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Research Article

Mediating Role of Environmental Awareness for the Nexus between Perceived Risks of COVID-19 Pandemic and Use of Sustainable Transportation: Evidence from Urban Passengers in Ethiopia, 2022

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The COVID-19 pandemic has been a global pandemic and a threat to humankind. In addition to many cases of illness and millions of deaths, the economy and social interactions have suffered. It remarkably declined overall transportation and mobility in most countries. However, given that there is a gap between environmental sustainability awareness and what is practiced by transport users, the goal of this study was to empirically assess the mediating role of environmental awareness in the casual links between perceived risks of the COVID-19 pandemic and ecologically sustainable transportation use. The study identified relevant theories, conceptual frameworks, and variables. Mixed research and surveys were carried out on the public and private transport service users in Addis Ababa, Ethiopia. Comparative analysis, structural equation modeling, and structural causal model framework were applied to estimate casual relationships among variables and test the hypotheses. Despite the rising of human-caused climate change denial beliefs, findings revealed that a large part of the causes of the COVID-19 pandemic are climate change, biodiversity misuse, and wildlife degradation, all of which are environmental in nature and anthropogenic. People perceived the COVID-19 pandemic as more of a risk to others than to themselves, and climate change or global warming has become a danger to humanity, mainly during the pandemic. Accordingly, the pandemic risks increased people's mainly passengers' awareness of the environment, and this caused them to give greater consideration to the environmentally attractiveness of the transport they use. This, in turn, encouraged people to take personal climate-friendly measures and pro-environmental behavior, mainly greater willingness to use public transportation than private transportation during the COVID-19 pandemic than before. Thus, the total effect of the COVID-19 pandemic anxiety on the use of public transportation is completely mediated by enhanced environmental awareness. These are evidence that COVID-19 has strengthened environmental awareness and promoted sustainable action in the context of the transportation industry of developing countries. The study informs that urban planning and policy need to consider pandemic-sensitive and innovative public health and transport systems, integrated public health education, one health approach, and smart city. It suggests that maintaining the environmental awareness of societies and encouraging them to mitigate climate change through urgent climate actions and modal shifts to the use of sustainable urban transport such as public transportation.

1. Introduction

According to the 2020 World Health Organization (WHO) report [1], COVID-19 is a global pandemic, and the coronavirus illness has been escalating globally. It has different effects on social life, the global economy, transportation, and the environment in addition to being a health issue. Crises are sudden, unfavorable changes in matters of security, the economy, politics, the environment, or public health. Local crises like famines, droughts, and wars occur all throughout the world, but these kinds of global events are uncommon [2, 3].

The increasing environmental devastation and climate change brought on by enhanced greenhouse gas emissions

and global warming is considered to be a disaster on a global scale. However, the significance of the effects of global warming is not high for the majority of people. The majority of people have not yet felt the effects of environmental degradation; however, there may have been local foods or other occurrences that may be linked to global warming. The majority of terrible predictions are based on scientific research, which many people find to be excessively nonconcrete [4–6].

While not everyone can see the effects of global warming, everyone can see the risks posed by the COVID-19 pandemic. The COVID-19 pandemic began in 2020, and it has persisted for a considerable amount of time. By the time the epidemic is over, there will have been hundreds of millions of infections and millions of deaths worldwide. For all of mankind, it is a scenario with the highest danger and degree of unpredictability. Due to the emergence of viral mutations, even the effectiveness of vaccinations is under doubt. There is no doubt that COVID-19 poses a hazard to the majority of people; however, for some, this threat is greater than for others [7–9].

According to Jean-Paul et al. [10], the main modes of transportation in cities include private transportation, freight transportation, and nonmotorized modes of movement, including walking and bicycling. Public transit options include trains, city buses, minibuses, and three-wheel rickshaws or Bajaj. The adoption of electric cars recently and the switch from private to public transportation are two examples of how eco-friendly and sustainable transportation is widely supported, mostly for the sake of social, economic, and environmental sustainability [11–13].

Massive efforts have been made in recent decades to promote the use of public transportation, mostly due to the need to slow down environmental deterioration and climate change. However, Ozbilen et al. [14] revealed that the COVID-19 pandemic's worldwide expansion and associated intervention strategies, such as travel restrictions, have put unanticipated strains on metropolitan public transportation networks. In many urban places throughout the world, transportation has consequently been severely interrupted [15, 16].

We can observe the pandemic's effects and the results of actions taken to halt or reduce the virus's global spread. Urban settings, social behavior, economics, urban transportation, and the environment all experience impacts [17, 18]. Millions of people were quarantined in their homes due to COVID-19, but today's infrastructure and transportation systems that once connected us on a global, national, and local level are being used less frequently, primarily in urban areas [19, 20].

Literature reveals that transportation patterns have changed and will continue to do so following partial and total lockdowns brought on by the COVID-19 pandemic. This research, for instance, demonstrates that once the coronavirus lockdown is lifted, there may be 20% less individuals utilizing public transportation in British cities than usual. Basbas [21] and Tsavdari et al. [22] also indicated that the number of commuters utilizing London's buses and tubes might decrease by as much as 40% from pre-lockdown levels.

According to research [23, 24], the pandemic and associated intervention policies, latent attitudinal variables, and perceptions can have an impact on people's travel, mobility behavior, and transportation utilization.

According to Helm et al. [25], COVID-19's highly visible dangers can raise public awareness of environmental issues. Due to the closer proximity of wild animals and people, which encourages so-called zoonosis, or the transfer of pathogens from animals to humans, there is, on the one hand, a clear link between environmental degradation and the COVID-19 pandemic's outbreak [26–30]. On the other hand, studies found that the worry and dread brought on by the pervasive risk of infection might promote compliance with those who seek to preserve the environment [31–33].

These theories were supported by research, such as Bouman et al. [34] and Bouman et al. [35], which also produced a theory of how the COVID-19 pandemic may affect social norms, which might promote environmental awareness. Despite the fact that a lot of people believe the epidemic threatens others more than themselves, they take pro-social actions that assist others. How much can be learned from the epidemic to encourage the reduction of global environmental concerns is the main concern for these academics. The COVID-19 pandemic's impact on global environmental consciousness is one explanation that might be offered.

By studying a shift in pro-environmental and eco-sensitive behavior following the epidemic, one may be able to find an explanation. Transportation through travel and mobility behavior is one area of the global economy where environmental consciousness is significant. National governments have effectively supported public transportation and, more recently, electric mobility through financial subsidies, tax exemptions, traffic restrictions, and other measures for a number of years while discouraging the use of private automobiles [36, 37].

This study is one of the few attempts to integrate sustainable transportation and mobility practices with pro-environmental psychological capital, green climate, and pro-environmental behaviors to predict the environmental performance in transportations. It examines the moderating role of environmental awareness and consciousness that was almost ignored. This study is important for transportations that are trying to adopt sustainable transportation and green mobility practices. It provided several suggestions to the practitioners while making the strategy to promote environmental performance with the help of sustainable transportation and mobility practices through various ways. It also assists the transportation policy, planning, and management to enhance pro-environmental psychological capital.

Therefore, this study responds to the call of research, such as [35, 38], which highlighted these gaps and emphasized to further explore the moderating part of environmental consciousness to fulfill the dearth of understanding in the context of organizational environmental studies.

While grand claims have been made about the impact of the pandemic on environmental quality and enhancement of environmental awareness as well as enhancing environmental awareness of people are successful in maintaining

sustainable transport and environmental management, a majority of case studies and examples of environmental impacts of the pandemic and public transport usage behavior are from the context of Global North, resulting in a lack of data for many medium- and low-income nations mainly in Africa.

Consequently, many environmental and climate awareness and public transport usage behaviors of people are excluded from existing studies, as well as pandemic impact analyses from the perspective of these locations. Further research was needed to be conducted in the Global South, for example, in the case of transport users people in urban Ethiopia in the current study, to determine how their environmental awareness levels are impacted by the pandemic and contribute to the sustainable transport use behavior.

The current study could fill the research gaps by focusing on the roles of mediating variables to understand both the direct and indirect roles of independent variables for the changes on dependent variables using evidence and perspective from selected low-income African countries and through the application of recent primary data obtained from urban transport user people and SEM model for analysis. Its focus on the link among the pressing, urgent, global issues and multidisciplinary topics such as zoonosis public health, environment, climate change, human behavior, psychology, and urban and transportation issues also makes the study novel. Thus, the focus area, method, and findings can help place this research in the current debates.

Although the manufacture of public transportation, including electric vehicles and, in particular, their batteries, necessitates the use of environmental resources, it is generally acknowledged that these transportation options represent at least a first step in the reduction of air pollution because they have minimal or no tailpipe emissions. Li et al. [39] and Requia et al. [40] suggest that increased environmental knowledge, value, and behavior may be the cause of the frequent readiness to offer and utilize public transportation services rather than private transportation vehicles (mostly those powered by internal combustion engines).

To date, although a number of studies have been published on the topic, there is no empirical evidence for the above theories. There have not been studies on the impacts of the COVID-19 pandemic by and on environmental factors. Past studies could not clearly address key questions, such as whether the pandemic is caused by environmental degradation or not and whether the pandemic has enhanced awareness, value, and concern about climate change and the environment. Thus, the current study is motivated to fill these literature and knowledge gaps by presenting a critical and empirical analysis of the casual relationships between the COVID-19 pandemic, environmental awareness and value (EAV), and environmental quality from transportation and passengers' perspective.

The author is motivated to do this study because the path to achieving environmental and urban sustainability has become increasingly challenged by the COVID-19 pandemic, a situation exacerbated by new coronavirus subvariants in recent years. In this context, the feasibility and roles of sustainable transport modes, which primarily aim to reduce climate change, have been questioned. Thus, this study examined the implications of the COVID-19 pandemic on a strengthened awareness of climate change and global warming threats and then on environmental quality based on the frequency of mobility using public transport modes compared to private vehicles. The results could serve as evidence and proof of the prior concepts, assumptions, and theories chosen for hypotheses development.

The proportion and level of intended and actual transportation vehicle use over the 2-year period from the start of the COVID-19 outbreak in 2020 to the corresponding 2-year period in the future (i.e., mid-2022–2024) were compared by comparing the responses of private and public transportation vehicle uses. The corresponding assumptions were then evaluated, and a theoretical basis for a potential chain of effects from pandemic dangers to greater awareness of the environment and climate change to higher acceptability of public transportation was created.

The major causes of the COVID-19 pandemic, covariants, climate change, the link between environmental degradation and the pandemic, as well as the types of its impacts on the environment, are points of argument. For example, the latest reports and studies, such as Franks [41], reveal that climate change denial and unscientific beliefs are growing, and religious institutions and various education curriculums are being taught that "human-caused climate change is not real and instead teach God has a plan to prepare a new heaven and earth with a better climate." Eventhough this research was done during the COVID-19 period, and the pandemic has officially ended, there are still worries and new concerns that COVID-19 and the recently seen covariants will somehow cause citizens around the world to lose sight of the urgency of the climate change crisis and need for environmental action.

Based on these scenarios, the author is motivated to investigate whether the beliefs about human-caused climate change and the pandemic are real or not, as well as the contribution of the pandemic to the enhancement of EAV based on people's perceptions.

EAVs in this study are founded on the psychological concept that the ecosystem confronts a variety of environmental problems as a result of human activities, particularly in the transport industries. Different transport users or passenger groups exhibit varying degrees of EAVs. Previous studies suggest that EAV commitment enhances sustainable consumption behavior, significantly influences purchase intentions, and can also mediate the relationship between environmental sustainability government initiatives and green practices [42, 43].

Having the role of EAVs as a mediator is essential because EAVs are one of the green triggers that are related to environmental concerns and comprehension. This means that when humans realize the value of the environment and the harm they are doing to it, they may be more willing and motivated to take action to protect it.

