



## International Conference On Business Management And Economics

### THE EMERGING NANOMARKET WITH NEW BUSINESS ENVIRONMENT

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#### **ABSTRACT**

*Market analysis with business environment is a very complicated issue. Market strategy is greatly influenced by the technology in the knowledge economy. The gap between production and consumption can be reduced for the smooth function of economy through the technology based market strategy covering product, price, place and promotion.. This paper uses nanotechnology and its advancement to map the emerging nanomarket with new business environment after the careful review of available literature and resources. The globaleconomy in the present century is driven by nanotechnology. Nanotechnology is a field of science and engineering that deals with structures having less than 100 nanometers. A nanometer is one billionth of a meter (10<sup>-9</sup> Meter). Its advancement particularly in molecular nanotechnology for mass production will change the production function with bottomup approach giving scope to the new business environment. It also focuses on nanoproduction function which is a gateway of nanomarket. It demonstrates the power of nanotechnology to bring about changes in production, business and marketing activities using nanomaterials as inputs and novel products as output in the emerging nanomarket. The business environment is a combination of internal and external factors that influences on company's operating situation covering ; improvements in technology competition, clients and suppliers, laws and government activities , marketing and business trends. It also shed light on nanoproduction function with bottom up approach using nanomaterial for industrial applications and goods and services for consumer world. The knowledge about nanotechnology and nanoproduction is need for business decisions . The role of superior human and organizational capabilities is identified to manage production and its related activities in the emerging nanobusiness environment. The present study identifies the issues of nanoproduction function, Rand D investment from private and public sector, creating infrastructure for nanotechnology, nano -education and training, venture capital, convergence technology, listing of nanomaterials and nanoproducts to develop database, international cooperation for transfer of technology in the emerging nanobusiness environment and concluded to establish a common platform of entrepreneurs, nanoscientists, market experts, economists and policy makers to discuss and address issues of nanotechnology in the new business environment. Keywords: Nanotechnology, Nanomaterials, Nanoproduction function, novel products, convergence technology, Nano scale operations, Nanosensors, nanomarket, nanobusiness environment.*

## INTRODUCTION

The study of Nanotechnology in Business Analysis is the Future Wealth of Nations. A business does not function in a vacuum. Nanotechnology and its advancement in business has changed production function paving the way for the emerging nanomarket with new business environment. Market analysis with business environment is a very complicated issue. Market strategy is greatly influenced by the technology in the knowledge economy. The gap between production and consumption can be reduced for the smooth function of economy through the technology based market strategy covering product, price, place and promotion.. An organization can survive and grow only when it continuously and quickly adapts to the changing technological environment. Nanotechnology and its link with business is based on the relationship between innovation and prosperity. The journey towards nano scale operation uncovers the hidden business opportunities of nanotechnology. We are living in a dynamic society where things are undergoing rapid changes with invention and innovation. The development of nanotechnology with its adoption and diffusion is bringing about changes in business environment through the nanoproduction function causing changes in products, services, life styles and living conditions. Business units need to understand nano scale operations and adapt the new technology for their survival. This technology has a significant influence on the emerging nanomarket and new business environment through the nano-production function.

## CONCEPTUALIZATION OF NANOTECHNOLOGY

Technology is an important driver of economic growth. The linkage between nanotechnology and business is based on the relationship between innovation and prosperity. The global economy in the present century is driven by nanotechnology. Its advancement particularly in molecular nanotechnology for mass production will change the production function with bottom up approach giving scope to the new business environment. We have to examine the business and marketing principles underlying the development under nano scale know-how, nano products and nanosystem.

Nanotechnology is a field of science and engineering that deals with structures having less than 100 nanometers. A nanometer is one billionth of a meter ( $10^{-9}$  Meter). The prefix nano comes from the Greek to mean dwarf and in science and technology it represents a nano scale operation. This new approach for R&D is to control the fundamental structure and behavior of matter at the level of atoms and molecules. In 1959, physicist Richard Feynman proposed a new field of study for science and technology at an atomic and molecular scale in his paper entitled "There is plenty of Room at the Bottom ". This view sparked an interest in developing technology to manipulate matter at the scale of atoms and molecules. The breakthrough in nanotechnology will increase the scale of economies paving the way for nano-production function with new business environment.



### **STATEMENT OF THE PROBLEM**

Inventions and innovations in nanotechnology have largely been responsible for changes in business environment. This study is explorative and descriptive in nature to identify the business and market issues by reviewing the literature and resources available on nanotechnology. An attempt is made to map the emerging nano-market with new business environment using nano-production function. Nanoproduction function is a link between smart materials as inputs and nano-products as output in the emerging nanomarket. This paper examines the growing demand for nanomaterials in input market and novel products for consumer world in product market with bottom up approach to identify the key business issues. Nanotechnology is changing the production function combining with information and biotechnology. The change in the state of art, method of production, knowledge, institutions, organizations and management practices will have to be reconsidered in our business environment due to the advancement in nanotechnology. The careful study of production function in the light of nano scale operation is expected to yield useful information for strategic business decisions. The study of business environment and nano-market underlying the development and deployment of nano scale know how, nano-products and nano-system is need of the hour.

### **SPECIFIC OBJECTIVES OF THE STUDY**

To examine the commercial application of nanotechnology .

To examine nanoproduction function and highlight the nano-inputs and novel products as output.

To map the emerging nanomarket with new business environment

To explore the business related issues of nanotechnology

To subject policy measures for business decisions

### **HYPOTHESES**

The following Hypotheses were set for the present study of emerging nanomarket and new business environment.

Nanotechnology and its advancement will change the market and business environment through the bottom up approach.

Nanotechnology explores the system of abundance by uncovering the hidden benefits of nano scale operation.

The advancement in nanotechnology will transform the conventional production function with IT and BT into Nanoproduction function

The development in nanotechnology develops market both for smart materials at input side and novel nano products as output in product market.

