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# Assessing the Impact of ICT, Tourism, Globalization and Urbanization on Environmental Degradation and Economic Growth

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## Abstract

*This study explores the impact of information and communication technology (ICT), tourism, globalization, and urbanization on the economic growth and environmental degradation of middle-income countries classified as overall, upper and lower-middle-income countries. It uses a micro panel dataset of 65 nations from 2000 to 2021 through a two-step Generalized Method of Moment estimation approach. The results indicate that the influence of ICT on environmental degradation differs across nation groups. Overall countries have a harmful effect, upper-middle countries exhibit a beneficial influence, and lower-middle countries show no significant link. Tourism continually causes environmental deterioration in all sorts of nations, emphasizing the need for eco-friendly tourist initiatives. Globalization has been seen to have a positive correlation with environmental degradation in countries classified as Overall and Upper-middle income, but a negative correlation in Lower-middle-income nations. Urbanization has a favorable influence on environmental deterioration in Overall and Lower-middle-income nations, but it does not have a significant impact in Upper-middle-income countries. These findings underscore the need to tackle the environmental impacts of information and communication technology (ICT), tourism, globalization, and urbanization. To attain a greener and more sustainable future while fostering economic growth, policymakers should prioritize sustainable development, introduce energy-efficient technologies, encourage responsible tourism practices, enforce environmental regulations, and advocate for inclusive urban planning.*

## Introduction

Global warming has affected numerous facets of our existence, such as economic growth, health, and societal welfare. So, the growing concern over environmental degradation (CO2) has become a crucial matter, playing a central role in the choices of

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worldwide policymakers. Along with pursuing robust and long-lasting economic growth, nations are progressively emphasizing enhancing environmental conditions. Consequently, researchers have dedicatedly investigated, discovered, and scrutinized the elements that contribute to the intricate web of environmental degradation. To decrease environmental degradation and tackle climate change, governmental bodies and organizations are implementing strategies (Balsalobre-Lorente et al., 2018; Sinha et al., 2017). Since the 1960s, concerns such as water scarcity, air pollution, energy dependence, and deforestation have contributed to environmental degradation, posing a challenge to the pursuit of sustainable economic growth (Adebayo et al., 2022; Akadiri & Akadiri, 2021; Fareed et al., 2021; Shan et al., 2021). Due to the advancements in technology and globalization, factors such as Information and Communication Technology (ICT), foreign direct investment (FDI), financial development, and trade openness have become significant contributors to CO2 emissions (Tang & Tan, 2015). Numerous studies have been conducted on the correlation between ICT and carbon emissions (CO2) and on globalization, tourism, and urbanization, both developed and developing economies with different perspectives. However advancements in ICT contribute to economic development, and their environmental consequences are significant worldwide (Lee & Brahmasrene, 2014). ICT has an astounding influence on the environment and magnificent consequences for income growth and human progress. Its impacts on the environment can be positive, negative, or neutral. Utilizing ICT for the reduction of environmental degradation has proven to be eco-friendly. Consequently, numerous countries are contemplating the integration of ICT to diminish their carbon emissions and protect the environment (Chien et al., 2021; Godil et al., 2020; Shehzad et al., 2022).

However, there are instances where ICT has negatively impacted environmental quality, with claims that it contributes to increased airborne carbon emissions (Arshad et al., 2020; Asongu et al., 2018; Park et al., 2018). The ICT sector is frequently criticized for exponentially increasing energy consumption. ICT devices are used increasingly in society, and demand for them has risen quickly. As a result, the need for energy in significant industries has increased recently. The demand for power by ICT devices is the primary factor driving up CO2 emissions. This has a direct connection to greenhouse gas emissions and global warming (Belkhir & Elmeligi, 2018). A study examines the correlation between ICT, economic growth, and carbon emissions within the ASEAN region from 1991 to 2009. The findings suggest that ICT has a discernible positive influence on economic growth while also affecting CO2 emissions (Lee & Brahmasrene, 2014). Despite this, ICT is also acknowledged for its limited influence on CO2 emissions. This leaves room for additional research into the exact effects of ICT on environmental quality. Moreover, ICT can improve economic growth in developing and emerging economies by lowering poverty and boosting productivity (Sanz & Hellström, 2011). According to specific surveys, underdeveloped nations are more significantly impacted by ICT than industrialized nations (Dimelis & Papaioannou, 2010).

Recently another factor tourism also contributes to not only the expansion of the industry but also overall economic development (Lee & Chang, 2008). However, as the tourism industry heavily relies on the natural environment, it is highly vulnerable to climate change (Serrano-Bernardo et al., 2012). Several studies have revealed that tourists are willing to pay more to visit destinations with high environmental quality (Huybers & Bennett, 2000). Nevertheless, the lack of comprehensive management plans to protect natural resources has resulted in environmental degradation in many tourist destinations,

leading to economic decline (Hall, 1998; Zhong et al., 2011). On the other hand tourism sector has developed into a strategic industry in various countries, acting as a significant employer and driver of economic progress (Becken & Hay, 2007; Gössling & Hall, 2006). Similarly to this Lanza et al. (2003) international tourism can help many nations balance their budgets by, among other things, creating jobs and stimulating economic growth. Over the past ten years, there has also been an incredible study on how tourism may increase economic development in wealthy and developing nations (Shahzad et al., 2017). A nation's tourism business is crucial because it provides income, strengthens the economy, builds infrastructure, and creates chances for investment and employment (Jalil et al., 2013).

Globalization may also encourage business development, growth, and improved commerce. As a result, lowering unemployment, income inequality, and poverty and boosts economic growth (A. Dar et al., 2021; A. A. Dar et al., 2021). It also refers to cultural, political, and economic dynamics that result in enlarged interconnection across countries (Goldberg & Pavcnik, 2007; Mills, 2009). Several studies support the link between economic development, globalization, and environmental degradation (Tamazian et al., 2009). The process of urbanization can also be regarded as a noteworthy factor in economic development, structural transformation, and environmental degradation. So urbanization is a recent occurrence and has been identified as a progressive element of contemporary economic development (Jones, 1991). Aside from rich nations, urbanization is rising in undeveloped countries (Sadorsky, 2014). Because urbanization cannot be regulated by legislation, everyone can move from one location to another. By 2050, emerging nations will be about 65 percent urbanized (Shahbaz et al., 2016). On the other hand, it has been suggested that urbanization could potentially lead to a rise in both business energy consumption and carbon emissions (Wang et al., 2016; Zhang & Lin, 2012). Numerous research studies have indicated that urbanization is a significant contributor to the emission of CO2 in both emerging and developed nations (Sbia et al., 2017); Zhang and Lin (2012). Urbanization typically results in heightened demands for energy consumption and increased levels of carbon dioxide emissions (Niu & Lekse, 2018).

It is crucial to tackle the pressing issue of environmental degradation and the worrisome increase in carbon dioxide (CO2) emissions, as they have a profound impact on economic growth, health, and societal well-being. The complex interconnections between Information and Communication Technology (ICT), Tourism, Globalization, Urbanization, Environmental Degradation, and Economic Growth present a multidimensional problem. These elements, although they have the potential to stimulate economic growth and enhance environmental conditions, also pose hazards to environmental stability and the preservation of resources. The research gap exists due to the absence of extensive studies investigating the collective effects of these factors in diverse middle-income nations. It highlights the interdependence between economic well-being and environmental conservation in the current internationally networked and technology-driven world. Past studies place a notable focus on the correlation between economic growth, environmental deterioration, and the factors that contribute to them, both in highly developed nations and lower-income countries. Nevertheless, middle-income nations, characterized by unique dynamics, have yet to be thoroughly investigated. Our study attempts to gain new insights into the intricate connection between economic development, environmental concerns, and important factors by specifically examining

middle-income nations. We believe that this distinctive viewpoint offers excellent prospects for comprehending and tackling sustainability difficulties.

This research aims to comprehensively examine the complex relationship between Information and Communication Technology (ICT), Tourism, Globalization, Urbanization, Environmental Degradation, and Economic Growth in middle-income countries from 2000 to 2021. The study focuses on four central research inquiries: What is the impact of ICT on the relationship between environmental deterioration and economic growth in middle-income nations from 2000 to 2021? What is the relationship between tourism environmental deterioration and economic growth in these nations within the same time frame? What is the impact of urbanization on environmental deterioration and economic growth in middle-income nations from 2000 to 2021? What are the effects of globalization on the deterioration of the environment and the expansion of the economy in middle-income countries within the given period? This study defines a precise scope, both in terms of geographical and temporal boundaries, concentrating on middle-income nations from 2000 to 2021. It offers a whole worldwide viewpoint, taking into consideration the differences among these countries in terms of economic levels, phases of development, and regional variances. The existing literature lacks a comprehensive analysis of the relationship between ICT, tourism, globalization, urbanization, environmental degradation, and economic growth, which creates a noticeable vacuum in the study. Frequently confined by small sample sizes or a narrow focus on certain countries, this gap fails to address the intricate interconnections between these variables across a diverse array of middle-income nations. This study aims to fill this research void by employing a comprehensive methodology, investigating the combined effects of these factors, and encompassing a wide range of middle-income nations. The research endeavors to offer useful insights to policymakers by examining these linkages across diverse socioeconomic groups and geographies. The primary objective is also to guide the formulation of policies that successfully achieve a harmonious equilibrium between economic expansion and environmental preservation. It acknowledges that these objectives are not mutually exclusive, but rather interdependent need in our contemporary society.