The increased awareness of environmental problems may result in the incorporation of eco-friendly and green practices into people's everyday lives. Companies are also

taking the initiative to raise consumer awareness of the sustainability practices used in the production and distribution of products [44–46].

The most important factors for environmental conservation might be environmental awareness, values, and the connection between them has been scrutinized by environmental psychologists and studies. They show that individuals who develop awareness, positive attitudes, and values tend to present higher levels of behavioral intention as well as actual behaviors related to the conservation of the environment. Without the mediation effect and roles of EAVs, pro-environmental behaviors cannot be fully practiced and then environmental conservation and environmental qualities are unthinkable [47].

Lewin's [48] behavior model also believes that behavior is the product of the interaction between the individual and the environment and makes a basic induction and division of the individual's internal elements and external environmental factors. Numerous studies, such as Zhang et al. [49] and Yu et al. [50], have been conducted to explain that human activities are the fundamental factor behind environmental deterioration and quality, and a lack of environmental awareness is a great hurdle to developing environmentally friendly behavior among human beings.

It is well established that EAVs play a vital role in shaping pro-environmental behavior and environmental quality. Therefore, enhanced EAVs make people more conscious of the environment and inculcate in them pro-environmental behavior [46, 51].

Based on these scenarios and the evidence in the research, literature, and theories, this study proposes the direct and indirect influence of EAVs on eco-friendly, green practices, and pro-environmental behavior and practices among urban transport service users. Thus, it is hypothesized that EAVs positively affect the use of sustainable transportation and also act as a mediator between COVID-19 pandemic impacts and the use of sustainable transportation, which is an eco-friendly and green practice by transport service users for environmental quality. That is why it is vital to have EAVs as mediating variables, which is the main contribution of this study.

The novelty of this research is thus indicated not only by the focus on the topic of the COVID-19 pandemic and recently seen covariants, a global topic that has seen significant progress in recent years, but also on a novel argument regarding its impacts and implications on the environmental awareness and concern as mediator variable. Consequently, the effects on the the enhancement of environmental quality through pro-environment travel choice behavior and use of eco-friendly transportation modes by people were not addressed by previous studies.

As most of the existing studies focus on the context of developed nations, a study conducted in low and middle-income nations such as Ethiopia is important to address their specific problems and needs. This study considers unique situational factors and contexts such as higher vulnerability levels to climate change and COVID-19 pandemic risks, lower socioeconomic development, and capacity to inform the need for unique and different approaches and special considerations in these countries. The situation and contexts of the pandemic, climate change, EAVs, urban transportation, and associated socioeconomic challenges are not the same throughout the world.

For example, as the availability, variety, and quality of existing transportation infrastructure and facilities are significantly different in these nations, eco-friendly choices and use of transportation are widely manifested by the use of conventional public transport modes such as city buses, midi-buses, mini-buses, and light rail. Unlike developed nations, electric vehicles, solar-powered vehicles, BRT, underground heavy rails, and other advanced technologies are very limited.

Presently, developing low-income nations are lagging behind and anxious about integrating environmental quality and sustainable development goals (SDGs) into their systems. As environmental quality and SDGs are inseparable, the accomplishment of SDGs with improved environmental quality is arguable due to various challenges. As a result, there is a need to raise environmental quality through different direct and indirect activities, such as raising awareness, mainly in these regions.

In this scenario, for the enhancement of pro-environmental actions and the effectiveness of environmental quality, it will be necessary to focus on their unique contexts and situational factors and adopt new types of development, social changes, and governance models. These all will require special considerations, reflection, new behaviors, and thoughtful action in research and policymaking.

That is why this study was conducted, and focusing on the unique situations and contexts of developing countries like Ethiopia as compared with other contexts has an additional contribution. It is thus novel and impactful, because it was done based on unique theories and models mainly from the perspective of transport service users or passengers and developing countries using inferential statistical casual analysis models.

Since this original research expands on the prior researches and theories using original data, it can be used as a proof for the previous concepts, arguments, and conclusions, as well as a baseline reference for further studies. However, it examines a different and new aspect of impact analysis by considering the implications for the policy, design, planning, and management of urban environmental, health, and transportation systems.

2. Literature Review

2.1. Links between Environment, COVID-19 Pandemic, and Impacts. To date, there is a large body of peer-reviewed scientific research consistent with the zoonosis theory and zoonotic origin of the COVID-19 pandemic. Zoonosis is an infectious disease of humans caused by a pathogen (an infectious agent, mainly a virus) that can transmit from a nonhuman, usually a vertebrate animal, to a human and vice versa. For example, the major modern diseases such as Ebola, HIV, bird flu, and swine flu.

Regarding the causes and modes of transmission, zoonosis theory reveals that the emergence of zoonotic diseases

originated with the domestication of animals. Zoonotic transmission can occur in any context in which there is contact with or consumption of animals, animal products, or animal derivatives. It can emerge at various hazardous animal–human interfaces at community, city, region, and global levels [26–28, 52].

The Hunan seafood market in Hunan, China, was the origin of the COVID-19 epidemic, according to research by Chakraborty and Maity [53]. Wildlife of many types, including bats, frogs, snakes, birds, and more, are exchanged at this market. By bringing humans and wildlife closer together owing to population increase and deforestation, so-called zoonosis, which is defined as a disease that is spread from animals to humans, leaves these marketplaces exposed to infections [54].

According to a report from the United Nations Environment Programme [6] and McIntire and Grace [55], environmental factors such as ecosystem degradation, climate change, global warming, unsustainable agriculture, wildlife exploitation, and land use change account for a sizable portion of the causes of the COVID-19 disease. Additionally, Brancalion et al. [56], Johnson et al. [28], Almukthar et al. [57], and Tollefson [8] showed that the COVID-19 pandemic has an immediate connection to nature and the environment. Environmental deterioration, particularly deforestation, brings animals closer to populated areas, which promotes the spread of endemic or even pandemic diseases, according to some studies.

People naturally and instinctively correlate COVID-19 with environmental factors as a result of this close connection. There are psychological impacts in addition to this brief explanation. People are acutely aware of the threat posed by COVID-19, which is an immediate and personal menace. The main policy suggestions for reducing the dangers of COVID-19 and other zoonotic illnesses include increasing public awareness, conducting research, creating capacity, providing incentives, improving governance, using transdisciplinary and one-health methods, etc. UNEP and automakers specifically called for the establishment of infrastructure for sustainable mobility in the context of the transportation industry for both current and future forms of road travel through public transportation and other cutting-edge technologies like electric vehicles [5, 58].

A new finding of UNDP in 2023 revealed that for our daily mobility, choosing sustainable transport modes such as public transport, biking, or walking cuts our carbon footprint by 2.2 tons yearly. It is not just about moving from place to place; it is about moving toward a sustainable and safer future. Sustainable transport is vital for urban growth and cutting emissions, playing a key role in achieving the SDGs by 2030 through building sustainable cities, tackling climate change, and driving innovation. Every choice to travel sustainably is a vote for cleaner air, healthier communities, and a resilient planet. UNDP calls us to gear up and make our journeys part of the global drive toward a greener tomorrow. Sustainable transport today paves the way for a greener future and a sustainable world for all. The recent reports about SDG encourage responsible choice and usage of transportation modes. They urge us to choose our mode of transportation wisely, opt for sustainable transportation choices, and reduce emissions for a healthier planet.

Among the past studies, Shahzad et al. [59] focused on the finance sector from the context of government servants in Malaysia and examined the factors influencing the acceptance of Fintech services and how consumers adopt it using an enhanced technology acceptance model. However, much less is known about how the pandemic impacts the kind of pro-environmental beliefs, values, and awareness people adopt in their transport mode choice and use practices.

Even though a study by Nisar et al. [60] is similar in its topic, the method mainly application of SEM and findings that revealed the moderating role of pro-environmental psychological capital, psychological green climate, and pro-environmental behaviors to enhance environmental performance, it is delimited on different perspective, i.e., the hotel sector and HRM practices in Pakistan. However, much more is unexplored about how the pandemic impacts these behaviors and the moderating role of pro-environmental psychological capital on sustainable transport use behavior and actions.

A study by Khadim et al. [61] is similar in its emphasis on the crucial roles of moderating variables and context of developing countries; it focused on the performance of logistic infrastructure and economic growth perspectives and used different methods, i.e., panel data and LPI index. Yang et al. [62] also conducted a similar investigation in its emphasis on the link between environmental sustainability perceptions and pro-environmental practices and the application of a survey questionnaire; it, however, focused on the context of students, schools, university workplaces, and used different method, i.e., the theory of planned behavior (TPB) model.

A study by Li and Yue [63] is partly similar in its emphasis on the issues of the environment, such as energy efficiency and emission and health from the perspective of the road transport sector or field; however, it used different method (i.e., LEAP model for analysis of longitudinal emission data) and recommended usage of new energy automobiles.

In addition, Ekwe et al. [64] examined the moderating role of soot risk tolerance for the association between exposure to soot and perceived soot risk concerns among oil-producing communities in Nigeria, where the positive association between the two variables was weakened by the moderating variable. Although the study by Olaoye [65] is similar in its emphasis on the nexus between environmental quality, energy consumption, and growth performance and from the context of African countries, it examined a different perspective, i.e., environmental quality as a predictor variable and its positive impacts on economic growth, which is also affected by energy consumption. It also used a different method, i.e., longitudinal data and FMOLS and DOLS as cointegration analytical techniques, resulting in a lack of evidence about the impacts of the pandemic.

A more similar paper by Bouman et al. [35] answered a question about what we can learn from the COVID-19 targeted public responses to promote mitigation of global

environmental crises and revealed that the responses to COVID-19 were partly promoted by strong personal behavioral norms: feeling morally compelled and responsible to act. These new behavioral norms played a positive mediating role and could be enhanced in global environmental crises to promote their mitigation and sustainable action. However, this study revealed that the mediating role played by the new behavioral norms is partial or incomplete, and the dependent variable, i.e., sustainable action, is expressed in terms of the sale and usage of electric vehicles in countries of the more developed regions.

Sobrino and Monzon [66] focused on how to manage urban transport to control climate change. Batty et al. [67] about the impacts of climate change on urban transport [68] and the challenges of growing the share of public and nonmotorized transport. However, the situation with pandemics is different, and the actual or possible impact of pandemics has not yet been researched.

According to Ruiu et al. [69], the COVID-19 pandemic invited individuals to reflect upon a more sustainable way of life and daily activities, tend to reconsider the anthropogenic impact on the environment and associate the COVID-19 pandemic with an opportunity to promote an eco-friendly world and to adopt an eco-sustainable approach using technology. However, the study is from the context of the UK population and did not explore the adoption of eco sustainable approach from the context of daily transport use behavior. Lieven [70] also conducted similar research but delimited to the concept of electric private cars.

Overall, their findings focused on an angle that the current study has not thought of and on an insignificant aspect because they have not presented the issue under study very well. The focus area, research questions, perspectives, and methods also show how the work of this study differs from or improves on the previous studies. Regarding the topics of the current study, i.e., origins, causes, and impacts of the COVID-19 pandemic, climate change, and global warming, findings of existing studies and opinions are also still diversified and points of argument.

The studies conducted in the past did not focus on the nexus between the perceived risks of the pandemic and the concern or consideration for environmentally friendly transportation types. Whether these two variables are directly or indirectly linked has not been studied. The implication of the pandemic on the environmental awareness of people, mainly passengers, has not been addressed so far. Thus, this study attempted to fill these research gaps using empirical casual impact analysis based on an up-to-date theory and model.