### **NANOPRODUCTION FUNCTION AND INDUSTRIAL REVOLUTION**

The production system based on nanotechnology would be totality of the commercial system that creates novel



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products and services offering through nanomarkets allowing buyers and sellers to transact and conduct trade. It is characterized not only by nano-products but also by other aspects of business such as financial markets with nano bonds, intellectual property rights and the know-how. The emerging nano system promises to create more innovate products for the consumer world. Nanotechnology may become embedded in every industry, every product and essential to every job ensuring a high quality of life. It appears cutting across many markets with so many varied applications in energy, medicine, materials, water treatment, environmental remediation, food processing and others. There will be high economic and business impact in future due to advancement in nanotechnology. Nanosensors are the wonderful inventions of Nanotechnology. It provides a platform for innovation across conventional boundaries of science, technology and commerce breaking the traditional production function.

The advancement in nanotechnology is transforming the traditional production function into nanoproduction function bringing about changes in input and output relationship. Scientists as nano scale carpenters all over the world started working to design and develop smart materials for industrial applications. This has enabled us to get smart materials as new inputs for industrial applications and to produce efficient novel products for consumer world. Thus, nanotechnology is almost innovative and its impact on many products and processes causing churn amongst economic winners and losers. Nanotechnology introduced over a time has penetrated the markets at a faster rate than its predecessors. It causes for devising new

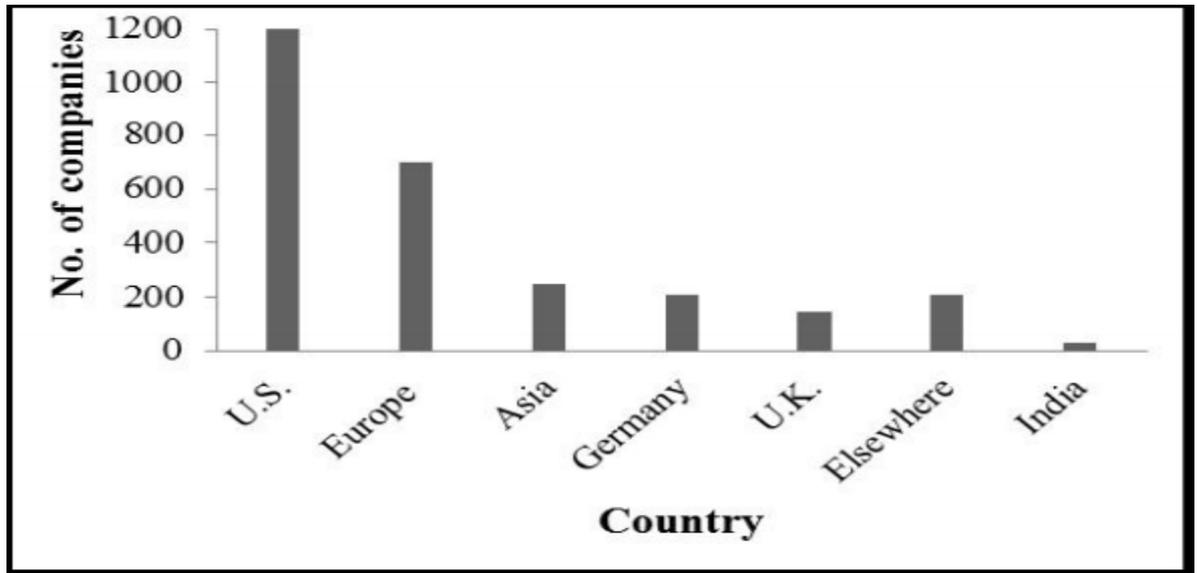
goods and new ways of producing existing goods and services. The development of nanotechnology will break supply chain by changing the taste and preferences of people with nano-products and pave the way for emerging nano market. This technology can bring about revolution in the bits of computers, genes of biotechnology and neurons of network through the nano scale manipulation. This technology and its convergence with IT and BT enhance human performance in production. Thus this magical technology is going to be the gateway for the emerging nanomarket and business environment where the players are expected to play new games as nanoproducers, nanodistributers and nanoconsumers.

The advancement in nanotechnology has profound influence on industrial development. Industries of tomorrow on account of nanotechnology will play a vital role in the knowledge economy. Nanotechnology promises a significant industrial wealth, the applications of which is useful for human welfare. We cannot ignore the dramatic developments in the production of materials and the manner in which materials are designed and manufactured due to advancement in nanotechnology. There are too many effective solutions and too many opportunities coming up in the marketplace. Nanotechnology makes the industries more competitive and drive the system towards new industrial revolution. Thus, Nanotechnology unleashes discoveries and put fuel to the next wave of industrial innovation and growth. Its advancement gives scope for the development of nano factories which are potentially a high quality, extremely low

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cost and very flexible manufacturing system. The growth of companies applying nanotechnology is shown figure-1

Fig-1: Showing the number of Companies Applying Nanotechnology as on 2008



Source: European Commission-2008

Industries are being transformed by the availability and application of nanotechnology. This new technology has allowed for substantial productivity in the manufacturing industries. The advancement in nanotechnology and its convergence with other technologies bring about revolution in the production process causing the flow of novel products in to the market. This new science is a great unknown even though nano-materials are being used for decades. i.e., Chinese Clay. In the mid 1980s, K. Eric Drexler published a paper entitled “Engine of Creation”, to popularize the potential of molecular nanotechnology. Molecular nanotechnology is a manufacturing technology for mass production that would allow precise control and positional assembly of molecule-sized building blocks through the nano-scale manipulator arms. Nanotechnology is

already a blossoming field but molecular nanotechnology is still in the preliminary research stage. This technology can create macro-scale products built from individual molecules using bottom up manufacturing technique.

