

# THE ROLE OF HUMAN CAPITAL AND EMERGING TECHNOLOGIES TO ACHIEVE THE CLIMATE NEUTRALITY GOALS IN TOURISM INDUSTRY: A REVIEW

## Abstract

Climate change poses a significant threat to all life on earth. Climate neutrality has emerged as a crucial objective to ensure the long-term survival of the earth's natural resources. Local and national authorities have implemented recent legislation to mitigate carbon emissions by compensating for alternative methods in many industries. Tourism industry, sometimes referred to as a “industry without chimney” in Turkish, generates a substantial quantity of greenhouse gases, surpassing initial projections. This study focuses on three primary factors: human capital, emerging technology, and climate neutrality. This study examines the impact of human capital and emerging technology on achieving climate neutrality, with a specific focus on the tourism industry. The existing body of research asserts that there is a connection between human capital, developing technology, and achieving climate neutrality. A study report has stated that human capital and developing technology might have both good and negative effects on the ecological system. However, the definition and idea of climatic neutrality necessitate a comprehensive comprehension, taking into account the interconnection with the other characteristics discussed in this work. In addition, despite several studies in the literature on the tourism industry, there has been limited investigation into the relationship between human capital and developing technologies in relation to climate neutrality. This study tries to evaluate and synthesize the relationship between human capital, new technologies, and climate neutrality in a concise manner. In a manner, this review study aims to establish a correlation between three key characteristics by analyzing fundamental texts that are key terms to the ecosystem. Some of the terms mentioned here are sustainability, carbon footprint, tourism industry, and awareness. Furthermore, this study asserts a robust correlation between human capital, developing technologies, and climate neutrality. Finally, the research discusses recommendations as well as theoretical and practical contributions.

**Keywords:** Sustainable Tourism, Environment Sustainability, Emerging Technology, Green Technology, Climate Technology, Climate Neutrality, Carbon Neutrality

## Introduction

Climate change poses a significant hazard to all life forms on Earth. Hence climate change is a frequently utilized term that has emerged as a buzzword across different fields in recent decades. Climate change implies periodic temperature fluctuations that lead to erratic atmospheric weather patterns or circumstances (Dietz, Shwom, & Whitley, 2020; Li, Wang, & Ho, 2011). In recent years, there has been an increasing emphasis on doing research that specifically address global climate change and environmental degradation (Baloch et al., 2023; Brown et al., 2021; Piguet, 2022). Environmental degradation encompasses a broad spectrum of detrimental consequences, such as the depletion of natural resources (Brown et al., 2021), the decline of biodiversity (Baloch et al., 2023), the exacerbation of air pollution (N. Zhang, Ren, Zhang, & Zhang, 2020), and the accelerating of climate change. The escalation of human activity has led to these consequences, which pose significant challenges to the environmental sustainability (J. M. Chen, 2021). Given the imminent threat of resource depletion, organizations are now exploring innovative methods and strategies to reduce their environmental footprint for a more sustainable world (Čuček, Klemeš, & Kravanja, 2015). Additionally, nations and organizations have implemented further measures to alleviate the adverse impacts of human activities.

The terms “sustainable” and “sustainability” have emerged as significant but pervasive concepts across various scientific fields (Elmo, Arcese, Valeri, Poponi, & Pacchera, 2020; Zuin, Eilks, Elschami, & Kümmerer, 2021). Many authors concisely define sustainability as the conservation of existing natural resources in order to ensure their availability for every living being, both presently and in the future (Hajian & Kashani, 2021; Kumar, 2021; Uralovich et al., 2023; Yuce, 2023). According to the author of this chapter, the term “sustainable” etymologically signifies the capacity to conserve natural resources amidst continuously growing populations, in conjunction with increasing output and consumption levels.

Climate neutrality has been a very contentious issue among researchers in multiple disciplines, experts, and politicians since the Paris Climate Summit in 2015 (Huovila et al., 2022; Kılış, Krajačić, Duić, & Rosen, 2020; Wolf, Teitge, Mielke, Schütze, & Jaeger, 2021). This summit was a significant milestone in addressing the unsustainable productivity and consumption of human practices; yet, it was not the inaugural effort to contemplate the future of living and nonliving entities. Climate neutrality, in a simple form, is neutering the anthropogenic activities or practices related emitted all greenhouse gases (Elavarasan et al., 2022; Kılış et al., 2020). Net zero refers to the equilibrium achieved when greenhouse gas emissions released into the atmosphere are counterbalanced by the adoption and implementation of environmentally sustainable actions, strategies, and rules and regulations. On the other hand, carbon neutrality is another important term that is used interchangeably with climate neutrality. In existing literature, carbon neutrality is used and investigated more often than climate neutrality (J. M. Chen, 2021; Huovila et al., 2022). There is a slight difference between two of them. While carbon neutrality emphasizes reducing the carbon dioxide (CO<sub>2</sub>) emission in the atmosphere, climate neutrality refers to combatting all greenhouse gasses including carbon dioxide emitted to the atmosphere.

