UTM UNIVERSITI TEKNOLOGI MALAYSIA

IJBES

International Journal of Built Environment and Sustainability
Published by Penerbit UTM Press, Universiti Teknologi Malaysia
IJBES 11(2)/2024, 1-26

Importance of Artificial Intelligence in Achieving SDGs in India

Shivani Gupta
Department of Computer Science and Engineering, Indira Gandhi University, Meerpur, Rewari, Haryana, India

Satinder Bal Gupta
Department of Computer Science & Engineering, Indira Gandhi University, Meerpur, Rewari, Haryana, India

Monika Gupta
Department of Chemistry, Vaish College, Rohtak, Haryana, India

ABSTRACT

Sustainable Development Goals (SDGs) represents the 2030 Agenda defined by the United Nations to attain sustainable development. It comprises outlines 17 goals that cover a range of issues. These goals focus on addressing the globe's most crucial economic, communal, and environmental challenges to provide a more sustainable future for every individual. In India, the government has initiated several schemes and programmes for attaining the targets set for different SDGs, but addressing the complex challenges associated with sustainable development requires continued efforts and collaborations from multiple stakeholders including governments, individuals, public and private sectors. Achieving the SDGs is a continuous process, and some targets may need more time and effort to get achieved. Regular monitoring and evaluation are significant for tracking progress and addressing the gaps or challenges that may arise. The COVID-19 pandemic put a critical impact on the advancement towards attaining the targets set for all the SDGs globally. India has been found to be off track for 19 out of the 33 SDG indicators and there is an urgent need to accelerate the momentum of achieving the targets by 2030. AI presents significant opportunities to address these challenges in India. Overall, in India, Artificial Intelligence is seen as valuable tool to achieve the targets set for different goals in the coming years. In this paper, the authors have discussed the schemes and programmes initiated by the Government of India to attain these SDGs and the role of Artificial Intelligence in attaining the targets by the year 2030.

Article History

Received: *22 August 2023*
Received in revised form : *02 December 2023*
Accepted: 31 December 2023
Published Online: *30 May 2024*

Keywords:

Machine Learning, Artificial Intelligence, Sustainable Development Goals (SDGs), Universal Goals

Corresponding Author Contact:

satinderbal@igu.ac.in

DOI: 10.11113/ijbes.v11.n2.1193

1. Introduction

SDGs of 2030 Agenda also called Universal Goals were developed for sustainable development in 2015 as a result of the success of MDGs (Millennium Development Goals). There are 17 goals that are interlinked and aimed at minimizing all kinds of poverty by making strategies that also help in economic growth and also addresses social needs, such as protection, education, job opportunities, health while tackling issues like climate change and preservation of surroundings and environment. Total 169 targets have been defined for these 17 goals which represent a plan of action to make this planet a better place for living and bring peace and prosperity for all the people living on the planet. All these goals are interconnected in such a way that the progress made in one goal will significantly influence the achievement of other goals. Sustainable development refers to a) Development of a nation that addresses the demands of people living in the present age and not understanding the demands of upcoming generations.

b) Working towards development of a safe and peaceful planet for the people. c) Protecting the natural surroundings and environment. All these can be achieved by the combined efforts of all the people (Singh et al. 2022). All these goals are connected to each other as increase in poverty will result in more health issues due to decline in the sanitation habits. So, due to this interconnectedness, any improvement in one of the 17 goals will have a positive impact on the other indirectly (Ashraf et al. 2022). The brisk advancements in use of digital technology these days is astounding. Massive quantities of data can be used by human beings for harnessing innovations in AI and achieving breathtaking improvements in numerous domains like health, education, e-commerce, transportation, agriculture and so on. It can be seen how AI enabled computing devices enable doctors in reducing medical errors, farmers in boosting production yields, customizing students training etc. AI can also be used in managing environmental consequences by controlling climate change, forecasting of weather and so on. The use of AI technology has great potential to uplift global GDP (Gross Domestic product), diminishing greenhouse gas emissions globally, automating manual tasks and many more (Naismith 2023). The connection of AI with Sustainable Development Goals (SDGs) can help to ensure that benefits provided by this technology reach a large number of people. AI can accelerate the speed for achieving SDGs. AI could act as both enabler as well as inhibitor for achieving SDGs (Goh and Vinuesa 2021). AI can help in accomplishing 134 (79%) targets from all the 17 goals but it may also put a negative influence on 59 (35%) targets (DEXAI 2022). Nanotechnology can also put a crucial part in protecting the environment by using novel and enhanced methods in achieving SDGs. It can be used to monitor and eliminate environmental pollutants. It can be helpful in minimizing the usage of energy consumption by developing efficient and effective technologies (Pokrajac et al. 2021). It is a universal technology that has a great potential to solve several problems as well as challenges faced by the people living in society (Aithal et al. 2021). Nanotechnology is a growing industry that has the ability to provide a number of economic as well as social benefits. It is an emerging technology which can bring rapid developments in the near future. It is predicted that this technology will contribute significantly in expanding the economy of the nation by creating jobs in the coming years (Sadiku et al. 2021). In this paper, the authors have discussed the importance of AI in accomplishing the 17 SDG goals defined by the UN (United Nations). Also, the schemes and programmes initiated by the Government of India in accomplishing these goals and the status of each of the goals in India at present have also been discussed.

2. Literature Review

The SDGs were initiated in 2015 and since then, all the countries across the globe have initiated several programmes for achieving the targets set for each goal. The improvements and advancements carried out by introduction of new latest technologies such as Artificial Intelligence, Nanotechnology, Machine Learning plays a vital role in attaining these targets. In order to analyze the importance and achievement of these targets many authors have done a lot of study on these SDGs. The increased usage of AI helps in achieving the SDG goals. The authors concluded that the findings of the largest language model developed by OpenAI, GPT-3's capabilities and limitations provided valuable insight into the several ways in which AI can help in achieving the SDGs in the society domain (Jungwirth et al. 2023). Several challenges are required to be addressed to fully utilize the capability of AI and DL (Deep Learning) in enhancing sustainability. These challenges involve the lack of logic and transparency in computer based intelligence and DL models, the adaptability and high dimensionality of data, the reconciliation of AI and DL with cutting edge remote organizations, and the moral contemplations and protection concerns related with these technologies. Man-made intelligence and DL are amazing assets that can shape a more reasonable future by tending to cultural difficulties and advancing dependable and moral practices. Continued innovative work in these fields will be critical to opening the maximum capacity of artificial intelligence and DL in driving manageability across different areas (Fan et al. 2023).

3. India's Position in SDGs Global Index

In the Global Index of SDG 2022, India's rank is found to be 121 out of the 163 countries which was 120 in 2021, 117 in 2020 and 115 in 2019. India's rank has downgraded consecutively in the last three years. It slipped down by two spots from 115 in the year 2019 to 117 in the year 2020 and then to 120 in the year 2021 and 121 in the year 2022 (Pandey 2022; Ghai 2021) as shown in figure 1.

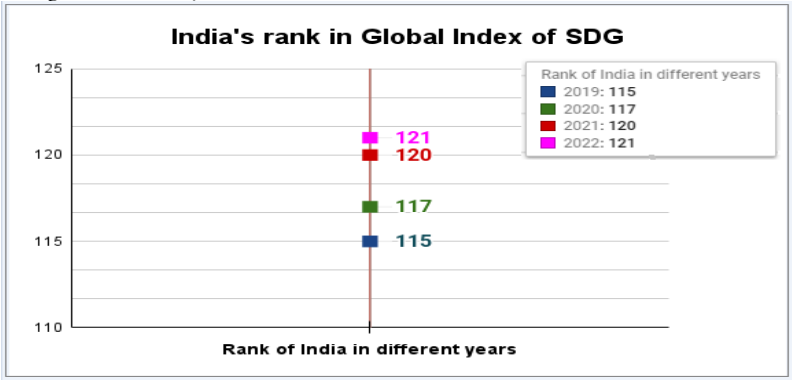

Figure 1 India's rank in Global Index of SDG

According to this current ranking, besides its neighboring country, Pakistan which ranks 129, India is falling behind every South Asian nation including Bhutan at 75, Sri Lanka at 87, Nepal at 96 and Bangladesh at 109. On the basis of the Environment Report 2022 released by the Centre for Science and Environment's State of India, the decrement in the position of India is due to the vital challenges faced in achieving 11 out of 17 goals comprising eradication of hunger, gender equality, better health and well-being and others. The report clarifies that the performance of India was also not good enough in dealing with different aspects of better education and living on shore (Chaudhary 2022). The report also announced that in 2021, India's performance had deteriorated in terms of terminating hunger and attaining food availability, attaining equality and constructing irrepressible infrastructure, boosting comprehensive and responsible industrialization and enriching transformation. While considering the alertness of Indian states, the report clarifies that Jharkhand and Bihar were found to be the least prepared states to achieve the target set for SDGs by 2030. Kerala got the first rank, Tamil Nadu and Himachal Pradesh secured second position and the four states Goa, Karnataka, Andhra Pradesh and Uttarakhand secured third position. In case of Union Territories, Chandigarh secured first place, Delhi, Lakshadweep and Puducherry secured second place and the Andaman and Nicobar Islands secured third place (PTI 2022a). According to the report, the overall SDG score of India was found to be 66 in 2020-21 and this was 60 in 2019-20 and 57 in 2018-19 (Tripathi 2022) as shown in figure 2 below. This score ranges from 0 to 100 and the high score signifies that a state is much closer to attain the set targets. This score defines the position of a country between worst outcome with score 0 and best outcome with score 100.

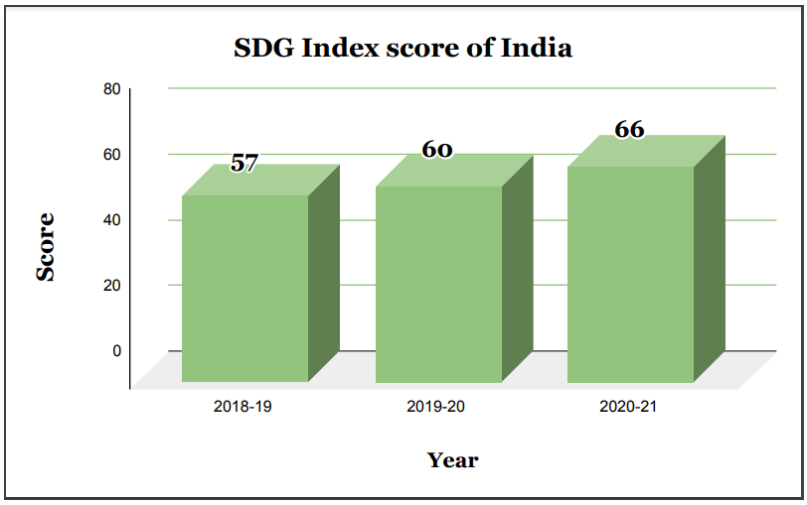

Figure 2 SDG Index score of India

4. Role of AI in achieving 17 SDGs

In this section, the authors have discussed all the 17 goals defined by the UN. The schemes and programmes initiated by the Government of India for achieving these goals have been discussed and how AI has helped in accelerating the process of achieving these 17 SDGs have also been defined. The seventeen SDGs are discussed below:

4.1 Goal 1 (No Poverty) - "Eradicate Poverty In All Modes From Everywhere By 2030"

Sustainable Development Goal 1 (SDG1) focuses on eradicating poverty by the year 2030. A total of 7 *Targets* and 14 *Indicators* have been defined for SDG 1 by the UN. Poverty comprises lack of access to sanitation, healthcare facilities, quality education, and clean water for drinking. On the basis of the report given by the UN organization approximately 16.4% or 228.9 million people of the Indian population were found to be multidimensional poor in the year 2020, while in the same year, another 18.7% or 260.9 million people were categorized as being vulnerable to multidimensional poverty. The report also highlighted that about 41.5 crore human beings living in India have come out of poverty from 2005-06 to 2019-21 which demonstrates that the targets set for this goal could be achieved by the year 2030 which aims at diminishing the population living in poverty by at least half including people of all ages (Sharma 2023a). Over the span of years, India has made a lot of progress in improving its poverty rate. The COVID-19 pandemic has created problems by increasing unemployment and thus, poverty. In the past few years, India has forged ahead in its fight against poverty. It is estimated that about 415 million people have come out of poverty in India since 2005. Due to the presence of diversity in the form of industries, agriculture, handicraft, services in the IT sector, the poor people have been provided with great opportunities to come out of poverty (Beglyakov 2023). The Indian Government has also initiated various schemes in order to eradicate poverty by fulfilling basic necessities of poor people. Some of the schemes are mentioned below (Bardia 2020):

- **Mahatma Gandhi NREGA:** This National Rural Employment Guarantee Act was initiated in 2005 and its main focus was on providing the livelihood to the people living in rural areas. In this scheme, people who volunteered for

manual unskilled work were provided with 100 days of wages in a financial year and thus reducing poverty.

- **National Rural Livelihood Mission:** It started in 2011 with an aim to provide the poor people with opportunities of self- employment and wages to the skilled labourers. This helped in enhancing the livelihoods of poor people and thus, contributed in eradication of poverty.
- **National Urban Livelihood Mission:** It started in 2013 with its main focus on categorizing the poor people living in urban areas into self help groups so as to create employment opportunities for these people.

4.1.1 Role of AI in Achieving the Goal 1 Targets

AI is used in many countries for fighting against poverty. AI provides solutions to handle issues like inequality, lack of access to necessary resources which results in poverty. AI can be used in providing clean water to the people by identifying water contamination sources and then finding ways for removing contaminants from water supplies. Government can take major steps in diminishing the poverty rate by making investments in water infrastructure projects including pumps, and reservoirs so that affordable water could be supplied to citizens. These investments can prove to have various benefits for the people living in society by providing improved education and better health facilities. This will help in increasing the opportunities and empowerment and thus, help in raising people out of poverty. AI can help children by providing them access to educational resources that can help them in gaining success and securing good jobs and these opportunities can help them in escaping from poverty. AI technology enabled virtual systems can be used for learning purposes that can make education more accessible to economically disadvantaged students. Nanotechnology can be used to minimize poverty by providing basic needs to the citizens (Symes 2023). Nanotechnology has also made crucial improvements and this study is broadening as costs are reducing. Because of these advanced innovations, nanotechnology is helping in eradicating poverty globally. It is helpful in alleviating issues of food insecurity. The nanosensors can be used effectively for detecting changes in moisture of various crops. This helps in identifying better-suited areas for particular crops. Not only this, they can automatically regulate the outlay of water and diminish water waste and thus, prevent losses to crops. It enhances the efficiency of agriculture and improves yields (Aithal et al. 2021). It can also be used in providing clean drinking water to people by using nanofiltration, a purification process based on nanotechnology. This process removes the hardness of water by eliminating viruses and divalent ions present in water. It also helps in the medical field by diagnosing the disease with a single test. It helps in detecting viral and bacterial infections easily and at less cost (Kunze 2021). Nanotechnology and AI are helping in eradication of poverty in developing countries by making continuous advancements. These technologies are cost-effective and versatile which make them viable technologies to be used in this fight against pennilessness.

