Strategic Management of Universal Technologies for Redefining Productivity & Performance

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ABSTRACT

Technology is an application of science and used to solve many complicated challenges in society to make human life comfortable and happy. Certain technologies have grown and expanded their branches to many areas and sectors of practice in such a way that they have been designated as General-Purpose Technologies. Such general-purpose technologies are identified and used in many industries to do business and to solve or simplify the problems of industries. During the last few years, it is observed that out of many general-purpose technologies, two technologies have shown accelerated growth and gave birth to many underlying sub-technologies: (1) Information Communication and Computation Technology (ICCT), and (2) Nanotechnology (NT). These two technologies are further identified as "Universal Technologies" due to their potential capability of solving problems related to basic needs, advanced wants, and dreamy desires of human beings in society. ICCT and Nanotechnology have opened up the possibility of ubiquitous solutions to many problems related to production and service industries by offering automated mobility, stability, and sustainability. In this paper, we have identified various strategies for effective management of ICCT & NT underlying technologies in solving issues pertaining to basic needs, advanced wants, and dreamy desires of human beings in society. The paper also discusses how these universal technologies can be unified to further strengthen their abilities in redefining the productivity in production-related industries and performance in service-related industries with the objective of moving towards technological singularity by building super-intelligent self-replicating machines.

Keywords: Universal technologies, Technology management, Strategic management of technologies, ICCT, Nanotechnology, Technological singularity, Technological unification, Redefining productivity & performance.

1. INTRODUCTION :

Technology management is an area of Management Science where business organizations plan and implement their technology development and adoption strategy by means of predicting and foreseeing the future changes so that to create a technology roadmap for competition, sustainability, and growth & prosper. Technology management is a part of corporate strategic management and organizations should identify a suitable strategy to compete in its industry by adopting a suitable strategy. Strategic management is a branch of management which consists of various well-structured and implementable ideas to ensure success in any decision-making process of that management level. Strategic management usually consists of some short cut methods in the decision-making process of a manager to ensure winning. Strategic management principles can be applied at operations level, business level, corporate or industry levels. The strategies followed at the operational level of an organization to improve productivity or efficiency in production organization or service organizations respectively are called operational strategy. Operational level strategies are also called functional strategies due to the reason that they are used in functional areas of the organizations. The various operational strategies include Design of Goods and Services, Quality Management, Process and Capacity Design, Location Strategy,

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Layout Design and Strategy, Human Resources and Job Design, Supply Chain Management, Inventory Management, etc. The strategies followed at the business level for new product or service innovations in production organization or service organization respectively is called business strategy. The various business strategies include Cost leadership, Aggressive marketing for enhancing sales, Product/service differentiation, Pricing strategy, and gaining technological advantages using emerging suitable technology. The strategies followed by an organization at corporate or industry level are called corporate strategy. These include growth strategy, expansion& diversification strategies, partnership strategies, Business stabilization strategies, Technology adoption strategies, Online business strategies, etc.

As well known in business management, management decision making is nothing but (1) identifying a issue as per the objective of the organization, (2) analysing the issue to discover the problems, (3) Synthesize the possible solutions or ideas for the problems, (4) Choose an optimum solutions using Quantitative analysis/operations research, (5) Implementing the optimum solution to get expected results as benefits. In this paper, the process of identification of emerging technologies based on analysing technologies using universal technology concept and the steps in adopting such technologies for realizing the organizational objectives of increasing productivity and/or enhancing performance.

2. RELATED WORK :

Many scholarly published research works is reported in the areas like technology management, strategies to manage technology, universal technologies, redefining productivity & performance, and strategic management of technologies. The review of related publications obtained from google scholar search is listed in table 1.