Although it falls outside the scope and aim of this conceptualized paper, it would be beneficial to provide a brief and concise overview of greenhouse gases. The atmosphere stores gases like carbon dioxide, nitrous oxide, chlorofluorocarbons, and methane, which we refer to as greenhouse gases. In fact, these gases are critical for the earth's sustainability. Without these gases, the Earth would freeze and become lifeless (Panepinto, Riggio, &

Zanetti, 2021). The primary issue with greenhouse gases stems from the conversion of beneficial gases into harmful ones, a result of human activities that prioritize unrestrained consumption and production methods. When gases accumulate excessively in the atmosphere, the previously balanced system begins to malfunction, leading to an unsustainable environment. Therefore, it is crucial to understand how we can achieve climate neutrality, or at least balance, our daily practices that negatively impact the environment's health due to the excessive greenhouse gas effect.

Human capital can be classified as individuals who possess a high degree of education, environmental awareness, knowledge, and abilities (Ahmed, Nathaniel, & Shahbaz, 2021; Carraro, De Cian, & Tavoni, 2014; Nakipova et al., 2021). Ahmed et al. (2021) Individuals who possess these characteristics play a vital role in order to preserve the natural capital of a country. Research has shown a substantial correlation between environmental sustainability and negative human capital (Ahmed et al., 2021; Liu, Teng, & Han, 2020). The majority of the studies indicate that individuals who possess advanced skills, knowledge, and competence are more tending to conserve natural resources. Nevertheless, it is imperative to acknowledge that this does not always mean that individuals with a high level of education can be considered to have sufficient awareness and maturity to grasp the importance of natural capital. It is also evident that they have the capacity to maintain their unsustainable production and consumption practices. As a matter of fact a study claimed similar argument by stating that “Surprisingly, human capital adds to environmental degradation” (Ahmed et al., 2021) in addition the economic growth and urbanization . Despite all of these studies, impact of human capital on environmental degradation has not been studied comprehensively, particularly in tourism industry. In addition to the existing knowledge, this chapter aims to analyze the literature and present their arguments about the impact of human capital on climate neutrality. This study will also enhance the growing body of research on the relationship between human capital, emerging technology, and climate neutrality in the context of the tourism industry.

Besides human capital (Carraro et al., 2014; Milovanović, 2017), there is also another important asset called natural capital. Natural capital (Collins, 1999), encompassing both renewable and non-renewable resources, constitutes the most essential asset for living organisms. Meraj, Kanga, Kranjčić, Đurin, and Singh (2021) defined natural capital as the assets, for example forests, rivers, air and agricultural land, of a nation that are responsible for its economic performance. Bateman and Mace (2020) also argued that there is a significant relationship between natural capital and decision-making process. Since natural resources are not infinite, organizations, individuals and policy makers need to contemplate on how they will use their assets before they make the decisions (Ahmed et al., 2021).

The global ecology is experiencing serious degradation due to various critical factors, including excessive energy use and the utilization of outdated technologies. Rapid and sophisticated technological breakthroughs undeniably offer countless advantages, profoundly impacting all facets of human existence (Yuce, 2021). Emerging technologies are becoming more prevalent and significantly impact several aspects of life constantly (Buhalis & Law, 2008). Whether it is emerging or not, technologies help companies and organizations in a number of ways, such as improving their efficiency and increasing the productivity along with increased consumer and labor force satisfaction (Ahmed et al., 2021; Buhalis & Law, 2008). Yet this does not mean that they are reducing carbon dioxide and help the planet.

By employing innovative solutions, we can mitigate the adverse effects of human activities and promote a more sustainable environment for all. Implementing suitable technologies that exert minimal adverse effects on the environment with various names such as green

technologies (Nylund, Brem, & Agarwal, 2022), climate-friendly technologies (Popp, 2011) energy-efficient technologies (Jaffe, Newell, & Stavins, 1999). In pursuit of sustainable economic growth and responsible usage of natural resources, it is also essential to implement relevant and effective creative solutions alongside suitable technologies. Despite the diversity of terminology, they all share a singular objective: to minimize the adverse effects of human activities and natural resource exploitation while increasing socioeconomic advantages. This method constitutes the most effective option, alongside the responsible utilization of supplies, products, and services, for alleviating detrimental effects on organizations. The current literature includes many studies highlighting the need to adopt suitable solutions to alleviate their negative environmental impacts. Grubb (2004) posited over two decades ago that identifying innovative and appropriate solutions for achieving climate neutrality is essential for environmental sustainability.