4.2 Goal 2 (Zero Hunger) - "End hunger, Achieve Food Security and Improved Nutrition and Promote Sustainable Agriculture"

A total of 08 targets and 14 indicators have been defined by the UN for this goal. Its main focus is to eradicate starvation and malnourishment in all forms by the year 2030. According to the GHI (Global Hunger Index) of year 2022, India is found to be at 107th position out of total 121 nations with a score of 29.1 which shows that India falls under the "serious" category. This rank in 2021 was 101 out of 116 countries and 94 in 2020 as shown in figure 3 below. While comparing to the neighboring countries in Global Hunger Index 2022, India is ahead of only Afghanistan which is at rank 109 and all other neighboring countries are ahead of India including Pakistan at 99, Bangladesh at 84, Nepal at 81 and Sri Lanka at 64 (PTI 2022b).

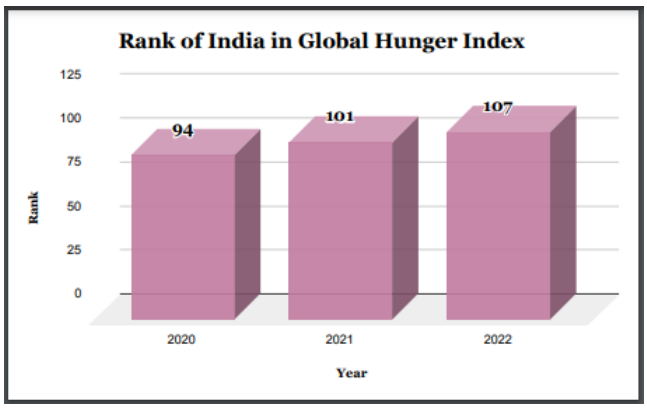

Figure 3 Rank of India in Global Hunger Index

Several schemes have been implemented by the government for achieving the targets (Dixit 2022). Some of them are explained below:

- **National Nutrition Mission (NNM):** Also known as *POSHAN Abhiyaan*, it was initiated by the Prime Minister Shri Narender Modi on the International Women's Day 2018 celebrated on 8th of March 2018 in the Jhunjhunu district of

Rajasthan with main focus on attaining *Kuposhan Mukt Bharat*. The scheme was launched to tackle the issue of malnutrition and provide complete nutritional food to children, pregnant women and lactating mothers. It has five pillars:

Pillar-1: Poshan Abhiyaan ICDS(Integrated Child Development Services: An app called Common Application Software (CAS) is used on mobile that provides assistance to the workers by helping them in delivering services and also enables them to monitor the programs organized at the Anganwadis across the country.

Pillar-2: Convergence Action Planning: It aims at improving nutritional outcomes by promoting coordination and sectoral efforts including all the departments like department of drinking water and sanitation, department of health and family welfare, department of education and many more.

Pillar-3: Strengthening the Capacity of officials using ILA (Incremental Learning Approach): The employees working in Anganwadi help in achieving the outcome using supervisor's meetings.

Pillar-4: Jan Andolan: Its main aim is to develop strategy for organizing campaigns so as to make people aware of the poshan abhiyaan on key technical areas, which comprises growth monitoring, immunization and Vitamin A, prevention of anaemia and diarrhea, hygiene and sanitation practices and so on.

Pillars-5: Performance Incentives: It involves strengthening delivery services and capacity building.

- **National Food Security Mission:** It was launched in 2007. This scheme was sponsored by the Centre. The main aim was to improve the production of rice, wheat and pulses. It was predicted that this aim could be achieved by expanding the area and enhancing the productivity, restorage of soil fertility and productivity, creating opportunities for employment. The coarse cereals were also included under the mission from 2014-15 onwards.
- **Zero Hunger Programme:** It was launched on 16 October 2017. It was mainly focused on agriculture, health and nutrition. Its main focus was intervening in farms by introducing nutritional farming systems, starting training for zero hunger, constructing genetic gardens by planting biofortified plants. This programme was launched in the following districts initially: Gorakhpur (Uttar Pradesh), Koraput (Odisha), Thane (Maharashtra).
- **Eat Right India Movement:** It was initiated in 2018. Its main aim is to create awareness among the consumers regarding consuming healthy, safe and nourished food. It is dependent on three main pillars: a) to eat *healthy*, b) to eat *safe* and c) to eat *sustainably*. Its aim is to create a culture in which people eat healthy and safe food by 2050. It aimed at making the food of India free from trans-unsaturated fat by the year 2022 and reducing the quantity of salt/sugar as well as oil content from the Indian food by 30% in three years**.**

4.2.1 Role of AI in achieving the Goal 2 Targets

AI can help in fighting against hunger by enhancing the yield of crops. Agricultural scientists use AI technology for developing novel varieties of crops that are more immune to diseases and pests, can resist utmost weather conditions, and need less amount of water for growing. AI systems can be used to recommend farmers regarding fertilizers and water needs of the crops by analyzing the previous data on composition of soil, different weather patterns and so on (Parchhanda 2023). This helps in increasing the yield using fewer resources. It can help in reducing food wastage by using sensors that can continuously monitor the condition of crops and can alert suppliers while diminishing food wastage. AI can help in the optimization of food distribution networks so that people belonging to remote areas can also get access to food. If used in a correct way, AI can have a great impact on improving the India's position in GHI (Global Hunger Index). AI not only helps in the improvement of crop yield by making use of precision agriculture but also helps in predicting food demand using analytics. AI can be used for addressing food insecurity and providing effective assistance and the possibilities have no end if the technology is used in the right manner. Nanotechnology can be used to strengthen food security by making use of nano sensors that help in preventing contamination of food throughout the process of manufacturing, processing, storage and transport. It can be used to improve the resistance power of plants and soil health. The efficiency of resources can also be enhanced using this technology by making use of intelligent sensors (Zhang 2021). In the case of food packaging, nanomaterials can be used by making bottles using nanocomposite that reduces the leakage of CO_2 from the bottle and increases the shelf life of beverages. Silver nanoparticles can also be used for storing the food that helps in killing bacteria. Nanoparticles can also be used to improve the color, texture and taste of food. So, it helps in keeping the food safe and healthy for a longer period and thus, it can be delivered safely to the people. Nanofertilizers can be used in agriculture to improve productivity (Neme et al. 2021).

4.3 Goal 3 (Good health and well-being) - "To Ensure Healthy Lives and Promote Well-Being For All At All Ages."

It focuses on providing a healthy lifestyle and boosting well-being for people of all age groups. Both well being as well as healthy life are significant for sustainable development. It addresses all the important health priorities including reproductive, child health, environment diseases, medicine and vaccines that are easily affordable and many more. Several schemes have been implemented by the government so that health care can be made accessible and affordable for all the people. Some of the schemes are mentioned below:

- **Ayushman Bharat Yojana (ABY):** It was launched in September 2018. It mainly focuses on providing healthcare services and health insurance facilities to all, especially the poor, at all levels. This scheme has two sub-missions: a) Establishment of Healthcare and Wellness Centres (HWCs): The major focus of these centers is ensuring access to health care services by the people at affordable prices. These centers also provide access to CHPC (Comprehensive Primary Health Care) which comprises services related to maternal health as well as child welfare and chronic diseases. It also provides the facility of free diagnosis and availability of essential medicines at free cost. b) PM-JAY (Pradhan Mantri Jan Arogya Yojana): Its focus is at providing monetary help to the poor people so that they can avail healthcare services. Citizens are provided with Ayushman Bharat card which can be used for getting cashless treatment till the cost of Rs. 5 lacs in all the listed

public as well as private hospitals included in the panel. The card holder cannot be denied for treatment by these hospitals and it covers all pre-existing diseases. The scheme provides expenses for 3 days prior to hospitalization and 15 days after being hospitalized, diagnostic supervision and drugs (Prasad et al. 2023).

- **PMBJP (Pradhan Mantri Bhartiya Janaushadhi Pariyojana):** It was initiated in November 2008 by the Ministry of Chemicals & Fertilizers. Its main objective is to make generic medicines of good quality available to all the people at affordable costs. For providing these medicines, Janaushadhi Kendras were set up at various centers. On the basis of the latest data available on *http://janaushadhi.gov.in*, 9,359 Janaushadhi kendras have been set up as of 2nd May 2023.
- **School Health & Wellness Programme:** It was launched in Feb 2020. It was started in all public schools and in schools receiving public funds under the Ayushman Bharat scheme for strengthening health care and prevention of diseases. The main objectives include providing information related to health and nutrition according to age, promoting healthy behavior, detecting diseases in children at early stage and treating them, identifying malnourished children, promoting yoga, hygiene, clean drinking water and many more. In this programme, two teachers, one male and one female, were appointed in every school, as *Health and Wellness Ambassadors* who were held responsible for achieving the objectives by organizing joyful and interactive activities at least one hour per week.

4.3.1 Role of AI in achieving the Goal 3 Targets

AI holds a lot of potential for bringing transformation in all aspects of healthcare which comprises diagnostic care, monitoring patients, clinical trials and delivery of medicines or equipment. It has the ability to provide personalized healthcare services. AI can provide assistance to healthcare workers in completing their tedious tasks easily in less time. It can provide access to information in real time that helps in early diagnosis of the patient which contributes to the recovery of the patient. Nanotechnology has a great potential and is significantly improving the health care system as it has made the process of diagnosis less expensive and easy. Nowadays smart pills are used for monitoring patients which use nanoscale sensors designed for detecting the existence of disease in an early stage for better treatment. Nanorobots are also used for treatment of a patient (Rawat et al. 2023). These robots contain small motors for navigating inside the body of the patient. These are injected into the body of the patient for the purpose of taking pictures of the disease site and then these pictures are used by the doctor for treatment. Nanomaterials can be easily integrated into biomedical devices. Nanosystems provide the facility to deliver the drugs to the target organ precisely and the release of medicine can also be controlled. The retention time is more in comparison to traditional techniques such as Nano-liposomes which is developed for this purpose and helps in treating cancers and cardiovascular diseases. With the swift advancement in use of nanotechnology, the scope of use of this technology in the medical field is endless for further development of novel diagnostics and treatments with greater rates of success (Anjum et al. 2021).

4.4 Goal 4 (Quality Education) - "Ensure Inclusive And Equitable Quality Education And Promote Lifelong Learning Opportunities For All"

Education emancipates the intellectual ability, helps in unlocking the imagination and is important for self-confidence. It is crucial for getting success and unlocks the door of opportunities which makes it possible for all in contributing to a progressive society. Learning provides benefits to all human beings and should be made available to all. It aims at ensuring that all children get free, high quality primary as well as secondary education by 2030 (Saini et al. 2023). It also focuses on eliminating gender discrimination in education, providing vocational training for the disabled persons, upgrading educational facilities and providing a safe environment to all children by 2030. The Indian Government has initiated many schemes (Varthana 2022; Nagaraj 2019) for attaining the purpose of quality education. Some of the schemes are mentioned below:

- **Study Webs of Active-Learning for Young Aspiring Minds (SWAYAM):** It was initiated by the Ministry of Education on 9th July 2017. Its main focus is to achieve the following three principles – access, equity, and quality. It is aimed at providing quality education using e-learning courses to a large number of students. It was launched for creating appropriate content for various courses for all classes up to higher education level, for delivering the best teaching free of cost through online learning resources. The total number of courses is 2,150 as of December 2022. The different modes of learning available are SWAYAM Portal, SWAYAM App, 34 SWAYAM Prabha DTH channels.
- **RTE (Right to Education) Act:** It was started in 2009 and according to this, education was made a fundamental right for each child in the age group of 6 and 14 years. It also defined some rules that need to be paid attention by each primary school in the nation. The children received the right to get education at no cost up to elementary level. The act also focuses on developing a curriculum which ensures that the child gets the benefit of development in every aspect and improving their knowledge and abilities. The Act made it a compulsion for private schools to reserve 25 per cent seats for children belonging to financially weaker sections.
- **Project Udaan:** It was launched by Prof. Ganesh Ramakrishnan, Professor in Department of CSE in IIT Bombay on 14 September 2021. This project has an in-built AI-powered translation ecosystem that can assist in translating engineering textbooks and different learning materials in just one-sixth of the time needed for manual translation. It enables translation of textbooks and learning materials in Engineering from English to Hindi as well as other languages used in India (PIB 2021). Thus, it helps in removing language barriers among students of different backgrounds.

4.4.1 Role of AI in Achieving The Goal 4 Targets

Artificial Intelligence in education has created a revolution by introducing new methods of learning. The use of AI in EdTech is rapidly increasing as it enhances the engagement of students by providing the facility of customized courses, interesting and interactive lectures, skill gaining through teaching with games and so on. It is forecasted that the AI education market will cross 20 billion USD by the year 2027 (IBL News 2021). The use of AI in education provides benefits not only for students but also for teachers. It allows access to learning resources anytime and from anywhere (Göçen and Aydemir 2020). It helps in performing tedious and time consuming tasks through automation. Chatbots can be used for replying to questions at any time. Personalized learning programs can be initiated for students according to their abilities (Seo et al. 2021). The performance of digital devices and its functions can be enhanced using nanomaterials. These devices are used for online learning. Nanomaterials help in making thinner, and highly flexible displays and sensors that are able to reduce the consumption of cost and energy in laptops, and smartphones. These can also improve the data storage and data processing capabilities of the devices (Celik et al. 2022).

4.5 Goal 5 (Gender Equality) - "Achieve Gender Equality And Empower All Women And Girls"

A total of 09 targets and 14 indicators have been defined by the UN for this goal. Its main aim is to ensure gender equality in all aspects of life of women and girls' which comprises (1) eliminating gender discrimination (2) eradication of brutality against women as well as girls (3) ending early and forceful relationship (4) initiating equal participation and better opportunities for girls and (5) global access to all the rights. The special focus is on adolescent girls so as to bring about a change in their families and communities. The Indian government has started various schemes over the past few decades for women so as to make sure that they get equal opportunities in education and work and thus, are economically secure (Mudoi 2020). Some of the schemes are mentioned below:

- **One-Stop Centre Scheme:** It was launched in 2015. The major focus of this scheme is providing necessary medical assistance to women. In this, women receive funding from the Nirbhaya fund so as to protect those women who are victims of any kind of gender-based violence. This scheme also provides legal help and counseling services to women.
- **Women Helpline Scheme:** It was launched in April 2015. Its main aim is to provide emergency help to women who have experienced abuse and this assistance is available for 24*7. A toll-free number (181) is provided by the government so as to provide quick and emergency assistance. This helpline number can be used in every state and union territory across the nation.
- **SWADHAR Greh:** It was launched in 2018 for women empowerment. Its main aim is to provide social, economic, and health security to women. It also provides them with a house, food, and clothes. The legal support is also provided to women.