### INDUSTRIAL APPLICATIONS OF NANOTECHNOLOGY

Nanotechnology Products and Applications database provides information about nanomaterials and nanostructure that are used today for industrial and commercial applications. Nanotechnology is impacting the field of consumer goods and several products that incorporate nanomaterials in a variety of items in the market. People do not even realize that novel products contain nanoparticles. Nanoproducts with novel functions are

**scratch-resistant glass, Car bumpers using nanocomposit, stain repellent cloth, radiation resistant sunscreen, stronger synthetic bones, lighter weight cell phone screens, glass packaging for drinks with longer shelf-life, and nanotexture balls for various sports.** Such novel products have also a promising potential especially in the field of cosmetics and potential applications in heavy industry. Nanotechnology is predicted to be a main driver of business and marketing and holds the promise of higher performance materials, intelligent systems and new production methods with significant impact on the system. Nanotechnology is set to have a major impact on many industries. Its impact on consumer products like cosmetics, clothing, personal care, sports equipment is significant. It is going to address of problem of energy constraints, climate change, affordable health care and access to clean water in the coming days. The demand for nanomaterials in the form of nanocomposites, nanoclays, nanopaints , nanolubricants and nanocrystals has already been in the factor market for industrial applications.

### **Nanocomposites**

An important use of nanoparticles is in the form of nanocomposites, nanomaterials that combine one or more separate components to design and exhibit overall the best properties of each component. This multi-functionality applies not only to mechanical properties but extends to optical, electrical and magnetic ones. A particular type of nanocomposite is where nanoparticles act as fillers in a matrix; for example, carbon black used as a filler to reinforce car tyres.

### **Nanoclays**

Clays containing naturally occurring nanoparticles have long been important as construction materials and are undergoing continuous improvement. Clay particle based composites – containing plastics and nano-sized flakes of clay – are also finding applications in car bumpers.

### **Tougher and Harder Cutting Tools**

Cutting tools made of nanocrystalline materials, such as tungsten carbide, tantalum carbide and titanium carbide are more wear and erosion-resistant and last longer than their conventional counterparts. They are finding applications in the drills used to bore holes in circuit boards.

### **Nanopaints**

Incorporating nanoparticles in paints could improve their performance by making them lighter and giving them different properties. Thinner paint coatings are used on aircraft would reduce their weight which could be beneficial to the environment.. It may also be possible to substantially reduce solvent content of paints with resulting environmental benefits. Anti-fouling surface treatment is also valuable in process applications such as heat exchange where it could lead to energy savings. Other novel and more long-term applications for nanoparticles might lie in paints that change colour in response to change in temperature or chemical environment.

### **Nanolubricants**

Nanospheres of inorganic materials could be used as lubricants by acting as nanosized ball bearings. The controlled shape is claimed to make them more durable than conventional solid lubricants and wear

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additives.. It is also claimed that these nanoparticles reduce friction between metal surfaces particularly at high normal loads.

### Catalysis

Chemical catalysis benefits especially from nanoparticles due to the extremely large surface to volume ratio. The application potential of nanoparticles in catalysis ranges from fuel cell to catalytic converters and photocatalytic devices. Catalysis is also important for the production of chemicals. Platinum nanoparticle are now being considered in the next generation of automotive catalytic converters because the very high surface area of nanoparticles

could reduce the amount of platinum required.

The market for nonmaterial's is growing all over the world. Scientists are busy in designing and developing nanomaterials for industrial application as nano-scale carpenters. The size of nanomaterials of different elements varies from on the nanosclale upto one thousand nanometers. They are in the form of nano-wires, nano crystals, quantum dots, nanoporous solid , nanotubes, and nanosheets/ surfaces. Some nanomaterials successfully designed for industrial applications are shown in table-1

**TABLE:1: LIST OF NANOMATERIALS**

Sl.No	Nanomaterials	Sl.No	Nanomaterials
1	Fullerenes (C60)	8	Aluminium oxide
2	Single-walled carbon nanotubes	9	Cerium oxide
3	Multi-walled carbon nanotubes	10	Zinc oxide
4	Silver nanoparticles	11	Iron nanoparticles
5	Nanoclays	12	Silicon dioxide
6	Carbon black	13	Polystyrene
7	Titanium dioxide	14	Dendrimers

Source: European Commission-2008

Nano scale operations conceive the entire production system based on nanomaterials in such a way that high added value and quality of final products and services as shown in table-2 and fig-2 and fig-3

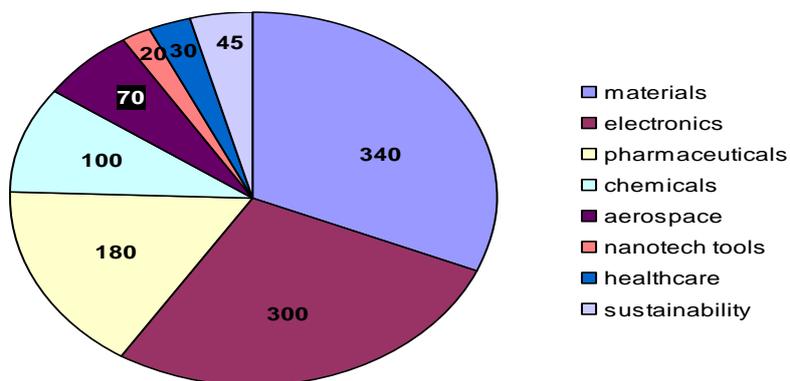
**TABLE-2: SHOWING KEY APPLICATIONS NANOMATERIALS**

Source: European Community-2008

Sl.No	Area	Application Details
1	Electronics and Communications	Storage Media
		Semiconductors
		Bio-molecular Electronics
2	Materials and Construction	Reinforced Materials
		Smart and Inorganic Fluids
		Scratch Proof Surface
		Self Cleaning and reactive eco efficient Windows