This paper is organized as follows: section 2 covers the literature review, while section 3 presents the data, empirical model, and estimation methods. In section 4, a thorough analysis of the empirical results and relevant discussion is provided. Lastly, section 5 highlights the key findings, and their policy implications, and suggests potential areas for future exploration.

## Literature review

In conducting this comprehensive literature review, our approach has been purposeful and focused, centering our examination solely on the Environmental Kuznets Curve (EKC) theory. This is done amidst an abundance of theoretical viewpoints that discuss the intricate connection between information and communication technology (ICT), tourism, globalization, urbanization, environmental degradation, and economic growth.

### ICT, Environmental Degradation, and Economic Growth

The Environmental Kuznets Curve (EKC) paradigm shows an inverted U-shaped association between environmental degradation and economic growth. Real production initially affects environmental deterioration; however, after a certain level of economic growth, pollution decreases as individual GDP rises (Grossman & Krueger, 1995). ICT is

the driving force behind the digitalized transit and production system, significantly increasing output. The environmental effect of ICT must be thoroughly examined to fight climate change (Zhou et al., 2019). The utilization effect, replacement effect, and expense effect of ICT impact the ecosystem. Regarding the impact of ICT utilization, the manufacturing cycle consists of production, processing, dissemination, and maintenance (Shahnazi & Dehghan Shabani, 2019). This production process generates more CO2 and consumes a lot of energy (Park et al., 2018). ICT garbage significantly increases CO2 emissions in developing countries, partly because of insufficient waste-handling expertise and technology (Khan et al., 2018). The following effect of ICT is a substitution, which boosts output productivity through several factors, including energy optimization (Coroama et al., 2012), decarburization (Zhang & Liu, 2015), and intelligent transit (Zhang et al., 2019). Another benefit of ICT is its cost impact, which tackles market rivalry to satisfy increasing demand and raise CO2 emissions (Shabani & Shahnazi, 2019). Various theories and stances describe how ICT and environmental harm are related. Among them is the ecological industrialization theory, which contends that the importance of ICT lies in its capacity to stimulate economic growth, which in turn results in favorable structural changes, environmental regulations, and technological advancements that lessen environmental pollution (Goundar & Appana, 2018; Jacobi et al., 2010; Poumanyvong & Kaneko, 2010; Sadorsky, 2014). Simpson et al. (2019) examined the connection between ICT and the ecosystem in 113 nations over 20 years, from 1990 to 2010. According to the findings, fixed telephone lines increased CO2 pollution in less developed countries, whereas the internet had a comparable effect on more developed ones. Conversely, Ozcan and Apergis (2018) looked at 20 developing countries between 1990 and 2015 and discovered that greater ICT access leads to less air pollution. However, N'dri et al. (2021) have shown that although there is no clear correlation for high-income developing countries, ICT can have positive ecological effects for low-income developing countries. On the other hand, (Bayraktar Sağlam, 2018; Edquist & Henrekson, 2017) studies have found that internet, ICT investments, mobile phones, and R&D play a positive role in economic growth. Their research suggests that ICT diffusion enhances the share of R&D and human capital formation, indirectly contributing to economic growth. Another study at the World Economic Forum discovered a favorable connection between information and communication technology (ICT) and economic growth; a 10% increase in the ICT sector results in a 0.76% rise in per capita GDP and a 1.03% increase in employment rate (Sabbagh et al., 2013). Furthermore, (Aghaei & Rezagholizadeh, 2017) endorsed the supply-leading hypothesis, establishing a solid correlation between growth and ICT sector expansion. By comparing developed and developing countries, a study showed that ICT's impact on economic growth is more significant in developed nations. Based on the literature we propose the following hypothesis of our study.

*$H1_a$: There is an association between ICT and Environmental degradation.*

*$H1_b$: There is an association between ICT and Economic growth.*

**Tourism, Environmental Degradation, and Economic Growth:**

The growth of international tourism promotes economic expansion and raises carbon dioxide emissions unevenly, depending on the rate of economic development and the amount of carbon dioxide emissions. The tourist-led economic growth theory has been substantiated, as the environmental benefits are notably significant for countries that are relatively more advanced. Simultaneously, these issues are relatively less significant for

nations that are comparatively less developed. Conversely, it has been revealed that the advancement of environmentally sustainable technologies fosters economic growth and mitigates carbon dioxide emissions, particularly in highly developed and environmentally degraded nations (Razzaq et al., 2023). According to another idea by Gwenhure and Odhiambo (2017) who conducted a literature analysis on the causal relationships between international travel and economic development. They concluded that most of the world's countries experience tourism-led economic growth. Another study also supported the unidirectional causal linkage between international travel and economic growth (Mitra, 2019; Primayesa et al., 2019). Many empirical studies have also shown evidence that economic expansion promotes the rise of tourism (Lin et al., 2019). Additionally, it has been claimed that economic growth and tourist development are connected (Bilen et al., 2017), (Akadiri & Akadiri, 2021; Dogru & Bulut, 2018). As a result, causal relationships between these variables are causative in both directions.

*$H2_a$: There is an association between Tourism and Environmental degradation.*
*$H2_b$: There is an association between Tourism and Economic growth.*

**Globalization, Economic Growth, and Environmental Degradation**

A study by Sethi et al. (2020) analyzed the environmental trajectory of India between 1980 and 2015 about the phenomena of globalization, financial development, economic expansion, and energy consumption. The novelty of the research lies in its investigation of ecological sustainability through a unified framework that takes into account the impacts of growth, globalization, and economic advancement. Research suggests that economic growth, globalization, and financial gains may have negative impacts on environmental sustainability. López and Galinato (2005) also found that globalization, which includes international trade and trade policy, plays a significant role in contributing to environmental degradation, specifically in the Philippines, Indonesia, and Malaysia. In the context of forest degradation, the shape of the environmental Kuznets curve is influenced by governance and trade openness. A study by Santiago et al. (2020) checked the effects of economic freedom and globalization on the growth of the economies of 24 developing nations from 1995–2015 in Latin America and the Caribbean. The findings demonstrated that globalization has positively impacted these nations' long-term economic growth and economic and social characteristics. Furthermore, it also uncovered evidence that the long-term economic progress of these Latin American and Caribbean nations is negatively impacted by economic freedom.

*$H3_a$: There is an association between Globalization and Environmental degradation.*
*$H3_b$: There is an association between Globalization and Economic growth.*

**Urbanization, Economic Growth, and Environmental Degradation**

According to Fan et al. (2019) the association between economic growth and urbanization has led to a degradation in climate conditions, while simultaneously leading to an enhancement in social conditions. The proliferation of urban areas was enabled through the adoption of regional institutional strategies, including the recurrent delineation of municipal boundaries, the formulation of comprehensive urban development plans, and the implementation of regulatory revisions. A study examined by Gasimli et al. (2019) the impact of energy consumption on carbon emissions in both the short and long term. The accumulation of carbon emissions in the atmosphere is attributed to trade, thus leading to a decline in environmental quality as a result of increased trade

openness. The results of the study provided evidence in favor of the proposition that the process of urbanization exerts a noteworthy and detrimental influence on carbon emissions. On the other hand, urbanization could result in higher business energy use and carbon emissions (Wang et al., 2016; Zhang & Lin, 2012). Urbanization has been identified in several studies as contributing to environmental deterioration in both developing and developed economies (Sbia et al., 2017; Zhang & Lin, 2012). The environment feels both good and negative consequences of urbanization. Depending on the level of development, urbanization has different effects on the environment (Poumanyvong & Kaneko, 2010). Conversely, urbanization and carbon emissions are positively correlated in several studies (Cole & Neumayer, 2004; Shahbaz et al., 2014). Additionally, Wu et al. (2016) provided evidence that the level of carbon emissions in the environment is increased by the urbanization process and energy use. As a result of better living conditions in cities, there is a positive correlation between total energy use and greenhouse gas emissions. Urban residents typically try to consume products with high energy content. Thus, the increased direct and indirect energy consumption caused by modern urban lifestyles contributes to global warming and climate change. But it is also true that the phenomenon of urbanization plays a crucial role in shaping the trajectory of economic growth and the structure of the economy. In contrast, the process of extensive urbanization is a relatively recent phenomenon that is classified as an advanced phase of contemporary economic growth (Jones, 1991). Although there is a strong correlation between urbanization and economic growth, it can be challenging to determine whether urbanization drives economic growth or the other way around (Annez et al., 2009).

