

Business Strategy for Nanotechnology Based Products and Services

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Abstract

The applications of nanotechnology in different identified areas provide lots of business opportunities. It includes Food, Medicine, Cleaner water, Better quality air, Electronics, Fuel Cells, Solar Cells, Batteries, Space Travels, Chemical sensors, Sporting goods, Fabrics, Cleaning products, Energy, Environment, Health, and Life span increase. The paper covers the applications, and benefits of nanotechnology innovations in different industries, possible business opportunities for new nanotechnology based products and services due to challenges for human prosperity on earth, and the global strategy on nanotechnology business with an expected time scale and future possibilities of nanotechnology innovations based on products and services in the field and the magic (like science fictions) going to happen in human life. In this paper, important nanotechnology features and their usage in industry, various products and services based on nanotechnology innovations and Business Strategy for them are identified. Applications & benefits of NT in Agriculture, Food packing & Clean water, in Renewable Energy & Storage, and in Medicine are discussed. Various Business Opportunities for New Nanotechnology based Products and Services, Developing a global strategy for Nanotechnology Business including PEST analysis model and ABCD analysing framework. Finally, some of the Future possibilities of nanotechnology innovations are mentioned and discussed.

Keywords: *Nanotechnology applications, Business based on Nanotechnology products & services, Global strategies to be used in Nanotechnology business.*

I. INTRODUCTION

The term business is commonly referred as doing anything with profit motivation. Organizations involved in business always develop their objective on sustainable profit for long term through formulating proper strategy. The term strategy in business management is viewed as long term or shortcut systematic plan to ensure winning in the process of reaching the objectives of the organization. The organizations which are involved in business of both products and services have similar objectives of earning profit for sustainable growth and expansion. The various strategies followed by organizations for sustainability and growth in their business model are competitive/red ocean strategy [1], monopoly/blue ocean strategy [2], environmental care/Green ocean strategy [3], unethical/black ocean strategy [4] or mixed /white ocean strategy [5]. Business organizations can sustain in their business based on using these strategies until there is a drastic change in features of products/services or in the business model. For example, due to advents in technology, the classical business model called brick and mortar model is changed to click and mortar model. Similarly it is anticipated that the breakthrough of nanotechnology is going to change the features of products and services in almost all areas in the society. The nanotechnology is expected to be the general purpose technology and is going to affect both basic needs and the aspirations of human life. The applications of nanotechnology in different identified areas provide lots of business opportunities. It includes Food, Medicine, Cleaner water, Better quality air, Electronics, Fuel Cells, Solar Cells, Batteries, Space Travels, Chemical sensors, Sporting goods, Fabrics, Cleaning products, Energy, Environment, Health, and Life span increase. These applications of nanotechnology in the society is expected to change the definition of civilization in the future generations and going to change the features and various products and the services so that business organizations may have to worry on developing new strategies for continuing in the business.

Table 1 : Nanotechnology features and their usage in Industry.

S. No.	Social Problem	Nanotechnology based solution	Industry/Society Usage
1	Nutritious food	Nano additives, Nano capsules, and Nanoparticle emulsions	Improving the nutritional value of foods, Improve the taste, colour, and texture of foods.
2	Food Synthesizer	Nanotechnology based simple machine that can be used to make any food for which it has a suitable "recepte", satisfies the visceral needs of good taste, and enjoyment.	Tasty and nutritious food to everybody at very low cost. This will completely solve the food scarcity in the world.
2	Clean drinking water	Nanotech filters	Conversion of salty water in to drinking water in large scale. Removal of micro pollutants, water softening, and wastewater treatment.
3	Renewable energy	Nanotech based solar cells and nano-polymer coatings.	High efficiency, low cost solar parks for electricity generation.
4	Shelter	Nanotechnology based power shelters. Low cost, highly durable building materials.	Low cost smart homes with self-sustainable electricity generation.
5	Poverty	Nanotech based food products, Nanofilters, nanophotovoltaic cells, nanodrugs solve basic problems of human beings.	Nanoproducts in health, food, energy and clean water produced in large scale at low cost will help to eradicate poverty.
6	Sustainable health	Nanotech monitored drug delivery, Nanomedicine, nanotech based organ replacement.	Monitoring & controlling diseases, Diagnosis, prevention and Treatment.
7	Long life	Nanotech in regenerative medicine & tissue engineering.	Life span expansion by curing all type of diseases.
8	Social Security	Nanotech based identification systems	Removes the discrimination due to gender, race, region, community, religion, etc.
9	Quality higher education	Nanotechnology applications will improve Information communication technology by improving the bandwidth and reducing communication cost.	Higher education will be online and ubiquitous and opportunity will be available for everybody.
10	Corruption	All basic human requirements will be solved using nanotechnology innovations.	When individual problems are solved through technology, people will have equality opportunity so that social evils like corruption, inequality etc. will become minimum.