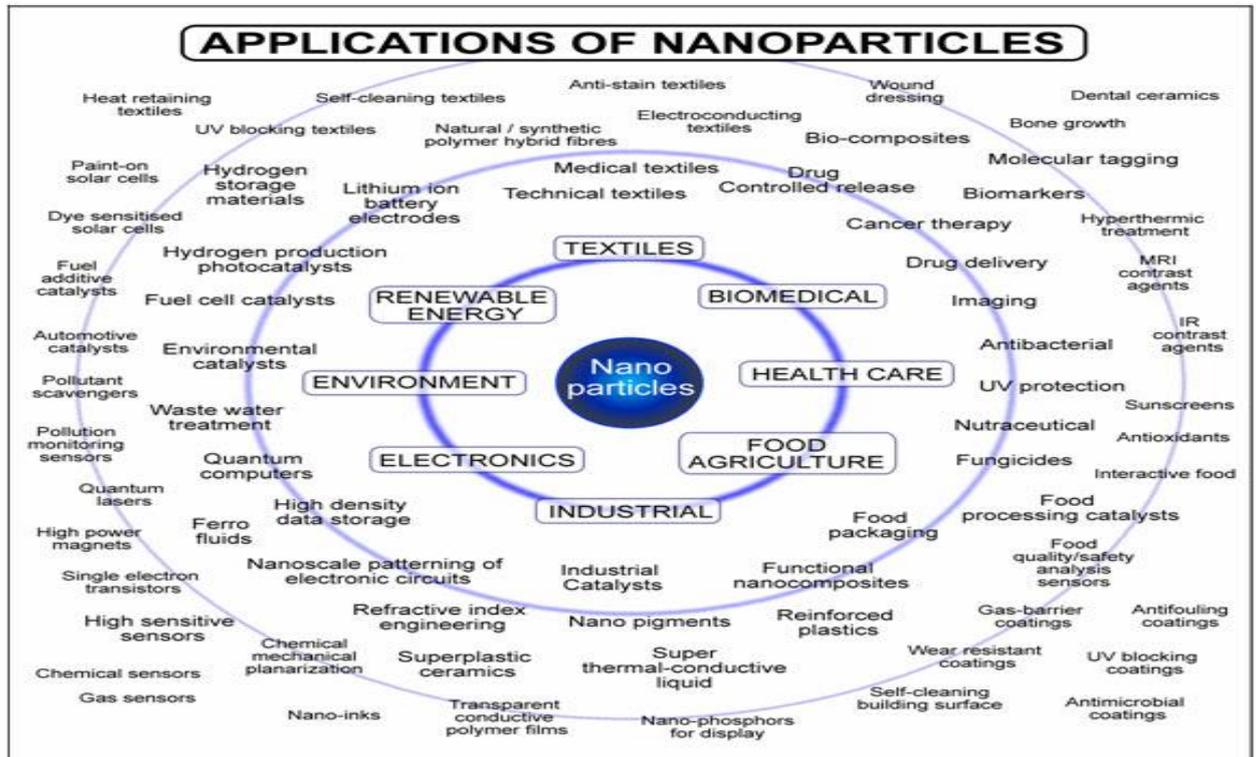
3	Pharmaceuticals and Healthcare	Miniaturized Diagnostics
		Nano-scale Coatings
		Ultra Precise nanostructured drug delivery systems
		Bones and tissue regeneration
4	Machinery and Tools	Extremely sensitive Sensors
		Clinical polishing
		Self assembling of structure from molecule
5	Energy	Batteries
		Artificial Photos for clean energy
		Low cost photovoltaic solar cells
		Safe storage for hydrogen for use as clean fuel
6	Environment and Water	Enhanced structure for water purification
		Nanostuctured filters for removing pollutants
		Improved remediation methods

Fig-2: showing nanoeconomy in the next 15-20 Years



Source: European Community-2006

Fig-3: Showing the Areas of Nanoparticles and their Applications



Source: European Community-2006

**Green Nanotechnology:**

It refers to the use of [nanotechnology](#) to enhance the environmental sustainability of processes producing [negative externalities](#). It also refers to the use of the products of nanotechnology to enhance [sustainability](#). It includes making green nano-products and using nano-products in support of sustainability. Green nanotechnology has been described as the development of [clean technologies](#), "to minimize potential environmental and human health risks associated with the manufacture and use of nanotechnology products, and to encourage replacement of existing products with new nano-products that are more environmentally friendly throughout their [lifecycle](#)."

Green nanotechnology has two goals: producing [nanomaterials](#) and products without harming the environment or human health and producing nano-products that provide solutions to environmental problems. It uses existing principles of [green chemistry](#) and green engineering to make nanomaterials and nano-products without toxic ingredients at low temperatures using less energy and renewable inputs wherever possible and using lifecycle thinking in all design and engineering stages. In addition to making nanomaterials and products with less impact to the environment, green nanotechnology also means using nanotechnology to make current manufacturing processes for non-nano materials and products more environmentally friendly. For example, nanoscale [membranes](#) can help separate desired chemical reaction products from waste materials. Nanoscale [catalysts](#) can

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make chemical reactions more efficient and less wasteful. [Sensors](#) at the [nanoscale](#) can form a part of [process control systems](#) working with nano-enabled information systems

### Nanoremediation and water treatment

Nanoremediation is the use of [nanoparticles](#) for [environmental remediation](#). Nanoremediation has been most widely used for groundwater treatment with additional extensive research in [wastewater treatment](#). Nanoremediation has also been tested for soil and sediment cleanup. Nanotechnology offers the potential of novel [nanomaterials](#) for the treatment of surface water, [groundwater](#), [wastewater](#) and other environmental materials contaminated by toxic [metal](#) ions, organic and inorganic solutes and [microorganisms](#). Due to their unique activity toward recalcitrant contaminants many nanomaterials are under active research and development for use in the treatment of water and contaminated sites. The present market of nanotech-based technologies applied in water treatment consists of reverse osmosis, nanofiltration and ultrafiltration membranes. Indeed, among emerging products one can name nanofiber filters, carbon nanotubes and various nanoparticles. Nanotechnology is expected to deal more efficiently with contaminants which convectional water treatment systems struggle to treat including bacteria, viruses and heavy metals. This efficiency generally stems from the very high specific surface area of nanomaterials which increases dissolution, reactivity and sorption of contaminants.