Table 1 : Review of related work

S.No.	Area of Work	Focus	Reference
1	Technology management	Art of high-technology management	Maidique, M. A. et al. (1984). [1]
2	Technology management	Based on process thinking	Gregory, M. J. (1995). [2]
3	Technology management	Information technology management through knowledge transfer approach.	Bolisani, E. et al. (1999). [3]
4	Technology management	Understanding technology management as a dynamic capability through the lens of dynamic capabilities theory	Cetindamar, D., et al. (2009). [4]
5	Technology management	Strategic management of technology	Harris, J. M., et al. (1983). [5]
6	Technology management	Developing strategy for product innovation	Cooper, R. G. (2000). [6]
7	Technology management	Design of products as per customer needs	Igor Ansoff, H. (1987). [7]
8	Technology management	Strategy for technology transfer	Bone, S., et al. (2,000). [8]
9	Technology management	Innovative classification of methods of the Future-oriented Technology Analysis	Halicka, K. (2016). [9]
10	Technology management	Integrating digital technologies to drive the business	Kane, G. C. (2015). [10]
11	Strategies to manage technology	A framework to manage the innovation strategies of new technology based firms	Davey, S. M. et al. (2011). [11]
12	Strategies to manage technology	The lessons of failure: learning to manage new manufacturing technology & capabilities needed to acquire technologies by firms	Bessant, J. (1993). [12]
13	Strategies to manage technology	Managing operations and information technology	Hayes, R. (2006). [13]

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14	Strategies to manage technology	Alternative conceptual lenses and be prepared to continuously make adaptations	Henderson, J. C. et al (1999). [14]
15	Strategies to manage technology	Alignment between IT strategies and the openness of open innovation strategies	Cui, T. et al. (2015). [15]
16	Universal technologies	When technologies converge and regulatory models diverge	Frieden, R. M. (1999). [16]
17	Universal technologies	ICCT and Nanotechnologies as universal technologies	Aithal P. S. et al. (2019) [17]
18	Redefining productivity & performance	Redefining productivity through inter-firm operations and supply chains	Scerri, M., et al (2011). [18]
19	Redefining productivity & performance	Redefining hospital performance	Dailey, R. C. (1988). [19]
20	Redefining productivity & performance	Rethinking and redefining the determinants of corporate profitability	Batra, R. et al. (2016). [20]
21	Strategic management of technologies	External resource leverage are the keys to effective technology	Roberts, E. B. (2001). [21]
22	Strategic management of technologies	Deals with the rise and character of modern technology strategy	Friar, J. et al. (1985). [22]
23	Strategic management of technologies	Strategies to effective management of technology	Antoniou, P. H. (2004). [23]
24	Strategic management of technologies	New approaches	Mitchell, G. R. (1985). [24]
25	Strategic management of technologies	Strategic perspectives of corporate sustainability management to develop a sustainable organization	Baumgartner, R. J. et al. (2017). [25]
26	Strategic management of technologies	Reinventing innovation management research in a digital world	Nambisan, S. et al. (2017). [26]
27	Strategic management of technologies	A framework for diagnosing and improving digital product and service innovation	Nylén, D. et al. (2017). [27]
28	Strategic management of technologies	Strategic Management Models & Indian Epics	Aithal, P. S. (2016). [28]

3. OBJECTIVES &METHODOLOGY :

The objective of this paper is to analyse and synthesize various strategies required to identify and monitor, adapt, and manage emerging technologies that can redefine the business processes for an organization. Following are the specific objectives identified and addressed :

(1) To know various strategies available to manage General Purpose technologies to fulfil their goal

(2) To identify the objectives of Universal technologies emerged recently

(3) To analyse the purview of Information Communication & Computation technology (ICCT) in solving the problems and supporting the advancement of civilization.

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(4) To analyse the purview of Nanotechnology in solving the problems and supporting the advancement of civilization.

(5) To discuss how ICCT and Nanotechnologies work together as complementary and unified technologies.

(6) To redefine the objectives of productivity of Manufacturing industries using unified universal technologies.

(7) To redefine the objectives of the performance of Service industries using unified universal technologies.

(8) To predict the technological singularity level of unified universal technologies through a technology roadmap.

The methodology adopted is a conceptual analysis by means of scanning strategic business models and emerging technologies that can re-define the business processes through their innovativeness and customer satisfying abilities. The data/information related to present strategies and emerging technologies are collected from Google scholar and other social research networks and analysed using predictive analysis methods to study the effect of emerging technologies on enhancing organizational productivity/performance in manufacturing or service organizations respectively.

4. STRATEGIC MANAGEMENT MODELS FOR NEW GENERAL PURPOSETECHNOLOGIES :

Technology is essential ingredient of every business organization to survive from disasters, sustain for long term in the business, differentiate themselves, convert as monopoly, and for grow and prosper. Organizations are advised to monitor emerging technologies which are affecting the organizational business in future days in an intelligent way using some predictive models. Organization should capable to identify suitable technology which can help to use all five kinds of strategies commonly used at business and industry levels.