4.5.1 Role of AI in achieving the Goal 5 targets

With the help of AI and nanotechnology, women can be provided with educational resources, opportunities for work, and latest information access. Empowering women with appropriate abilities is of most extreme significance to use the conceivable outcomes offered by computer based intelligence. As this innovation keeps on reshaping different areas, guaranteeing women's admittance to preparing and upskilling attempts becomes essential. AI systems can be designed to recognize and reduce biases in the process of decision-making including job recruitment, promotion, and so on, thus subsequently advancing fairness and gender equality. By addressing bias in algorithms, AI can contribute to creating more equitable frameworks and mitigating discrimination. Different educational tools powered by AI can provide customized learning experiences, helping bridge gender gaps in education by addressing individual learning needs. Online platforms which implement AI can promote access to education and skill development for women and girls, particularly in STEM (Science, Technology, Engineering, and Mathematics) fields. Women4Ethical AI is a platform launched by UNESCO to improve gender equality and to make sure that AI systems are designed and utilized for safe advancements. The platform focuses on encouraging global gender equality leaders in emerging technologies for collaborating and implementing UNESCO's Recommendation on the Ethics of Artificial Intelligence with a gender lens (Eddy 2023). Digitalization can help women by making their lives easy and secure. It can help them in gaining education, reducing violence, helping them by providing healthcare services in rural areas and so on.

4.6 Goal 6 (Clean water and sanitation for all) - "Ensure availability and Sustainable Management Of Water And Sanitation For All"

It focuses at providing global facility of clean and low-cost water for drinking, improving sanitation and hygiene, and diminishing open defecation. It also focuses on improving quality of water and its efficient use and to strengthen supply of freshwater in order to promote practices of water conservation. The India's Union budget estimate of 2023-24 shows an increase in the budget estimation of the Department of DWS (Drinking Water and Sanitation) which has increased from 67,221 crores in 2022-23 to 77,223 crores in 2023-24 as shown in figure 4 below. This increase shows that India has made progress in this goal.

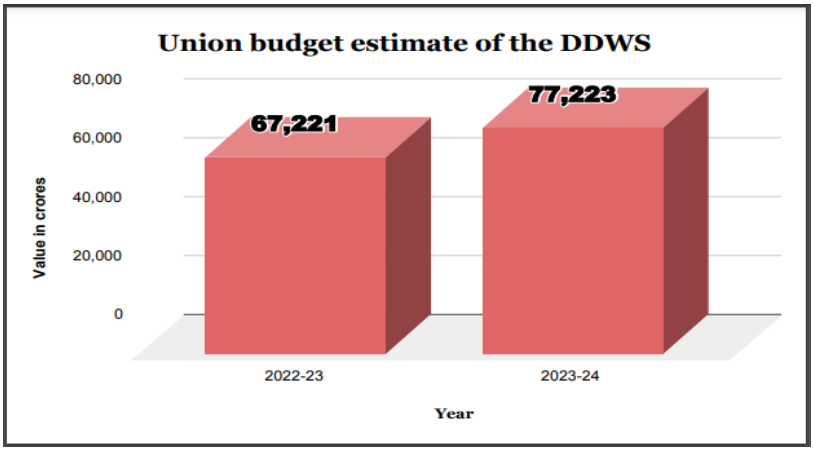

Figure 4 Union budget estimate of DWS

The Indian Government has initiated several schemes for achieving the targets set for this goal. Some of the schemes are mentioned below:

- **Jal Jeevan Mission:** It was launched in 2019. It is envisioned to supply about 55 liters of water to each person everyday in all rural households through individual Functional Household Tap Connections (FHTC) by the year 2024 (Bhaduri 2023).
- **Swachh Bharat Mission - Urban 2.0 and Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0:** It was initiated by PM Narender Modi on 1 October 2021 for a period of 5 years up to 2025-26. These schemes denote a step in effectively confronting the challenges faced by people and will also prove to be of great help in achieving Sustainable Development Goal 6 by 2030. It was an initiation to provide water security to the cities and avail every home with functional water tap connections. The goal of this scheme would be attained by conserving water, revitalizing water wells, recycling of used water after treatment, and collecting rainwater. Women SHGs will manage the water demand and monitor the quality of water. According to an estimation, the project expenses of SBM-U 2.0 is about Rs 1.41 lakh crore, expenses of AMRUT 2.0 is about Rs 2.87 lakh crore. AMRUT 2.0 focuses at providing facility of water supply in all the houses to around 4,700 people living in urban areas with the help of approximately 2.68 crore tap connections and overall coverage of garbage and septage in about 500 AMRUT cities by providing approximately 2.64 crore sewer connections. This will be beneficial for about 10.5 crore people living in cities.
- **Mission Amrit Sarovar:** It was launched by PM Modi on 24 April 2022. The main aim of the mission was to develop and rejuvenate 75 reservoirs in every region of the nation, considering it as a celebration of Azadi ka Amrit Mahotsav. It mainly focuses on conservation of water, participation of people and properly utilizing the soil excavated from water bodies in infrastructure projects. As reported by the Rural Development Ministry, in just about 11 months of the launch of this scheme, 80% of the target has already been attained as about 40,000 water reservoirs have already been built so far (Staff 20023). About 50,000 Amrit Sarovars have to be developed in total under this scheme.

4.6.1 Role of AI in Achieving The Goal 6 Targets

AI has the potential to bring about a revolution in improving the efficiency of using water and managing sanitation with the help of engineering and forecasting. Clean Water AI is an IoT device that uses AI for detecting unhealthy bacteria and harmful particles present inside the water. It can work consistently in real time and analyze the data using a digitized microscope which is attached to a computer system and has Ubuntu OS. It also identifies the contaminated sites and marks them on a map. AI and ML can be used effectively for treating water and detecting problems. EMAGIN, which makes use of AI to provide accurate and timely information that, can help in saving cost and water (DAIA 2019). Their computer program can provide information regarding various kinds of pollutants existing in water so that the water can be treated timely. SEW (Smart Energy Water), an organization driven by AI, having products such as Smart Customer Mobile, and SmartiQ plays a crucial role in the advancement of efficiency of using water. While using Smart Customer Mobile, users can help in reducing water usage; enrol themselves in programmes aimed at conserving water and get refunds. It also provides the facility for reporting water waste and leaks with the help of a mobile phone. SmartiQ is a cloud IoT platform based on AI and ML that helps in getting real time information regarding efficiency of energy, conservation of water, segmentation of customer and leakage of water. Nanotechnology is proving to be a promising technology by demonstrating remarkable achievements in several fields including treatment of wastewater. Nanostructures provide highly efficacious catalysts and redox active media to purify wastewater. Nanomaterials are very effective in eliminating various bacteria and impurities from wastewater including natural as well as man-made solvents, heavy metals, biotic germs, and pathogens that can spread harmful diseases such as cholera and typhoid (Jain et al. 2021). Nanofiltration (NF) membrane is used in Membrane technology and is gaining a lot of attention recently as it is used effectively in treatment of drinking water and wastewater (Sangalang 2022). The usage of nanotechnology is very promising in the management of wastewater.

4.7 Goal 7 (Affordable and clean energy) - "Ensure Access To Affordable, Reliable, Sustainable And Modern Energy For All"

A total of 5 Targets and 6 Indicators have been defined by the UN for this goal. It aims at a) ensuring global access to renewable, low-cost, and advanced energy services by the year 2030 b) significantly increasing the portion of renewable energy in the complete mix of energy by the year 2030 c) improving the energy efficiency by double rate d) enlargement of infrastructure and enhancement of technology to supply advanced and sustainable energy services for all human beings. The energy obtained from sustainable resources including wind, water, solar, biomass and geothermal energy is renewable, inexhaustible and clean. Some of the initiatives taken by the Indian government are mentioned below:

- **Deen Dayal Upadhyay Gram Jyoti scheme:** DDUGJY was launched on November 20, 2014. It was aimed at ensuring the continuous supply of electricity to all including agricultural as well as non-agricultural consumers in rural areas. Under this scheme, it was decided to provide electricity to 18,452 unelectrified villages by 01 May 2018. It aims at increasing agriculture yield, improving the access to radio, telephone, television and internet facilities, providing access to electricity in schools, panchayats, hospitals and so on.
- **Renewable Energy vision:** On the basis of the Renewables 2022 Global Status Report announced by REN21, India stands at 4th position in considering the total installed capacity of renewable energy (excluding hydro power), 4th in wind as well as solar power capacity. Among all the Indian states, Rajasthan and Gujarat stands at the first position, Tamil Nadu, Karnataka, and Maharashtra stands at the second position — all these states jointly accounts for about 70% of the whole green energy usage in the nation, while Manipur, Tripura, and Goa are the three states which have the lowest usage of green energy (Paul 2023). The total power generation capacity of India as on February 28, 2023 was found to be about 412.21 GW. Out of this, the total installed renewable energy capacity was about 168.96 GW in which solar power accounts for 64.38 GW, hydro power accounts for 51.79 GW, wind power accounts for 42.02 GW and bio power accounts for 10.77 GW (PTI 2023) as shown in figure 5 below:

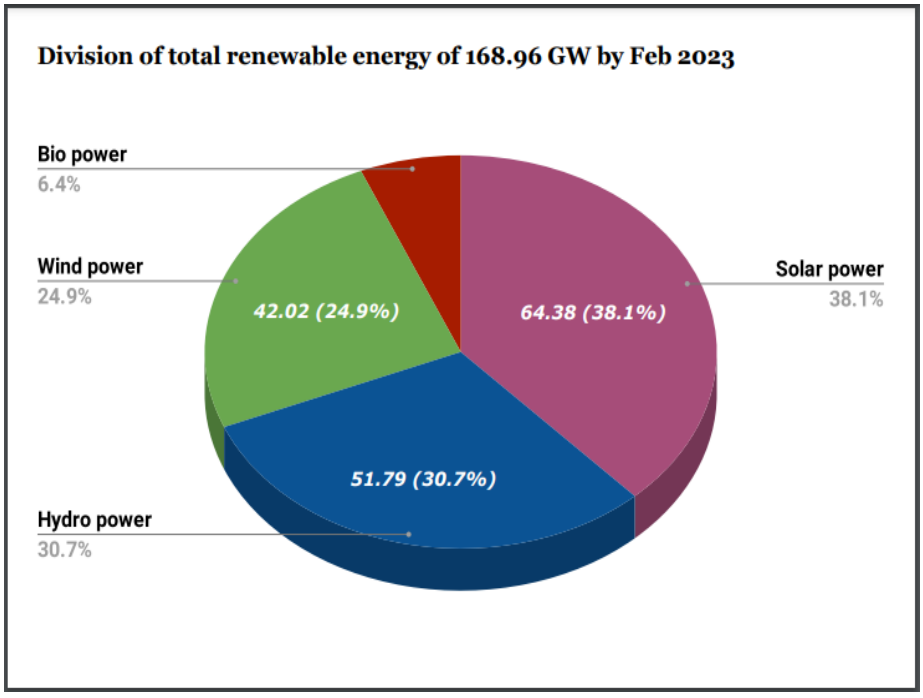

Figure 5 Division of total renewable energy (PTI 2023)

4.7.1 Role of AI in achieving Goal 7 targets

AI is proving to be an important tool in the development of affordable and clean energy solutions in order to meet the growing demand of clean renewable energy. AI can help in diminishing the cost and improving efficient methods of producing renewable energy. AI makes use of predictive analytics and ML algorithms in order to analyze past data for predicting the future energy needs. AI makes use of robots to automate the tasks and improve the efficiency of energy production. Robots can work in hazardous environments for monitoring the equipment and performing various maintenance tasks without causing any risk to human lives. Thus, AI has a great potential in revolutionizing the process of producing affordable and clean energy. Due to the advancements in AI technology consumers can avail clean energy at lower costs. AI and Quantum ML are significant tools that can be utilized to recognize patterns and trends in data to optimize energy production and utilization. Using AI and QML, analysts can foster more effective energy creation and utilization models that can assist with reducing emissions and conserving resources.

This can help in mitigating the cost of energy production, thus making clean energy affordable for users. QML can be utilized to foster quantum calculations that can be utilized to upgrade energy effectiveness. Quantum calculations can handle a lot of information quicker than conventional calculations, making them appropriate for energy improvement. Nanotechnology helps in developing highly efficient and portable energy systems which contribute in meeting the urgent energy goals and reducing the harmful effect caused as a result of human activities. The main focus of nanotechnology research is on solar, hydro and biomass energy. These are the promising alternative energy sources which help in reducing global climate change, mitigating the dependency on foreign oil, improving the economy, and protecting the environment (Gürsel 2020). Nanotechnology has the potential to improve technologies such as solar photovoltaic, solar thermal, and solar-to-fuel. It makes use of nanoparticles for solar thermal energy applications that have the ability to absorb and convert about 90% of the captured sunlight into heat.

4.8 Goal 8 (Decent Work And Economic Growth) - "Promote Sustained, Inclusive And Sustainable Economic Growth, Full And Productive Employment And Decent Work For All"

A total of 12 targets and 17 indicators have been defined for this goal by the UN. Its main aim is to attain more economic productivity and create more jobs using diversification and technological innovations. It also focuses on protection of labor rights and providing a decent and secure working environment. It also aims at eliminating forced labor, human trafficking, and child labor (Mishra 2023a). The government of India has initiated various schemes that could help in achieving this goal. Some of the schemes are mentioned below:

- **NSDM (National Skill Development Mission):** It was initated in 2015 by the Union Cabinet on World Youth Skills day. It helps in implementing a framework for skill development so as to provide learning opportunities for life. It helps in fulfilling the demand of employers for work and industry by providing workforce productivity. This helps the people to get sustainable livelihoods by getting work after skill training. It provides support to the people belonging to weaker and disadvantaged sections of society by organizing skill development activities. It also maintains a database, Labour Market Information System (LMIS), which acts as a portal to match the demands of skilled workers in the nation.
- **Skill India Mission:** It was launched in 2015. Its main objective was to create more job opportunities, increase the scope for enhancement of talents among the Indians. It also focussed on developing sectors previously covered under skill development for many years and identifying novel sectors that need skill enhancement. It was aimed that about 40 crore people living in India will be provided training in various skills by the year 2022.
- **Pradhan Mantri Youth Training Program:** It was launched in 2015 under the skill development sector by Government of India in order to recognize and standardize skills. Its objective is to provide skill training related to industrial work to the Indian youth so as to assist them in gaining a job and a better livelihood. Certificate was also provided to the individuals after completion of training. In the Budget of 2023, it was also decided that new jobs need to be created through various proposals including PMKVY 4.0 under which about 30 Skill India centers would be initiated for encouraging business expansion internationally, thus creating more job opportunities (ET Online 2023).

4.8.1 Role of AI in Achieving Goal 8 Targets

A very important aspect of decent work is to follow the rule of Equal Pay for Equal Work without taking into consideration gender or race. AI helps in measuring an employee's performance and ensuring that every worker is paid fairly on the basis of his contribution to the organization. The organization utilizes algorithms and data-driven insight information to ensure that everyone is receiving fair compensation and thus prevents occurrence of any type of discrimination. AI provides better working conditions by automating the tasks and using robots and thus helps in reducing strain on workers. AI can highly impact the training process of employees for developing skills. It can provide solutions in the form of online courses, interactive tutorials that are designed in such a way that it can help the employees in quickly mastering new skills or refine the existing ones. For example, AI-powered platforms like Degreed or Step Upwards provide personalized learning facilities for employees, which allow them to quickly acquire the knowledge they need to perform better at their jobs. Nanotechnology helps in increasing productivity as it needs a lesser number of people for producing the same unit of output. AI is projected to add $967 billion to the Indian economy by the year 2035, and around $450-500 billion to the GDP of the country by the year 2025, which accounts for about 10% of the country's target of $5 trillion GDP. AI has the potential to boost the Indian economy by enhancing productivity, mitigating costs and creating opportunities for innovation and growth. (Express Web Desk 2023).