### Aerospace and vehicle manufacturers

Lighter and stronger materials will be of immense use to aircraft manufacturers for good performance. Spacecraft will also benefit from nanomaterials where weight is a major factor. Nanotechnology might thus help to reduce the size of equipment and thereby decrease fuel-consumption required to get it airborne. [Hang gliders](#) may be able to halve their weight while increasing their strength and toughness through the use of nanotech materials. Nanotech is lowering the mass of super capacitors that will increasingly be used to give power to assistive electrical motors for launching hang gliders off flatland to thermal-chasing altitudes. Much like aerospace, lighter and stronger materials would be useful for creating vehicles that are both faster and safer. Combustion engines might also benefit from parts that are more hard-wearing and more heat-resistant.

### Energy applications of Nanotechnology:

Scientists and Engineers all over the world have been developing energy applications of nanotechnology. [Nanotechnology](#) is any technology that contains components smaller than 100 [nanometers](#). Nanotechnology related to energy is [nanofabrication](#). Nanofabrication is the process of designing and creating devices on the nanoscale. Creating devices smaller than 100 nanometers opens many doors for the development of new ways to capture, store, and transfer energy. The inherent level of control that nanofabrication could give scientists and engineers would be critical in providing the capability of solving many of the problems in the generation of energy technologies. They are also developing ways of utilizing nanotechnology for the development of [consumer](#) products. Benefits already

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observed from the design of these products are an increased efficiency of [lighting](#) and [heating](#), increased electrical storage capacity and a decrease in the amount of [pollution](#) from the use of energy.

### **APPLICATION OF NANOTECHNOLOGY IN INFORMATION AND COMMUNICATION FIELDS:**

Information and communication technology is an important and rapidly growing industrial sector with a high rate of innovation. Enormous progress has been made by making a transition from traditional to nanotechnology electronics. Nanotechnology has created a tremendous change in information and communication technology. Breakthrough in information and communication technology due to nanotechnology can happen in two steps. First step is top-down miniaturization approach which will take conventional microstructures across the boundary to nanotechnology. Secondly, in the longer term, bottom-up nanoelectronics and nanosystem engineering will emerge using technologies such as self-organization process to assemble circuits and systems.

#### **Nanoelectronics**

Nano-scale operation taking place on ultra-integrated electronics combined with powerful wireless technology as low-price mass products, ultra miniaturization, the design of innovative sensors, production of cheap and powerful polytronic circuits, novel system architectures using nanotechnology for future DNA computing and quantum computing to solve problems for which there are no efficient classical algorithms. Due to the development of

nanoelectronic components, quantum cryptography for military and intelligence applications is emerging.

#### **Memory storage**

Memory storage before the advent of nanotechnology relied on transistors, but now reconfigurable arrays are formed for storing large amount of data in small space. For example we can expect to see the introduction of magnetic RAMs and resonant tunnel elements in logical circuits in the near future. Every single nanobit of a memory storage device is used for storing

information. Molecular electronics based on carbon nanotubes or organic macromolecules will be used.

#### **Semiconductors**

Nano amplification and chip embedding is used for building semiconductor devices which can even maintain and neutralize the electric flow. Integrated nanocircuits are used in the silicon chips to reduce the size of the processors.

#### **Display and audio devices**

Picture quality and resolution of display devices has improved with the help of nanotechnology. Nanopixelation of these devices make the picture feel real. Similarly frequency modulation in audio devices has been digitized to billionth bit of signals.

#### **Data processing and transmission**

In the field of data processing and transmission development of electronic, optical and optoelectronic components are expected to lead to lower cost or more precise processes in the field of

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manufacturing technology. Development of nanoscale logical and storage components are made for the currently dominant CMOS technology using quantum dots and carbon nanotubes. Photonic crystals have potential for use in purely optical circuits as a basis for future information processing based solely on light (photonics). In molecular electronics, nanotechnology can be used to assemble electronic components with new characteristics at atomic level. Smaller, faster and better components based on quantum mechanical effects, new architectures and new biochemical computing concept called DNA computing are possible with nanotechnology. The new phenomenon, called the "quantum mirage" effect may enable data transfer within future nanoscale electronic circuits too small to use wires.

### Future nanotechnology areas

Nanotechnology is the next industrial revolution and the telecommunications industry will be radically transformed by it in the future. Nanotechnology has revolutionized the telecommunications, computing and networking industries. The emerging innovation technologies are:

\*Nanomaterials with novel optical, electrical, and magnetic properties

\*Faster and smaller non-silicon-based chipsets, memory and processors

\*New-science computers based on Quantum Computing

\*Advanced microscopy and manufacturing systems

\*Faster and smaller telecom switches including optical switches

\*Higher-speed transmission phenomena based on plasmonics and other quantum-level phenomena

\* Nanoscale MEMS: micro-electro-mechanical systems

### EVOLUTION AND GROWTH OF NANO-MARKET

Nanoproduction function is the gateway of nanomarket. The players are nanoproducers, nanodistributors and nanoconsumers. A nano-market is shaped by the features of buyers and sellers, pricing, supply and demand, production and distribution in the emerging nanobusiness environment. Nanotechnology is a cross-section technology and will redefine all known technologies and markets in the 21st century. It will create new applications and processes and change the production structure. Nanomarket comprises of factor market on input side and novel product market for consumer world. The demand for smart materials on input side is growing rapidly. Nanotechnology will complement and change life science, pharmacy, diagnostic and drug delivery system in medicine, food preservation and food processing, environmental remediation,

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water treatment, energy, electronics, mechanical engineering and so on.

The global markets for pure nanotech products is growing very fast and is estimated at some trillion US dollars by 2020. There are more than 4000 companies and research institutes dealing with nano scale operation in the world. The total markets for nanotechnology worldwide has grown from USD 110.6 billion in 2003 to 299.9 billion in 2006 and USD 891.1 billion in 2015. The data is based on a latest study from Helmut Kaiser Consultancy, Tübingen (Germany). They offer clients a range of services including syndicated reports and customizable consulting solutions that address the nano-market including materials, production technologies and applications. Nano-scale materials are used in a range of consumer products. Some of the applications to be found in the market include much more effective cosmetics offering better protection, more flexible and resistant tennis rackets and non scratch glasses etc. Researchers consider it to be just a matter of time before nano- products start entering into our everyday life. The development of new products and their entry into markets requires large scale R and D investments on nanotechnology. The consumer world is exploding with “nanotechnology enhanced” products. The flow of efficient and attractive novel products for consumer world is going to change the distribution, supply with smart packing and market strategy in the emerging nanomarket.