Achieving climate neutrality goals requires not only human capital and technological improvements but also the integration of numerous aspects, including financial support for the countries and industries that cannot afford adapting the newer approaches. As L. Chen et al. (2022) reported that 26<sup>th</sup> United Nations Climate Change Conference of the Parties (COP26) which was held in Glasgow between 31<sup>st</sup> October to 12<sup>th</sup> November 2021 reaffirmed the major goals of Paris agreement. Nearly 200 countries and 120 leaders also agreed on four major headings to reduce the global greenhouse gas emissions (United\_Nations, 2021). These four key headings were coal, cars, cash and trees in order to keep the global average temperature below 2 °C, above pre-industrial levels with a target of 1.5 °C as soon as possible.

Adapting to any challenge, including climate change, is crucial for addressing persistent ecological problems. Despite the necessity for proficient workers and sophisticated technology solutions to reverse atmospheric carbonization and environmental degradation, the challenge is exacerbated by individuals' failure to adapt to climate change-related threats (Ahmed et al., 2021). Developing adaptation strategies and procedures to address climate change will mitigate the risks linked to climate change-related challenges, particularly extreme weather phenomena.

The travel industry has been an essential economic asset for many nations globally (Thommandru et al., 2023). Tourism generates foreign exchange and income; however, it also generates a significant amount of waste, such as plastic and culinary waste, which is referred to as the global tourism footprint (Lenzen et al., 2018; Thommandru et al., 2023). Tourism contributes to carbon emissions yet does not produce adequate remedies to alleviate its negative impacts.

In light of the escalating climate change challenges threatening the earth, there is a heightened interest in exploring the correlation between human capital, developing technology, and climate neutrality. Additionally, there is a growing need to investigate novel ideas, approaches, and practices in order to mitigate rapid climate fluctuations. Consequently, it is essential to ascertain the precise principles that can facilitate climate neutrality, as this is crucial for the well-being of individuals, nations, and our ecosystem including the biodiversity. Lastly, despite various studies defining climate neutrality, carbon neutrality, and offsetting, there is a necessity to differentiate these concepts, especially in the tourism industry.

Although tourism has become a major business yielding considerable economic advantages, it is essential for all stakeholders to devise creative measures to mitigate the deterioration of the

ecological system (Liu et al., 2020). Despite substantial study on human capital, new technologies, and climate neutrality, there is a scarcity in peer-reviewed papers that expressly examine the convergence of these factors. Fewer studies have highlighted the correlation between human capital, developing technology, and climate neutrality in the tourism industry. This chapter intends to deliver a fundamental analysis through a survey of recent literature. This study aims to examine the following questions in the light of the stated objectives:

- a. What is the influence of human capital on climate neutrality?
- b. What is the effect of new technology on climate neutrality?
- c. In what ways may humans and emerging technologies facilitate climate neutrality within the tourism sector?

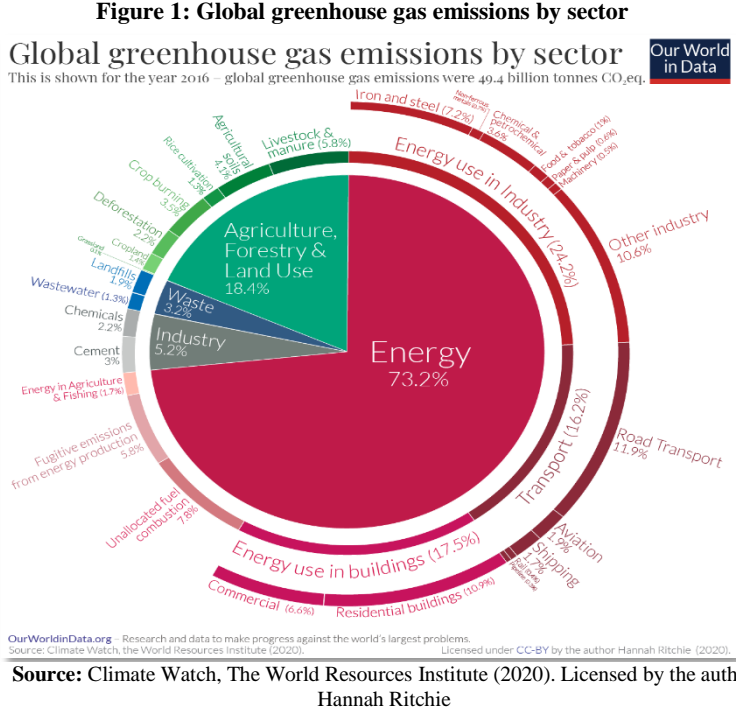
## **2.1. Theoretical background and Review of Related Literature**

