

## A proposal for modified human development index for BRICS countries. A holistic approach towards sustainable human development

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**Abstract.** *Study attempts to align HDI with the Sustainable Human Development approach. Modified HDI, integrating employment, human values, environmental sustainability, quality aspects of health and education, as a simple generalization within the structure of the existing methodology, is developed for BRICS countries for the period 2000-2019. Proposed MHDI's environmental sustainability dimension index was created using Principal Component Analysis. Framed dimensional indices were regressed on the MHDI values, followed by post-hoc analysis, assisted in generating policy implications. Computed MHDI scores were lower than HDI values for all BRICS members, indicating a lower human development scenario in these countries than what HDI perceives.*

**Keywords:** BRICS, sustainable human development, modified human development index, principal component analysis, post-hoc analysis.

**JEL Classification:** C38, F15, I15, I25, O15, O44.

## 1. Introduction

Sustainable development is a multidimensional concept emphasizing integration and striking a dynamic balance between a region's economic, social, and environmental aspects to ensure inter-generational and intragenerational equity (Kwatra et al., 2020). In accordance with Pearce et al. (1989), sustainability can only be ensured by broadening the definition of development to include social and cultural development, working to reduce poverty and deprivation, conserving and improving the resource base to ensure the permanent eradication of poverty and assimilate economics and ecology into all levels of decision-making.

In this respect, Triple Bottom Line explicates the three pillars of sustainability: environmental, social, and economic. Spangenberg (2004) stated that sustainable development integrates four factors (adding institutional to the above three), signifying the presence of integration between development and sustainability.

The majority of those who subscribe to the human development paradigm see sustainability as merely another component of achieving human development objectives. On the other hand, the sustainability paradigm sees opposite and visualize sustainability as the key concern for humans' continued existence.

As described by Dewan (2009), sustainable human development is to integrate sustainability and human development goals. Goals for sustainability and human development have always been typically viewed as separate objectives. But as mentioned, there is a need for the convergence of these two critical objectives.

The SHD conditions' numerical values show whether or not higher human development is attained using sustainable methods.

In reality, the Human Development Index (HDI) measures a country's human development, composed by UNDP. But, many scholars put arguments disfavoured its implication as per HD and SHD paradigms. Hence, require modifications to align it with SHD paradigm.

### 1.1. Shortcomings of HDI as a composite indicator

Although the HDI's launch culminated qualitative improvement, it was not without its critics. It is stated that it praises the country's high economic development as a number while ignoring environmental or sustainability principles, i.e., rewarding the biggest polluters on the earth (Ivanov and Peleah, 2013; Hickel, 2020). According to several researchers, the HDI somehow only encapsulates some aspects of human well-being (McGillivray, 1991; Trabold-Nubler, 1991; Streeten, 1995; Morse, 2003). Security, political involvement, and human rights are a few illustrations (Anand and Sen, 1992a, 2000b; Ranis et al., 2006). Even the distribution of human advancement remains skeptical (Grimm et al., 2008).

Ravillion (2010) questioned the intrinsic and instrumental relevance of the dimensions included in the HDI. Murray (1993) and Srinivasan (1994) doubted the conceptual definition, equations, and data quality used to estimate human development. It even fails to encounter Sen's notion of functioning (does not measure achievements); only includes

the absolute measures of capabilities (Assa, 2021). It needs to address the degree of economic and social cohesion but cannot even assess the degree of linkage of public sector policies with human development (Bilbao-Ubillos, 2011).

Ravallion (1997), Decancq and Lugo, (2008) state that the implication of weights needs to convey the implicit trade-offs between the dimensions. Deb (2015) even questioned the new HDI methodology of 2010. As a synthetic indicator, it is criticized by many scholars (McGillivray, 1991; Trabold-Nubler, 1991; McGillivray and White, 1993; Dossel and Grounder, 1994; Gormely, 1995; Doraid, 1997; Noorbakhsh, 1998; Chowdhury and Squire 2006; Bilbao-Ubillos, 2013).

Assessing the components, Hickel (2020) administered that the education component does not capture the quality strand. Moreover, it is challenging to sum up two different metrics in a step, like life expectancy is an outcome-based statistic, whereas income is an input-based statistic. Quality aspects in the health dimension need to be included. Mazumdar (2003) and Streeten (1981) highlighted human advancement, stating that income alone does not suffice to measure well-being. In addition, HDI, based on the basic needs approach, must address the improvement of the range of basic human needs such as health, sanitation, and education.

Even higher life expectancy values do not guarantee healthy life years in varied population segments (Jha et al., 2017). A range of researchers even criticized the new methodology introduced by UNDP and stated that HDI does not look into the elasticity of the substitution rate between the sub-indices (Biggeri and Mauro, 2010, 2018; UNDP, 2013; Klugman et al., 2011). As per Assa (2021), Income being a flow concept differs from the other two, namely, health and education, as they are the stock elements.

No HDI component, though, presently fully captures the inextricably linkage of Sustainable human development to human development (UNDP, 2010). Deb (2015) devised that any anticipated modifications to the HDI methodology should portray a holistic picture of SHD, contemplating two vital concerns: adding missing dimensions and transitioning to the statistical estimation of dimensional weights. Also, the proposed index could determine if current policies align with a long-term sustainable route from a sustainable perspective or Sustainable Human Development (Jin et al., 2020).

## 1.2. Existing amendments referring to Sustainable Human Development (SHD)

A plethora of studies tried to broaden the basic scope of the HDI metric by inculcating more key aspects of human advancement. HDI is a well-known index that ranks countries on low, medium, high, and very-high human development levels. Therefore, it is used for international comparison among the nations. Hence, it is required that it must stand strong in plating what is expected from it. So, adding other relevant variables determining human well-being in a nation is essential.

Available literature does so by adjusting or modifying the index. Barrera-Roldán and Saldívar-Valdés (2002) proposed Sustainable Development Index by incorporating employment, potable water, sewage, infrastructure, poverty, air quality, protected areas,

and land usage in the index except the three indicators stated by HDI. On the same line, to accommodate parameters under the resource and environmental dimension, Costantini and Monni (2005) added the Air pollution index, Water pollution index, Soil pollution from Agriculture index, and Energy index with employment to frame Sustainable HDI.

In 2006, Ediger and Tatildil estimated energy-adjusted HDI after understanding the adverse effects, importance, and ideology of energy depletion by considering total primary energy consumption, Electricity consumption, energy use, and CO<sub>2</sub> emissions. A composite indicator for Sustainable Development was prepared by Kondyli (2010), introducing economic structure, size of the economy, potable water, biodiversity, sea quality, quality of land, size of the population, population structure, poverty, and unemployment.

Working on the limitations of the health component to address the quality aspects, Engineer et al. in 2010 modified HDI with two different variables- Expected lost healthy years and healthy life expectancy. The two explanatory variables portrayed the morbidity via HDI as the existing one only talks about mortality when it comes to the health of the citizens in a country. Jha et al. (2017), on the same line, addressed the health components of the HDI metric by talking about Health-adjusted for HALE and LHE.

The inclusion of decent employment, food, housing, and social security with health and education leads to the Index of Economic and Social Rights Fulfilment (Fukuda-Parr et al., (2010). Bilbao-Ubillos, in 2013 composed a composite dynamic HDI with the summation of social and environmental parameters: health, ecological footprint, economic welfare, gender situation, education, personal safety, inequality, and poverty. Except for the three dimensions of HDI, Ivanov and Peleah (2013) computed Affordable HDI by introducing a Clean and balanced environment (forest, soil, air, biodiversity, water, and habitat) as a dimension. In 2014, Li et al. proposed the Green Development Index throwing light upon the environmental and social indicators of human advancement. He used Threatened animals, CO<sub>2</sub> emissions, Potable water, PM10 (particles less than 10 microns in diameter), Sanitation facilities, Forest, Education, Health, Primary energy consumption, Land conservation, Income, and Poverty for the same.