4.9 Goal 9 (Industry, innovation and infrastructure) - "Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation"

A total of 08 Targets and 12 Indicators have been defined for this goal by the UN. It focuses on constructing novel and green infrastructures, refurbishing previously designed buildings and utilizing the smart technologies to their highest potential so as to contribute in reducing the negative impact of environmental and risk of disaster. It also aims at building resilient infrastructure and promoting the efficient usage of natural resources. The Indian government has taken a lot of initiatives to achieve this goal. Some of the schemes are mentioned below:

- **PM MITRA (Mega Integrated Textile Regions and Apparel Parks) scheme**: This scheme was initiated by the Ministry of textiles in the Union Budget for the year 2021-22. It is influenced by the idea of **5F** which means **F**arm to **F**ibre to **F**actory to **F**ashion to **F**oreign. It was aimed at constructing 7 PM MITRA Parks for the textile sector with an expense of 4,445 crores in the following states: Maharashta, Telangana, Tamil Nadu, Gujarat, Uttar Pradesh, Madhya Pradesh and Karnataka. It was believed that these gardens would have

modern industrial infrastructure and use the latest technology. It strives to fulfill the perception of boosting an Aatmanirbhar Bharat and to make India stand at a strong position in the textiles industry around the globe. It will be helpful in attracting a funding of crores and creating more number of jobs approximately in lacs. It was expected that each Park would generate about 01 lacs of direct and 02 lacs of indirect job

4.9.1 Role of AI in achieving Goal 9 Targets

Artificial intelligence and nanotechnology acts as a potential tool that helps in understanding and solving complex problems. It helps in providing capabilities for infrastructure innovation, allows making fast and automatic decisions. It has the ability of processing and analyzing huge quantities of data which enables it to make accurate decisions. The infrastructure innovation that is driven by AI helps in making cities more efficient and safer. The algorithms that are based on AI can help in analyzing data obtained from sensors on power lines and predicting the need of maintenance, or identification of failure. This helps in preventing outages and breakdowns so as to improve the reliability of the overall system. While considering infrastructure projects, AI can be used as a significant tool that helps in boosting efficiency and effectiveness. It helps in enhancing not only automation processes but also surveillance capabilities that helps in making faster decisions, which ensures the security of infrastructure and makes it cost-effective.

4.10 Goal 10 (Reduced inequalities) - "Reduce Inequality Within And Among Countries"

A total of 10 Targets and 11 Indicators have been defined for this goal by the UN. To overcome the problem of inequality can be considered as the heart of the Sustainable Development Goals. To reduce inequality, some policies have to be developed for strengthening and boosting communal, economical, and political incorporation. Inequalities can exist in any form and the worst of all is social exclusion which means that an individual is denied access to fundamental rights, basic opportunities or resources like housing, employment, and healthcare and so on. It is important to make sure that all the individuals get equal opportunity. The 2022 Commitment to Reducing Inequality Index (CRII) is the first to analyze the governments' policies and actions taken by 161 countries for fighting against inequality at the time of COVID-19 pandemic. India stood at 129th position in 2019 CRII and has improved the ranking in CRII 2022 as it has risen by six places to 123 out of total 161 countries (Abhirr 2022) as shown in figure 6 below:

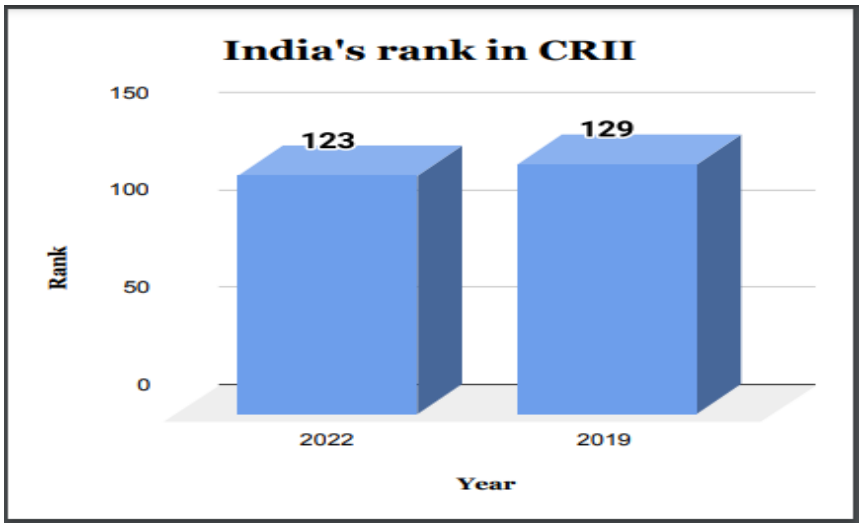

Figure 6 India's Rank in CRII

3

The Indian government has taken some initiatives to achieve this goal which are mentioned below:

- **Reservation Policies:** The Indian government has implemented reservation policies to ensure social and educational opportunities for marginalized communities. Reservation quotas are provided in educational institutions, government jobs, and elected bodies for Scheduled Castes, Scheduled Tribes and Other Backward Classes. These policies aim at addressing historical disadvantages and promoting inclusivity.
- **Direct Benefit Transfer**: The Indian government has launched the DBT scheme to transfer subsidies and welfare benefits directly into the bank accounts of beneficiaries. This initiative helps to eliminate leakages and ensure that benefits reach the intended beneficiaries, thereby reducing inequality and ensuring better access to government support.
- **Jan Dhan Yojana**: It is a monetary inclusive initiative that focuses on providing access to banking facilities, insurance, and pensions for all. This initiative has been particularly beneficial for low-income groups and rural populations, enabling them to access formal financial services and reducing economic inequalities.

4.10.1 Role of AI in Achieving Goal 10 Targets

AI has a great potential to provide benefits to the people living in the society. AI can play a significant role in making sure that all the people get fair and equal opportunities. AI is creating a revolution to provide assistance to the people in need. By using predictive analytics techniques and ML algorithms, organizations can discover patterns within populations which help them in making more informed decisions related to the proper utilization and allocation of resources. AI can help in creating job opportunities for unemployed and underemployed. Education inequality is a major concern for many countries across the globe. AI can enhance the access to education as well as training especially for students who belong to weaker and disadvantaged sections and have fewer resources available.

4.11 Goal 11 (Sustainable Cities And Communities) - "Make Cities And Human Settlements Inclusive, Safe, Resilient, And Sustainable"

This goal has total 10 targets and 14 indicators that help to measure the sustainability of the cities and communities in many aspects. The targets set for this goal include providing facility of ample, secure, and low-cost housing facilities and essential services, protecting the cultural heritage of cities by improving the quality of air and reducing the waste. The Indian government has taken a lot of initiatives to achieve this goal. Some of the schemes are mentioned below:

- **Smart Cities Mission:** It was launched on June 25, 2015. It aimed at enhancing the living standard of people residing in different parts of India and boost monetary growth. Around 31% of the Indian population resides in cities, and they contribute approximately 63% of GDP, on the basis of the data collected in Census 2011. It is estimated about 40% of Indians will be residing in cities by 2030 and contribute about 75% to the GDP. This mission promises to enhance the living standard of 100 cities and towns. It was mainly focused on the expansion of housing opportunities for all the people which is a basic necessity. Smart Cities Mission is forecasted to lower congestion problems, providing security, reducing air pollution and promoting interaction and local economy. The pedestrians are made for walking and cycling to reduce accidents. In order to enhance the living standard of Indians, playgrounds, parks, as well as open gyms are developed (Mishra 2023).
- **PMAY-U (Pradhan Mantri Awas Yojna-Urban):** It was initiated in 2015 under the "Housing for all" mission. It was aimed at constructing 20 million low-cost and cheap pucca houses by 31st March 2022. The PMAY-U scheme has got extension till 31st December 2024, so as to finish construction of houses sanctioned up to 31st March 2022. For this, the Union Budget 2023-24 has incremented the allocation to this Yojana by 66% up to Rs 79,000 crore (Mishra 2023b).
- **AMRUT (Atal Mission for Rejuvenation and Urban Transformation):** It was initiated on 25 June 2015. Its main focus was to improve the quality of life of people living in urban areas by providing essential facilities including water, sewerage, and transport. It aimed at improving the environment by decreasing pollution, providing parks and increasing greenery so as to enhance the well-being of the people, encouraging and facilitating use of walking and cycling as transportation. It aimed at renewing 500 urban cities in 5 years (Gogoi 2023).
- **SBM-U (Swachh Bharat Mission–Urban):** It was initiated on 2 Oct 2014. It was mainly focused on making cities Open Defecation Free (ODF) by constructing toilets and providing the facility of scientific management of solid waste (PIB 2023).

4.11.1 Role of AI in achieving Goal 11 targets

At present, nearly all the cities are making advancements so as to become smart cities. The new technologies are being incorporated in the daily lives of people to improve their living standard which comprises use of the Internet of Things, ML, AI, Nanotechnology. These play a vital role in strengthening the current infrastructure and also move further towards the upgradation (Hart 2022). In order to further improve the smart cities, nano sensors are used that can access data accurately. Nanotech uses the strength of its ultrasmall science, which allows the tiny sensors to store and access huge amounts of data obtained from multiple sources. These nano sensors help in establishing better smart cities by providing correct data to the software programs. The Internet of Nano Things (IoNT), makes use of sensors, hubs to merge all the data, routers for transmission of the data over large distances, and uses advanced software (Duke 2023). Nanotechnology can also be applied in the fabrication of a special kind of glass which has the property of self-cleaning due to the ultra-thin coating on the glass. The conical-shaped nanoparticles exist on the glass surface which is helpful in trapping air and allowing small amounts of water molecules for getting in contact with the surface. Thus, self-cleaning glass needs very little maintenance, which reduces the expenditure on window cleaning in buildings. AI has the ability to reform the way in which cities operate, offering more prominent productivity, further developed security, and more customized services. AI can be utilized to enhance traffic management, allowing for more efficient routing of vehicles and enhanced safety. AI can also be utilized to monitor and analyze data from various sources, allowing for more accurate predictions and better decision-making.

4.12 Goal 12 (Responsible Consumption And Production) - "Ensure Sustainable Consumption And Production Patterns"

A total of 11 Targets and 13 Indicators have been defined by the UN for SDG 12. In order to attain growth in the economy and achieve sustainable development, there is an urgent need to decrease our ecological footprint which can be obtained by making changes in the way human beings produce and consume resources. The ecological footprint is a mechanism that helps to determine the dependency of humans on natural resources. It indicates the number of resources needed to support sustainable development. It is expressed in global hectares (gha), and helps in determining the area on land required by every person to fulfill their needs. Agriculture sector uses the highest amount of water globally and irrigation claims need of 70% of the freshwater

required for human use. So, the sharable natural resources need efficient management and the proper disposal of toxic and harmful waste is also needed which is the main aim of this goal. It is important to encourage industries, businesses as well as consumers to follow the 3R formula (Reduce, Recycle and Reuse) to achieve these goals and assist growing countries to take a step forward towards a responsible pattern of consumption as well as production by the year 2030. The Indian government has taken a lot of initiatives to achieve this goal. Some of the schemes are mentioned below:

- **National Policy on Biofuels**: The Union Cabinet approved this policy in May 2018. Its main focus is to attain the objective of mixing 20% of biofuels with crude oil or fossil-based fuels by the year 2030. By implementing this policy, the main focus of the government is to increase the usage of biofuels in energy and transport sectors. This is possible by increasing the manufacturing of biofuels from conventional feedstock. It also focuses on the usage of latest technologies for strengthening the production of biofuel. It also focuses on providing the facility to mix biofuels with conventional fuels (PIB 2022a).
- **Renewable energy:** On the basis of the Renewables 2022 Global Status Report announced by REN21, India stands at 4th position in considering the total installed capacity of renewable energy (excluding hydro power), 4th in wind as well as solar power capacity. Among all the Indian states, Rajasthan and Gujarat stands at the first position, Tamil Nadu, Karnataka, and Maharashtra stands at the second position — all these states jointly accounts for about 70% of the whole green energy usage in the nation, while Manipur, Tripura, and Goa are the three states which have the lowest usage of green energy (Paul 2023). The total power generation capacity of India as on February 28, 2023 was found to be about 412.21 GW. Out of this, the total installed renewable energy capacity was about 168.96 GW in which solar power accounts for 64.38 GW, hydro power accounts for 51.79 GW, wind power accounts for 42.02 GW and bio power accounts for 10.77 GW (PTI 2023).

4.12.1 Role of AI in achieving Goal 12 targets

Consumption and production are driving forces for economic development. But, at present the available natural resources are not utilized properly. AI can be used to decrease the consumption of energy and improve usage of affordable and renewable energy. AI helps in optimizing the consumption and production levels by making use of vertical green farms, eradicating waste and enhancing yields and efficiency of resources. By raising consumer awareness and empowering responsible consumption, AI supports objective of advancing sustainable consumer behavior. AI-powered smart grids can streamline energy consumption, advancing responsible energy usage and mitigating carbon emissions. AI algorithms analyze energy consumption patterns to recognize opportunities for energy efficiency enhancements. Nanotechnology can be used to create nanocomposites for the purpose of storing energy. Storage of energy is important to maintain a balance between demand and supply of renewable sources such as wind and solar. Nanocomposites help in combining nano particles with different types of materials such as polymers, metals and so on which helps in enhancing the use of batteries, fuel cells.

