

SOCIETAL PERCEPTIONS OF NANOTECHNOLOGY AN EMPIRICAL STUDY**HARITMA CHOPRA^{a1}, YOGESH SUMAN^b AND VAISHALI SINGH^c**^aDepartment of Chemistry, Maitreyi College, South Campus, Delhi University, New Delhi, India^bDepartment NISTADS, CSIR, New Delhi, India^cDepartment USBAS, GGSIP University, Dwarka, New Delhi, India**ABSTRACT**

Perception of industry and academia has been captured through a survey in respect of the potential of nanotechnology. Academia believes that market for nanotechnology based products has grown over the years, while the awareness about the toxic effects of nanotechnology remains low. Healthcare, electronics and materials are perceived as major areas for nanotechnology applications. According to the industry, the demand for nanoproducts will grow at a low pace in future. Besides this lack of knowledge about the target market and high cost associated with nanotechnology are the major barriers.

KEYWORDS : Nanotechnology, Barriers, Toxic Effects, Healthcare, Electronics, Material

Nanotechnology has opened up enormous opportunities for industrial growth and employment generation (Roco et.al., 2001). Recognizing the potential of nanotechnology, the year 2000 witnessed the introduction of National Nanotechnology Initiative (NNI) (<http://www.nano.gov/about-nni/what,2015>) in the United States. In May 2007, the Government of India launched the Nano Mission, a mission for Nano Science and Technology, under the aegis of Department of Science and Technology (DST) (<http://nanomission.gov.in, 2015>), with an initial allocation of 1000 crore for the same. The mission largely focuses on capacity building and creation of R&D infrastructure in the country for leveraging the potential of nanosciences. Several universities and institutions responded to this initiative by setting up the nanoscience centers and started post graduate programmes in nanoscience and technology. Indian industrial enterprises have also come forward to participate and collaborate with academic institutions for Research & Development in nanosciences. There is a strong and confident notion among researchers and scientists in the potential of nanotechnology to lead a revolution in technology and industry which will in turn benefit the society as a whole (palmberg et al., 2009). However, off late concerns are being raised regarding the risks associated, whether environmental or health related, with the production and use of nanomaterials (simonis et al., 2015).

METHODOLOGY

The current work aims to study the perceptions of industrial units and academia (comprising of faculty and students) in regard to benefits of nanotechnology as well as perception regarding the risks associated and potential barriers in the growth of nanotechnology in the country e.g. availability of finance and high cost of nanotechnology based products; potential areas of its application. The study also tries to find out the extent of collaboration between Government research institutions and industrial units for conducting nanotechnology based research (Bhattacharya et al., 2012).

The perception of the three main interest groups is captured through a mail survey with the help of structured questionnaire. Separate questionnaires were developed for industry and academia (www.nano.gov, 2014). Over 400 questionnaires were sent to various industrial units and academia. For industrial units the directory published by Centre for Knowledge Management of Nanoscience & Technology, Hyderabad was used as sampling frame and list of university departments involved in teaching of Nanotechnology was prepared using their websites (www.nanostart.de, 2014). A total of 67 and 38 filled questionnaires were received from academia and industrial units respectively. Few questionnaires received from respondents were incomplete and accordingly they were excluded from the analyses of respective questions not answered by them. Patterns emerging from the analysis of filled questionnaires are shown in the subsequent sections.

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RESULTS AND DISCUSSION

Academia

Respondents from academia believe that market for nanotechnology based products has grown over last ten years and nanotechnology has created new profitable business opportunities. But consumers are not well aware about nanotechnology based products. They also feel that consumers are not well aware about toxic effect of nanotechnology and there is not adequate level of regulatory structure at Government level to control the toxic effect of nanotechnology. As far as benefits of nanotechnology are concerned majority of them feel that nanotechnology has helped the industry in increasing the range of products, in improving quality of products, entering new markets, increasing market share and in increasing capacity utilization. Among potential areas for nanotechnology application respondents believe that healthcare is the most important area where nanotechnology can be applied, followed by electronics and materials (Figure 1). With regard to important challenges in the future growth of nanotechnology in the country respondents think that 'high cost of nanotechnology related equipments', 'lack of quality control standards in nanotechnology', 'difficulty

in commercialization of nanotechnology related research of Government Research institutions', 'lack of demand for nanotechnology related products' and 'lack of knowledge about potential of nanotechnology' are major challenges which need to be dealt with.

Industrial Response

Trends emerging from industrial firms show that most of the enterprises started their nanotechnology activities in 1999, 2005, 2006 and 2007. As far as clients are concerned most of the firms sell their nanotechnology related products to other private sector firms and private end use. Other major consumers are various manufacturers and educational institutions.

There is a strong perception among industry that the market for nanotechnology related products has grown during last ten years and nanotechnology has created new profitable business opportunities for them. But the demand for the nanotechnology based product will grow at a small pace in the future.