Sharma and Sharma (2015) revisited the notion of the human development paradigm and, by viewing the importance of protection of human values in a nation, presented the Value-based HDI by engulfing human values as a positive concept against the corruption in a nation, being considered as a lousy and negative component. He used the Corruption Perception Index (CPI) given by Transparency International to depict the status of protecting human values in a nation. With the composition of the Aggregate SD Index, Bolcarova and Kolosta (2015) addressed social inclusion, economic growth, greenhouse gas emissions, resource productivity, renewable energy consumption, health and natural resources in the augmentation of sustainable development in a country. Bravo (2014) proposed the Human sustainable development index to highlight the need for HDI upgradation on Sustainable Human Development Paradigm by summing CO<sub>2</sub> emissions in the play with other HDI dimensions. In contrast, Ture (2013) adjusted the HDI on the sustainability dimension by using ecological footprint as a measure and named the same as Eco-sustainable HDI.

Highlighting the vitalness of the political/institutional dimension of sustainability or the political grounds affecting the human advancement of nations; Salas-Bourgoin (2014) proposed Modified HDI; inculcating employment and democracy index that comprise of personal security, the rule of law, freedom of expression, political participation, and equality of opportunity. Similarly, discussing the environment and political sustainability, Biggeri and Mauro (2018) constructed Sustainable HDI taking per capita CO<sub>2</sub> emissions and freedom (civil liberties and political rights) into account with other components of HDI.

Most of these indices do not align with either the triple bottom line approach or the three-pillar model of sustainable development (i.e., they do not measure sustainability on all the three dimensions - environment, economic, and social). PCA reduces the dimensionality of the actual datasets (indicators), so is used when many indicators need to be taken (Gan et al., 2017). Also, they reduce the risk of double weighting, which may occur in the case of the equal weighting method (Yeheyis et al., 2013).

So, the proposed MHDI gave equal weightage to all the dimensions as they all have equal significance for human development in a nation.

### 1.3. Objectives of the study

Given the importance of Human Development and its contribution to a country's growth, much research has been done. Also, the economic muscle and growth potential of BRICS nations make sense to base the study on this group of nations. So, the research article contributes to the body of literature and tried to propose an index that deciphers the true picture of human development in these developing group of nations. Therefore, the study aims to construct the composite index on the foundation of the Sustainable Human Development (SHD) paradigm by undertaking the HDI as a base index for BRICS countries from 2000-2019. Moreover, to investigate the relative impact of the proposed dimensions, namely, Health Index, Sustainability Index, Income Index, Education Index, Employment Index, and Human Values index on MHDI and to perform cross-country multi-comparisons for all sub-indices under MHDI.

The specified time span is selected to avoid the disturbances caused by the COVID prevalence that could have lead to drastic changes when it comes to the system and expenditure level of education, healthcare facilities, environment, etc., that impacts human development and are used as variables in the study.

This introduction is followed by a discussion of the relevance of variables that have been used in the study. Next, operationalization of the concept of the SHD paradigm that deciphers the description of undertaken variables is discussed. Section 3 elaborates on the Material and Methodology of the construction of the proposed index- MHDI. Then, the environmental sustainability dimension has been postulated using Principal Component Analysis. It is followed by the tabulation of computed MHDI and UNDPs' HDI values, inspection the of relative significance of sub-indices in MHDI, and post-hoc analysis. Then, policy implications for cross-country have been discussed, summing up the paper by the concluding section for BRICS countries in regard to human development measures and their practices.

## 2. Relevance of undertaken variables

Abdullah et al. (2016) examined the relationship between energy consumption, environment, health, and its resulting impact on BRICS' economic growth. The findings highlighted the significance of green growth and sustainable development policies that accelerate growth and improve the nation's welfare. Then, Wang et al. (2022) stated that BRICS economies face severe environmental issues that negatively impact human health. Their analysis found that rising CO<sub>2</sub> emissions reduced life expectancy and increased the death rate in BRICS nations. Moreover, environmental innovations, exacerbating health problems, and environmental policy stringency, uplift the health status of the people.

Human development goes beyond material comforts. The nation's ideology of "happiness and peace to all", according to Basu (2005), is compatible with human values and Indian traditions because people are more than impersonal economic beings. Ranis, Stewart, and Samman (2006) identified eleven crucial facets of human development and well-being outside the HDI domain. They emphasized the importance of spiritual well-being as a sign of society development, which is a great idea, and perceptions of corruption (a lousy idea). It has been extensively studied how human values affect legislation meant to advance human development (Dahl, 2013 and Deneulin, 2011). Unexpectedly, Sen's capabilities approach has never considered human values for an unknown reason.

Salas-Bourgoin (2014) argues that human development should consider other factors like employment and environmental sustainability to assess progress. Employment helps people feel more dignified and provides them with the resources to meet their basic needs and escape poverty. Therefore, its central tenet is that employment and development are positively correlated and that rising employment levels signify that society has given people more options and opportunities.

Government spending has become essential to accomplish many significant goals, and as a result, it has had numerous favourable knock-on effects that advance humanity. Government spending on health and education positively and significantly impacted Makassar City's human development index (Hasan, 2019).

Engineer, Roy, and Fink (2010) claimed that the current HDI only addresses mortality, leaving out the morbidity component. It is also unacceptable to only think about quantity without embracing quality. The actual life expectancy of a country is determined by deducting the unhealthy years of life from the healthy life expectancy. When addressing a country's human development, the model must include a dimension for resources and the environment.

Even energy use has a significant role in predicting human development. Given the energy consumption level, HDI is an increasing function of time, whereas energy consumption needs to be declined to achieve a target HDI. The long-run association between the natural environment and HDI and the energy consumption is proved by causality analysis in three regions: energy-poor nations, transitioning nations, and energy-advantaged nations (Martínez and Ebenhack, 2008). However, HDI failed to consider energy use as a factor in determining human development, whereas without energy use, there is no survival of human society (Roy and Dalei, 2020).

Indeed, human development could never have occurred without energy, as it is vital in all aspects of human life. Energy use directly impacts all three dimensions of human development, including health, education, and living standards (Ray et al., 2016). Renewable energy, as one type of energy, is gaining increasing attention because of the hazardous impact associated with using traditional energy (Aydin, 2019). Research on the relationship between renewable energy and human development has also produced mixed results. In 2013, Brazil, India, China, and South Africa were among the top 10 countries that invested extensively in renewable energy. As per (Wang et al., 2021), usage of renewable energy stimulates human development.

A large portion of the forest, access to clean drinking water, and arable land will increase human well-being directly and indirectly. At the same time, the decline in human well-being will be brought on by various factors, including the use of fertilizers, fossil fuels, and CO<sub>2</sub> emissions. According to the findings of Ganda (2022), human capital has both short- and long-term, significantly favourable relationships with environmental sustainability and quality. Human capital has a bi-directional causality link with environmental sustainability, while environmental quality also causes human capital (indicating a uni-directional causality relationship).

### 3. Operationalization of the concept of the SHD paradigm

MHDI index tries to accommodate the human advancement notion relying on the sustainability pillars or triple bottom line approach as mentioned in Table 1.

