.531 | 0.732 | 0.62  | 0.506 | 0.83  |       |       | 0.8986           | 0.6894 | 0.8492 | 0.436 |
| 6   | Perceived behavioral control                  | 0.558 | 0.409 | 0.722 | 0.686 | 0.515 | 0.849 | 0.709 | 0.912            | 0.7216 | 0.8717 | 0.672 |
| 7   | Pro-environmental behavior                    | 0.427 | 0.425 | 0.63  | 0.495 | 0.511 | 0.609 | 0.79  | 0.8684           | 0.6249 | 0.7982 | 0.434 |

Fig. 2. Data analysis flow of the research.
one. The coefficient of determination measures the overall effect size and variance explained in the endogenous construct for the structural model and is thus a measure of the model's predictive accuracy. Based on the model, it can be stated that 61% of the changes in the intention variable can be predicted by the exogenous variables of knowledge, attitude, subjective norms and perceived behavioral control.

According to the results, the COVID-19 variable has created an impact factor of $\beta = 0.127$. Since the t-value is greater than the critical value, the moderating role of COVID-19 is significant at the 99% confidence level.

4.2. Knowledge. According to the results, the COVID-19 variable has little direct effect on intention. While as a moderating variable it can affect the relationship between knowledge and intention of individuals ($\beta = 0.492$). The effect of knowledge on intention in the first model is equal to $\beta = 0.560$, while in the second model (Table 5), COVID-19 has created an impact factor of $\beta = 0.492$. Since the t-value (2.689) is greater than the critical value (2.56), the moderating role of COVID-19 is significant at the 99% confidence level.

4.2.1. Perceived behavioral control. According to Table 4, the effect of perceived behavioral control on intention in the first model is equal to 0.320. In the second model, the moderating variable of COVID-19 has created an impact factor of $\beta = 0.213$. Since the t-value (1.99) is greater than the critical value (1.96), the moderating role of COVID-19 is significant at the 99% confidence level.

4.2.1.4. Subjective norms. The effect of subjective norms on intention in the first model is equal to 0.389 (Table 4) and in the second model with COVID-19 as a moderating variable, this value is 0.363 (Table 5). Since the t-value (3.336) is greater than the critical value (2.56), the moderating role of COVID-19 is significant at the 99% confidence level.

**Fig. 3.** Structural model, estimate values, and evaluating the quality of the model using CV-Redundancy and CV-Communality Indexes.

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| Table 4 | Hypotheses testing results. |
|---|---|
| Variables | Dependent | Independent | T statistics (|$\text{O/STERR}$) | Std $|\beta|$ | p-Value |
| Intention | Attitude | 2.100623 | 0.296009 | 0.001*** |
| | Knowledge | 15.275843 | 0.559846 | 0.003*** |
| | Perceived behavioral control | 2.431686 | 0.32055 | 0.001*** |
| | Subjective norms | 2.544730 | 0.38900 | 0.001*** |
| Pro-environmental behavior | Intention | 8.058688 | 0.510 | 0.00100 *** |

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Gof = 0.376.

| Table 5 | The impact of the COVID-19 pandemic on pro-environmental behavioral variables. |
|---|---|
| Variables | Dependent | Independent | T statistics (|$\text{O/STERR}$) | Std $|\beta|$ | p-Value |
| Intention | Attitude | 2.382656 | 0.127138 | 0.001*** |
| | Knowledge | 2.689 | 0.492 | 0.003*** |
| | Perceived behavioral control | 1.989663 | 0.213079 | 0.001*** |
| | Subjective norms | 3.336 | 0.363660 | 0.001*** |
| Pro-environmental behavior | Intention | 4.580349 | 0.436845 | 0.001*** |

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Gof = 0.548.
4.2.2. Pro-environmental behavior

4.2.2.1. Intention. The effect of intention on pro-environmental behavior in the first model is equal to 0.510 (Table 4) and in the second model with COVID-19 as a moderating variable, this value is 0.437 (Table 5). Since the $t$-value is greater than the critical value (2.56), the moderating role of COVID-19 is significant at the 99% confidence level (Fig. 4).

5. Discussion

In this research, in the context of an extended form of the Theory of Planned Behavior, the effect of various variables on individuals’ “intention” and “pro-environmental behavior” beside the impact of the COVID-19 pandemic as a moderating variable on pro-environmental behavior mechanism were investigated. According to the results, a positive and significant relationship exists between the three variables of “knowledge about environmental crises”, “subjective norms” and “perceived behavioral control” with individual’s intention to perform pro-environmental behavior. The results of many other studies also emphasize the role of knowledge (Arcury and Christianson, 1993; Hsu and Roth, 1996; Chanda, 1999), attitude (Mitchener and Jackson, 2012), values, beliefs and norms (Stern et al., 1999; Eriksson et al., 2006; Jansson et al., 2011) and perceived self-efficacy and behavioral control (Bandura, 1999; van Dinther et al., 2011).

Based on the findings of this research, there is a positive and significant relationship between intention and the occurrence of pro-environmental behaviors ($\beta = 0.510$). In this regard, Ajzen et al. (2004) believe there is a certain mental biasness about the occurrence of desirable and undesirable behaviors in individuals. They consider the probability of the so-called “desirable” behaviors higher than the reality which leads to a mismatch between intention and behavior or behavioral reactions.