2.2. Transportation and the COVID-19 Pandemic in Addis Ababa City, Ethiopia. Being located in the horn of Africa, Ethiopia has around 105 million inhabitants and is characterized as being predominantly rural, with about 20% of its population living in urban areas. However, the country's urban population will triple in absolute numbers between 2010 and 2040 because of the rapidly accelerating urbanization, which is mainly driven by continued migration to urban areas. With a population of close to 5 million, the capital, Addis Ababa, accounts for a large part of this rapid urbanization trend [71]. As indicated on the map of study areas in Figure 1, there were eleven sub-cities in the Addis Ababa city administration, which holds about 527 square kilometers of area [73–75].

Though a recent phenomenon, this internal migration is expected to increase significantly during the years to come due to the fact that Addis Ababa is not only a financial and political center but also a diplomatic capital. As a result, the city is hampered by fundamental multidimensional transportation-related issues and challenges like rising private car ownership and usage, traffic congestion and accidents, air pollution, and a vast disparity between demand and supply for public transportation [71].

For example, the total number of vehicles registered until July 2020, at both federal and regional levels in Ethiopia, has reached close to 1,200,110 vehicles. Out of this total registered number, Addis Ababa has registered around 630,440 vehicles, which is the largest number (about 52%) in the country [76].

According to World Bank [77], 54% of the city's residents use walking as one of their primary modes of transportation. While 15% of the total travel time is spent in private cars predominantly and taxis, the overall share of the public transport system is about 31%.

At present, the public transportation system is made up of formal, publicly owned modes like city buses (namely, Sheger and Anbessa), the public service employes transport service enterprise (PSETSE), and the light rail transit service, as well as informal, privately owned modes like minibuses taxi (capable of carrying about 24–30 people), minibus taxis (11–16 people), and Bajajs, a type of three-wheeled motorized rickshaw with a loading capacity.

Addis Ababa light rail transit, in particular, is another new and electrified public transport mode operating on a total of 34 km of two lines using 39 stations, of which five are common stations between these two lines. Data from the AALRT office (2021) indicated this LRT network is providing passenger services for about 125,000 people on average per day on the two corridors, namely the north–south and east–west corridors.

Addis Ababa City Transport Authority (AATA) report (AATA) report [78] shows that minibus taxis account for the largest share of the public transportation network with 86% of ridership, followed by Anbesa city buses with 5%, both minibuses and PSETSE with 3% each, AALRT with 2%, and sheer city bus with the remaining 1% [79]. In the public transportation network illustrated in Figure 2, mass rapid transits, light rail transits, and city bus rapid transits are the predominantly used public transportation networks. For example, about 687 Anbessa city buses are running on 124 routes throughout the city, and roughly 8,911 minibus taxis are operating on 1,265 routes in all subcities, predominantly with blue and white vehicles. The routes of their networks are allowed by the City Transport Authority.

Based on data from 2018 to 2019, an average of 309,888 passenger trips per day are hosted in the service. The Anbesa buses operate a vast route network, so headways can

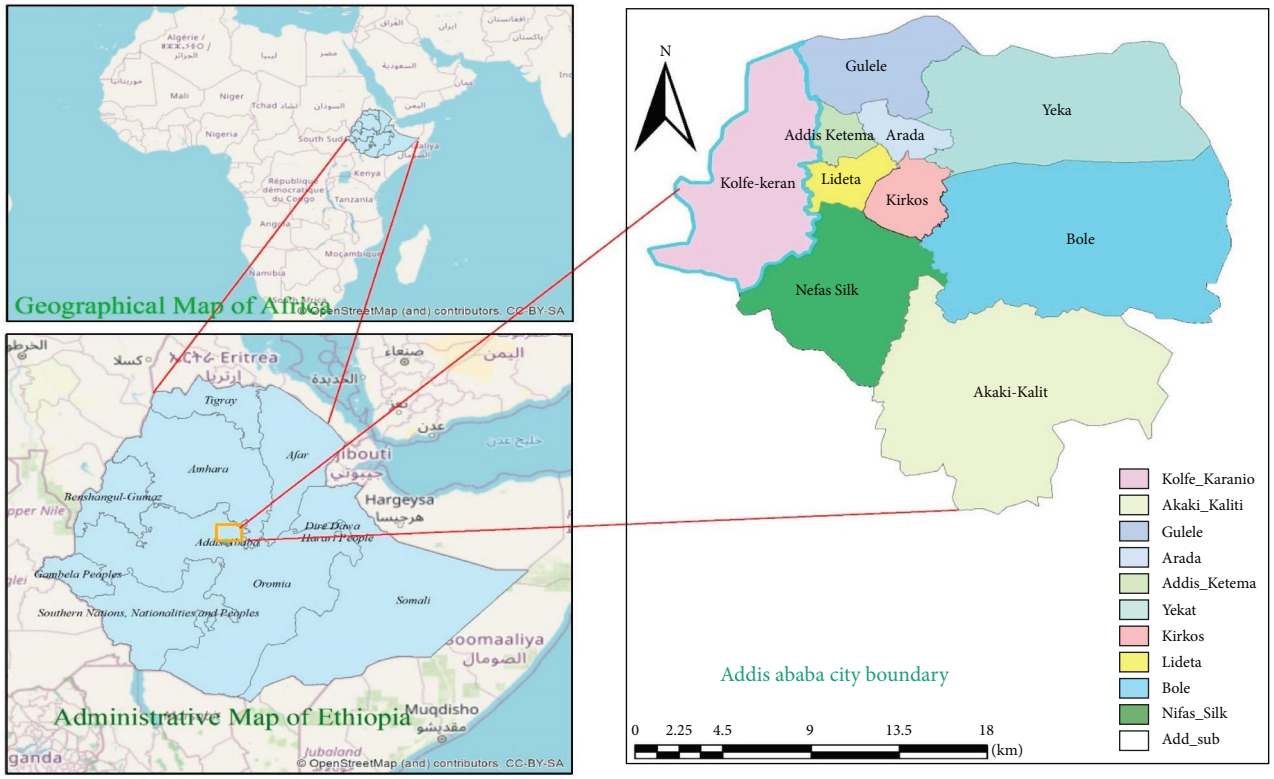

Figure 1: Map showing Addis Ababa city, Ethiopia. Source: Ethiopian Mapping Agency [72].

occasionally be up to 90 min. Additionally, Sheger city buses are running, using about 217 vehicles on 48 corridors and transporting about 198,000 passengers daily. Even though Sheger buses operate along many of the same corridors served by Anbessa buses, the routes and network are predominantly concentrated in the inner parts of the city.

Worldwide, especially in Ethiopia, the COVID-19 epidemic has impacted economic activity and way of life. The epidemic persists in spreading despite rising vaccination rates, having an unparalleled effect on people's lives. On March 13, 2020, the first incidence of COVID-19 was recorded in Ethiopia, mostly in important cities like Addis Ababa.

The Ethiopian government proclaimed a nationwide state of emergency on April 8, 2020, following the early preventative steps such as requiring passengers to enter quarantine, mask requirements, and communication initiatives. The government also chose to impose travel restrictions, restrict access to transit, forbid public gatherings, and close schools. A number of national COVID-19 response strategies, including national recommendations to maintain basic health services, were also promptly established by the Ethiopian Federal Ministry of Health [1, 80].

According to the COVID-19 Map-Johns Hopkins Coronavirus Resource Center [81] the pandemic's status and stage in Ethiopia have changed significantly during the past 18 months. Ethiopia was hit significantly harder by the second wave (mostly February–June 2021), comparable to other African nations, while the initial wave in the first half of 2020 spread more slowly throughout Africa. At this point, the maximum number of instances and frequency were noted, and since then, there has not been any indication of a slowdown. At the time of the survey's collection for this study (i.e., from October to December of 2021), Addis Ababa city, in particular, entered the third wave, and other crises like the new delta virus, the desert locust outbreak, and armed conflict in various regions were further exacerbating the pandemic's negative effects.

Around 365,776 confirmed COVID-19 cases and 6,486 fatalities were recorded at the time the surveys were completed. With a total of around 500,014 cases and 7,572 fatalities projected through March 2023, Ethiopia now has the fourth-highest ranking in Africa. Despite the recent small rise, Ethiopia had a lower death rate than the regional average throughout the epidemic. Due to the fact that the real case and death counts are thought to be significantly higher than those recorded, the infection rate rose to its greatest level during the third stage after the second [82].

The COVID-19 scenario is still unsettled, and it has so far had differing effects on the country's various regions, with Addis Ababa city suffering disproportionately more. Globally speaking, metropolitan areas and transportation systems serve as both the major sources and victims of the wide-ranging effects of the COVID-19 pandemic, climate change, and environmental degradations. This is also the reason the research's study area was this rapidly urbanizing city in Ethiopia.

The modeling framework for this modern and original area of research enables the study to fill research gaps and

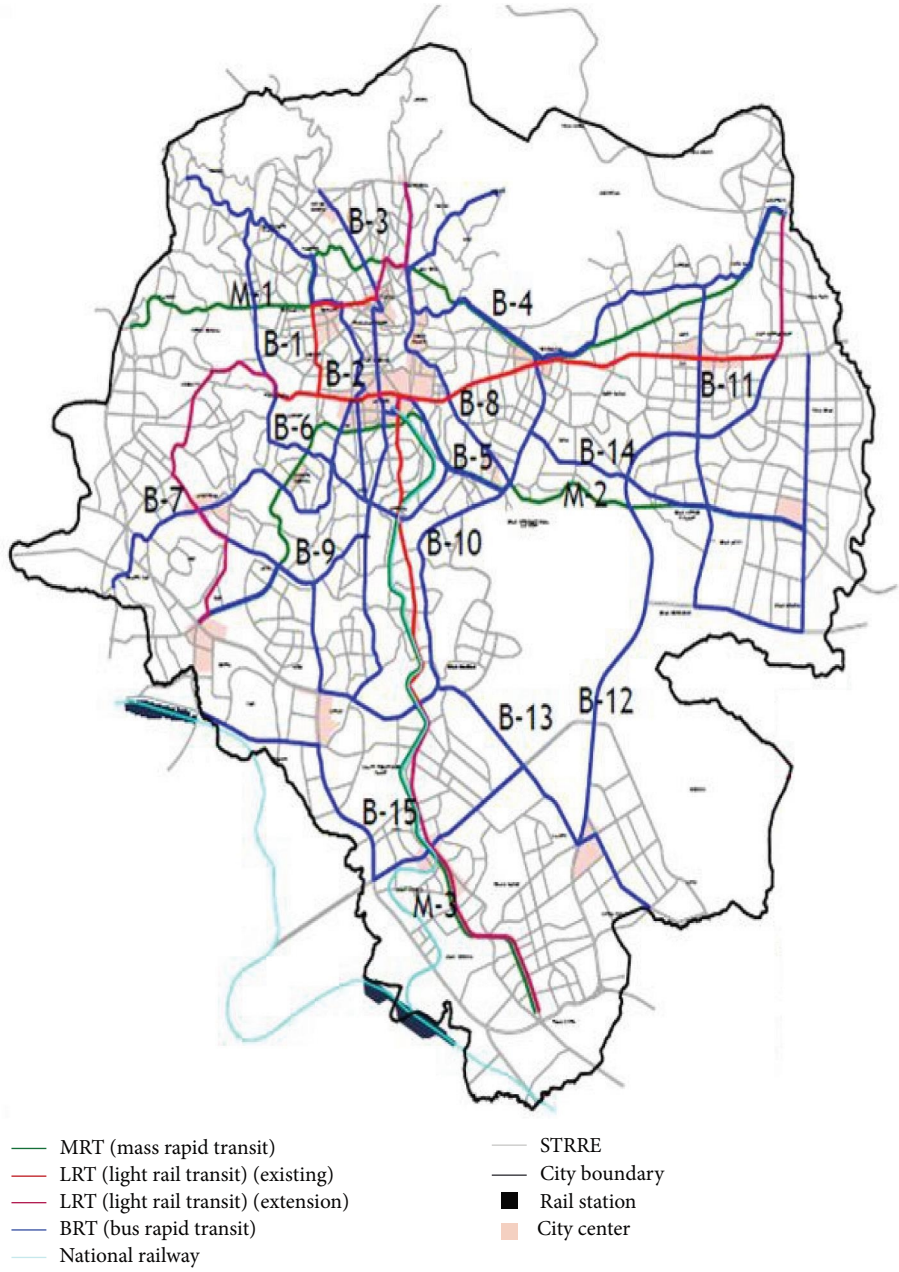

Figure 2: Addis Ababa city public transportation networks. Source: Adapted from Addis Ababa city structure and master plan (2017–2032).

make use of cutting-edge analytical models and recent theoretical underpinnings. The results of this empirical study, carried out in Addis Ababa, Ethiopia, were presented to identify the drivers' motives and adequately model these motivations. In order to strengthen policy formulation for the future and the post-COVID-19 world, taking into account the particular contexts of the developing countries, the evidence will assist policymakers in better grasping the precise relationships between the perceived COVID-19 impacts and the environment. A sound understanding of this topic is needed to design interventions to slow down and prevent the spread of the COVID-19 pandemic with environmentally sustainable mobility behaviors through consistent or adaptable strategies.