*$H4_a$: There is an association between Urbanization and Environmental degradation.*

*$H4_b$: There is an association between Urbanization and Economic growth.*

**Theoretical framework**

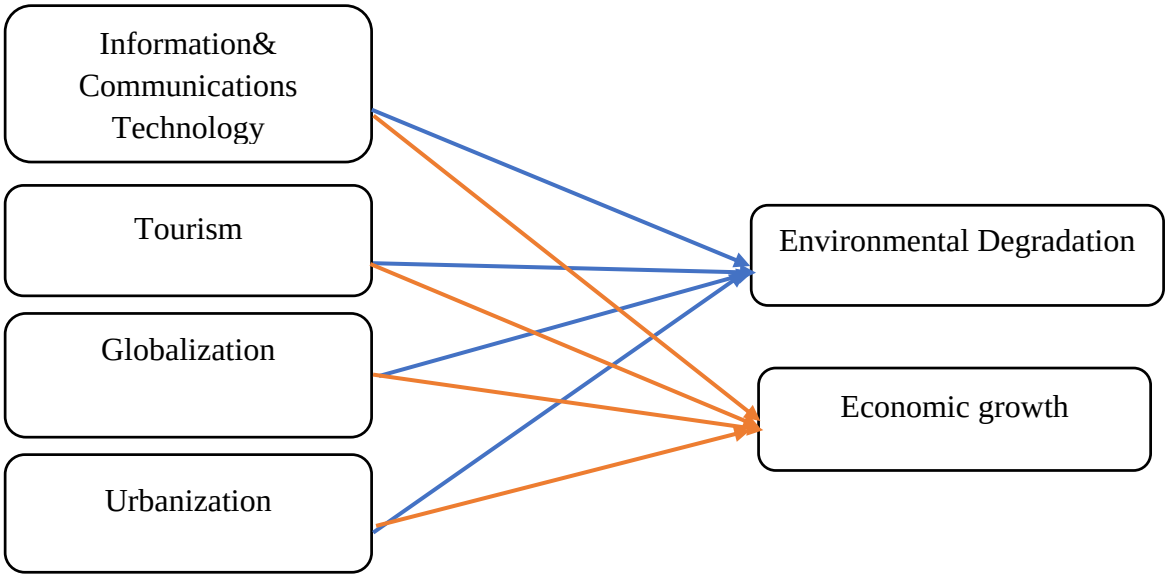


*Figure 1. Conceptual Framework*

## Methodology

In the present study, our approach focused on employing a balanced panel dataset comprising 65 countries, which were classified into two separate groups: upper-middle-income (UMC) and lower-middle-income countries (LMC), from the year 2000-2021. The selection of these nations was based on distinct criteria established using data from the World Development Indicators (WDI) database, which functioned as the primary data source for this study. The country selection criteria were guided by the Gross National Income (GNI) per capita thresholds delineated by the World Bank. After this stringent data selection procedure, the resulting dataset consisted of 65 countries that were subsequently classified into UMC and LMC groups based on their GNI per capita levels, laying the groundwork for this research analysis. There were 32 cross-sections for UMC and 33 for LMC. To explore the connection between ICT, globalization, tourism, urbanization, environmental degradation, and economic growth. Carbon dioxide (CO2) emissions served as an indicator of environmental degradation, while gross domestic product (GDP) represented economic growth. Additionally, fixed telephone subscriptions were used as the independent variable for ICT, tourist arrivals and receipts for tourism, trade volume for globalization, and urban population numbers for urbanization. Table 1 displays the data collected for these variables from the World Bank's World Development Indicators.

*Table 1: Variable description and data sources*

| Variables | | Proxy& Measurements | Data source |
|---|---|---|---|
| DVs | Environmental degradation | CO2 emissions (metric tons per capita). | WDI |
| | Economic growth | GDP per capita (current US$) | WDI |
| IVs | ICT | Fixed telephone subscriptions (per 100 people) | WDI |
| | Tourism | Number of tourist arrivals number of tourist receipts | WDI |
| | Globalization | Trade (% of GDP), | WDI |
| | Urbanization | Urban population (% of the total population) | WDI |

**Regression Equations**

The dynamic panel model uses a two-step-GMM (Generalized Method of Moments) to assess the impact of all independent variables on the dependent variable for 65 countries.

$$CO2_{it} = \alpha_0 + \beta_1 ICT_{it} + \beta_2 Tourism_{it} + \beta_3 Globalization_{it} + B_4 Urbanization_{it} + e_{it} \quad (Eq....1)$$

$$GDP_{it} = \alpha_0 + \beta_1 ICT_{it} + \beta_2 Tourism_{it} + \beta_3 Globalization_{it} + B_4 Urbanization_{it} + e_{it} \quad (Eq....2)$$

Where:

**α0** = The intercept, representing in both equations the average level of CO2 emissions and GDP when all independent variables are equal to zero.

**β1-β4**=The coefficients of the independent variables, representing the change in CO2 emissions and GDP associated with a one-unit increase in each independent variable, holding all other variables constant.
**e** = The error term, representing the unexplained variation in CO2 emissions and GDP not accounted for by the independent variables.

**Estimation method**

The present investigation employs the Generalized Method of Moments as the suitable technique for estimation followed by (Lasisi et al., 2020). The GMM is deemed suitable due to following reasons: The employed technique effectively addresses endogeneity by utilizing the explanatory variable and the lagged endogenous variable as independent variables simultaneously. Additionally, it accounts for potential heteroscedasticity in the model. Furthermore, the method corrects for biases in the difference estimators. Lastly, it is noteworthy that the number of years in each country (T) is less than the number of estimated countries, which is 65 (N). In order to attain the study's objective utilizing the aforementioned benefits of the GMM, a two-step approach developed by (Arellano & Bover, 1995) and (Blundell & Bond, 1998) is being utilized. Therefore, the first stage of the two-step dynamic system-GMM estimation is depicted as follows.

$$logCO_{2i,t} = \gamma_0 + \gamma_1 logCO_{2i,t-1} + \gamma_2 logICT_{i,t} + \gamma_3 logT_{i,t} + \gamma_4 logG_{i,t} + \gamma_5 logU_{i,t} + \varepsilon_{i,t1} \quad (Eq....3)$$

$$logGDP_{i,t} = \delta_0 + \delta_1 logGDP_{i,t-1} + \delta_2 logICT_{i,t} + \delta_3 logT_{i,t} + \delta_4 logG_{i,t} + \delta_5 logU_{i,t} + \varepsilon_{i,t2} \quad (Eq....4)$$

The used variables are expressed using natural logarithms. The notations 't' and 'i' refer to the time period (t = 2000, 2001, 2002, …, 2021) and the i-th sequence (i = 1, 2, 3, …, 65), while γ and δ symbolize constants. The ε_(i,t1) and ε_(i,t2) variables are treated as random elements presumed to be white noise. To improve the accuracy of the estimates, additional diagnostic tests are employed, such as the Sargan test to validate over-identifying restrictions and the Arellano-Bond AR (2) test for detecting higher-order autocorrelation, following the recommendations of Blundell and Bond (1998).

## Data Analysis and Findings

Table 2 displays descriptive statistics for all groups of countries: overall, UMC, and lower-middle-income countries including measures of central tendency and variability.

*Table.2. Descriptive statistics*

| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| **CO2 emission** | 2.289952 | 2.257408 | 0.085597 | 15.34075 |
| **GDP** | 3684.712 | 2777.093 | 223.7119 | 14613.04 |
| **ICT** | 11.24831 | 10.03684 | 0.049852 | 46.80816 |
| **Int.Tourist Arr** | 4688770 | 1.21E+07 | 4400 | 1.06E+08 |
| **Int.Tourist Receipt** | 2.81E+09 | 5.59E+09 | 800000 | 6.44E+10 |
| **Globalization** | 76.44893 | 33.38472 | 15.68299 | 220.4068 |
| **Urbanization** | 52.64196 | 19.31488 | 13.397 | 92.229 |

**Descriptive statistics UMC**

| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| **CO2 emission** | 3.355903 | 2.462712 | 0.665457 | 15.34075 |
| **GDP** | 5380.607 | 2806.27 | 440.5387 | 14613.04 |
| **ICT** | 17.72029 | 9.550134 | 1.389005 | 46.80816 |
| **Int.Tourist Arr** | 6671836 | 1.63E+07 | 16000 | 1.06E+08 |
| **Int.Tourist Receipt** | 3.64E+09 | 6.93E+09 | 1.31E+07 | 6.44E+10 |
| **Globalization** | 82.06944 | 34.11174 | 15.68299 | 220.4068 |
| **Urbanization** | 62.00287 | 15.46935 | 23.012 | 92.229 |

**Descriptive statistics LMC**

| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| **CO2 emission** | 1.256303 | 1.410826 | 0.085597 | 7.137045 |
| **GDP** | 2042.543 | 1440.806 | 223.7119 | 9225.845 |
| **ICT** | 5.010372 | 5.538234 | 0.049852 | 29.02017 |
| **Int.Tourist Arr** | 2681296 | 4218014 | 4400 | 2.88E+07 |
| **Int.Tourist Receipt** | 1.98E+09 | 3.68E+09 | 800000 | 3.17E+10 |
| **Globalization** | 71.0311 | 31.7632 | 16.35219 | 186.4682 |
| **Urbanization** | 43.56471 | 18.32171 | 13.397 | 89.093 |

Comparing the mean values of overall, upper-middle-income, and lower-middle-income countries for the given variables, the mean value for CO2 emissions is the highest in UMC countries (3.355903), followed by overall (2.289952) and LMC (1.256303) countries. The mean value for GDP per capita (5380.607), ICT (17.72029), tourist arrivals (6671836) and globalization (82.06944) are highest in upper-middle countries. UMC countries tend to have higher mean values for these variables than overall and LMC countries.