Meanwhile, the occurrence of unexpected disasters caused by the destruction of nature by human intervention, can create more sensitivity and attention in people which may end in positive environmental behaviors. The outbreak of the Corona Pandemic is an opportunity to examine the change in consciousness and attitudes and, consequently, human behavior towards the nature. In the case of our investigation, this unpleasant disaster has led to an increase in people’s knowledge about their environment. Lucarelli et al. (2020) also suggest that the COVID-19 crisis has affected people’s knowledge and information about the environmental problems as a cause of pandemic crises which has led to an increase in people’s intention to develop environmentally friendly behaviors.

Furthermore, this investigation shows that the pandemic situation has positively affected individuals subjective norms, or the social pressure every one perceives to perform environmental friendly actions. It can be declared that the pandemic has led to a better understanding of our common future and the responsibility for the environmental protection. Individuals’ attitude to perform pro-environmental behaviors has also increased as a result of the pandemic. In the mindset of a person believing that the occurrence of crises such as COVID-19, SARS, etc. is related to environmental degradation (like climate change, global warming, increasing environmental pollution, etc.), continuation of these problems will increase the likelihood of such crises in the future (cognitive), suffering and despair will be felt about this destruction and exposure (emotional) and will motivate the person to perform environmentally friendly behaviors (behavioral).

Recognized as a determinant of both intention and the behavior (Wallston, 2001), our investigation shows that the role of perceived behavioral control over environmental actions has been influenced by the pandemic situation. In other words, access to resources, facilities and a sense of ability in people to face crises such as COVID-19 can strengthen their intention to develop control behaviors to reduce environmental degradation.

Eventually, the COVID-19 pandemic has positively influenced the relationship between intention and pro-environmental behavior. As the results show, unexpected crises and lack of knowledge to deal with them, can trigger individuals’ sensitivity on the one hand and motivate them to handle such situations and reduce their vulnerability on the other hand. The results of the study demonstrated that although people may reorder their priorities at certain times during crises, experiencing such critical situations can provide a basis for learning in the society, which is in line with the findings of Hunter (2021) that suggested a positive relationship between coping with crises related to environmental degradation and increased environmental knowledge and pro-environmental behavior.

The results of the present study are in conformity with other researches investigating the relationship between the COVID-19 pandemic and pro-environmental behavior. Lucarelli et al. (2020) also suggest that the pandemic has positively influenced the individuals’ awareness about recognizing environmental degradation as a possible cause resulting in increased awareness level and occurrence of pro-environmental behaviors or as expressed by Bronfman et al. (2021) reinforced environmental preventive measures. Also, the findings approve the results of Ching and Kajino (2020), Hepburn et al. (2020), and Botzen et al. (2021) that suggest learning experience to be very important in overcoming natural disasters such as epidemics, climate change, etc. This study showed that the knowledge and information
gained from experiencing tragic events and crises on a global scale can amplify people's sensitivity and concerns and motivate them to control such events and prevent the occurrence of destructive environmental behaviors. Based on the results, knowledge and information obtained from this type of experiences create the ability to predict the consequences of destructive behaviors through cognitive processes, and therefore should be considered extremely important in reducing future unsustainable activities.

6. Conclusion

Perhaps one of the historical turning points in man's understanding of the power of the nature and his weakness to control it can be witnessed in the COVID-19 case. The pandemic situation shattered the so-called “technological optimism” that all global problems can be solved with the help of science and technology and highlighted the need to respect and preserve the nature. Undoubtedly, observing and modeling others’ behaviors play an important role in learning and changing behavioral patterns. If people have to focus merely on trial and error to comprehend what to do, in critical situations this process can be extremely difficult and painful if not risky. Consequently, the ability to control previously learned behaviors based on the capability to predict the outcome using cognitive processes, can be very important to reduce the destructive activities and prevent forthcoming tragic events. According to the results of this investigation, information, knowledge and understanding of the critical situations can stimulate and strengthen the mechanism of pro-environmental behavior. In other words, promoting knowledge about the causes and consequences of profound crises can strengthen behavioral intentions through providing effective initiatives to deal with natural and man-made disasters. Given that people are extremely vulnerable to unpredicted circumstances, adopting reinforced models and strategies that assist them in becoming more resilient, will be remarkably effective. It is necessary to mention that this research has faced its own limitations. Since this study was cross-sectional, there was still incomplete understanding of the origin and possible causes of the pandemic at the time of its implementation. In addition, direct communication with respondents was impossible due to quarantine conditions. This circumstance caused specific limitations of online surveys, in which the statistical population would be restricted to people with access to the Internet. Considering the significance of constant “change” in terms of the people's behavior, increasing knowledge on the causes and ways of control and finally the behavioral and psychological responses of the society, we suggest long-term and more comprehensive studies to be conducted covering different cultures, regions with dissimilar access level to information and faculties. Furthermore, this study has mainly examined the individual level variables. Consequently, investigating the role of social variables in the occurrence of pro-environmental behaviors during and after the pandemic era is suggested for future investigations.

CRediT authorship contribution statement

Lobat Zebardast: Conceptualization, Methodology, Writing – original draft. Writing – review & editing. Mahjabin Radaei: Data curation, Investigation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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