Before theory development, the following major research questions were identified in relation to each of the hypotheses:

(i) Does the transport user people in urban areas of low-income countries link the causes of the pandemic (infectious disease) to biodiversity misuse and degradation by humans during the pandemic than before?

(ii) To what extent the COVID-19 pandemic is realized as a threat to humans? Do the transport user people realize more so to others than to themselves?

(iii) How and why do transport users perceive that climate change or global warming is anthropogenic and real, than saying human-caused climate change is not real?

(iv) If the climate change/global warming is realized as a threat to humans, do the transport user people perceive more so to themselves than to others?

(v) Has the COVID-19 pandemic enhanced the EAV of the transport user people, mainly during the pandemic than before?

(vi) Has the outbreak of the COVID-19 pandemic positively affected transport user people to give greater concern and consideration to the choice and use of public transportation than private transportation use?

(vii) How the perceived risk of the COVID-19 pandemic affected transport user people to give greater concern and consideration to the use of public transportation, such that the total effect is mediated by enhanced EAV?

Therefore, the motivation of this survey is to find pieces of evidence and answer key questions by developing a conceptual framework and alternative hypotheses based on relevant literature, models, and theories.

The zoonosis theory and various studies such as Brancalion et al. [56], Gyan [54], Johnson et al. [28], Almukthar et al. [57], Tollefson [8], and UNEP [6] confirmed that the pandemic not only originated in animals because of biodiversity misuse and environmental degradation by human action but also poses an immediate and personal threat to human beings.

On the other hand, Shammas and Sun [83], Thagard [84, 85], and Malinverni and Brigagão [86] revealed that in the last few years, people denied and ignored the threats of catching COVID-19, engaged in harmful behaviors, and leaders were reluctant to implement effective policies. This was because the spread of the disease depends heavily on the behaviors and choices of individual people; psychology is an important contributor to the understanding and treatment of pandemics. Though the facts about COVID-19 risks have been tested in the literature, considering the new and conflicting scenarios, as well as the perceptions and psychological reasons for the denial and acceptance of the pandemic in the current study, are vital for the success of efforts to address it. The following hypotheses are formulated to test the scenarios and reality:

H1: The study participants, i.e., transport user people in urban areas of low-income countries, link the causes of the pandemic (infectious disease) to biodiversity misuse and degradation by humans, during the pandemic than before.

H2: If the COVID-19 pandemic is realized as a threat to humans (both themselves and others), then the transport user people realize more so to others than to themselves.

The reality of human-caused climate change, its widespread impacts on all forms of life, and the urgency of its crisis have already been tested and widely accepted in the literature. Recent studies indicated that 75% of infectious diseases, including the COVID-19 pandemic, which has acute consequences for human health, originate from animals, mainly due to the misuse of biodiversity and climate change. It's time to transform how we engage with nature and climate because when we prioritize healthy ecosystems, we safeguard our own well-being [5, 6, 69].

However, these days, climate change denials and unscientific beliefs against the reality of climate change's causes and impacts are growing. They are saying that human-caused climate change is not real; instead, it is natural, normal, good for us, and has happened at other points in history [6, 41, 87]. As the perceptions and psychological reasons for the denial and acceptance of human-caused climate change are vital for the achievement of efforts to address it, the following hypotheses are formulated based on these scenarios:

H3: During the pandemic, transport users perceive that climate change or global warming is anthropogenic and real, than saying human-caused climate change is not real.

H4: If the climate change/global warming is realized as a threat to humans (both themselves and others), then transport user people perceive it more so to themselves than to others.

Various studies show that the COVID-19 pandemic is seen as a new opportunity for the environment because it has led to numerous positive impacts, such as reductions in noise and emissions of GHGs and enhanced air and water quality in urban areas [88–91]. On the other hand, the pandemic is seen as a threat not only to the socioeconomic conditions of all humanity but also to the environment due to its negative effects, such as increased shoreline pollution, hospital, and household waste, and reduced recycling practices [91, 92].

The contribution of the pandemic to the enhancement of EAV has not been well-studied so far. However, some literature confirms that there is untapped potential and opportunity that can impact people's environmental awareness, and the positive environmental effects of the pandemic can serve as an example of changes in society's way of life [93, 94].

Ruiu et al. [69], Sarkis et al. [89], and Cohen [95] present a new existing link between the pandemic and environmental awareness, in which a window of opportunity opens up to accelerate environmental awareness toward broader sustainability transitions during and after the COVID-19 pandemic.

According to Wu and Chang [31], Murray and Schaller [32], and Vess and Arndt [33], since the COVID-19 pandemic is so well-known, group members are more likely to comply due to the pathogen's danger; the perceived risks of the pandemic infections and related deaths may increase environmental awareness. These emotional consequences may increase EAVs, together with the scientific evidence that the pandemic emerged as a result of human environmental devastation. Based on these scenarios, the following hypothesis is developed:

H5: The COVID-19 pandemic has enhanced the EAV of the transport user people, mainly during the pandemic than before.

H6: The results in H1–H5 are stronger for participants who had used or had thought about using public transportation than those who had used or had thought about using private transportation, mainly with ICE vehicles.

Studies such as Cahyanto et al. [96] also confirm that perceptions of travel risks in risky periods and situations have a big impact on people's decision-making, such as choices on transport mode options and reducing or avoiding travel. Travel risk

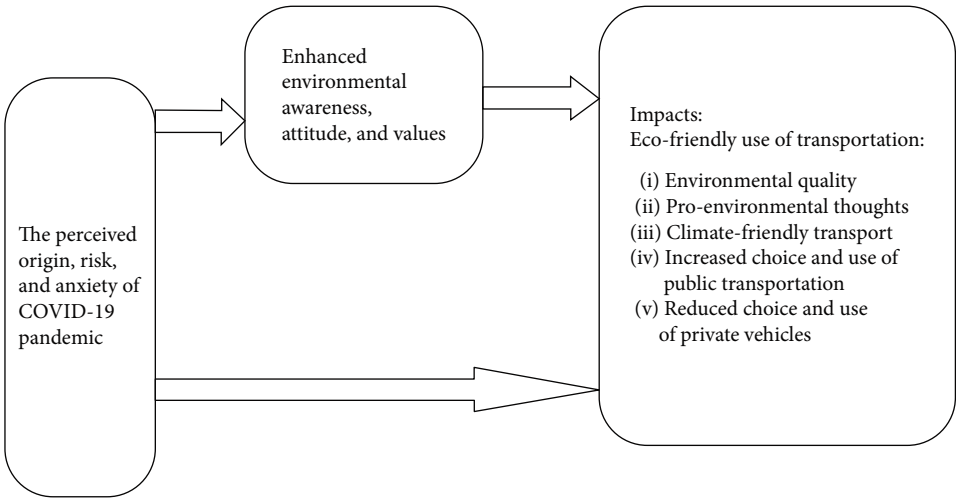

Figure 3: Conceptual framework: causal links b/n independent, mediating, and dependent variables. Source: Researcher's work (2022) (present study). N.B: this conceptual framework shows the causal links between independent, mediating, and dependent variables, including the COVID-19 pandemic, environmental awareness, and eco-friendly use of transportation, such as public transportation, respectively.

perceptions are the main factor in discouraging or encouraging certain transport use behaviors and travel decisions [97].

Moges and Mitiku [98] also confirmed that the clear and latent attitudinal variables of the pandemic and the associated response measures hugely impacted urban settings, travel and mobility behaviors, and specifically, the choice and use of both private and public transport modes. People who identify themselves as greener and care more about the environment are more likely to choose and use eco-friendly and environmentally sustainable means of transportation, such as electric cars, public transit, and others [25, 99].

According to Ajzen [100], the TPB has been extensively adopted in transport research to understand travel behavior and attitudes, which constitute a well-established determinant of travel choices in the context of this theory. Accordingly, compared to their travel behavior before the pandemic, people will have more future travel willingness and intentions with public transport. These higher future travel willingness and intentions with public transport will be affected mainly by the type of attitudes toward the operational performance of public transport in the post-pandemic era [101]. Owing to these facts, the following hypothesis is developed:

H7: The outbreak of the COVID-19 pandemic has positively affected transport user people to give greater concern and consideration to the choice and use of public transportation than private transportation use.

The protection motivation theory and existing literature assume that people's perception of risk is based on their cognitive assessment of its seriousness, whereas the severities of indicators of risk reflect their awareness of serious circumstances. This means that when the seriousness, vulnerability, and severity levels of transport systems are perceived to be higher, travel risk perceptions are the main factor discouraging the choices for and uses of certain transport types in risky situations, such as the pandemic period [97, 102–105].

Bouman et al. [34, 35], Helm [25], and Ruiu et al. [69] also confirmed that people naturally and instinctively correlate COVID-19 pandemic issues with environmental factors and are well aware of the imminent danger that COVID-19 poses to them personally. Since the results are total risk aversion and uncertainty, personal standards and moral obligations are impacted by such a mental state. As a result, their awareness and concern for environmental quality may improve.

According to Lewin's behavior model, as behavior is the product of the interaction between the individual and the environment, enhanced EAVs make people more conscious of the environment, inculcating a pro-environmental behavior in them [46, 48, 51].

Therefore, these relevant theories, models, and concepts were empirically considered in the current study to design and test the 8th hypothesis and a conceptual, casual model framework (Figure 3) indicated below:

H8: The perceived risk of the COVID-19 pandemic (variable—*A*) has affected transport user people to give greater concern and consideration to the use of public transportation (variable—*C*), such that the total effect is mediated by enhanced EAV (variable—*B*). It is hypothesized that EAVs are strengthened by the COVID-19 pandemic risk anxiety. And EAV is the main driver behind environmental quality through eco-friendly mobility behavior and actions (i.e., choice and use of public transportation) among people during the pandemic than before.

The hypothesis sought to understand EAV as a pathway through which the association between perceived of risks of the COVID-19 pandemic (COVID-19) and the usage of eco-friendly and sustainable transport options (STU) that could be explained among transport user people of in urban areas of Ethiopia. Considering various evidences and literature, it is hypothesized that the positive association between COVID-19 and is significantly mediated by EAV such that the association is strong for transport users with high EAV scores and weak for those with low EAV scores. As a result, the enhanced EAV is crucial to the usage of eco-friendly and STU, mainly public transportation (which is vital for better climate and environmental quality) in urban communities with perception of and exposure to risks of the COVID-19 pandemic.