### **Climate Change**

The world has witnessed many dramatic disasters including wars, epidemics and economic turnovers which led all living things hardly adapt the new habitat since the antiquity. The human beings and other living organisms also faced with the extreme weather conditions such as ‘temperature, precipitation and storm events’ (Dietz et al., 2020) for tens of hundreds of years according to the findings of the geological (Rousseau, Bagniewski, & Ghil, 2022; Weyl, 1968) and archeological work (Wang & Bresson, 2021) such as Port of Ephesus, even though some argue that sea level is dropped due to the different reasons other than the climate change. Although some critical warnings made by Joseph Fourier and Eunice Newton Foote in between 1820-1850 of the greenhouse gases effect on earth exist, it took a long time to convince scientific community, government and organizational authorities to be greatly interested in the near future (History, 2023). As in the aforementioned definition, climate change refers to uncommon and unpredictable dramatic fluctuations in temperature that causes catastrophic ecological and social outcomes over short or long durations (Dietz et al., 2020; Li et al., 2011). While it is challenging to definitively attribute climate change to specific parameters, research suggest that anthropogenic activities are a significant factor contributing to the climate-related challenges faced by the Earth (Dietz et al., 2020; Zalasiewicz & Williams, 2021). According to Our World in Data (<https://ourworldindata.org/ghg-emissions-by-sector#article-citation>), individuals emit 50 billion tons of greenhouse gases per year (Ritchie, 2020). Ritchie (2020) also contends that numerous sectors are responsible for global greenhouse gas emissions. Moreover, Ritchie (2020) identified as in the Figure 1, the energy sector (electricity, heat, and transport) is the largest contributor to greenhouse gas emissions at 73.2%, followed by the chemical and petrochemical industry at 3.6%, and the food and tobacco industry at 1%. Lastly, she argues in her article that other industries contribute 10.6% of the greenhouse gas emission.

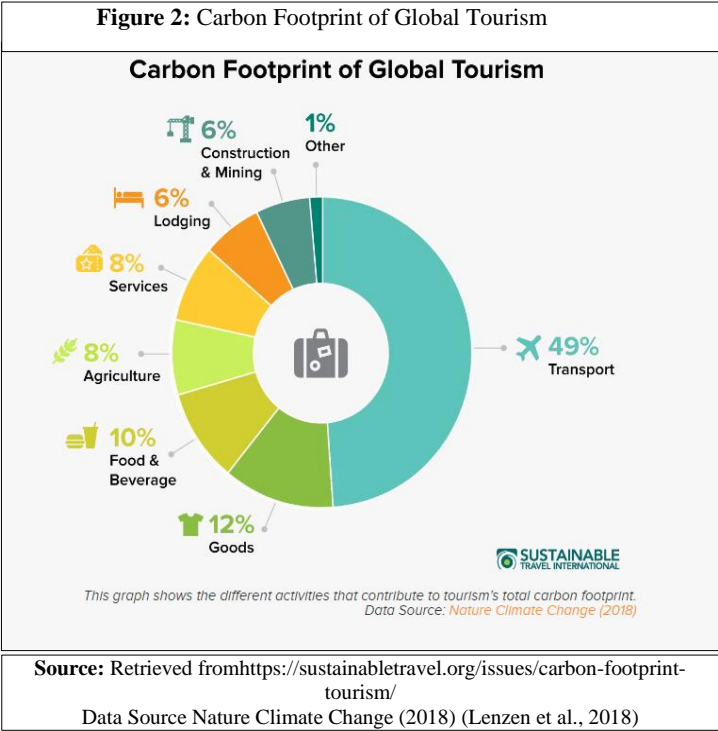
The tourism industry which is, according to Lenzen et al. (2018) a trillion dollar industry, significantly impacts the world via trade and local economies (Thommandru et al., 2023). Tourism contributes 7% of global exports, 10% to global domestic goods and generating approximately 20% of employment (Greif & Houdre, 2024; Lenzen et al., 2018).

Despite the data being sourced from highly reputable institutions, complete reliance on them is unfeasible due to their primary focus on the results of economic conditions. These institutions often disregard to consider the costs associated with human impact, environmental degradation, and other critical issues. Although the facts may seem accurate, it is essential to examine the concealed costs one must confront. Ultimately, the question should be asked: Was it worth it? If not, how can one ensure that the outcomes are significantly beneficial for all involved? Consequently, local, national, and international organizations must devise new strategies to ensure that outcomes significantly benefit all stakeholders without compromising finite natural resources, in accordance with the definition of sustainability.



