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The Role of Infrastructure Investment on Inclusive Growth and Human Development Index: Evidence from Emerging Economies

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ABSTRACT

The paper examines the effect of infrastructure investment on the Human Development Index (HDI) score for five middle-income countries, namely Brazil, South Africa, Turkey, Mexico and Vietnam. The dynamic panel data model was used in the study. Data was sourced from the World Bank and the United Nations Development Programme focused on the prevalence and utilisation of five types of infrastructure in the countries mentioned above: electricity, water, sanitation, transport, telecommunications, and schools. The findings show that HDI is too narrow to be used as the main tool to measure human development and suggest that water and sanitation as well as the electrification of households were crucial infrastructures that had a positive impact on the HDI and be viewed as one type of infrastructure when researching the relationship between infrastructure investment and the HDI. The paper concluded and highlighted the need for infrastructure investors and policymakers to have a multi-dimensional approach to measuring the impact they would like to make. In this way, they would have more pronounced insights about which infrastructure they should invest in and how it will improve the wellbeing of society.

Keywords: Inclusive Growth, Infrastructure Investment, Human Development Index
JEL Classifications: H41, H50, H54

1. INTRODUCTION

Globally, there have been many talks about how infrastructure investment can be one of the key strategies that countries can implement to help grow the economy while absorbing large numbers of the unemployed into the mainstream economy, thus lowering poverty and inequality (Batool et al., 2020). The challenges of poverty, inequality and unemployment are global, and policymakers are constantly working on how to alleviate them. These challenges affect primarily women, children and the youth most acutely, and Covid-19 pandemic has exacerbated these challenges by worsening unemployment and deepening inequality and poverty, especially in poor and middle-income countries (Batool et al., 2020; Abotsi and Ampah, 2024). Also, the pandemic has had a significant economic impact on the global economy, with emerging market economies hard hit and looking for means to kickstart their economies to deal with the impact of job losses that have raised the unemployment rates, and higher levels of poverty, due to weaker economies. Policy-makers worldwide have identified infrastructure investment as one of the key means by which they can generate economic growth and absorb more people into the gainfully employed.

It becomes clear that in modern thought, the idea of infrastructure has broadened, and this broadening potentially creates more targeted investment opportunities to improve the well-being and development of a country's citizens. Therefore, the concept of infrastructure can be considered foundational (Kanoi et al., 2022). However, in our modern age, we need to look at infrastructure beyond its foundational physical aspects and acknowledge that there are also foundational systems that are not physical structures that make life easier, improve productivity and enable development (Kanoi et al., 2022). With Information and communications technology increasingly becoming one of the fastest-growing components of the most significant infrastructure projects (Flyvbjerg, 2013), the explicit battle of what should be considered infrastructure and what should be excluded is alive and ongoing (Kanoi et al., 2022). Researchers must advise whether the infrastructure concept be expanded to include technology such as cloud computing, artificial intelligence, and the different software codes and algorithms that enhance our daily experiences.

This study sought to determine whether infrastructure investment can advance the goal of inclusive growth that would increase human development, as measured through the Human Development Index (HDI) (UNDP, 2019) in middle-income countries as measured by the World Bank. The paper dealt with key concepts: infrastructure, inclusive growth and human development. Infrastructure is a broad concept that can be split into physical (Kuada, 2013) and social infrastructure (Chandra et al., 2014), where physical infrastructure refers to water, energy, communication and transportation services (Straub, 2011); and social infrastructure relates to health and education facilities (Kuada, 2013). Inclusive growth has been defined as broad-based economic growth that benefits a broader base of a country's working population. Its focus is not on alleviating poverty through redistribution but on growth built on improving productivity and creating available work opportunities (Bakker and Messerli, 2017; Adeosun et al., 2020). Lastly, the Human Development Index is a measure created by the United Nations that seeks to measure human development in countries by focusing on and measuring three main factors that are life expectancy at birth, level of education and GDP per capita measured in dollars on a purchasing power of parity basis (Sapkota, 2014; Lind, 2019).

2. LITERATURE REVIEW

2.1. Defining Infrastructure

In Straub (2011), infrastructure was defined as transportation facilities; water and waste treatment; telecommunications; and energy generation, transmission and distribution. However, this description of infrastructure has been expanded in recent times (Chirgwin et al., 2021; Nchofoung et al., 2022). This expanded definition is supported by Kuada (2013), who intimates that there are two types of infrastructure: physical and social. Social infrastructure has also been defined as the services and processes that increase the community's capacity to improve and enhance the quality of life of the people (Chandra et al., 2014). This would include developments in healthcare, education, access to information, quality housing, arts and culture, employment and general public welfare and safety (Chandra et al., 2014). Both forms of infrastructure play an essential role in the economic development of a country (Kuada, 2013). The author identifies communication, transport and energy facilities as physical infrastructure while health and education facilities as social infrastructure.

2.2. Defining Inclusive Growth

The concept of inclusive growth has been used extensively in the political discourse; however, it is unclear what inclusive growth means (Xun and Guanghua, 2017). According to Bakker and Messerli (2017), the idea of inclusive growth evolved from the concept of pro-poor growth. Pro-poor growth began to be at the forefront when discussing economic development and economic growth in the 1990s as development agencies realised that the economic policies followed increased economic growth and inequality (Bakker and Messerli, 2017). Mutiiria et al., (2020) defined pro-poor growth, in its absolute sense, as that growth whereby the poor experience economic growth that is higher than the average economic growth rate, resulting in inequality falling.

Inclusive growth differs from pro-poor growth in that Inclusive growth focuses on growth that is broad-based and includes a more significant proportion of a country's workforce, and not limited only to those in poverty, that it must not be based on redistribution but must be about the creation of productive and sustainable economic opportunities (Bakker and Messerli, 2017; Joshi, 2010). On the other hand, pro-poor growth focuses on poverty alleviation and a reduction in inequality which is driven by redistribution and taxes and tends to be biased towards those who are already under the poverty line (Bakker and Messerli, 2017). Adeosun et al. (2020) acknowledge that these concepts of pro-poor and inclusive growth overlap. However, inclusive growth was the better concept as it was more broad-based, covering a broader swathe of the population while seeking to reduce poverty and inequality through expanding economic opportunities. In this, they agree with Balakrishnan et al. (2013), which defined inclusive growth as growth that is not associated with an increase in inequality. According to Rauniyar and Kanbur (2010), pro-poor growth reduces income poverty but can still see the levels of inequality rise in a society, while inclusive growth decreases income inequality so that more income is accrued to those with lower incomes. Thus, pro-poor and inclusive growth seek to increase incomes. However, inclusive growth seeks to do this through being broad-based and creating economic opportunities to lower inequality bracket people (Djokoto, 2022).

Therefore, inclusive growth is about more than just distributing income; it is also about increasing output and ensuring that what is produced is distributed widely so that it is inclusive (Lee, 2019). Ultimately inclusive growth seeks to improve people's living standards by ensuring that increases in society's wealth are shared more equitably across different groups (Pigeron-Piroth, et al., 2017; OECD, 2015c; Joshi, 2010).

2.3. Infrastructure Investing and its Support of Inclusive Growth

The research into how investing in infrastructure boosts employment seems ambiguous (di Cataldo and Rodríguez-Pose, 2017). In the literature, there is a causal connection between infrastructure development and economic growth (Rauniyar and Kanbur, 2010). This linkage also underpins infrastructure's role in inclusive growth. This sentiment led Straub (2011) to state that even though there is research linking infrastructure availability and economic growth, there is still uncertainty and debate about the reliability and persistence of this causal link. On the face of it, infrastructure investment should have a direct and positive effect on economic growth and the general upliftment of the population. However, this is not guaranteed as setbacks can befall infrastructure projects such that a project becomes too expensive due to cost overruns (Flyvbjerg, 2009) or projects that are ill-conceived, poorly planned, and don't add value to society (Nchofoung et al., 2022; Joshi, 2010).

Infrastructure matters because it provides key final consumption items to households, such as roads, water accessories and telecommunications (Straub, 2011; Amador-Jimenez and Willis, 2012). These items are crucial to the well-being of society through which their well-being can be improved (Mohanty et al., 2016). Furthermore, investing in general infrastructure contributes to economic growth driven by enhanced productivity (Ghosh, 2017). Public infrastructure being roads, water, energy and telecommunications (Straub, 2011). In Ghosh (2017), the author put forth that human well-being benefits greatly from infrastructure investment in education and health. The provision of safe drinking water to hospitals, electricity to schools and a road network that is accessible enhance the well-being of society (Das and Borah, 2021; Zhang and Zong, 2019; Hlotywa and Ndaguba, 2017).