The conceptual casual model framework in Figure 3 is developed with three major variables: anxiety about the perceived risk of the COVID-19 pandemic (independent variable; see H1), the actual and intended use of public transportation (dependent variable; see H6), and the enhancement of EAV (mediator variable; see H5).

Based on the conceptual framework, the findings of each hypothesis were cross-checked and linked with the relevant concepts and theories. To this end, the hypotheses were tested by an empirical survey on the perceptions and actions of public and private transportation user peoples on their daily transport mode choice and use in urban areas.

Mainly for the H3, H4, and H5, comparisons to the past (EAV before the outbreak of the pandemic in March 2020) were made to assess and indicate whether EAV has changed during the pandemic or not. Using the key hypotheses, another comparative analysis was also applied between participants who had used or had thought about using public transportation compared to those who had used or had thought about using private transportation, mainly with ICE vehicles. These comparisons and hypothesis testing were done basically to increase the validity and quality of findings. So that these hypotheses could state that the results are not due to chance and also significant in terms of supporting related debates, concepts, and the theory.

3. Materials and Methods

3.1. Sampling Design and Validity. Literature shows that sampling design and strategies are directly related to sampling validity, population validity, and external validity. Sampling choices and strategies can introduce a variety of biases into research findings that reduce the external validity of samples. Sampling validity refers to how well the sample represents the population under study. Although random sampling is the ideal way to achieve sampling validity, random sampling is not always feasible or practical, so one may need to use other alternative methods, including stratified sampling, cluster sampling, convenience sampling, or a combination of both. Perhaps the most important aspect of sampling equations and strategies is that the larger the sample, the larger the sampling validity [106–108].

Due to this fact, researchers' choices in selecting sampling design, sampling frames, and sampling participants need to be clearly articulated. Particularly for this transport survey carried out on the transport service user people (who are mobile in nature with no fixed location address) of a large city, obtaining a perfectly random sample is usually hard and impractical. This is because establishing a sampling frame or having a list of exact figures and locations of all public transport user individuals and selecting random samples using random numbers was difficult or impossible. This was absurd; other feasible sampling methods were used instead.

The best the author could do is to find representative samples by selecting a sample reasonably large and diverse enough to be somewhat representative of the diversity in the population. This means those in the sample were not likely to be different than those not in the sample, at least for the variables of interest and to produce precise estimates. The best compromise was to apply a combination of random, nonrandom, and representative sampling designs, including stratified, simple random, convenience, and judgment samplings intermittently, as well as a scientifically estimated sample size using a valid formula.

These sampling instruments targeted public transport (mainly city buses, midi buses, minibuses, and AALRT) and private vehicle users in urban settings, particularly Addis Ababa city, as the study population. The population from which the samples were taken was not homogenous mainly in their transport use experiences and behaviors. Hence, samples were initially stratified into homogeneous classes to achieve groups with similar characteristics (in terms of transport use experience and behavior) and get an accurate representation.

The reasons why stratified sampling was chosen were: the study population was not homogenous; the need to remove observer and selection bias; the application of statistical tests required reasonably randomly collected data; the need to cover a large area quickly; time and resources were very limited; and it allowed comparison and segment analysis of results between sample groups or strata.

To obtain stratified random samples from the city mainly for the survey questionnaires, the following approaches and procedures were applied:

Step 1: The study populations in the city were divided into two homogenous strata, i.e., public transport users and private vehicle users, which were stratified by the typical transportation choice and use behavior of the person.

Step 2: A sample size of 384 (which was later adjusted) was scientifically estimated using a formula from Cochran's [109] for the infinite or unknown study population with a 95% confidence level, and this sample size was proportionally divided for both strata. As indicated in the transport modal share of the city, there is a difference of about 20% between the share of public transport (31%) and private vehicles (about 10%). Thus, 80% (i.e., 307) of the sample size was made from public transport user segments and 20% (i.e., 77) from private vehicle user segments.

Step 3: From a total of about nine transport terminals in the city, six were randomly selected.

Step 4: Out of the about 30 corridors/streets of the six terminals, 18 were randomly selected. Such a strategy ensured that the sample locations were spread randomly throughout the study area and that all terminals, corridors, or streets were given equal chances of being chosen.

Step 5: Finally, representative samples of both types of transport users were chosen from 18 corridors or streets using segmentation analysis, convenience, and judgment sampling intermittently, according to the criteria of convenience, availability, and accessibility.

The selection factors were an age of above 18 regardless of other demographic backgrounds, the public and private transport use experience of about 2 years before and after March 2020 in the city, and the ability of both types of transport users to provide information about their use experience for the period before March 2020 (the pre-COVID-19

Table 1: Operationalization of variables.

Variables	Variable type	Measurement level
Actually used mode for mobility (public vs. private transport)	Variables of interest	Nominal and binary
Use intentions for mobility (public vs. private transport)	Variables of interest	
The COVID-19 pandemic is a risk (mode and speed of transmission, infection, death, and recovery rates) to me	Observed variables: for perceived risks of COVID-19 pandemic, as independent variable	Ordinal/7-point Likert scale
The COVID-19 pandemic is a risk to others		
Environmental degradation caused COVID-19 pandemic	Observed variables: for environmental awareness and values, as mediator variable	Ordinal/7-point Likert scale
Climate change is anthropogenic		
Climate change/global warming is a risk to me		
Climate change/global warming is a risk to others		
My transport mode usage helped to reduce CO_2 emissions	Observed variables: for sustainable transport use behavior, as dependent variable	Ordinal/7-point Likert scale
My transport mode usage improved air quality		
My transport mode usage helped to decrease noise		
The environmental sustainability of my transport mode usage has increased significantly		
The range/variety of my transport mode usage has increased significantly		

Source: Researcher's work (2022) (present study).

period) based on memory compared to their experience since March 2020 (during the COVID-19 pandemic period).

The ability to predict the typical transport use behavior in the next 2 years was also essential. Those who did not meet the criteria were filtered out at the very beginning of the survey, as they were considered not mature enough to respond to the questionnaire. These baseline data were used to ensure that the chosen samples fit the right criteria.

To improve the validity of sampling instruments and avoid sampling validity errors, training and monitoring of data collectors were done to ensure representativeness (such as age, sex, educational status, transport use behavior, etc.), consistency, and accuracy. Expert and researcher consultation was applied, and common mistakes such as sampling bias, sampling error, population specification error, ecological fallacy, and cross-population generalization were well considered and addressed. Statistical conclusion validity was also achieved by ensuring adequate sampling procedures.

Even though the results from this sampling design may not fully generalize to the intended population, the results could generalize to the population that the sample did represent. Overall, the sampling design and instruments chosen for the study were determined to be reasonably valid. The sampling techniques also ensured obtaining a sample that could achieve the aims and objectives of the study. It is believed that this choice realistically produced a sample that could enable the researcher to reach the research aim of determining the mediating role of enhanced environmental awareness for the development of sustainable and eco-friendly transport use behavior among urban transport users in Addis Ababa, Ethiopia, during the COVID-19 period.

3.2. Data Collection. A mixed-methods research approach was ideal for this study, providing both quantitative and qualitative evidence. Particularly, a sequential mixed approach (first a close-ended questionnaire and then a semi-structured interview) was more suitable to obtain different but complementary data on the topic than using a single research approach. In addition to the use of secondary data, a cross-sectional survey was applied to collect primary data by administering questionnaires only to about 460 participants who had used or had thought about using transport services within the last 2 years since the outbreak of the pandemic in March 2020.

The questionnaire was developed based on the proposed hypotheses and relevant variables (Table 1). The first question assessed whether people used transportation services or had thought about using them. Then, the type of transport service (public or private transportation) was asked. Subsequently, the participants indicated their feelings toward the COVID-19 pandemic as a danger to themselves and to others. To obtain the most reliable results, the participants were also asked whether they had already been infected with COVID-19 or died due to the pandemic.

Based on the considerations of relevant theories, models, and conceptual assumptions of literatures such as Bouman et al. [34, 35] and Helm [25], the survey continued with a question regarding the participants' awareness that COVID-19 could have been caused by deforestation and environmental destruction. Further questions were asked for the participants' opinions about global warming and whether it is caused by humans or not. They could state whether they see global warming as a danger to themselves or to others.

To assess the final outcome variables, the participants were asked whether the COVID-19 pandemic had strengthened their environmental awareness. Those who had used or had thought about using public transportation were asked whether the outbreak of the pandemic had caused them to give greater concern and consideration to the use of public transportation as an eco-friendly mobility option.

As shown in Table 1, Except for the questions regarding personal infection status and transport modal choice, which are

binary in nature (answered YES or NO), the other items were assessed on a 7-point Likert scale (i.e., 1 = "strongly disagree," 2 = "disagree," 3 = "somewhat disagree," 4 = "neutral," 5 = "somewhat agree," 6 = "agree," and 7 = "strongly agree").

Researchers do not agree with the appropriate number of points on the Likert scale. Literature specifies that the progressive structure of Likert scales from 3 to 5 and to 7 is typically such that each successive Likert item is treated as indicating a better response than the preceding value. Nunnally [110] suggests that having more scale points is better, but there is a diminishing return after around 11 points.

Thus, the 7-point Likert scale is believed to be the most accurate of the Likert scales as it captures the best sentiment of the respondent. Using seven points is more likely to have a good balance between having enough points of discrimination without having to maintain too many response options. It also delivers more data points to run statistical information and better accuracy in the results for more complex and stronger inferential statistics analysis tools such as SEM and bivariate correlational analyses.

The responses were recorded on the 7-point Likert scale, as it is more sensitive to get an observation with more details and descriptions of test information. It also enabled respondents to provide relatively more self-reflection and more accurate feedback than in the five-response category. As the total number of question items in this study is adjusted to not be excessive and reduced to a manageable level, the complexity of the application phase and the bias in response style, which usually arise from a 7-point Likert scale, are found to be minor and insignificant. Even though using a 5-point scale is simpler, there is less response error on a 7-point Likert scale than on a 5-point scale.

Thus, the total number of question items is well considered and limited to address the weak side, mainly the complexity or boredom of the use of a 7-point Likert scale for respondents. Accordingly, the strong sides and advantages of the 7-point Likert scale are given priority by significantly minimizing their weak points.

Additionally, some control questions were asked considering the assumptions of Soyez [111] and Soyez et al. [112], and some demographic variables were derived. These included the environmental concern factor, which involved about five items and a new scale to assess the environmental attractiveness of public transportation to the participants.

These additional items were: "public transportation vehicles help to reduce CO_2 emissions," "public transportation improves air quality in urban areas," "public transportation helps to reduce noise," and "the range of public transportation modes has increased significantly." They were chosen as concern factors for the attractiveness of the public transits and measures of the sustainable transport use behavior, which is a latent dependent variable. All the survey questions are structured based on the operationalization of the variables indicated in Table 1. The survey was administered on about 460 samples. As suggested by literatures such as [113, 114], the potential nonresponse rate because of respondent's refusal or lack of cooperation can dealt by making up to 20% increase in the participation of survey respondents. Nilima [115] also showed that final sample size = effective sample size/(1 − nonresponse rate anticipated).

Though the computed minimum sample size was 384, this number was adjusted to 460, considering the large population size of the city and the anticipated high probability (about 20%) of nonresponse rates in such kinds of onboard, transport, and online surveys. Since the sample size is determined by a scientific formula and based on the desired accuracy of a 95% width of the confidence interval, its sufficiency for such a quantitative survey is justified.

Through the attainment of data saturation, the collection of qualitative data was carried out from the purposively selected 15 interviewees, who are composed of experts, managers, operators, and typical passengers. Even though the passengers who were simply available and accessible on board, at stations or streets during the time of the surveys were selected to participate, the trained survey moderators could consider the composition and proportion of samples from various demographic backgrounds with the collaboration of public transport operators and staff.