The emerging nanomarket can be examined both from the angle of product market and factor market. The factor markets encompasses Bio-Plastics Markets ,Batteries and Super capacitors for the Smart Grid ,Smart Glass in the

Automotive Sector, Self-Cleaning Window Markets ,Markets for Low-Cost Sensors ,Powered Smart Card Markets, Building-Integrated Photovoltaics Markets, OLED Lighting Materials Market , Advanced Glazing Systems Market, Markets for Inorganic and Organic Thin-Film PV Encapsulation , Markets for OLED Encapsulation Materials, Markets for Optically Functional Films and Coatings in Displays etc Similarly , the list of nanoproducts market has been growing rapidly. Some popular nano products are Bumpers on cars, Paints and coatings to protect against corrosion, scratches and radiation, Protective and glare-reducing coatings for eye glasses and cars, Metal-cutting tools, Sunscreens and cosmetics, Longer-lasting tennis balls, Light-weight and stronger tennis racquets, Stain-free clothing and mattresses, Dental-bonding agent, Burn and wound dressings, Ink and Automobile catalytic converters.

### Consumer Goods:

#### Surfaces and coatings

The most prominent application of nanotechnology in the household is self-cleaning or "easy-to-clean" surfaces on ceramics or glasses. Nanoceramic particles have improved the smoothness and heat resistance of common household equipment such as the flat iron.The first sunglasses using protective and anti-reflective ultrathin polymer coatings are on the market. For optics, nanotechnology also offers scratch resistant surface coatings based on nanocomposites. Nano-optics could allow for an increase in precision of pupil repair and other types of laser eye surgery.

#### Textiles

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The use of engineered nanofibers already makes clothes water- and stain-repellent or wrinkle-free. Textiles with a nanotechnological finish can be washed less frequently and at lower temperatures. Nanotechnology has been used to integrate tiny carbon particles membrane and guarantee full-surface protection from electrostatic charges for the wearer. Many other applications have been developed by research institutions such as the Textiles Nanotechnology Laboratory at Cornell University.

### Cosmetics

Sunscreens is an important field of nano application. The traditional chemical UV protection approach suffers from its poor long-term stability. A sunscreen based on mineral nanoparticles such as titanium oxide offer several advantages. Titanium oxide nanoparticles have a comparable UV protection property as the bulk material.

### Sports

Nanotechnology may also play a role in sports such as soccer, football, and baseball. Materials for new athletic shoes may be made in order to make the shoe lighter. Baseball bats already on the market are made with carbon nanotubes that reinforce the resin which is said to improve its performance by making it lighter. Other items such as sport towels, yoga mats, exercise mats are on the market and used by players in the National Football League which use antimicrobial nanotechnology to prevent parasuram from illnesses caused by bacteria.

Nanotechnology has tremendous influence over the consumer market and changing consumer behavior. The consumers have become more aware of products and they

are quality conscious. The technological advancement has increased competition giving rise to consumer oriented products and marketing techniques. Consumer behavior is subject to changes in the attitude , motivation, perception , spending habits in the emerging nanomarket. Marketing may be marketing of services and marketing of goods. Service marketing refers to marketing of business to consumers ( B2C) and business to business ( B2B) services like telecommunications services, financial services, health care services, hospitality services , travel services and professional services etc. Nanoproduction will have a significant impact on B2B and B2C business in the emerging new business environment. The number of novel products identified under identified areas of nano-applications is shown in table-3

### Some more common novel products applications are listed below:

- Bumpers on cars
- Paints and coatings to protect against corrosion, scratches and radiation
- Protective and glare-reducing coatings for eyeglasses and cars
- Metal-cutting tools
- Sunscreens and cosmetics
- Longer-lasting tennis balls
- Light-weight, stronger tennis racquets
- Stain-free clothing and mattresses
- Dental-bonding agent
- Burn and wound dressings
- Ink

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- Automobile catalytic converters

Table-3: Showing the details of product Applications of Nanotechnology

Source: European Community-2008

Sl.No	Particulars	No of Products Applications
1	Commodities	1
2	Construction	20
3	Energy	20
4	Environment	8
5	Food	4
6	Food Packaging	1
7	Food Processing	3
9	Filtration	3
10	Liquid Filters	1
11	Industrial	11
12	Information and Communication Technology	13
13	Medical	21
14	Precision Engineering	5
15	Textile and Garments	4
16	Transportation	15

There is competition among countries for R and D investment on this magical technology and thereby to secure a market share. This popular investment is based on the supply and demand for branded nano-products, nano-equities and forward contracts to deliver nano-products in the emerging market. According to National Science Foundation, the market for nano-products would be \$ 1 Trillion by 2010 and it will cross more than \$ 3 trillion by 2020. Nanotechnology is making a significant impact on the jobs we work at and the products that we enjoy. Uniting innovators to bring nanotechnology from **laboratory to marketplace** is the need of the hour. Promoting advanced research insight and best practices, smart packaging, showcasing the latest tools and equipment, enabling strategic partnerships and providing licensing with IPR, developing infrastructure ,venture capital and matching buyers and sellers are the issues of emerging nano-market

### THE EMERGING NANOBUSINESS ENVIRONMENT

Nanobusiness environment would be the totality of the commercial system that creates products and services to buyers and sellers for their transactions. Its scope is directly related to the human activities involving production, distribution, exchange and consumption activities. All kinds of nanosavy profession and occupations, economic agents and their activities contribute to the nanobusiness environment. The advancement in nanotechnology satisfies human needs for exploration across science and technology boundaries. All economic and business activities relating to production and exchange of goods and services for earning economic returns are subject to risk and uncertainty factors in the emerging nanobusiness environment. Both external and internal factors of business environment get affected by the nano-

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scale operations. It will influence on the functioning, performance and decision making process under the new business environment. Factors such as demographic factors, political and legal factors, economic factors, technological factors, natural factors, public and media, customers, market intermediaries, investors and share holders, competitors and employees are external to business. Factors such as man, money, machinery, management, marketing and miscellaneous factors. are 6 Ms' and considered as internal factors. They include vision and mission of the company, dynamic nature of top management in research and development, organizational structure and culture, company image, competitive advantage, capital assets and financial position of the company, human and industrial relation. All these factors get affected by the development and advancement in nanotechnology. The nano scale operations is going to bring about changes in both internal and external factors of business environment.

