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Estimation and Evaluation of the Sustainability Index in Pakistan Focusing SDGs

"There is only one alternative to sustainability: unsustainability." (Bossel, 1999)

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Abstract

Achieving sustainability has become critical for global survival and averting ecological collapse, emerging as a worldwide priority that extends beyond national concerns to sub-national levels, particularly urban regions. Since these areas are centers of innovation and socioeconomic concentration, urban sustainability is essential to sustainable development. This study is unique because it estimates the sustainability index rooted in the SDG framework for Pakistan, its provinces, and urban divisions using the same year of reference and data sources. Employing the triple-bottom approach, it computes indices for economic, social and environmental sustainability. The result revealed that the overall sustainability score for Pakistan is 53.5 per cent using arithmetic aggregation and 41.7 per cent using geometric aggregation, showing a 22 per cent decline in signalling variability across the three sub-indices. The scores indicate that Pakistan's economic progress is achieved at the expense of environmental sustainability, reflected by the low environmental index score at each level. At provincial levels, Sindh stands out among provinces in scoring overall sustainability under both aggregation strategies, followed by Punjab and KPK, while Balochistan is far behind in overall sustainability. The divisional results reveal that Punjab accounts for 80 per cent of the top-performing divisions, with the remaining 20 per cent divided evenly between KPK and Sindh. However, it is worth mentioning that these divisions are only halfway to meeting the required sustainability goals and targets in absolute terms. In a nutshell, more integrated policies are needed to address challenges in social and environmental dimensions as well, ensuring that economic progress translates into long-term sustainable growth.

Keywords: Sustainability Index, SDGs, Urban Divisions, Sub-Dimensional Indices.
JEL Classification: O1, O2, C82.

I. Introduction

Sustainability emerged as a buzzword recently in public discourse and academia. Achieving sustainability seems more like a global movement. To grow sustainably, the world must effectively gauge its performance to ensure continuing progress toward

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the ultimate goal. Various indicators have been used for tracking and assessing the environment and the ecology for more than half of the last century; however, to gauge and account for sustainable development, the development of indicators is relatively recent in history, formally after the United Nations Conference on Environment and Development (Earth Summit) in 1992 with its Agenda 21 [Wu and Wu (2012)]. Since then, substantial efforts have been made to design and implement indicators developed for gauging sustainability at various locational aggregations such as worldwide, countrywide and indigenous levels by many government/non-government and local/international organisations and researchers/academicians.

Measures for gauging this performance, especially in reference to sustainable development, include primarily developed Sustainability Indicators and Indices (SIIs). These primarily developed indices and indicators played a vital role in understanding the science of sustainability and framing the base for practising it [Feil, et al., (2019)]. It becomes indispensable to struggle for sustainability indices and indicators, enabling the world to compare its current conditions with its past ones to track if it is converging or diverging from the desired sustainable trajectory [Guo, et al., (2022)]. This would also enable the world to develop relevant policies accordingly for framing future actions and implementations for improved monitoring and evaluations of growing in a sustainable context. Though developing indices and indicators capture diversified perspectives, the complexity of issues to be incorporated and related dimensions, including economic, environmental and social sustainability concerns, is challenging and a milestone to achieve.

The concerns regarding sustainability and its assessment are not confined to the country level but also at disaggregated levels within the country, especially in the urban context [Hassan and Lee (2015)]. Urban areas are fertile land for growing social, political, economic and cultural concentration, strengthening novelty and creativity [Nagy, et al., (2018)]. Thus, assessing urban sustainability becomes essential to growing sustainably [Hassanzadehkermanshahi and Shirowzhan (2022)]. For assessing sustainability at aggregated and disaggregated levels, such as regions, divisions, and cities, indicators are comparable using harmonisation and reliability using authentic data sources and theoretical underpinnings regarding definitions and estimations. SDGs are an attempt towards making such comparison viable.

SDGs are getting popular in research and policymaking in Pakistan as well, though yet especially in the context of Pakistan; efforts are confined to the estimation and prioritisation of targets at national and provincial levels and not to the urban divisional/city level analysis even though urban regions/cities are the centre of economic growth, creativity and modernisation. The economic structure of urban regions/cities is of immense importance not only from the point of view of their development and growth but also for national development and growth. It is better to understand the dynamics of these urban regions to understand national growth and development dynamics. Thus, the sustainable growth of cities is very much crucial for the sustainable growth of the entire country [Tabassum and Nazeer (2021)].

Moreover, as understanding SDGs is at a primitive stage in Pakistan, most of the frameworks presenting data for its indicators and even trends of these indicators over time lack a typical year; that is, the data for different indicators in targets is available for different fiscal years. It is appropriate as far as one intends to evaluate the performance of the individual indicator or target. However, if the goal is to develop a single measure for evaluating the overall sustainability, one must compare the data over the entire SDG framework. This research made an attempt towards achieving this outcome. Given bounded rationality, the research constraints itself to indicators within the SDG targets for which the data is available for the same fiscal years using various secondary data sources published by authentic publishers. The research also contributes to providing an overview of the triple bottom sustainability index along with its sub-indices for efficient understanding of the scenario and efficient policymaking not just at the aggregated provincial and national level but at the divisional level as well.

The study aims to estimate and evaluate sustainability by developing an overall sustainability index based on the three pillars of economic, social and environmental sustainability, for which sub-indices are also calculated using SDG goals and targets. Thus, the study employed the triple-bottom approach[1] of sustainability. Arithmetic and geometric aggregation strategies are used to estimate the overall sustainability index and its sub-pillar indices. Unlike arithmetic aggregation, geometric aggregation accounts for the interdependency and dispersion among the components to be aggregated. The research generally examines the sustainability scores at provincial, national and divisional levels for comparative purposes across both aggregation strategies employed.

After introducing the research in Section I, the research is designed to present the review of the existing literature on both single and multi-dimensional sustainability indices in Section II. The methodology adopted and the estimation techniques are discussed in Section III. The core data sources used are also mentioned in the methodology section. The results of the estimations are evaluated and reported in Section VI and finally, conclusions drawn from the results are discussed in Section V of this research.

II. Literature Review

There exists a vast and rapidly flourishing literature on sustainability, its indices and the indicators used in the indices, especially since the 1990s, which is overwhelmed with the outbreak of the Sustainable Development Goals (SDGs) in 2015 when the global framework was presented and its implementation was encouraged worldwide. Enormous attempts have been made at global, national and, local or regional levels in the literature history to attain this milestone encompassing single-indicator-based in-

[1] The triple bottom line, also known as the three pillars of sustainability, is a concept that identifies the essential sub-components of sustainable development. However, it is not a set of instructions that can only be followed. According to this viewpoint, sustainability is made up of three key components: the environment, the economy, and society. These three components are known as "planet, people, and profit".

dices to multiple-indicator-based indices and even measuring sub-indices for ending up with the aggregated sustainability composite indices. Thus, it would be far beyond the domain of this research to incorporate each one of these attempts made in the literature. However, this research would try its best to present a comprehensive overview of the research on sustainability index based on covering more than one sustainability dimension in the national and international literature. Sustainability is multidisciplinary in nature; hence, using various integrated frameworks becomes indispensable to account for its various dimensions, as its monitoring is quite difficult using single indicators [Diaz-Sarachaga, et al., (2017)]. The most common multi-dimensional indices reported in the literature are discussed briefly.

The Human Development Index (HDI) was developed by UNDP (2005) in 1990 and is published yearly at the country level. The development of HDI was backed by the notion that economic growth alone is not the only criterion for assessing a country's development. It was designed to capture three sub-themes that are 'decent living standard, long and healthy life, and access to knowledge', using a single indicator for each of the former two sub-themes which are 'per capita GDP, life expectation at birth' respectively and two indicators for the third sub-theme of education namely 'combined gross enrolment ratio for primary, secondary and tertiary education and adult literacy rate'. Initially, the index takes an arithmetic mean of these sub-themes to compute the overall index of Human Development. However, since 2010, geometric mean has been used for aggregation after releasing the inter-dependence between the sub-themes [UNDP (2011, 2015)].

Various variants of HDI are also available, incorporating: (i) Inequalities in each HDI sub-theme to come up with an Inequality-adjusted HDI (IHDI), (ii) Gender disparities using female HDI to male HDI ratio in the Gender Development Index (GDI). (iii) Gender inequalities resulting in loss of potential development attributable to the existence of gender inequalities in empowerment, health and the labour market in its Gender Inequality Index (GII) and finally (iv) Shortages in education, health and living standards at the household level in the Multi-dimensional Poverty Index (MPI) [UNDP (2016)]. As per Van de Kerk and Manuel (2008), HDI is more valuable for signalling sustainable development in developing countries than in developed ones because it contains less information for signalling the growth of a developed nation.

The City Development Index (CDI) was developed by UNCHS (2001). It was computed for 125 countries. 11 variables were used under five core categories: infrastructure, waste, health, education and city product indices. Indicators within the sub-indices are weighted at first using two-step Principal Component Analysis (PCA), which was simplified afterwards. These sub-indices are then aggregated using equal weights to end up with the composite index, the CDI. The estimation of this index is similar to that of the UNDP Human Development Index. It was developed to rank cities according to their level of development. It is a baseline for the comparative study of indicators which designate urban conditions. This index has been updated and enriched in the past and has proven to be an effective tool for assessing the quality of life and the city environment.

The Sustainable Society Index (SSI) was developed by Van de Kerk and Manuel (2008) and is published once every two years. They developed this index, believing that sustainability is narrowly defined in most existing indicators and indices developed until then, along with transparency issues and lack of regular update availability. They devised an index incorporating the core quality of life and sustainability aspects wrapped with simplicity and transparency. They used 22 indicators under five core categories, out of which 3 represent the quality of life (Personal Development, Clean Environment and Well-balanced Society) and 2 reflect the aspects of sustainability (Sustainable Use of Resources and Sustainable World) with a weight of 1/7 to the former and that of 2/7 for the later while aggregation. The SSI varies between 0 and 10, with 10 representing 100 per cent sustainability. The index was calculated for 150 countries, and as it is available every couple of years, an overtime in-depth assessment is possible.

The notion that a healthy environment is inevitable for healthy humans is at the core of the Well-being Index (WI) proposed by Prescott-Allen (2001). This index results from the arithmetic average of the Human Well-being Index (HWI) and Ecosystem Well-being Index (EWI), which are further subdivided into three and two sub-indices, respectively. The well-being index is based on 36 indicators under the HWI and 51 under the EWI. These dimensions are aggregated using a weighted arithmetic mean of the sub-indices or variables, which are then normalised using a proximity-to-target approach employing related indicator targets.

The Sustainable Cities Index (SCI) is estimated by Arcadis (2015) and provides the ranking based on this index for 100 cities around the world, usually every year after 2015. Additional indicators were included in the index calculation each year to make it more representative and reliable for assessing city-level sustainability. The subcategories used in this index are people, planet and profit, which are closely aligned with the social, environmental and economic aspects of sustainability as targeted in the SDGs framework [Arcadis (2018, 2022)]. Initially, 50 cities from 31 countries were ranked based on this index, estimated using 20 indicators. Nine indicators were used in the economic subhead, while six indicators were included in each of the remaining two pillars. One indicator that was common in the people and profit sub-index was transportation, though it was included only once in the overall composite index. The overall composite index was reached using a three-stage simple averaging process carried out at the indicator, sub index and overall index level. In contrast, the index estimated 2018 used subjective weighting for components within the sub-indices, though the overall index was still calculated using equal weight.

The literature most relevant to this piece of work is that of Sachs, et al., (2016). Based on the global goal agenda 2030, they provided an extensive methodology and dashboard for evaluating progress towards achieving sustainable goals and targets by initially coming forth with a sustainability index named SDG Index for 149 countries. With time, the index is continuously updated regarding the included number of indicators, improved metadata definitions and global coverage by increasing the number of countries for which it is estimated. As for the index, the indicators within each goal are normalised and rescaled using technical optimums or the average of top/bottom performers (observed) as optimums to range between 0 and 100, with 100 being the optimum performance. All the indicators are then aggregated using simple and geometric means, first at the goal level and then for all goals as a whole, to end up with the SDG index score for countries. On the one hand, the arithmetic mean is simple and straightforward in interpreting scores, while on the other, though being less intuitive in meaning, the geometric mean is equipped to reflect limited substitutability among goals, which implies that being strong on one goal cannot be fully substituted with being weak on another one. As the correlation between the scores generated using the two aggregation methods approached unity, they reported the arithmetic index scores for countries for simplicity of interpretation.

The Sustainability City Index (SCI) developed by Alfaro-Navarro, et al., (2017) is an index based on a triple bottom frame incorporating the intellectual capital approach along with correcting for subjective weighting and simple arithmetic averaging for the composite index with objective weighting using Principal Component Analysis (PCA) and geometric averaging which is more appropriate for such index estimation. This index was developed for 158 European cities. Human resources, quality of life, infrastructure efficiency, environmental sustainability, tourism, mobility, innovation, accessibility and business are all the sources of knowledge that contribute to a city's intellectual capital, which enables sustainable urban growth and enhanced wealth capacity. Broadly, intellectual capital includes Human Capital (HC) accounting for individual and social capital, Structural Capital (SC) representing non-human capital and Residual Capital (RC) reflecting errors in the measurement or specification of these capitals. After being framed as per the triple bottom approach, the index was calculated using forty (40) indicators categorised as environmental (having 17 indicators for pollution, land use, water management and consumption), social (having 15 indicators aggregated under education, health, safety and cultural aspects) and economic (having eight indicators including gross domestic product and other labour market variables) dimensions. Indicators not on a percentage scale are normalised to have values between 100 and 0. This index is based on a triple bottom frame incorporating an intellectual capital approach along with correcting for subjective weighting and simple arithmetic averaging for composite index with objective weighting using PCA and geometric averaging, which is more appropriate for such index estimation, and its formula is given in Equation (1):

$$SCI_i = \alpha + \beta + \delta \sqrt{ED_i^{\alpha} - EcD_i^{\beta} - SD_i^{\delta}} \tag{1}$$

with i representing cities and ED, EcD and SD represent the three pillars of environment, economic and social aspects respectively. α, β and δ are the generated weights using PCA.

Wu and Wu (2012) reviewed the sustainability literature in depth, from distinguishing between an indicator and index to qualities of sustainability indicators/indices, their aggregation issues, and a base for categorising various indicators/variables per various non-thematic to thematic frameworks in literature. They discussed sustainable development or sustainability in the light of its core scientific perspectives and principles. They reviewed a number of influential and inclusive indicator frameworks. Their research may serve as a base towards constructing, interpreting and implicating the sustainability indicators in practice.

Böhringer and Jochem (2007) analyzed 11 well-known sustainability indices in the literature used in policy considerations and concluded that apart from the debate regarding their conciseness and transparency, these indices suffer from a lack of basic scientific requirements fundamental in index formulation. This includes normalisation, weighting, and aggregation issues. Generally, subjective judgments were used as a base for indicator weighing and normalisation, which introduced substantial arbitrariness in the index. Further, no systematic assessment of critical assumptions or even specification of such assumptions is made. Moreover, scientific rules that ensure consistency and relevance of the computed indices were often not employed. All this ceases the adequateness of the so-called sustainability indices towards effective policy making if they are not becoming fully useless or misleading.

In 2019, Paoli and Addeo (2019) estimated the sustainability index based on SDGs for 28 member states of the EU and evaluated its performance among these states. To them, for improving the reliability of SDGs, the operational definition has to be refined to strengthen their scientific understanding. They identified gaps and priorities for achieving SDGs. According to them, unemployment, gender equality and sustainable agriculture are the key areas that need to be taken care of in general. The research aimed at simplifying the framework conceptually at the core of SDGs on the one hand and at providing a methodology for the assessment of SDGs on the other hand. They computed country-level indices at three different levels, namely goal-wise indices, pillar-wise indices and eventually, the composite index for the country. One hundred two indicators, excluding indicators in goals 6 and 14, were selected for computations based on their availability for 90 per cent of the EU states. Pillar-based indices were used to identify priorities within the state, while the composite index was helpful in evaluating the performance of SDGs across EU countries—a two-step PCA was employed to prioritise the project. The entire dataset of indicators was first examined to identify the meaningful clusters of variables. Next, the variables with the highest loadings were subjected to another fresh principal component analysis. The operation ended when only one component was retrieved, which majorly synthesised the total variance and had the most variables with high loadings.

Dimension-wise sustainability of ten megacities in China was examined by Haung, et al., (2016) using a number of sustainable indicators for reflecting economic, social and environmental aspects of sustainability. This study concluded that the Genuine

Progress Indicator (GPI) was constant from 1994 -2005, and it started to increase from 2006. Due to increased economic growth, the pressure on the environment (ecological footprint) increased, while bio-capacity decreased for ten megacities with smaller deficits in bio-capacity for western cities. The Index of Human well-being (Human Development Index) increased simultaneously, and an index of socioeconomic inequality, i.e. Gini and urban-rural income ratio, widened. However, this broadening trend ceased in recent years for the majority of these ten megacities. The urban environment and city development (Environmental Performance Index and City Development Index) improved gradually, particularly in waste treatment and infrastructure development. To improve overall sustainability, it is suggested that China must maximise its economic development and focus on improving the environmental quality of its megacities.

Nhamo, et al., (2021) investigated poverty in the context of SDG. They discussed the necessity of combating poverty in the context of the SDGs, leadership in SDG implementation, and an emphasis on service delivery and SDG achievement at the local government level. The research examined initiatives that are globally related to SDG implementation, as they provide balance in terms of the 2030 agenda, which is being rolled out for economic growth, environmental sustainability, and social protection. Servaes (2017) highlighted the Sustainable development of Asia and examined UN MDGs along with the changes and development from UN MDGs to SDGs (2015-2030). Further, they also gave an overview of the 2030 agenda and its impact on South Asian countries, which is also provided in this study.

According to a report on Human Development, the urban population faces deplorable socioeconomic conditions. About one-fifth of the population in urban Pakistan is poor. Moreover, one-third of this same population lives in urban slums. Among 122 nations, Pakistan is ranked 80th regarding water quality, as in urban areas, only 15 per cent of the total urban population has access to water, which is considered safe to drink. Throughout the country, pesticides, coliforms, and toxic metals have contaminated ground and surface water [Azizullah, et al., (2011)]. Improper basic infrastructure, inadequate sanitation, informal settlements, scarcity of clean water, lack of public transportation, solid waste mismanagement, stagnating economic activities and poor governance are the core issues in achieving sustainability in urban areas /cities [Michael, et al., (2014), Mapar (2017) and Zamanzadeh, et al., (2017)]. Moreover, rising inequalities in education also contribute to deteriorating human development and economic growth [Sajid, et al., (2022)].

Pakistani cities face environmental, social and economic problems, and scanty information is available [Xu, et al., (2023)]. According to Ghalib, et al., (2017), urban issues can be assessed by computing urban sustainability indices that encompass the three key pillars of sustainability. Using 40 indicators computed from second-hand data and compiled over a time span from 2004 to 2014 for five selected urban centres of Punjab, they developed a rational indicator system covering the three sustainability pillars. These selected urban centers include Multan, Faisalabad, Gujranwala, Rawalpindi, and Lahore, the provincial capital. Scores of the sub-pillar indices reflected the poor performance of cities under the environmental pillar compared with the remaining two pillars of economic and social sustainability. A decreasing trend was observed in the environmental sub-index from 2004-2014, with cities scoring between 0.27 and 0.58. Decreased land greenery, population influx, rapid urbanisation, industrialisation and high levels of air and water pollutants contributed to this declining trend. The positive trend in the economic sub-dimensional index echoed the improvement in the standard of living. In contrast, there are smaller variations in the social pillar index scores of cities, as indicated by the range of 0.49-0.58.

The aggregated sustainability index's value ranged between 0.41 and 0.52 for the cities considered. Thus, none are considered sustainable against the standard score range of 0.75 or higher. Two out of five cities can be classified as moderately sustainable, both (Lahore and Faisalabad) having a score around 0.52, while the remaining three were weakly sustainable with a score below 0.50.

Mangi, et al., (2020) conducted a comparative study on two metropolitan cities, Beijing and Karachi, to assess their degree of urban sustainability using socioeconomic and environmental indicators of development progress. The study analysed that social, economic, and environmental indicators progressed consistently in Beijing, while these indicators were poorly sustainable in Karachi. In all sectors, Karachi city faces challenges; hence, there is a need for improvement to achieve urban sustainability.

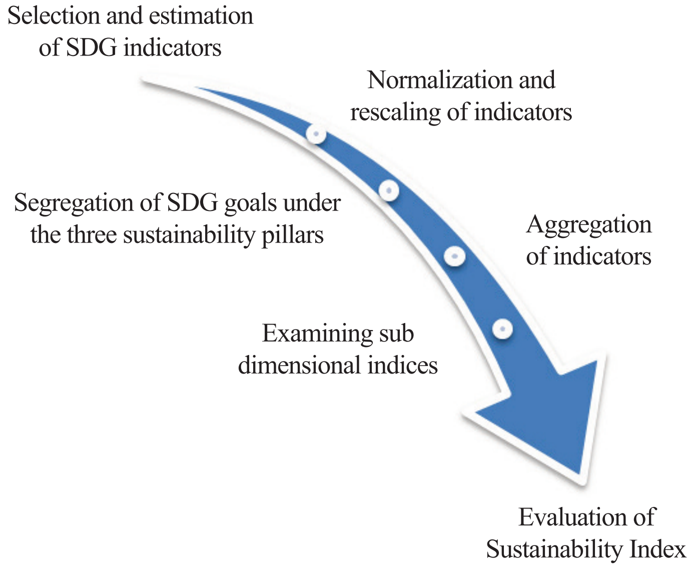
Umar and Asghar (2018) attempted to estimate a sustainability index for Pakistan and its provinces based on the SDG goals. Though they do not compile indicators for the same year of reference, they did not report sub-pillars of sustainability, nor did the scope of the study extend at divisional levels. They used approximately 33 indicators to compute the overall SDG index. The study reported a high degree of correlation between the arithmetic and geometric aggregations scores, signalling more or less similar outcomes from both methods. According to the results of Umar and Asghar (2018), the scorecard of the SDG index showed that Pakistan will have a hard time achieving SDGs by 2030. Balochistan rural areas stand at the bottom, whereas urban regions of Punjab and KPK also stand behind the targets to be achieved, although their performance is better than other provinces. The SDG heatmap indicated a dire need to focus on health, education, poverty, water and sanitation, and food security issues in all regions, as these are the key challenges faced by all provinces in general. Government and stakeholders are urged to recognise the gaps identified in implementing and financing SDGs, and a political will is required to stay aligned and keep progressing towards achieving them.

In a nutshell, there exists a growing literature on urban sustainability focusing either on its specific pillar or estimating it from all three pillars collectively. However, in the context of Pakistan, urban sustainability deserves to be explored, which is confronting concentration pressures attributable to rapid urbanisation activities. In Pakistan, the literature is inclined towards the environmental pillar, explicitly discussing the emission of gases resulting from heavy vehicle usage and unsustainable industrial practices. Less attention is given to capturing all three sustainability pillars under one roof. The literature also lacks estimation of the three-pillar sustainability index at macro and meso levels. Moreover, literature available in the context of Pakistan for the estimation of SDG index at the national and provincial levels used data from different years for different indicators rather than ensuring that all the indicators should be computed for the same year for consistency. Therefore, analysing the insights into the sustainability of regions encompassing its three broad sub-dimensions would be of great policy relevance.

III. Methodology

The assessment methodology in this research is indicated in Figure 1. Compiling data, constructing variables for computing indicators, estimating and evaluating sustainability, and its sub-dimensional pillar, not only at national but at meso levels, is quite extensive, especially in developing countries like Pakistan, where there is restrictive data availability. Thus, the assessment in this research is split into two sub-heads. The first half involves scrutiny of available data, selection of variables, estimation, normalisation and aggregation of indicators, targets and goals at various geographical levels.

The second half of the assessment examines and discusses the estimated sustainability pillar-wise indices and the overall sustainability index across geographical levels of aggregations, i.e., for national, provincial, and urban divisions. This descriptive analysis is performed using statistical representations of the computed index scores across pillars



Source: Authors' illustration.

FIGURE 1

Methodology for Assessment Designed for Evaluation in this Research of sustainability and across multiple geographical aggregations within the country. Thus, this part constitutes the results section.

1. Estimating the Sustainability Indices

Three key steps are involved in estimating the sustainability indices. First is the selection of indicators that are computable from the datasets with data at various geographical levels of aggregation, i.e., at national, provincial, and divisional levels. The second was to normalise and rescale each indicator distribution to make it unitless and comparable with the remaining data distributions of indicators, along with getting rid of the extreme values within the indicator distribution where necessary prior to extraction of data at a particular geographical level. Finally, the third was an aggregation of the distributions of indicators within and across SDG goals at various geographical aggregations for the overall index and the sub-dimensional indices. Details of each one of them are discussed below, along with the study area considered and the data sources used in this research.

2. Selection and estimation of indicators

In order to follow the framework discussed above, the availability of indicators at various geographical levels was first examined across the goals. The selection of indicators was based on the availability of data from the same data source at the national, provincial, and divisional levels. Moreover, the same definition of indicators was followed across the geographical levels to ensure comparability and consistency. For further statistical adequacy, data quality, timeliness and coverage, the data is extracted from representative dataset sets available for the same year, i.e. 2018-19, covering data for various geographical aggregation levels. The table in Appendix (Table A-5) indicates the available indicators estimated from various data sets for Pakistan, its provinces and urban divisions. The table reports the adopted definitions of each estimated indicator and mentions its compliance with the standard SDG metadata definition given by UNDP. FC represents full compliance, while PC represents partial compliance with SDG metadata definitions. The table also mentions the sources from where the data is extracted and the year for which indicators are estimated. To ensure consistency, the data for the same year is used across all sources.

3. Normalisation and Restructuring of Indicators

Acknowledging the sensitivity of rescaling towards outliers and the limits for normalising, prior to normalisation and restructuring, extreme values, if any, in the distribution of estimated indicators are removed before data extraction at a particular geographical level. The former may become an unintended threshold that may result in introducing spurious variability in data, while the latter may affect rankings regions in relative terms [OECD and JRC (2016), Lafortune, et al., (2018) and Booysen (2002)]. The series of indicators are then rescaled using upper and lower bounds to confine their values between 0 to 1, following the standard normalisation method dominant in literature [Sachs, et al., (2021 and 2022), UNDP (2015, 1990), UNCHS (2001) and Morris (1978)]. The series are rescaled using Equation (2).

$$X_i' = \left(\frac{X_i - \underline{X}_i}{\overline{X}_i - \underline{X}_i}\right) \quad (2)$$

where,

X_i = actual value of indicator *i* for aggregation at specific regional level (national, provincial and urban divisions).

$\underline{X}_i$ = lower bound representing the worst performance by a region in indicator *i*.

$\overline{X}_i$ = upper bound representing the best performance by a region in indicator *i*.

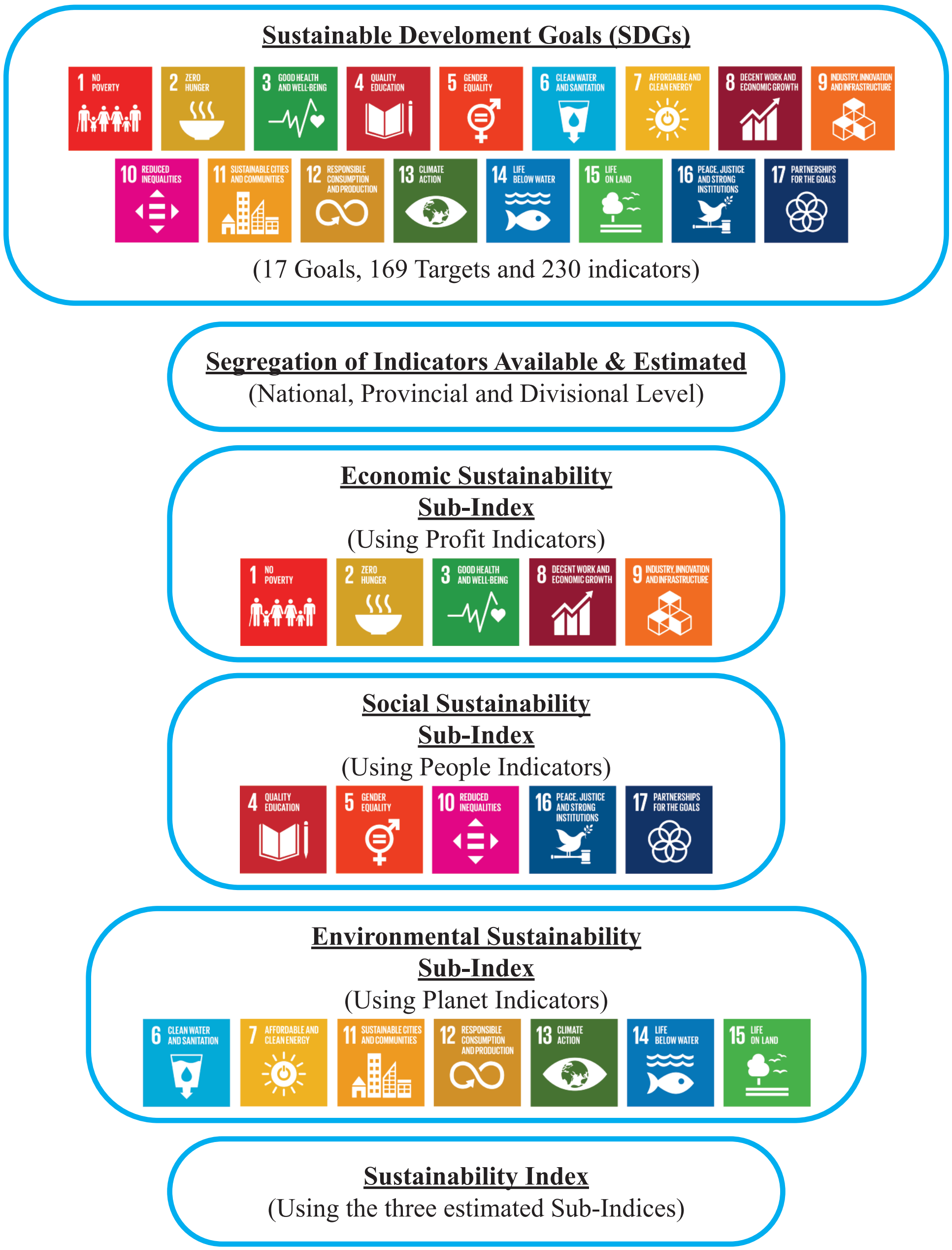
X_i' = the normalised data series for indicator *i* for a specific regional level.

The closer an indicator value is to 1, the more sustainable a region is towards achieving the SDG sustainability threshold and vice versa. Values, if any, beyond the upper bound and below the lower bound are taken as 1 and 0, respectively. The upper bound of the series is the technical optimums that are to be achieved by 2030, as mentioned in the SDG framework. Although there are some indicators for which the optimum thresholds are either not available or are not specifically quantified, for such indicators, the optimum thresholds are set either by leaving none behind or by using the observed values within the indicator series. Some indicators include poverty, mortalities, thetimatio population living in slums or inadequate housing. Indicate sustainability while moving in opposite directions, i.e. towards zero, were restructured from negative to positive by simply reversing them. For instance, instead of calculating the population below the poverty line that needs to be eradicated completely, it was taken as the population above the poverty line with a target to have all above the threshold by 2030.

4. Segregating SDG goals among sub-dimensional sustainability indices

This research followed the standard SDG index and dashboard methodology primarily for evaluating the regional progress towards achieving sustainability at disaggregated regional and provincial levels, contributing eventually to attaining sustainable development at the aggregated national level. It further classifies the goals under the three well-established pillars of sustainability and evaluates the sustainability of these pillars at various aggregation levels alongside the overall sustainability scores. Figure 2 depicts the strategy for calculating dimensional indices and the overall index of sustainability.

First, the indicators within the 17 goals are computed using data sources considered at various geographical levels. The computed indicators are then segregated among the three sub-dimensional pillars of sustainability [Kostoska and Kocarev (2019)]. Indica-



Source: Authors' framework for Sustainability Index estimation.

FIGURE 2

Framework for Estimating the Sustainability Index and its Sub-Indices tors within goals 1, 2, 3, 8 and 9 are placed under the profit or economic pillar, while those computed for goals 4, 5, 10, 6 and 17 fall into the people or social sustainability pillar. The remaining indicators computed for the leftover goals (6, 7, 11, 12, 13, 14 and 15) become part of the third planet or environmental pillar, though data availability for indicators under this pillar is relatively limited. Finally, a composite index of sustainability is computed by combining all these three sub-dimensional indices.

5. Aggregation and weighing of indicators

After the segregation of goals under the three sustainability pillars, the computation of the sub-dimensional indices and the overall composite sustainability index, as well as the aggregation and weighting of indicators, are performed. The indicators are aggregated at the target level. At the level of the goal, aggregation is performed for the sub-dimensional pillars individually to end up with the three sub-indices of sustainability representing its economic, social and environmental aspects at a given geographical level. Finally, aggregating the three sub-indices gives the composite index of sustainability.

Aggregating various variables into an index holds profound implications on ranking within individual dimensions indices and the overall index (OECD & JRC, 2016). For computing the scores of SDG*j* for geographical level *i* (for national level *i*=*1*, for provinces *i* = *1, 2, 3, 4* and for divisional level *i* = *1, 2, 3, …., 29*) use of the standard Constant Elasticity of Substitution (CES) function (Equation 3) permits maximum flexibility in aggregation of data [Blackorby and Donaldson (1982) and Arrow, et al., (1961)].

$$I_{ij}\,(N_{ij}, I_{ijk}, \rho \left[\sum_{k=1}^{N_{ij}} \frac{1}{N_{ij}} I_{ijk}^{-\rho}\right]^{-\frac{1}{\rho}} \qquad (3)$$

where

I_{ij} is the aggregation of indicators for SDG*j* and geographical level *i*.
I_{ijk} represents indicator k score within SDG*j* at geographical level *i*.
N_{ij} denote the number of indicators within SDG *j*
ρ symbolises the extent of substitutability among the indicator components within the range $-1 \leq \rho \leq \infty$ (Arrow et al., 1961and Nicholson, 2012).

The CES function transforms accordingly depending on the elasticity of substitution (σ) between components of the aggregated index. The elasticity of substitution σ[2] is linked with the parameter of substitutability ρ as follows in Equation (4).

$$\sigma = \frac{1}{1+\rho} \qquad (4)$$

The parameter for substitutability ρ can easily be derived given the value of elasticity of substitution σ as under in Equation (5).

2 Ranges between $0 \leq \sigma \leq \infty$.

$$\rho = \frac{1 - \sigma}{\sigma} \tag{5}$$

Three exceptional cases of CES functions are vigorously discussed and considered in the literature. The first case is of perfect substitutes having $\sigma = \infty$ and $\rho = -1$, implying that the components of the overall index are perfect substitutes to one other. Thus, the progress of one component is offset by the regress of the other, reflecting weak sustainability. With equal weighing among components, the CES function assumes the form of the simple average or arithmetic mean as presented in Equation (6).

$$I_{ij} (N_{ij}, I_{ijk}) \left[\sum_{k=1}^{N_{ij}} \frac{1}{N_{ij}} I_{ijk} \right] \tag{6}$$

Next is the case of strong sustainability that implies no substitutability among the components of the index. CES function under no substitutability i.e., having $\sigma = 0$ and $\rho = \infty$, transform into Leontief function having orthogonal contours. Here in this case, the lowest score across the indicators k within SDGs defines the score of SDG j and geographical aggregation i as mentioned in Equation (7).

$$I_{ij}(I_{ijk}) = Min \{I_{ijk}\} \tag{7}$$

With $\sigma = 1$ and $\rho = 0$, the CES function gives the third intermediate case by transforming into a Cobb-Douglas function that delineates linear substitutability. This implies that the overall goal index I_{ij} for geographical level i is computed as the geometric mean of the components using Equation (8).

$$I_{ij} (N_{ij}, I_{ijk}) = \prod_{k=1}^{N_{ij}} \sqrt[N_{ij}]{I_{ijk}} \tag{8}$$

The geometric mean is frequently used to aggregate non-homogenous variables with limited complementarity in situations where the analysis focuses on percentage changes rather than absolute changes. For example, the Human Development Index (HDI) switched from arithmetic to geometric mean aggregation across three dimensions in 2010 [UNDP (2015)].

Individually, each SDG is of utmost importance to the policymakers; there was no consensus over assigning distinctive weights to specific SDGs [SDG Index Report (2021)]. In fact, they delineate a group of somewhat complementary policy priorities. Hence, the study used arithmetic mean to come up with the aggregated indicator scores for every SDG, implying that equal weights are assigned to each indicator. Giving equal weight to SDGs is indicative of policymakers' commitment to regard all SDGs equally as part of a comprehensive and integrated strategic policy framework. Consequently, the number of indicators within a particular goal developed inverse proportionality with the individual relative indicator weight within that goal.

It would be enlightening to know the implication of all three cases, i.e., arithmetic mean, geometric mean and Leontief function for aggregation. Progress towards every SDG goal is desired because the SDG framework holds a set of goals taken as an integrated and indivisible plan of action. Thus, assuming that goals are perfect substitutes as a rationale for using arithmetic means might not be appropriate. In contrast to the arithmetic mean, the geometric average has the benefit of reflecting an anticipated "penalty" on extremely low scores. Concurrently, using the Leontief function is misleading in reflecting a region's progress across SDGs as it gives excessive weight to the one SDG in which a region performs the worst. Thus, this research has focused on the first two cases, the arithmetic and geometric mean, for aggregation.

After aggregations are made for each SDG *j*, dimension-wise arithmetic and geometric indices are computed using Equation (9).

$$I_{id} = \frac{1}{\mathrm{n}} \sum_{j=1}^{n} I_{ij} \qquad \text{or} \qquad I_{id} = \sqrt[n]{I_{i1} \ x \, I_{i2} \ x \, I_{i3} \ x \ldots\ldots x \ I_{ij}} \tag{9}$$

where I_{id} represents the sub-dimension index with *d* taking the value from 1 to 3 for economic, social and environmental pillars of sustainability, respectively. *j* (1,2,…..*n*) reflects the number of SDG goals within each sub-dimensional index.

Finally, using the following equation, this research computed the overall sustainability score at the national, provincial, and divisional levels based on the SDG framework as shown in Equation (10).

$$I_{i} = \frac{1}{\mathrm{d}} \sum_{d=1}^{3} I_{id} \qquad \text{or} \qquad I_{i} = \sqrt[d]{I_{i1} \ x \, I_{i2} \ x \ldots \ \ldots \ I_{id}} \tag{10}$$

where I_i is the overall composite index of sustainability at a given geographical aggregated level *i*. Equations 9 and 10 will be adjusted to be divided by the number of goals (*n*) within each sub-dimension and by the total number of dimensions (*d*=*3*) respectively for asthmatic average while for geometric average root to the power *n* and *d* were used correspondingly.

IV. Estimation Results

Achieving sustainable development has become inevitable, given the sharply increasing scarcity of resources and the deteriorating capacity of nature for resource regeneration as the world population has grown over time. To address these global concerns, the United Nations came forward with a global goal agenda 2030 for countries to evaluate their growth, given the sustainable targets within each goal. This global framework, which has targets to be achieved by 2030, would enable them to foresee whether they are growing towards/on or away from the desired sustainable trajectory. Being a global agenda, the SDG framework is designed for all countries, whether they are developed, developing or underdeveloped. The framework contains some targets and goals more relevant for developed than developing or underdeveloped countries. Moreover, some targets are global in scope and thus become less lucrative while evaluating progress towards sustainability at a specific country level or within a country at various disaggregated geographical levels. However, evaluating progress towards such a sustainable trajectory is dependent upon the quality and availability of statistics regarding indicators within this global framework that are more appropriately reported in documented economies in relation to the undocumented ones.

Pakistan is a developing country, and around three-fourths of its economy is undocumented, as reported in the LFS 2017-18 report [GoP (2018)]. Thus restricting the scope for evaluating such progress appropriately both because of quality and non-availability of required data for all the indicators within the framework. These data concerns and constraints are further intensified for disaggregated geographical levels.

As the study aims to estimate and examine the progress towards sustainability at national and sub-national levels, not all goals and targets are relevant to such analysis. Hence, the research commenced by examining and evaluating indicators and targets within the SDGs framework to segregate indicators that are global in nature or are more like a stimulus to sustainability, such as administrative and monitoring measures or expenditures that serve as input for betterment rather than an outcome defining the state of sustainability at the moment. Moreover, there are also a few indicators and targets that are repeated in other goals as well. After deducting these from the total indicators, computable indicators with individual goals are left. These computable indicators are computed so that the data is available from the same data source at national and sub-national levels, along with having the data for the same year. The difference between computable and computed indicators is the indicators that are dropped either because of the non-availability of definition, data, or any other criteria discussed earlier. The results of this scrutiny are presented in Table 1. In total, 85 indicators are excluded from the 244, i.e., around 35 per cent of indicators, because of being either stimulus or global in nature. Out of these 85 indicators, 58 per cent are global, 20 per cent comprise financial allocations and flows, 15 per cent regarding monitoring and administration, and 7 per cent are repeated indicators. The study computed indicators covering at least one target for more than 80 per cent of the goals. The highest computation ratio of indicators is for goal 4, followed by goals 1, 8 and so on. In total, 57 indicators are estimated for this analysis, covering 48 SDG targets, probably the highest number of indicators used for computing the sustainability index for Pakistan so far.

1. National Level Results

In order to achieve a sustainable growth path by exerting all of Pakistan's available resources and energies, it is crucial to evaluate Pakistan's status in relation to various sustainable development goals and implement plans accordingly. This piece of work is unique in categorizing various indicators under the three well-established dimensions

TABLE 1

Examining computability of SDG indicators

SDGs Goals	Targets	Indicators		Excluded
	Computed/ Total	Computed/ Total	Computed/ Computable	Gl+F+M+R
G-1: No Poverty	4/7	6/14	6/9	1+4+0+0
G-2: Zero Hunger	2/8	2/14	2/12	0+2+0+0
G-3: Good Health &Well-being	9/13	11/27	11/25	0+1+1+0
G-4: Quality Education	7/10	8/12	8/10	0+1+1+0
G-5: Gender Equality	4/9	5/14	5/10	3+0+1+0
G-6: Clean Water & Sanitation	2/8	2/11	2/9	0+0+2+0
G-7: Affordable & Clean Energy	1/5	2/6	2/4	1+1+0+0
G-8: Decent Work & Economic Growth	8/12	9/17	9/14	0+1+2+0
G-9: Industry, Innovation & Infrastructure	3/8	4/12	4/10	0+2+0+0
G-10: Reduced Inequality	3/10	3/11	3/7	3+1+0+0
G-11: Sustainable Cities & Communities	2/10	2/15	2/10	2+1+1+1
G-12: Responsible Consumption & Production	0/11	0/13	0/3	5+1+1+3
G-13: Climate Action	0/5	0/8	0/0	6+0+1+1
G-14: Life Below Water	0/10	0/10	0/6	2+1+1+0
G-15: Life on Land	1/12	1/14	1/9	5+0+0+0
G-16: Peace & Justice Strong Institutions	1/12	1/23	1/18	2+0+2+1
G-17: Partnerships to Achieve the Goal	1/19	1/25	1/5	19+1+0+0
Total	48/169	57/244	57/159	49+17+13+6

Gl=Global, F=Financial Flows, M=Monitoring and administrative and R=Repeated indicators other than those already taken under the remaining three groups.[3]
G=Goals, T=Targets and I=Indicators
Computed/Total=ratio of a number of targets or indicators computed to the total number of targets in a specific goal or the total number of indicators within each goal.
Computed/Computable=ratio of number of indicators computed to the total number of computable indicators within each goal.

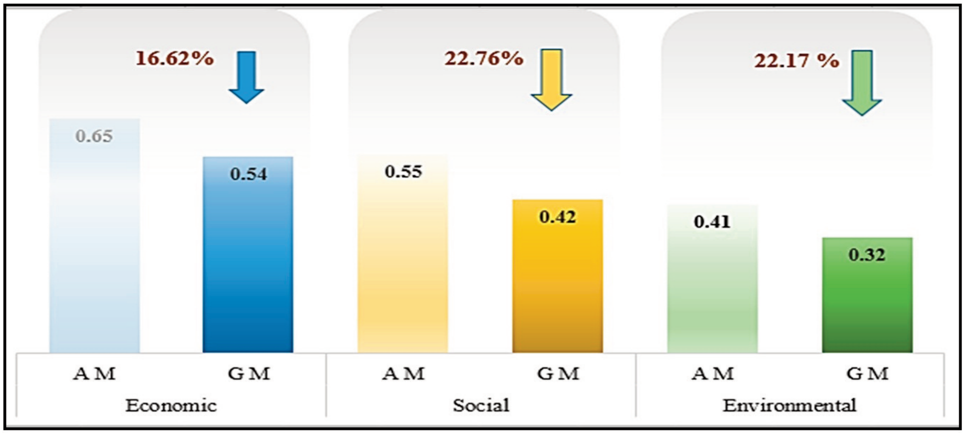
Source: Authors' estimation.

[3] See Appendix (Table A-1 to A-4) for goal-wise global, repeated, monetary and administrative and monitoring indicators.

of sustainability in literature: economic, social, and environment, to develop a roadmap for achieving sustainability in general and developing a comprehensive understanding of these pillars in particular.

To estimate dimension-level indices for the three pillars of sustainability, aggregation is performed using both arithmetic and geometric mean, initially at the goal level using indicators within each goal and then at the dimension level using goals within each dimension for various geographical aggregations. The scores of the three sub-indices at the national level are reported in Figure 3.

The results indicated that the estimated scores using arithmetic means are greater than those computed using the geometric one for all the sub-pillars. Although the percentage decrease in scores[4] within individual dimensions from arithmetic to geometric mean varies across the sustainability dimensions. The percentage decline in scores (23 per cent) within the social dimension is the highest among dimensions, followed by approximately 22 per cent in the environment and 17 per cent in the economic dimension. This implies that disparities within the social dimension are higher than in environmental and economic dimensions. Among the three dimensions, the nation performed relatively much higher in the economic aspect, as indicated by an index score of 0.65 and 0.54 per arithmetic and geometric aggregations, respectively. The arithmetic scores for social and environmental aspects of sustainability are 0.55 and 0.41 respectively. In contrast, the corresponding scores per geometric aggregations are about 13 and 9 points less than their arithmetic counterparts.

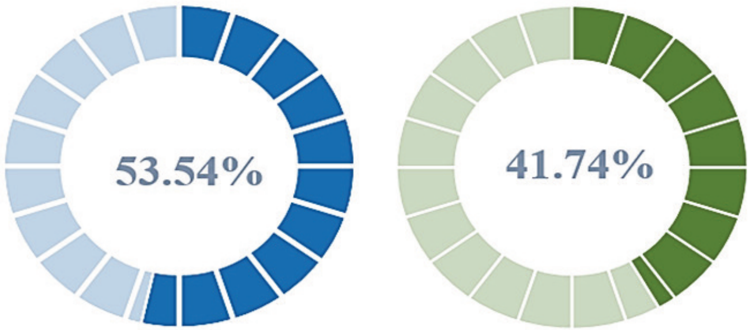


Source: Authors' estimation.

FIGURE 3

Comparing scores of sustainability pillars for Pakistan

[4] Percentage change in index score between A.M and GM index scores is computed as per cent change in scores = [(A.M index score – GM index score) / A.M index score] *100



Source: Authors' estimation.

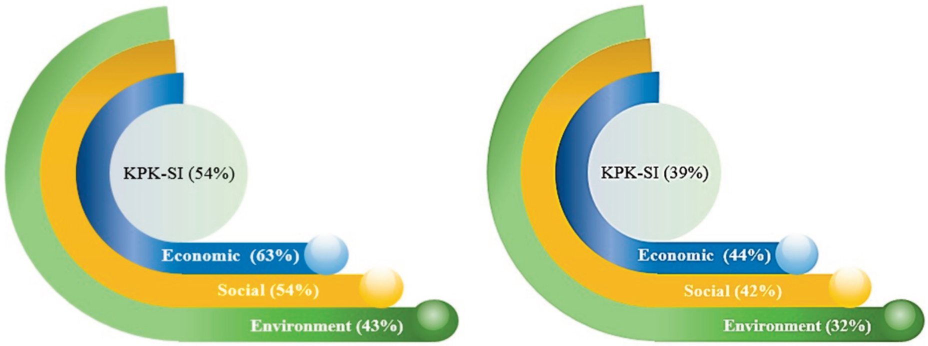
FIGURE 4

Comparing overall sustainability index scores of Pakistan

Finally, aggregation of the three sub-indices arithmetically and geometrically gives the overall sustainability score of 53.5 per cent and 41.74 per cent for Pakistan, as reported in Figure 4. These scores are also more or less in line with the SDG index scores reported by UNDP for Pakistan (55.6 per cent) in 2019 despite that they used more and different sets of indicators that are available for the national level but not for disaggregated ones [Sachs, et al., (2019)]. The overall score of the sustainability index was reduced by almost 22 per cent, signaling variability across the three sub-indices. It can be observed from the score of the sub-indices that the country is developing economically but at the cost of its environment, i.e., the economic development in Pakistan is not environmentally friendly, as indicated by the significantly lower score of its environment sub-index.

2. Provincial Level Results

The outcomes of the provincial disaggregation are presented in Figures 5 to 8. The left side of the figures reports the arithmetic index scores for overall and sub-dimensional sustainability, while the right side of the figures gives the index values using geometric averages. At provincial levels, Sindh stands out among provinces in scoring overall sustainability as per aggregation strategies (arithmetic score of 55.3 per cent and 45.2 per cent score of geometric). With a minimal arithmetic score difference, Punjab and KPK are next in line, having a score of 54.0 per cent and 53.5 per cent, respectively. Although the geometric score of KPK (39.1 per cent) decreased relatively more than that of Punjab (41.8 per cent), it showed more significant intra-province disparities across dimensions in KPK. Further, Balochistan, the most deprived province of Pakistan, is left far behind in terms of the overall sustainability score computed arithmetically (45.5 per cent) and geometrically (25.6 per cent).

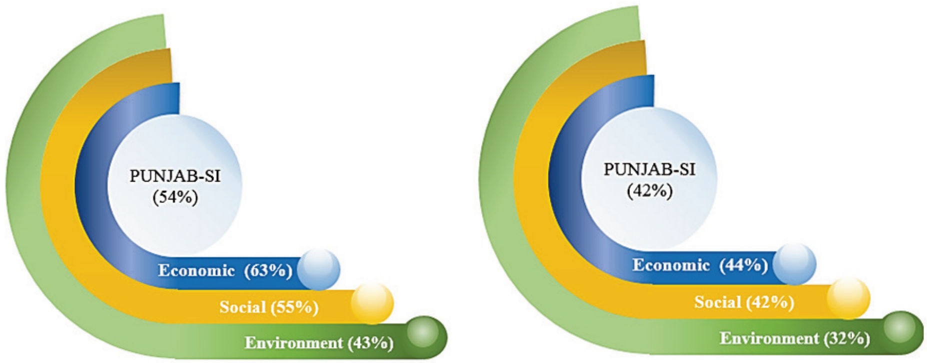


Source: Authors' estimation.

FIGURE 5

Comparing overall and dimension-wise sustainability scores for KPK per both aggregation strategies

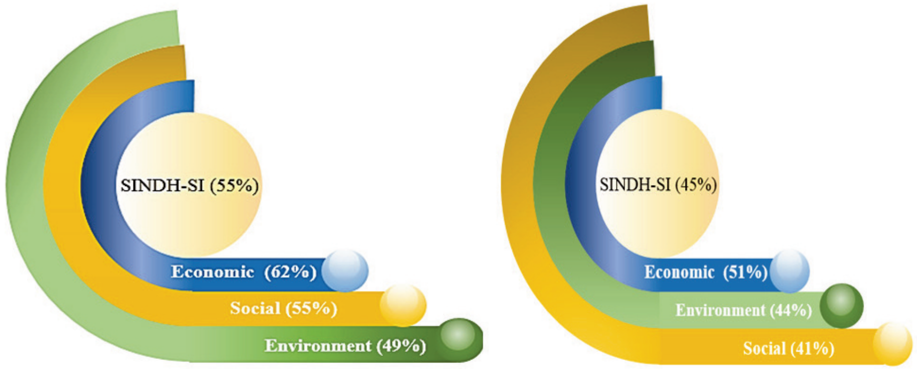
In KPK and Punjab, the economic sustainability AM scores being 63 and 63.3 per cent while the GM scores are 44.1 and 51.8 per cent correspondingly higher followed by social AM scores are 54.2 per cent and 55.4 per cent while the GM scores are 41.7 per cent and 43.6 per cent correspondingly and environment AM scores being 43.4 per cent for both while the GM scores are 32.5 per cent and 32.5 per cent correspondingly; sustainability as per both aggregation methods used for measuring dimension-wise sustainability indices.



Source: Authors' estimation.

FIGURE 6

Comparing overall and dimension-wise sustainability scores for Punjab, using both aggregation strategies

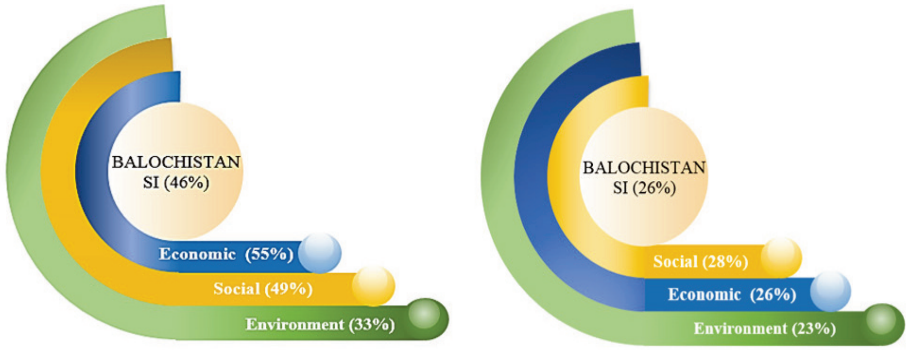


Source: Authors' estimation.

FIGURE 7

Comparing overall and dimension-wise sustainability scores for Sindh based on both aggregation strategies

The same sequence of dimensional sustainability prevails in both Sindh and Balochistan as far as arithmetic aggregations are concerned. The economic, social and environmental sub-pillar scores for Sindh are 62.2, 54.6 and 49.1 per cent, while those for Balochistan are 55.2, 48.7 and 32.8 per cent. Although, on moving towards geometric aggregations scores of the three pillars for these two provinces, it is observed that the dimensional contribution to overall sustainability varies from

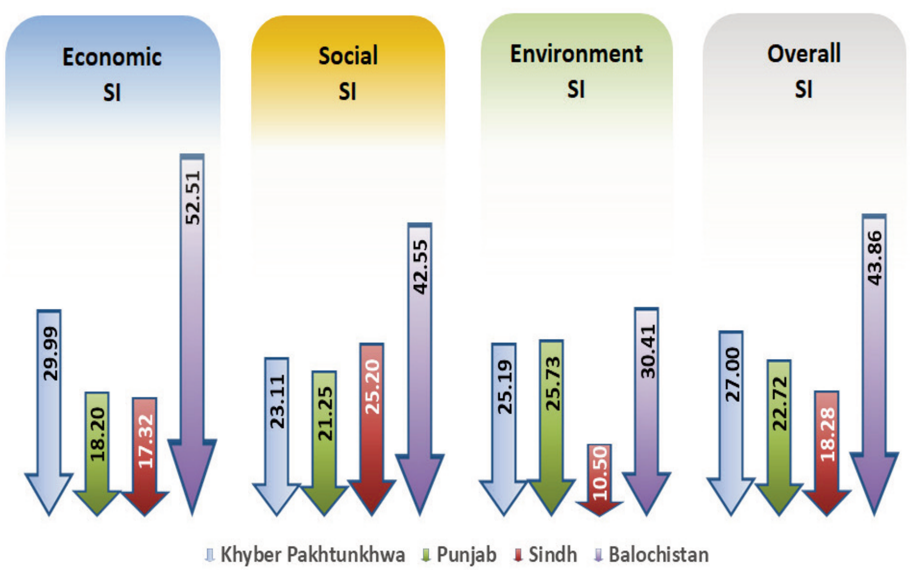


Source: Authors' estimation.

FIGURE 8

Comparing overall and dimension-wise sustainability scores for Balochistan, using both aggregation strategies social to environment after economic one in Sindh. On the contrary, in Balochistan, the dimensional contribution made by the social pillar is greater than that of the economic and environmental pillars in relative terms.

The percentage decline in the overall and the sub-pillars of sustainability indices across the two aggregation methods is shown in Figure 9. This percentage decline from arithmetic to a geometric aggregation-based score reflects the existence of inequalities, interdependence and variations within the aggregation components across provinces. It can be seen at a glance that Balochistan has the largest percentage decrease in its index scores for all dimensions and, eventually, for the overall index score among provinces. Beyond Balochistan (44 per cent), the decrease in the percentage of the overall sustainability score is higher for KPK (27 per cent) in comparison with Punjab (23 per cent) and Sindh (18 per cent). The percentage score reduction in the economic dimension is highest for Balochistan (53 per cent) and KPK (30 per cent), while for Sindh (25 per cent), it is in the social sub-index and environmental sub-pillar for Punjab (26 per cent). This implies that there are much greater disparities in economic indicators in Balochistan, followed by KPK, than in Punjab and Sindh. Further, other than Balochistan, variability across social components is more dominant in Sindh, followed by KPK and Punjab, while dispersion within environmental aspects is more in the case of Punjab.



Source: Authors' estimation.

FIGURE 9

Comparing percentage decrease in index scores across aggregation methods

1. Regional Level (Urban Divisions) Results

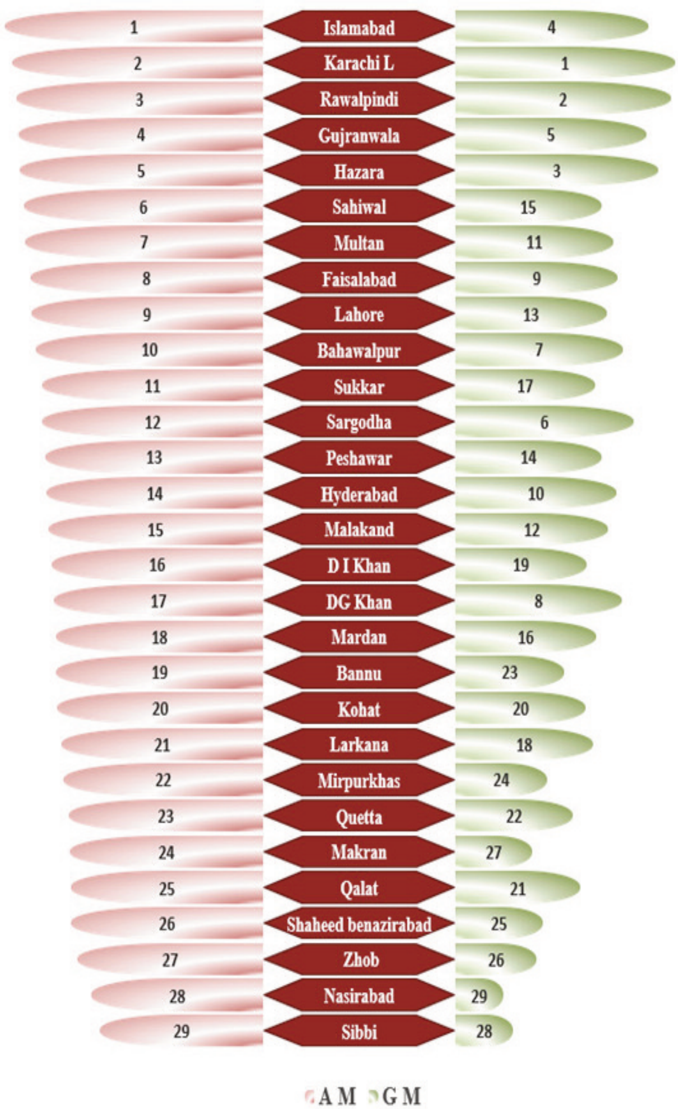
The breakdown of the analysis at the divisional level offers an inclusive picture of society in terms of specific sustainability characteristics. Aggregate figures, however, do not adequately depict whether regions of the nation have advanced significantly or have lagged behind in terms of growth. To ensure effective policy formulation and corresponding actions, precise and inclusive understanding regarding disaggregated geographical regions is crucial, especially the urban divisions, which contribute more in directing the nation toward achieving a sustainable development path. Therefore, the following figure portrays the estimated sub-dimensional sustainability index scores for urban divisions of Pakistan, along with a comparison of their arithmetic and geometric scores. Moreover, Figure 10 also depicts the ranking of urban divisions, indicating the performance of individual divisions within each sustainability pillar.

The most well-performing division as per arithmetic sustainability index scores is Islamabad (67.0 per cent), and the division which is far behind from achieving a sustainable trajectory is Sibbi, the division of the most deprived province of Pakistan with a score of 42.3 per cent. Whereas Karachi stands first (57.0 per cent) as per the geometric sustainability index score, and again, the urban division of Balochistan, Nasirabad, stands least with a score of 12.3 per cent. Out of ten well-performing divisions, eighty per cent of the representation is from Punjab, and KPK and Sindh equally contribute the remaining twenty per cent. However, it is worth mentioning that these well-performing divisions are still about halfway behind in achieving the desired sustainability goals and targets in absolute terms. Intra and inter-dimensional disparities are more pronounced in urban divisions of Balochistan, reflected by a decline in SI scores as we move from one aggregation strategy to another. In contrast, the smallest reduction in overall score across aggregation strategies is for Karachi, implying the least inter and intra-dimensional variability.

Overall sustainability scores can be reverted into its three sub-dimensions scores as to provide the relative contribution of each dimension at divisional level as reported in Figure 11.[5] This would enable the concerned authorities to understand at the grassroots level which aspect of sustainability is required to be prioritized for a particular region/division. For instance, in Figure 11 , Islamabad stood first as per the overall sustainability score arithmetically computed, but the major contribution towards its overall score is from its environmental and social pillars, although its economic pillar is weak as compared to other divisions within the same pillar. As per the arithmetic score ranking under the economic pillar, Islamabad ranked at 10th position while at 24th position according to its geometric score rank. Moreover, among pillars, the greatest decline in sub-dimensional scores from arithmetic to geometric score estimation is also observed in its economic pillar. On the other hand, as per the overall geometric score ranking, Karachi topped among divisions. In general, the performance of Karachi is quite satisfactory in

[5] The pillar-wise arithmetic and geometric scores values for divisions, reflected as colored bars in figure 11, are reported in Appendix Table A-6.

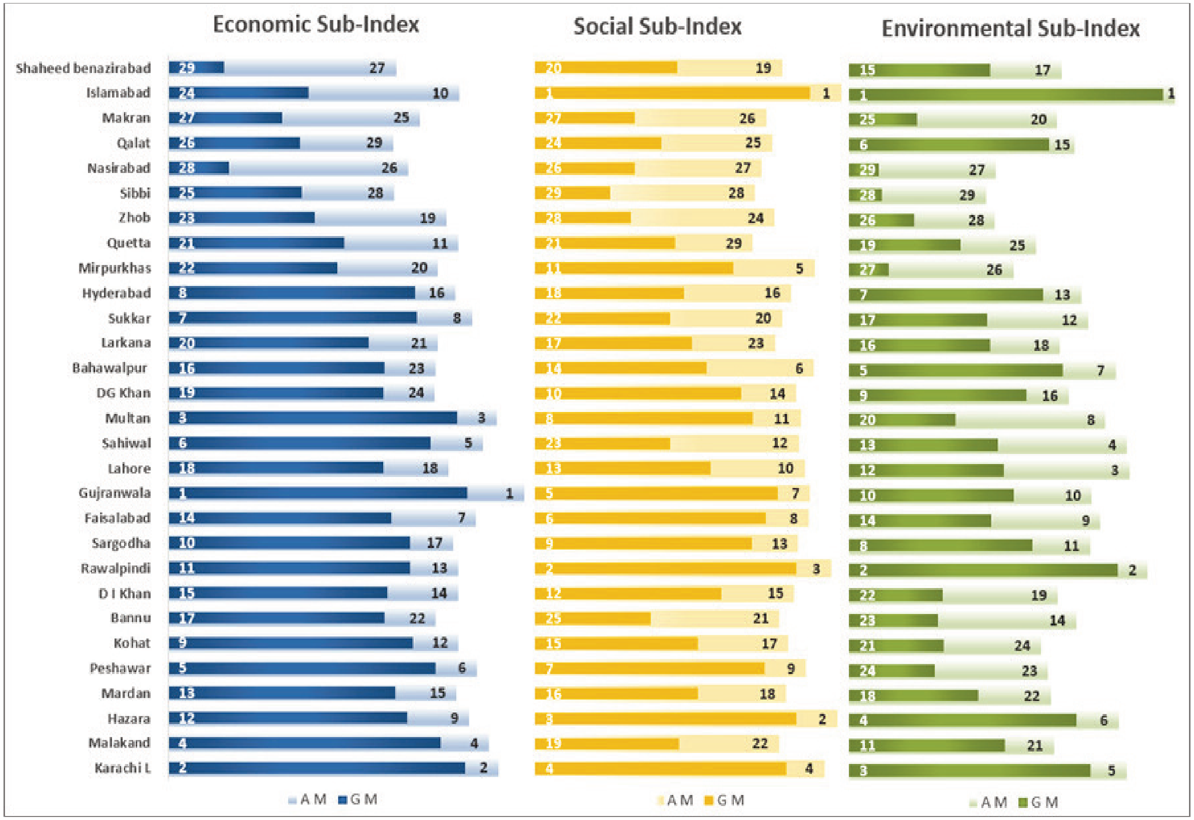
all sub-dimensions, particularly its economic dimension, which is strongest among pillars. This is also apparent from its significant contribution to national income. Further, for Karachi, the gap between arithmetic and geometric scores in all three sustainability aspects is least among divisions.



Source: Authors' estimation.

FIGURE 10

Overall sustainability scores comparison for urban divisions



Source: Authors' estimation.

FIGURE 11

Pillar-wise index ranking for urban divisions per arithmetic and geometric aggregations

Within the economic pillar, the Gujranwala division, which has two large cities, Sialkot and Gujranwala itself, is placed at rank 1 in both types of scores. Moreover, the results of those divisions which are located in Balochistan are in line with the aggregated results mentioned before. For almost all divisions, all three pillars are relatively weak, along with substantial divergences across indicators used to describe these dimensions as reflected by a large decline in scores while switching from arithmetic to geometric technique. Kalat, Quetta and Sibbi are lowest in ranks as per economic, social and environmental pillars, respectively. A similar conclusion can be drawn for divisions in Punjab as they are also more or less the mirror image of its aggregated provincial findings. As far as divisions in KPK are concerned, in general their economic pillar is stronger in relative terms followed by their social and environmental ones majorly. Within KPK divisions, the arithmetic economic index score of Peshawar is the highest, while Malakand stands out in terms of the geometric economic score. Social and environmental pillar scores are highest for Hazara, irrespective of aggregation methods used among KPK divisions.

V. Conclusion and Policy Implications

To grow sustainably, the world needs to effectively gauge its performance to ensure continuing progress towards the ultimate goal. Though, inadequate availability of information and data in developing countries usually predominated by a greater portion of their economy as informal makes this task of estimating progress towards achieving sustainability much difficult. In Pakistan, efforts have been being made at national levels to gather information and compute indicators as per the SDG framework and observe their trends over time, though aggregating them into one single statistic of sustainability is rarely found. Moreover, those focusing SDGs are restricted to either national or provincial level with qualifications regarding year of reference in particular along with not discussing sub sustainability pillars as well. To account for all such concerns to the best of its ability, this research aimed at estimating and examining progress towards achieving sustainability at the macro and meso levels and for overall and pillar-wise sustainability. Arithmetic and geometric aggregations are used to estimate indices to compare and account for inequalities among components within an index. The research utilizes data sources that provide data for all geographical disaggregation levels considered here for the same year of reference, i.e., 2018-19. Majority of the indicators are computed based on the data from two renowned microdata set published by Pakistan Bureau of Statistics namely Household Integrated Income Survey (HIES) and Labor Force Survey (LFS) along with various other sources mentioned earlier in the methodology section. In the computation of the sustainability indices, both for the overall and the sub-dimensional ones, the study benefited from the basic methodology provided in the SDG index and dashboards.

The results indicated that Pakistan is halfway towards achieving defined sustainability targets. However, moving from arithmetic to geometric mean, this index score declines by 22 per cent. The social dimension has the largest percentage score loss (23 per cent) across the two averaging strategies, followed by the environment (22 per cent), and the economic dimension (17 per cent). This suggests that differences in component values in the social dimension are greater than those in the environmental and economic elements. According to arithmetic and geometric aggregations, the nation performed considerably better economically than the other two, as shown by an index score of 0.65 and 0.54, respectively. The arithmetic scores for social and environmental sustainability are 0.55 and 0.41, respectively, whereas the equivalent geometric aggregate values are around 13 and 9 points lower.

Sindh excels better among the provinces in scoring overall sustainability under both aggregation methodologies (arithmetic score of 55.3 per cent and geometric score of 45.2 per cent). Punjab and KPK are in second and third place, respectively, with a little arithmetic score differential of 54.0 per cent and 53.5 per cent. Since KPK's geometric score (39.1 per cent) declined more than Punjab's (41.8 per cent), this indicates that KPK has higher intra-province differences in its sub-sustainability dimensions. Furthermore, according to the total sustainability score calculated arithmetically (45.5 per cent) and geometrically (25.6 per cent), Balochistan, the province of Pakistan with the most deprivations, falls far behind in progress towards sustainability among provinces.

At the divisional level, eighty per cent of the ten well-performing divisions are from Punjab, whereas the remaining twenty per cent is split evenly by KPK and Sindh. For divisions within Balochistan, all three sustainability pillars are found to be relatively weak. The stated findings raise awareness of the SDG's progress and are worthwhile as a tool for directing national initiatives and long-term plans for inclusive development. Unsustainability might be tackled at the national, provincial, or divisional levels by enacting diverse policies and mobilizing resources appropriately. Moreover, the study also estimated indices for sub-sustainability pillars as well. It further presents an elaborated picture indicating where to focus more on a particular geographical aggregation.

To improve the Sustainable Development Goals (SDGs) index score within a multidimensional framework, it is essential to create a diversified policy impact that effectively addresses the complex interplay between social, economic, and environmental dimensions. Despite the progress in the economic pillar, there are still serious issues in two other pillars, making shared prosperity and achieving sustainable growth problematic. Deepening efforts are required in the social dimension to sustain perks received from the progress of economic pillars because only growth is not enough to achieve sustainability. However, it is necessary but not sufficient. Education and gender equity are the two main facets of the social dimension that require immediate attention from policymakers. The divisions in Balochistan are in dire need of policy focus as the province, along with its divisions, stands relatively far behind in terms of both the overall and the sub-dimensional sustainability scores in general. Hence, it is suggested that they expand their coverage in social protection and financial assistance programs to provide short-term relief to them. However, for long-term stability, development expenditures that will boost employment and growth opportunities are to be directed more towards the province.

Unsustainability should be tackled at the national, provincial, or divisional levels by enacting diverse policies, developing area-specific policies, and mobilizing resources appropriately. Equal treatment should be achieved in terms of economic and social possibilities. In contrast, unequal people should not be considered equally eligible for all of these changes as most of the divisions in Punjab stand at the same ladder of sustainability, whereas in KPK and Sindh, only the division comprising the capital city is performing relatively better, and all others are far behind. Therefore, providing infrastructure and social development amenities in underprivileged areas helps raise their standard to bring these regions comparable to those relatively sustainable ones.

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APPENDIX

TABLE A-1

Goal-wise list of global level indicators

Goal	Global Level Indicators	Total
1	1.5.3	1
2		
3		
4		
5	5.6.2, 5.a.2, 5.c.1	3
6		
7	7.a.1	1
8		
9		
10	10.6.1, 10.7.2	2
11	11.b.1, 11.c.1	2
12	12.1.1, 12.a.1	2
13	13.1.2, 13.2.1, 13.3.1, 13.3.2, 13.a.1, 13.b.1	6
14	14.6.1, 14.b.1, 14.c.1	3
15	15.6.1, 15.8.1, 15.a.1, 15.b.1, 15.c.1	5
16	16.8.1, 16.10.2	2
17	17.2.1, 17.5.1, 17.6.1, 17.6.2, 17.7.1, 17.9.1, 17.10.1, 17.11.1, 17.12.1, 17.13.1, 17.14.1, 17.15.1, 17.16.1, 17.17.1, 17.18.1,17.18.2, 17.18.3, 17.19.1, 17.19.2	19

Source: Authors' estimation.

TABLE A-2

List of indicators that are repeated in other goals

Goal	Indicator	Repeated Indicator(s) as	Total Repeated indicators
1	1.5.1, 1.5.3, 1.5.4	11.5.1, 13.1.1 11.b.1, 13.1.2 11.b.2, 13.1.3	6
2			
3			
4	4.7.1	12.8.1, 13.3.1	2
5			
6			
7	7.b.1	12.a.1	1
8	8.4.1, 8.4.2	12.2.1, 12.2.2	2
9			
10	10.3.1, 10.6.1	16.b.1, 16.8.1	2
11			
12			
13	13.2.1	13.b.1*	1
14			
15	15.7.1, 15.a.1	15.c.1 15.b.1	2
16			
17			

* slightly amended

Source: Authors' estimation.

TABLE A-3

List of indicators regarding monetary flows

Goal	Indicator
1	1.a.1, 1.a.2, 1.a.3, 1.b.1
2	2.a.2, 2.b.1
3	3.b.2
4	4.b.1
5	
6	6.a.1
7	7.b.1
8	8.a.1
9	9.5.1, 9.a.1
10	10.b.1,
11	11.4.1
12	12.c.1
13	
14	14.a.1
15	
16	
17	17.3.1

Source: Authors' estimation.

TABLE A-4

List of indicators regarding administration and monitoring

Goal	Indicator
1	
2	
3	3.d.1
4	4.7.1
5	5.1.1
6	6.b.1
7	
8	8.8.2, 8.b,1
9	
10	
11	11.3.2, 11.b.2
12	12.b.1
13	13.1,3
14	14.b.1
15	
16	16.5.2, 16.a.1
17	

Source: Authors' estimation.

TABLE A-5

Details of the indicators estimated for measuring sustainability

UNSD Indicator Codes	Level	Years/ Source	Compliance with SDG Meta data Definition	Adopted definition
Indicator codes[6] were developed by UNSD for data transfer, tracking and other statistical purposes.				
C010101	N, P, D	2018-19 HIES	FC	Population classified as poor given the international poverty line of $ 1.25 and OECD adult equivalency scale. OECD equivalency scale gives a weight of 1 to head of household, 0.5 to adults and 0.3 to children.
C010201	N, P, D	2018-19 HIES	FC	Population classified as poor given the national poverty line of approx. Rs.125.6 per day per adult estimated using Cost of Basic Needs (CBN) approach and national adult equivalency scale that gives a weight of 1 to members 18 years and above while 0.8 to those below 18 years of age (Planning Commission of Pakistan).
C010202	N, P, D	2018-19 HIES	FC	Population that is multi-dimensionally poor among the total population within a given geographical boundary. The estimation is performed following PBS methodology for computing multidimensional poverty index (MPI). The estimation though excludes deprived access to basic health facilities which is not reported in HIES and deprivation in terms of land & livestock as it is in rural context only.
C010301	N, P, D	2018-19 HIES	PC	Proportion of population covered by social protection including Benazir Income Support Program (BISP), public assistance and zakat relative to total population in a region.
C010401	N, P, D	2018-19 HIES	PC	A composite index capturing access to basic vices including drinking water, sanitation, clean fuel, garbage collection, handwashing with soap, internet and electricity was estimated as proportion of population having access to all these services divided by the total population living in a given geographical region.
C010402	N, P, D	2018-19 HIES	PC	Proportion of adult population owning any type of land among the entire adult population in a region considered.

[6] See the Global SDG Framework or the official SDG website for details and metadata definitions.

TABLE A-5 *(Continued)*

Details of the indicators estimated for measuring sustainability

UNSD Indicator Codes	Level	Years/ Source	Compliance with SDG Meta data Definition	Adopted definition
C020102	N, P	2018-19 HIES	FC	Prevalence of moderate and severe food insecurity estimated by PBS considering SDG meta data definition.
C020c01	N, P, D	2018-19 inflation monetary SBP	FC	Consumer price index computed by SBP is taken to represent this indicator.
C030102	N, P, D	2018-19 HIES	FC	Calculated as the ratio of birth attended by skilled health workers such as doctors, midwives, lady health worker and nurses, to the total numbers of births reported at a given disaggregation level.
C030302	N, P, D	2018-19 HIES	FC	Incidence of tuberculosis/100,000 individuals within the defined geographical region under consideration.
C030601	N, P, D	2019 PBS & Provincial Development Statistics	FC	Ratio of total fatal injuries in accidents to total accidental injuries in a given regional boundary.
C030701	N, P, D	2018-19 HIES	FC	Estimated as the ratio of women population of 15 to 49 years being satisfied with their need for family planning with modern methods.
C030702	N, P, D	2018-19 HIES	FC	Estimated as total number of live births to total number of child bearing by women aged 15-19 years per 1000 births.
C030802	N,P, D	2018-19 HIES	FC	Calculated as the share of health expenditures in total expenditures of the household. Proportion of HH who spent more than 10 per cent of their total expenditure as health expenditures within a geographical region.
C030a01	N,P, D	2018-19 HIES	FC	Proportion of population aged 15 years at least, using tobacco products at a given disaggregation level.
C030b01	N,P, D	2018-19 HIES	FC	Population proportion under 5 years being fully vaccinated at various aggregation levels

TABLE A-5 *(Continued)*

Details of the indicators estimated for measuring sustainability

UNSD Indicator Codes	Level	Years/ Source	Compliance with SDG Meta data Definition	Adopted definition
C030c01	N,P, D	2018-19 HIES	FC	Proportion of health workers i.e doctors, nurses, midwives and pharmacists per 1000 population in a given regional boundary.
C040102	N,P, D	2018-19 HIES	FC	Proportion of population who completed their respective educational level out of the total population within the respective age group (3 to 16 years) at a given disaggregation level.
C040201	N, P, D	2018-19 HIES	P.C	Proportion population aged under 5 years who are education-wise and health-wise on track among the respective total population. Education on track if their educational attainment is in accordance with their age while health on track is reflected if they are fully immunized and does not suffer from severe diseases.
C040202	N, P, D	2018-19 HIES	FC	Ratio of children who have completed at least one education before the official primary entry age to total population of children within a region.
C040301	N, P, D	2018-19 HIES	FC	The number of people in selected age groups participating in formal or non-formal education or training is expressed as a percentage of population of the same age and gender. Next a parity index was estimated as the ratio of proportion of women to proportion of men.
C040401	N, P, D	2018-19 HIES	FC	Proportion of individuals having ICT skills such as sending emails, using internet for business, shopping, banking, education, research etc., among the total population aged 15-64 years at a given aggregation level.
C040501	N, P, D	2018-19 HIES	FC	Gender Parity Index (age 3-40) is equal to Currently attending (enrolled) female ratio to currently attending male ratio
C040601	N, P, D	2018-19 HIES	PC	Ratio of individuals who can read and write with understanding in any language and are able to solve simple math to total population aged 15 years and more at a given aggregation level.

TABLE A-5 *(Continued)*

Details of the indicators estimated for measuring sustainability

UNSD Indicator Codes	Level	Years/ Source	Compliance with SDG Meta data Definition	Adopted definition
C040c01	N, P, D	2018-19 LFS	PC	Proportion of teachers who took teachers training out of total population of teachers at a given aggregation level.
C050401	N, P, D	2018-19 LFS	FC	Time spent or hours spent on unpaid care and domestic work is computed as the total hours spent by population in care and domestic work divided by the total hours irrespective whether they are engaged in such activities or not.
C050501	N, P	National assembly	PC	Proportion of seats represented by women in national assembly.
C050502	N, P, D	2018-19 LFS	FC	Total number of individuals at managerial positions divided by the total employed population of a given gender in a region. Afterword's parity index was estimated as a ratio of proportion of women to proportion of men.
C050601	N, P, D	2018-19 HIES	PC	Proportion of women who take decisions regarding child birth, health and use of contraceptives with all married women of age between 15-49 years.
C050b01	N, P, D	2018-19 HIES	FC	Ratio of population who own a mobile phone within the entire population in a given geographical region.
C060101	N, P, D	2018-19 HIES	FC	Population with access to improved drinking water in relation to the entire population living in a given geographical boundary. Sources of improved drinking water includes piped water, public tap, borehole, tube wells, protected springs, closed wells etc. as defined in SDG meta data.
C060201	N, P, D	2018-19 HIES	FC	Ratio of population that have access to improved sanitation among the entire population. Further the indicator was constructed using multiple conditions like sanitation facility which is not share with non-household members, is connected to cover or underground drains and having water and soap available for handwashing.

TABLE A-5 *(Continued)*

Details of the indicators estimated for measuring sustainability

UNSD Indicator Codes	Level	Years/ Source	Compliance with SDG Meta data Definition	Adopted definition
C070101	N, P, D	2018-19 HIES	FC	Ratio of population having access to electricity to the total population in a given geographical region.
C070102	N, P, D	2018-19 HIES	FC	Ratio of population using clean fuel and technology for activities like cooking (gas and electricity), heating (solar energy, electricity, LPG, gas and biogas) and lighting (electricity, solar energy and gas) to the total population.
C080101	N , P, D	2018-19 HIES	PC	As GDP is not available at disaggregated regional levels. This study used income from all sources i.e wages, interest, rent and profit income, to proxy regional GDP. Growth of income per capita between 2015-16 and 2018-19 was calculated as change in per capita income between years divided by per capita income in base year.
C080201	N , P, D	2018-19 HIES	PC	Growth of income per employed persons between 2015-16 and 2018-19 was calculated as change in per employed income between years divided by per employed income in base year.
C080302	N , P, D	2018-19 LFS	FC	Informal employment is estimated as defined by PBS in LFS.
C080501	N, P, D	2018-19 LFS	FC	Total wages earned in rupees divided by the number of hours worked.
C080502	N, P, D	2018-19 LFS	FC	Ration of unemployed persons to labour force population multiplied by 100.
C080601	N, P, D	2018-19 LFS	FC	Youth Population (aged 15–24 years) not in education, employment or training/total Youth population (aged 15–24 years)
C080701	N, P, D	2018-19 LFS	FC	Proportion of Children aged 10-17 years who are employed in total population of children aged 10-17 years.

TABLE A-5 *(Continued)*

Details of the indicators estimated for measuring sustainability

UNSD Indicator Codes	Level	Years/ Source	Compliance with SDG Meta data Definition	Adopted definition
C080801	N, P, D	2018-19 LFS	PC	Occupational injuries per 100,000 employed persons is estimated using total occupational injuries reported and total employed persons.
C081001	N , P, D	2019 Statistics of Scheduled Banks, SBP	FC	Total number of bank branches per 100,000 adults
C090201	N , P, D	2018-19 HIES	PC	Share of manufacturing income to total income of individuals within a given geographical boundary
C090202	N , P, D	2018-19 LFS	FC	Total employment in manufacturing sector divided by total employment in all sectors of the economy multiplied by 100.
C090502	N , P, D	2018-19 HIES	FC	Ratio of total number of researchers (such as M.Phil., Ph.Ds. and MS) per million population.
C090c01	N , P, D	2018-19 HIES	FC	Population covered by a mobile network divided by total population
C100101	N , P, D	2018-19 HIES	FC	Change in income per capita among bottom 40 per cent and the total population between 2015-16 and 2018-19 divided by income per capita in base year multiplied by 100. Gap between bottom 40's and total population's income per capita was calculated.
C100201	N , P, D	2018-19 HIES	FC	Proportion of population below half of median income to total population.
C100401	N , P, D	2018-19 HIES	PC	Share of Labour wage income plus social protection to total income from all sources into 100.
C110101	N , P, D	2018-19 HIES	PC	Proportion of population living in slums i.e in housing that lack improved water and sanitation accessibility along with overcrowding (>3 person per room) and house structure durability (not durable material used on roof, walls and floor), in relation to total population.

TABLE A-5 *(Continued)*

Details of the indicators estimated for measuring sustainability

UNSD Indicator Codes	Level	Years/ Source	Compliance with SDG Meta data Definition	Adopted definition
C110603	N , P, D	2018-19 HIES	PC	Proportion of population who reported garbage collection by municipality and private means.
C150101	N , P, D	2019 Development Statistics (All provinces)	FC	Forest area in relation to the total geographical area for a given level or region of computation.
C160101	N , P, D	2019 Development Statistics (All provinces)	FC	Murders per 100,000 population in a particular geographical region.
C170801	N , P, D	2018-19 HIES	FC	Ratio of population surfing internet to total population within a geographical region.

N, P and D equals national, provincial and divisional aggregation levels.
Source: Authors' estimation.

TABLE A-6

Index scores for various divisions

S.No.	Divisions	EcSI		SoSI		EvSI		SI	
		A M	G M	A M	G M	A M	G M	A M	G M
1	Karachi L	0.719	0.646	0.629	0.546	0.604	0.525	0.65	0.57
2	Malakand	0.698	0.592	0.531	0.312	0.445	0.340	0.558	0.397
3	Hazara	0.656	0.521	0.657	0.567	0.587	0.495	0.633	0.527
4	Mardan	0.628	0.495	0.546	0.353	0.439	0.280	0.538	0.366
5	Peshawar	0.672	0.583	0.589	0.500	0.434	0.188	0.565	0.379
6	Kohat	0.632	0.534	0.550	0.355	0.418	0.206	0.533	0.339
7	Bannu	0.583	0.470	0.532	0.25	0.494	0.193	0.536	0.283
8	DI Khan	0.630	0.478	0.564	0.405	0.454	0.204	0.549	0.341
9	Rawalpindi	0.631	0.525	0.644	0.569	0.649	0.586	0.641	0.559
10	Sargodha	0.620	0.527	0.573	0.471	0.525	0.400	0.573	0.463
11	Faisalabad	0.671	0.486	0.595	0.502	0.547	0.309	0.604	0.423
12	Gujranwala	0.775	0.650	0.598	0.526	0.528	0.358	0.634	0.497
13	Lahore	0.610	0.469	0.586	0.383	0.611	0.337	0.602	0.393
14	Sahiwal	0.686	0.571	0.573	0.294	0.605	0.324	0.621	0.379
15	Multan	0.714	0.629	0.577	0.473	0.558	0.232	0.617	0.410
16	DG Khan	0.581	0.467	0.568	0.448	0.478	0.387	0.542	0.433
17	Bahawalpur	0.581	0.471	0.607	0.374	0.58	0.466	0.589	0.434
18	Larkana	0.587	0.437	0.522	0.341	0.459	0.308	0.522	0.358
19	Sukkar	0.661	0.541	0.537	0.294	0.521	0.299	0.573	0.362
20	Hyderabad	0.625	0.536	0.557	0.323	0.505	0.422	0.562	0.418
21	Mirpurkhas	0.587	0.367	0.608	0.43	0.357	0.086	0.517	0.238
22	Quetta	0.632	0.382	0.474	0.305	0.407	0.243	0.504	0.305
23	Zhob	0.606	0.319	0.521	0.208	0.318	0.142	0.481	0.211
24	Sibbi	0.492	0.290	0.479	0.164	0.298	0.071	0.423	0.150
25	Nasirabad	0.522	0.132	0.493	0.217	0.32	0.065	0.445	0.123
26	Qalat	0.489	0.287	0.516	0.276	0.491	0.435	0.499	0.325
27	Makran	0.548	0.249	0.502	0.217	0.453	0.148	0.501	0.200
28	Islamabad	0.633	0.306	0.665	0.598	0.710	0.683	0.669	0.500
29	Shaheed benazirabad	0.495	0.122	0.538	0.310	0.462	0.308	0.498	0.227

Where EcSI, SoSi, EvSI and SI represent economics, social, environmental and overall sustainability indeices.
Source: Authors' estimation.