II. NANOTECHNOLOGY PRODUCTS & SERVICES

Table 2 : Nanotechnology Products

S. No.	Type of Products	Nanotech based innovation
1	Food Product 1 :	Food processing Nanofilters
2	Food Product 2 :	Nanocarrier systems for delivery of nutrients and supplements in the form of liposomes or biopolymer-based nanoencapsulated substance
3	Food Product 3 :	A range of inorganic additives (silver, iron, silica, titanium dioxide, selenium, platinum, calcium, magnesium) is available for supplements, nutraceuticals, and food and feed applications.
4	Food Package 1 :	TopScreen is a range of ecological finished barrier coating formulations, used in the production of paper or cardboard destined for packaging with specific barrier requirements.
5	Food package 2 :	Plastic polymers with nanoclay as gas barrier; nanosilver and nanozinc oxide for antimicrobial action; nanotitanium nitride for strength.
6	Food Package 3 :	A number of nanomaterial-based coatings are available for food preparation surfaces and for coating food preparation machinery.
7	Drinking water from Sea :	Nanotechnology based sea water desalinator.
8	Drinking water from sewage systems :	Nanotech based graphene treatment plant
9	Drinking water from contaminated sources	Nanofilter based water purifier
10	Electricity	Nanofilm coated solar cells & Panels
11	Battery	Nanotube based Li-ion Batteries
12	Fuel Cells	Graphene based ultracapacitors
13	Cosmetics	Nano-sunscreens, Anti-aging skin cream, Hair growth products using liposomes and ethosomes.
14	Medicines	Diagnostics products, therapy products,
15	Sports equipments	Nanotechnology based Tennis Ball, , football helmet, baseball bats, tennis and badminton racquets, hockey sticks, racing bicycles, golf balls/clubs, skis, fly-fishing rods, archery arrows, etc.
16	Automobile parts	Light & strong components, Fuel efficiency, durable tires, Coatings and paints, Sensors, engine coolents, batteries, fuel cells etc.
17	Drug delivery	Polymeric micelles based nanoparticles can be used for drug delivery systems, Nano-Photodynamic therapy etc.
18	Building materials	Nanotech based concrete, corrosion inhibitor coatings for roofing, self-cleaning coatings for glass, nanoporous aerogel materials as insulation materials, UV adsorbing nanoparticles, nanofiltration and light activated nanoparticles.
19	Electronic components	Nanotech based computer processors, Nanomemory devices, Nanophotonic devices, Nanotech based display devices, Nanotech detectors etc.

Table 3 : Nanotechnology services :

S. No.	Type of Services	Nanotech based innovation
1	Advertising	Innovations in displays boards
2	Banking	Innovations in security & information storage
3	Insurance	Innovation in information collection and storage, Online business in insurance
4	Retailing	Improved product features, Using high speed and secured technology based on nano devices
5	Tourism	Increased speed of communication using nano-electronic devices
6	Transportation service	Nanotech based communication and tracking, online reservation etc.
7	Distribution	Nanotech based communication and tracking.
8	Hospitality and food services	Nanotech based food processing, food packaging, food delivery, clean water supply, reduce, reuse, and recycle waste etc.
9	Entertainment and Recreation	Nanotech based energy, electronic equipments, Entertainment equipments and Recreation systems.
10	Mass communication & Media	Nanotech based communication and storage devices, e-media etc.
11	Health Care services	Nanotechnology based health diagnosis, Health therapy and health information service.
12	Electronic Communication services	Nanotech based electronic devices to improve the bandwidth and authentication, electronic documents etc.
13	IT & IT enabled services	Nanotechnology based IT hardware components improves the quality of IT enabled services.
14	Education Services	Nanotechnology helps to improve online services including education services. Nanotechnology also helps to improve multi-media based education.
15	Public utility services	Nanotechnology based opportunities improves the public utility services related to rainwater, waste and recycling, water and waste water, toxics, community and energy.
16	Real Estate & Leasing	Nanotechnology improves ICT which improves the quality of services in various real estate and leasing processes.
17	Public Administration services	Nanotechnology based innovations in food processes, water and waste management, energy and health management improves the public administration services.
18	Defence Services	The various resources used in defence services are improved in terms of their quality using nanotechnology.
19	Business support services	Nanotechnology based control of greenhouse gases emission improves the quality of various business support services.
20	Marketing services	Nanotechnology supported marketing concepts based on reducing, recycling and re-using resources improves the benefits of marketing services.
21	Professional, scientific and technical services	Since nanotechnology is going to be general purpose technology, the quality of many professional services can be improved by using nanotech based innovations.
22	Social services	Nanotechnology based environmental sustainability and decreasing environmental degradation improves the quality of social services in the society.

