Green Nanotechnology Innovations to Realize UN Sustainable Development Goals 2030

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Green Nanotechnology Innovations to Realize UN Sustainable Development Goals 2030

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ABSTRACT

Purpose: *Adoption of suitable technology and managing it strategically to solve social problems of the world is the need of the hour. United nations being a multi-country membership organization, has announced 17 Sustainable Development Goals (SDG) in the year 2015 with a slogan of action to end poverty, to protect the planet, and to ensure peace and prosperity by the year 2030. It is argued that nanotechnology that is considered a technology of the 21st century can be used to realize thirteen out of seventeen Sustainable Development Goals by 2030. These thirteen SDGs include: Reduce Poverty, Reduce Hunger, Health & Well-Being, Clean Water & Sanitation, Affordable renewable energy, Sustainable Industrialization, Ensure Sustainable Production & Consumption, Combat on Climate Change, Conserve Ocean & Marine Resources, and Protect life on Land.*

Methodology: *The study uses explorative research methodology based on developing postulates. The data and information are collected from various related scholarly publications searched through suitable keywords in Google scholar.*

Findings: *Nanotechnology anticipated as a universal technology has capabilities to solve problems of society at the basic level, comfortable level, and dreamy desirable levels. Nanotechnology, if not managed strategically and carefully has dangers to human health due to its potential risks of predicted nanotoxicity. In this paper, we have analysed these potentials challenges of nanotechnology, its strategic management, and developed a model of how green and eco-friendly nanotechnology can be used in many industries to realize these thirteen sustainable development goals and eliminates the threat of the technification of development processes.*

Originality/Value: *The paper discusses the advantages and benefits of systematic management of green and eco-friendly nanotechnology in the process of realizing individual sustainable goals in detail. Further, the concept, current research outcome, and the industrial prospects of achieving global SDG using eco-friendly green nanotechnology are analysed using predictive analysis framework of explorative research methodology.*

Paper type: *Exploratory Research Analysis.*

Keywords: SDG, Nanotechnology (NT), Green nanotechnology (GNT), Strategic management, Green nanomaterials, Green synthesis, Eco-friendly production, Technification

1. INTRODUCTION :

Technology, being an application of science provides tools to solve or improve problems or facilities respectively to lead comfortable and enjoyable life in society [1]. The improvements or discovery of new technology in the history led to many technology generations and each generation provided new tools to improve the quality of human life [2-3]. Many technologies had applications in area or industry and hence called as General-Purpose Technologies (GPT) [4-6]. Table 1 lists various technology generations identified with the impact and the time period of effectiveness.

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Table 1: Technology generations and their applications [7]

S. No.	Technology Generation with Time period	Name & Characteristics
1	First Generation (4,000-2,800 BC)	Mechanization: Characteristics – Tools, Weapons, and Printing (Knowledge Era)
2	Second Generation (18th Century)	Steam Engine Technology: Characteristics - Industrial Revolution (Industrial era)
3	Third Generation (19th Century)	Electricity Technology: Characteristics - Power generation & Usage
4	Fourth Generation (20th Century)	Automobile Technology: Characteristics - Long distance commuting & transportation
5	Fifth Generation (20th Century)	Airplane & space Technology: Characteristics - International Travel & Transportation
6	Sixth Generation (20th Century)	Telephone Technology: Characteristics - Distance communication
7	Seventh Generation (20th Century)	Television Technology: Characteristics - Video communication
8	Eighth Generation (20th Century)	Computer Technology: Characteristics - Data Processing
9	Ninth Generation (20th Century)	Internet Technology: Characteristics - Data & Information Communication, E-business
10	Tenth Generation (20th Century)	Mobile Communication & Biotechnology: Characteristics - Ubiquitous communication & Bio-engineering, Gene Therapy
11	Eleventh Generation (21th Century)	ICCT underlying Technologies: Characteristics - Ubiquitous computing & Communication, and Total Automation
12	Twelfth Generation (21th Century)	Nanotechnology: Characteristics - Solutions to nutritious food, drinking water, renewable energy, Nanomedicine & Therapy

