Impact factor of Nanotechnology on Society

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Abstract

The Nanotechnology (NT) had already touched the many aspects our lives in more ways than one, but every new technology comes with risks and issues. This may involve Professional risks, Political risks, Privacy risks, Intellectual property risks, Human Enhancement issues, Environmental risks, health risks, safety risks and Futuristic risks. Futuristic risks involve the losses that can happen from the futuristic application of a technology. The benefits and risks of technology are so large that it is not easy to define that nanotechnology is Constructive technology or Destructive technology. A huge investment has already been made or much more investment is in planning. NT has hit the market of India in the field of materials, security, semiconductor devices, medicine, textiles, cosmetics, cleaner water specially .The paper discuss the major impact of nanotechnology in India including risks to be assessed before, after and during the development of applications.

Keywords

Nanotechnology; Impacts; Risks; Applications; Development; Research.

1. Introduction

There is remarkable development in field of nanotechnology, all over the world. Nanotechnology deals with small particle (10^{-9} meter) but its applications are very big and having wide impact. Nanotechnology is not a new word or technology now. But still describing a little bit about the technology. Nanotechnolgoy was first introduced by A Physicist, Richard feyman. He gave a talk 'There is Plenty of Room at the bottom'. Nano means small (10^{-9} meter) and *Technology* refers to the theoretical and practical knowledge, skills, and artifacts that can be used to develop products and services as well as their production and delivery systems [8]. The term nanotechnology has come to have two primary meanings [3]:

1) New science and technology that takes advantage of properties operating at the nanoscale, and

2) Building with atomic precision through the use of molecular machine systems.

The first meaning refers to developments occurring today; the second to an ambitious technological goal at least a decade off. These radically different meanings are making coherent discussion of public investment policy and societal implications very difficult.

Top down and Bottom up are two types of approaches that can be used for synthesis of nano materials. Bottom up approach starts with the smaller component and build up into complex componets atom by atom whereas Top down approach we used to breaking down the system into small subsystem. Each one has its advantage and disadvantage. Colloidqal dispersion is one of the technique for Bottom up approach while Miling, Etching, Deposition are basic approaches in top down approach.one of the problem with top down approach is imperfection of surface structure.Bottom up approach is generally used in nanotechnology.

A spoon containing lg of nanomoterial is enough for everyone in the world to have 300,000 particles each [4].

Emerging technologies have a significant influence on human societies and societies also influence the emerging technologies in terms of ethical issues. Nano divide is one of major problem for the society for example rich people can have advantage of nanotechnology enhance medical treatment at least in the beginning stage [9].

When we develop any application of a technology with inappropriate and insufficient information; some ethical issues will always be there. Varieties of risks will also be there. Risk [7] is generally defined as the probability of an undesired event and the magnitude of its consequences. The objectivist concept implies that risks are 'real' and can be calculated, the interpretivist approach suggests that 'risks are mediated through social process'. In other words, "risks and their

manifestations are social artefacts fabricated by social groups and institutions.
More interactions between scientists, economists and public are needed to identify and reach the robust balance between benefits and limiting factors of nanotechnology [6].

2. Impacts of Nanotechnology

Nanotechnology has affected many fields from Medical, Food and Agriculture, Textiles, Energy, National security to Space Exploration among others.
Highly skilled man power is required for Nanotechnology. A huge investment is required for the research in this field. Nanotechnology often involves converging many areas viz chemistry, biology, engineering together.
Availability of human resources with technical expertise in the field of nanotechnology should speed up the process of innovation in this field. Thus supply of highly skilled technical labor is necessary to carry out the necessary research work in the field of nanotechnology [8]. One of the important social issues associated with S&T field is funding. Sometimes funding makes scientists to shift to a particular S&T field, which is nicely funded [1]. A large number of nano products are in markets simply by modifying the few properties of materials.