In Sub-Saharan Africa, according to Kuada (2013) had experienced low growth because of low investment in infrastructure. This is also attributed to a lack of good governance and widespread corruption (Doumbia, 2019). In general, it can be said that if the infrastructure is built far away from the socially excluded households, the costs of accessing that infrastructure could rise, resulting in these households participating less in society and exacerbating their exclusion (di Cataldo and Rodríguez-Pose, 2017). However, the converse is also true in that a decline in investment in infrastructure leads to the dampening of inclusive growth across all economies (Joshi, 2010). Furthermore, when infrastructure projects are coordinated, the rural-urban divide is reduced, leading to more stable and balanced development concerning social welfare, the economy and the environment (Rana et al., 2017; Joshi, 2010).

2.4. Infrastructure Investment and its Impact on the Human Development Index (HDI)

According to Sharma and Sharma (2015), the HDI can be defined as a geometrical average of three indices that measure life expectancy, years of schooling and standard of living measured as gross national income per capita (Tsaurai and Ndou, 2019). By looking at life expectancy and years of schooling, over and above just GDP per capita, the HDI sought to provide a broader characterisation of development that was not possible if we only looked at income (Ravallion, 2012; Liu et al., 2021). The standard of living measures the nation's gross domestic product (GDP) per person. This is measured in U7S Dollars based on a Purchasing Power of Parity (PPP) basis (Muto and Saiki, 2024; Hopkins, 1991). Regarding schooling, the literacy and enrolment rates are primary, secondary and tertiary institutions (Valero et al., 2023). Life expectancy measures how long an average person can expect to live in their country and the average number of years of education that an average 25-year-old has attained which was added in 2016 (Valero et al., 2023; Lind, 2019).

According to (Das and Borah, 2021), the HDI might not be the best measure of a country's human development, however, they hold that it is the most efficient. Measuring human development is tricky because there is so much variation in the level of development within a country itself. This is also compounded by the variation in levels of development in different countries (Das and Borah, 2021). It is, therefore, essential to understanding that the HDI gives a generalised view and identifies trends.

According to Atangana, and Oberholster, (2023), 88 percent of the population globally has access to potable water, whereas sanitation coverage is slightly lower at 76 percent. For example, high-income countries exhibit near-universal electricity access, whereas only 44 percent of the population in Sub-Saharan Africa has dependable electricity access (Bhattacharyya and Palit, 2021). High-income nations benefit from nearly universal access to these services, which enhances their elevated HDI scores (Picatoste et al., 2021). Nonetheless, low-income nations, especially in Sub-Saharan Africa (Nchofoung et al., 2022), face challenges due to restricted access to clean water, sanitation, and electricity, which considerably impedes human development outcomes (Atangana and Oberholster, 2023).

Wang et al., (2024) compare access to clean water and enhanced sanitation facilities across various regions, Sub-Saharan Africa exhibits the lowest access to improved sanitation, with merely 28% of the population served. Conversely, European and North American nations report nearly universal access to both clean water and enhanced sanitation facilities (Pereira et al., 2021). According to Jin et al., (2020), nations with enhanced access to clean water and improved sanitation typically exhibit lower child mortality rates and increased life expectancy, thereby elevating their HDI scores. Nations such as Chad and Somalia, encounter significant health challenges where fewer than 30% of the populace has access to clean water, (Ohwo and Agusomu, 2018).

Blimpo and Cosgrove-Davies, (2019) highlighted the significance of electricity access in economic development, education, and healthcare, the study found that access to electricity is essential for human development, facilitating educational opportunities via digital learning and enhancing healthcare delivery. In essence, there is evidence that infrastructure investment positively affects household income, educational performance and job opportunities (Van de Walle et al., 2013). This is supported by (Parikh et al., 2015), who found that the provision of electricity in the Indian slum positively impacted the health, literacy levels and incomes of the people. Countries with restricted electricity access, such as South Sudan and Malawi, encounter substantial obstacles to development (Valickova and Elms, 2021).

Sapkota (2014) examine the disparities in transport infrastructure and mobile network accessibility across different regions and income brackets, and how these elements affect human development. Countries possessing robust transport infrastructure, like Germany and the United States, demonstrate elevated HDI scores. Mobile connectivity has emerged as a vital catalyst for development, with nations such as South Korea excelling in mobile phone penetration, thereby facilitating improved access to education and services (Lee et al., 2018). Saif et al., (2019) examine the impact of access to transport networks, such as roads, railways, and public transit, on economic activity, education, and service accessibility. The study found that effective transport networks are vital for economic advancement and fundamental services. For example, countries with advanced transport infrastructures, such as France and Japan, achieve higher HDI scores owing to improved access to education and healthcare (González et al., 2020).

Examining the significance of mobile and internet connectivity in improving education, commerce, and service accessibility, especially in the remote or rural areas of the Central African Republic, (Zanden, 2023), noted that inadequate mobile connectivity, specifically below certain thresholds disadvantages individuals and jeopardises human development indices. Countries with high mobile penetration, like South Korea and the United Arab Emirates, have improved access to online education and healthcare services, thus enhancing their HDI scores (De la Hoz-Rosales et al., 2019; Balouza, 2019; Salemink et al., 2017). Also, Glewwe and Muralidharan, (2016) examine the influence of school enrolment rates on educational outcomes and their correlation with the HDI. Increased school enrolment generally results in improved educational outcomes and elevated HDI. High school enrolment rates exhibit a positive correlation with HDI scores, especially in nations such as Finland and Canada, where enrolment surpasses 95% (Avalueva et al., 2022; Klasen, 2018). Low enrolment rates in nations such as Afghanistan and Mali result in diminished HDI scores owing to limited access to education (Zürcher, 2022).

In a study conducted in South Africa, Gnade et al. (2017) looked at what effect basic infrastructure had on economic growth and development, the study found that, in general, investment in basic social infrastructure can help in poverty alleviation and social development, but they also found that for infrastructure investment to be beneficial, it must meet the needs of that particular area. The objective is to expand housing, water and sanitation, electricity, transportation, information and communications technology (ICT), educational institutions, and healthcare facilities for the new urban inhabitants.

It is essential to acknowledge that having infrastructure on its own is not a panacea for low growth, inequality and poverty. Infrastructure investment must be accompanied by precise planning and understanding of which infrastructures are needed (Nchofoung et al., 2022) and having the operational efficiency to utilise the infrastructure in such a way that it materially benefits the country and its people and achieves improvements that have a direct bearing on human development (Das and Borah, 2021). Subsequently, infrastructure enhances human development, and by extension, the HDI. It leads to increased incomes, higher productivity gains, increased employment and employment opportunities, improved income distribution and allows for more diversification within the economy (Mohanty et al., 2016; Castells-Quintana et al., 2019). For example, Mohanty et al. (2016) found that investment in information and communications technology, postal services, electrification of the community, schools, and water and sanitation profoundly affected the development levels in that area.

Infrastructure can positively impact inclusive growth and human development. However, the literature lays out that for there to be both inclusive growth and human development, the investment in infrastructure must be well-planned, taking into consideration the needs of the community and this is guided by good governance that minimises corruption (Doumbia, 2019), efficient maintenance and effective operation of the infrastructure (Flyvbjerg, 2009). Though different researchers have identified that there is a gap in the research that addresses impact of infrastructure investment on inclusive growth and advance human development (Tsaurai and Ndou, 2019; Xun and Guanghua, 2017), however, there is significant evidence that infrastructure can have a positive impact on inclusive growth and human development (Green et al., 2015; Dos Santos et al., 2022).

As to whether the HDI is appropriate for human development, some researchers have acknowledged its shortcomings (Lind, 2019; Das and Borah, 2021), however, many have recognised and acknowledged it as the primary index to measure social welfare (Tsaurai and Ndou, 2019; Sharma and Sharma, 2015; Green et al. (2015), while others preferred it as it measured three indices in one, thus making it efficient (Liu et al., 2021). This question is best left to individual researchers as there will never be a perfect index that meets everyone's needs. In measuring human development, the HDI has stood the test of time. From its formulation in 1990 (Sapkota, 2014), by the United Nations Development Program, to today, it is still a trusted index to measure a country's level of human development and to be able to benchmark itself against the leading countries of the world (Liu et al., 2021). Therefore, it is proposed that the objectives of inclusive growth and human development find congruent expression in the HDI as it measures whether people's incomes are rising and whether they are receiving sufficient quality education and are living healthy lives (Lind, 2019). These indicators represent some of the critical questions that policymakers are trying to find meaningful solutions for, which, on its own, give relevance and importance to the HDI to be used as a measuring tool for societies that wish to measure if they are making progress in bettering the lives of their people. It is important to note that different societies are at different levels of development. Therefore, it would not be prudent to use the HDI as a blunt instrument of measurement (Tsaurai and Ndou, 2019) as it does not deal with issues of equity and justice (Liu et al., 2021) which might have a direct bearing on the index score without giving a broader context of why the index level is where it is. It should be treated as a guide and supplemented by further research to understand whether inclusive growth and human development are advanced.