4.13 Goal 13 (Climate Change) - "Take urgent action to combat climate change and its impacts"

A total 5 Targets and 8 Indicators have been defined by the UN for this goal. Climate change is a natural menace to the whole world and it cannot be denied. Its impact can already be seen and its results can be catastrophic unless action is being taken now. Some changes can be made. The changes needed to protect our planet can be brought using education, technological innovations and strict adherence to the climatic commitments. These changes can also result in a lot of opportunities for modernizing the infrastructure which in turn will help in creating new jobs and promoting greater prosperity across the world. The CCPI (Climate Change Performance Index) is a surveillance tool that helps in tracking the climate protection performance of 59 countries and the European Union and it has been published every year since 2005. India stood at 10th position in CCPI 2022 and rose two spots to rank 8th in CCPI 2023 (PIB 2022c). It is shown in figure 7 below:

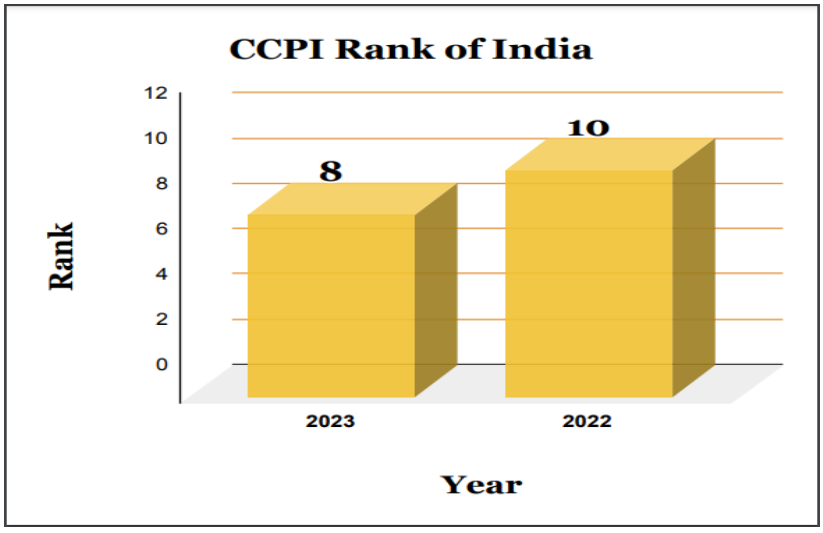

Figure 7 CCPI Rank of India in 2022 and 2023

The Indian government has taken a lot of initiatives to achieve this goal. Some of the schemes are mentioned below:

- **NDC (Nationally Determined Contribution)**: Nationally Determined Contribution, is a climate action plan That aims at reducing emissions and adapting to various impacts caused by climate change. It is required by each party involved in the Paris Agreement to establish an NDC and it is updated after every five years. First NDC was submitted by India in 2015. India has recently updated its NDC and it is made according to the announcements made by PM Modi's at the COP26 (26th session of the Conference of Parties) held in Glasgow in 2021. In the updated NDC, India has made a commitment to lower the emissions concentration of GDP by about 45% till 2030, from the 2005 level, and to attain approximately 50% of the accumulative capacity utilization of electric energy from renewable energy resources by 2030. The main aim is to decrease the import of crude oil or fossil fuel by about 1 lac crores and generate atleast 6 lac jobs by increasing the production capacity by atleast 5 MMT (Million Metric Tonnes) of Green hydrogen per year. It focuses on adding capacity of 125 GW of renewable green energy by the year 2030 so as to attain net zero harmful emissions by the year 2070 (Sharma 2023b).
- **NAPCC (National Action Plan on Climate Change)**: It was initiated in 2008. Its main focus was to make everyone aware of the threats caused by changes in the climate and the different ways to tackle this change. There are about 08 national missions under the NAPCC and these missions represent multiple purposes, long-period strategies needed for attaining primary goals in climate change. It aims at deployment of latest technologies so as to adapt and mitigate Greenhouse gases emissions at a fast speed (PIB 2022b).

4.13.1 Role of AI in Achieving Goal 13 Targets

The datasets related to climate are huge and need a lot of time for analyzing and using the data for making informed decisions and deciding the changes that need to be made in the policy. AI helps in analyzing the huge data and forecasting the changes that occur in the environment so that the changes in the climate can be tackled easily (Mastrola 2023). The emission of gases containing carbon compounds commonly referred to as GHG (Green House Gases) results in global warming and this causes vast changes in climate. The ignition of crude oil is the major source of carbon emissions. Fossils include crude oil, gas and coal that are present in automobiles and transportation vehicles. Nanotechnology helps to reduce the need of fossil fuels which in turn reduces global warming. Use of renewable energy results in zero emissions of harmful gases and nanotechnology helps in generating more renewable energy from domestic feedstock. Global warming can be eliminated by improving the usage of renewable energy. Nanotechnology is extensively used to tackle climatic changes and control global warming. It is proving to be a beneficial tool that helps in protecting the environment so as to keep the environment pollution free (Rose 2022).

4.14 Goal 14 (Life below water) - "Conserve And Sustainably Use The Oceans, Seas And Marine Resources For Sustainable Development"

A total 10 targets and 10 indicators have been defined by the UN for SDG 14. About 70% of the surface on Earth is covered with Oceans and it plays a vital role in providing life on this planet. The oceans constitute the most disparate and significant ecosystem that contributes to Universal cycling and regulation of climate. The biotic resources comprise food stuff and other substances provided by the ocean. These estuaries contribute to eradicating poverty by creating new jobs and empowering women. Oceans and marine zones are significantly important for the welfare of the human beings. In order to achieve the 2030 Agenda, the conservation and sustainable use of oceans is essential. They help in regulating the universal ecosystem through absorption of heat and carbon dioxide (CO2) from the atmosphere. But they are highly at risk due to environmental degradation, changes in climate, water pollution and overfishing. In order to enhance the productivity of oceans and protect them from environmental degradation many schemes and policies have been initiated by the

Indian government. Some of the initiatives are mentioned below (Balasubramanian 2023):

- **Blue economic policy:** India's draft blue economy policy is anticipated as a vital plan for unlocking the nation's potential for economic upswing and well-being. The draft policy defines the vision and strategy that needs to be adopted so as to completely utilize the abundance of oceanic resources present. This policy is aimed at improving the contribution of the blue economy in India's economic growth, enhancing the living standard of coastal communities, preserving marine biodiversity and maintaining the safety and security of marine resources.
- **MSP (Marine Spatial Planning)**: It is a method that helps in bringing together different users of the ocean comprising energy sector, industries, factories, conservation purposes so as to make highly informed and synchronized decisions regarding the sustainable utilization of marine resources. MSP serves as an important governance tool that ensures the advent of a blue economy known for the sustainable management of ocean resources, rather than a brown economy which is environmentally unsustainable. Brown growth refers to the economic development which depends heavily on the use of fossil fuels and does not pay attention to the negative effects of production and consumption of harmful fuels on the environment. Puducherry is the first UT to launch the country's first Marine Spatial Planning (MSP) framework as part of a treaty signed under the integrated Ocean Initiative by India and Norway. The main aim of this initiative was to create a balance between sustainable management of ocean resources and preservation of the coastal environment.
- **Sagartat Samriddhi Yojana:** It was launched by the PM in March 2021 during the release of *Maritime India Vision 2030*. A total of 1,049 projects with a projected cost of Rs. 3,62,229 crores were identified in this initiative. Its aim was to address the challenges faced by coastal areas including development of coastal infrastructure, industries, and tourism. The NTCWPC (National Technology Centre for Ports, Waterways and Coasts) has been built under this scheme in IIT Madras in about 77 crores (ETGovernment 2023). It will help in providing solutions to challenges faced by the maritime sector by providing scientific support and through education, research and technology transfer at national as well as international levels. It will help in strengthening the growth of India's maritime sector. It has the capability to undertake 2D and 3D inspections related to research and consultancy in coastal as well as waterways sectors across all disciplines. It has been planned by the government to operationalise 23 waterways by 2030 for strengthening private investment in the ports sector.

4.14.1 Role of AI in achieving Goal 14 targets

AI and Machine Learning help in conserving oceans by fighting against pollution caused by plastic. ML solves the biggest challenge of tracking and finding out how plastic gets inside the bodies existing in water. The CounterMEASURE project started by UNEP's in coalition with GIC (Geoinformatics Center) at AIT (Asian Institute of Technology) evolved strategies that helped in measuring plastic waste present in the Mekong River with the help of "geospatial data and images of plastic waste supplied by researchers and volunteers." This new ML model has proved to be a game changer which shows the significance of AI (Babakhani et al 2022). AI can be used to create new tools which can help in getting highly detailed and clear perspective of the problem of pollution created by plastic in river water which gets drained into the oceans. Robots can be used that can automatically reach in the depths of the ocean to discover new things. AI helps in understanding the complexity of the impact caused by climate change on our planet, and how this change is affecting the oceans. Marine nano-ecotoxicology helps in assessing the environmental threats that are associated with ENMs (Engineered Nanomaterials) that enter the marine environment. The huge production of ENMs having properties of high biological reactivity and their integration in daily life applications have imposed an urgent need to enlighten the risk on human lives and environment. Nanotechnology and AI can help in reducing the risk on human life and environment caused due to these harmful materials (Corsi 2021).

4.15 Goal 15 (Life on land) - "Protect, Restore And Promote Sustainable Use Of Terrestrial Ecosystems, Sustainably Manage Forests, Combat Desertification, And Halt And Reverse Land Degradation And Halt Biodiversity Loss"

This goal majorly focuses on safeguarding terrestrial ecosystems, controlling sustainability of forests and preserving the natural surroundings of land in order to rehabilitate biotic ecosystems and halt loss in biological variety. It focuses on providing secure and sustainable livelihoods which will be appreciated by the upcoming generations. Some of the initiatives started by the government of Indian for attaining the targets set for this goal are mentioned below:

- **National Mission for a Green India**: It was initiated in Feb 2014. Its objective was to protect the natural resources and livelihoods against the harmful effects caused by changes in climate and to identify the importance of forest cover on the sustainable development, biodiversity conservation, and food and water security. As of December 31, 2022, the forest area had risen by 26,287 hectares and the quality of forest had strengthened in about 1,02,096 hectares (Koshy 2023). India has not achieved the set targets and is struggling to improve the quantity as well as quality of trees as well as forest area plantations which are set under this mission, on the basis of data obtained via the RTI Act.
- **Soil health card scheme**: It was initiated on 19 February 2015 at Suratgarh, Rajasthan. It was initiated for the welfare of farmers. Soil health cards are issued to the agronomists once every two years. It helps them in understanding the level of nutrients present in the soil. This helps the farmers to know about the crops that can be planted in the soil to get maximum yield. The SHC scheme also provides the farmers with the information regarding the amount of fertilizers and changes needed to improve soil health in the long run.

4.15.1 Role of AI in Achieving Goal 15 Targets

AI technology helps in creating automated processes that gather remote sensing data related to biodiversity. AI plays a crucial role in protecting the environment. AI and nanotechnology when used with sensors, help making predictions and detecting risk of fires so as to avoid losing hectares of forests. The aerial images can also be used to get greater flexibility as compared to implantation of sensors. Drones can also be used for exploring places that can be dangerous for human life. AI can be used for early detection of diseases in plants and make predictions to enhance the usage of water in crops (Palomares et al. 2021). AI-enabled remote sensing technologies can detect satellite imagery and examine changes in biodiversity and ecosystems. AI applications in agriculture add to sustainable land use by optimizing crop management, lessening the use of pesticides, and enhancing soil health. Accurate farming practices reduce environmental impact and advance biodiversity in agricultural landscapes.

4.16 Goal 16 (Peace, Justice And Strong Institutions) - "Promote Peaceful And Inclusive Societies For Sustainable Development, Provide Access To Justice For All And Build Effective, Accountable And Inclusive Institutions At All Levels"

SDG 16 has twelve targets and twenty-four indicators defined by the UN. It aims at reducing violence of all forms and death rates related to it. It aims at eradicating abuse, corruption and bribery, exploitation and brutality against children and others. It also promotes equal access to the orders of law at all levels including national as well as international to get justice. It is focused on evolving efficacious and transparent institutions at each level. It focuses on imparting legal identification to all the people, including birth certificate by the year 2030. Some of the initiatives started by the government of India (Begum 2022) for attaining the targets set for this goal are mentioned below:

- **PRAGATI (Pro-Active Governance and Timely Implementation) platform:** It was initiated on 25 March 2015. It is a multi-purpose platform which is focused at dealing with the complaints and grievances of a common man and at the same time tracking and reviewing significant programmes initiated by the the government in centre as well as state. The PRAGATI platform comprises three tiers namely PMO, Secretaries of the Union Government, and Chief Secretaries of the States. It especially integrates three latest technologies including computerized management of data, video-conferencing and geo-spatial technology. A monthly meeting is held where the PM discusses the issues with all including the Secretaries, and Chief Secretaries through Video-conferencing facility accredited by data and geo-informatics visuals. This meeting is conducted one time in each month on Fourth Wednesday at 3.30 PM and this day is called PRAGATI Day.
- **Digital India mission:** It was launched by PM on 01 July 2015. Its main aim was to offer high-speed internet facilities in rural areas, provide digital infrastructure facilities to all, enable on demand governance and services. It was started with a vision to make inclusive progress in the domain of manufacturing, services, and job opportunities.
- **Right to Information Act, 2005:** This goal emphasizes the significance of an appropriately working administrative system for achieving sustainable development. Right to information is considered as a significant part of this goal as it provides people with knowledge for demanding services from public authorities. This act helps in increasing transparency and accountability, reducing corruption and establishing good governance by providing an easy access to information by common people.

4.16.1 Role of AI in achieving Goal 16 targets

Haystack, an investigative tool developed by Capgemini for linking unstructured data with the analytical environment. It provides a customizable solution for identification of anomalies. When AI and nanotechnology is combined with Haystack, the analysis can be improved beyond data coalition. These solutions provided by AI can be used for alerting law authorities that enforces law regarding frauds and other crimes so as to make the system highly transparent and responsive. AI can also be used in the form of an anti-corruption tool when associated with big data analytics. Initially, big data comprising information related to corruption can be collected from various sources and then, it is compiled. Then, this information can be fed as an input into AI systems for processing in order to drive insights from the data and then, it is analyzed to make predictions. AI, when used in combination with data mining, provides the facility of detecting and preventing activities related to corruption in the field of public possession.

4.17 Goal 17 (Partnerships for the goals) - "Strengthen The Means Of Implementation And Revitalize The Global Partnership For Sustainable Development"

It aims at reinvigorating the global coalition for the purpose of continuous development. The 2030 Agenda is global and requires all the developed and developing nations to take action. The collaboration is needed among the governments, society and the private sector. All these goals can be achieved only with a strong commitment to universal partnership and collaboration. An inclusive partnership is needed to achieve successful development.

- **BRICS (Brazil, Russia, India, China, South Africa)**: All the nations involved in the coalition have proved to be a powerful tool for promoting SDGs in developing countries. All the countries in BRICS share common goals and challenges and are involved in actively building support systems by making collaborations and using financial help for achieving SDGs like innovation and infrastructure, clean energy, healthcare, and sustainable economic growth. The BRICS Academy of Sciences at the BRICS convention on Big Data on SDGs held on April 26-27, 2022 emphasized on the use of Big Data to meet SDGs. These data science tools have the capability to significantly enhance the progress towards achieving the targets set for various SDGs. The progress made by different countries in achieving SDGs can also be

monitored by collecting data and latest tools for analyzing the data. Thus, data science can be used to identify hidden patterns in the collected data and generate meaningful insights from it (Zhihao 2022).

- **Indo-German Partnership:** The partnership agreement was signed between both nations on 2 May 2022. India and Germany have recognized the importance of international cooperation and mutual support in achieving the SDGs. Both countries have made commitments to implement the goals within their own territories and contribute to global efforts. According to this agreement, Germany agreed to provide a monetary help of 10 billion Euros till 2030 for supporting India's plan of improving greenery. Both the parties agreed to enhance the usage of green energy sources, eradicate emission of greenhouse gases, and tackle climate change. The agreement included building a roadmap on the basis of input provided by the Indo-German Green Hydrogen Task Force for enhancing renewable energy capacities in both countries, with specific focus on solar and wind power generation (Kumari 2022).