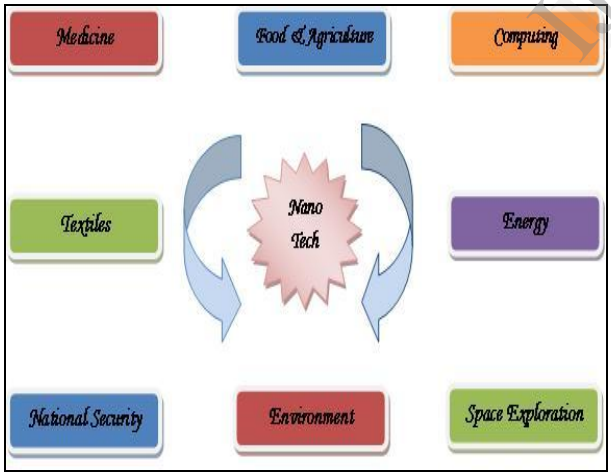

Fig 1. Various Fields of Applications for Nanotechnology

According to Environment Protection Agency: Nanoscale cerium oxide has been developed to decrease diesel engine consumptions; iron nanoparticles can remove contaminants from soil and ground water; and nano-sized sensors hold promise for improved detection and tracking of contaminants.

In the field of medicine, nanotechnology has provided nano particles to deliver the drugs to specific cells, polymer based nanoparticles are invented to improve the pharmacological properties of drugs. Current research is going on to design nanoparticles for the treatment of Cancer; these nanoparticles are attracted or absorbed by diseased cell. One can envision nano scale robotic systems for medical applications [3].
In Agriculture, nano technology has developed smart warning system to alert the farmers regarding the disease before they are visible to farmers and in Food research, nano technology has affected the entire process from production, prcoessing and consumption of food.
Applications in computing involve the use of carbon nanotubes to design faster and smaller components. Hewett packard is developing a memory device called memristora and also trying to develop Registive Random Access Memory (ReRAM).
In IBM's Zurich Research Lab, scientists are engineering a new data-storage technology called Millipede. Instead of a thousand legs, this Millipede has thousands of silicon tips, each with an apex of about 10 nanometers (nm), many times thinner than a human hair [5].
Nanotechnology in textiles includes desinging of fabric with self cleaning, Flame retardant, protection against chemical threats, wrinkle and stain resistant features. Nanotechnology can be used to desined fabrics with good performance without any compromise.
Nanotechnology has affected the Energy Sector ranges from long lasting batteries, low cost system of heating, air conditioning, and better method for capturing, transfering and storing of energy.
One of the big innovations in Nanotechnology is Cleaner Water which includes the use of nanorobotics to break down each atom of water pollution. According to United Nations, more than one billion people in developing countires donot have access to clean water.
Nanotechnology has helped in National Security. Carbon nanotubes and diamond films have much higher strength to weight ratio than steel which will make lighter and stronger parts for defence equipments, aircrafts. There are some nano particles which can make aircrafts more resistive to lighting.
M. C. Roco, leader in nanotechnology policy, has recognized four phases in the development of nanotechnology products,

1. Passive Nanostructures (2000-2005): In this first period the passive properties of nanomaterials, including nanotubes and nanolayers, gives more and more opportunities to renew products of everyday life

2. Active Nanostructures (2005-2010): Nano structures become active in this phase and they change their state during the use in a way that can be predicted.

3. Systems of Nanosystems (2010-2015): In these 5 years assemblies of nanotools work together to achieve a final goal. This means that a great advancement in robotics, biotechnology, and new generation information technology will appear.

4. Molecular Nanosystems (2015-2020): This stage involves the intelligent design of molecular and atomic devices, leading to "unprecedented understanding and control over the basic building blocks of all natural and man-made things."

Defining nanotechnology as a new and revolutionary technology also puts risk on the agenda [7]. A higher-level integration is necessary in the innovation cycle through public and private partnerships nor isolated and private and innovative use and integration of existing technologies [9]. Nanotechnology will definitely change our educational system in many ways.

3. Risks Involved in Nanotechnology

Some risks come by birth with technology. And some risks come during development and uses of technology.

Once materials are reduced to this size, they often behave unexpectedly. Materials not only display different properties at the nanoscale, they are also more readily absorbed by the human body, either through the skin, lungs, or digestive tract [4]. Nanotechnology advocates believe their technology will be able to solve all human problems [3].