3. METHODOLOGY

The study examines the effect of infrastructure investment on inclusive growth and the HDI score for five emerging economies middle-income countries, namely Brazil, South Africa, Turkey, Mexico and Vietnam. The study focused its analysis on the prevalence and utilisation of six types of infrastructure of electrification of households, access to clean water, access to sanitation, the number of people using air transport (as a proxy for transport infrastructure), the number of people with mobile subscriptions (as a proxy for information and communications technology infrastructure) and the number of schools enrolments (as a proxy for school infrastructure).

The data covered the period from 2005 to 2019. The data for the six types of infrastructure was obtained from the World Bank Development Indicators' Databank website and it freely available to the general public. Similarly, the HDI data was sourced from the UNDP reports data centre, which was also publicly available to the public. The HDI was measured and compiled by the UNDP. It measured a country's development achievement across three main dimensions of human development, i.e., life expectancy at birth; level of education as measured by a combination of the adult literacy rate (weighted at two-thirds), and mean years of schooling (weighted at one-third); and standard of living, as measured by real per capita income (Kusharjanto and Kim, 2011). In this way, the study limited the idiosyncratic effects that a purely regional study could generate. The countries that the study focused on were South Africa, Brazil, Mexico, Turkey and Vietnam.

The model applied in the study was based on the dynamic panel data model used by Kusharjanto and Kim (2011) focused on a single country and the improvements from Sapkota, (2014) framework and developed model. The modified model in Sapkota (2014) was modified for a cross-country study. The below dynamic panel-data regression model was therefore used to analyse the impact of infrastructure investment on the HDI of these middle-income countries:

$$Y_{it} = \alpha + \beta_1 Y_{it-1} + \beta_2 WAT_{it} + \beta_3 SAN_{it} + \beta_4 ELE_{it} + \beta_5 TRA_{it} + \beta_6 MOB_{it} + \beta_7 SCH_{it} + \eta_i + \eta_t + \varepsilon_{it} \quad (1)$$

Equation 1 highlights the dependent variable Y_{it} which is measured by the HDI of each i-th country at year t. Y_{it-1} is the one period lag of the dependent variable. $INFRA_{it}$ represents the infrastructure-related variables, C_{it} represented the vector of control variables, η_i was the country-fixed effect, η_t was the time-varying effect, and ε_{it} was an error term. The constant term was α, and $\beta1$, $\beta2$, and $\beta3$ were the coefficients of each explanatory variable, which were the parameters of interest. The study explored the relationship of the HDI scores of the different countries against the infrastructure indicators using a panel regression analysis where the HDI was regressed on the infrastructure indicators – electrification, access to water, access to sanitation, air transport passengers, mobile telephone subscriptions and the number of school enrolments.

4. RESEARCH RESULTS

The following section presents the results of the data analysis. It begins by explaining that the size of the variables for Air Transport and Mobile subscriptions was much larger than that of other variables and was given in a different format. This meant converting these numbers to match the other variables so they could be used in a panel regression. In addition, two missing entries under School Enrolment for Brazil were estimated and added. This helped to balance the data.

4.1. Descriptive Statistics

The results in Tables 1-6 encapsulate the HDI values across the five countries examined in the study. The HDI is a composite metric utilised to rank nations according to human development, encompassing indicators associated with infrastructure investment. This analysis enhances the conventional HDI framework by integrating vital indicators such as access to clean water, sanitation, electricity, transportation, mobile connectivity, and school enrolment rates, which are crucial for comprehending comprehensive human development outcomes.

To find out how different factors affected the HDI, a panel regression was done with the HDI as the dependent variable and water, sanitation, electricity, transport, mobile phone coverage, and school enrolment as the independent variables. The results of the VIF showed that multicollinearity was very high for Water and Sanitation and Transport and Mobile and that these variables should be seen together and not separated. This was done, and the regression results in Table 7 highlighted that one of these variables was excluded from the regression. The other variables remained below a 5, indicating that their multicollinearity scores were insignificant.

4.2. Regression Analysis 1

A panel regression was run on data of the variables of "water," "Sanitation," "Electricity," "Transport (m)," "Mobile (m)," and "School enrol." Also, the VIF method was used to determine which variables were causing multicollinearity. Multicollinearity occurs when a regression has a strong correlation between two or more independent variables. The initial analysis showed that Water and Sanitation are highly correlated. This makes sense as sanitation is more effective with access to water. Therefore, removing one of these two variables could decrease the correlation of the remaining variable (Table 8).

In Table 9, a test for homoscedasticity was done, which is when the variance of the data is the same across all values. However, the Breusch-Pagan test indicated heteroskedasticity, which means the variance was not the same across all values. This was because the p-value, a measure of statistical significance, was 0.04. This outcome made the results of the regression unreliable. The regression summary (regression estimation) gave the regression coefficients. Table 9 shows regression coefficients adjusted for heteroskedasticity. The data suggested that water, mobile subscriptions, and sanitation are all negatively related to the HDI. This was counter-intuitive because access to water was intertwined with human development. This effect was relatively pronounced based on the estimated entry in Table 9. Similarly, Mobile Subscriptions also had a negative relationship with the HDI; however, the effects were significantly less when looking at the estimate. School enrolments could be considered statistically insignificant in their relationship to the HDI. The statistical insignificance of school enrolments was unexpected as years of schooling were a component in calculating the HDI. After adjusting for imbalanced data, the regression was done again.

4.2.1. Regression summary

The regression was adjusted to consider things that could throw off the results, and it showed that two variables affected the HDI: water and sanitation and mobile phones. However, both cases associated a higher number with a lower HDI. This suggests that in

Table 1: Results for all groups variable

Variables	Valid N	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	Standard deviation
Water	75	94.0824	95.2312	84.78337	99.4773	91.4473	96.7164	3.64641
Sanitation	75	82.1058	83.5422	61.64097	98.6930	74.8476	89.6294	9.69816
Electricity	75	95.8885	99.1142	80.70000	100.0000	96.1000	99.8213	6.35225
Transport (m)	75	44.3978	31.3394	5.28383	115.5955	17.0266	67.9456	32.64909
Mobile (m)	75	105.5345	88.4976	9.59320	280.7288	65.8241	122.0352	61.01419
School enrol	75	107.7385	106.6061	93.15498	133.2622	102.6704	110.5408	8.13287

Table 2: Results of South Africa

Variables	Country=ZAF Descriptive statistics							
	Valid N	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	Standard deviation
Water	15	90.4744	90.5618	87.16428	93.5012	88.6777	92.2963	2.02526
Sanitation	15	70.9535	71.0481	64.01581	77.5845	67.0863	74.8476	4.33732
Electricity	15	83.6133	83.9000	80.70000	85.9000	82.0000	85.2000	1.70540
Transport (m)	15	17.1137	16.4078	11.84466	26.2113	12.9327	19.7449	4.36692
Mobile (m)	15	66.3054	68.3940	33.95996	96.9725	45.0000	87.9995	21.66288
School enrol	15	103.8251	103.4184	98.37447	108.0247	102.6704	106.2501	2.95027

Table 3: Result of Brazil

Variables	Country=BRA Descriptive Statistics (DATA XBWA 20220816)							
	Valid N	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	Standard deviation
Water	15	97.0270	97.0510	95.0841	98.9355	95.9646	97.9558	1.21241
Sanitation	15	83.5004	83.5422	77.5648	89.2988	80.1541	86.8602	3.74886
Electricity	15	99.0388	99.5195	97.0935	99.8000	98.5266	99.7000	0.87237
Transport (m)	15	80.0962	94.1424	37.6617	102.9175	58.7632	100.4036	23.98706
Mobile (m)	15	199.5431	209.4100	86.2103	280.7288	150.6414	248.3237	61.82097
School enrol	15	119.3285	114.8582	106.9851	133.2622	113.3700	130.7210	9.09530

Table 4: Result of Mexico

Variables	Country=MEX Descriptive Statistics (DATA XBWA 20220816)							
	Valid N	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	Standard deviation
Water	15	96.6042	96.7164	93.0967	99.4773	94.9081	98.4529	2.04016
Sanitation	15	86.6323	86.7098	81.2738	91.7367	83.6583	89.6294	3.34101
Electricity	15	99.0911	99.1142	97.9106	100.0000	98.9327	99.5000	0.51486
Transport (m)	15	37.4138	32.9094	15.7282	69.9378	21.2430	53.3133	17.53062
Mobile (m)	15	93.4613	100.7272	47.1287	122.0352	75.3035	111.7306	23.33394
School enrol	15	108.1945	108.6008	104.6558	110.6335	106.2777	110.4135	2.07299

countries with better infrastructure (electricity, transport, schools), these things have less impact on the HDI.