III. APPLICATIONS, AND BENEFITS OF NANOTECHNOLOGY INNOVATIONS

(1) Food & Water :

Advances in nanotechnology supports to secure a healthy food supply by enabling cost-effective methods for the early detection of insects, diseases, and other contaminants, to improve plant and animal breeding, and create high value-added products of nanobiomaterials for food and non-food applications [8]. Nanomaterials are used in different types of food & food packaging with following examples :

(1) Nanoparticles are being used to deliver vitamins or other nutrients in food and beverages without affecting the taste or appearance. These nanoparticles actually encapsulate the nutrients and carry them through the stomach into the bloodstream. For many vitamins this delivery method also allows a higher percentage of the nutrients to be used by the body because, when not encapsulated by the nanoparticles, some nutrients would be lost in the stomach.

(2) Development of nanocapsules containing nutrients are underway that would be released when nanosensors detect a deficiency in our body. This could result in a super vitamin storage system in our body that gives just what and when we need.

(3) Nanomaterials are being developed to improve the taste, colour, and texture of foods. For example “interactive” foods are being developed that would allow you to choose which flavor and colour a piece of food has. The idea is that nanocapsules that contain flavour or colour enhancers sit in the food waiting until a hungry consumer triggers them.

(4) Nanoparticle emulsions are being used in ice cream and various spreads to improve the texture and uniformity.

(5) Nanosilver is incorporated in food cutting boards, cleaning sprays, kitchenware, food storage containers and refrigerator compartments for its antimicrobial properties.

(6) Nanoparticles in nanoceuticals and nutritional supplements, such as colloids of zinc nanoparticles and other nano-sized minerals, and nano-encapsulates are on the market with claims of having enhanced uptake and/or targeted delivery of content (Bouwmeester et al. 2009 [9]).

(7) Nanoparticles such as nanoclays are incorporated into plastic beer bottles to increase strength, make them more shatterproof, and extend shelf life by acting as a barrier to keep oxygen outside the bottle and carbon dioxide inside.

(8) Bottles made with nanocomposites that minimize the leakage of carbon dioxide out of the bottle; this increases the shelf life of carbonated beverages without having to use heavier glass bottles or more expensive cans.

(9) Food storage bins with silver nanoparticles embedded in the plastic. The silver nanoparticles kill bacteria from any food previously stored in the bins, minimizing harmful bacteria.

(10) Nanosensors in plastic packaging can detect gases given off by food when it spoils and the packaging itself changes color to alert you to food gone bad. Plastic films are being developed that will allow the food to stay fresher longer. These films are packed with silicate nanoparticles to reduce the flow of oxygen into the package and the leaking of moisture out of the package.

(11) Nanosensors are under development to detect bacteria and other contaminants such as salmonella on the surface of food at a packaging plant. This will allow for frequent testing at a much lower cost than is incurred by sending samples to a lab for analysis. This point-of-packaging testing, if conducted properly, has the potential to dramatically reduce the chance of contaminated food reaching grocery store shelves.

(12) Nanosensor based detectors are being developed to detect pesticides on fruit and vegetables. While this would be useful at a packing plant I'm anxiously waiting for the handheld version so I can check out the apples and grapes in my local grocery store.

(13) Targeted delivery of salty taste using nanomaterials could potentially be developed and lead to reduced salt intake, in turn reducing hypertension and health disease (Chen, Weiss, and Shahidi 2006 [10]).