4.17.1 Role of AI in achieving Goal 17 targets

AI has the capability to process huge quantities of data quickly and efficiently which enables better analysis of complex development challenges. It helps in identifying hidden patterns, trends, and correlations in data, which allows governments and its policymakers to make highly informed decisions and allocate resources effectively. AI-powered systems provide assistance in monitoring progress, evaluating the effect of interventions, and recognizing the areas for improvement. AI helps to strengthen global partnerships by facilitating communication, collaboration, and knowledge sharing among governments across geographical boundaries. NLP (Natural Language Processing) capabilities of AI can bridge language barriers and enable real-time translation, facilitating meaningful discussions and enhancing cooperation. AI-powered platforms and virtual networks can foster partnerships and encourage the trading of ideas and finest implementations. Nanotechnology enables manipulation of matter at the atomic and molecular scale which contributes to sustainable development. It helps in developing new materials, energy solutions, water purification technologies, and more. Both AI and nanotechnology can contribute to addressing environmental challenges. AI can assist in analyzing environmental data, tackling climate change. It helps in optimizing energy consumption, improving waste management systems, and enabling smart resource allocation. Nanotechnology can contribute to sustainable manufacturing processes, cleaner energy production, and efficient water and air purification technologies.

5. ANALYSIS OF SDGS STATUS IN INDIA BY 2023

In the previous section, all the 17 SDGs are discussed. The authors have discussed the schemes, programmes or policies initiated by the government of India for attaining the targets set for each of these goals. Also, the role played by AI in attaining the set targets by 2030 has also been explained. In this section, the status of these goals in India is analysed. It has been analysed that which goal has made how much progress in the last few years and which goal needs more momentum so as to achieve the set targets. The analysis done by the authors is mentioned in table 1 below:

Table 1 Analysis of SDGS Status in India by 2023

Sr. No.	SDG	Initiatives taken by the Indian Government	AI role in achieving SDG	Status of SDG in India
1.	**Goal 1 (No Poverty)** - Eradicate poverty in all modes from everywhere by 2030	• Mahatma Gandhi NREGA • National Rural Livelihood Mission • National Urban Livelihood Mission	• Handle issues like inequality, lack of access to necessary resources. • Used effectively for detecting changes in moisture of various crops which helps in identifying better-suited areas for particular crops. • Automatically regulate the outlay of water and diminish water waste and thus, prevent losses to crops.	In about 15 years from 2005-06 and 2019-20, about 415 million people in India which shows a sharp downtrend from 55.1% to 16.4% have been successfully uplifted from the state of living in poverty (TNN 2022; Jha 2023).
2.	**Goal 2 (Zero Hunger)** – "End hunger, achieve food security and improved nutrition and promote sustainable Agriculture"	• National Nutrition Mission • National Food Security Mission • Zero Hunger Programme • Eat Right India Movement	• Enhance the yield of crops • Develop novel varieties of crops that are more immune to diseases and pests, can resist utmost weather conditions, and need less amount of water for growing. • Nanotechnology can be used to strengthen food security by making use of nano sensors that help in preventing contamination of food throughout the process of manufacturing, processing, storage and transport	According to the GHI (Global Hunger Index) of year 2022, India is found to be at 107th position out of total 121 nations with a score of 29.1 which shows that India falls under the "serious" category (FP Explainers 2022).
3.	**Goal 3 (Good health**	• Ayushman Bharat Yojana (ABY)	• Provide personalized healthcare services.	The SDG index score of Indian states and union territories in this goal lies betwixt 97 and 59 in

	and well-being) - "To ensure healthy lives and promote well-being for all at all ages."	• Pradhan Mantri Bhartiya Janaushadhi Pariyojana (PMBJP) • School Health & Wellness Programme	• Has made the process of diagnosis less expensive and easy. • Smart pills are used for monitoring patients which use nanoscale sensors designed for detecting the existence of disease in an early stage for better treatment. • Nanorobots are also used for treatment of a patient.	which Delhi scored 97, the highest among the UTs and Gujarat scored 86, the highest among states (Alves 2023).
4.	**Goal 4 (Quality Education) -** "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all"	• SWAYAM • RTE Act • Beti Bachao, Beti Padhao	• Enhances the engagement of students by providing the facility of customized courses, interesting and interactive lectures, skill gaining through teaching with games • Nanomaterials help in making thinner, and highly flexible displays and sensors that are able to reduce the consumption of cost and energy in laptops, and smartphones.	In 2021, the SDG index score of India lied betwixt 80 and 29 in which Kerala scored 80, the highest among states and Chandigarh scored 79, the highest among UTs (Jaganmohan 2022a).
5.	**Goal 5 (Gender equality) -** "Achieve gender equality and empower all women and girls"	• One-Stop Centre Scheme • Women Helpline Scheme • SWADHAR Greh	• Women can be provided with educational resources, opportunities for work, and latest information access. • Digitalization can help women by making their lives easy and secure.	According to the Economic Survey 2022-2023, the Gender Inequality Index (GII) score of India is found to be 0.490 in 2021 and a rank of 122 out of 190 countries. (Singha 2023; Benu 2023).
6.	**Goal 6 (Clean water and sanitation for all) -** "Ensure availability and sustainable management of water and sanitation for all"	• Jal Jeevan Mission • Swachh Bharat Mission - Urban 2.0 and Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0 • Mission Amrit Sarovar	• Clean Water AI is an IoT device that uses AI for detecting unhealthy bacteria and harmful particles present inside the water. • Nanostructures provide highly efficacious catalysts and redox active media to purify wastewater. • Nanomaterials are very effective in eliminating various bacteria and impurities from wastewater including natural as well as man-made solvents, heavy metals, biotic germs, and pathogens that can spread harmful diseases such as cholera and typhoid.	The India's Union budget estimate of 2023-24 shows an increase in the budget estimation of the Department of DWS (Drinking Water and Sanitation) which has increased from 67,221 crores in 2022-23 to 77,223 crores in 2023-24. This increase shows that India has made progress in this goal. (Bhaduri 2023).
7.	**Goal 7 (Affordable and clean energy) -** "Ensure access to affordable, reliable, sustainable and modern energy for all"	• Deen Dayal Upadhyay Gram Jyoti scheme • Renewable Energy vision	• Diminish the cost and improve efficient methods of producing renewable energy. • AI makes use of predictive analytics and ML algorithms in order to analyze past data for predicting the future energy needs. • Nanotechnology helps in developing highly efficient and portable energy systems which contribute in meeting the urgent energy goals and reducing the harmful effect caused as a result of human activities.	On the basis of the Renewables 2022 Global Status Report announced by REN21, India stands at 4th position in considering the total installed capacity of renewable energy.
8.	**Goal 8 (Decent work and economic growth) -** "Promote sustained, inclusive and	• NSDM • Skill India Mission • Pradhan Mantri Youth Training Program	• AI helps in measuring an employee's performance and ensuring that every worker is paid fairly on the basis of his contribution. • AI can highly impact the training process of employees for	In 2021, the SDG index score for this goal lied betwixt 78 and 36 for all Indian states and UTs in which Himachal Pradesh scored the highest value of 78 among all states and among UTs, Chandigarh scored 70 (Jaganmohan 2022b)

	sustainable economic growth, full and productive employment and decent work for all"		developing skills. • Nanotechnology helps in increasing productivity as it needs a lesser number of people for producing the same unit of output.	
9.	**Goal 9 (Industry, innovation and infrastructure) -** "Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation"	• PM MITRA scheme • Make in India	• Provides capabilities for infrastructure innovation, allows making fast and automatic decisions. • It has the ability of processing and analyzing huge quantities of data which enables it to make accurate decisions. • The infrastructure innovation that is driven by AI helps in making cities more efficient and safer.	In 2021, the SDG index score for this goal lied betwixt 72 and 23 for all Indian states as well as UTs in which Gujarat state scored the highest value of 72 (Jaganmohan 2022c)
10.	**Goal 10 (Reduced inequalities) -** "Reduce inequality within and among countries"	• Reservation Policies • Direct Benefit Transfer • Jan Dhan Yojana	• AI can help in making more informed decisions related to the proper utilization and allocation of resources. • AI can help in creating job opportunities for unemployed and underemployed. • AI and nanotechnology can enhance the access to education as well as training especially for students who belong to weaker and disadvantaged sections and have less resources available	India stood at 129th position in 2019 CRII and has improved the ranking in CRII 2022 as it has risen by six places to 123 out of total 161 countries. But India is far behind the other BRICS countries in CRII 2022 as South Africa ranks at 27, Russia ranks at 36, China ranks at 50 and Brazil ranks at 77 (Abhirr 2022).
11.	**Goal 11 (Sustainable cities and communities) -** "Make cities and human settlements inclusive, safe, resilient, and sustainable"	• PMAY–U • AMRUT • SBM–U	• Nanotech uses strength of its ultrasmall science, which allows the tiny sensors to store and access huge amounts of data obtained from multiple sources. • These nano sensors help in establishing better smart cities by providing correct data to the software programs. • The Internet of Nano Things (IoNT), makes use of sensors, hubs to merge all the data, routers for transmission of the data over large distances, and uses advanced software.	In 2021, SDG index score for this goal lied betwixt 39 and 98 for all Indian states as well as UTs (Jaganmohan 2022d). On the basis of the Asia Pacific Sustainability Index 2021, the four cities of India comprising Delhi, Bengaluru, Hyderabad and Mumbai became successful in getting a place in the list of upper 20 highly sustainable cities in the Asian countries (LiveMint 2022).
12.	**Goal 12 (Responsible consumption and production) -** "Ensure sustainable consumption and production patterns"	• National Policy on Biofuels • Renewable energy	• AI can be used to decrease the consumption of energy and improve usage of affordable and renewable energy. • AI helps in optimizing the consumption and production levels by making use of vertical green farms, eradicating waste and enhancing yields. • Nanotechnology can be used to create nanocomposites for the purpose of storing energy.	The pandemic resulted in the significant rise in the use of products made by plastic materials to fulfill the medical requirements. The e-waste generation increased during the lockdown as India generated about 3.2 million tonnes of residue and got third position around the world (Surjit 2022).
13.	**Goal 13**	• NDC	• AI helps in analyzing the huge data	The CCPI (Climate Change Performance

	(Climate Change) - Take urgent action to combat climate change and its impacts.	• NAPCC	and forecasting the changes that occur in the environment so that the changes in the climate can be tackled easily. • Nanotechnology helps to reduce the need of fossil fuels which in turn reduces global warming. • Use of renewable energy results in zero emissions of harmful gases and nanotechnology helps in generating more renewable energy from domestic feedstock.	Index) is a surveillance tool that helps in keeping track of the climate conservation performance of around 59 countries and the EU (European Union) and it has been published every year since 2005. India stood at 10th position in CCPI 2022 and rose two spots to rank 8th in CCPI 2023 (PIB 2022c; Joshi 2021).
14.	**Goal 14 (Life below water) -** "Conserve and sustainably use the oceans, seas and marine resources for sustainable development"	• Blue economic policy • Marine Spatial Planning (MSP) • Sagartat Samriddhi Yojana	• AI can be used to create new tools which can help in getting a highly detailed and clear perspective of the problem of pollution created by plastic in river water which gets drained into the oceans. • Robots can be used that can automatically reach in the depths of the ocean to discover new things. • Marine nano-ecotoxicology helps in assessing the environmental threats that are associated with ENMs that enter the marine environment.	Scores for this goal improved by 3.96% from 47.79 in 2010 to 49.69 in 2020 (Outlook 2023). On the basis of the progress till 2020, India stands at 70th position in the world for Life Below Water SDG (India data insights 2022).
15.	**Goal 15 (Life on land) -** "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss"	• National Mission for a Green India • Soil health card scheme	• AI technology helps in creating automated processes that gather remote sensing data related to biodiversity. • AI plays a crucial role in protecting the environment. • AI and nanotechnology when used with sensors, help making predictions and detecting risk of fires so as to avoid losing hectares of forests.	Scores for this goal improved significantly from 26.28 to 55.94 by more than 112% (Outlook 2023). In 2021, SDG index score for this goal lied betwixt 27 and 93 for all the Indian states and UTs. Arunachal Pradesh and Madhya Pradesh scored 93 and 84 among all states. Among the UTs, Chandigarh scored 85. (Jaganmohan 2022f).
16.	**Goal 16 (Peace, justice and strong institutions) -** "Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels"	• PRAGATI platform • Digital India mission • Right to Information Act, 2005	• AI can be used for alerting law authorities that enforces law regarding frauds and other crimes so as to make the system highly transparent and responsive. • AI can also be used in the form of an anti-corruption tool when associated with big data analytics.	In 2021, the SDG index score for this goal lied betwixt 46 and 86 for all Indian states and union territories. Uttarakhand and Gujarat scored 86 and 82 among all states. Among the UTs, Puducherry scored 86 (Jaganmohan 2022g).
17.	**Goal 17 (Partnerships for the goals) -** "Strengthen the	• BRICS • Indo-German Partnership	• NLP (Natural Language Processing) capabilities of AI can bridge language barriers and enable real-	India has been alluring in international cooperation and partnerships for addressing global challenges and promoting sustainable development. It has collaborated with many

means of implementation and revitalize the global partnership for sustainable development"	time translation, facilitating meaningful discussions and enhancing cooperation. • AI-powered platforms and virtual networks can foster partnerships and encourage the trading of ideas and finest implementations. • Nanotechnology enables manipulation of matter at the atomic and molecular scale which contributes to sustainable development.	different countries, international organizations, and agencies so as to share knowledge, technologies, and best practices (Hindu 2023).