Technology is an application of science and used to solve many complicated challenges in society to make human life comfortable and happy. Certain technologies have grown and expanded their branches to many areas and sectors of practice in such a way that they have been designated as General-Purpose Technologies. Such general-purpose technologies are identified and used in many industries to do business and to solve or simplify the problems of industries.

GPT's are characterized by (1) Pervasiveness – The GPT should spread to most sectors. (2) Improvement – The GPT should get better over time and, hence, should keep lowering the costs of its users. (3) Innovation Opportunity – The GPT should support to invent and produce new products or processes. Whole eras of technical progress and growth appear to be driven by a few 'General Purpose Technologies' (GPT's), such as the Steam engine, Electric motor, Semiconductors based devices, etc [29].

In all the three organizational levels, technology management is an essential strategy for survival, sustainability, differentiation, monopoly, and growth & expansion. The adoption and management of technology is crucial to every organization and is the lifeblood of the organization to keep it sustainable. The technology management includes identifying and implementing the technology which can support the organization for enhancing its productivity and performance in the local and global business environment.

5. UNIVERSAL TECHNOLOGIES :

It is observed that some of the general purpose technologies are grown as umbrella technologies and gave birth to many sub technologies under them as underlying technologies to solve basic and advanced problems of the society to make the life of human being comfortable. These underlying technologies are growing both horizontally and vertically to solve (1) basic problems like nutritious food, clean water for drinking and irrigation, low cost durable shelters, low cost, reliable and renewable energy for individuals, homes, transports, and industries, quality basic education for everybody, affordable health services; (2) advanced problems like easy & affordable access to products and services related to everyone's daily needs foreasy &comfortable life with happiness; (3) dreamy desires related problems like flying, space travel, virtual reality, life span expansion, and much more fantasy including antiaging and achieving immortality. The technology which supports to solve the problems related to the above

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three areas are called universal technology. Thus, universal technologies either alone or with other general purpose technologies are capable of solving all kinds of problems in the society. Based on scanning the technologies of the 21st century, it is identified that two general purpose technologies have grown to support many underlying technologies and shown their capabilities to solve almost any problems in society at all the three levels. These two technologies identified as universal technologies are Information Communication and Computation Technology (ICCT) [30-32]and Nanotechnology (NT) [33-35]. Both these universal technologies have many underlying technologies and these underlying technologies are also capable to grow as killer technology in their application areas.

5.1 ICCT Underlying Technologies :

Information Communication & Computation Technology (ICCT) is a Technology to generate, transmit, process, store, and deliver information in the electronic or optical signal format. Mainly of these are used for intangible applications in various industry sectors both for managing and controlling various processes.