Nanotechnology innovations in low cost water purification are expected to solve drinking water problem of the world. Agriculture currently uses 70% of the world's water supply. To feed 2 billion more by the year 2030 there will be a 60% increase in demand on the water supply. Considering the current rates of consumption, population and development, some two-thirds of the world population will be affected by droughts by the year 2050 which will increase the demand for fresh water. Nanotechnology filters play an important role in converting sea water in to pure drinking water thereby providing a possible solution to the problem of the world's ever-growing population demanding more and more fresh drinking water. Another variety of nanotechnology based microbe filters relies on silver nanoparticles embedded in a cage made of aluminum and chitosan, a carbohydrate derived from the chitin in crustacean shells. The cage blocks macroscale water contaminants as well as protects the nanoparticles from sediments that would otherwise accumulate on their surfaces, thereby preventing them from releasing microbe-zapping ions. Thus nanotechnology based filters can be used for purification of sea water and contaminated water for drinking purpose. Nanotechnologies will produce huge environmental benefits in terms of water management and treatment by improving filtering, decontamination, desalination, conservation, recycling, analysis and monitoring and sewerage systems.

Table 4 : Applications & benefits of NT in Agriculture, Food packing & Clean water

S. No.	Applications	Benefits
1	Nanotechnology in Agriculture	Maximizing Productivity of Agriculture Precision farming using nanosensors, pest nanocides, and inexpensive decentralized water purification.
2	Plant gene therapy	Creating pest resistant, high yield crops that require less water.
3	Nanoparticles for removing contamination, moisture sensors, detection of pathogens.	Higher crop yields, reduction in the use of pesticides and improved water management.
4	Nanotech in food and drink packing	Tracking, quality monitoring and anti-counterfeiting, provides enhanced information on product and is environmentally friendly.
5	Use of nano-sized additives in food products	Better dispensability of water insoluble additives in food products without the use of additional fat or surfactants. To enhance taste and flavour due to the enlarged surface areas of the nano-sized additives, and enhance absorption and bioavailability in the body compared with conventional bulk forms.
6	Nano-encapsulated nutrients and supplements	Enhanced bioavailability, antimicrobial activity, and other health benefits.
7	Use of certain inorganic nano-sized additives including transition metals (e.g. silver, iron), alkaline earth metals (e.g. calcium, magnesium), and nonmetals (e.g. selenium, silica).	Enhanced tastes and flavours due to enlarged surface areas, enhanced absorption and improved bioavailability.
8	Anti-microbial and anti-fungal packaging, smart sensing, biodegradable packaging.	Improved barrier properties and heat-resistance.
9	Nanotech agri-food packaging	Anti-counterfeit, anti-tamper, anti-microbial, sensors (temperature, moisture, light, decay), integrated power (intelligent tags, self-healing containers)
10	Nano-filtration membrane technology	Removal of dissolved salts from salty water, removal of micro pollutants, water softening, and wastewater treatment.

(2) Energy & Energy Storage :

Energy is the most important basic resource after food and water for human prosperity. Demand for energy on earth is forecasted as increasing 50% by the year 2025 with most of these being fossil fuels. Currently over 1.6 billion humans have no access to electricity and 2.4 billion rely on plant material, vegetation, or agricultural waste as an energy and heating source. It is estimated that our fossil fuel consumption is escalating and could become double by the year 2025. Meanwhile, Earth's glaciers are receding, the CO₂ concentrations in the atmosphere have nearly doubled, and world temperatures, recorded since 1861, were the hottest in three of the past five years. 1998 was the warmest of record, 2001 came in the second warmest and 2004 was the fourth warmest [6]. Nanotechnology innovations in renewable energy solves entire energy requirement of human beings for their basic needs and for the comfortable life. Balancing humankind's need for energy with the environmental cost to our planet is a major challenge. Nanotechnology based energy solutions through more efficient lighting, fuel cells, hydrogen storage, solar cells, locally distributed power generation, and decentralized generation and storage by reinventing the power grid are expected to create more potential business opportunities.

Using nanotechnology battery storage capacity could be extended, solar cells could be produced cheaper, and the lifetime of solar cells or batteries for electric energy applications could be increased.

Table 5 : Applications & benefits of NT in Renewable Energy & Storage

S. No.	Applications	Benefits
1	Organic dye sensitized solar cells	Improved efficiency and cost reduction
2	Use of Si nanocrystals with different band gap values as solar panels	Higher conversion efficiency
3	Nanocoating as anti-reflection layers on solar cells	Increases the energy yield
4	Nanomaterials have higher specific electrode surfaces	More powerful batteries, accumulators and supercapacitors
5	Use of Nano materials with quantum dots and nanolayers	Optimized light absorption properties.
6	Nanostructured fillers in component of high voltage power lines	High electrical insulation.
7	Epoxy made of carbon nanotubes used in rotor blades of wind power plants	Improved strength of rotor blade parts.
8	Nanomaterials are potential ingredients in achieving high temperature superconductors	Energy savings by reducing loss.
9	Nanomaterials acts as better catalyst in production of petrol from Crude oil	Improves the efficiency of fuel production.
10	Nanotechnology based storage batteries	Batteries that are less flammable, quicker-charging, more efficient, lighter weight, and that have a higher power density and hold electrical charge longer.
11	Nanomaterial based heat absorbing sensors	Converts waste heat in computers, automobiles, homes, power plants, etc., to usable electrical power.