Adoption of suitable technology and managing it strategically to solve social problems of the world is the need of the hour [8-9]. The 11th and 12th technology generations of current 21st century are identified as Information Communication & Computation Technology (ICCT) and Nanotechnology (NT). ICCT is capable to provide optimum solutions in service sector industries [10-17] and Nanotechnology is capable of providing optimum solutions to manufacturing industries [18-28]. Further, nanotechnology has solutions to (1) basic need based problems like (i) providing nutritious food to every one through improving natural and artificial food production, (ii) providing potable water for drinking and agriculture, (iii) renewable energy for daily use, (iv) safety shelters, (v) Affordable health facilities, (2) Wants based facilities to provide comfortable facilities for enjoyment like (i) transportation, (ii) Communication, (iii) Computation, (iv) Entertainment, (v) Education, (vi) Smart homes, (vii) Comfortable health facilities, etc., (3) Dreamy desires like (i) Optical computation, (ii) Embedded intelligence, (iii) Chameleon chips, (iv) Space travel, (v) Super intelligent machines, (vi) Organ regeneration, (vii) Anticipated immortality, etc.

United nations being a multi-country membership organization, has announced 17 Sustainable Development Goals (SDG) in the year 2015 with a slogan of action to end poverty, to protect the planet, and to ensure peace and prosperity by the year 2030. It is argued that nanotechnology that is considered a technology of the 21st century can be used to realize thirteen out of seventeen Sustainable Development Goals by 2030 [29-32].

2. GREEN NANOTECHNOLOGY :

The potential benefits of nanotechnology including improved manufacturing methods, improved environment and water purification systems, efficient renewable energy systems, physical systems property improvement and performance enhancement, optimization of health problems through nanomedicine, better food production methods & enhanced nutrition in food, large-scale infrastructure

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auto-fabrication through self-replicating machines, etc, but if not handled properly with creating proper awareness and precautions may have potential disadvantages in terms of risks to the health of living beings, environment, social life, and economy of the countries [32].

Green nanotechnology practices reduce potential impact on health and environment and will not pose any challenges for continuation of living beings on earth. Such sustainable technologies will not create footprint of any chemical processes used [33]. This also reduces production of green gasses during manufacturing processes and supports use of natural organic resources and do not contribute to increase the entropy of the universe. Green technologies will not contribute environmental degradation and supports automation of every process that avoids human intervention.

3. RELATED WORKS :

S. Aithal et al (2021) [32] made a systematic review on scholarly publications to find out the current status in green nanotechnology related issues. Based on the review, understanding of various issues of environmental degradation, the opportunities and challenges of using nanotechnology as green and eco-friendly technology is discussed and analysed. Opportunities & Challenges for Green Technology in 21st Century is also studied based on systematic review [34].

In this paper, we have analysed these potentials challenges of nanotechnology, its strategic management, and developed a model of how green and eco-friendly nanotechnology can be used in many industries to realize these thirteen out of seventeen sustainable development goals and eliminates the threat of the technification of development processes. The paper also discusses the advantages and benefits of systematic management of green and eco-friendly nanotechnology in the process of realizing individual sustainable goals in detail. Further, the concept, current research outcome, and the industrial prospects of achieving global SDG using eco-friendly green nanotechnology are analysed using predictive analysis framework of explorative research methodology.

4. OBJECTIVES OF THE STUDY :

The objectives of this study are:
(1) To understand the importance of green nanotechnology.
(2) To analyse the suitability and opportunity of green nanotechnology to realize the UN global SDG.
(3) To use predictive analyse to foresee the realization of 13 sustainable development goals.
(4) To suggest the effective use of green nanotechnology to fulfil the implementation of SDG by given timeline.

5. RESEARCH METHODOLOGY :

The study uses explorative research methodology based on developing postulates. The data and information are collected from various related scholarly publications searched through suitable keywords in Google scholar.

6. OBJECTIVES OF UN SDG :

Sustainable Development Goals are identified by United Nations Member States in the year 2015 with an objective to end poverty, to protect the planet, and to ensure peace and prosperity throughout the world by the year 2030. The SD goals and suitable 21st technologies to realize them to balance social, economic, and environmental sustainability are listed in table 2. To realize each SD goal based on the objective of an issue as maximum or minimum, suitable technologies are selected and proposed. It is argued that nanotechnology and ICCT, individually or combinedly are capable to achieve global sustainable goals to a larger extent within the given target of 15 years [35]. It is argued based on postulates of green nanotechnology, thirteen out of 17 SDGs can be realized by promoting green nanotechnology solutions by 2030.