Majority of them feel that awareness about the toxic effect of nanotechnology is not adequate and also India doesn't have adequate regulatory structure at Government level to counter the toxic effect of

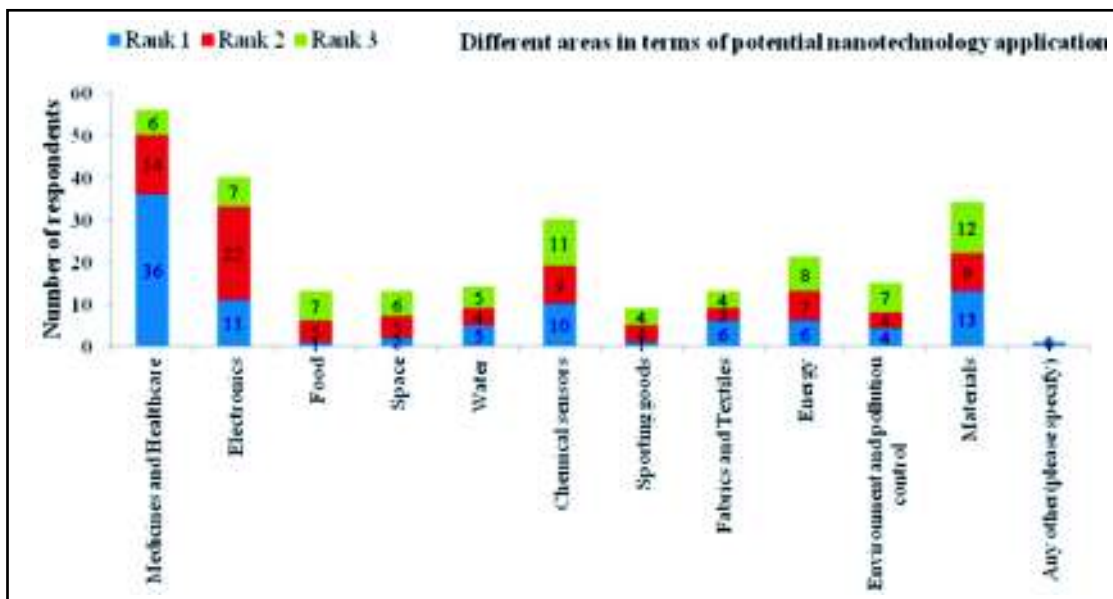


Figure 1: Respondent Perception About Potential Areas for Nanotechnology Application

nanotechnology. Industry also feels that consumers are not well aware of nanotechnology based products.

They perceive medicine and healthcare as the most promising sectors for nanotechnology applications followed by the electronics and materials.

With regard to important challenges in the future growth of nanotechnology in India, it emerged that 'Lack of strong intellectual property control regime' followed by 'Lack of demand for nanotechnology based products' and Lack of knowledge about target markets are the most

serious challenges in the future growth of nanotechnology. These are followed by 'High cost of nanotechnology related patents' and 'Lack of knowledge about applications of nanotechnology' (Figure 2).

They also think that nanotechnology has helped industrial firms to enter new markets and in increasing range of products, and their market share. But it has not been able to help them in improving the flexibility of production process and labor cost. Therefore it can be said that nanotechnology has helped firms in achieving product