(3) Medicine: Things behave differently at the nanoscale. An excellent example is the fact that gold (which looks yellow at our “normal” scale) actually reflects red light at the nanoscale. This has resulted in the design of experimental systems that kill cancerous cells with normal visible light, but leave normal cells unharmed. Nanotechnology based devices can be developed to keep track of daily changes in physiological variables such as the levels of glucose, of carbon dioxide, and of cholesterol, without the need for drawing blood. Also, body tissue can be reproduced or repaired using nanotechnology, which could eventually develop into treatments to replace or repair organs. When a cell of human body get damaged, with the help of nanobots, damaged cells are completely rebuilt, one atom at a time, creating a flawless and brand new, or better than new youthful cell. Nanobots work like tiny surgeons as they reach into a cell, sense damaged parts; repair them by reformatting new atoms, and leave. By repairing and rearranging cells and surrounding structures, nanobots can restore every tissue and bone in the body to perfect health – including replacing aging skin with new, resilient skin, restoring youthful looks and good health. Thus nanotechnology supports drug delivery, therapy techniques, diagnostic techniques, antimicrobial techniques, cell repair, cancer detection & curing, gene therapy, nanotech in regenerative medicine & tissue engineering, life span extension etc.

Table 6 : Applications & benefits of NT in Medicine

S. No.	Applications	Benefits
1	Nanoparticulate drug delivery	Better patient care and understanding of biological processes.
2	Nanosilver dressings	To prepare wound healing material
3	Semiconductor nanocrystals fluorescent biological labels	Can be used as fluorescent probes in biological staining and diagnostics as superior to existing fluorophores.
4	Diagnostic tools,	Methods for prevention of diseases.
5	Drugs and drug discovery	early detection and prevention of diseases.
6	Prosthetics and implants	Nanotechnology implants can monitor the body chemistry of patients and trigger drug release at a specific location inside the body Biological implants and nanoelectronic devices can be used to enhance sight for the vision impaired and hearing for those who are hard of hearing.
7	Non-invasive or minimally invasive surgical tools, gene chips and biochemical sensors	Early detection and prevention of diseases
8	Cancer detection & curing	Detection & Treatment of Cancer.
9	Nanotech in regenerative medicine	Eventually develop into treatments to replace or repair organs.

IV. BUSINESS OPPORTUNITIES FOR NEW NANOTECHNOLOGY BASED PRODUCTS AND SERVICES

The following nano-technology product have huge business opportunities :