Table 2 : SD goals and suitable technologies to achieve them [32]

Goal No.	Focus Issue	Goal by 2030	Objective
1	Reduce Poverty	To Zero	Nanotechnology supports to minimize poverty

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2	Reduce Hunger	To Zero	Nanotechnology supports to minimize Hunger
3	Health & Well-Being	To Everyone	Nanotechnology supports to provide quality Health & Well-Being
4	Clean Water & Sanitation	To Everyone	Nanotechnology supports to provide to everyone
5	Affordable renewable energy	To Everyone	Nanotechnology supports to provide it to everyone
6	Decent Employment	To Everyone	Nanotechnology supports to maximize employment
7	Sustainable Industrialization	Everywhere	Nanotechnology supports for sustainable industrialization in every country
8	Reduced Inequalities among Countries	To Zero	Nanotechnology supports to minimize inequalities
9	Safe & Sustainable Cities & Communities	Everywhere	Nanotechnology supports to develop environmentally sustainable and safe cities
10	Ensure sustainable Production & Consumption	Everywhere	Nanotechnology supports to ensures sustainable Production
11	Combat on Climate Change	To Zero	Nanotechnology supports to minimize environmental degradation and to combat on climate change
12	Conserve Ocean & Marine Resources	Everywhere	Nanotechnology supports to conserve Ocean and marine resources
13	Protect life on Land	Everywhere	Nanotechnology supports to protect life on land

7. OPPORTUNITIES TO REALIZE UN SDG USING GREEN NANOTECHNOLOGY :

Nanotechnology (NT) along with Information Communication and Computation technologies (ICCT) can be used as potential technologies to realize the Sustainable Development Goals. If United Nations promotes nanotechnology research by creating awareness among youths and funding the research in the areas related to SDG adequately, the objectives of the goals can be achieved within the timeframe of 2030. The branches of NT including Nanomaterials Design Technology, Nanomaterial fabrication, Nanomaterials characterization, Nanomechanics technology, Nanoelectronics Technology, Nanophotonics Technology, Nanobiotechnology, and Nanomedicine, are expected to change the rules of development games [36] in many areas including Agriculture & food industry, Drinking water systems [37], Efficient Automobiles [38], Renewable energy systems [39-41], High speed optical computers, Low cost durable shelters, Embedded intelligence, Space vehicles, Health & Medical solutions [42-43], etc in all member countries by 2030. This will allow human beings to become ubiquitous and provides total automated products and services for individuals and hence acts as a pillar of social, technological, and economical transformation [32].

8. PREDICTIVE ANALYSIS OF GREEN NANOTECHNOLOGY TO REALIZE UN SDG :

8.1 Predictive analysis model:

Predictive analysis is a simple method to predict the future based on collecting current data and information from reliable sources. It is developed recently to address decision-making problems related to predicting the future. Predictive analysis is an analytical top-down method consisting of several techniques to predict future possibilities using present trends. It can be qualitative or quantitative. It is different from predictive analytics in such a way that it will support to predict the future. On the other hand, predictive analytics is a method of generating information from historically available datasets to

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determine and predict future trends and outcomes. [44]. A qualitative predictive analysis is used to predict future possibilities by studying present trends using a self-developed predictive analysis model shown in figure 1.
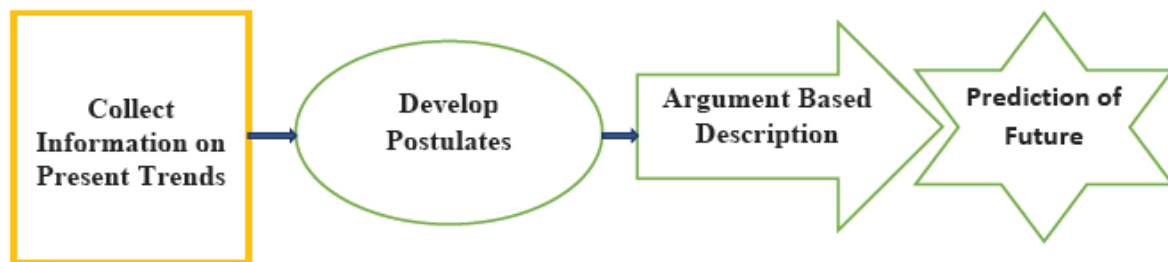