*Table.3. Unit Root Test*

| ***Variables*** | ***ADF-Fisher test*** | |
|---|---|---|
| | Level | 1st diff: |
| ***CO2*** | 117.9659 | 1077.3648*** |
| ***ICT*** | 133.8747 | 674.5234*** |
| ***GDP*** | 55.1329 | 864.2644*** |
| ***T.Arr*** | 103.2721 | 366.3082*** |
| ***T.Rec*** | 110.7016 | 340.2128*** |
| ***GL*** | 178.8965*** | 1244.9189*** |
| ***Ur*** | 1156.2768*** | 707.3535*** |

Carbon dioxide emissions (CO2), tourist arrivals (T.Arr) & tourist receipts (T.Rec), ICT, globalization (Gl) and Urbanization (Ur). ***, **, as well as * demonstrate the levels of significance at 1%, 5%, and also 10%, respectively.

The table 3 shows results of the ADF-Fisher test for various variables at level and first difference. The majority of variables are non-stationary at level but become stationary after taking the first difference, as indicated by the significant values (***). The exceptions are TRG and URP which are stationary at level itself.

*Table.4. CO2 correlation matrix for Overall, Upper and Lower-middle countries*

| **Matrix of correlations Overall** | | | | | | |
|---|---|---|---|---|---|---|
| **Variables** | **CO2** | **ICT** | **T.Arr** | **T.Rec** | **Gl** | **Ur** |
| **CO2** | 1 | | | | | |
| **ICT** | 0.768*** | 1 | | | | |
| **T.Arr** | 0.459*** | 0.264*** | 1 | | | |
| **T.Rec** | 0.444*** | 0.28*** | 0.821*** | 1 | | |
| **Gl** | 0.358*** | 0.296*** | 0.018 | -0.036 | 1 | |
| **Ur** | 0.669*** | 0.544*** | 0.475*** | 0.452*** | 0.014 | 1 |
| Matrix of correlations UMC | | | | | | |
| **CO2** | 1 | | | | | |
| **ICT** | 0.425*** | 1 | | | | |
| **T.Arr** | 0.344*** | -0.168*** | 1 | | | |
| **T.Rec** | 0.344*** | -0.086** | 0.838*** | 1 | | |
| **Gl** | 0.237*** | 0.131*** | -0.113*** | -0.178*** | 1 | |
| **Ur** | 0.209*** | 0.033 | 0.562*** | 0.504*** | -0.39*** | 1 |
| Matrix of correlations LMC | | | | | | |
| **CO2** | 1 | | | | | |
| **ICT** | 0.699*** | 1 | | | | |
| **T.Arr** | 0.466*** | 0.302*** | 1 | | | |
| **T.Rec** | 0.407*** | 0.268*** | 0.789*** | 1 | | |
| **Gl** | 0.443*** | 0.382*** | 0.086** | 0.026 | 1 | |
| **Ur** | 0.686*** | 0.426*** | 0.366*** | 0.341*** | 0.151*** | 1 |

**Note:** carbon dioxide emissions (CO2), tourist arrivals (T.Arr) & tourist receipts (T.Rec), ICT, globalization (Gl) and Urbanization (Ur).The ***, **, and * are respectively 1%, 5%, and 10% significant levels**.**

The table 4 presents the correlation matrix of CO2, the Overall group reveals a moderately strong positive correlation (0.669) between CO2 and urbanization, suggesting a potential association between higher CO2 emissions and increased urbanization rates. The data indicates a significant and positive correlation (0.821) between international tourist arrivals and international tourist receipts. The correlation coefficient between CO2 emissions and ICT is positively significant (0.768), indicating that a rise in CO2 emissions is accompanied with an upsurge in the adoption of ICT. The correlation matrix pertaining to Upper-middle Income Countries (UMCs) indicates a moderately robust positive correlation (0.699) between ICT and CO2 emissions. This implies that an escalation in CO2 emissions is linked to an upsurge in the adoption of information and communication technology. The correlation coefficient between carbon dioxide (CO2) and urbanization exhibits a moderately strong and positive relationship, as indicated by a value of 0.686. Based on the data, there appears to be a slight positive correlation (0.033) between ICT and urbanization. The LMC indicates a strong positive correlation (0.699) between the adoption of information and communication technology and CO2 emissions. This implies a correlation between the escalation of ICT usage and the amplification of CO2 emissions. The correlation between CO2 and urbanization exhibits a moderately strong and positive relationship, as evidenced by a coefficient value of 0.686. This proposition implies a potential correlation between escalated levels of carbon dioxide emissions and elevated

urbanization rates. The data suggests that there is a moderate positive correlation (0.366) between international tourist arrivals and urbanization.

*Table.5. GDP correlation matrix for Overall, Upper and Lower-middle countries*

| **Matrix of correlations Overall** | | | | | | |
|---|---|---|---|---|---|---|
| **Variables** | **GDP** | **ICT** | **T.Arr** | **T.Rec** | **Gl** | **Ur** |
| **GDP** | 1 | | | | | |
| **ICT** | 0.639*** | 1 | | | | |
| **T.Arr** | 0.419*** | 0.262*** | 1 | | | |
| **T.Rec** | 0.456*** | 0.281*** | 0.821*** | 1 | | |
| **Gl** | 0.128*** | 0.291*** | 0.023 | -0.032 | 1 | |
| **Ur** | 0.621*** | 0.544*** | 0.471*** | 0.449*** | 0.014 | 1 |
| Matrix of correlations UMC | | | | | | |
| **GDP** | 1 | | | | | |
| **ICT** | 0.194*** | 1 | | | | |
| **T.Arr** | 0.503*** | -0.159*** | 1 | | | |
| **T.Rec** | 0.555*** | -0.077** | 0.836*** | 1 | | |
| **Gl** | -0.184*** | 0.144*** | -0.106*** | -0.172*** | 1 | |
| **Ur** | 0.356*** | 0.019 | 0.556*** | 0.5** | -0.386*** | 1 |
| Matrix of correlations LMC | | | | | | |
| **GDP** | 1 | | | | | |
| **ICT** | 0.492*** | 1 | | | | |
| **T.Arr** | 0.257*** | 0.301*** | 1 | | | |
| **T.Rec** | 0.28*** | 0.265*** | 0.791*** | 1 | | |
| **Gl** | 0.28*** | 0.37*** | 0.092** | 0.031 | 1 | |
| **Ur** | 0.534*** | 0.431*** | 0.363*** | 0.336*** | 0.15*** | 1 |

**Note:** gross domestic product (GDP), tourist arrivals(T.Arr) & tourist receipts (T.Rec), ICT, globalization (Gl) and Urbanization (Ur).The ***, **, and * are respectively 1%, 5%, and 10% significant levels**.**

The data in table 5 indicates a positive correlation (0.639) between a country's GDP and its level of development in ICT. This suggests that an increase in a country's GDP is associated with a corresponding increase in its level of ICT development. The data suggests a positive correlation (0.621) between urbanization and GDP. A noteworthy correlation within the Overall matrix pertains to the relationship between international tourist arrivals and international tourist receipts. (0.821). Furthermore, the observed correlation between globalization and the aforementioned variables exhibits a negative trend, implying that an increase in globalization does not necessarily result in elevated levels of economic progress in UMC (UMCs). The correlation between GDP and ICT in LMCs is notably stronger (0.492) compared to the UMC matrix, suggesting a stronger association between economic advancement and technological development in LMCs.