**Table 1.** Elevating HDI on the SHD paradigm

	Dimension	Indicators	Description	Pre-mise	Source	Sustainability Pillar
HUMAN DEVELOPMENT	Education	Mean Years of Schooling	Expected years of schooling at birth	+	UNDP	Social
		Expected Years of Schooling	Mean years of schooling	+	UNDP	
		Public Expenditure on education	Education expenditure (% of GNI)	+	WDI	
	Health	Healthy Life Expectancy	Healthy life expectancy at birth (Years)	+	WHO	
		Public Expenditure on health	Current health expenditure (% of GDP)	+	WDI	
	Values	Human Values	Corruption Perception Index	+	Transparency International	
	Income	GNI per capita	GNI per capita (PPP\$)	+	UNDP	Economic
	Employment	Employment to population ratio	Employment to population ratio, 15+ (total %)	+	WDI	
		Non-vulnerable employment	100 – vulnerable employment, total (% of total employment)	+	WDI	
	Environment	Natural resources depletion	Natural resources depletion (% of GNI)	–	WDI	Resource and Environment
Energy consumption		Energy depletion (% of GNI)	–	WDI		
Carbon dioxide emissions		CO <sub>2</sub> emissions (metrics tons per capita)	–	WDI		
Access to basic drinking water services		People using at least basic drinking water services (% of population)	+	WDI		
Arable land		Arable land (% of land area)	+	WDI		
	Fossil fuel consumption	Fossil fuel energy consumption (% of total)	–	WDI		

**Source:** Author's compilation.

Hence, complying with the Sustainable human development paradigm (SHD). The table aligns Amartya Sen's notion of human development considering capabilities, functionings, and agency or the human development paradigm on which the UNDP's HDI metric rests with the triple bottom line approach of sustainability.

#### 4. Material and methodology

According to the standard framework of HDI dimension index formulae, the dimension indices of income, health, employment, human values, and education are computed as follows:

$$\text{Dimension Index (DI)} = \frac{(\text{Absolute Value} - \text{Minimum Value})}{\text{Maximum Value} - \text{Minimum Value}}$$

Only the environmental sustainability index is framed employing PCA.

Table 2, illustrated below, tries to decipher the amalgamation of Sen's notion of Human Development and the Triple Bottom Line sustainability approach as a step to address Sustainable Human Development (SHD) Paradigm. The main idea of the proposed MHDI is to blend range of choices, human capabilities, and opportunities available in a nation as per Sen's concept with the parameters of sustainability (economic, social, and environmental), via the means of the composite index (MHDI).

**Table 2.** Modified Human Development Index Estimation (MHDI)

MHDI Components						
	Choices		Human capabilities	Opportunities		
Dimensions	Income	Employment	Education	Health	Values	Environmental sustainability
Method Employed to get dimension Index	DI Formula	AM of indicators	AM of indicators	AM of indicators	DI Formula	PCA
	ECONOMIC SUSTAINABILITY		SOCIAL SUSTAINABILITY			ENVIRONMENT SUSTAINABILITY
MHDI (GM)	$\sqrt[6]{\text{Employment Index} * \text{Income Index} * \text{Education Index} * \text{Value Index} * \text{Sustainability Index} * \text{Health Index}}$					

**Source:** Prepared by author, where: AM – Arithmetic Mean, GM – Geometric Mean, PCA – Principal Component Analysis.

As per Kwatra, Kumar, and Sharma (2020) social sustainability refers to poverty reduction; economic sustainability refers to the long-term sustainability of both renewable and non-renewable resources so that they feed into the production system and provide long-term economic benefits; and environmental sustainability refers to preservation and maintenance of the life forms that exist on earth (Goodland, 1995; Sutton, 2004).

Minimum and maximum values for the income and education index are used as per the UNDP. For other variables, minimum and maximum values are selected from the observed data. Moreover, missing values are replaced with the mean values, and equal weighting is given to all HDI dimensions.



Three new dimensions are added in the HDI: employment, sustainability, and human values. Consideration of public expenditure also encapsulates quality aspects of a nation's health and education. Human values broadly represent a nation's system (summarised in such a way that it has a linear relationship with corruption) (Sharma, 2015). The table reflects variables extracted under the heading of sustainability dimension following PCA. According to the PCA, the percentage of arable land with a nation and population having access to drinking water are reduced. The head employment indicator consists of two sub-indicators: the employment-to-population ratio and the percentage of non-vulnerable employment in a country.

To assess the impact of proposed sub-indices on the MHDHI, the following equation has been regressed;

$$MHDI_{it} = \alpha + \beta_1 E.I_{it} + \beta_2 V.I_{it} + \beta_3 S.I_{it} + \beta_4 I.I_{it} + \beta_5 H.I_{it} + \beta_6 Ed.I_{it} + \varepsilon_{it}$$

Where,

E.I. = Employment Index.

V.I.= Human Values Index.

S.I.= Sustainability Index.

I.I.= Income Index.

H.I.= Health Index.

Ed.I. = Education Index.

Also, the "i" subscript depicts the country, and "t" denotes the time (years).  $\alpha$  is the intercept,  $\beta$ 's are the coefficients of the respective explanatory variable, MHDHI is Modified Human Development Index, and  $\varepsilon$  is the random error.

To explore the cross-country differences of BRICS for sub-dimensional indices; one-way ANOVA is conducted using Post-hoc analysis on the basis of mean differences.

## 5. Environmental sustainability dimension

Amongst all the dimensions, the sustainability dimension is framed with the aid of PCA. A total of ten variables were taken into account: fertilizer consumption, natural depletion, energy consumption, CO<sub>2</sub> emissions, Access to basic drinking water, Forest area, Arable land, fossil fuel consumption, and access to basic sanitation services and use of renewable resources. PCA eliminated four variables – fertilizer consumption, forest area, access to basic sanitation services, renewable energy consumption. Leftover relevant six variables are used as indicators to frame environmental sustainability, as mentioned in the table.

**Table 3.** *KMO and Bartlett's Test*

KMO	.612
Bartlett's Test of Sphericity	
Approx. chi-square	769.122
Degree of freedom (df)	15
P ( $\alpha=5\%$ )	.000

**Source:** Author's own computation. KMO – Kaiser Meyer Olkin.

**Table 4.** Indicators and their derived weights under Environmental Sustainability Head

Indicators	C1	C2	Weight
Fertilizer consumption	X	X	X
Natural depletion	Yes	X	0.817
Energy consumption	Yes	X	0.805
CO <sub>2</sub> emissions	Yes	X	0.896
Access to basic drinking water	Yes	X	0.076
Forest area	X	X	X
Arable land	X	Yes	0.786
Fossil fuel consumption	Yes	X	0.886
Access to basic sanitation services	X	X	X
Renewable Energy consumption	X	X	X
Component weights	0.825	0.175	X

**Source:** Author's own computation.

Table 3 elaborates on the diagnostic procedures validating the application of the PCA technique to construct the environmental sustainability index of BRICS nations for the data. KMO value, being higher than 0.50 depicts the suitability for PCA and value of Bartlett's Test of Sphericity; below 0.05 depicts the significance concluding the strong relationship among variable, or correlation matrix is not identity matrix as is required by factor analysis to be justifiable. The internal reliability of the model as per the Cronbach's Alpha is 0.693. In Table 5, we can observe that we obtained two principal components, where PC1 explains the 49.47% of the variations and PC2 elucidates 81.86% of the variations. The weights of the indicators are displayed in Table 4.

**Table 5.** Eigenvalue and factor selection

Indicator of PCA	PC1	PC2
Eigenvalue	2.968	1.944
Variability (%)	49.467	32.398
Cumulative %	49.467	81.865

**Source:** Author's own computation. PCA – Principal Component Analysis, PC – Principal Components.

## 6. Tabulating retrieved MHD and UNDPs HDI values

The HDI values are computed by UNDP, incorporating three heads- education, health, and income. MHD is computed utilizing six heads, as mentioned above in the proposal. Table 6 depicts the calculated MHD values and HDI values of BRICS nations from 2000-2019, lying in the range of 0 to 1. Values more towards 1 show the presence of high human development in the country, whereas values sliding toward zero show less human advancement in that particular nation.