6. Observations And Discussion

In the above section, the authors have analysed the performance of India in attaining the targets set for all the goals. From the analysis, it has been observed that on the basis of the report titled "Global Multidimensional Poverty Index 2022" announced jointly by the Oxford Poverty and Human Development Initiative (OPHI) and the United Nations Development Programme (UNDP), in nearly 15 years from 2005-06 and 2019-20, about 415 million people in India which shows a sharp downtrend from 55.1% to 16.4% have been successfully uplifted from the state of living in poverty. It shows that India has been performing well on the indicators set for SDG 1. But there is a need for a long-term solution to eradicate poverty in India as the highest number of poor children exists in India when compared to the world and this number accounts for about 21.8% or 97 million between 0-17 years of age. AI is used in many countries for fighting against poverty. AI provides solutions to handle issues like inequality, lack of access to necessary resources which results in poverty. AI can be used in providing clean water to the people by identifying water contamination sources and then finding ways for removing contaminants from water supplies. AI technology enabled virtual systems can be used for learning purposes that can make education more accessible to economically disadvantaged students. According to the GHI (Global Hunger Index) 2022, India got a rank of 107 out of total 121 countries with a score of 29.1 which shows that India falls under the "serious" category. Also the child-wasting rate, reflecting acute malnutrition, in India is found to be the highest in the world at about 19.3%. India has shown improvement in child stunting rate as the rate has improved by 3.2% from 38.7% in years 2012-16 to 35.5% in years 2017-21 and child mortality rate improved from 4.6% in year 2014 to 3.3% in year 2020. AI can have a great impact on improving the India's position in GHI (Global Hunger Index). AI not only helps in the improvement of crop yield by making use of precision agriculture but also helps in predicting food demand using analytics. AI can be used for addressing food insecurity and providing effective assistance and the possibilities have no end if the technology is used in the right manner. For achieving SDG 3, AI holds a lot of potential for bringing transformation in all aspects of healthcare which comprises diagnostic care, monitoring patients, clinical trials and delivery of medicines or equipment. It has the ability to provide personalized healthcare services. Artificial Intelligence in education has created a revolution by introducing new methods of learning for accomplishing the targets of SDG 4. The use of AI in EdTech is rapidly increasing as it enhances the engagement of students by providing the facility of customized courses, interesting and interactive lectures, skill gaining through teaching with games and so on. The use of AI in education provides benefits not only for students but also for teachers. For SDG 5, different educational tools powered by AI can provide customized learning experiences, helping bridge gender gaps in education by addressing individual learning needs. Online platforms which implement AI can promote access to education and skill development for women and girls, particularly in STEM (Science, Technology, Engineering, and Mathematics) fields. Goal 6 is aimed at enhancing the quality and ease of living of people and the India's Union budget estimate of 2023-24 shows an increase in the budget estimation of the DDWS which has increased from 67,221 crores in 2022-23 to 77,223 crores in 2023-24. This increase shows that India has made progress in this goal. AI has the potential to bring about a revolution in improving the efficiency of using water and managing sanitation with the help of engineering and forecasting. Clean Water AI is an IoT device that uses AI for detecting unhealthy bacteria and harmful particles present inside the water. It can work consistently in real time and analyze the data using a digitized microscope which is attached to a computer system and has Ubuntu OS. AI is proving to be an important tool in the development of affordable and clean energy (SDG 7) solutions in order to meet the growing demand of clean renewable energy. AI can help in diminishing the cost and improving efficient methods of producing renewable energy. AI makes use of predictive analytics and ML algorithms in order to analyze past data for predicting the future energy needs. AI is projected to add $967 billion to the Indian economy by the year 2035, and around $450-500 billion to the GDP of the country by the year 2025, which accounts for about 10% of the country's target of $5 trillion GDP. AI has the potential to boost the Indian economy by enhancing productivity, mitigating costs and creating opportunities for innovation and growth (SDG 8). The industry, infrastructure innovation (SDG 9) that is driven by AI helps in making cities more efficient and safer. The algorithms that are based on AI can help in analyzing data obtained from sensors on power lines and predicting the need of maintenance, or identification of failure. AI can help in reducing inequality (SDG 10). AI has a great potential to provide benefits to the people living in the society. AI can play a significant role in making sure that all the people get fair and equal opportunities. AI is creating a revolution to provide assistance to the people in need. The new technologies are being incorporated in the daily lives of people to improve their living standard which comprises use of the Internet of Things, ML, AI, Nanotechnology. These play a vital role in strengthening the current infrastructure

and also move further towards the upgradation. In order to further improve the smart cities, nano sensors are used that can access data accurately (SDG 11). On the basis of the Asia Pacific Sustainability Index 2021, the four cities of India comprising Delhi, Bengaluru, Hyderabad and Mumbai became successful in getting a place in the list of upper 20 highly sustainable cities in the Asian countries. Bengaluru topped in Indian cities with 14th rank and was the single Indian city that achieved the 'Gold' level categorization. Delhi was at next place with 17th rank followed by Hyderabad with 18th rank and Mumbai with 20th rank. In achieving SDG 12, AI can be used to decrease the consumption of energy and improve usage of affordable and renewable energy. AI helps in optimizing the consumption and production levels by making use of vertical green farms, eradicating waste and enhancing yields and efficiency of resources. In 2021, the SDG index score for goal 12 lied betwixt 47 and 99 for all the states and UTs of India. Tripura and Nagaland scored 99 and 91 respectively among the states and among the UTs, Ladakh and Jammu and Kashmir scored 95. On the basis of the study financed by the SSNC (Swedish Society for Nature Conservation) and executed by the campaigning group named CUTS (Consumer Unity & Trust Society) India, it can be said that the importance of sustainable consumption and production is increasing. But the COVID-19 has put a adverse influence on the acceleration of achieving SDG targets by 2030. The stagnation, joblessness and the communal-distancing affected the process of production and consumption to a large extent. The pandemic resulted in the significant rise in the use of products made by plastic materials to fulfill the medical requirements. In order to promote hygiene for preventing Covid-19, people started using plastic plates, cups, bottles and so on which further increased the production and consumption of plastic products. Also, an increase in the manufacturing of fake medical assistance products was observed. The e-waste generation increased during the lockdown as India generated about 3.2 million tonnes of residue and got third position around the world. In achieving the targets of SDG 13 (Climate Change), AI helps in analyzing the huge data and forecasting the changes that occur in the environment so that the changes in the climate can be tackled easily. The CCPI (Climate Change Performance Index) is a surveillance tool that helps in keeping track of the climate conservation performance of around 59 countries and the EU (European Union) and it has been published every year since 2005. India stood at 10th position in CCPI 2022 and rose two spots to rank 8th in CCPI 2023. Due to this improvement, India became the only G-20 country to get a position in the top 10 of CCPI. This performance is due to its less carbon emissions and improvement in the use of renewable energy. India obtained high ratings in the emission of green house gases and use of energy categories but middle rating for policy related to climate and usage of renewable energy. AI and Machine Learning help in conserving oceans i.e. Life below Water (SDG 14) by fighting against pollution caused by plastic. ML solves the biggest challenge of tracking and finding out how plastic gets inside the bodies existing in water. Robots can be used that can automatically reach in the depths of the ocean to discover new things. AI helps in understanding the complexity of the impact caused by climate change on our planet, and how this change is affecting the oceans. AI technology helps in creating automated processes that gather remote sensing data related to biodiversity i.e. Life on Land (SDG 15). AI plays a crucial role in protecting the environment. AI and nanotechnology when used with sensors, help making predictions and detecting risk of fires so as to avoid losing hectares of forests. SDG 14 and 15 are mainly concerned with protection of biodiversity and sustainable development. According to an analysis on SDG scores published in iScience, performance of India has been found well in achieving SDG 15. Between 2010 and 2020, scores for SDG 14 improved by 3.96% from 47.79 in 2010 to 49.69 in 2020 while score for SDG 15 improved significantly from 26.28 to 55.94 by more than 112%. AI can be used to achieve SDG 16 as AI, when used in combination with data mining, provides the facility of detecting and preventing activities related to corruption in the field of public possession. India has been alluring in international cooperation and partnerships for addressing global challenges and promoting sustainable development. It has collaborated with many different countries, international organizations, and agencies so as to share knowledge, technologies, and best practices. According to study broadcasted by the Lancet journal, India is lagging behind in attaining more than 50% of indicators under the SDGs defined by the UN, seven years before the 2030 deadline. India is off track for 19 out of the 33 SDG indicators. The study pointed at a desperate need to accelerate the spur on majorly four goals including No Poverty, Zero Hunger, Good Health and Well-Being and Gender Equality. India is doing fairly well on 13 targets which comprise opening accounts in bank for women, generating birth certificates, providing internet facility, access to electricity, and reduction in child marriage.

7. Conclusion

The authors conclude that in order to achieve the 19 off-track targets, India needs momentum. The latest technologies especially AI can provide significant contribution in achieving all the SDGs directly or indirectly in India by 2030. This combination of advanced technologies offers promising solutions to address key challenges in various sectors, including healthcare, agriculture, energy, and water management. The progress towards achieving the SDGs is a complex and ongoing process. Many factors, such as policy implementation, resource allocation, and collaboration among various stakeholders, play a crucial role. Partnerships are of paramount importance in achieving the goals. The SDGs are a common agenda for all countries across the globe, which requires collaboration and cooperation among governments, international organizations, civil society, businesses, and individuals. Overall, by harnessing the potential of AI, India can make significant strides towards achieving the SDGs by 2023, addressing critical societal challenges, and improving the well-being of its citizen.

Acknowledgements

The authors sincerely acknowledge the reviewers whose insightful feedback greatly improved the quality of this article. Additionally, the authors would like to thank the authorities of Indira Gandhi University, Meerpur for providing the research facilities to complete this work.

References

Abhirr, V.P. (2022). 2022 CRII: India moves up six places in inequality index but continues to be among lowest performers in health spending. Retrieved May, 2023, from https://www.oxfamindia.org/press-release/2022-crii-india-moves-six-places-inequality-index-continues-be-among-lowest-performers-health.

Aithal, S. & Aithal, P.S. (2021). Green Nanotechnology Innovations to Realize UN Sustainable Development Goals 2030. *International Journal of Applied Engineering and Management Letters*. 5(2): 96-105.

Alves, B. (2023). Sustainable Development Goal index on good health and well-being in India as of 2021, by state and union territory. Retrieved May, 2023, from https://www.statista.com/statistics/1243498/sdg-index-india-good-health-and-well-being-goal-by-state/.

Anjum, S., Ishaque, S., Fatima, H., Farooq, W., Hano, C., Abbasi, B.H. & Anjum, I. (2021). Emerging Applications of Nanotechnology in Healthcare Systems: Grand Challenges and Perspectives. *Pharmaceuticals (Basel).* 14(8): 707. 10.3390/ph14080707.

Apparel Resources News-Desk. (2023). PM announces states for PM MITRA parks, here is the list. Retrieved May, 2023, from https://in.apparelresources.com/business-news/trade/pm-announces-states-for-pm-mitra-parks-here-is-the-list/.

Ashraf, S.M., Firdous, Z. & Tariq, M. (2022). Impact of COVID-19 on Sustainable Development Goals in India. *2022 2nd International Conference on Emerging Frontiers in Electrical and Electronic Technologies, Patna, India.* 1-6. 10.1109/ICEFEET51821.2022.9848117.

Babakhani, P., Phenrat, T., Baalousha, M. et al (2022). Potential use of engineered nanoparticles in ocean fertilization for large-scale atmospheric carbon dioxide removal. *Nature Nanotechnology*. 17: 1342–1351. https://doi.org/10.1038/s41565-022-01226-w.

Balasubramanian, H. (2023). Sagarmala project: Objectives, cost, and current status. Retrieved May, 2023, from https://housing.com/news/sagarmala-project/.

Bardia, A. (2020). 4 Poverty Alleviation Schemes in India for Rural Development. Retrieved May, 2023, from https://borgenproject.org/poverty-alleviation-schemes-in-india/.

Beglyakov, E. (2023). The Current State of Poverty in India. Retrieved May, 2023, from https://borgenproject.org/state-of-poverty-in-india/.

Begum, N. (2022). India's Inclusive Policy Initiatives for the Implementation of Sustainable Development Goals: Selected Ruminations on SDG-16—The Way Forward. *Indian Journal of Public Administration*. 68(4). https://doi.org/10.1177/00195561221108560.

Benu, P. (2023). What the Economic Survey 2022-23 says about gender inclusion in India. Retrieved May, 2023, from https://www.thehindubusinessline.com/data-stories/data-focus/what-the-economic-survey-2022-23-says-about-gender-inclusion-in-india/article66454795.ece.

Bhaduri, A. (2023). Budget 2023-24: Drinking water supply and sanitation continues to get priority. Retrieved May, 2023, from https://www.indiawaterportal.org/articles/budget-2023-24-drinking-water-supply-and-sanitation-continues-get-priority.

Celik, I., Dindar, M., Muukkonen, H. et al. (2022). The Promises and Challenges of Artificial Intelligence for Teachers: a Systematic Review of Research. *TechTrends*. 66: 616–630. https://doi.org/10.1007/s11528-022-00715-y.

Chaudhary, S. (2022). India Slips To Rank 120 On 17 SDGs Adopted As 2030 Agenda, Lies Behind All South Asian Nations. Retrieved May, 2023, from https://thelogicalindian.com/sustainability/sustainable-development-goals-india-rank-120-34221.

Corsi, I., Bellingeri, A., Eliso, M.C. et al. (2021). Eco-Interactions of Engineered Nanomaterials in the Marine Environment: Towards an Eco-Design Framework. *Nanomaterials*. 11: 1903. https://doi.org/10.3390/nano11081903.

DAIA. (2019). Artificial Intelligence and Global Challenges — Clean Water and Sanitation. Retrieved May, 2023, from https://medium.com/daia/artificial-intelligence-and-global-challenges-a-plan-for-progress-39b69df9cba3.

DEXAI. (2022). AI - An enabler or inhibitor in delivering the 17 goals and 169 targets of UN's Sustainable Goals?. Retrieved May, 2023, from https://www.dexai.eu/un_sustainable_goals.

Dixit, M. (2022). What is the Government Scheme to end hunger? Retrieved May, 2023, from https://www.google.com/amp/s/m.groundreport.in/article/what-is-the-government-scheme-to-end-hunger/101362/amp

Duke University. (2023). 'Smart' tech is coming to a city near you: Proponents say real-time sensors, data will improve the everyday lives of citizens. But some worry it could exacerbate existing inequalities. *ScienceDaily*. Retrieved May, 2023, from www.sciencedaily.com/releases/2023/04/230425205142.htm

Eddy, N. (2023). UNESCO launches Women4Ethical AI Expert Platform. Retrieved Nov, 2023, from https://techstrong.ai/articles/unesco-launches-women4ethical-ai-expert-platform/.

ETGovernment. (2023). Sonowal to inaugurate National Technology Centre for Ports, Waterways & Coasts at IIT-M. Retrieved May, 2023, from https://government.economictimes.indiatimes.com/news/technology/sonowal-to-inaugurate-national-technology-centre-for-ports-waterways-coasts-at-iit-m/99705903

ETOnline. (2023). Govt to launch Pradhan Mantri Kaushal Vikas Yojana 4.0: FM Nirmala Sitharaman. Retrieved May, 2023, from https://www.google.com/amp/s/m.economictimes.com/jobs/govt-to-launch-pradhan-mantri-kaushal-vikas-yojana-4-0-fm-nirmala-sitharaman/amp_articleshow/97516312.cms

Express Web Desk. (2023). Artificial intelligence expected to add $500 billion to India's GDP by 2025: Report. Retrieved Nov, 2023, from https://indianexpress.com/article/business/economy/artificial-intelligence-expected-to-add-500-bn-to-india-gdp-by-2025-8507775/.

Fan, Z., Yan, Z. & Wen, S. (2023). Deep Learning and Artificial Intelligence in Sustainability: A Review of SDGs, Renewable Energy, and Environmental Health. *Sustainability*. *15(18): 13493.* https://doi.org/10.3390/su151813493.