The knowledge of nanobusiness environment enables to exploit opportunities present in the industry and helps a business to gain a first movers advantage and capture virgin markets. It helps to identify threats present in the industry and to overcome drastic cyclic and seasonal fluctuations and makes business pro-active and cope up with dynamic nanobusiness environment. It is very important to identify the key performance indicators that affect a new business and aid in controlling deviation in performance under nanobusiness environment. The careful examination of nanobusiness environment helps to face competition by analyzing the market share,

market growth, market demand and strategic action of the competitors besides creating a good image in the minds of the public and consumers through constant evaluation, feedback and control over production under nanobusiness environment. In the coming days, nanotechnology is going to be the key driver and determinant of business and economic growth. It will spread its tentacles to all sectors of the economy and bring about revolution in all spheres of life. Business and marketing management becomes difficult without the knowledge of nano scale operations. The advancement in nanotechnology and its convergence with information technology and biotechnology and networking makes business and marketing strategy very complex.

### CONCLUSION

The result analysis of this paper is used to draw some market specific and business oriented conclusions.

The impact of nano scale operation on product development through the production function can be anticipated. Life becomes challenging in the emerging nanobusiness environment with increasing shelf life of nano products. This is time to initiate research nanoproduction function which is a gateway of nanomarket. The development of sophisticated microscope like Transmission Electron Microscope (TEM), Scanning Tunneling Microscope (STM), Scanning Electron Microscope (SEM) and Atomic Force Microscope (AFM) have facilitated nano scale operations leading to nanoproduction function. All products follow a logical product life cycle and it is vital for marketers to understand and plan for the various stages and their unique challenges

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in nanoproducts. The researchers believe that nanomaterials can be used to reproduce almost any inanimate object. By building an object atom by atom, molecular manufacturing is being developed. Molecular nanotechnology can produce new materials with improved performance over existing materials. The nano scale production process is concerned with transforming a range of nano inputs into novel products for market. This involves two main sets of resources under nanoproducts system - the transforming resources and the transformed resources. The transforming resources include the buildings, machinery, computers and people that carry out the transforming processes. The transformed resources are the raw materials and components that are transformed into end products. Any production process involves a series of links in a nano production chain with value addition. Adding value therefore is not just about manufacturing but includes the marketing process covering advertising, promotion and distribution that make the final nano product more desirable. The producers in the emerging nanobusiness environment become nano savvy and they would be identified as nanoproducts. It is very important for businesses to identify the nano production processes that add value and make nanobusiness more attractive. Adding more features by improving quality, changing the packaging and offering the product in different sizes or quantities can make novel product more appealing to nanocustomers.

Nanotechnology based products that address large consumer markets are increasingly being launched. Management at companies making and selling such products must decide how to market those

products. Nano has already found its way into lots of products we use every day, from clothing to tennis racquets. In fact, we can find dozens of products manufactured using some kind of nanotechnology by just browsing through the consumer products using nanotechnology. The companies must decide whether their marketing campaigns should emphasize the nano scale components or materials inside of the products. Notwithstanding the challenges, it may be possible to formulate a highly successful marketing campaign based on the "nano inside" concept. Because there is not a widespread understanding of the subject among the general public, there is an opportunity to educate audiences and establish a leadership position in introducing nanotechnology-based products to the world. People in the emerging nanomarket become nano savvy and identified as nanoconsumers. Companies seeking to promote nanotechnology-based products should apply a strategic and multidimensional approach. In any marketing campaign, companies must clearly articulate this nanotechnology showing its value to the end products or services. The benefits offered by the novel products and their features need to be understood and the unique selling proposition of the nano products need to be studied. In addition, the potential buyers of the nano products need to be identified and understood.

Nanotechnology promises more business opportunities. The impact of nanotechnology on marketing and business environment is profound. There is no business theory well developed to understand the impact of nanotechnology on digital market and business environment. This market information

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system for nanomaterials and nanoproducts is not only useful for data mining in a digital world but also useful for strategic decisions.. **NanoMedia** is a new-generation information carrier with concurrent high-resolution visual display and multispectral storage capabilities for applications across a wide-range of industries. It is ideal for authentication and branding applications and allows for long-term, low-energy, high-capacity storage. Digital marketing also known as data-driven marketing is an umbrella term for the marketing of products and services using digital technologies such as internet, mobile phones, display advertising and other digital medium. Nanotechnology and its convergence with information technology and telecommunications will transform production function causing the flow of nano products into the market. It makes revolution in information technology paving the way for faster and smaller non-silicon-based chipsets, memory and processors. The super computers based on Quantum Computing with giant servers for handling mega data base relating to sales and marketing activities. The data base for nanoresearch and publications , nano companies , smart materials developed and novel products is not well developed. There is urgent need to develop database for nano-materials and nanoproducts create Market Information System using nano media . Listing of nanomaterials designed for industrial applications and novel products flowing into market is need of the hour to work out market strategy in the emerging nanomarket.

Pricing of nanoproducts is an important issue since it covers the actual amount the end user is expected to pay for a product in the market. How a product is priced will

directly affect how it sells. This is to be linked with the perceived value of the nano product. If a product is priced higher or lower than its perceived value, then it will not sell. The price set for nano products must represent value to the customers. By comparing the price of competitors charge and the features they offer, we can assess whether nano product offers greater value for money. That is why it is imperative to understand how customers perceive nanoproducts in the market . if nano product has little value in the eyes of the consumer, then it may need to be underpriced to sell. Pricing may also be affected by distribution plans, value chain, costs and markups and how competitors price novel products in the emerging nanomarket. The issue of pricing is found both in factor and product markets.. Pricing decisions also cover the level of discount offering to to nanocustomers, nanoretailers and nano distributors. So the issue of pricing of nanomaterials in factor market and nanoproducts in the product market should be addressed through the nanoawareness program and training.