Figure 1 shows the new regression resulted in a decrease in standard deviation. This meant there was less dispersion of results, and the curve was leaner.

Figure 2 shows the residual plot points look random, meaning the model was a good fit.

4.2.2. Adjusted for heteroskedasticity

In Table 10, there was a need to adjust for heteroskedasticity, the results show that it had similar effects to the adjustment for multicollinearity.

The first analysis examined how six independent variables affected the response variable (HDI). However, it was found that the results were unreliable, so a different approach was taken to improve the reliability of the results.

4.3. Regression Analysis 2

In the second approach, the years were looked at as categorical variables, and it was found that the response variable had changed over the years, considering the covariates. The same Companies/Tickers were retained as in the first analysis before adjustments. This second approach provided more insight into the relationship between the response and the covariates over the years.

Figure 3 The initial data analysis found that the data had a normal distribution with a few data points that differed from the rest. A normal distribution is defined by a bell-shaped curve, with the majority of data points clustered around the mean, and the frequency of data points diminishing as they deviate from the mean. This signifies that most of the dataset adheres to discernible

Table 5: Results of Turkey

Variables	Country=TUR							
	Descriptive Statistics (DATA XBWA 20220816)							
	Valid N	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	Standard deviation
Water	15	95.7260	95.7605	94.47209	96.8690	95.04727	96.4143	0.76562
Sanitation	15	94.4533	94.5880	89.78012	98.6930	91.93026	97.0136	2.84721
Electricity	15	99.9735	100.0000	99.85088	100.0000	99.96072	100.0000	0.04893
Transport (m)	15	64.6110	63.3503	16.94383	115.5955	25.50509	100.3665	36.46509
Mobile (m)	15	67.3722	67.6805	43.60897	80.7909	61.97581	75.0617	10.15824
School enrol	15	100.9921	101.2990	93.15498	107.1543	98.63050	103.0273	3.81839

Table 6: Results of Vietnam

Variables	Country=VNM							
	Descriptive statistics (DATA XBWA 20220816)							
	Valid N	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	Standard deviation
Water	15	90.5806	90.4367	84.78337	96.2051	87.2558	94.1025	3.72504
Sanitation	15	74.9893	75.1528	61.64097	87.7081	67.4984	82.5989	8.37266
Electricity	15	97.7255	98.5550	93.20527	100.0000	96.1000	99.4000	2.18809
Transport (m)	15	22.7542	16.9761	5.28383	53.2270	9.9911	37.3493	15.74752
Mobile (m)	15	100.9908	120.3241	9.59320	140.6391	74.8723	131.6737	43.38343
School enrol	15	106.3524	107.7544	97.72135	115.4352	101.6588	110.3296	5.28510

Table 7: Adjusted Regression Summary

Variables	F (6,50)=14.37 P=0.000 R-Squared=0.63 Adj. R-Squared=0.46 Breusch-Pagan test for heteroskedasticity: BP=29.59, P=0.00				
	1 Standard coefficient	2 Estimate	3 Standard error	4 t.value	5 P-value
Water	−1.397	−0.0192	0.0031	−6.11	<0.01
Sanitation	1.443	0.0075	0.0016	4.68	<0.01
Electricity	0.256	0.0020	0.0016	1.27	0.21
Transport (m)	0.133	0.0002	0.0001	1.73	0.09
Mobile (m)	−0.166	−0.0001	0.0001	−2.03	0.05
School enrol	0.096	0.0006	0.0004	1.62	0.11

Table 8: Initial Regression Summary: The Estimate gives the regression coefficients

Variables	F (6,56)=16.27 P=0.000 R-Squared=0.64 Adj. R-Squared=0.47 Breusch-Pagan test for heteroskedasticity: BP=20.03, P=0.04				
	1 Standard Coefficient	2 Estimate	3 Standard error	4 t.value	5 P-value
Water	−1.321	−0.0134	0.0027	−4.90	<0.01
Sanitation	1.064	0.0053	0.0015	3.64	<0.01
Electricity	1.498	0.0049	0.0008	5.94	<0.01
Transport (m)	0.254	0.0004	0.0001	3.74	<0.01
Mobile (m)	−0.261	−0.0002	0.0001	−3.16	<0.01
School enrol	0.017	0.0001	0.0004	0.35	0.73

patterns, implying that standard values of your key variable(s) are adequately represented. The existence of a normal distribution frequently indicates that the data may be appropriate for parametric tests, which presuppose normality (e.g., ANOVA).

Table 9: Initial adjustment for heteroskedasticity

Variables	1 Standard coefficient	2 Estimate	3 Standard error	4 Statistic	5 P value
Water	−1.321	−0.013414	0.006036	−2.223	0.03
Sanitation	1.064	0.005295	0.002857	1.854	0.07
Electricity	1.498	0.004922	0.001172	4.201	<0.01
Transport (m)	0.254	0.000397	0.000252	1.574	0.12
Mobile (m)	−0.261	−0.000210	0.000057	−3.687	<0.01
School enrol	0.017	0.000124	0.000319	0.387	0.70

Table 10: Heteroskedasticity for adjusted data

Variables	1 Standard coefficient	2 Estimate	3 Standard error	4 Statistic	5 P value
Water	−1.397	−0.019179	0.007253	−2.644	0.01
Sanitation	1.443	0.007451	0.002722	2.738	<0.01
Electricity	0.256	0.002014	0.001327	1.518	0.14
Transport (m)	0.133	0.000204	0.000292	0.698	0.49
Mobile (m)	−0.166	−0.000136	0.000035	−3.924	<0.01
School enrol	0.096	0.000590	0.000239	2.466	0.02

Table 11 analysis sought to identify factors that influence the data. The six stated independent variables were treated as random variables, and the years as categorical variables. The F-values gave a sense of whether there was an actual variance between the data groups. The year group had a very high F-value, followed by the water variable. Electricity, though smaller than the other two, had an F-value of 3.93, which was significant considering that, for there to be no variance between the data groups, the F-value should equal close to 1. The Transport, Mobile Subscription, School Enrolment, and Sanitation data groups were closer to the value of 1, denoting no variance. The F-values were supported by the p-values, whereby the Year data group and the Water data group had p-values way below 0.05, denoting statistical significance. Electricity had a p-value

Table 11: ANOVA

Variables	Random effects: Random=~1|Country ANOVA type: Sequential Correlation=AR (1)			
	Num DF	Den DF	F value	P value
(Intercept)	1	56	2895,35	<0.001
Year	14	56	16,44	<0.001
Water	1	56	12,6	<0.001
Sanitation	1	56	0,37	0,548
Electricity	1	56	3,93	0,052
Transport (m)	1	56	2,68	0,108
Mobile (m)	1	56	1,89	0,175
School enrol	1	56	1,67	0,201

ANOVA: Analysis of variance

Table 12: Year groups Random effects model summary statistics

Year Intercept and the Variables	Random effects: random = ~1|Country marginal R^2 (variance explained by fixed effects) = 0.65 conditional R^2 (variance explained by entire model) = 0.65				
	Value	Standard error	DF	t value	P value
(Intercept)	0.3859	0.1541	56	2.5	0.015
Year|2006	0.0051	0.0022	56	2.34	0.023
Year|2007	0.0093	0.0034	56	2.73	0.009
Year|2008	0.0146	0.0048	56	3.07	0.003
Year|2009	0.0189	0.006	56	3.13	0.003
Year|2010	0.0227	0.0075	56	3.03	0.004
Year|2011	0.0296	0.0087	56	3.42	0.001
Year|2012	0.0346	0.0097	56	3.56	<0.001
Year|2013	0.0417	0.0108	56	3.87	<0.001
Year|2014	0.0451	0.0119	56	3.78	<0.001
Year|2015	0.0464	0.0131	56	3.54	<0.001
Year|2016	0.0481	0.0141	56	3.41	0.001
Year|2017	0.0488	0.0153	56	3.19	0.002
Year|2018	0.0491	0.0165	56	2.98	0.004
Year|2019	0.0499	0.0174	56	2.87	0.006
Water	0.001	0.0029	56	0.34	0.734
Sanitation	0.0011	0.0016	56	0.66	0.51
Electricity	0.001	0.0005	56	1.95	0.056
Transport (m)	0.0003	0.0001	56	2.05	0.045
Mobile (m)	−0.0001	0.0001	56	−1	0.319
School enrol	0.0002	0.0002	56	1.29	0.201

very close to 0.05, thus cementing its position as statistically significant.