**Table 6.** Computed MHD and HDI values of BRICS nations

BRICS	BRAZIL			RUSSIA			INDIA			CHINA			SOUTH AFRICA		
Year	MHD	HDI	AD	MHD	HDI	AD	MHD	HDI	AD	MHD	HDI	AD	MHD	HDI	AD
2000	0.629	0.685	-0.056	0.495	0.722	-0.227	0.302	0.495	-0.193	0.431	0.588	-0.157	0.573	0.631	-0.058
2001	0.640	0.691	-0.051	0.510	0.728	-0.218	0.304	0.499	-0.195	0.443	0.596	-0.153	0.544	0.611	-0.067
2002	0.650	0.699	-0.049	0.536	0.734	-0.198	0.305	0.506	-0.201	0.453	0.606	-0.153	0.537	0.619	-0.082
2003	0.639	0.695	-0.056	0.531	0.742	-0.211	0.311	0.518	-0.207	0.460	0.618	-0.158	0.527	0.619	-0.092
2004	0.645	0.698	-0.053	0.532	0.748	-0.216	0.313	0.527	-0.214	0.464	0.628	-0.164	0.529	0.619	-0.090
2005	0.676	0.7	-0.024	0.521	0.753	-0.232	0.319	0.536	-0.217	0.466	0.64	-0.174	0.524	0.622	-0.098
2006	0.649	0.702	-0.053	0.529	0.76	-0.231	0.326	0.546	-0.220	0.476	0.653	-0.177	0.533	0.626	-0.093
2007	0.658	0.706	-0.048	0.531	0.769	-0.238	0.330	0.555	-0.225	0.488	0.667	-0.179	0.547	0.632	-0.085
2008	0.671	0.717	-0.046	0.529	0.775	-0.246	0.331	0.563	-0.232	0.500	0.678	-0.178	0.556	0.646	-0.090
2009	0.685	0.719	-0.034	0.545	0.773	-0.228	0.325	0.569	-0.244	0.508	0.687	-0.179	0.562	0.655	-0.093

BRICS	BRAZIL			RUSSIA			INDIA			CHINA			SOUTH AFRICA		
Year	MHDI	HDI	AD	MHDI	HDI	AD	MHDI	HDI	AD	MHDI	HDI	AD	MHDI	HDI	AD
2010	0.682	0.727	-0.045	0.537	0.781	-0.244	0.322	0.579	-0.257	0.512	0.699	-0.187	0.560	0.664	-0.104
2011	0.683	0.731	-0.048	0.550	0.79	-0.240	0.321	0.588	-0.267	0.520	0.707	-0.187	0.559	0.665	-0.106
2012	0.698	0.735	-0.037	0.574	0.798	-0.224	0.330	0.597	-0.267	0.532	0.716	-0.184	0.572	0.675	-0.103
2013	0.709	0.753	-0.044	0.581	0.802	-0.221	0.337	0.604	-0.267	0.541	0.724	-0.183	0.576	0.685	-0.109
2014	0.719	0.756	-0.037	0.582	0.807	-0.225	0.339	0.616	-0.277	0.538	0.731	-0.193	0.582	0.693	-0.111
2015	0.714	0.756	-0.042	0.594	0.809	-0.215	0.338	0.624	-0.286	0.544	0.739	-0.195	0.591	0.701	-0.110
2016	0.716	0.758	-0.042	0.599	0.815	-0.216	0.338	0.63	-0.292	0.555	0.746	-0.191	0.590	0.703	-0.113
2017	0.710	0.761	-0.051	0.610	0.82	-0.210	0.331	0.64	-0.309	0.560	0.75	-0.190	0.579	0.705	-0.126
2018	0.705	0.762	-0.057	0.607	0.823	-0.216	0.328	0.642	-0.314	0.558	0.755	-0.197	0.582	0.707	-0.125
2019	0.710	0.765	-0.055	0.609	0.824	-0.215	0.339	0.645	-0.306	0.568	0.761	-0.193	0.589	0.709	-0.120
Average Values for the time-period 2000-2019															
MHDI	0.679			0.555			0.324			0.506			0.560		
HDI	0.726			0.779			0.574			0.684			0.659		

**Source:** MHDI, computed by author. HDI – by UNDP. AD – Absolute Difference (MHDI-HDI).

The above table shows the derived MHDI and HDI values for all BRICS nations for 20 years. On average, the MHDI values for Brazil lie around 0.679, whereas the HDI value revolved around 0.726. Similarly, the average HDI values for Russia, India, China, and South Africa were 0.779, 0.574, 0.684, and 0.659, respectively. With the proposed modifications to capture a realistic picture of the status of human development, the HDI values altered to 0.555, 0.324, 0.506, and 0.560 for Russia, India, China, and South Africa, respectively, with the introduction of MHDI.

## 7. Inspecting the relative effect of sub-indices framed on MHDI

The sub-indices framed were regressed on MHDI to know the relative significance of the dimensions or the specific index. The results will assist us to investigate which bundle of variables forming the specified dimensional sub-index, are impacting the human advancement in the bloc of BRICS and to what extent.

**Table 7.** Diagnostic tests for checking the model consistency

Test	Results	Model Consistency
Wooldridge test for Autocorrelation Durbin-Watson	F= 27.519 Pr>F= 0.006**	Presence of Autocorrelation in the model
Pesaran abs test of cross-sectional independence	$\chi^2(1)= 1.451$ Pr= 0.147***	No Cross-sectional dependence found
Cook-Weisberg test for heteroskedasticity	$\chi^2(2)= 32.62$ Pr>chi2= 0.000*	Presence of heteroscedasticity in the model

**Note:** \*, \*\*, and \*\*\* Significant at 1, 5, and 10 per cent levels.

**Source:** Authors' computation.

**Table 8.** Regressing sub-indices on MHDI

Methods for panel data	(1)	(2)	(3)	(4)
	POLS	Fixed Effects Model	Random Effects Model	FGLS
Model 1 (Dependent variable is MHDI)				
Income Index	0.077** (2.45)	0.074*** (1.95)	0.077** (2.45)	0.209* (6.31)
Health Index	0.183* (13.37)	0.21* (10.91)	0.183* (13.37)	0.193* (17.49)
Human Values Index	0.299* (16.21)	0.163* (6.32)	0.299* (16.21)	0.281* (29.77)
Employment Index	0.27*	0.311*	0.27*	0.216*

Methods for panel data	(1)	(2)	(3)	(4)
	POLS	Fixed Effects Model	Random Effects Model	FGLS
	(21.65)	(12.80)	(21.65)	(14.97)
Education Index	0.199*	0.147*	0.199*	0.158*
	(17.99)	(7.73)	(17.99)	(13.74)
Sustainability Index	0.109*	-0.133*	0.109*	0.103*
	(15.93)	(-3.82)	(15.93)	(14.47)
_constant	-0.053*	0.204*	-0.053*	-0.092*
	(-2.86)	(4.36)	(-2.86)	(-4.82)
Observations	100	100	100	100
R-squared	0.99	0.95	0.99	
F-test	2252.915	299.941		
Prob> F	0.00	0.00		
Wald chi2			13517.492	4325.443
Prob>chi2			0.00	0.00