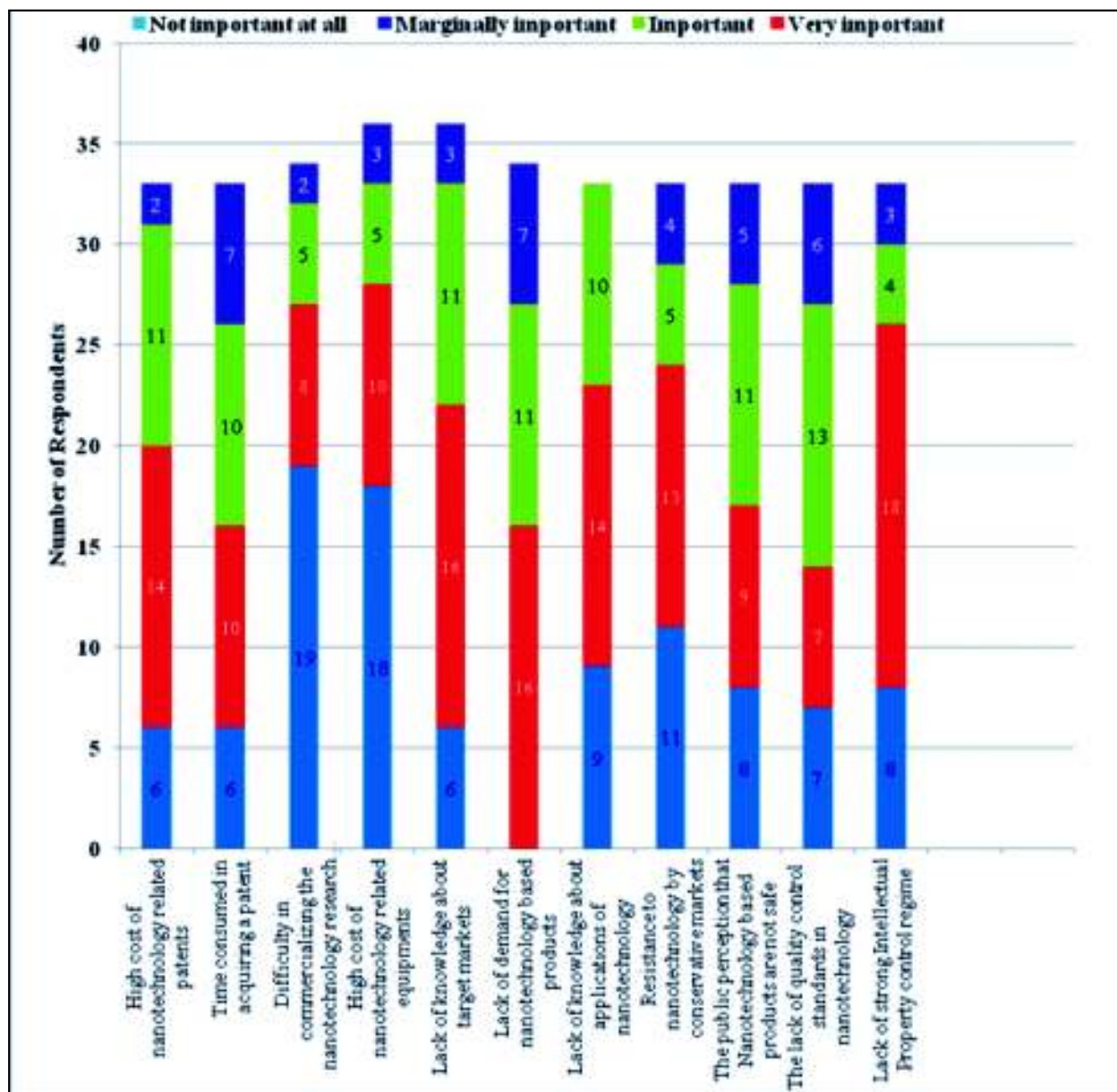


Figure 2: Industrial Perception About Important Factors in Growth of Nanotechnology

innovation rather than process innovation. Government R&D labs and Universities have emerged as a major provider of nanotechnology related technical know-how for the industry.

Policy Based Suggestions

Industrial firms engaged in nanotechnology related activities are not much aware about the target markets so they need to take up more of market based research to find new markets. Consumers have to be made aware about toxic effects of nanotechnology and also regulatory structure at Government level to counter the toxic effect of nanotechnology needs to be enhanced. Since medicine & healthcare, electronics and materials have emerged as most important areas where nanotechnology can be applied, more research inputs are needed in these areas.

Apart from these more efforts should be made to commercialize the research done by Government research institutions. Quality control standards in nanotechnology should be enhanced. People should be made aware about the potential of nanotechnology in diverse fields. This will lead to increase in demand for nanotechnology based products which will consequently help nanotechnology industry.

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REFERENCES

Benefits and applications , accessed from website of National Nanotechnology Initiative (NNI) available at <http://www.nano.gov/you/nanotechnology-benefits> accessed on 11.03.2014.

Bhattacharya S., Pushkaran J. A., Shilpa, 2012 CSIR-NISTADS policy brief - July 2012 Nanotechnology development in India: investigating ten years of India's efforts in capacity building, NISTADS. available at https://www.academia.edu/2276198/Nanotechnology_Development_in_India_Investigating_Ten_Years_of_Indias_Efforts_in_Capacity_Building accessed on 18.03.2014

<http://nanomission.gov.in/> accessed on 08-05-2015.

National Nanotechnology Initiative, <http://www.nano.gov/about-nni/what>, accessed on 08-05-2015.

Palmberg,C Hélène, 2009. Nanotechnology: an overview based on indicators and statistics, STI working paper 2009/7 Statistical Analysis of Science, Technology and Industry, OECD, <http://www.oecd.org/sti/inno/43179651.pdf> accessed on 18.03.2014.

RocoMC and Bainbridge WS,2001.Societal Implications Workshop Report, National Science Foundation, Arlington, Virginia, March 2001

Simonis F andSchilthuizen: S. Nanotechnology innovation opportunities for tomorrow's defence, <http://www.futuretechnologycenter.eu/downloads/nanobook.pdf> accessed on 08-05-2015.

Solving problems with nanotechnology, accessed from website of 'Nanostart Investment', available at <http://www.nanostart.de/index.php/en/nanotechnology/solving-problems-with-nanotechnology> accessed on 11.03.2014.