In Table 12, the mean values of the Regression Coefficients highlighted that the Year group was more sensitive to changes in other data groups. The year group means were much higher than the group (i.e. water, sanitation, electricity, transport, mobile and school enrollment). The p-values confirmed the statistical significance of the year group as all the p-values were below 0.05, while those of the other group were mainly higher than 0.05.

There was a problem with multicollinearity (when two or more variables are highly correlated) in the water and sanitation data. This was more pronounced than in the previous analysis. This suggested that combining Water and Sanitation into one variable would be better to eliminate the multicollinearity issue.

Figure 1: Normal probability plot

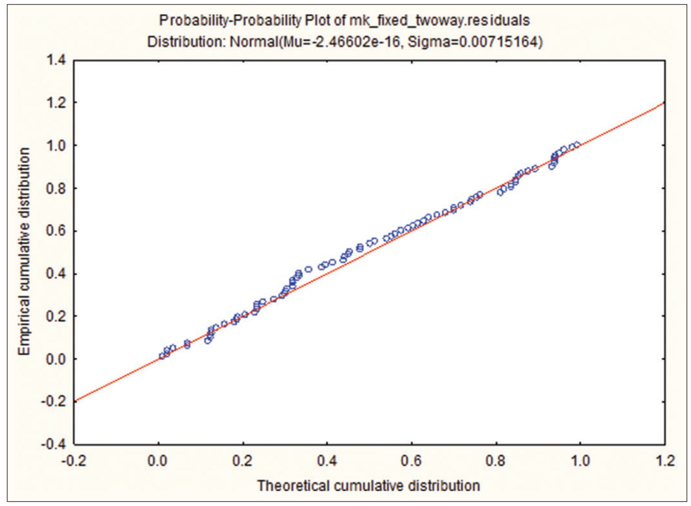


Figure 2: Residual versus depVar

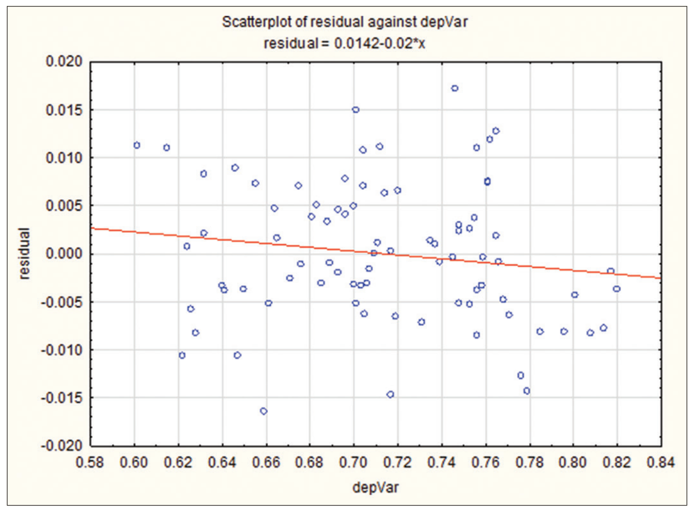


Figure 3: Normal probability plot

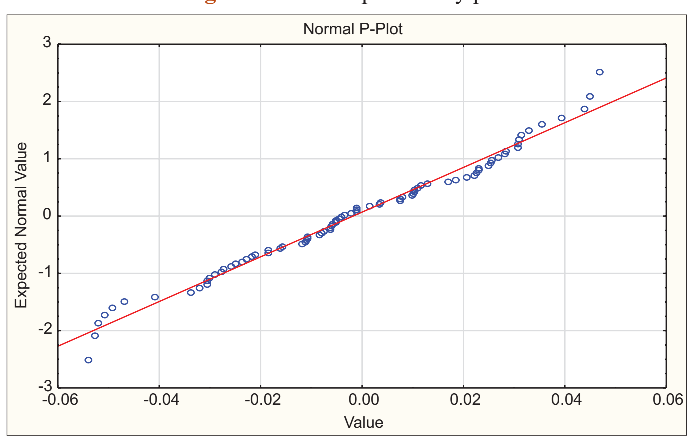


Table 13 displays the results of a post-hoc Least Significant Difference (LSD) test, to compare group means after identifying a significant effect in an ANOVA test. Values with a significance level of <0.001 indicate robust evidence of differences across years. In 2005 (group g), nearly all comparisons with subsequent years (e.g., 2006 to 2012) exhibit p-values <0.001, indicating that 2005 is statistically distinct from those years. On the other

Table 13: Appendix, Supporting Data from Analysis – *Post hoc* groups

Cell No.			LSD test variable Is mean [Table 8] Probabilities for *post hoc* tests Error: Between MS =													
	Year	Group	(1) 0.68487	(2) 0.68999	(3) 0.69421	(4) 0.69948	(5) 0.70373	(6) 0.70759	(7) 0.71452	(8) 0.71945	(9) 0.7266	(10) 0.72998	(11)	(12)	(13)	(14)	(15)
1	2005	g		0.023	0.009	0.003	0.003	0.004	0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.002	0.004	0.006
2	2006	f	0.023		0.074	0.013	0.008	0.003	0.002	0.001	<0.001	<0.001	0.001	0.002	0.003	0.006	0.008
3	2007	f	0.009	0.074		0.024	0.011	0.013	0.002	0.001	<0.001	<0.001	0.001	0.002	0.004	0.007	0.01
4	2008	e	0.003	0.013	0.024		0.063	0.044	0.005	0.002	<0.001	<0.001	0.002	0.003	0.006	0.012	0.016
5	2009	de	0.003	0.008	0.011	0.063		0.156	0.007	0.002	<0.001	<0.001	0.002	0.003	0.008	0.015	0.021
6	2010	d	0.004	0.009	0.013	0.044	0.156		0.007	0.002	<0.001	<0.001	0.002	0.003	0.008	0.017	0.023
7	2011	c	0.001	0.002	0.002	0.005	0.007	0.007		0.033	0.001	0.002	0.007	0.012	0.027	0.048	0.062
8	2012	a	<0.001	0.001	0.001	0.002	0.002	0.002	0.033		0.002	0.004	0.017	0.028	0.057	0.095	0.114
9	2013	b	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.002		0.133	0.208	0.203	0.268	0.334	0.344
10	2014	b	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.004	0.1330		0.583	0.428	0.481	0.538	0.523
11	2015	b	<0.001	0.001	0.001	0.002	0.002	0.002	0.007	0.017	0.208	0.208		0.471	0.535	0.6	0.571
12	2016	b	0.001	0.002	0.002	0.003	0.003	0.003	0.012	0.028	0.203	0.203	0.471		0.792	0.805	0.72
13	2017	ab	0.002	0.003	0.004	0.006	0.008	0.003	0.027	0.057	0.268	0.268	0.535	0.792		0.9	0.758
14	2018	ab	0.004	0.006	0.007	0.012	0.015	0.0017	0.048	0.095	0.334	0.334	0.6	0.805	0.9		0.721
15	2019	abc	0.005	0.008	0.01	0.016	0.021	0.023	0.068	0.114	0.344	0.334	0.571	0.72	0.758	0.721	

hand, the years 2013, 2014, and 2015 (group b) exhibit elevated p-values (e.g., 0.133, 0.208, 0.583), signifying a reduced number of significant differences among them. The post-hoc LSD test indicates significant differences in the dataset across multiple years, especially during the initial period (2005–2007). In contrast, subsequent years (2013 onwards) exhibit greater stability, characterised by fewer substantial discrepancies between them. The outcome is instrumental in comprehending historical patterns, identifying transformative periods, and providing a basis for subsequent analyses.

Figure 4 shows that countries are generally developing more and more quickly, but the rate of development has slowed down in recent years. This may be because of the global financial crisis in 2008-2009, which slowed down the economies of many countries.