The questionnaires were translated into the local language, and surveys were conducted from February 1, 2022 to April 20, 2022, during peak and off-peak hours, weekdays, and weekends, all to increase data representativeness and validity. Online surveys were also applied to those who had email and internet access. Since these question items are very personal health-related sensitive questions, the ethical guidelines of voluntary participation, anonymity, and informed consent were followed.

3.3. Data Analysis. After the data were processed, descriptive statistics were applied using percentage, mean, and frequency to analyze the data through IBM SPSS Statistics (Version 24) software. A pre- and postcomparative impact analysis was applied to determine statistical significance levels and differences among various groups of observations, such as agreement levels between public and private transportation users and before and after the pandemic.

A retrospective pretest analysis design was used to make pre- and post-COVID-19 outbreak scenario measurements. Literatures such as [116, 117] revealed that in this design, participants report more easily and significantly when the reference period is shorter because it requires shorter time memories. By capturing factual or routine information this design is better for situations that include measuring change over a very short period. It is also appropriate to gauge perceptions of change without having collected baseline data before and to diminish response-shift bias.

As March 2020 was the date on which the first case of COVID-19 was reported and a national state of emergency was declared in the country, this date was used as a timeline for pre- and post-COVID-19 analysis. A period of 2 years was equally used for the temporal comparison of before and after March 2020.

Thus, since there are no similar "before" studies and the length of the reference period is shorter to easily memorize past situations, the historical review for data about the pre-COVID-19 period is based on the memories of participants.

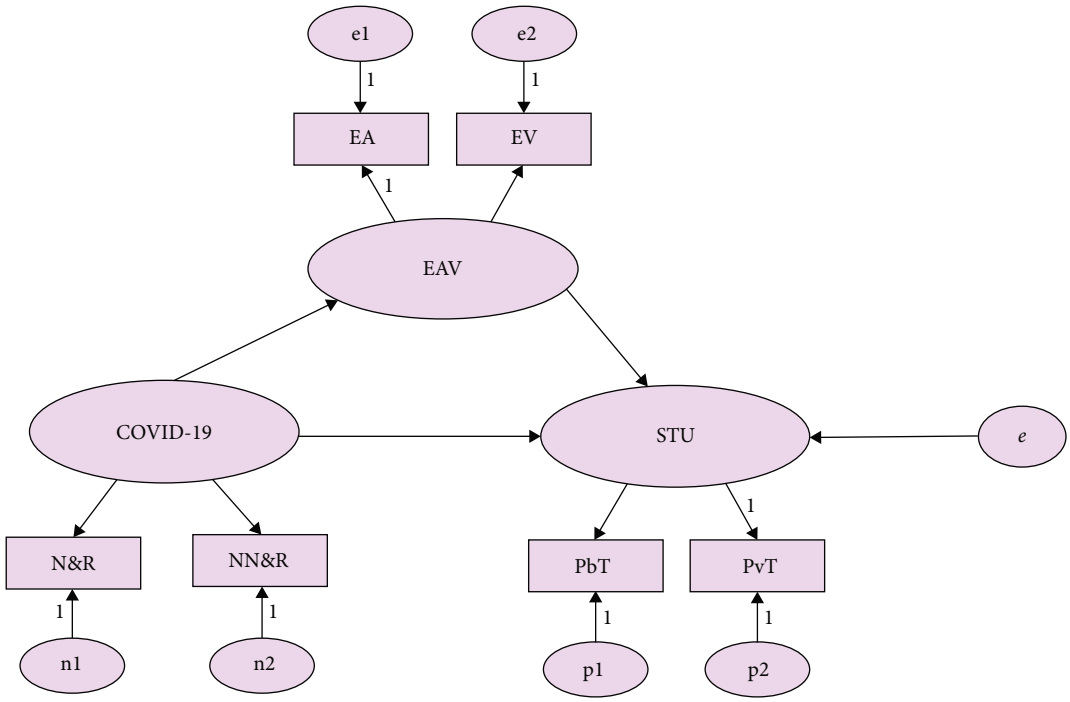

Figure 4: Path diagram of SEM showing the observed and latent variables as well as the direct and indirect effects on preassumed causal relationships. Source: computation using my own survey data (present study). COVID = the perceived risks of COVID-19 pandemic. EAVs = environmental awareness and values. STU = sustainable transport use behaviors (H8). N&R = COVID-19 is originated from nature's destruction by humans and risky to me (H1, H2, H3, and H4). NN&R = COVID-19 is not originated from nature's destruction by humans and not risky to me. EA = environmental awareness enhanced (H5, H6, and H7). EV = environmental values enhanced (H5, H6, and H7). PbT = public transportation use behaviors increased (H6, H7, and H8). PvT = private transportation (with ICE) use behaviors increased. e = total errors.

This means that assumptions about the environmental awareness and concern of participants in the pre-COVID-19 period are not directly tested.

These comparative analyses were used on the basis of "actually used" transport types and "use intentions" for daily mobility using the Wilcoxon signed-rank test. Further inferential statistical analyses were performed with hypothesis testing, structural equation modeling (SEM), and structural causal model analysis to estimate the casual relationships and impacts among the proposed independent, mediator, and dependent variables. Accordingly, valid causal inferences were made among the basic variables involved in H8. In addition, the qualitative data obtained from key interview informants were analyzed using thematic narrative analysis based on the relevant themes.

3.3.1. SEM. SEM is a powerful statistical technique used to test and evaluate the eighth hypothesis, multivariate causal relationships, and complex relationships among observed and latent variables using path analysis and a path diagram. This is because the common function of path analysis, i.e., mediation, assumes that a variable can influence an outcome directly and indirectly through another variable. SEM also differs from other modeling approaches as it tests the direct and indirect effects on preassumed causal relationships using AMOS software.

In this basic usage of SEM through path analysis with mediation, the causal relationships include both indirect and direct effects among the three latent variables. The acronym in the models, particularly EAVs, is a latent variable hypothesized as a mediator that intervenes with the causal relationships. The acronym COVID-19 (the perceived risks of the COVID-19 pandemic) is a latent variable acting as an independent variable, while STU (sustainable transport use behaviors) is a latent variable acting as a dependent variable.

Measuring an abstract concept, i.e., a latent variable, such as the COVID-19 pandemic, climate change, environmental awareness, sustainable transport, perception, behavior change, etc., can pose a problem for behavioral and ecological research. While direct measurements or units for these abstract concepts may not exist, statistical methods can derive these values from other related variables. As indicated in Figure 4, SEM measures each latent variable based on their observed variables. The latent variable, COVID-19, was measured in terms of mode and speed of transmission, infection, death, and recovery rates of the COVID-19 pandemic to oneself and others in the study area.

The latent variable, EAV, was also measured in terms of environmental degradation caused by the COVID-19 pandemic; climate change is anthropogenic; climate change/global warming is a risk to me; and climate change/global warming is a risk to others.

Variables such as my transport mode usage helped to reduce CO_2 emissions; my transport mode usage improved air quality; my transport mode usage helped to decrease noise; the environmental sustainability of my transport mode usage

Table 2: Demographic background of participants.

City	N	Sex		Age (mean)	Educational status				
		Male	Female		Illiterate (%)	Primary education (%)	Secondary education (%)	Diploma (%)	First Degree and above (%)
Addis Ababa	413	235	178	42	7	12	26	33	22

Source: Computation using my own survey data (present study).

Table 3: Travel behavior and experience of respondents.

Actually used mode in the last 2 years				Use intentions for the next 2 years			
Public transport	Private transport		Others	Public transport	Private transport		Others
	ICE vehicles	EV			ICE vehicles	EV	
305	50	17	41	285	58	33	37

N.B: Same participants ($N = 413$) were allowed to answer both questions (for actually used and use intentions). Source: Field survey (2022).

has increased significantly; and the range or variety of my transport mode usage has increased significantly were the observed variables used to measure STU or sustainable transport use behavior of public transport mode. The selection of the appropriate variables was initially carried out using confirmatory factor analysis (CFA).

Accordingly, the effect of COVID-19 on STU is the direct effect (i.e., *c*), while the effect of COVID-19 on STU via EAV is the indirect effect (Figure 4). Consequently, the total effect is the direct effect plus the indirect effect. Path analysis with mediation was applied, considering its theoretical and statistical assumptions. This means the independent and dependent variables are chronologically correlated, and the model is recursive, in which the causal relationship and causal dependency are unidirectional.

4. Results

A well-designed participant information sheet was prepared, and in all study sites, a total of about 460 individuals, believed to be users of both public and private transportation services by the survey moderators, accepted the invitation to participate in the survey. However, around 10.3% of the questionnaires were found to be invalid, and they were rejected because the participants did not actually use or think about using both public and private transportation modes for about 2 years before and after the outbreak of the COVID-19 pandemic (i.e., March 2020).

This helped to compare the actually used modes and use intentions of transport types for mobility of participants. Accordingly, 413 questionnaires (nearly 89.7%) were found to be well-completed and valid for analysis after being processed and edited.

The final SEM results, quality, and robustness of the model and estimates were ensured after the assumptions of SEM, such as normality, linearity, and multicollinearity, were checked. The reliability and validity of the measurement model, mainly SEM, were achieved through indicators such as Cronbach's alpha, CFA, and others. A Cronbach's alpha test was performed on the questionnaire with nine items for measuring internal validity based on Cronbach's alpha coefficient and other criteria. As a result, Cronbach's alpha was found to be 0.803, which indicated a high level of internal consistency and validity for the scale. The CFA, which was also run before the application of SCM and SEM, reveals that the constructs are distinct.

The results shown in Table 2 indicate that the samples were fairly balanced between males (about 57%) and females (43%). Regarding the composition of participants based on their levels of education, the majority (55%) of them had diplomas and first degrees (with 33% and 22%, respectively).

Secondary education-completed participants also accounted for 26%; 12% were with primary education, and the group of illiterates accounted for only 7%. Besides, the average age of the participants was found to be 42 years. Thus, the samples and data set were believed to be representative and adequate for the survey.

To estimate the changes in the transport usage, mobility behavior, and related environmental awareness of participants, they were asked two questions: which transportation mode has been predominantly used since the outbreak of the pandemic, and which mode do you intend to predominantly use in the future? Accordingly, Table 3 revealed that in the last about 2 years (or since the outbreak of the pandemic), the predominant modes of transportation actually used by about 305 (or 74%), 67 (or 16%), and 41 (or 10%) of participants were public transportation, private transportation, and other modes, respectively.

In the group of actual private transportation users, internal combustion engine (ICE) vehicles accounted for 12%, and electric vehicles accounted for 4%. Besides, about 285 (or 69%), 91 (or 22%), and 37 (or 9%) of the participants showed use intentions (in the coming 2 years) for public transportation, private transportation, and other modes, respectively. In the group of potential or future private transportation users, ICE vehicles accounted for 14%, and electric vehicles accounted for 8%.

More specifically, in the group of actual transport users during the pandemic, public transportation modes accounted for 74%, and in the group of future or potential transport users, they accounted for 69%. Even though the overall use of public transportation will slightly reduce (from 74% to 69%) in the next 2 years, both the actual use and use

Table 4: COVID-19 anxiety, climate change awareness, and sustainable travel behavior.