An extensive body of literature highlights that, tourism substantially adds to global greenhouse gas emissions, which exacerbate extreme weather occurrences (Greif & Houdre, 2024). The adverse impact of tourism is increasing as an escalating number of individuals visit the destinations around the earth. Although measuring and estimating the actual impact and volume of greenhouse gas emissions generated by tourism activities is challenging, some organizations and research studies asserts different estimates from various sources differ. The World Trade Organization (WTO) reported that tourism accounted for 2.5-3% of carbon dioxide emissions from 2008 to 2010 (Lenzen et al., 2018). It is evident that numerous criteria contributing to the tourism carbon footprint are not incorporated into the aforementioned ratio. Given that tourism operations are intricately linked with numerous other sectors, the diagram above also omits the adverse effects of tourism. However, it is evident that tourism is not exempt from this. According to (Greif & Houdre, 2024) at weforum.org, tourism accounts for 8% of world carbon dioxide emissions. A substantial number of studies have concluded that transportation is the primary source of greenhouse gas emissions. Figure 2 demonstrates that transportation, which includes hot air balloons and aircraft, is responsible for approximately 49%, followed by goods 12% of the 8% carbon footprint of global tourism (Lenzen et al., 2018).

As illustrated in Figure 2, each tourism branch approximates an environmental adverse consequence. Previously, the sole method of measuring the total emission of the tourism industry was to concentrate on aviation, as it was recognized as an industry without a chimney. The remaining branches and factors, including the construction of tourism facilities and the provision of accommodation services, were excluded from the equation. Upon the inclusion of the estimated data from the other branches and activities of tourism, it is evident that the greenhouse gas emissions from tourism are more than four times the level that was previously declared (Lenzen et al., 2018).



Research indicates that the tourist sector comprises direct, indirect, and induced contributors (Aynalem et al., 2016). Nonetheless, each classification has a variety of suppliers that release differing amounts of carbon into the atmosphere. Figure 2 illustrates that aircrafts account for 49% of greenhouse gas emissions, making it the predominant source of pollution. The remaining industries comprise products at 12%, food and beverages at 10%, and various categories. These industries can establish objectives to diminish their carbon footprint and mitigate their adverse effects by adopting a climate-neutral policy. Lastly, while tourism is an essential source of income for many destinations, yet, classical tourism activities cannot be sustained. Hence more ecofriendly approaches such as green businesses and alternative tourism types are needed in order to achieve sustainable tourism goals.

Organizations have primarily addressed issues by identifying the key factors detrimental to their environment. Therefore, corporate and organizational leaders, along with civil society leaders, must collaborate to enhance the environmental sustainability of corporate practices and human activities. A recent study conducted by Berrang-Ford, Ford, and Paterson (2011) asserts that human will need to adapt the climate change challenges since it has been unavoidable task. Further, bringing together of the different shareholders into the table can help to analyze the issues with broader understanding and quicker adaptation towards the environmental situation. When resources are used at minimum, less greenhouse gases will be

produced and it will be easier to balance the negative impacts. Working as a team will not only generate newer ideas, but it will also help focusing on achieving the common goals of the organizations and society at large. Moreover, collaborating with authorities using the advanced technology will improve the individual and organizational skills to help the society in case of the imminent environmental situations such as storm and float related issues.

Another study by I. Khan, Zhong, Khan, Dong, and Nuță (2024) indicates that carbon dioxide (CO<sub>2</sub>) can be reduced using appropriate technological adaptation and effective action approaches such as education of all in a society. Although technology has been seen by some researchers as one of the detrimental factors on environmental related problems earth face today, if it is used wisely, it can play a significant role in reducing greenhouse gases produced due to the anthropogenic activities, in particularly, industrial production, mostly called Fordism.

### **The concept of climate neutrality, carbon neutrality, offsetting and net-zero in literature**

Climate change is one of the not only ecologically, but also socially, culturally and politically greatest threats in the age we live in. According to the US National Climate Assessment, “earth’s climate is now changing faster than at any point in the history of modern civilization, primarily as a result of human activities” (Jay et al., 2018). Due to increasing human population and consumption, energy consumption also increases significantly. This vicious cycle leads to a significant decrease in limited natural resources of the world and causes constantly mounting greenhouse gases in the atmosphere. Consequently, climate neutrality has emerged as a vital global policy mandating substantial commitment to address this challenge.

As it was mentioned above, climate neutrality has been receiving a popular interest among researchers in recent years as climate change severely influences every aspect of our life. According to Geden and Schenuit (2019) the European Union (EU) and other developed countries, which are the major greenhouse gas contributors, are under pressure to ensure the climate neutrality objectives are achieved by 2050 since they are the frontrunners of the international climate policy. Geden and Schenuit (2019) also asserted that European Union has already its greenhouse gas emission by 23% since 1990. The Paris Climate Summit plays a pivotal role to confront with the ongoing unsustainable anthropocentric practices, approaches and ideas. The 2015 (December 12<sup>th</sup>) Paris Climate Summit (COP21), also known as the Paris Agreement, was the catalyst for the objective of achieving climate neutrality before by the end (2050) of this century (UNFCCC, n.d.). What makes Paris Agreement important? The Paris agreement is a significant milestone in the fight against climate change, as it is the first mandatory accord that unites all countries to address and mitigate its effects (UNFCCC, n.d.). Paris Agreement required all parties to adhere to the policies that aim to reduce greenhouse gas emissions by a minimum of 55% from 1990 levels by 2030. The COP 21 summit also determined to limit the global temperature rise to fewer than 2°C and limiting the temperature increase 1.5°C above pre-industrial levels (UNFCCC, n.d.; United\_Nations, n.d.).