Figure 5's scatter plots illustrate the correlation between the X-axis, which encompasses water availability, sanitation, electricity, transport, school enrolment, and mobile penetration across the five countries examined, and the HDI on the Y-axis. The red trendline indicates a robust positive linear correlation among water availability, sanitation, transport, and HDI, with correlation coefficients of $r = 0.84$, $r = 0.91$, and $r = 0.78$, accompanied by a highly significant p-value ($p < 0.01$). This suggests that an increase in water availability, sanitation, and transportation correlates with a rise in HDI. The correlation coefficients for electricity access and mobile penetration are $r = 0.57$ and $r = 0.48$, respectively, indicating a moderate positive relationship between electricity access and HDI. The correlation coefficient for school enrolment indicates a negative correlation ($r = -0.03$) with the HDI, accompanied by an insignificant p-value ($p < 0.78$). This scatter plot demonstrates a robust correlation between dependent variables and HDI, underscoring its significant influence on enhancing quality of life and developmental outcomes across regions.

5. DISCUSSION

Analysing the effect of infrastructure investments on a nation indicates that relying solely on the HDI may obscure the comprehensive advantages these investments confer on society. In the panel regression and Anova analysis, Water and Sanitation infrastructure had a statistically significant relationship with the HDI. This was supported by Green et al. (2015), who found that countries that invested in freshwater sources and infrastructure ensured water safety while countries that didn't were at high risk of experiencing water scarcity. Water and sanitation were independent variables; however, they suffered from high levels of multicollinearity that suggested that it would be best to see them as one variable. In the panel regression, the data seemed to suggest that water had a negative relationship to the HDI; however, the results of the panel regression could not be accepted entirely due to the unreliability of the analysis results as a result of high variability in results.

The second analysis identified Water and Sanitation as being statistically significant, followed by the level of access to electricity among households. This was aligned with Kuad (2013) and Josh (2010), who noted that one of the key determinants of

Figure 4: Year LS mean graph

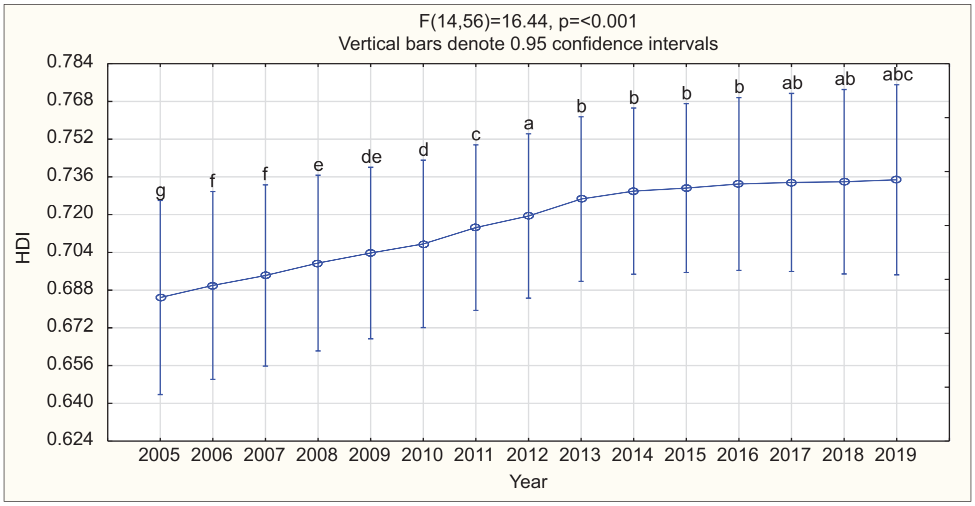
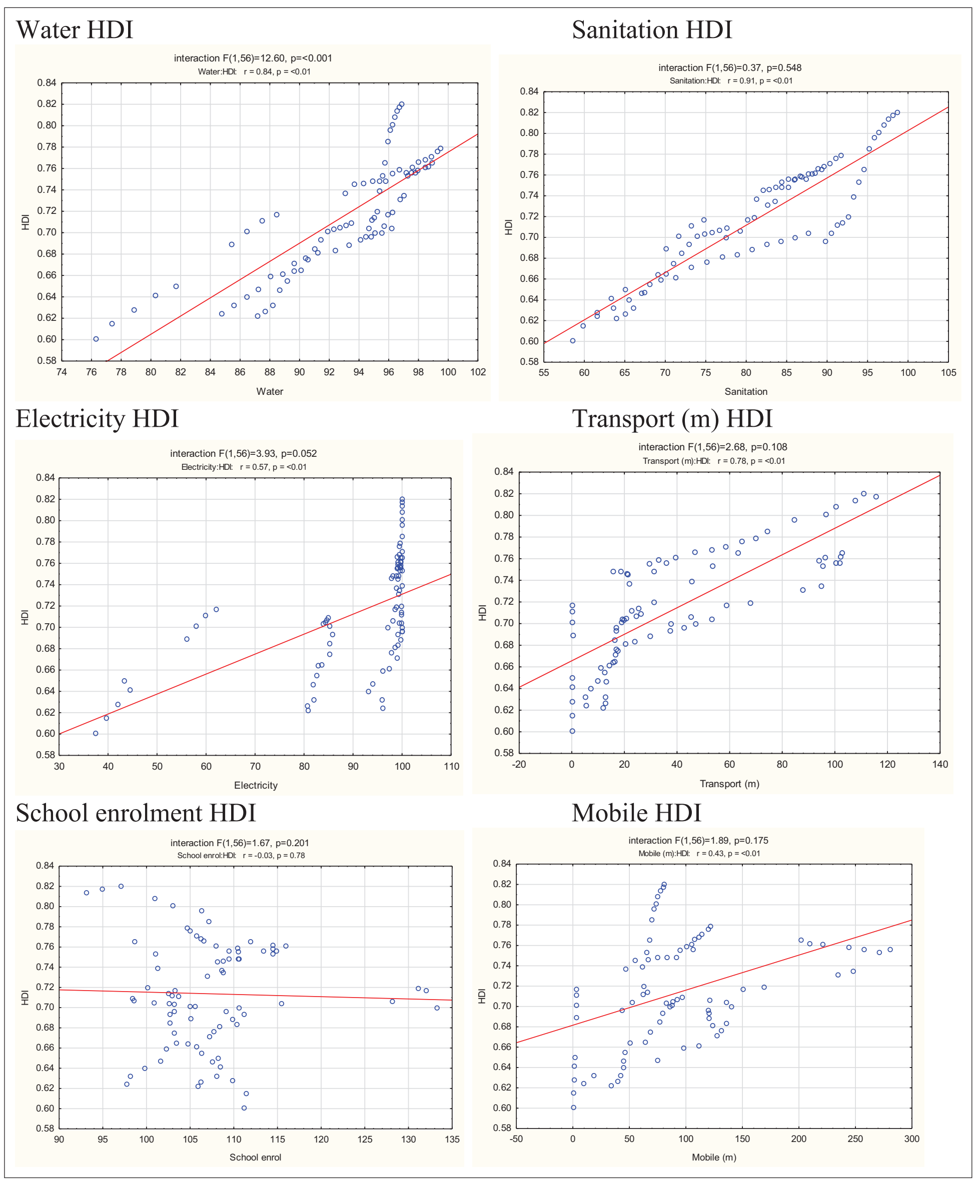


Figure 5: Scatterplot analysis results for each variable



a country's development was how much it invested in energy, among other vital infrastructures. On the other hand, the number of air transport passengers, mobile subscriptions and school enrolments had no statistical significance in determining the HDI.

This analysis seemed to highlight that factors that influence the HDI could be very narrow, which meant that utilising only the HDI as a measure of the socioeconomic condition of citizens was not prudent as the HDI could miss the contributions that the different infrastructures make to society. As Chandra et al. (2014) highlighted the benefits of social infrastructure as contributing to a society's economic development, it was essential to recognise that different infrastructures could have a meaningful impact if their contribution were measured broadly and holistically. In the case of school enrolments, which was a proxy for school infrastructure, it was expected that it would have a significant impact on the HDI as the rate of primary school enrolments was a crucial input in calculating a country's HDI score Tsaurai and Ndou, 2019). Increasing the number of schools, which in turn allows an increase in the number of school enrolments, is positive for a country as the literacy levels will tend to rise and potentially enable economic development down the road (Chotia and Rao, 2017).

Similarly, growing the number of mobile subscriptions through investment in information and communications technology allowed more citizens to actively participate in the modern economy and access information and insights that could improve their lives, thus enhancing human development (Kanoi et al., 2022). Lastly, a rising number of air transport passengers, a proxy for transport infrastructure, enabled the expansion of economic activity within a country as it shortened travel time allowing remote areas to connect to the economic hubs. The building of airports that enable the movement of many people inside and outside a country also opens up the movement of goods and services across the same domains (Straub, 2011). Such openness is a catalyst for increasing economic development and expansion, leading to higher GDP per capita, which is a key input into the formulation of the HDI (Xun and Guanghua, 2017).

It is to be noted that the comprehensive analysis of HDI, as presented by Chirgwin et al., (2021), which includes dimensions such as water, sanitation, electricity, transport, mobile connectivity, and school enrolment, reveals significant disparities in infrastructure among the five countries examined in this study. It is therefore essential to realise that though this study identifies water and sanitation, and electricity as crucial infrastructure that has a positive influence on the HDI, the other infrastructures also potentially have a positive impact on human development even though it may not be directly expressed through the HDI (Chandra et al., 2014; Chotia and Rao, 2017).

6. CONCLUSION

The HDI is a powerful tool that the United Nations developed to help countries measure themselves relative to others on standard metrics to determine if they are progressing in human development (UNDP, 1990). However, though the HDI does give countries a high-level view of their progress on these metrics, it fails to account for other developments that come from a country's investment in different infrastructures, which potentially have a profound effect on the socioeconomic condition of the society. Therefore, it is essential to understand the limitations of the HDI and to utilise it as an impact measuring tool, aware that it will not account for some of the investments that society makes for its betterment.

In this current study, it is suggested that middle-income countries would do well to invest in water and sanitation, and electrification of households coupled with the expansion of electricity generation capacity to enhance those countries' HDI score. This study highlighted that water, sanitation, and electricity infrastructures are positively related to the HDI and that such investment will enhance human development. Investments in other infrastructure categories might not influence the HDI, however, that does not mean they will not benefit the country. Policy initiatives aimed at enhancing water availability, sanitation, electricity, transportation, school enrolment, and mobile penetration may yield substantial advancements in human development. Subsequent investigation could examine whether enhancing these variables directly results in improvements in HDI or if other mediating factors are implicated.

6.1. Managerial Implications

This study should make managers, infrastructure investors and policymakers aware that it is important to have a multi-dimensional way of measuring the impact of their infrastructure investment so that they get a clearer picture of which investments add value to society and advance human development. Relying on one metric, such as the HDI, could limit and hinder awareness of different societal infrastructures. It would be incumbent on the decision makers to ensure a comprehensive due diligence process before investing in the different infrastructure projects, followed by a far-reaching cost-benefit analysis to determine what value that project would add to society. This way, investors will have a clearer sense of which infrastructure projects to invest in and why. This would require more time and resources; however, it will minimise the experience of infrastructure projects that don't deliver the value they thought they would and thus become a liability to society instead of a benefit. Policymakers should give guidance on which infrastructures are primarily needed in the country and should play a key role in guiding the flow of investment so that imbalances are not created through over-investment in one infrastructure category.

6.2. Reconciliation of Research Objectives

The research objectives sought to determine whether investing in infrastructure can improve the HDI of a select number of middle-income countries. In addition, the research sought to guide policymakers and infrastructure investors on what infrastructure they should prioritise if they improve the HDI scores of their countries while simultaneously growing their economies. The study did give guidance on this to a certain extent; however, it also highlighted the dangers of focusing on one particular metric to measure the socioeconomic development of a country.

6.3. Limitations and Recommendations for Future Research

The study suffered from a limitation in actual infrastructure data. The researcher had to rely on proxy variables to give insights into a particular infrastructure category. This meant that there was a lack of direct infrastructure data that was standardised across different countries. Furthermore, the study focused on five emerging market countries: South Africa, Brazil, Mexico, Turkey and Vietnam. Future studies could look at Southern African countries to see which infrastructure investments can have a profound effect on the socioeconomic development of the countries and how else human development can be measured outside of the HDI construct. This could entail looking at a multi-dimensional index that captures a broader set of developmental factors.

REFERENCES

Abotsi, A.K., Ampah, I.K. (2024), Public debt and economic growth in Africa in the pre-Covid Era: The role of control of corruption. International Journal of Economics and Financial Issues, 14(1), 144-153.

Adeosun, O.A., Olomola, P.A., Adedokun, A., Ayodele, O.S. (2020), Public investment and inclusive growth in Africa. International Journal of Social Economics, 47(12), 1669-1691.

Amador-Jimenez, L., Willis, C.J. (2012), Demonstrating a correlation between infrastructure and national development. International Journal of Sustainable Development and World Ecology, 19(3), 197-202.

Atangana, E., Oberholster, P.J. (2023), Assessment of water, sanitation, and hygiene target and theoretical modeling to determine sanitation success in sub-Saharan Africa. Environment, Development and Sustainability, 25(11), 13353-13377.

Avalueva, N.B., Alekseeva, A.S., Alieva, E.F., Fiofanova, O.A. (2022), Education, socio-economic development and human capital: Cross-country analysis. Academy of Strategic Management Journal, 21, 1-17.

Bakker, M., Messerli, H.R. (2017), Inclusive growth versus pro-poor growth: Implications for tourism development. Tourism and Hospitality Research, 17(4), 384-391.

Balakrishnan, R., Steinberg, C., Syed, M.H. (2013), The Elusive Quest for Inclusive Growth: Growth, Poverty, and Inequality in Asia [Article]. IMF Working Paper, 13(152), 1.

Balouza, M. (2019), The impact of information and communication technologies on the human development in the gulf cooperation council countries: An empirical study. Management Studies and Economic Systems, 4(2), 79-113.

Batool, Z., Bokhari, S., Akbar, M. (2020), Does infrastructure contribute to inclusive growth. Journal of Economics, 1(1), 11-27.

Bhattacharyya, S.C., Palit, D. (2021), A critical review of literature on the nexus between central grid and off-grid solutions for expanding access to electricity in Sub-Saharan Africa and South Asia. Renewable and Sustainable Energy Reviews, 141, 110792.

Blimpo, M.P., Cosgrove-Davies, M. (2019), Electricity Access in Sub-Saharan Africa: Uptake, Reliability, and Complementary Factors for Economic Impact. Washington, D.C: World Bank Publications.

Castells-Quintana, D., Royuela, V., Thiel, F. (2019), Inequality and sustainable development: Insights from an analysis of the human development index. Sustainable Development, 27(3), 448-460.

Chandra, S., Sharma, N., Joshi, K., Aggarwal, N., Tupil Kannan, A. (2014), Resurrecting Social Infrastructure as a Determinant of Urban Tuberculosis Control in Delhi, India. Available from: https://www.health-policy-systems.com/content/12/1/3

Chirgwin, H., Cairncross, S., Zehra, D., Sharma Waddington, H. (2021), Interventions promoting uptake of water, sanitation and hygiene (wash) technologies in low-and middle-income countries: An evidence and gap map of effectiveness studies. Campbell Systematic Reviews, 17(4), e1194.

Chotia, V., Rao, N.V.M. (2017), Investigating the interlinkages between infrastructure development, poverty and rural-urban income inequality: Evidence from BRICS nations. Studies in Economics and Finance, 34(4), 466-484.

Das, N.J., Borah, B. (2021), Contribution of social infrastructure on human development: A cross section study of Indian States. Turkish Journal of Computer and Mathematics Education, 12(13), 173-176.

De la Hoz-Rosales, B., Ballesta, J.A.C., Tamayo-Torres, I., Buelvas-Ferreira, K. (2019), Effects of information and communication technology usage by individuals, businesses, and government on human development: An international analysis. IEEE Access, 7, 129225-129243.

di Cataldo, M., Rodríguez-Pose, A. (2017), What drives employment growth and social inclusion in the regions of the European Union? Regional Studies, 51(12), 1840-1859.

Djokoto, J.G. (2022), The investment development path and human development: Is there a nexus? Research in Globalization, 4, 100079.

Dos Santos, S., Gastineau, B., Golaz, V. (2022), Population and water issues: Going beyond scarcity. In: International Handbook of Population and Environment. Berlin: Springer. p263-282.

Doumbia, D. (2019), The quest for pro-poor and inclusive growth: The role of governance. Applied Economics, 51(16), 1762-1783.

Flyvbjerg, B. (2009), Survival of the unfittest: Why the worst infrastructure gets built-and what we can do about it. Oxford Review of Economic Policy, 25(3), 344-367.