Variables	Agreement levels			
	Public transport users	Private vehicle users	Mean	Significance of the difference
COVID-19 pandemic is a risk to me	4.86	4.63	4.74	$p = 0.051$
COVID-19 pandemic is a risk to others	5.58	5.34	5.46	$p < 0.001$
Environmental degradation caused COVID-19	5.74	5.38	5.56	$p < 0.001$
Climate change/global warming is anthropogenic	6.45	6.06	6.25	$p < 0.001$
Climate change/global warming is a risk to me	5.53	5.11	5.32	$p < 0.001$
Climate change/global warming is a risk to others	5.84	5.42	5.63	$p < 0.01$
Environment concern for the attractiveness of the transport they use	5.48	4.29	4.88	$p < 0.001$
COVID-19 pandemic enhanced my environmental awareness	5.71	4.01	4.86	$p < 0.01$
Public transportation modes are friendly to the environment	6.10	—	—	$p < 0.01$

N.B: Data were generated from the answers given on a 7-point Likert scale ranging from 1 = strongly disagree to 7 = strongly agree. Source: Field survey (2022).

Table 5: The summary of results of the final path analysis of SEM.

$r(A, B)$	$r(B, C)$	$r(A, C)$	Indirect effect $r(A, B) \times r(B, C)$	Direct effect $r(A, C)$	Total effect	N	Sig. value	R^2
0.56	0.78	0.06	0.43	0.06	0.49	285	$p < 0.001$	0.57

Source: Field survey (2022).

intentions of public transportation account for the largest proportion. Results also revealed the proportion of use of electric vehicles will double (from 4% to 8%) in the next 2 years, though it accounted for a much smaller proportion compared to public transport modes.

In Table 4, it is demonstrated that both kinds of participants somewhat agreed that the COVID-19 pandemic is a risk to them personally, with an overall average value of 4.74. The difference in agreement level between both groups was also statistically significant ($p < .001$).

Accordingly, for private vehicle user groups, this value was lower (4.63) but higher for public transportation user groups (4.86).

On the other hand, for the view of participants that the COVID-19 pandemic is a risk to others, these values were higher, i.e., 5.58 and 5.34 for public transportation users and private vehicle users, respectively.

Thus, this result supports H1, and people perceived the COVID-19 pandemic as more of a risk to others than to themselves. Even though most participants overall agreed that environmental degradation caused the COVID-19 pandemic (mean value of 5.56), the value was higher for public transportation users compared to private vehicle users. This finding is consistent with H2. Regarding the perception that climate change or global warming is anthropogenic (i.e., caused by human activities), there was an even higher agreement level (mean value of 6.25) for both groups, which supports H3.

Accordingly, the participants agreed that this climate change or global warming is a risk to them personally (mean value of 5.32), and more specifically, the values are 5.53 and 5.11 for public transportation and private vehicle users, respectively. However, the agreement levels of participants are higher for the variable that global warming is a risk to others, with a mean value of 5.63. Thus, evidence supports H4, and it showed that the majority of people really perceived climate change or global warming as a risk, but more as a risk to others than to themselves.

Table 4 also reveals that the majority of the respondents specified that the COVID-19 pandemic and associated risks increased their awareness of the environment and their concern for the environmental attractiveness of the transport they use (4.86 and 4.88, respectively). Thus, these findings were found to be in line with H5. Overall, the evidence in Table 4 shows that the above effects are statistically significant and stronger for public transportation than for private vehicles. These findings could also support H6 at $p < 0.001$. Statistically significant differences were seen between public transportation and private vehicles for the level of agreement regarding the seventh variable.

Those respondents who had used or had thought about using public transportation modes more agreed that the outbreak of the pandemic had caused them to give greater consideration to the environmentally attractiveness of the use of public transportation (with a value of 5.48), which supports H7. These levels of agreement among participants during the pandemic were compared with their corresponding levels before the outbreak of the pandemic (before March 2020). Accordingly, levels of agreement during the pandemic were found to be stronger than before the pandemic.

As indicated in Table 5 and Figure 5, H1, H5, H7, and H8 were further analyzed and tested using path analysis of SEM to estimate correlations and make causal inferences among the variables of interest. These variables were: I perceive the COVID-19 pandemic as a risk mainly to me (denoted by a and COVID-19); the COVID-19 pandemic and associated risks have increased

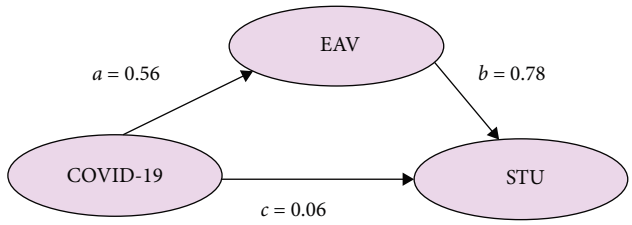

Figure 5: The final path analysis with mediation of the model. Source: computation using my own survey data (present study). COVID = the perceived risks of COVID-19 pandemic. EAVs = environmental awareness and values. STU = sustainable (or eco-friendly) transport use behaviors.

my awareness of environmental thoughts (denoted by *b* and EAV); and the COVID-19 pandemic risks have caused me to take personal climate-friendly measures, including making the use of public transportation a priority (denoted by *c* and STU).

In this model, "*A*" refers to the exogenous independent variable because it is clearly caused by the COVID-19 pandemic crisis, which is an external shock. "*C*" refers to the dependent variable or end result with regard to the environmental concern for the actual and intended use of public transportation for mobility.

In addition, "*B*" represents the enhancement of environmental awareness as a mediating variable between "*A*" and "*C*." The dataset obtained from those participants who had used and had thought about future use of public transportation ($N = 285$) was included in the model with mediation.

According to the final SEM results, the model was significant and explained 57% of the variation in the data, which is reasonably valid and fit (Sig. = 0.01, $R^2 = 0.57$). Accordingly, the three hypothesis test results are found to be significantly and positively correlated in the public transportation users group: $r(A, B) = 0.56$, $r(A, C) = 0.06$, $r(B, C) = 0.78$, and all $p < 0.001$.

The correlations among the three variables were also statistically significant at $p = 0.01$, and the overall type of correlation among them was positive and strong ($r = 0.942$ for *A* with *B*; $r = 0.918$ for *A* with *C*; and $r = 0.973$ for *B* with *C*). In addition, the correlation of each of the demographic data (sex, educational status, and age) with the responses of each of the above three variables (*A*, *B*, and *C*) was also found to be statistically significant at $p = 0.01$. These correlation coefficients show that the hypotheses and assumptions of path analysis are accepted because the types of correlations among "*A*," "*B*," and "*C*" are positive and strong, mainly for (*A*, *B*) and (*B*, *C*). The final model was also found to be recursive, i.e., the causal relationship and causal dependency are unidirectional.

Regarding the mediation analysis based on the final model results, the indirect effect (i.e., *A* on *C* via *B*) was computed to be 0.43 (i.e., 0.56×0.78), while the direct effect, or *A* to *C*, was 0.06 (which is weaker), and consequently, the total effect (direct effect plus indirect effect) was computed to be 0.49. It is found that pro-environmental behavior have encouraged by the increase in environmental awareness. For example, adding the increase in environmental awareness as a mediator (*B*) reduces the total effect of (*A*) on (*C*) to only 0.06. Nevertheless, the indirect effect (i.e., via environmental awareness) accounts for the remainder of the total effect, with a value of 0.43, and the total effect of "*A*" on "*C*" is equal to 0.49.

As indicated by the outputs of the final SEM in Figure 5, the three latent variables were tested to estimate and validate the strength of the linear causal relationships and mediation. As a result, a significant causal relationship and mediation outputs were observed. The effect of COVID-19 on the STU (i.e., *c*) and on the EAV (i.e., *a*) is $r = 0.06$ and $r = 0.56$, respectively, whereas the effect of EAV on the STU (i.e., *b*) is found to be $r = 0.78$. The reason that COVID-19 causes STU is because COVID-19 generates EAV, and EAV impacts STU. The effect that COVID-19 (or *A*) has on STU (or *C*) was really found to be because of EAV (or *B*). This means that the true driver of the choice and use of public transportation services is the rise in the EAVs of passengers, which is caused by the perceived risks of the COVID-19 pandemic.

Qualitative findings from most of the informants ($n = 13$) also revealed that environmental and climate change awareness is enhanced by the risks of the pandemic, and thus, they usually prefer public transportation to private vehicles. However, they pointed out that the limited availability and supply of public transportation services, weak pandemic control measures, and other government restrictions during the pandemic period were strong barriers for even the greenest-minded individuals to adequately use the services of public transportation. This finding really supports H8. Thus, the total effect of the COVID-19 pandemic and related risk anxiety on the use of public transportation is completely mediated because this effect is no longer significant.

In addition to the Cronbach's alpha test and use of control variables for validity checks, the study could consider possible sources of bias. For instance, one major business concern with the data exclusively obtained from such a cross-sectional survey is the interdependency of commonly assessed answers among respondents. This means an answer could have been biased by preceding answers. For example, in Table 4, this could mean that a high score for anxiety on COVID-19 pandemic risks could lead to high scores displaying an increase in environmental awareness, which in turn could have increased the intention to consider using public transport or private vehicles.

To test whether the results could have been biased by preceding answers, the question regarding potential public transportation use was placed at the end of the original questionnaires used for this analysis, whereas this similar question was placed at the beginning of the questionnaire in a pilot study (used as a control survey) conducted with other participants. Thus, as the results of both questionnaires were similar, there was no worry about possible bias in the findings.

Furthermore, the nine variables were also significantly related to each other, some more strongly than others. Their correlations with concerns and awareness about climate change or global warming show consistency. Of course, environmental awareness, value, and concern issue is a snapshot

in time, and drawing conclusions regarding how it changed during the pandemic may be difficult. But, from the correlation seen among the selected variables (mainly the enhanced awareness of climate change or the environment), it can be concluded that the more the COVID-19 pandemic increased climate change or environmental awareness, the higher the environmental concern should be.

The results, mainly from the public transport group, are also consistent and plausible since the higher the environmental awareness, concern, and values, the more public transport vehicles are appreciated as eco-friendly vehicles. The qualitative results obtained from the majority of the interview participants ($n = 14$) were also similar. They believe that the environmental awareness, attitude, and value of passengers are enhanced, especially because of the severity of the pandemic risks. As a result the choice and use of public transportation is relatively increased during the pandemic due to sustainability concerns. However, they showed that there are situational or external factors challenging their willingness and motivation to make eco-friendly and sustainable transport use, such as inadequate supply and quality of public transportation services in the city.

Hence, the risks of the COVID-19 pandemic, the fear of climate change or global warming and the consequent impacts on life are particularly present in Addis Ababa city. These results are plausible since the city is extremely densely populated, faced higher COVID-19 infection cases, transmission, and mortality rates, experienced a rapid increase in private vehicles, and most of the residents are still public transportation dependents, which could lead to serious problems. The fact that these are the cases that can support the assumptions of data validity in the current study.

5. Discussions and Conclusions

5.1. Theoretical and Practical Implications. Although a number of studies have been published on the topic of COVID-19 already, the focus of this study was to empirically assess the impacts of the COVID-19 pandemic on environmental factors and the nexus between the COVID-19 pandemic and environmental sustainability, mainly in the context of urban transportation.

In line with the findings of zoonosis theory, IAS Gyan [54], Johnson et al. [28], Helm et al. [25], Forster [118], Weaver et al. [119], and UNEP [6] this study revealed that environmental and biodiversity degradation factors substantially caused the outbreak of the COVID-19 pandemic. The pieces of evidence confirm that climate change, environmental degradation, and the outbreak of COVID-19 are strongly linked. The perceived risks of COVID-19 of 75% of the transport users are also found to be severe and immediate to all humanity, personally to themselves than others, which verified H1 and H2. Climate change and biodiversity degradation are really perceived as human-caused, which in turn caused the pandemic

Independent of the far-reaching message of this study, from these literatures, one must bear in mind that the COVID-19 pandemic itself has a strong connection to nature and the environment because of its perceived origin, zoonosis theory, i.e., the transmission of pathogens from animals to humans in degraded environments via zoonotic pathogens, mainly viral. A large part of the causes of COVID-19 are climate change, global warming, unsustainable agriculture, land use change, wildlife exploitation, and hazardous animal–human interfaces, all of which are environmental in nature.