(1) Artificial Intelligence & Robotics
(2) Big Data & Intelligence Technology
(3) Blockchain Technology
(4) Cloud Computing Technology
(5) Cyber Security Technology
(6) 3D Printing Technology
(7) Digital Marketing Technology
(8) Internet & Internet of Things(IOT)
(9) Information Storage Technology
(10) Optical Computing Technology
(11) Online Education Technology
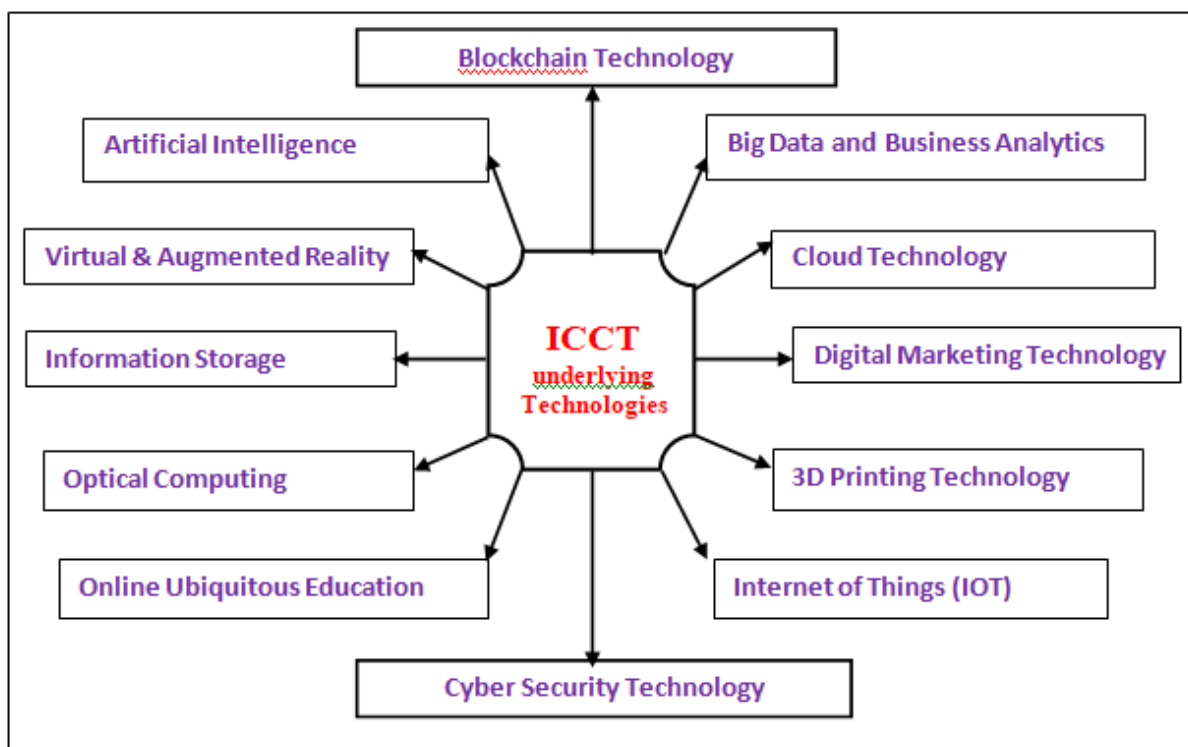(12) Virtual and Augmented Reality

Fig. 1 : Block diagram representing various underlying technologies of ICCT [30]

Applications of ICCT underlying Technologies :

ICCT underlying technologies [31] are used for developing machines which can understand, plan, think, compare, and decide like human beings using artificial intelligence technology (AIT). They can also

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communicate, monitor, and control the devices interconnected using the internet of things technology (IoT). They can analyse and compare, and identify the intelligence for business using Big data & Intelligence technology. The machines can keep track of information or financial transactions which can completely eliminate fraud and corruption in the society using Blockchain technology. Human beings and machines can make use of distant hardware devices, software, and other applications without owning them and as rental facilities using cloud computing technology. The secrecy &security of the information stored, transmitted, and processed can be maintained using cyber security technology. As technology progress and aspirations of people enhance, more and more data and information storage facilities are required and can be realized using information storage technology. Development of high speed computers are continuously in demand for integrating computational processes support the entire world using optical computers and cloud computing technologies so that few computers are enough to maintain world information processing requirement. Any device or structure made of any material or mix of materials in any size can be produced by three-dimensional printing layer by layer to produce real devices and systems using 3D Printing technology. The companies in any industry and individuals can sell their products and services to entire globe by means low cost, affordable marketing using the internet called digital marketing technology. ICCT also allows ubiquitous education & training systematically using online education technologies and models so that off-campus education in any area and at any level are possible. Virtual reality technology allows to create an artificial environment to mimic the real situations with the help of a computer machine and presented to a user in such a way that the user suspends the belief and accepts it as a real environment. Table 2 lists some of the prominent applications of ICCT underlying technologies in industries and for individuals in society.

Table 2 : Prominent applications of ICCT underlying technologies

S. No.	ICCT Underlying Technologies	Prominent Applications
1	Artificial Intelligence & Robotics	Creating intelligent machines which can understand, plan, think, compare, and decide like human beings. The objective is to create super intelligent machines which can mimic the actions of human brain and overtake human intelligence.
2	Big Data & Intelligence Technology	Continuous data generated at high speed from CCD's and business processes are analysed by means of descriptive analytics, predictive analytics, and prescriptive analytics to find intelligence and relationship associated with them for futuristic decisions.
3	Blockchain Technology	Protects the information or documents related to a chain of transactions so that all and every previous transaction related to a digital document or digital currency so that any kind of fraud or corruption can be totally eliminated.
4	Cloud Computing Technology	Use of external hardware, software, or software applications ubiquitously by a company or individuals as rented or free facility for used time so that physical owning of such facilities can be eliminated. This will optimize the utilization of any digital storage and processing device by sharing with other users globally for rent.
5	Cyber Security Technology	Used for providing the security and secrecy of data, information in digital devices during processing, storing, and transmission stages as well for identifying the actual user of a system. Cyber security technology has responsibility to protect computers, networks, programs, and data for any kind of exploitation from unauthorized access or attacks.
6	3D Printing Technology	Using 3D Printing technology, any device or structure made of any material including, plastic, rubber, metals, mud, cement, or their mixtures in any proportion and in any size can be fabricated layer by layer into a three dimensional structure to produce real devices and systems.