Ghosh, M. (2017), Infrastructure and development in rural India. Margin: The Journal of Applied Economic Research, 11(3), 256-289.

Glewwe, P., Muralidharan, K. (2016), Improving education outcomes in developing countries: Evidence, knowledge gaps, and policy implications. In: Handbook of the Economics of Education. Vol. 5. Netherlands: Elsevier. p653-743.

Gnade, H., Blaauw, P.F., Greyling, T. (2017), The impact of basic and social infrastructure investment on South African economic growth and development. Development Southern Africa, 34(3), 347-364.

González, S.A., Aubert, S., Barnes, J.D., Larouche, R., Tremblay, M.S. (2020), Profiles of active transportation among children and adolescents in the global matrix 3.0 initiative: A 49-country comparison. International Journal of Environmental Research and Public Health, 17(16), 5997.

Green, P.A., Vörösmarty, C.J., Harrison, I., Farrell, T., Sáenz, L., Fekete, B.M. (2015), Freshwater ecosystem services supporting humans: Pivoting from water crisis to water solutions. Global Environmental Change, 34, 108-118.

Hlotywa, A., Ndaguba, E.A. (2017), Assessing the impact of road transport infrastructure investment on economic development in South Africa. Journal of Transport and Supply Chain Management, 11, a324.

Hopkins, M. (1991), Human development revisited: A new UNDP report. World Development, 19(10), 1469-1473.

Jin, H., Qian, X., Chin, T., Zhang, H. (2020), A global assessment of sustainable development based on modification of the human development index via the entropy method. Sustainability, 12(8), 3251.

Joshi, G.S. (2010), Infrastructure development strategies for inclusive growth: India's Eleventh Plan. Leadership and Management in Engineering, 10(2), 65-72.

Kanoi, L., Koh, V., Lim, A., Yamada, S., Dove, M.R. (2022), What is infrastructure? What does it do? Anthropological perspectives on the workings of infrastructure(s). Environmental Research: Infrastructure and Sustainability, 2(1), 012002.

Klasen, S. (2018), Human Development Indices and Indicators: A Critical Evaluation. Human Development Report Office Background Paper, 1.

Kuada, J. (2013), Infrastructure and development in Africa FULL TEXT Infrastructure and development in Africa. African Journal of Economic and Management Studies, Bingley, 4(1), Doi: 10.1108/ajems.2013.43904aaa.001

Kusharjanto, H., Kim, D. (2011), Infrastructure and human development: The case of Java, Indonesia. Journal of the Asia Pacific Economy, 16(1), 111-124.

Lee, N. (2019), Inclusive growth in cities: A sympathetic critique. Regional Studies, 53(3), 424-434.

Lee, S.J., Choi, M.J., Rho, M.J., Kim, D.J., Choi, I.Y. (2018), Factors affecting user acceptance in overuse of smartphones in mobile health services: An empirical study testing a modified integrated model in South Korea. Frontiers in Psychiatry, 9, 658.

Lind, N. (2019), A development of the human development index. Social Indicators Research, 146(3), 409-423.

Liu, C., Nie, F., Ren, D. (2021), Temporal and spatial evolution of China's human development index and its determinants: An extended study based on five new development concepts. Social Indicators Research, 157(1), 247-282.

Mohanty, A.K., Nayak, N.C., Chatterjee, B. (2016), Does infrastructure affect human development? Evidences from Odisha, India. Journal of Infrastructure Development, 8(1), 1-26.

Mutiiria, O.M., Ju, Q., Dumor, K. (2020), Infrastructure and inclusive growth in sub-Saharan Africa: An empirical analysis. Progress in Development Studies, 20(3), 187-207.

Muto, M., Saiki, Y. (2024), Synchronization analysis between exchange rates on the basis of purchasing power parity using the Hilbert transform. The North American Journal of Economics and Finance, 74, 102191.

Nchofoung, T.N., Asongu, S.A., Njamen Kengdo, A.A., Achuo, E.D. (2022), Linear and non-linear effects of infrastructures on inclusive human development in Africa. African Development Review, 34(1), 81-96.

OECD. (2015c), All on Board: Making Inclusive Growth Happen. OECD Economic Surveys, 2017 Paris, Luxembourg: OECD Publishing. p51.

Ohwo, O., Agusomu, T.D. (2018), Assessment of water, sanitation and hygiene services in sub-Saharan Africa. European Scientific Journal, 14(35), 308-326.

Parikh, P., Fu, K., Parikh, H., McRobie, A., George, G., Fu, P., McRobie, H. (2015), Infrastructure provision, gender and poverty in Indian Slums. World Development, 66, 468-486.

Pereira, M.A., Marques, R.C. (2021), Sustainable water and sanitation for all: Are we there yet? Water Research, 207, 117765.

Picatoste, X., Novo-Corti, I., TÃ® rcÇŽ, D.M. (2021), Human development index as an indicator of social welfare. In: No Poverty. Cham: Springer International Publishing. p449-459.

Rana, I.A., Bhatti, S.S., e Saqib, S. (2017), The spatial and temporal dynamics of infrastructure development disparity - From assessment to analyses. Cities, 63, 20-32.

Rauniyar, G., Kanbur, R. (2010), Inclusive growth and inclusive development: A review and synthesis of Asian Development Bank literature. Journal of the Asia Pacific Economy, 15(4), 455-469.

Ravallion, M. (2012), Troubling tradeoffs in the human development index. Journal of Development Economics, 99(2), 201-209.

Saif, M.A., Zefreh, M.M., Torok, A. (2019), Public transport accessibility: A literature review. Periodica Polytechnica Transportation Engineering, 47(1), 36-43.

Salemink, K., Strijker, D., Bosworth, G. (2017), Rural development in the digital age: A systematic literature review on unequal ICT availability, adoption, and use in rural areas. Journal of Rural Studies, 54, 360-371.

Sapkota, J.B. (2014), Access to Infrastructure and Human Development: Cross-Country Evidence. JICA-RI Working Papers. p1-26.

Sharma, H., Sharma, D. (2015), Human development index - revisited: Integration of human values. Journal of Human Values, 21(1), 23-36.

Straub, S. (2011), Infrastructure and development: A critical appraisal of the macro-level literature. Journal of Development Studies, 47(5), 683-708.

Tsaurai, K., Ndou, A. (2019), Infrastructure, human capital development and economic growth in transitional countries. Comparative Economic Research. Central and Eastern Europe, 22(1), 33-52.

United Nations Development Programme. (1990), Human Development Report 1990. Oxford University Press. 1990. Available from: https://hdr.undp.org/system/files/documents/hdr1990encompletenostats.pdf [Last accessed on 2024 Sep 23].

United Nations Development Programme. (2006), Human Development Report 2006: Beyond Scarcity: Power, Poverty and the Global Water Crisis. Palgrave Macmillan. Available from: https://hdr.undp.org/content/human-development-report-2006 [Last accessed on 2024 Sep 23].

Valero, D., Cook, J., Lee, A., Browne, A.L., Ellis, R., Pancholi, V.S., Hoolohan, C. (2023), Addressing water poverty under climate crisis: Implications for social policy. Social Policy and Society, 22(4), 747-762.

Valickova, P., Elms, N. (2021), The costs of providing access to electricity in selected countries in Sub-Saharan Africa and policy implications. Energy Policy, 148, 111935.

Van de Walle, D.P., Ravallion, M., Mendiratta, V., Koolwal, G.B. (2013), Long-term Impacts of Household Electrification in Rural India. World Bank Policy Research Working Paper, (6527).

Wang, S., Zhang, M., Tang, N., Ali, Q. (2024), Catalyzing sustainable development: Exploring the interplay between access to clean water, sanitation, renewable energy and electricity services in shaping China's energy, economic growth, and environmental landscape. Heliyon, 10(10), e31097.

Xun, Z., Guanghua, W. (2017), Rural infrastructure and China's inclusive growth. China Economist, 12(5), 100.

Zanden, J.L. (2023), Examining the relationship of information and communication technology and financial access in Africa. Journal of Business and Economic Options, 6(3), 26-36.

Zhang, X., Zong, G. (2019), Transport Infrastructure, Spatial Connectivity and Inclusive Economic Growth: An Empirical Study Based on the Dynamic Spatial Durbin Model. In: ACM International Conference Proceeding Series. p67-73.

Zürcher, C. (2022), Evidence on Aid (in) Effectiveness in Highly Fragile States: A Synthesis of Three Systematic Reviews of Aid to Afghanistan, Mali, and South Sudan, 2008-21 (No. 2022/160). WIDER Working Paper.