FPExplainers. (2022). Explained: What is the Global Hunger Index? Why has India rejected it?. Retrieved May, 2023, from https://www.firstpost.com/explainers/global-hunger-index-india-rank-107-government-11463151.html

Ghai, D. (2021). India's position in sustainable development goals. Retrieved May, 2023, from https://blog.ipleaders.in/indias-position-in-sustainable-development-goals/

Göçen, A. & Aydemir, F. (2020). Artificial Intelligence in Education and Schools. *Research on Education and Media*. 12(1): 13-21. 10.2478/rem-2020-0003

Gogoi, R. (2023). Amrut Scheme 2023 Details, How To Apply, Benefits. Retrieved May, 2023, from https://bhartiyamanavadhikar.in/amrut-scheme-2023-details/

Goh, H.H. & Vinuesa, R, (2021). Regulating artificial-intelligence applications to achieve the sustainable development goals. *Discov Sustain.* 2, 52. https://doi.org/10.1007/s43621-021-00064-5

Gürsel, H. (2020). The future of renewable energy: Nanotechnology. Retrieved May, 2023, from https://nanografi.com/blog/imagine-the-future-of-renewable-energy-nanotechnology/

Hart, L. (2022). Retrieved May, 2023, from how nanotechnology can benefit smart cities. https://nanografi.com/blog/how-nanotechnology-can-benefit-smart-cities/

Hindu Bureau. (2023). India likely to miss deadline for 50% of SDG indicators: Lancet study. Retrieved May, 2023, from https://www.thehindu.com/news/national/india-likely-to-miss-deadline-for-50-of-sdg-indicators-lancet-study/article66551843.ece

IBL News. (2021). AI Technology in Education Will Grow 40% Annually Until 2027. Retrieved May, 2023, from https://iblnews.org/ai-technology-in-education-will-grow-40-annually-until-2027/

India data insights. (2022). Life below water: Data on India's conservation efforts. Retrieved May, 2023, from https://idronline.org/article/water-sanitation/life-below-water-data-on-indias-conservation-efforts/

Jaganmohan, M. (2022a). Sustainable Development Goal index on quality education in India as of 2021, by state and union territory. Retrieved May, 2023, from https://www.statista.com/statistics/1243517/sdg-index-india-goal-quality-education-by-state/

Jaganmohan, M. (2022b). Sustainable Development Goal index on decent work and economic growth in India as of 2021, by state and union territory. Retrieved May, 2023, from https://www.statista.com/statistics/1243552/sdg-index-india-goal-work-and-economic-growth-by-state/

Jaganmohan, M. (2022c). SDG index on industry, innovation, and infrastructure India 2021, by state. Retrieved May, 2023, from https://www.statista.com/statistics/1243555/sdg-index-india-goal-industry-infrastructure-by-state/

Jaganmohan, M. (2022d). SDG India index on sustainable cities and communities 2021, by state. Retrieved May, 2023, from https://www.statista.com/statistics/1244042/sdg-index-india-sustainable-cities-goal-by-state/#:~:text=As%20of%202021%2C%20the%20Sustainable,score%20of%2091%20and%2089

Jaganmohan, M. (2022e). Sustainable Development Goal index on responsible consumption and production in India as of 2021, by state and union territory. Retrieved May, 2023, from https://www.statista.com/statistics/1244097/sdg-index-india-responsible-consumption-and-production-goal-by-state/

Jaganmohan, M. (2022f). SDG India index on life on land 2021, by state. Retrieved May, 2023, from https://www.statista.com/statistics/1244201/sdg-index-india-life-on-land-goal-by-state/

Jaganmohan, M. (2022g). SDG India index on peace, justice and strong institutions 2021, by state. Retrieved May, 2023, from https://www.statista.com/statistics/1244230/sdg-index-india-peace-justice-strong-institutions-by-state/

Jain, K., Patel, A.S., Pardhi, V.P. & Flora, S.J.S. (2021). Nanotechnology in Wastewater Management: A New Paradigm Towards Wastewater Treatment. *Molecules*. 26(6): 1797. 10.3390/molecules26061797

Joshi, A. (2021). India Ranked 10 in the Climate Change Performance Index 2022 Report. Retrieved May, 2023, from https://www.mercomindia.com/india-ranked-10-ccpi-2022-report

Jha, R. (2023). Number Of Poor People In India Dropped By About 415 Million In 15 Years: UN. Retrieved May, 2023, from https://planet.outlookindia.com/reports/number-of-poor-people-in-india-dropped-by-about-415-million-in-15-years-un-news-414717

Jungwirth, D. & Haluza, D. (2023). Artificial Intelligence and the Sustainable Development Goals: An Exploratory Study in the Context of the Society Domain. *Journal of Software Engineering and Applications*, **16**: 91-112. doi: 10.4236/jsea.2023.164006.

Koshy, J. (2023). States fall short of targets to improve forest cover, quality. Retrieved May, 2023, from https://www.google.com/amp/s/www.thehindu.com/sci-tech/energy-and-environment/states-come-up-short-in-targets-to-plant-trees-improve-forest-cover/article66436049.ece/amp/

Kumari, R. (2022). India and Germany to launch an Indo-German Partnership for Green and Sustainable Development. Retrieved May, 2023, from https://newsonair.com/2022/05/03/india-and-germany-to-launch-an-indo-german-partnership-for-green-and-sustainable-development/

Kunze, Z. (2021). 3 Ways Nanotechnology is Alleviating Poverty. Retrieved May, 2023, from https://borgenproject.org/nanotechnology-is-alleviating-poverty/

LiveMint. (2022). 4 Indian cities among top 20 sustainable cities in Asia Pacific: Report. Retrieved May, 2023, from https://www.livemint.com/news/india/4-indian-cities-among-top-20-sustainable-cities-in-asia-pacific-report-11656500720000.html

Mastrola, M. (2023). How AI can help combat climate change. Retrieved May, 2023, from https://hub.jhu.edu/2023/03/07/artificial-intelligence-combat-climate-change/

Mishra, P. (2023). Smart Cities Mission 2023: All You Need to Know about Smart Cities. Retrieved May, 2023, from https://www.magicbricks.com/blog/smart-cities-mission/127407.html

Mishra, S. (2023a). Assessing India's Progress Towards Achieving Sustainable Development Goal 8: Decent Work and Economic Growth. Retrieved May, 2023, from https://taxguru.in/corporate-law/assessing-indias-progress-achieving-sustainable-development-goal.html

Mishra, S. (2023b). What is Pradhan Mantri Awas Yojana (PMAY)?. Retrieved May, 2023, from https://housing.com/news/pradhan-mantri-awas-yojana/

Mudoi, H. (2020). Government Policies for Gender Equality and Constitutional Measures in India: An Analysis. *PalArch's Journal of Archaeology of Egypt/Egyptology*. 17(9): 83-90.

Nagaraj, V. (2019). School education that parents should know about. Retrieved May, 2023, from https://parenting.firstcry.com/articles/government-schemes-for-school-education-that-parents-should-know-about/

Naismith, A.M. (2023). AI Can Propel Corporate Sustainability Ambitions into Action. Retrieved May, 2023, from https://www.triplepundit.com/story/2023/ai-artificial-intelligence-sustainability/766026

Neme, K., Nafady, A., Uddin, S. & Tola, Y.B. (2021). Application of nanotechnology in agriculture, postharvest loss reduction and food processing: food security implication and challenges. *Heliyon*. 7(12): e08539.

Outlook planet desk. (2023). India Is Scoring High On SDG Related To Life On Land. Retrieved May, 2023, from https://planet.outlookindia.com/news/india-is-scoring-high-on-sdg-goals-related-to-life-on-land--news-415176

Palomares, I., Cámara, E.M., Montes, R. et al. (2021). A panoramic view and swot analysis of artificial intelligence for achieving the sustainable development goals by 2030: progress and prospects. *Appl Intell*. 51: 6497–6527. https://doi.org/10.1007/s10489-021-02264-y

Pandey, K. (2022). India's SDG preparedness ranking continues to decline: Report. Retrieved May, 2023, from https://www.downtoearth.org.in/news/governance/india-s-sdg-preparedness-ranking-continues-to-decline-report-83158

Parchhanda, V. (2023). Role of Technology to eradicate Hunger. Retrieved May, 2023, from https://www.cxotoday.com/cxo-bytes/role-of-technology-to-eradicate-hunger/

Paul M (2023) India's renewable energy capacity at 122 GW in February. https://www.livemint.com/news/india/indias-renewable-energy-capacity-at-122-gw-in-february-11680179203975.html. Accessed 18 May 2023.

PIB (2021) Make in India and Startup India. https://pib.gov.in/pressreleaseshare.aspx?prid=1703787. Accessed 18 May 2023.

PIB Delhi (2022a) Cabinet approves Amendments to the National Policy on Biofuels 2018. https://www.pib.gov.in/PressReleasePage.aspx?PRID=1826265. Accessed 18 May 2023.

PIB Delhi. (2022b). National Mission on Strategic Knowledge for Climate Change (NMSKCC). Retrieved May, 2023, from Retrieved May, 2023, from https://pib.gov.in/PressReleasePage.aspx?PRID=1883746

PIB Delhi. (2022c). India jumps 2 spots higher, and now ranks 8th as per Climate Change Performance Index (CCPI, 2023). Retrieved May, 2023, from https://www.pib.gov.in/PressReleasePage.aspx?PRID=1878023

PIB Delhi. (2023). CSR for Swachh Bharat Mission (Urban) 2.0. Retrieved May, 2023, from https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1913232

PIB Mumbai. (2021). 'Project Udaan,' an AI-based translation software ecosystem: IIT Bombay Professor and his team launch project on Hindi Divas. Retrieved Nov, 2023, from https://pib.gov.in/PressReleasePage.aspx?PRID=1754787.

Pokrajac, L., Abbas, A., Chrzanowski, W. et al. (2021). Nanotechnology for a Sustainable Future: Addressing Global Challenges with the International Network4Sustainable Nanotechnology. *ACS Nano*. 15: 18608−18623. https://doi.org/10.1021/acsnano.1c10919

Prasad, S.SV., Singh, C., Naik, B.N., Pandey, S. & Rao, R. (2023). Awareness of the Ayushman Bharat-Pradhan Mantri Jan Arogya Yojana in the Rural Community: A cross-sectional study in Eastern India. *Cureus*. 15(3): e35901. 10.7759/cureus.35901

PTI. (2023). India's renewable energy capacity reaches 168.96 GW till Feb 2023: Minister R K Singh. Retrieved May, 2023, from https://indianexpress.com/article/business/economy/indias-renewable-energy-capacity-reaches-168-96-gw-till-feb-2023-minister-r-k-singh-8510493/

PTI. (2022a). The Economic News, India slips 3 spots to rank 120 on 17 SDG goals adopted as 2030 agenda: Report. Retrieved May, 2023, from https://economictimes.indiatimes.com/news/economy/indicators/india-slips-3-spots-to-rank-120-on-17-sdg-goals-adopted-as-2030-agenda-report/articleshow/89924013.cms

PTI. (2022b). India ranks 107 on 2022 Global Hunger Index, behind Pakistan, Bangladesh and Nepal. Retrieved May, 2023, from https://economictimes.indiatimes.com/news/india/level-of-hunger-in-india-serious-ranks-107-on-global-hunger-index-2022/articleshow/94876759.cms

Rawat, B., Bist, A.S., Supriyanti, D., Elmanda, V. & Sari, S.N. (2023). AI and Nanotechnology for Healthcare: A survey. *Aptisi Transactions on Management (ATM)*. 7(1): 86-91. https://doi.org/10.33050/atm.v7i1.1819

Rose, H. (2022). How Does Nanotechnology Combat Global Warming and Climate Change. Retrieved May, 2023, from https://nanografi.com/blog/how-does-nanotechnology-combat-global-warming-and-climate-change/

Sadiku, M.N.O., Ashaolu, T.J., Majebi, A.A. & Musa, S.M. (2021). Future of Nanotechnology. *International Journal of Scientific Advances*. 2(2): 131-134. 10.51542/ijscia.v2i2.9.

Saini, M., Sengupta, E., Singh, M., Singh, H. & Singh, J. (2023). Sustainable Development Goal for Quality Education (SDG 4): A study on SDG 4 to extract the pattern of association among the indicators of SDG 4 employing a genetic algorithm. *Education and Information Technologies*. 28: 2031–2069.

Sangalang, R.H .(2022). Nanotechnology for Clean and Safe Water: A Review. *Oriental Journal of Chemistry*. 38(2).

Seo, K., Tang, J., Roll, I. et al. (2021). The impact of artificial intelligence on learner–instructor interaction in online learning. *International Journal of Educational Technology in Higher Education*. 18(54). https://doi.org/10.1186/s41239-021-00292-9

Sharma, A. (2023a). Economic Survey 2023: India aims 45% reduction in emission intensity of its GDP by 2030 from 2005 levels. Retrieved May, 2023, from https://www.cnbctv18.com/economy/economic-survey-2023-india-aims-45-reduction-in-emission-intensity-of-its-gdp-by-2030-from-2005-levels-15810141.htm/amp

Sharma, P. (2023b). India on track to meet SDG target as over 400 million exit poverty. Retrieved May, 2023, from https://www.livemint.com/budget/economic-survey/india-on-track-to-meet-sdg-target-as-over-400-million-exit-poverty/amp-11675194553575.html

Singh, A., Kanaujia, A. & Singh, V.K. (2022). Research on Sustainable Development Goals: How has Indian Scientific Community Responded?. *Journal of Scientific & Industrial Research*. 81: 1147-116. 10.56042/jsir.v81i11.64456.

Singha, A. (2023). Economic Survey 2023 | 'India has made significant progress in gender equality'. Retrieved May, 2023, from https://www.cnbctv18.com/india/economic-survey-2023-india-has-made-significant-progress-in-gender-equality-15809351.htm

Staff, M. (2023). Mission Amrit Sarovar: 40,000 water bodies developed under the scheme, 80% target achieved. Retrieved May, 2023, from https://myind.net/Home/viewArticle/mission-amrit-sarovar-40000-water-bodies-developed-under-the-scheme-80-target-achieved

Surjit, S. (2022). India Produced 3.2 Million Tonnes of E-Waste Last Year, Actionable Plan Required To Attain SDG 12 Targets: Study. Retrieved May, 2023, from https://thelogicalindian.com/sustainability/india-achieving-sdg-12-by-2030-33517

Symes, K.S. (2023). Nanotechnology; Creating Innovative Solutions for Poverty, Sanitation, Clean Water and; Conflicts. Retrieved May, 2023, from https://nano-magazine.com/news/2023/3/20/transforming-the-world-through-nanotechnology-innovative-solutions-for-poverty-sanitation-and-clean-water-as-well-as-conflicts?format=amp

TNN. (2022). 415 million exited poverty in India in 15 years: UNDP. Retrieved May, 2023, from https://timesofindia.indiatimes.com/india/415-million-exited-poverty-in-india-in-15-years-undp/articleshow/94927710.cms

Tripathi, S. (2022). Economic Survey 2022: India Moved Up To 66 On NITI Aayog's SDG India Index Last Year. Retrieved May, 2023, from https://planet.outlookindia.com/news/economic-survey-2022-india-moved-up-to-66-on-niti-aayog-s-sdg-india-index-last-year-news-414699

Varthana, T. (2022). 7 measures you should take to improve the quality of education in your school. Retrieved May, 2023, from https://varthana.com/school/7-measures-you-should-take-to-improve-the-quality-of-education-in-your-school/

Zhang, P., Guo, Z., Ullah, S., Melagraki, G., Afantitis, A., & Lynch, I. (2021). Nanotechnology and artificial intelligence to enable sustainable and precision agriculture. *Nature plants*. 7(7), 864–876. https://doi.org/10.1038/s41477-021-00946-6

Zhihao, Z. (2022). BRICS to use big data to achieve sustainable development goals. Retrieved May, 2023, from https://global.chinadaily.com.cn/a/202204/28/WS6269eeb7a310fd2b29e59d2b.htm