One of the very big problems related to nanotechlogy is disposal of goods. If once a product is of no use or damaged, we may assume any electronic goods, we cannot dump them like that. Suppose we throw the items in dust bin; it may produce nanoparticles that can be harmful.

One more example we can take of drugs, suppose some nano drug is made for particular treatment; while taking the drug it may fell down and breaks in parts, then it will produce nanoparticle that easily mixed with air and goes to the healthy person through respiration process without his knowledge. So, a nanodrug made for the treatment of some disease may produce so many patients for some other unknown disease. So we donot know how to consider nanotechnology as 'Blessing' or 'Curse'. According to scientists, there is little evidence of people getting problems by the exposure of nanomaterials. But it is also seen that nanoparticle of a material will behave differently as compared to large particle of same material. One of the applications of nanotechnology is in cosmetics for sunscreen cream, ofcourse this is beneficial as compared to traditonal cream, but there are nanoparticles that can penetrate in our body through skin and give some unwanted results.

Dr. K. Eric Drexler introduced a term "grey goo" in his book Engines of Creation (1986). Basically "grey goo" involves self-replication of nanorobot called assemblers in uncontrolled manner in a natural environment thus turning the Earth into"grey goo". The development of nanotechnology in this idea can create problems so strict rules must be followed in order to protect society.

4. Risk Handling For Nanotchnology

If the use of nano materials cannot be stopped then risk assessment or precautionary steps are required, but the lack of knowledge about the hazards complicate the risks assessments. Even during the production of nano materials in a factory, they may be harmful for the workers and nobody knows when it will show effects. Some policies regarding occupation, health and safety should be there in working environment to protect the workers from the exposure of nanomaterials and also requires safety precaution during the production of materials.

This is a big challenge for government to regulate the production of nanomaterials. Most of goverenment and rule making agencies believe that they donot have suffient data or knowledge to decide the impact factor of a nanomaterial or in which category they should put that nanomaterial. Even the insurance companies are in dilemma that how to make the policies as they are also unknown about the complete threats of the technology and merely presence of nano particles has nothing unless it has done some vulnerable.

As nanotechnology is efficient in field of national security by introducing some smart weapons and nanosensors. But this is also a major drawback of nanotechnogy. Increasing the functionality or capability of weapons like miniaturization will be a threat also. This technology can go to hands of terrorist or anti social elements; then we should be prepared for that also or we require those prodcuts which can handle those weapons i.e. weapons against nanoweapons.

Bowman and Hodge (Bowman & Hodge, 2006) use a pyramid model to argue for a complex regulatory system for nanotechnology [2].

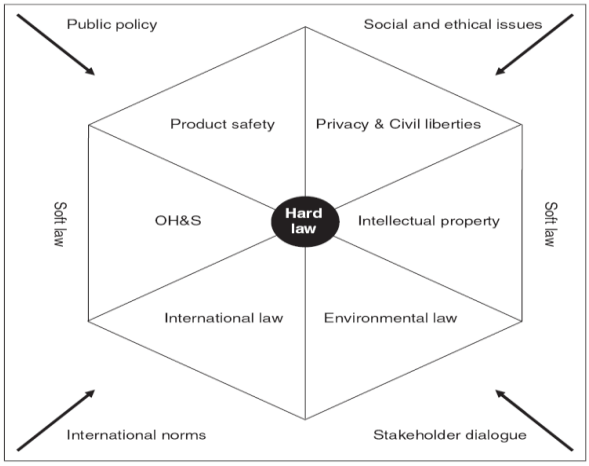

Fig 2. Bowman & Hodge nanotechnology regulatory pyramid

There is an emerging debate about nanotechnology and its implications for society [7].

A hexagonal pyramid with involves product safety, privacy and civil libraries, occupational health and safety, intellectual safety, international law, environmental law. There are soft and hard laws to handle different types of issues.

Research should identify the quality of work, life and environment to which citizens give highest priority [6]. Public awareness is the mostly required for how to use, whether to use or not certain materials beacuse nano product may be good for personel but not for environment. Nanoparticles might not be recyclable or eco friendly and on disposal or dumping, these nano materials might form a new category of non-ecofriendly toxin and create a new threat to the environment, health and safety.