**Source:** Author's own computation.

**Note:** (t and z statistics in parentheses).

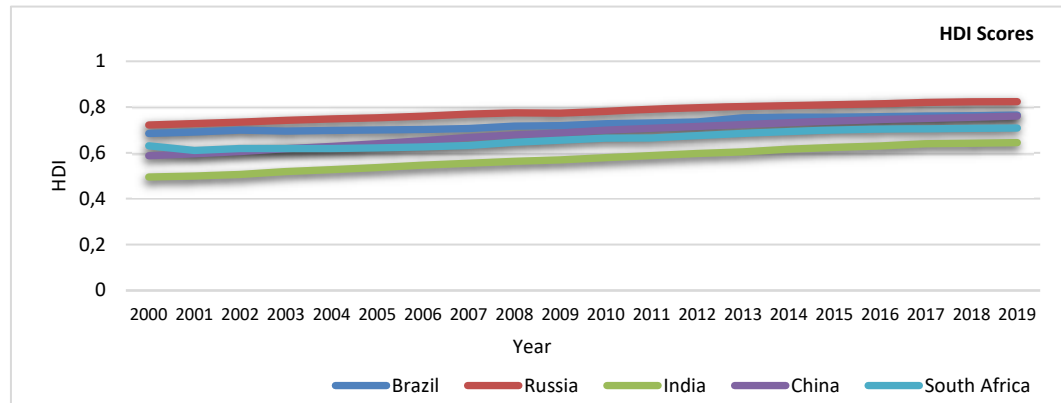
\*, \*\*, \*\*\* denotes statistical significance at 1%, 5% and 10%, respectively.

The Modified HDI sub-dimensions prompted the development of a panel dataset and the application of the associated methodology. All accepted methods, such as pooled OLS, Fixed effects models, and Random effects models, have been employed to estimate the model. Even model investigation tests, F-test (between Pooled OLS and FEM), BP-LM (between REM and Pooled OLS), and Hausman tests have been employed. Finally, the results of the Hausman test (p value-0.000) favour FEM. Every diagnostic test has been carried out as tabulated in Table 7. Finally, FGLS is employed as  $T > N$ , to cater the issues of serial correlation and unknown form of heteroscedasticity.

It is visualized that all the dimensional indices have a positive and highly significant impact on the MHDI. A unit increase in the Income index, Health index, Human values index, Employment index, Education index, and Sustainability index leads to change in the MHDI by 0.21%, 0.19%, 0.28%, 0.22%, 0.16%, and 0.110%, respectively.

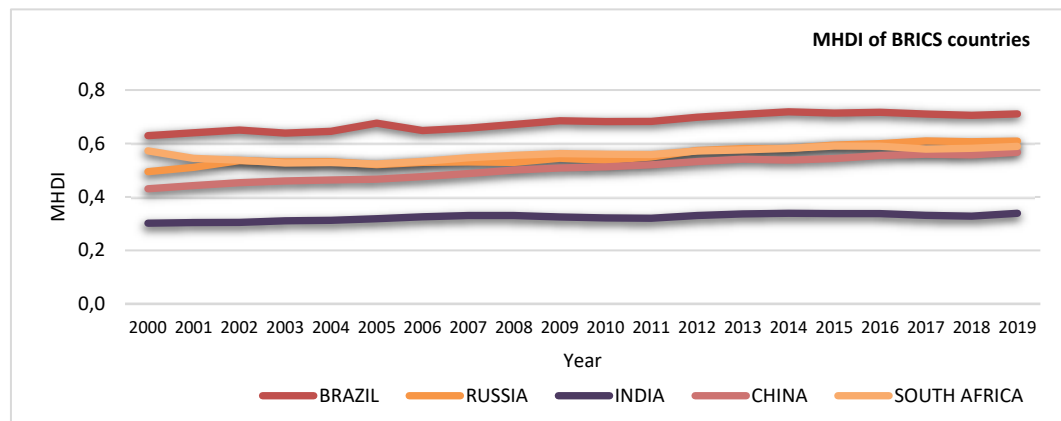
MHDI framed to explain the human development in a nation; when regressed, claims that in BRICS nations, human values, where their prevails less corruptive environment, corruption-free securing the human rights contribute maximum when it comes to human development. Then, employment level, and opportunities, income level of the citizens and health status of individuals, availability of healthcare facilities, education level of residents and quality of education contributes to human advancement. The study affirms that environmental sustainability in the BRICS contributes to the progress of humankind significantly but comes on last among other dimensional indices, when it comes to ranking the order for impacting the MHDI.

The HDI scores for the BRICS nations are shown in Figure 1 based on UNDP calculations. India's HDI score is extremely low by comparison in 2000, but it has since started to increase. Up until 2007, it is rated as having low human development, but things started to change in 2008, and now it is rated as having medium human development. Russia, on the other hand, have high levels of human development up until 2012, but after that, it rose to extremely high levels. Within a 20-year period, the remaining three member countries have increased from medium scores of human development to a high levels of HDI.

**Figure 1.** HDI of BRICS nations

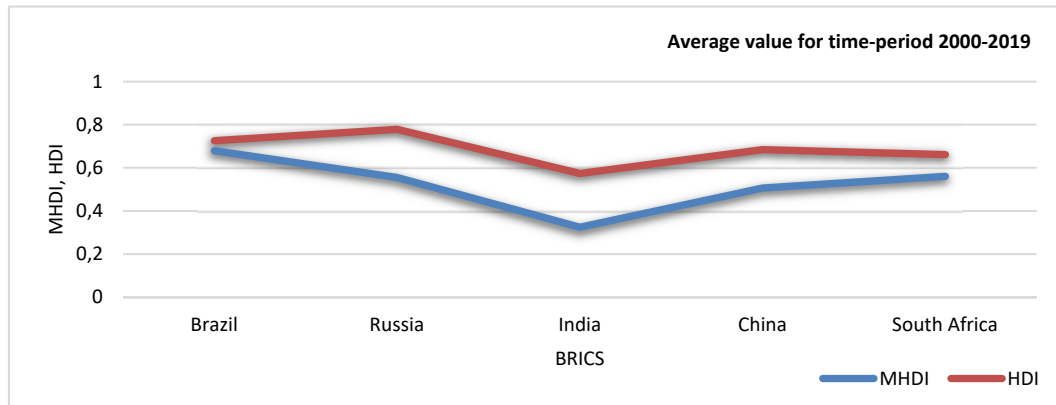
**Source:** Author's own computation.

Initially, from 2000 to 2005, Brazil was at the top of the list, with South Africa and China following closely behind. However, the equation changed between 2005 and 2015. China surpassed South Africa within the specified timeframe, and Brazil maintained its lead over these two. After 2015, all three are classified as having high human development. The gap in HDI scores between Brazil and China narrowed, but South Africa remains slightly below their levels.

**Figure 2.** MHDI of BRICS nations

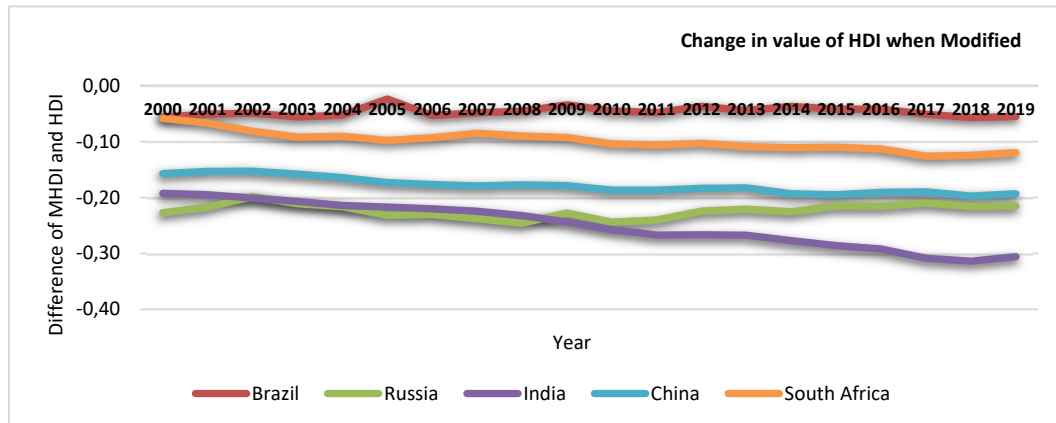
**Source:** Author's own computation.

The BRICS countries' MHDI scores are demonstrated in the diagram above. These scores are calculated after incorporating in additional indicators that have been suggested based on how important they are to a country's overall human well-being. In the Indian scenario, it is nearly identical over the specified time frame of 20 years. Brazil is first on the list. It progressed from the edge of being at a medium stage to high human advancement. According to MHDI, South Africa somewhat is ranked second with Russia on third for initial years. From 2003 to 2016, they both somewhat came on the same scores. The kind of upward trend is seen in the trend of China's MHDI values.

**Figure 3.** Average values of BRICS members from 2000-2019

**Source:** Author's own computation.

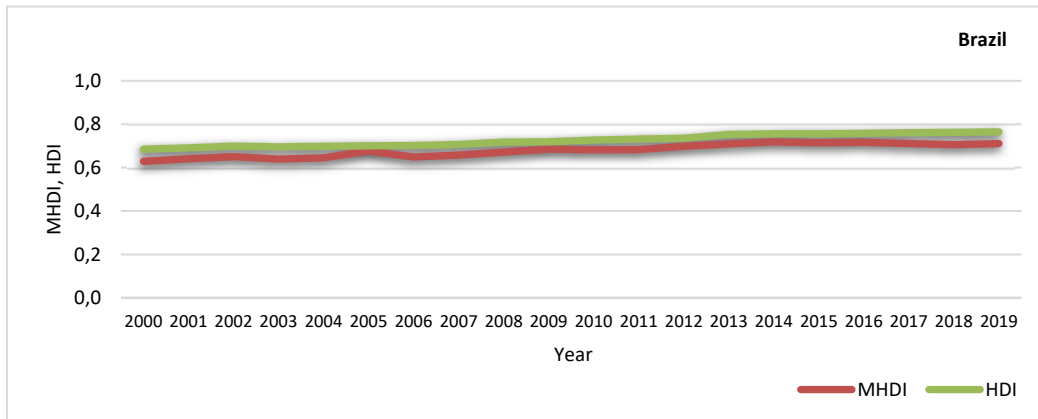
The above diagram shows the average level of human development in the BRICS nations over a 20-year period, from 2000 to 2019, as determined by HDI and MHDl. Brazil somewhat have a very slight decrement in its average value when modified in comparison to other four nations. The drastic fall can be seen in the case of India followed by Russia, according to visualizations. China and South Africa encounters a lower gap between both the methodologies for estimating human well-being.

**Figure 4.** Changes in the values of HDI after modification (MHDl-HDI)

**Source:** Author's own computation.

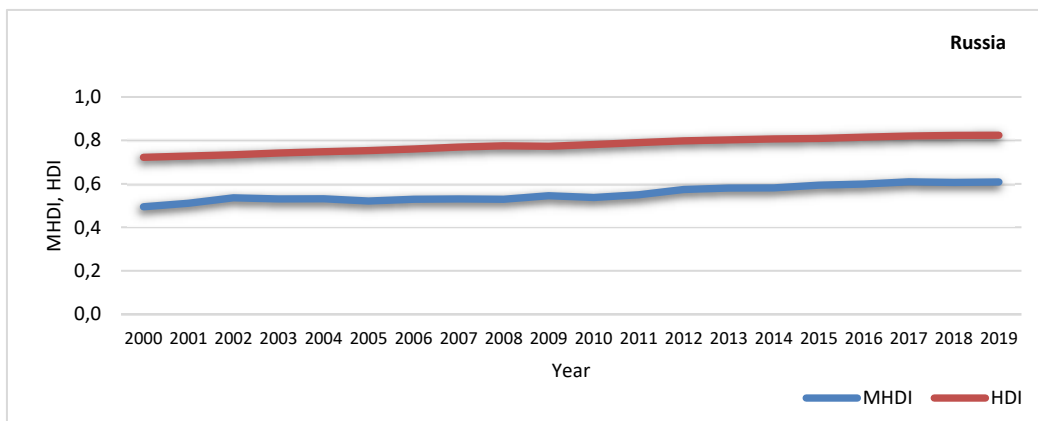
The graph above showcases the absolute difference between the two indices taken into account after subtracting HDI values from MHDl scores. The introduction of the MHDl resulted in a lowering of human development in each of the five member countries. India has suffered the most severe deterioration in trend with time, followed by Russia. Brazil has the smallest fall in values followed by South Africa. China lies somewhere in between, neither very low deterioration as visualized in the case of Brazil and South Africa, nor very high deterioration as in case of Russia and India.

**Figure 5.** *MHDI and HDI scores of Brazil*



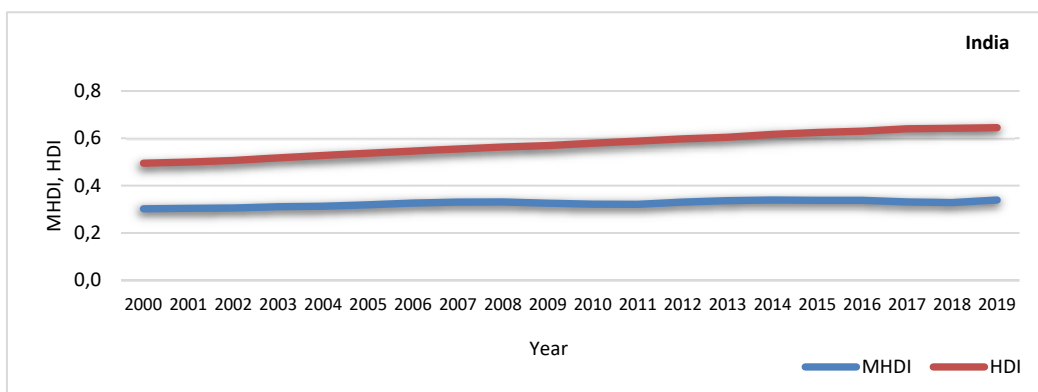
Source: Author's own computation.

**Figure 6.** *MHDI and HDI scores of Russia*

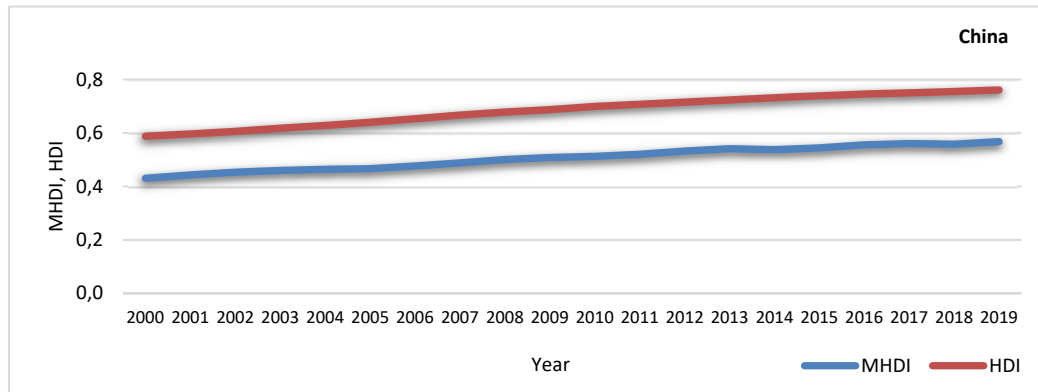


Source: Author's own computation.