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7	Digital Marketing Technology	Digital marketing technology allows the companies and individuals to sell their products and services to entire world by means low cost, affordable ubiquitous marketing techniques using internet.
8	Internet & Internet of Things(IOT)	Internet of things technology (IoT) is used to communicate, control, and monitor various digital devices used in home, office, and company environment interconnected using internet. IOT has major application in interconnecting various cyber-physical systems in industry 4.0.
9	Information StorageTechnology	This technology supports the development of high density digital and optical storage devices of capability Terabytes,Petabytes, Exabytes, Zettabytes, and Yottabytes.
10	Optical Computing Technology	Fabrication of high speed optical computers based on optical signal switching and optical signal processing using optical logic gates and flip-flops by means suitable materials/devices.
11	Online Education Technology	Allows to transform traditional campus based education into Massive Online Open Courses (MOOC) based education. Ex : EDX, COUSERA, NPTEL, SWAYAM, etc.
12	Virtual and Augmented Reality	Create an artificial environment to mimic the real situations with the help of a computer machine and presented to a user in such a way that the user suspends the belief and accepts it as a real environment. It has applications in entertainment and education. Augmented reality is a pseudo or mixed reality of real and virtual worlds by the assistance of a computer-generated perceptual information and used to enhance customer experience in business services.

The above ICCT underlying technologies are capable to solve many problems related to human comfortability and dreamy desires. These underlying technologies along with a suitable manufacturing technology can do marvel to solving many problems of the individuals of society. ICCT at its nascent stage, is expected to support the production of super intelligent machines which can replace human employees by robots in many industries.

5.2 Nanotechnology Underlying Technologies :

Nanotechnology is another general purpose technology supports manufacturing of various products using special properties of Nanoparticles (10^{-9} m). It is a manufacturing technology with potential ability to improve the features of existing products and to produce new products in various fields. Nanotechnology has many subfields called nanotechnology underlying technologies. Nanotechnology is a boon to the mankind if handled carefully. Nanotechnology is capable to solve problems of basic types, advanced problems related to human comfortability, and even problems related to dreamy desires if used with other application type technologies like ICCT. Nanotechnology can solve problems related to providing nutritious food by producing artificial food, converting environmental water and sea water into drinking water in large scale using renewable energy, providing low cost and strong shelters at low cost, low cost renewable energy to required amount, solutions to low cost and durable transportation facility, durable consumer products and textiles, easy health and medical solutions. Nanotechnology at its nascent stage, is expected to support for the production of self-replicating nanomachines which can further build any structure as per the requirement. The important underlying technologies of nanotechnology are listed below :

(1) Nanomaterials development Technology
(2) Nanomechanics Technology
(3) Nanoeletronics Technology
(4) Nanophotonics Technology
(5) Nanobiotechnology
(6) Nanomedicine

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Applications of Nanotechnoloy underlying Technologies :

Nanomaterials of suitable type and properties are used in Nanotechnology treated Seeds in Agriculture, in food packets, production of artificial food, Customized location focused rain and large scale production of drinking water from sea &environment, nanomaterial fabricated textiles with many special properties, nanomaterial based cosmetics, paints, consumer durables, building materials, improving products quality, durability in many industries, etc. Nanomechanics Technology is used in manufacturing equipment, nanoelectromechanical systems (NEMS) etc. Nanoeletronics Technology is used in production and use of nanodiodes, nanotransistors, Nano integrated circuits, and nanostructure based electronic memories. Nanophotonics Technology deals with nanomaterial based solar cells, optical memories, optical computers, etc. Nanobiotechnology deals with bio-medical applications of nanomaterials including drug delivery, targeted therapy, Gene delivery, Molecular imaging, Bio-marker mapping, detection & diagnosis of diseases etc. Nanomedicine has subareas like biological imaging for diagnostics, Biosensors for toxin detection, Regenerative medicine, