Intelligent Monitoring: Leveraging Big Data and AI to Evaluate Sustainable Development Goals

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Abstract

The 2030 Sustainable Development Agenda of the United Nations offers a crucial framework for social, economic, and environmental action. Unfortunately, in many nations, there is insufficient data to provide a complete indicator system that would help with the methodical implementation and tracking of progress toward the Sustainable Development Goals (SDGs). Big data and artificial intelligence (AI) are currently being used to provide effective and affordable solutions for urgent urban socioeconomic and environmental issues worldwide. The study suggests that artificial intelligence (AI) and big data can increase the productivity and competitiveness of natural and human resources, increase the efficiency of urban industries, reduce the cost of delivering urban services, and promote climate resilience. These technologies may also aid in resolving South Asia's typical urban issues. The study assessed the efficacy of AI and big data efforts and technologies in addressing urban development issues as well as their potential for scaling up in South Asian cities. The report concludes that by building big data and associated IT infrastructure, working together regionally to promote research and innovations, enhancing technological readiness, and reducing obstacles to innovation, South Asia can optimize the benefits of AI and big data technologies.

Key Words: SDGs, Artificial intelligence, big data, climate resilience, South Asia, data infrastructure

Introduction

Sustainability has been a top concern for national governments ever since the Rio Declaration on Environment and Development, the Principles for the Sustainable Management of Forests,

and Agenda 21 at the 1992 United Nations Conference on Environment and Development (UNCED). However, the abuse of natural resources and unsustainable development techniques that have propelled the world economy's fast rise over the past three decades have resulted in serious socioeconomic and environmental problems. In response to these global concerns, 193 United Nations Member States overwhelmingly adopted the 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs) in 2015, marking a major step forward for sustainable development.[1] Since the adoption of the SDGs, the drive for sustainability has received constant support and attention from financial institutions, firms in the public and private sectors and on several levels of national and regional governing structures.

However, the world is likely to miss most of the SDGs, especially SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 15 (Life on Land), given the current pace and progress of the Member States. Research on various SDGs is currently divided by institutional structures and funding sources rather than being conducted concurrently in light of their integrated structure, particularly the close integration of economic, social, and environmental perspectives within the SDG framework.[2] Given the complexity of the SDGs, more participation from natural and social scientists, engineers, and economists is required to develop more comprehensive implementation strategies, conduct interdisciplinary research, and have cross-disciplinary discussions in order to achieve the SDGs.[3]

Currently, 70% of city dwellers have limited access to at least one essential service, such as housing, water, or power, while cities generate 75% of energy-related greenhouse gas emissions and 80% of the world's GDP. 70% of the world's population is expected to reside in urban areas by 2050.[4] Additionally, it is projected that by that time, 90 percent of the world's population growth, 80 percent of its wealth, and roughly 60 percent of its energy consumption will occur in urban areas, leaving developing nations and emerging economies grappling with

[1] Nations U. Transforming Our World: The 2030 Agenda for Sustainable Development United Nations [Internet]. 2015
[2] Keynejad RC, Yapa HM, Ganguli P. Achieving the sustainable development goals: investing in early career interdisciplinarity. Humanities and Social Sciences Communications. 2021 Dec;8(1).
[3] Matson P. Systems-level partnerships for sustainability at scale. Nature Sustainability. 2022 Jan;5(1):1-2.
[4] United Nations. The world's cities in 2016. Data Booklet. 2016 Mar 26.

issues of sustainability, environmental protection, and natural resource management.[5] Even though data indicates that South Asia is one of the world's fastest-growing regions, with strong economic growth, declining rates of poverty, and advanced human development metrics, 40% of the world's poor (399 million people) still live in extreme poverty, making less than $1.25 per day.[6] Around 800 million people in South Asia are at risk of their earnings declining as a result of climatic stress, while disasters brought on by climate change, including as floods, droughts, and coastal erosion, have impacted nearly 1.7 billion people and caused $127 billion in damage between 1990 and 2017.[7] Furthermore, more than 80% of the population may have worse living standards by 2050 as a result of climatic change.[8]

The urbanization of South Asia is considered an engine of economic growth, supporting the growing industrialization, SMEs, employment, migration, and numerous socio-economic activities. Urbanization is increasing at a never-before-seen rate because of serious social and environmental problems such social vulnerability, inequality, pollution, environmental degradation, food, water, and energy insecurity for the growing population, and a reduction in quality of life.[9] Common issues facing South Asian cities include deforestation, improper land use, pollution, poverty, fast population growth, inequality, insufficient water and sanitation systems, urban heat island effect, and natural disasters.[10] Furthermore, regional trade only makes up 5% of global trade, making South Asia one of the least economically linked regions in the world.[11] Due to intense urbanization and population pressure, most South Asian cities are losing their open spaces, tree cover, water sources, and clean air, which significantly reduces the standard of living for locals. Artificial intelligence (AI) and sustainable big data innovation can provide cost-effective and practical solutions to urgent urban environmental problems in South Asia, including resource conservation, sustainable consumption and

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[5] United Nations. Department of International Economic, United Nations. Department for Economic, Policy Analysis. World urbanization prospects. United Nations, Department of International Economic and Social Affairs; 2003.

[6] Twining Ward L, McComb JF. COVID-19 and tourism in South Asia: Opportunities for sustainable regional outcomes.

[7] Mani M, Bandyopadhyay S, Chonabayashi S, Markandya A. South Asia's hotspots: The impact of temperature and precipitation changes on living standards. World Bank Publications; 2018 Jul 12.

[8] ibid

[9] Ellis P, Roberts M. Leveraging urbanization in South Asia: Managing spatial transformation for prosperity and livability. World Bank Publications; 2015 Nov 13.

[10] Arfanuzzaman M, Dahiya B. Sustainable urbanization in Southeast Asia and beyond: Challenges of population growth, land use change, and environmental health. Growth and Change. 2019 Jun;50(2):725-44.

[11] Kathuria S. A glass half full: The promise of regional trade in South Asia. World Bank Publications; 2018 Sep 19.

production, energy efficiency, ecosystem monitoring, environmental protection, and natural resource management.[12]

The incorporation of AI has revolutionized existing procedures by bringing in cutting-edge techniques and instruments that maximize several aspects of the building lifecycle. Drones with AI capabilities are being utilized, for example, to monitor development and do site surveys. The speed and accuracy with which these drones can gather data enables stakeholders to spot possible problems and take prompt, well-informed decisions. Predictive analytics, automation, and data-driven insights that improve decision-making, expedite processes, and boost project outcomes have empowered the sector.[13]

The third industrial revolution (I3), which was typified by the expansion of the internet (later known as the internet of things, or IOT) and the extensive use of information technology to mechanize manufacturing, ushered in the digital age. The Fourth Industrial Revolution (I4), characterized by scientific and technical breakthroughs that are upending industries and eliminating national boundaries, is a systematic shift that is unique in its speed, potential, and impact on systems. The world is today on the cusp of new revolution. It is now widely accepted that the primary drivers of the I4 Revolution are software engines supported by the big data revolution or artificial intelligence (AI). In order to manage the environment, create smart cities, produce food and precision agriculture, improve socioeconomic conditions, enforce the law effectively, maintain urban sustainability, and plan and monitor urban areas, South Asia must use AI and big data. Additionally, it's imperative that the area invest in big data and AI innovation and related capacity creation.

The possibility for scaling up current advancements in AI and large data

Big Data is the term used to describe large, intricate datasets produced by digital interactions, such as social media, satellite images, mobile phone usage, and sensor networks. Algorithms capable of analysing these statistics, identifying trends, and formulating forecasts without the assistance of humans are referred to as artificial intelligence. These instruments have been

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[12] Dubey R, Gunasekaran A, Childe SJ, Papadopoulos T, Luo Z, Wamba SF, Roubaud D. Can big data and predictive analytics improve social and environmental sustainability?. Technological forecasting and social change. 2019 Jul 1;144:534-45.

[13] Pan Y, Zhang L. Roles of artificial intelligence in construction engineering and management: A critical review and future trends. Automation in Construction. 2021 Feb 1;122:103517.

combined to: Use satellite photography to track crop production (SDG 2: Zero Hunger). Monitor real-time water and air pollution (SDGs 6 and 13). Forecast disease outbreaks

 (SDG 3: Health and Well-Being) through prediction Utilizing financial and mobile data, map urban slums and poverty (SDG 1 and 11).

In the areas of urban and regional development, environmental monitoring, industrial efficiency, early warning, disaster preparedness, natural resource management, and agriculture and food systems, the globe has achieved some impressive strides in big data and artificial intelligence technology. These days, commercially accessible sensors assess crop and soil health, measure water quality indicators (such as pH, dissolved oxygen, electrical conductivity, and turbidity), and use artificial intelligence (AI) to forecast irrigation water requirements.[14] Satellite data can be used to monitor the nation's forests, wetlands, and urban green spaces.[15] Some of the practical implementations are South Asian Urban Development : South Asian cities are using AI and big data to enhance service delivery, optimize resource utilization, and create climate resilience (Arfanuzzaman, 2021). For example, AI-powered real-time traffic and pollution monitoring systems have greatly decreased emissions in cities. China's Big Data Strategy for the SDGs: Big data technologies for assessing SDG indicators in 254 Chinese cities were examined in a 2023 study that was published in Nature Communications. The findings showed that big data outperformed traditional techniques in terms of both temporal and spatial accuracy (Nature, 2023).

Big data and AI's potential for tracking and implementing the SDGs

Every second, Big Data collects data. The technologies that are currently available allow for variation in addition to the acquisition of large datasets. The use of AI and the process of gathering and storing big data have an effect on global prosperity, human well-being, and the achievement of the SDGs.[16] Big data and artificial intelligence (AI) solutions can help with monitoring people's well-being, making effective use of urban forests, water bodies, and land, managing and planning healthcare (including disease outbreaks), reducing urban

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[14] Illangasekare TH, Han Q, Jayasumana AP. Environmental underground sensing and monitoring. InUnderground Sensing 2018 Jan 1 (pp. 203-246). Academic Press.

[15] Prandi C, Nisi V, Ribeiro M, Nunes N. Sensing and making sense of tourism flows and urban data to foster sustainability awareness: a real-world experience. Journal of big Data. 2021 Mar 24;8(1):51.

[16] Habitat UN. Habitat III issue papers. New York: UN Habitat.[Online] Available: http://unhabitat.org.[Accessed: 1/3/2016]. 2015.

environmental degradation, promoting equity, and ensuring that open data is used to the public's advantage.[17] Big data and artificial intelligence (AI) can highlight previously hidden disparities in South Asian society and urban development, and urban policymakers have unique chances to create, evaluate, and promote big data practices linked to sustainable development. For example, using satellite imagery to track encroachment on public land and urban places allows law enforcement and legislators to act quickly to stop the encroachment. Despite being in its early stages of development, artificial intelligence has the potential to revolutionize how we handle and keep an eye on urban problems. However, artificial intelligence is also reducing the sector's ecological impact at a time when demand is continuously increasing, our product variety is growing, and we are seeing the repercussions of fossil fuel use on biodiversity, air quality, and quality of life. AI is improving agricultural conditions in both developed and developing countries, giving the former a competitive edge. Big data can be utilized for many things within the SDGs framework, including analysing the massive volumes of data collected by satellites, mobile devices, websites, applications, sensors, and other devices to predict social welfare, poverty, and inequality on a personal level and to understand gender differences in urban mobility.

This figure illustrates the application of AI and big data in SDG tracking and monitoring, providing South Asian cities with a valuable lesson on how to embrace new technology for a

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[17] Estoque RC. A review of the sustainability concept and the state of SDG monitoring using remote sensing. Remote Sensing. 2020 May 31;12(11):1770.

successful urban future and expedite urban transformation. Although the emergence of AI and urban big data has the potential to support SDG targets and indicators, research indicated that urban policymakers should identify how to best implement these innovations by creating mayoral institutions for urban big data governance, advancing shared skill sets and culture, building capacity, creating an enabling environment, and establishing specialized research and learning initiatives.[18]

South Asia's preparedness to embrace AI and big data technologies

The main prerequisites for using AI and big data to address pressing urban issues are South Asia's strong data infrastructure and technological readiness. A country's degree of advantage and preparedness is determined by how well it does on the World Economic Forum's (WEF) technical readiness index (TRI). Table 1 displays the TRI trend for South Asian countries between 2008 and 2017.

Table 1. Technological readiness indicator in South Asia.

Country	2017	2014	2011	2008	% change from 2009 to 2017
Bangladesh	120	120	122	126	-4.76
Bhutan	105	105			0
India	107	121	93	69	55
Nepal	119	128	130	130	-8.5
Pakistan	111	114	115	100	11
Sri Lanka	106	94	85	82	29.27
Average	**111**	**114**	**109**	**101**	**9.9**

Source: World Economic Forum

Bangladesh and Nepal seem to be doing much better in the TRI in 2017 than their neighbours, which suggests that they are in a better position to use AI and big data technologies to solve urban problems. In contrast, Bhutan and Sri Lanka are less able to take advantage of AI and big data because their TRI is the lowest. Bangladesh and Nepal have lower TRI scores than

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[18] Krishnamurthy R, Smith KL, Desouza KC. Urban informatics: critical data and technology considerations. Seeing Cities Through Big Data: Research, Methods and Applications in Urban Informatics. 2017:163-88.

2008, by 4.76% and 8.5%, respectively, while having comparatively higher TRI scores in South Asia in 2017. Bhutan's performance has remained same after getting TRI since 2014. Despite having relatively low TRI scores in 2017, India and Sri Lanka have improved by 55% and 29.27%, respectively, since 2008. Pakistan's TRI score was higher in 2011 and 2014, although it has improved by 11% since 2008. According to the current state of affairs, South Asian nations have the opportunity to develop their data infrastructure and technological preparedness in order to fully capitalize on the advantages of artificial intelligence and big data.

Conclusion and recommendations

Big data and the analytical tools that process it can now process and analyse enormous amounts of historical data more efficiently than ever before due to the sheer volume of data. AI and big data solutions can significantly lessen the present issues with unsustainable urbanization. Through cooperation between the various actors in South Asia and other parts of the world, the study makes it abundantly evident that AI and big data have the greatest potential to mobilize scalable and integrated approaches and have a major positive impact on the SDGs, the urban socio-economic and environmental system, population well-being, climate resilience, inclusive development, increased food production, and improved social cohesion. The proper use of AI and big data technologies can improve the performance of the urban socioeconomic and environmental systems, make better use of natural resources, increase the inclusion of the diverse and particularly the most vulnerable, and make public services easier to access.

In the future, South Asian governments and scientists may collaborate more effectively not only to address current urban socioeconomic and environmental issues, but also to make powerful decisions for the future with more foresight now. With 28% of South Asians under the age of 15, the millions of tech-savvy youth of today will shape tomorrow's customers, businesspeople, and technicians while advancing the big data and artificial intelligence revolution for a flourishing South Asia. Globally, the amount of data is rapidly growing. 90% of the world's data was created in the last two years, according to studies, and is expected to grow by 40% per year. A significant portion of this data was gathered from regular contacts with digital products or services, such as social media, credit cards, mobile phones, and the internet. As a result, using AI and big data is becoming more and more important for South Asian human growth. Given how far behind Western countries it is, South Asia should act

quickly to maximize the benefits of big data and artificial intelligence (AI) technology in order to improve the SDGs and the welfare of its people. The paper makes the following recommendations to promote big data and AI-based development in South Asian cities in light of the unsustainable urbanization, low TRI, and poor socioeconomic status.

- Because AI uses both structured and unstructured data—such as manuals, maintenance logs, weather data, financial transaction data, consumption data, and market/industry data—to process data and make creative decisions without human intervention, a trustworthy data infrastructure needs to be established at the national level.

- South Asian countries need to promote research and innovation in order to support the expansion of big data solutions and AI products, start-ups, etc.

- The private sector gathers a significant amount of big data related to public welfare in South Asia. For AI and big data technology to yield the most possible benefits, strong public-private collaborations are consequently necessary.

- Among the many things that must be done is to increase the big data and artificial intelligence capabilities of the South Asian nations.

- SMEs must be given incentives to invest in big data, artificial intelligence (AI) and related infrastructure, big data platform services, data and cyber protection, and analytical services. Data security, data integrity, data privacy and protection, data surveillance, data quality, and ethics must all be given consideration. Digital and social well-being South Asian nations must take action to draw in foreign investment in areas such as capacity building, IT and data infrastructure, platform services, and big data and AI-related services.

- By reducing legislative, logistical, and non-tariff trade barriers, South Asian countries can increase their e-commerce and big data-based digital services. Additionally, this will boost urban economic development, employment, productivity, and regional exports.

- Because the South Asian area lacks resources and lags behind in technological advancement, a trust fund might be established under SAARC to support research, innovation, and start-ups in AI and big data solutions.

Artificial intelligence and big data have the ability to completely change how the world monitors progress toward the SDGs. To guarantee that no one is left behind, its implementation must be supported by robust governance, moral protections, and inclusive policies.

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