The distribution and supply of nanoproducts to the customers of different markets crossing regional and national boundaries is yet another issue of nanomarket . The placement strategy for distribution of nanoproducts is a challenging task. The most appropriate channel for the marketing of novel product with suitable package has to be worked out. About the place of marketing , we must understand where nanocustomers reside and the prospects of buying nano products. If there is B2C transaction , arrangement can be made through retail outlets, mail-order catalogs and the Internet. If the business is from B2B, novel products can be offered



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directly through a sales force or on the Internet or indirectly through nanodistributors in order to maximize sales and minimize transport cost. Therefore, the problem of working out distributive strategy with placement arises in the emerging nanomarket.

The promotion of nano products is also a challenge in the emerging nanomarket. Because customers are not aware of novel products and building preference for brand is a challenging job. We can promote nanoproducts through a variety of nanomedia channels like advertising, direct mail, website content, newsletters and press releases. For effective promotion of nano products, communicate the benefits that are most important to nanocustomers and make them fully aware of nanoproducts. In this regard market research for novel products is helpful for the promotion of nanoproducts.

Nanotechnology can change the nature and attitude of stake holders of business and marketing fields. In the coming days, People become nano savvy and their life style will change in the smart business environment. The word nano becomes fashion and prefixed to identify the stake holders as nanoproducers, nanodistributors, nanomarketeers, nanoconsumers in the emerging nanomarket. Nano Businessmen, market experts and nanoscientists know too little about each other's fields and this has become major constraint for policy decisions. The work force at different levels in the manufacturing sector is not trained to work at nano scale in the knowledge based economy. They are not aware of nanotechnology and its effect on production function and marketing. The

human resource management is going to become complicated in the emerging nanobusiness environment. We have to work out strategy for business development considering nano production process, nanolabour and nano marketing. There is urgent need to create nano awareness among different stake holders of marketing and business entrepreneurs. to *steam* the engine of nanotechnology for business development.

Nanotechnology as a general purpose technology is going to bring about changes in commerce and business education. The present business education fails to consider nano scale operation and its impact on marketing and business activities. There is need to create trained nanolabour force through nanoeducation to manage increasing nanobusiness activities. The R and D investment on nano scale activities should be increased. Invention and innovation of nanotechnology should be carefully used for commercial purpose. In this process, the role of entrepreneurs to put the new invention into practice should not be neglected.

The development of infrastructure for nanotechnology is really a challenging task in the present century. We have to carefully study the necessary and sufficient infrastructure for nanotechnology. For this, educational infrastructure can be created by teaching nanotechnology as a compulsory subject in universities and colleges. Nanoresearch activities in university and colleges should be encouraged. The future work force to work in the knowledge based economy and smart business environment should be trained. There is need to constitute an



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expert committee to study the problem of nanoinfrastrure in the knowledge based economy.

Nanotechnology is going to integrate other advanced technologies like IT, BT and Networking through the convergence technology and making revolution in bits, gene and neurons. There is urgent need to study the changes in IT, BT and Networking due to advancement in nanotechnology and their influence on production function and novel products in the new business environment. Business analysis in the light of nanotechnology and its convergence is the need of hour and it can uncover many hidden benefits for human welfare.

Venture capital plays a key role for the advancement of nanotechnology in the knowledge economy..As nanotech-based consumer products are commercialized, management must grapple with how to market those products. As of August 21, 2008, the Project on Emerging Nanotechnologies estimates that over 800 manufacturer-identified nanotech products are publicly available with new ones hitting the market at a pace of three to four each week. When it comes to nanotech companies, the entrepreneurs really need to think about the new business models.The nanocompanies may issue nanobonds to raise capital for their activities. The venture capital firms have to work out strategy to finance nanotech companies. There is urgent need for venture capital to take the inventions of nanotechnology from laboratory to the market place. The careful examination of this situation uncovers information about tiny nanofactories, nanocompanies, issue of nanobonds and their effect on capital market and the

importance of venture capital and it becomes helpful for policy decisions

Nanotechnology will touch all aspects of business covering, production, employment, output, pricing, and marketing and create global competitiveness. Concern about emerging technology and its impact on business systems is very important. In order to take the benefits and opportunities of Nanotechnology in business, policy makers all over the world should be kept informed about the impact of nanotechnology on business environment. The global leaders can play a greater role in transforming the nano inventions from lab to market for commercial exploitation. Similarly the attention of international organizations should be drawn towards this issue to get international co-operation.

### **ABOUT FUTURE RESEARCH**

Marketing is very important to facilitate continuous production in the business environment by reducing the gap between production and consumption activities. Market in a digital world is really a challenging task and the marketing force should be aware of products and they are reaching customers using digital tools through the customer relationship management. Nanotechnology is the general purpose technology and it is going to create second industrial revolution. It impact on production function ,which is a gateway for nanomarket, is formidable. The demand for nanomaterials is continuous increasing for industrial applications and its market is a question of some trillion dollars. At the same time , nanoproducts are entering into the market and unfortunately the stake holders are not aware of nanoproduction function and its



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marketing process. People engaged in marketing and salesmanship are not fully aware of nanotechnology and its impact on their activities. There are many issues to take up for research in the emerging nanomarket. This paper draws the attention of market researcher towards nanoproduction function and development of novel product, market for nanomaterials, nanotraining for the marketing personnel, Nanomedia and Nanomarket Information System, the growth of Nanofirms, Nanoeducation and Training, IPR for Nanoreserch and Products, development of Nanoinfrastructure and the scope of further research goes as long as nanotechnology bombarding the system of scarcity from the bottom up approach.

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