*Table.6. CO2 Multicollinearity*

| **"Overall"** | |
|---|---|
| Number of obs | 1213 |
| F( 5, 1207) | 702.38 |
| Prob > F | 0 |
| R-squared | 0.7442 |
| Adj R-squared | 0.7432 |
| Root MSE | 0.52263 |
| "UMC" | |
| F( 5, 605) | 86.79 |
| Prob > F | 0 |
| R-squared | 0.4177 |
| Adj R-squared | 0.4129 |
| Root MSE | 0.51292 |
| "LMC" | |
| F( 5, 596) | 335.46 |
| Prob > F | 0 |
| R-squared | 0.7378 |
| Adj R-squared | 0.7356 |
| Root MSE | 0.49856 |

Table 6 presents the CO2 multicollinearity for the Overall model; there are five predictor variables and 1213 observations. The F-test for the model is highly significant ($p < 0.001$), indicating that the model is a good fit for the data. The R-squared value of 0.7442 suggests that the model explains about 74% of the variance in the response variable. There are also five predictor variables for the UMC model. The F-test is significant ($p < 0.001$), indicating a good fit for the model. Still, the R-squared value is lower than for the Overall model, at 0.4177, suggesting that this model explains less of the variance in the response variable. The multicollinearity table shows an F-value of 86.79, which is significant ($p < 0.001$), indicating that there may be multicollinearity among the predictor variables. For the LMC (lower) model, the F-test is highly significant ($p < 0.001$), and the R-squared value is higher than for the LMC (upper) model, at 0.7378, suggesting that this model explains more of the variance in the response variable.

*Table.7. GDP Multicollinearity*

| **"Overall"** | |
|---|---|
| F( 5, 1252) | 302.65 |
| Prob > F | 0 |
| R-squared | 0.5472 |
| Adj R-squared | 0.5454 |
| Root MSE | 0.57912 |
| "UMC" | |
| F( 5, 630) | 82.56 |
| Prob > F | 0 |
| R-squared | 0.3959 |
| Adj R-squared | 0.3911 |
| Root MSE | 0.48165 |
| "LMC" | |
| F( 5, 616) | 78.57 |
| Prob > F | 0 |
| R-squared | 0.3894 |
| Adj R-squared | 0.3844 |
| Root MSE | 0.57844 |

Based on the information provided in table 7 for GDP, it seems that the models for Overall, UMC and LMC are all experiencing multicollinearity, as indicated by the shallow probability values (Prob > F = 0) for each model. The R-squared values for each model suggest that Overall has the highest degree of explained variance (R-squared = 0.5472), followed by UMC (R-squared = 0.3959) and LMC (R-squared = 0.3894). However, it is essential to note that the R-squared values alone do not provide a complete picture of the quality of the models. Looking at the Root MSE values, we can see that UMC has the lowest value (0.48165), followed by Overall (0.57912) and LMC (0.57844). This suggests that the model for UMC may have better predictive accuracy than the other two models.

*Table.8. CO2 Variance Inflation Factor (VIF)*

| **Variable** | **VIF** | | | **1/VIF** | | |
|---|---|---|---|---|---|---|
| | **Overall** | **Upper** | **Lower** | **Overall** | **Upper** | **Lower** |
| ICT | 1.63 | 1.28 | 1.33 | 0.615103 | 0.779741 | 0.751668 |
| Int.tourist arrivals | 3.25 | 4.08 | 2.76 | 0.307996 | 0.244843 | 0.362719 |
| Int.tourist receipts | 3.18 | 3.5 | 2.69 | 0.314472 | 0.286121 | 0.371445 |
| Globalization | 1.15 | 1.11 | 1.18 | 0.869075 | 0.898371 | 0.845447 |
| Urbanizations | 1.76 | 1.82 | 1.45 | 0.566897 | 0.54795 | 0.691653 |
| **Mean** | **VIF** | **VIF** | **VIF** | **2.19** | **2.36** | **1.88** |

The CO2 (VIF) in table 8 measures multicollinearity among the independent variables in a regression model. A VIF value of 1 denotes the absence of any correlation between the independent variables. Typically, a VIF value exceeding 5 is indicative of a significant level of multicollinearity. The VIF values for each independent variable in the model and the reciprocal of the VIF (1/VIF) are presented in the provided table. The VIF

values of the independent variables in a model are generally low, suggesting that there is no significant multicollinearity among them.

*Table.9. GDP Variance Inflation Factor (VIF)*

| **Variable** | **VIF** | | | **1/VIF** | | |
|---|---|---|---|---|---|---|
| | **Overall** | **Upper** | **Lower** | **Overall** | **Upper** | **Lower** |
| ICT | 1.62 | 1.28 | 1.33 | 0.617249 | 0.781771 | 0.749977 |
| Int.tourist arrivals | 3.24 | 3.99 | 2.78 | 0.30879 | 0.250536 | 0.359265 |
| Int.tourist receipts | 3.18 | 3.45 | 2.71 | 0.314922 | 0.290034 | 0.36849 |
| Globalization | 1.15 | 1.1 | 1.17 | 0.872824 | 0.905484 | 0.854959 |
| Urbanizations | 1.76 | 1.79 | 1.44 | 0.569767 | 0.559669 | 0.696615 |
| **Mean** | **VIF** | **VIF** | **VIF** | **2.19** | **2.32** | **1.89** |

The GDP (VIF) values in table 9 for international tourist arrivals and global tourist receipts are 3.24 and 3.18, respectively, indicating their high levels of multicollinearity. In contrast, it can be observed that urbanization exhibits a comparatively low VIF value of 1.76, thereby suggesting a lower degree of correlation with the remaining variables incorporated in the model. The variables of ICT and globalization exhibit VIF values of 1.62 and 1.15, respectively. However, the degree of multicollinearity does not appear to be excessively significant.

*Table.10. GMM estimates the effect of ICT, Globalization, tourism and Urbanization on Environmental degradation for Overall, Upper and Lower-middle Countries*

Two-step dynamic panel estimation

| | **Overall** | **Upper** | **Lower** |
|---|---|---|---|
| CO2 | 0.922528*** | 0.8494201*** | 0.9595*** |
| | 0.000 | 0.000 | 0.000 |
| ICT | -0.011499*** | 0.0341357** | 0.0037 |
| | 0.000 | 0.002 | 0.638 |
| Tourism | 0.0279027*** | 0.021897** | 0.0332** |
| | 0.000 | 0.034 | 0.005 |
| Globalization | 0.1502958*** | 0.070513*** | -0.104*** |
| | 0.000 | 0.000 | 0.000 |
| Urbanization | 0.1523171*** | -0.037905 | -0.126*** |
| | 0.000 | 0.409 | 0.000 |
| _cons | -1.55743 | -0.396591 | 0.4521 |
| **AR (1)** | 0.016** | 0.049** | 0.014** |
| **AR (2)** | 0.492 | 0.718 | 0.586 |
| **Sargan test** | 0.008 | 0.998 | 0.260 |
| **Hansen test** | 0.334 | 0.325 | 0.194 |
| **Number of obs** | 1183 | 591 | 592 |
| **Number of groups** | 65 | 32 | 33 |
| **Number of instruments** | 61 | 29 | 29 |

The * and ** and *** are respectively 5%, 1% and 0%significant levels**.**

Table 10 displays the outcomes of the GMM estimations. The statistical significance of each variable is supported by the p-values, all of which exhibit values below 0.05. The coefficient that pertains to environmental degradation displays a positive and statistically significant correlation with all three country categories, namely Overall (0.922528), Upper (0.8494201), and Lower (0.9595) middle-income countries. This indicates an increase in CO2 within the countries. The values about ICT exhibit a heterogeneous association across diverse country cohorts. It reveals that the variable "Overall" exhibits a negative coefficient of -0.011499, whereas the variables "Upper-middle" and "Lower-middle" countries exhibit positive coefficients of 0.0341357 and 0.0037, respectively. Moyer and Hughes (2012) also investigated the possibility that the advancement of ICTs increases carbon emissions, while Amri (2018) showed from the perspective of Tanzania that ICT's impact on carbon emissions from 1975 to 2014 was minimal. Zhou et al. (2019) examined several industries while examining the connection between ICT and carbon emissions in China. The phenomenon under consideration is distinguished by the employment of digital technologies, which diminishes the need for physical mobility and conveyance, consequently leading to a decrease in carbon emissions. Table 9 has also revealed a positive and statistically significant correlation between the coefficient linked to tourism and environmental degradation in Overall (0.0279027), Upper (0.021897), and Lower (0.0332) middle income. Tourism has a positive influence on environmental degradation in all categories. When a country is classified as having a lower-middle-income status, the degree to which tourism

contributes to environmental degradation is relatively less significant. The aforementioned phenomenon can be ascribed to the comparatively lesser prevalence of tourism-centric activities in said countries. The coefficient for Overall and Upper-middle-income countries indicates a statistically significant positive impact of 0.1502958 concerning globalization. It suggests that globalization has a positive effect on environmental degradation in countries overall and upper, but a negative effect on lower-middle income. The heightened international trade and economic activities resulting from globalization have been identified as contributing factors to increased carbon emissions and pollution, leading to environmental degradation in both overall and UMC. The results indicate that urbanization has a positive effect on environmental degradation in middle-income nations. Urbanization in lower-middle-income countries has a significant and positive effect on environmental degradation.