- (1) Any agricultural product which supports improvement in agricultural crop yield.
- (2) Any product which controls crop diseases.
- (3) Any product which avoids the usage of pesticides.
- (4) Any product which simplifies agricultural production work.
- (5) Any Product which decreases the cost of agricultural production .
- (6)) Any Product which decreases the cycle time of the crops.
- (7)) Any Product which lowers the water requirement for irrigation and other resources.
- (8) Any product which supports to removal of dissolved salts from salty water.
- (9) Removal of micro pollutants.
- (10) Water softening and wastewater treatment.
- (11) Any food product with nano- additives to enhance taste and flavour.
- (12) Any nanotech based food and drink package to tracking, quality monitoring and anti-counterfeiting.
- (13) Any product with nano-encapsulated nutrients and supplements to improve the health condition.
- (14) Any Cosmetics product with better performance.
- (15) Any nanotechnology based packaging which keeps food items fresh for long period.
- (16) Any nanotechnology based food item which decreases the hungriness of human beings without affecting their normal life.
- (17) Any product which keeps teeth white and strong.
- (18) Any product based on nanotechnology which growths hair selected places of the human body like head.
- (19) Any product based on nanotechnology which improves the quality of games and sports materials.
- (20) Any nanotechnology food product prepared artificially.
- (21) Any product based on nanotechnology to clean the air of the atmosphere.
- (22) Products for nanotechnology based energy solutions through more efficient lighting, fuel cells, hydrogen storage, solar cells, locally distributed power generation, and decentralized generation and storage by reinventing the power grid.
- (23) Nanotechnology based long-life cheaper cloths with no wrinkle, stain, or allow the growth of bacteria.
- (24) Any products like anti-microbial socks, underwear and sporting apparel, wind and water proof jackets, wrinkle and stain resistant suits, casual wear and swimsuits that protect against UV rays.
- (25) Nanotechnology based fabrics which is water and stain resistant, insulates against heat or chill, dirt rinses off in rain, and reduces odours and bad smell.
- (26) Nanotechnology based construction materials with properties like energy efficiency, ultra high strength, extra durability, and extremely lightweight.
- (27) Nano-modified cement for improving concrete properties, performance and durability.
- (28) Nanotechnology based medicine for diseases like HIV/AIDS, Ebola, Cancer, and the Avian Flu.
- (29) Products like nanorobots which can slow or reverse the aging process, and life expectancy.
- (30) Products like nanorobots which can perform cosmetic surgery, rearranging the atoms of human body to change ears, nose, eye color or any other physical feature of human beings as per their wish to alter.
- (31) Any nano-system which build various products with molecular-level precision with virtually no chemical waste and pollution.
- (32) Any nanotech based product made by more efficient and lighter materials for automotive and aircraft systems, High performance tyres for automobiles, efficient and non-platinum based catalytic converters, novel more efficient fuel and power sources etc.
- (33) Any low cost nanotechnology products which increases the performance of memory, displays, processors, solar powered components, and embedded intelligence systems.
- (34) Any nanotech product which improves the efficiency of home entertainment electronics, 3D televisions, performance of videogames etc.
- (35) Any nanotech system which supports preparation of drugs containing nano-sized active ingredients.
- (36) Any breakthrough drug delivery systems based on nanotechnology that allow deposition of medications in previously inaccessible areas of the body, and improved diagnostic tests and medical devices.
- (37) Nano-photonics based computer systems with infinite storage ability, infinite bandwidth, and infinite processing ability at tremendous speed.
- (38) Nanotech based materials and devices which supports low cost and secured space exploration like propulsion fuels, coatings, structural materials, smart uniforms, electronics and life support environments.
- (39) Nanotechnology based 3D printer systems which allow to replicate anything, including diamonds, water and food.
- (40) Nanotechnology supported system for removal of a substance called lipofuscin from certain types of non-dividing cells, including the brain, heart, liver, kidneys and eyes to extend the human lifespan.

The following nano-technology based services have attractive business opportunities :

- (1) Advertising services using nanotechnology to decrease environmental foot print.
- (2) Nanotech supported Banking and Insurance services by improving security & information storage ability.
- (3) Retailing service can be supported by high speed and secured technology based on nano devices
- (4) Using nano-electronic devices tourism service can be improved by using increased speed of communication.
- (5) The quality of transportation services can be improved using nanotech based communication and tracking, online reservation etc.

- (6) Hospitality and food services can be also improved using nanotech based food processing, food packaging, food delivery, clean water supply, reduce, reuse, and recycle waste etc.
- (7) Entertainment and Recreation services can be improved using nanotech based energy, electronic equipments, Entertainment equipments and Recreation systems.
- (8) Mass communication & Media services can be improved using nanotech based communication and storage devices, e-media etc.
- (9) Nanotechnology based health diagnosis, Health therapy and health information service will support to improve quality Health Care services.
- (10) Electronic Communication services get support by nanotech based electronic devices to improve the bandwidth and authentication, electronic documents etc.
- (11) Nanotechnology based IT hardware components improves the quality of IT enabled services.
- (12) Nanotechnology helps to improve online education services with improved multi-media based education.
- (13) Nanotechnology based opportunities improves the public utility services related to rainwater, waste and recycling, water and waste water, toxics, community and energy.
- (14) Nanotechnology in Real Estate & Leasing service improves ICT which improves the quality of services in various real estate and leasing processes.
- (15) Nanotechnology based innovations in food processes, water and waste management, energy and health management improves the public administration services.
- (16) The various resources used in defence services are improved in terms of their quality using nanotechnology.
- (17) Nanotechnology based control of greenhouse gases emission improves the quality of various business support services.
- (18) Nanotechnology supported marketing concepts based on reducing, recycling and re-using resources improves the benefits of marketing services.
- (19) Using the general purpose technology characteristics of nanotechnology, the quality of many professional services can be improved.
- (20) Nanotechnology based environmental sustainability and decreasing environmental degradation improves the quality of social services in the society.

Any business organization which focus on research and development in above products and services and capable to market them has opportunity for sustainable growth for long time.