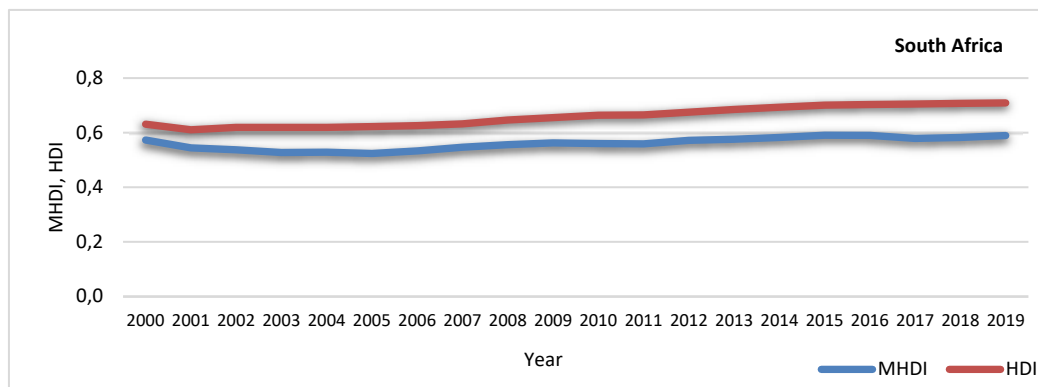
**Figure 7.** *MHDI and HDI scores of India*



Source: Author's own computation.

**Figure 8.** *MHDI and HDI scores of China*

**Source:** Author's own computation.

**Figure 9.** *MHDI and HDI scores of South Africa*

**Source:** Author's own computation.

Charts 5-9 exhibit each nation's HDI and MHDI scores from 2000 to 2019. All five countries' MHDI scores fell short of their HDI values. Additionally, over 20 years, almost all of them showed an increase in both metrics (HDI and MHDI). Considering the case of Brazil, MHDI values were lower than HDI, but the difference between the two is not massive. Both are close by. The same is in the case of South Africa. Therefore, other RIC members should take few lessons from the Brazil in terms of the additive measures of MHDI proposed.

## 8. Post-hoc analysis

Post-hoc analysis has been carried out to learn inter-country differences among the BRICS countries in regard to the sub-indices of proposed MHDI reflecting nations' human development. It assists in understanding the variations in the mean values of the indices among the member countries with the help of multi-comparisons via one-way ANOVA. According to Levene's statistics, the BRICS countries exhibits heterogeneity (unequal



variances). Hence, Dunnett's T3 is applied as a result. In this case, with unequal variance, it is appropriate to proceed with post-hoc analysis because all of the indices F statistics are significant according to ANOVA. Welch and Brown-Forsythe's testing clarifies the same.

**Table 9.** Test of homogeneity of variances

Indices	Levene Statistic	df1	df2	Sig.
Sustainability Index	18.888	4	95	.000
Education Index	4.975	4	95	.001
Employment Index	10.067	4	95	.000
Human Values Index	3.281	4	95	.014
Health Index	9.363	4	95	.000
Income Index	21.267	4	95	.000

**Note:** Based on mean.

**Source:** Author's computation.

**Table 10.** Robust tests of equality of means

		Statistic <sup>a</sup>	df1	df2	Sig.
Sustainability Index	Welch	3983.145	4	45.593	.000
	Brown-Forsythe	1950.032	4	34.249	.000
Education Index	Welch	163.925	4	47.029	.000
	Brown-Forsythe	132.528	4	74.497	.000
Employment Index	Welch	640.401	4	44.859	.000
	Brown-Forsythe	836.009	4	74.900	.000
Human Values Index	Welch	120.999	4	47.177	.000
	Brown-Forsythe	86.896	4	75.476	.000
Health Index	Welch	312.426	4	44.673	.000
	Brown-Forsythe	160.946	4	68.434	.000
Income Index	Welch	110.823	4	44.682	.000
	Brown-Forsythe	97.186	4	41.801	.000

**Note:** Asymptotically F distributed.

**Source:** Author's computation.

**Table 11.** BRICS cross-country comparisons on dimensional indices of MHD

Post-hoc Comparisons (Dunnett's T3)							
Country		Mean Difference (I-J) of the Indices					
(I)	(J)	Sustainability Index	Education Index	Employment Index	Human Values Index	Health Index	Income Index
Brazil	Russia	.6895552*	-.0819807	-.1176780*	.13000*	.3328164*	-.0726738*
	India	.4084712*	.3836286*	.3943125*	.04750*	.5320439*	.1807318*
	China	.6512936*	.3336037*	-.0819106*	.02350	.2288577*	.0796422*
	South Africa	.7363206*	-.0684779	.0665364*	-.06800*	.3016481*	.0211080*
Russia	Brazil	-.6895552*	.0819807	.1176780*	-.13000*	-.3328164*	.0726738*
	India	-.2810840*	.4656093*	.5119906*	-.08250*	.1992276*	.2534055*
	China	-.0382616	.4155844*	.0357674*	-.10650*	-.1039587*	.1523159*
	South Africa	.0467654*	.0135028	.1842145*	-.19800*	-.0311683	.0937818*
India	Brazil	-.4084712*	-.3836286*	-.3943125*	-.04750*	-.5320439*	-.1807318*
	Russia	.2810840*	-.4656093*	-.5119906*	.08250*	-.1992276*	-.2534055*
	China	.2428224*	-.0500249	-.4762232*	-.02400	-.3031863*	-.1010896*
	South Africa	.3278494*	-.4521065*	-.3277761*	-.11550*	-.2303959*	-.1596238*
China	Brazil	-.6512936*	-.3336037*	.0819106*	-.02350	-.2288577*	-.0796422*
	Russia	.0382616	-.4155844*	-.0357674*	.10650*	.1039587*	-.1523159*
	India	-.2428224*	.0500249	.4762232*	.02400	.3031863*	.1010896*
	South Africa	.0850270*	-.4020815*	.1484471*	-.09150*	.0727904	-.0585342*
South Africa	Brazil	-.7363206*	.0684779	-.0665364*	.06800*	-.3016481*	-.0211080*
	Russia	-.0467654*	-.0135028	-.1842145*	.19800*	.0311683	-.0937818*
	India	-.3278494*	.4521065*	.3277761*	.11550*	.2303959*	.1596238*
	China	-.0850270*	.4020815*	-.1484471*	.09150*	-.0727904	.0585342*

**Source:** Author's computation

**Note:** \* denotes the significance at level 5%.

As per the Dunnett's T3 post-hoc analysis:

- Russia's mean difference is found to be large and higher than that of all other member countries for the Income Index, which shows the GNI per capita scenario. Brazil comes second, followed by South Africa, China and, then, India in last and mean differences are significant for all.
- Employment Index deciphering the availability of employment opportunities and its non-vulnerability, the order of countries found to be highest for Russia, followed by China, Brazil, South Africa, and then, India. These differences among all the countries are significant in nature.
- Health Index, portraying the healthcare facilities and life expectancy of the population, is found to be highest in Brazil, followed by China, South Africa, Russia, and India. The mean difference is significant for all except for, between China and South Africa, South Africa and Russia.
- Addressing the Human Values Index, South Africa tops the rest, followed by Brazil, China, India and Russia. Wherein, the results are insignificant for China and India, China and Brazil.
- Brazil considerably outperforms China in terms of educational facility quality and expected and mean years of schooling of citizens. But, rank-wise, Russia tops the list, followed up by South Africa, Brazil, China and India. But, the results are found to be insignificant for all the countries except for Brazil and China.
- Brazil came on first when countries were ranked in terms of environmental sustainability, followed by India, China, Russia, and South Africa. With the exception of China and Russia, all mean differences are statistically significant.