*Table.11. GMM estimates the effect of ICT, Globalization, tourism and Urbanization on Economic growth for Overall, Upper-middle, and Lower-middle Countries*

Two-step dynamic panel estimation

| | **Overall** | **Upper** | **Lower** |
|---|---|---|---|
| GDP | 0.86144*** | 0.76623*** | 0.89087*** |
| | 0.000 | 0.000 | 0.000 |
| ICT | 0.01138*** | 0.10340*** | -0.00022 |
| | 0.000 | 0.000 | 0.973 |
| Tourism | 0.009943*** | 0.05876*** | 0.03216*** |
| | 0.000 | 0.000 | 0.000 |
| Globalization | 0.28630*** | -0.01839 | 0.10014*** |
| | 0.000 | 0.115 | 0.000 |
| Urbanization | 0.10230*** | 0.001681 | -0.07413*** |
| | 0.000 | 0.964 | 0.000 |
| _cons | -.6300515 | 0.95681 | 0.26765 |
| **AR (1)** | 0.001*** | 0.008*** | 0.025*** |
| **AR (2)** | 0.003*** | 0.00*** | 0.328 |
| **Sargan test** | 0 | 0 | 0 |
| **Hansen test** | 0.306 | 0.324 | 0.320 |
| **Number of obs** | 1229 | 617 | 612 |
| **Number of groups** | 65 | 32 | 33 |
| **Number of instruments** | 65 | 33 | 33 |

**Note:** The * and ** and *** are respectively 5%, 1%, and 0% significant levels**.**

Table 11 presents the coefficient estimates for GDP are positive and statistically significant for all three categories of countries - Overall (0.86144), Upper-middle (0.76623), and Lower-middle (0.89087). This indicates that economic growth is increasing in all three groups of countries. For the impact of ICT, the coefficient is positive and statistically significant for Overall (0.01138) and Upper-middle (0.10340) countries, while it is not statistically significant for Lower-middle countries (-0.00022). The potential impact of ICT on economic growth is attributed to the capacity of digital technologies to augment productivity and foster innovation. Conversely, the absence of a

noteworthy impact in nations categorized as Lower-middle income may be attributed to the restricted availability and implementation of ICT within these regions. The tourism coefficient exhibits a positive and statistically significant association across all three categories, namely Overall (0.009943), Upper-middle (0.05876), and Lower-middle (0.03216). Regarding the impact of globalization, it can be observed that the coefficient exhibits a positive and statistically significant value for both Overall (0.28630) and Lower-middle (0.10014) countries. However, for Upper-middle countries, the coefficient is not statistically significant (-0.01839). The coefficient for urbanization is positive and statistically significant for Overall (0.10230) and negative and statistically significant for Lower-middle (-0.07413) countries, while it is not statistically significant for Upper-middle countries (0.001681). This indicates that urbanization has a positive effect on economic growth in Overall countries but a negative effect in Lower-middle countries. The positive effect of urbanization on economic growth in Overall countries may be explained by the concentration of economic activities and innovation in urban areas. However, the negative effect in Lower-middle countries may be due to inadequate infrastructure and public services, leading to environmental and social challenges. In favour of current results Appiah-Otoo and Song (2021) also found that ICT accelerates economic growth in both developed and poor countries. Contrast findings by Nguyen (2018) indicate that there is at least a causal association between urbanization and economic development. Dogru and Bulut (2018) also found that economic growth and tourism development are interconnected and drive economic growth and vice versa in these nations.

## Conclusions and Discussion

### Theoretical contributions

The key theoretical insights of this research hold considerable importance. This study introduces an innovative method by concurrently investigating the collective influence of numerous independent factors on both environmental degradation and economic expansion. By incorporating aspects such as ICT, tourism, globalization, and urbanization, this research delivers an all-encompassing examination of their consequences on the environment and the economy. In addition, this research augments the current body of literature by supplying a comparative evaluation of the independent variables concerning environmental degradation and economic development. The results enable a combined assessment and differentiation of these factors' effects across different countries. These discoveries contribute to the current knowledge base and supply valuable information for those involved in sustainable development, environmental management, and economic growth endeavors.

### Practical Implications

The findings emphasize the importance of adopting a balanced and eco-friendly approach to growth. It is crucial for decision-makers to focus on strong environmental policies and rules that tackle the undeniable link between environmental deterioration and all categories of nations. This involves lowering CO2 emissions, encouraging the use of renewable energy, and applying more rigorous environmental criteria. Moreover, it is essential to create sustainable ICT policies, taking into account the varying influences of ICT on environmental damage and economic expansion among different country groups. Sustainable tourism methods should be endorsed by governments to leverage the financial advantages of tourism while reducing its ecological footprint. A harmonized approach to

globalization is vital, concentrating on eco-friendly trade and investment practices. Finally, sustainable urbanization tactics should be employed to guarantee economic prosperity while mitigating the adverse environmental and societal outcomes of urban growth. By adopting these pragmatic steps, nations can attain sustainable development through balancing economic progress with ecological preservation and social welfare.

**Conclusion**

In this study, the effect of information and communication technology, tourism, globalization, and urbanization on economic growth and environmental degradation are explored in middle-income countries. The empirical findings, were obtained from a micro panel dataset covering 65 nations from 2000 to 2021. The influence of ICT on environmental deterioration differs among country categories, with Overall countries having a detrimental effect, Upper-middle countries showing a positive impact, and Lower-middle countries presenting no significant correlation. Tourism consistently affects environmental degradation positively across all nation types, underscoring the necessity for eco-friendly tourism strategies. Globalization contributes positively to environmental damage in Overall and Upper-middle-income nations, while negatively affecting Lower-middle-income countries. Urbanization positively impacts environmental degradation in Overall and Lower-middle-income nations, but exhibits no substantial effect in Upper-middle-income countries. These results emphasize the significance of addressing the ecological repercussions of ICT, tourism, globalization, and urbanization, as well as adopting sustainable methods in various countries. In order to lessen the environmental damage caused by ICT, tourism, globalization, and urbanization, Upper-middle income nations should emphasize the adoption of energy-saving technologies, eco-friendly tourism approaches, environmental rules for global trade, and sustainable urban development and design. Enacting these strategies will help lower energy usage, handle electronic waste, decrease transportation emissions, preserve natural resources, and encourage the use of renewable energy. The results suggest that there is a rise in economic growth for all income groups. Both ICT and tourism contribute significantly to the economic growth of Overall and Upper-middle nations, but ICT's influence is not prominent in Lower-middle countries. Globalization has a favorable impact on the economy of Overall and Lower-middle nations, although it doesn't have the same effect on Upper-middle countries. Urbanization boosts economic growth in Overall countries, yet it negatively impacts Lower-middle countries. Insufficient infrastructure and public amenities restrict the potential growth in productivity linked to urbanization. Limited availability of education, healthcare, and transport systems obstructs the progress of human resources and economic enhancement. Moreover, unrestrained urban expansion and irregular settlements contribute to environmental decline and exhaustion of resources, intensified by poor urban planning and governance. Social and financial inequalities aggravate the detrimental effects, with the concentration of economic pursuits in metropolitan regions side-lining specific demographic groups and broadening income disparities. Future research may explore the possible relationship between economic growth and income inequality, examine sustainable approaches to mitigate the negative impacts of tourism and globalization on economic growth, investigate the equilibrium between economic growth and environmental degradation, and utilize advanced modelling techniques to gain a deeper insight into the underlying mechanisms and causal relationships among these variables.

While this research effectively accomplishes its objectives, it's crucial to acknowledge and address various limitations that present opportunities for future research. Firstly, the reliance on available data, which can vary in quality and completeness among countries, introduces the potential for measurement biases that need mitigation in future studies. Secondly, although the study reveals significant associations between variables, establishing causality remains a formidable challenge, necessitating ongoing exploration and methodological enhancement. Thirdly, the study's limited exploration of regional and contextual variations within middle-income countries constrains the broader applicability of its findings, emphasizing the importance of in-depth regional analyses. Lastly, the research's focus on middle-income nations prompts questions regarding the transferability of findings to other income groups or regions, emphasizing the importance of expanding the scope of inquiry. In conclusion, these limitations underscore the ongoing imperative for future research to advance our understanding of the intricate interactions among information technology, tourism, globalization, urbanization, environmental sustainability, and economic development, ultimately guiding more effective and context-sensitive policy development.

## References

Adebayo, T. S., AbdulKareem, H. K., Kirikkaleli, D., Shah, M. I., & Abbas, S. (2022). CO2 behavior amidst the COVID-19 pandemic in the United Kingdom: The role of renewable and non-renewable energy development. *Renewable Energy*, *189*, 492-501.

Aghaei, M., & Rezagholizadeh, M. (2017). The impact of information and communication technology (ICT) on economic growth in the OIC Countries. *Economic and Environmental Studies*, *17*(2 (42)), 257-278.

Akadiri, S. S., & Akadiri, A. C. (2021). Examining the causal relationship between tourism, exchange rate, and economic growth in tourism island states: evidence from second-generation panel. *International Journal of Hospitality & Tourism Administration*, *22*(3), 235-250.