V. DEVELOPING A GLOBAL STRATEGY FOR NANOTECHNOLOGY BUSINESS

- (1) First entry advantage for R & D : An organization which identifies the opportunity in above discussed products and services and invests for developing such products or services will get first movers advantage due to the fact that the new product or service developer can patent such discoveries/innovations.
- (2) Identifying new areas of Nanotechnology Applications : While investing on R & D, and developing the product or services, the organizations have to use blue ocean strategy to develop unique products or services in new but essential area of application in the society.
- (3) Focusing on Solutions to Basic Need Problems Area : While considering the market size, the products and services developed using nanotechnology addressing basic needs of the people of the society have better market opportunities so that such organization can prosper quickly.
- (4) Focusing on Solutions to Luxurious Problems Area : Organizations can also plan their strategy to identify the possible products and services related to the comfortability of the users. Such products or services can be sold at premier price to increase the profitability of the organization.
- (5) Developing low cost products and services in Basic Need Problems Area : Since the business organizations have social responsibility, they have to plan to develop products related to the basic needs of the people as well as luxurious products or services for the comfortability of the people. Such low cost strategy is important in improving the brand image of the organization.
- (6) Developing Premier Products and services in Luxury Area : The products or services identified should be developed through focussed research in the field either by self-investment or through collaboration to get the first movers advantage.
- (7) Identifying new applications of developed Products & Services : The organizations can also focus on identifying new applications of the products or services developed through their innovative strategy.
- (8) Focusing on Environmental benefits by Greening the Products and Services : The organizations doing business in nanotechnology based products/services have to focus on environment and the negative effect of the technology. Organizations have to monitor the dangerous effect of their product/services to take care of future generations.
- (9) Studying and avoiding side effects and social impact of developed Products and services :
To know the side effects of the developed products/services before marketing them, the organization should do enough testing systematically. In case of medicinal products, proper clinical trials have to be organized to test the consequences of the side effects.
- (10) Studying the business environment for developed products to follow suitable business strategy : While identifying the opportunity through business analysis and developing the products/services for production and marketing, the organization should select its business strategy by using either competitive or red ocean strategy, monopoly or blue ocean strategy, environmental sustainability or green ocean strategy, or the combination of them called white ocean mixed strategy so that organization can

realize its objective of doing long time profit by winning its challenge. Apart from the business strategy, the organization can follow global strategy to expand its market to entire world. The key aspects of such global strategy include:

1. Treating the global market as the domestic market for standard products.
2. Creating a global marketing mix, which at the same time recognises regional and national differences, such as differences in language and tastes in providing services.
3. Creating global production and distribution systems, e.g. super-factories covering major areas of the world.
4. Concentrating on power-brands - the most successful brands and products. Because the global market is so large there are substantial benefits to be gained from economies of large scale production, marketing and distribution. Rather than producing thousands of different products it makes sense to narrow down the range to a much smaller number in order to support these brands across the globe.

PEST analysis

Creating a global strategy for nanotechnology products/services involves first carrying out an environmental analysis of political, economic, social, and technological trends that are relevant to the products or services operating on a global scale. Having a clear set of objectives about product/services strategic plans has to be developed which enables the organisation to focus on global markets. A key element of this global strategy will be a global marketing plan identifying an appropriate marketing mix, coupled with production and distribution plans of the product/service. The PEST analysis of the organization and its nanotechnology based product/services include [11] Political Environment analysis, Economic Environment analysis, Social Environment analysis, and Technological Environment analysis. Marketing activities of such organizations involve building up loyal customer support in targeted markets, and out-competing the competition through superior customer service, reliability and other customer benefits.

ABCD Analysis :

As per simple ABCD model, application of identified nanotechnology based product/service in a given field/area has to be analysed by choosing determinant issues. Identifying affecting factors for these determinant issues and corresponding the four constructs : advantages, benefits, constraints and disadvantages have to be listed. Finally the critical constituent elements for each affecting factors for developed products/services have to be identified [12].