This implies that other nations should look into the plans and policies of Brazil when it comes to environmental sustainability and healthcare facilities. Moreover, Russia's policies must be looked when considering the educational-related facilities development, income-generating activities, employment prospects, and human values. Mostly, India and South Africa are lying at the last in the descending order of the ranking among distinct sub-indices.

## 9. Policy implications

The results of the post-hoc analysis assisted in framing the policies for BRICS member nations as follows:

- South Africa and India must aim to eliminate gender differences in job opportunities, outcomes, and the percentage of informal unemployment within their borders because they are ranked lower than other countries. Even they should examine the policies of Russia, China, and Brazil as they have higher rankings. They, too, should contribute to education, social welfare, and training because these factors influence the skill level and employability of the workforce.
- Even though there are many non-significant variances of mean groups in the case of the education index, China and India are placed on lower ranks, despite the adoption of numerous efforts like the Sarva Shiksha Abhiyan in India and an emphasis on vocational education and training in China. All five nations must work to enhance teacher training programmes, decrease gender disparities, boost access to higher education and

infrastructure development, and raise participation rates in both secondary and higher education. Russia performed well in the education rankings, thus other member nations should adopt its strategy of placing a significant emphasis on science, maths, and other related subjects.

- Despite having a sizable amount of natural and human capital at their disposal, the BRICS' operations must be practically sustainable. Since they have the fastest-growing economies, their economic expansion come at a cost to the environment. Russia and South Africa, who rank lower in the environmental sustainability index, must adopt the policies and practices followed by the other three member countries in order to efficiently and sustainably safeguard and utilize the natural wealth.

Russia is heavily reliant on the extraction of mineral, oil, and gas resources, so, must make steps to minimise carbon emissions and safeguard sites such as national parks and nature reserves. South Africa suffers a number of environmental concerns, including water scarcity, air pollution, and soil degradation, and must thus establish laws to address these issues. All of these member countries should take responsibility for developing policies that address the specific environmental issues they face, promote environmental sustainability, and reduce their environmental effect. Furthermore, they must make significant investments in renewable energy to reduce emissions, as few of them are among the world's largest emitters of greenhouse gases. They must endeavour to reduce coal usage, promote electric vehicles, improve access to clean water, and implement efforts and steps to conserve biodiversity.

- Brazil topped the health index ranking parameter as it implemented several health initiatives, such as the Family Health Program, which provides primary care services to low-income families, and making significant progress in reducing infant mortality rates and combating infectious diseases, such as HIV/AIDS. Russia and India were in the bottom two spots. As a result, they must monitor the initiatives of Brazil, China, and South Africa to promote healthcare facilities and the quality of life of their inhabitants. BRICS must address the issues of malnutrition, mortality, access to healthcare, countering increased rates of infectious diseases, universal access to healthcare in rural regions, increment in the public expenditure on healthcare and must work to enhance the effectiveness of medical services providers, conduction of awareness programs.
- With varied degrees of severity, corruption is a significant issue in all of the BRICS nations, further impeding human progress. In terms of the human values index, South Africa came out on top, followed by Brazil and China. India came on last-second whereas, Russia was last. With a blend of individualist and collectivist traditions, Brazil and South Africa have more varied cultural values than other countries. That has an even greater impact on matters like commercial practises, social policies, and perspectives on government intervention. Harmony and uniformity must be valued, thus efforts must be made to enhance institutions, promoting transparency and accountability, and foster a culture of ethical conduct. All other nations should look into their plans and strategic ways of respecting human values, maintaining corruption free environment.
- The ranking order for the Income Index was Russia > Brazil > South Africa > China > India, where the mean difference was statistically significant. Russia has considerable

natural resources, particularly oil and gas, which have aided its economic development, and Brazil, too, has a diverse economy with a strong agricultural sector and a booming technological industry. China and India must monitor the steps taken by Russia, Brazil, and South Africa in terms of economic structure, resource utilisation, and other factors. BRICS as a whole should look for infrastructural improvement, promotion of innovation and entrepreneurship, and strengthening governance frameworks and institutions.

These distinctions are crucial for policymakers because they will help them to advance humankind and provide them a focus for improving their economy and, particularly, citizens on all fronts.

## 10. Conclusion

Human development is not just about advancing individuals socially and economically. Even other political and sustainability domains must be considered. As a result, HDI does not accurately represent a nation's citizenry's state of well-being. MHDI has been proposed as an attempt by adding employment, human values, public spending on health and education, healthy life expectancy, and environment-related variables to the estimation; that painted a completely distinct portrayal of the BRICS countries. All factors impact people's well-being either directly or indirectly. It is crucial to elevate the HDI metric on the HD paradigm and the hotly debated SHD paradigm as a holistic approach.

The modified HDI scores for the BRICS nations were lower than their HDI results. Their contributions to human development are not diminished in any way by this; rather, it serves as a "magnifying glass" that makes their strengths and flaws more obvious. South Africa was the country with the smallest average difference between MHDI and HDI, after Brazil. India, Russia and China are the countries with the highest average differences between the two. Hence, suggests other countries to review Brazils' plans and policies in the respective segments and possibly take keynotes from them to narrow down the gap. The RICS countries must also take care of the plans and policies that were in place within Brazil's borders and help the country to move up the ladder of human development after modifications.

Seeking the contribution of the proposed variables on MHDI, Human values Index tops the list in positively contributing to it. Other indices too positively contributed to MHDI. It directs BRICS countries to focus on reducing corruption to ensure protection of human values, income-generating activities, deploying employment opportunities to their citizens, spending more on uplifting healthcare and education services. The study even discusses the ranking of BRICS in regard to distinctive sub-indices of MHDI.

The study demands the nations to re-address their citizens' well-being in terms of availability of employment opportunities, human values perseverance, their education, health, quality of health and education services, resources, and environmental quality in which they survive as they all directly or indirectly affect their development, productivity, growth. The motto of the proposal is just to suggest the nations to upgrade their lens of measuring and viewing human development.

The proposal of MHDI could further be employed on other nations to provide them with the true picture of their nation's human development. Moreover, the study has used such variables that are of international importance and data is easily available.

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## Appendix

**Table 12.** *Descriptive statistics*

Indices	N	Minimum	Maximum	Mean	Std. deviation	Skewness	Kurtosis
Sustainability Index	100	.598	1.415	.87369	.276174	.962	-.587
Education Index	100	.146	.845	.52777	.221325	-.299	-1.373
Employment Index	100	.048	.663	.44939	.186165	-1.070	-.186
Human Values Index	100	.210	.510	.35940	.073138	-.174	-.680
Health Index	100	.220	.942	.51907	.185104	.277	-.649
Income Index	100	.489	.841	.69826	.095150	-.582	-.561
MHDI	100	.302	.719	.52505	.119878	-.476	-.626
HDI	100	.495	.824	.68444	.080251	-.402	-.470

**Source:** Author's computation.

**Table 13.** *ANOVA results*

		Sum of Squares	df	Mean Square	F	Sig.
Sustainability Index	Between Groups	7.460	4	1.865	1950.032	.000
	Within Groups	.091	95	.001		
	Total	7.551	99			
Education Index	Between Groups	4.113	4	1.028	132.528	.000
	Within Groups	.737	95	.008		
	Total	4.850	99			
Employment Index	Between Groups	3.336	4	.834	836.009	.000
	Within Groups	.095	95	.001		
	Total	3.431	99			
Human Values Index	Between Groups	.416	4	.104	86.896	.000
	Within Groups	.114	95	.001		
	Total	.530	99			
Health Index	Between Groups	2.956	4	.739	160.946	.000
	Within Groups	.436	95	.005		
	Total	3.392	99			
Income Index	Between Groups	.720	4	.180	97.186	.000
	Within Groups	.176	95	.002		
	Total	.896	99			

**Source:** Author's computation.