Amri, F. (2018). Carbon dioxide emissions, total factor productivity, ICT, trade, financial development, and energy consumption: testing environmental Kuznets curve hypothesis for Tunisia. *Environmental Science and Pollution Research*, *25*, 33691-33701.

Annez, P. C., Buckley, R. M., & Spence, M. (2009). *Urbanization and growth*. Commission on Growth and Development: World Bank.

Appiah-Otoo, I., & Song, N. (2021). The impact of ICT on economic growth-Comparing rich and poor countries. *Telecommunications Policy*, *45*(2), 102082.

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of econometrics*, *68*(1), 29-51.

Arshad, Z., Robaina, M., & Botelho, A. (2020). The role of ICT in energy consumption and environment: an empirical investigation of Asian economies with cluster analysis. *Environmental Science and Pollution Research*, *27*, 32913-32932.

Asongu, S. A., Le Roux, S., & Biekpe, N. (2018). Enhancing ICT for environmental sustainability in sub-Saharan Africa. *Technological Forecasting and Social Change*, *127*, 209-216.

Balsalobre-Lorente, D., Shahbaz, M., Roubaud, D., & Farhani, S. (2018). How economic growth, renewable electricity and natural resources contribute to CO2 emissions? *Energy policy*, *113*, 356-367.

Bayraktar Sağlam, B. (2018). ICT diffusion, R&D intensity, and economic growth: a dynamic panel data approach. *Journal of the Knowledge Economy*, *9*, 636-648.

Becken, S., & Hay, J. E. (2007). *Tourism and climate change: Risks and opportunities* (Vol. 1). Multilingual Matters.

Belkhir, L., & Elmeligi, A. (2018). Assessing ICT global emissions footprint: Trends to 2040 & recommendations. *Journal of Cleaner Production*, *177*, 448-463.

Bilen, M., Yilanci, V., & Eryüzlü, H. (2017). Tourism development and economic growth: a panel Granger causality analysis in the frequency domain. *Current Issues in Tourism*, *20*(1), 27-32.

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, *87*(1), 115-143.

Chien, F., Anwar, A., Hsu, C.-C., Sharif, A., Razzaq, A., & Sinha, A. (2021). The role of information and communication technology in encountering environmental degradation: proposing an SDG framework for the BRICS countries. *Technology in Society*, *65*, 101587.

Cole, M. A., & Neumayer, E. (2004). Examining the impact of demographic factors on air pollution. *Population and Environment*, 5-21.

Coroama, V. C., Hilty, L. M., & Birtel, M. (2012). Effects of Internet-based multiple-site conferences on greenhouse gas emissions. *Telematics and Informatics*, *29*(4), 362-374.

Dar, A., Pan, B., Qin, J., Zhu, Q., Lichtfouse, E., Usman, M., & Wang, C. (2021). A review on sustainable ferrate oxidation: Reaction chemistry, mechanisms and applications to eliminate micropollutant (pharmaceuticals) in wastewater. *Environ. Pollut*, *290*(275), 117957.

Dar, A. A., Shakoor, A., Niazi, N. K., Tufail, M. A., Syed, J. A. S., Sarfraz, M., Faheem, M., Shabbir, S., ul Haq, I., & Wang, C. (2021). A meta-analysis of photocatalytic performance and efficiency of bismuth oxide (BiO2_x). *Journal of Cleaner Production*, *322*, 129070.

Dimelis, S. P., & Papaioannou, S. K. (2010). FDI and ICT effects on productivity growth: A comparative analysis of developing and developed countries. *The European Journal of Development Research*, *22*, 79-96.

Dogru, T., & Bulut, U. (2018). Is tourism an engine for economic recovery? Theory and empirical evidence. *Tourism Management*, *67*, 425-434.

Edquist, H., & Henrekson, M. (2017). Swedish lessons: How important are ICT and R&D to economic growth? *Structural Change and Economic Dynamics*, *42*, 1-12.

Fan, P., Ouyang, Z., Nguyen, D. D., Nguyen, T. T. H., Park, H., & Chen, J. (2019). Urbanization, economic development, environmental and social changes in transitional economies: Vietnam after Doimoi. *Landscape and urban planning*, *187*, 145-155.

Fareed, Z., Salem, S., Adebayo, T. S., Pata, U. K., & Shahzad, F. (2021). Role of export diversification and renewable energy on the load capacity factor in Indonesia: A Fourier quantile causality approach. *Frontiers in Environmental Science*, 434.

Gasimli, O., Haq, I. u., Naradda Gamage, S. K., Shihadeh, F., Rajapakshe, P. S. K., & Shafiq, M. (2019). Energy, trade, urbanization, and environmental degradation nexus in Sri Lanka: bounds testing approach. *Energies*, *12*(9), 1655.

Godil, D. I., Sharif, A., Agha, H., & Jermsittiparsert, K. (2020). The dynamic nonlinear influence of ICT, financial development, and institutional quality on CO2 emission in Pakistan: new insights from QARDL approach. *Environmental Science and Pollution Research*, *27*, 24190-24200.

Goldberg, P. K., & Pavcnik, N. (2007). Distributional effects of globalization in developing countries. *Journal of Economic Literature*, *45*(1), 39-82.

Gössling, S., & Hall, C. M. (2006). An introduction to tourism and global environmental change. In *Tourism and global environmental change* (pp. 1-33). Routledge.

Goundar, S., & Appana, S. (2018). Mainstreaming development policies for climate change in Fiji: a policy gap analysis and the role of ICTs. In *Sustainable Development: Concepts, Methodologies, Tools, and Applications* (pp. 402-432). IGI Global.

Grossman, G., & Krueger, A. (1995). Economic growth and the environment. Quarterly Journal of Economics. 110 (2), 353-377. In.

Gwenhure, Y., & Odhiambo, N. M. (2017). Tourism and economic growth: A review of international literature. *Tourism: An International Interdisciplinary Journal*, *65*(1), 33-44.

Hall, D. R. (1998). Tourism development and sustainability issues in Central and South-Eastern Europe. *Tourism Management*, *19*(5), 423-431.

Huybers, T., & Bennett, J. (2000). Impact of the environment on holiday destination choices of prospective UK tourists: implications for Tropical North Queensland. *Tourism Economics*, *6*(1), 21-46.

Jacobi, P., Kjellen, M., McGranahan, G., Songsore, J., & Surjadi, C. (2010). *The citizens at risk: from urban sanitation to sustainable cities*. Routledge.

Jalil, A., Mahmood, T., & Idrees, M. (2013). Tourism–growth nexus in Pakistan: Evidence from ARDL bounds tests. *Economic Modelling*, *35*, 185-191.

Jones, D. W. (1991). How urbanization affects energy use in developing countries. *Energy policy*, *19*(7), 621-630.

Khan, N., Baloch, M. A., Saud, S., & Fatima, T. (2018). The effect of ICT on CO2 emissions in emerging economies: does the level of income matter? *Environmental Science and Pollution Research*, *25*, 22850-22860.

Lanza, A., Temple, P., & Urga, G. (2003). The implications of tourism specialization in the long run: an econometric analysis for 13 OECD economies. *Tourism Management*, *24*(3), 315-321.

Lasisi, T. T., Alola, A. A., Eluwole, K. K., Ozturen, A., & Alola, U. V. (2020). The environmental sustainability effects of income, labor force, and tourism development in OECD countries. *Environmental Science and Pollution Research*, *27*, 21231-21242.

Lee, C.-C., & Chang, C.-P. (2008). Tourism development and economic growth: A closer look at panels. *Tourism Management*, *29*(1), 180-192.

Lee, J. W., & Brahmasrene, T. (2014). ICT, CO2 emissions and economic growth: evidence from a panel of ASEAN. *Global Economic Review*, *43*(2), 93-109.

Lin, V. S., Yang, Y., & Li, G. (2019). Where can tourism-led growth and economy-driven tourism growth occur? *Journal of Travel Research*, *58*(5), 760-773.

López, R., & Galinato, G. I. (2005). Deforestation and forest-induced carbon dioxide emissions in tropical countries: how do governance and trade openness affect the forest-income relationship? *The Journal of Environment & Development*, *14*(1), 73-100.

Mills, M. (2009). Globalization and inequality. *European Sociological Review*, *25*(1), 1-8.

Mitra, S. K. (2019). Is tourism-led growth hypothesis still valid? *International Journal of Tourism Research*, *21*(5), 615-624.

Moyer, J. D., & Hughes, B. B. (2012). ICTs: do they contribute to increased carbon emissions? *Technological forecasting and social change*, *79*(5), 919-931.

N'dri, L. M., Islam, M., & Kakinaka, M. (2021). ICT and environmental sustainability: any differences in developing countries? *Journal of Cleaner Production*, *297*, 126642.