VI. FUTURE POSSIBILITIES OF NANOTECHNOLOGY INNOVATIONS

- (1) Nanomachines are devices built from individual atoms. Some researchers believe that nanomachines will one day be able to enter living cells to fight disease. They also hope to one day build nanomachines that will be able to rearrange atoms in order to construct new objects. If they succeed, nanomachines could be used to literally turn dirt into food and perhaps eliminate poverty.
- (2) Nanotechnology has the potential to completely revolutionise all the three key aspects of healthcare sector-Diagnosis, prevention and Treatment. It can completely change the healthcare sector for the next generation. Nanotechnology will help medical professionals in today's most excruciating medical issues, such as repairing of damaged organs, diagnosis and treatment of cancer cells, removal of obstruction in brain and it can help in better drug delivery system.
- (3) By using nanotechnology system it is possible to measure hundreds of complicated factors simultaneously, avoiding the risk of losing samples waiting days for lab results, and lab mess-ups. Nano filters are able to remove the smallest of known viruses. Nanotechnologically made, antimicrobial coating is another promising area for preventing diseases. Nanotechnology can help design certain drugs that very difficult to manufacture because of structural constraints by using a controlled manufacturing system at the atomic and molecular level. Nanotechnologically, the drugs can be designed such as to eliminate the toxic part of it and leave the "effective" one.
- (4) Nanotechnology can be used for solar photocatalysis of water and CO₂ in which carbon dioxide of atmosphere can be reduced and hydrogen can be separated to use as hydrogen fuel using solar energy. This technology of Photoreduction of CO₂ with water to form hydrocarbon (methane, methanol etc.) is very beneficial due to negative CO₂ foot print which cleans the environment and also supports sustainable transportation using the existing infrastructure for hydrogen fuel distribution.
- (5) Nanotechnology can be used for both in vivo and in vitro biomedical research and applications. Nano particles can be used in targeting tumor cells at initial stage. Particles like den trine, quantam dofs and fullerene. Nanotechnology can be used to develop "signature protein" to treat cancer.

VII. CONCLUSION

In this paper, important nanotechnology features and their usage in industry, various products and services based on nanotechnology innovations and Business Strategy for them are identified. Applications & benefits of NT in Agriculture, Food packing & Clean water, in Renewable Energy & Storage, and in Medicine are discussed. Various Business Opportunities for New Nanotechnology based Products and Services, Developing a global strategy for Nanotechnology Business including PEST analysis model and ABCD analysing framework. Finally, some of the Future possibilities of nanotechnology innovations are mentioned and discussed.

REFERENCES

- [1] Porter M.E. (1998) Competitive advantage, creating and sustaining superior performance, 2nd Ed. The Free Press, New York.
- [2] Han Kim W., Renee Mauborgne, (2006) Blue Ocean Strategy, pp. 29 - 32.
- [3] Hou, Shengtian (2007) Green ocean strategy: Obtaining sustainable competitive advantage, Beijing: Tsinghua University Press pp. 183-197.

- [4] Aithal P.S., Suresh Kumar P. M., (August 2015) Black Ocean Strategy - A Probe into a New type of Strategy used for Organizational Success, GE International Journal of Management Research, Vol. 3, Issue 8, pp. 45 - 65.
- [5] Aithal P.S., (2016) The concept of Ideal Strategy & its realization using White Ocean Mixed Strategy, Unpublished.
- [6] Aithal P. S., & Shubhrajyotsna Aithal,(2015), Managing Anticipated Breakthrough Technologies of 21st Century - A Review, *International Journal of Research & Development in Technology and Management Sciences*, 21 (6) pp 112 - 133.
- [7] Aithal, P. S., and Shubhrajyotsna Aithal, (2015"b"), Ideal Technology Concept & its Realization Opportunity using Nanotechnology, *International Journal of Application or Innovation in Engineering & Management*, 4 (2) pp 153-164.
- [8] Jean C. B., (2010) Nanotechnology for Food Applications: More Questions Than Answers, *The Journal of Consumer Affairs*, Vol. 44, No. 3, pp. 528 – 545.
- [9] Bouwmeester, Hans, Susan Dekkers, Maryvon Y. Noordam, Werner I. Hagens, Astrid S. Bulder, Cees de Heer, Sandra E.C.G. ten Voorde, Susan W.P. Wijnhoven, Hans J.P. Marvin, and Adrienne J.A.M. Sips. 2009. Review of Health Safety Aspects of Nanotechnologies in Food Production. *Regulatory Toxicology and Pharmacology*, 53: 52–62.
- [10] Chen, Hongda, Jochen Weiss, and Fereidoon Shahidi. (2006) Nanotechnology in Nutraceuticals and Functional Foods. *Food Technology*, 603: 30–36.
- [11] Abhishek Gupta, (2013) Environment & PEST Analysis: An Approach to External Business Environment, *International Journal of Modern Social Sciences*, 2(1) pp. 34-43.
- [12] Aithal, P.S., (2016) Study on ABCD Analysis Technique for Business Models, business strategies, Operating Concepts & Business Systems, *International Journal in Management and Social Science*, 4 (1) pp. 98-115.