Furthermore, the Paris Climate Agreement declared that all sectors (Geden & Schenuit, 2019), including organizations, cities, destinations, and governments, can achieve climate neutrality if they endeavor to reduce greenhouse gas emissions to a minimal level. To attain this crucial objective, all stakeholders must overcome obstacles such as financial constraints and the formulation of requisite regulations (Zhou, 2021). On the other hand, to achieve climate neutrality, consumers must adopt sustainable consumption practices, including land use,

avoiding unnecessary purchases, reusing repairable items, rejecting non-eco-friendly products and services, and recycling recyclable materials (Geden & Schenuit, 2019; Lenzen et al., 2018; Wolf et al., 2021). Therefore, in addition to adapting to the reality of climate change-related issues, it is crucial to adopt novel insights, approaches, and perspectives to ensure a more sustainable environment.

In reality, what does the term "climate neutrality" mean? Despite the fact that the ultimate objective is to achieve climate neutrality or net zero emissions, the public and mainstream media have confused the two concepts. In research papers, it is also challenging to obtain a concise and lucid explanation of these two terms. It is evident that these concepts are inadequately defined. Climate neutrality can be defined as "greenhouse gas neutrality," as cited by Geden and Schenuit (2019). The common thread between the two is a desire to mitigate the environmental damage caused by human and commercial activities. Climate neutrality is achieved by absorbing the greenhouse gas emission at a specific location in a manner that can be eliminated greatly even if it is not completely through the implementation of avoidance measures by businesses and individuals.

Achieving climate neutrality goals are challenging since the world is demanding a bigger economic growth, more comfortable life style and possessing more or bigger personal assets while the population constantly increases. In order to meet the requirements of demand, suppliers will need to use more raw materials and energy that will cause more global greenhouse gas emissions (L. Chen et al., 2022). Over-exploitation of raw materials and non-renewable energy sources undoubtedly, will undermine the future generations' living conditions (L. Chen et al., 2022; Wolf et al., 2021).

Net Zero denotes a concept synonymous with climate neutrality, which seeks to eliminate all greenhouse gases, including CO<sub>2</sub> emissions, from the atmosphere (Greif & Houdre, 2024). The objectives of climate neutrality and Net Zero do not aim to eliminate all greenhouse gas emissions. They ensure that anthropogenic activities associated with hazardous gas emissions are balanced with an equivalent number of emission mitigation strategies. Lastly, in the literature, climatic neutrality and Net Zero are used interchangeably as they both accomplish identical objectives.

Conversely, as Geden and Schenuit (2019) employed the term "greenhouse gas neutrality," this work defines it succinctly as "carbon dioxide neutrality." Carbon neutrality can be defined as carbon emissions are generated by individuals, organizations, and enterprises, but they do so with the aim of the adverse effects of the carbon dioxide (CO<sub>2</sub>) emissions through the application of mitigation techniques (J. M. Chen, 2021; Sun, Duru, Razzaq, & Dinca, 2021). These methods involve implementing advanced technologies to reduce energy and water consumption that will help carbon emission levels to the minimum.

The extent of which sectors, destinations, and individuals are impacted by the greenhouse gas or carbon dioxide effect is contingent upon a variety of factors, such as their level of awareness of the ecosystem, the quantity of human and financial capital they possess, and the technology they utilize. Researches also indicate that eco-friendly practices can reduce the impact of individuals' awareness, expertise, and leadership on the quantity of carbon emissions that leads more sustainable work environment (J. M. Chen, 2021). Waste management, energy conservation, and water conservation are just a few of the readily implementable new measures that individuals and companies can implement these to mitigate their negative impacts. While it is currently impossible to completely eliminate greenhouse

gas emissions, there are numerous measures that businesses and organizations can take to significantly reduce their CO<sub>2</sub> emissions.