Exposure to nanomaterials is achievable through Production, transport, storage, and disposal of nanomaterials among many other sources. So, some environmental laws should be there. A nanomaterial has to face these laws before coming to the market. Environmental health and safety issues are having both positive and negative aspects. Nanotechnology can improve health (drugs for cetain uncurable diseases like cancer), environmental pollution like cleaner water etc.

The meaningful research on ethical and societal issue of nanotechnology which hits the ground was about safe manufacture and use of nanomaterils for the practical purpose [11]. Scientists stressed upon awareness which can be done through certain mechanisms such as campaign, public forums, exhibitions (e.g. where they could showcase NT products, nanomedicine, and new materials) and seminars regarding its various features [1]. There is a large body of literature on risk perception and risk management.

Finaly, Governance of Nano-risks in to which all suggestions can be integrated is now being a hot issue [9]. Here governance means "the actions, processes, traditions and institutions by which authority is exercised and decisions are taken and implemeted [10] and risk governance delas with the identification, assesssment, management and cumminications of risks in abroad context.

5. India's initiative regarding the technology

Nanotechnology impact on India is predicted to be larger than any other boom like Information Technology, Bio technology. India launched its national nano technology initiatives in 2001. Metro areas like Bangalore and chennai are the main centre for this technology to grow.

Governments are creating policy initiatives to promote developments in the nanoscale science and technology developments. It could be possible for a manufacturer with 30 years' experience to see his market disappear within a week, thanks to a newly patented technology [4].Nanotechnology investment in India is a government-led initiative through the Department of Science and Technology (DST), and the Nanoscience and Technology Initiative (NSTI) [1]. This department constitutes a Nano Mission Council which has been operating across many educational institutions, majority of which are in the Bangalore, Chennai, and Hyderabad etc. Research in India is mostly focused in various universities, government research institutions, like IISc in Bangalore, Indian Institutions of Technology (IITs), Sastra University in Tanjavur, Karunya University in Coimbatore, Osmania University in Hyderabad, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), and many others.

The market for nanotechnology has changed rapidly over the last three years. Originally interest in the new materials came from research departments and academic institutions [4]. Council of Scientific and Industrial Research (CSIR) has set up 38 laboratories in India dedicated to research and development in Nanotechnology. This technology will be used in diagnostic kits, improved water filters and sensors and drug delivery. The Government of India has approved the launch of a mission on Nanoscience and Nanotechnology (Nanomission) with an allocation of Rs. 1000 crore for 5 years [8]. There are approximate 300 academic nano techbnology programs in India. Nearly 40 universities across India are providing nanotechnology research activities.

As per survey, currently there are 30 companies in India involved in nanotechnology related business

activities.In addition, there are 47 nanotechnology and nanoscience related research organization in India.
India has to not participateonly only but also to win the race and attract the nanotech-based industries, it needs to focus on cutting-edge research in Nanotechnology and develop human resources to implement the technology.

6. Conclusion and Future Works

Nanotechnology has shown the people; the power of rearranging the atoms. And they behave in different manner as compared to traditional elements. Precautions are always required from the beginning during the development of new technology; specialy when a small mistake can lead to unmeasurable losses or unaccountable hazards. Nanotechnology has covered the society form all around because of its appliactions in various fields. Beacuse of tough competition, the cheap and despicable products in market can add fuel to fire of risks. Some business minded people bothered about benefits not the ethics and also public is always in craze to use new technology, those who cannot afford will definitely go for these cheap products. Rules, constraints, Government restirction, public education and ofcourse morality are required to achieve the target set during the initiation of the word Nanotechnology. As the companies are not disclosing the full secrets of their artefacts before launching the products in market. In that case, if something bad happens then it's too late to control. There are many research activities that require hazard identification, risk assessment, analysis, risk handling; these are still underdeveloped in India. Government has to regulate these types of things or to create new rules. After all technologies are developed for the welfare of society. Overall impact of the technology Depends upon, whether people accept it in positive way or not? Any technology i.e. nanotechnology can be used for promotional or destructive uses.

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