Fig.1 : Predictive Analysis Model to predict future [44- 45]

The procedure of predictive analysis consists of four stages which include (i) Collecting information on present trends, (ii) Developing postulates based on present trends, (iii) Generating argument-based descriptions, and (iv) Predicting the future. This analysis method helps to predict the future changes by developing postulates and responding for it using either Survival strategy, Sustainable strategy, Monopoly strategy, Competitive strategy, or Growth & Expansion strategy [46-47].

8.2 Postulates through Predictive Analysis:

(1) Green nanotechnology innovations support to minimize poverty by solving basic need-based problems of citizens of the countries.

(2) Green nanotechnology innovations support to minimize Hunger & thirst by improving the productivity of food grains either naturally or artificially to everyone.

(3) Green nanotechnology supports to provide quality Health & Well-Beings to everyone in the entire world by means of finding simple & effective drugs for every disease.

(4) Green nanotechnology supports to provide clean drinking water to everyone including plants for long-living through desalination of seawater using renewable energy and moving the clouds to desired locations.

(5) Green nanotechnology supports everyone by providing efficient production and storage techniques for solar and winds energy as renewable energy.

(6) Green nanotechnology supports the countries to maximize employment by offering research and development of various new and innovative products and services in basic need, advanced wants, and dreamy desire areas thereby creating enhanced job opportunities.

(7) Green nanotechnology supports sustainable industrialization in primary, secondary, tertiary, and quaternary industry sectors in every country for sustainable economic growth.

(8) Green nanotechnology supports economic development in every country which minimizes the inequalities among the countries.

(9) Green nanotechnology supports to develop environmentally sustainable, clean, and safe cities by minimizing water, air, and other environmental pollutions.

(10) Green nanotechnology supports to ensures sustainable production by promoting the use of renewable energy and smart materials so that the durability of the products and services are the longest.

(11) Green nanotechnology supports to minimize environmental degradation and to combat on climate change of the world.

(12) Green nanotechnology supports to conserve ocean and marine resources by controlling the pollution and toxicity in the ocean through solar light and temperature-controlled reactions using suitable nanomaterials.

(13) Green nanotechnology supports to protect life on land through minimizing environmental degradation and large-scale sustainable cleaning of already degraded air, and water. It will also control green gas emission and production of toxic materials thereby protecting all life on earth.

9. SUGGESTIONS :

Based on the postulates developed on the predictive analysis principles, the following suggestions are proposed:

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(1) Promotion of nanotechnology research in the countries by creating awareness of potential applications.

(2) Promoting nanotechnology education and training at school levels by creating nanotechnology popularization programs.

(3) Encouraging companies of different industries to start industrial research using their profit and CSR funds as well as providing some tax incentive policies.

(4) Promoting Patents in nanotechnology areas by means of additional incentives and decreasing timeframes.

(5) Country governments should give priority to green nanotechnology research by starting separate nanotechnology mission programmes and Centre of Excellence in Nanoscience and nanotechnology in all Universities and affiliated research centres.

(6) Simplifying the national policies on the commercialization of nanotechnology products in different industries by adopting the single-window model.

10. CONCLUSION :

Nanotechnology being general-purpose universal technology has the potential ability to use as a tool to solve problems and challenges of different levels in society. But it is feared that nanotechnology, if not handled properly with precautions may have potential disadvantages in terms of risks to the health of living beings, environment, social life, and economy of the countries. Green nanotechnology is a concept and practice where all possible environmental threats are taken care of. It is argued through predictive analysis that green nanotechnology is safe and secured for the environment and suitable & effective technology and has the ability to help to realize thirteen out of seventeen sustainable development (SD) goals of the United Nations within the planned timeframe of 2030.

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