Whether this connection or the psychological effects of fear and anxiety have a stronger impact on environmental awareness could not be determined in this study. However, due to the fact that the majority of participants, to some extent, believed the zoonosis spillover theory, the results are consistent with the thought that the pandemic is caused by the various kinds of environmental degradation that are the results of mainly human activities. Environmental factors could significantly influence the incidence of the pandemic.

Contrary to the findings of Franks [41] and Nerger [87], this study confirmed that more than 75% of transport user people still perceived that climate change is really and predominantly caused by human's actions and an immediate threat to all forms of life, mainly to themselves. These evidences really verified the third and fourth hypotheses.

Through the findings of the robust models, the assumption that COVID-19 has strengthened individuals' EAV was supported by the evidences that individuals with higher COVID-19 risk anxiety developed higher EAVs. In line with Sarkis et al. [89], Cohen [95], Sofo and Sofo [93], and El Zowalaty et al. [94], the fifth hypothesis was strongly verified, as the perceived risks as well as causes of the COVID-19 pandemic and climate change could promote environmental awareness, attitude and values among urban transport user people during the pandemic than before the outbreak of the pandemic.

The individuals with higher perceived risks of the pandemic and climate change also developed higher choice and use intentions with regard to eco-friendly public transportation. In line with the sixth hypothesis, the enhanced EAVs during the pandemic were stronger for participants who had used or had thought about using public transportation than those who had used or had thought about using private transportation, mainly with ICE vehicles. Public transportation vehicles are conceptualized as a substitute for private vehicles, with the difference being that they often do not generate higher emissions and are the first steps toward an emission-free, cleaner, and quieter environment. Since a shift toward more EAV could be directly observed in the study, the use of public transportation services made it possible to assess the assumptions of the selected model, theories, and concepts.

This finding is generally consistent with recent studies such as Storrow [2], Harvey [4], Rupani et al. [7], Tollefson [120], and the University of East Anglia and University of Exeter Communications [9] that indicate the reduction of carbon emissions during the pandemic due to a lower number of vehicles on the streets and, consequently, travel restrictions and lockdown measures by governments in many countries. On the other hand, there are some studies, such as [121], that notably indicate the return of carbon emissions

to near-pre-pandemic levels by the latter part of 2020 despite reduced activity in many sectors of the economy.

Based on these findings, the high correlations between the incidence and severity of the COVID-19 pandemic are measured by the incidence rate and the modal share of public transportation. In support of the seventh hypothesis, the results show that the relationship is more than a correlation since it was found to have a causal effect.

These findings were consistent with those that were concluded by Rume and Islam [122], Cox et al. [102], Kozak et al. [97], Lieven [36, 70], and Li et al. [103] which showed that when people's environmental awareness rises, they are more inclined to choose and use environmentally friendly transport such as electric vehicles and public transportation for sustainable mobility, due to the perceived efficacy and self-efficacy predictors of intentions to use. In line with the assumptions of TPB and Downey et al. [101], attitudes of individuals toward environmental quality and operational performance of public transport are the determinant factors to use intentions of sustainable transportations.

This is because people enhanced and reconceptualized their pro-environmental behavior more during the COVID-19 pandemic than before the pandemic. The increased current and future use intention of public transportation but unwillingness to use private transportation may arise from the enhanced conceptualization of pro-environmental behavior and concern.

It could be argued that people are increasingly using public transportation because of the incentives and subsidies from the government that make its service tariffs affordable. However, the control questions regarding this concern revealed that the participants preferred public transportation equally because of its environmental friendliness and governmental subsidies.

The higher the COVID-19 pandemic and perceived risks, the higher the awareness of environmental thoughts, and ultimately, the higher the environmental-friendly mobility behavior, such as making the use of public transportation a priority. The participants' cognitive, emotional, and psychological agreement with the environmental advantages of public transportation was even higher and more significant. Of course, the limited availability, quality, and supply of public transportation services, weak pandemic control measures, and other government restrictions during the pandemic period are situational factors and strong barriers for even the greenest-minded individuals. This is because, as the supply of public transportation vehicles and private transportation vehicles converges, passengers will be free to decide between the two vehicle types, and as this study has shown, eco-sensitive people prefer public transportation.

The application of SEM implies that it is a powerful multivariate analysis tool that has great potential in this multidisciplinary ecological, health, and behavioral study as public data accessibility continues to increase, representing the complex network of the urban ecosystem. This could help the study transform from being mere hypothesis-driven research to a more inductive, data-driven, and model-based study. Through the findings of the SEM and structural causal models, the assumption that the perceived risk of the COVID-19 pandemic has affected people to give greater concern and consideration to the use of public transportation is mediated by enhanced EAV, which is supported by the evidence that the effects of enhanced environmental awareness are significantly larger than the perceived risk of the COVID-19 pandemic.

The finding was similar with the assumptions of Li et al. [103], Lewin's behavior model, Bouman et al. [34, 35], and Helm [25], which indicate that enhanced EAVs make people more conscious of the environment, inculcating a pro-environmental behavior in them. Similarly, when a particular transport system is perceived to have higher vulnerability and severity levels, travel risk perceptions are the main factor discouraging the choices for and uses of such transport types in risky situations.

Transport user people strongly correlated COVID-19 pandemic issues with environmental factors and are well aware of the imminent danger that COVID-19 poses to them personally. Based on this, the reason that the COVID-19 pandemic causes the use of public transports is because the pandemic enhances EAVs. The effect that the pandemic has on public transport use behavior was really on account of the enhanced EAVs. This means that the enhanced EAVs of passengers are the true driver of the willingness and motivation to choice and use public transportation services than private vehicles, which is caused by the perceived risks of the COVID-19 pandemic.

The findings of the aforementioned studies, including Bouman et al. [35], Li and Yue [63], Olaoye [65], and Ruiu et al. [69], focused on an angle that the current study has not thought of and on insignificant aspect because they have not presented the issue under study very well. They did not explore the adoption of an eco-sustainable approach from the context of daily transport use behavior in low-income nations. The new observation and insight generated through the results of the current study show that increased need and commitment of transport user people to use public transportation as a sustainable action during the COVID-19 period are predominantly, not partly, mediated by the EAVs which are enhanced as a result of higher level perceived pandemic-related risks and anxiety in urban areas of low-income countries. This analysis will be helpful to the topic under study and advance the knowledge in the field, i.e., the nexus between the zoonosis health problems, awareness on environmental degradation and climate change, as well as sustainable and environmental-friendly transportation use behavior of people, mainly in urban areas of low-income countries during COVID-19 pandemic era. It also adds to the existing literature and arguments.

Overall, the study sought to understand EAV as a pathway through which the association between perceived of risks of the COVID-19 pandemic and the usage of eco-friendly and STU that could be explained among transport user people of in urban areas of Ethiopia. In line with the conclusions of previous studies such as Bouman et al. [35] and Ruiu et al. [69], evidences confirmed that the hypothesized positive association between perceived of risks of the

pandemic and sustainable transport use behavior was significantly mediated by EAV. Even from the context of this developing country, the association was strong for transport user people with higher EAV, and this implies that enhanced EAV is crucial to the usage of eco-friendly and STU, mainly public transportation in urban communities with perception of and exposure to risks of COVID-19 pandemic. This is ultimately vital for better climate and environmental quality, mainly in urban areas of developing countries during the pandemic and in the future.

The study findings unveil interesting and meaningful empirical evidence on the relationship between perceived risks of the COVID-19 pandemic and sustainable transport use behaviors under the mediating roles of the enhanced environmental awareness, attitude, and values/ethics. Although the prior literature provides no information about the direct impact of EAVs on sustainable transport use behaviors for environmental quality, the present study's findings still conform with the existing literature, which has deciphered that EAVs could trigger pro-environmental behavior and action, i.e., use of public transport modes, avoid use of private vehicles mainly with ICE, etc.).

5.2. Conclusion and Limitations. Regarding the proposed hypotheses, the levels of agreement of participants during the pandemic were compared with their corresponding levels of agreement before the outbreak of the pandemic (before March 2020). Of course, respondents indicated their level of agreement before the pandemic was based on memory due to the absence of similar surveys in the past and the lack of well-organized past data.

However, literature such as Heath et al. [123] supports that pre- and postprogram survey participants report more easily and significantly when the reference period is shorter because it requires shorter time memories (such as 2 years in the case of this study) for recall. Accordingly, the current study could show levels of agreement during the pandemic were found to be stronger than before the pandemic period.

The pandemic situation is not only significantly caused by the degradation of the environment, but it also enhances awareness and concern about climate change and increases the consideration of eco-friendly mobility options, including public transportation, which may assist with the restoration of the ecological system.

The current study could show the unexpected effects and lessons of the COVID-19 pandemic. However, whether environmental awareness will be strengthened by such a global crisis with no direct link to environmental causes is an open question. At this point, further research is recommended to find an answer to this question. However, the study is limited to doing so because this would require a broader study on a new global crisis.

Even though lack of role of moderators and a truly or fully random sample due to the very nature of respondents is one of the limitations of this study, based on the evidence of its robust model, it is possible to reasonably infer that even though the COVID-19 pandemic is mainly considered a threat to all humanity due to its widespread negative effects; it unexpectedly brought its own opportunities, such as the enhancement of people's awareness of ecosystem degradation, climate change, and concern for the environment.

It took a step back to ask what the pandemic could teach about how its origin is closely related to environmental degradation, how a low-emissions future might look, and how the world might get there. Therefore, the study findings reasonably inform us that urban planning and policy in the developing countries, including Ethiopia, need to consider pandemic-sensitive, adaptive, innovative, and sustainable transportation, mainly in urban areas, during the pandemic and in the future, which can fit their actual contexts.

It suggests that enhancing the environmental awareness of societies and encouraging them to protect the environment, mitigate climate change and avoid hazardous animal–human interfaces are important. For this purpose, preventive policies are advisable, such as making sure animals are not infected, preventing infection and zoonoses transmission at the regional, city, and community levels, and focusing on the environmental knowledge, safety, and health of passengers and operators. Support societies to make modal shifts and use eco-friendly transport options, mainly public transportation, through capacity building and environmental education.

This study noted that, especially in the developing countries, reducing activity in the transport, industrial, and residential sectors is not practical, mainly in the short term, as a means of cutting emissions and enhancing ecosystem quality. However, reducing emissions and enhancing ecosystem quality permanently will require the transition to low-carbon behavior and technology or maintaining pro-environmental behavior, mainly in the transport industry. Hence, the study suggests that African countries be committed to climate-friendly measures toward sustainable transport and development based on Africa's aspiration by 2063 to attain growth and a quality environment. Although the findings offer some support for the pro-environmental awareness, attitude, and values consistency hypothesis, which are more of internal cognitive, emotional, and psychological factors. They also highlight key situational or external determinant factors underlying public transport choice and use behaviors reflections that may help policymakers consider the existing situations to more effectively promote eco and environmental-friendly transport uses.

Accordingly, public transportation and electric vehicle (mainly driven by renewable energy) agencies, mainly in the developing nations, need to be provided with policy support, incentives, and subsidies to expand the provision of services with much concern for climate change and global warming. The study also suggests potential strategies, including integrated public health education, one health approach, and smart city for urban sustainability. Urban governance also needs to be urgently considered to achieve the global sustainability goals through inclusive, shared responsibility, joint interventions, and interdisciplinary approaches in areas such as the environment, public health, transport, politics, economy, etc. Further research is also required considering more random samples, the role of moderators, and wider scope.

Data Availability

Most of the data used to support the findings of this study are included within the article. Additional data sharing is not applicable to this article as no new data were created or analyzed in this study.

Disclosure

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

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