Nguyen, H. M. (2018). The relationship between urbanization and economic growth: An empirical study on ASEAN countries. *International Journal of Social Economics*, *45*(2), 316-339.

Niu, H., & Lekse, W. (2018). Carbon emission effect of urbanization at regional level: empirical evidence from China. *Economics*, *12*(1).

Ozcan, B., & Apergis, N. (2018). The impact of internet use on air pollution: Evidence from emerging countries. *Environmental Science and Pollution Research*, *25*, 4174-4189.

Park, Y., Meng, F., & Baloch, M. A. (2018). The effect of ICT, financial development, growth, and trade openness on CO 2 emissions: an empirical analysis. *Environmental Science and Pollution Research*, *25*, 30708-30719.

Poumanyvong, P., & Kaneko, S. (2010). Does urbanization lead to less energy use and lower CO2 emissions? A cross-country analysis. *Ecological economics*, *70*(2), 434-444.

Primayesa, E., Widodo, W., & Sugiyanto, F. (2019). The tourism-led growth hypothesis in Indonesia. *E-review of Tourism Research*, *17*(1).

Razzaq, A., Fatima, T., & Murshed, M. (2023). Asymmetric effects of tourism development and green innovation on economic growth and carbon emissions in Top 10 GDP Countries. *Journal of Environmental Planning and Management*, *66*(3), 471-500.

Sabbagh, K., Friedrich, R., El-Darwiche, B., Singh, M., & Koster, A. (2013). Digitization for economic growth and job creation: Regional and industry perspectives. *The global information technology report*, *2013*, 35-42.

Sadorsky, P. (2014). The effect of urbanization on CO2 emissions in emerging economies. *Energy economics*, *41*, 147-153.

Santiago, R., Fuinhas, J. A., & Marques, A. C. (2020). The impact of globalization and economic freedom on economic growth: the case of the Latin America and Caribbean countries. *Economic Change and Restructuring*, *53*, 61-85.

Sanz, A. G., & Hellström, J. (2011). *Information Economy: Report 2011: ICTs as an Enabler for Private Sector Development*. UN.

Sbia, R., Shahbaz, M., & Ozturk, I. (2017). Economic growth, financial development, urbanisation and electricity consumption nexus in UAE. *Economic research-Ekonomska istraživanja*, *30*(1), 527-549.

Sethi, P., Chakrabarti, D., & Bhattacharjee, S. (2020). Globalization, financial development and economic growth: Perils on the environmental sustainability of an emerging economy. *Journal of Policy Modeling*, *42*(3), 520-535.

Shabani, Z. D., & Shahnazi, R. (2019). Energy consumption, carbon dioxide emissions, information and communications technology, and gross domestic product in Iranian economic sectors: A panel causality analysis. *Energy*, *169*, 1064-1078.

Shahbaz, M., Loganathan, N., Muzaffar, A. T., Ahmed, K., & Jabran, M. A. (2016). How urbanization affects CO2 emissions in Malaysia? The application of STIRPAT model. *Renewable and Sustainable Energy Reviews*, *57*, 83-93.

Shahbaz, M., Sbia, R., Hamdi, H., & Ozturk, I. (2014). Economic growth, electricity consumption, urbanization and environmental degradation relationship in United Arab Emirates. *Ecological Indicators*, *45*, 622-631.

Shahnazi, R., & Dehghan Shabani, Z. (2019). The effects of spatial spillover information and communications technology on carbon dioxide emissions in Iran. *Environmental Science and Pollution Research*, *26*, 24198-24212.

Shahzad, S. J. H., Shahbaz, M., Ferrer, R., & Kumar, R. R. (2017). Tourism-led growth hypothesis in the top ten tourist destinations: New evidence using the quantile-on-quantile approach. *Tourism Management*, *60*, 223-232.

Shan, S., Ahmad, M., Tan, Z., Adebayo, T. S., Li, R. Y. M., & Kirikkaleli, D. (2021). The role of energy prices and non-linear fiscal decentralization in limiting carbon emissions: Tracking environmental sustainability. *Energy*, *234*, 121243.

Shehzad, K., Zaman, U., Ahmad, M., & Liu, X. (2022). Asymmetric impact of information and communication technologies on environmental quality: analyzing the role of financial development and energy consumption. *Environment, Development and Sustainability*, *24*(2), 1761-1780.

Simpson, J. M., Dunlap, R. E., & Fullerton, A. S. (2019). The treadmill of information: development of the information society and carbon dioxide emissions. *Sociology of Development*, *5*(4), 381-409.

Sinha, A., Shahbaz, M., & Balsalobre, D. (2017). Exploring the relationship between energy usage segregation and environmental degradation in N-11 countries. *Journal of Cleaner Production*, *168*, 1217-1229.

Tamazian, A., Chousa, J. P., & Vadlamannati, K. C. (2009). Does higher economic and financial development lead to environmental degradation: evidence from BRIC countries. *Energy policy*, *37*(1), 246-253.

Tang, C. F., & Tan, B. W. (2015). The impact of energy consumption, income and foreign direct investment on carbon dioxide emissions in Vietnam. *Energy*, *79*, 447-454.

Wang, Y., Li, L., Kubota, J., Han, R., Zhu, X., & Lu, G. (2016). Does urbanization lead to more carbon emission? Evidence from a panel of BRICS countries. *Applied Energy*, *168*, 375-380.

Wu, J., Wu, Y., Guo, X., & Cheong, T. S. (2016). Convergence of carbon dioxide emissions in Chinese cities: a continuous dynamic distribution approach. *Energy policy*, *91*, 207-219.

Zhang, C., & Lin, Y. (2012). Panel estimation for urbanization, energy consumption and CO2 emissions: A regional analysis in China. *Energy policy*, *49*, 488-498.

Zhang, C., & Liu, C. (2015). The impact of ICT industry on CO2 emissions: a regional analysis in China. *Renewable and Sustainable Energy Reviews*, *44*, 12-19.

Zhang, D., Rong, Z., & Ji, Q. (2019). Green innovation and firm performance: Evidence from listed companies in China. *Resources, Conservation and Recycling*, *144*, 48-55.

Zhong, L., Deng, J., Song, Z., & Ding, P. (2011). Research on environmental impacts of tourism in China: Progress and prospect. *Journal of Environmental Management*, *92*(11), 2972-2983.

Zhou, X., Zhou, D., Wang, Q., & Su, B. (2019). How information and communication technology drives carbon emissions: a sector-level analysis for China. *Energy economics*, *81*, 380-392.

**Annexure**

*Country list*

| Country | Country Code | Category | Country | Country Code | Category |
|---|---|---|---|---|---|
| Albania | ALB | UMC | Algeria | DZA | LMC |
| Argentina | ARG | UMC | Angola | AGO | LMC |
| Armenia | ARM | UMC | Bangladesh | BGD | LMC |
| Azerbaijan | AZE | UMC | Benin | BEN | LMC |
| Belarus | BLR | UMC | Bhutan | BTN | LMC |
| Bosnia and Herzegovina | BIH | UMC | Bolivia | BOL | LMC |
| Brazil | BRA | UMC | Cambodia | KHM | LMC |
| Bulgaria | BGR | UMC | Cameroon | CMR | LMC |
| Colombia | COL | UMC | Comoros | COM | LMC |
| Costa Rica | CRI | UMC | El Salvador | SLV | LMC |
| Cuba | CUB | UMC | Eswatini | SWZ | LMC |
| Dominica | DMA | UMC | Ghana | GHA | LMC |
| Dominican Republic | DOM | UMC | Haiti | HTI | LMC |
| Ecuador | ECU | UMC | Honduras | HND | LMC |
| Fiji | FJI | UMC | India | IND | LMC |
| Georgia | GEO | UMC | Indonesia | IDN | LMC |
| Guatemala | GTM | UMC | Kenya | KEN | LMC |
| Jordan | JOR | UMC | Lebanon | LBN | LMC |
| Kazakhstan | KAZ | UMC | Mongolia | MNG | LMC |
| Malaysia | MYS | UMC | Morocco | MAR | LMC |
| Mauritius | MUS | UMC | Morocco | MAR | LMC |
| Mexico | MEX | UMC | Nepal | NPL | LMC |
| Moldova | MDA | UMC | Nigeria | NGA | LMC |
| Montenegro | MNE | UMC | Pakistan | PAK | LMC |
| North Macedonia | MKD | UMC | Philippines | PHL | LMC |
| Paraguay | PRY | UMC | Senegal | SEN | LMC |
| Peru | PER | UMC | Solomon Islands | SLB | LMC |
| Serbia | SRB | UMC | Sri Lanka | LKA | LMC |
| South Africa | ZAF | UMC | Tanzania | TZA | LMC |
| Thailand | THA | UMC | Tunisia | TUN | LMC |
| Tonga | TON | UMC | Vanuatu | VUT | LMC |
| Ukraine | UKR | UMC | Vietnam | VNM | LMC |
| | | | Zimbabwe | ZWE | LMC |