### **The concept of sustainable tourism in literature**

Tourism has been a significant propelling force for global domestic product and has generated a variety of economic benefits worldwide (N. Khan, Hassan, Fahad, & Naushad, 2020; Lenzen et al., 2018). In the 1980s, efforts were initiated to promote a tourism industry that is referred to as "Industry without Chimneys." (Kumar, 2021). An industry that lacked a chimney was not required to generate any products; rather, it was to provide visitors with access to the natural resources. However, history has shown that natural resources can suffer harm even in the absence of chimneys. Eventually, tourism evolved into an industry that not only significantly contributes to the global economy (N. Khan et al., 2020), but also releases greenhouse gases into the atmosphere (Dube & Nhamo, 2021). As previously said, tourism provides substantial prospects for the economic, social, and cultural vitality of destinations, while also exerting a considerable influence on the environment. Estimates indicate that the tourist sector currently accounts for 8% of worldwide carbon dioxide (CO<sub>2</sub>) emissions (Baloch et al., 2023; Dube & Nhamo, 2021; Lenzen et al., 2018). The tourism sector has been endeavoring to attain climate neutrality (Lenzen et al., 2018; Sun et al., 2021) by following particular directives set forth by international organizations. Tourism industry highly depends on a skilled workforce that creates the human capital to ensure a quality of service for the visitors (Milovanović, 2017; Nakipova et al., 2021). Moreover, tourism also requires constant follow up with the latest effective technologies for its effective business operation and improve consumer satisfaction in the context of tourism field (Yuce, Arasli, Ozturen, & Daskin, 2020). To mitigate greenhouse gas emissions, the industry can enhance its efficiency and productivity by adopting sustainable practices and advanced digital technologies.

### **Human capital, climate change, emerging technology and climate neutrality**

Human capital is a crucial concept for nations, corporations, and organizations. Highly qualified human capital is more likely to result in greater value, enhanced economic growth, and a more secure future for society as a whole. Although there is not a common agreement on the definition of the human capital, it can be defined as the quality of knowledge, heightened awareness, enhanced responsibility, and receptiveness to novel concepts and technology (Carraro et al., 2014). Having a healthy human capital offers numerous benefits from personal development to environmental sustainability (J. Zhang & Danish, 2019). A study asserts that educational attainment provides numerous benefits such as using the information communication technologies (Ahmed et al., 2021). Human capital also stimulates awareness that positively affects the environmental sustainability (Ahmed et al., 2021; J. Zhang & Danish, 2019). Ahmed and Wang (2019) posited that human capital has potential to reduce the ecological footprint (Čuček et al., 2015).

Given that human activities profoundly influence climate change, climate neutrality, and sustainability (Ahmed & Wang, 2019; Carraro et al., 2014; Zhou, 2021), it is imperative to address natural capital (Bateman & Mace, 2020; Collins, 1999). The literature has extensively analyzed the impact of human capital on sustainability (Caradonna, 2022; Elmo et al., 2020). Policymakers at local, national, and international levels, along with scholars, prioritize not only financial capital or economic outcomes to attain sustainability objectives, but also assess the tangible effects of human activities, such as tourism. They also ensure the consideration of both human (social) and natural (environmental) capitals. Human capital and policies are essential in influencing the success or failure of sustainability initiatives. As policymakers

constitute a segment of human capital, their awareness, knowledge, and competence are crucial. Consequently, it is also essential to examine the scale, intensity, causation, and directionality of the relationship between human capital and climate change.

Extensive studies have investigated the role of the human capital in different concepts. While some of these studies examined the relationship between human capital and environmental sustainability (Ahmed et al., 2021), human capital and tourism development (Hajiyeva & Teymurova, 2019), human capital and tourism education (Kasa, Kho, Yong, Hussain, & Lau, 2020) others investigated relationship between human capital and economic growth (Fahimi, Saint Akadiri, Seraj, & Akadiri, 2018) and human capital and innovation (Carraro et al., 2014). All these studies indicate that people with high quality of the human capital is crucial for all aspect.

Studies also show that as human capital's value increases, their impact on productivity and efficiency also increases in terms of protecting the natural resources where tourism affairs in high demand (Ahmed et al., 2021; Milovanović, 2017; Nakipova et al., 2021). A study also indicates that human capital plays an important role in adapting the climate change related issues and acting actively to produce the solutions (Berrang-Ford et al., 2011). Human capital is driving force in terms of more sustainable economic growth (J. Zhang & Danish, 2019).

Despite the fact that majority of the literature indicate that technology has positive and strong relation to stimulate the individuals' awareness to reduce their carbon footprint (Lenzen et al., 2018), yet some studies indicate technology itself is the major source of the environment degradation (Ahmed et al., 2021).

Technology has significantly transformed the lives of individuals across every aspect (Pencarelli, 2020; Yuce et al., 2020). Moreover, technology profoundly impacts business operational processes. In the tourism sector, technology has revolutionized operations, encompassing reservations, marketing, and the enhancement of business intelligence. Current research posits that the integration of relevant technology in the hospitality sector converts the corporate landscape into an eco-friendly organization (Yuce, 2023). An environmentally sustainable hotel that utilizes advanced technology and proficient personnel reduces its greenhouse gas emissions by conserving energy and water. The organization not only aids in environmental conservation but also diminishes expenses, allowing for expenditures to mitigate their carbon dioxide emissions. Current literature indicates that developing technologies may positively influence the mitigation of the adverse effects associated with rapid population growth, productivity, and consumption patterns. What is crucial to comprehend regarding new technologies? Emerging technologies encompass artificial intelligence, robots, nanotechnology, digital twins, immersive technologies like Immersive Technologies (Yuce, 2022), electronic word of mouth (E-WoM (Abubakar & Ilkan, 2016), Big Data (Samara, Magnisalis, & Peristeras, 2020), and Digital Twin (Yuce, 2023).

While technology significantly influences societal and economic advancement, it concurrently presents substantial environmental hazards due to its enhancement of industrial efficiency, resulting in reduced pricing (Ahmed et al., 2021). As the trend of accelerating the production of electronics at reduced costs intensified, energy consumption increased, resulting in heightened greenhouse gas emissions. Companies are accountable for surpassing carbon emissions at the operational level. Tourism enterprises must function dynamically to satisfy the expectations of continually evolving consumer profiles. Recent research indicates that environmentally sustainable hotels considerably attract more visitors and impact their decision-making. Consumer expectations have significantly evolved over the past century due

to heightened understanding of climate change. Consequently, numerous travelers solicit the perspectives of others when investigating destinations and accommodations prior to their vacation. Conversely, websites that endorse hotels and other enterprises within the tourism sector utilize eco labels to distinguish environmentally sustainable hotels from their counterparts.

## **Conclusion**

Anthropogenic activities are major triggers for the greenhouse gas emissions absorbed in the atmosphere. Increased greenhouse gases cause the malfunctioning of the natural climate cycle that leads climate change related problems. Unpredictable weather events such as sudden storms, hurricanes, excessive heat or cold, float and more are the major outcomes of the climate change related problems human challenge in recent years. The fundamental tenet of sustainability is human capital with accountability, awareness, adaptation and using the emerging the technology efficiently to minimize the negative impacts of climate related issues. Responsible action demands that all endeavors, encompassing policy formulation and technical implementation, are essential for fostering a sustainable environment. Individuals and organizations should adopt and utilize the appropriate technology to operate ethically and optimize the advantages gained from natural resources across the whole production and consumption cycle to extend the longevity of these resources.

It is increasingly possible that tourism will continue to produce an increasing amount of greenhouse gas emissions, as it is expanding at an unprecedented rate. In other words, the complexity of addressing climate-related challenges will also increase. It is essential to take decisive action to reduce the emissions that are the result of global tourism, which contributes to climate change. National governments and international organizations are endeavoring to address this escalating challenge. Conversely, enterprises and individuals within the tourist sector have commenced efforts to mitigate the escalating levels of greenhouse gases accumulating in the environment. Ultimately, business and organizational leaders, in conjunction with civil society leaders, must cooperate to improve the environmental sustainability of corporate operations and human endeavors.

On the other hand, this paper aimed to widen the current understanding and meaning of sustainability by looking into from the etymological perspective. Despite the extensive use of the sustainability not only in public media, but also in literature, it demands clarification about what we are trying to sustain. It is clear that humans cannot sustain the classical attitude, approach, strategy and method while producing and consuming. Therefore, the question must be asked: what do we need to sustain the natural resources? Hence this paper discussed the role human capital and newer innovative and appropriate emerging technology on sustaining the natural capital of the earth.

There is parallel relationship between production and consumption that directly influence the destiny of the environment. As mass production phase speeded up, consumption of the products and services were increased. All in all, it is essential to cultivate individuals to ensure they obtain sufficient knowledge, wisdom, and awareness regarding natural resources along with adopting the appropriate technologies that is eco-friendly by using the renewable energies. It is clear that individuals with more income potential exhibit a superior comprehension of the significance of environmental protection.

As a result, this reviewed paper discussed how human capital and technological innovations affected the preservation of natural sustainability. This paper also presents recommendations

for researchers in tourism area to investigate the relationship between each dimension of this study in different methodologies to provide more analytical based information. The current literature on climate change appears ambiguous or perhaps conflicting. Moreover, this paper also suggests philosophers to discuss about the relationship between human capital's human and anthropogenic activities' anthropos (In Greek anthropos is human). The majority of researchers agree that human activities contribute to climate change, while simultaneously underscoring the importance of human capital in mitigating its causes. In other words, whereas human capital is beneficial, its impact on environmental conservation is harmful. This sounds like an absolute dilemma. Prior to discussing the primary feature of human capital, hence, it is prudent to elucidate the distinction between 'human' and 'anthropos,' despite their synonymous in nature. How can an individual rectify an issue when they are the principal instigator? Therefore, this paradoxical concept requires clarification. Since this chapter does not aim to participate in academic debate in this topic; rather, it offers philosophers the chance to explore whether humanity represents the solution or the dilemma of climate change.

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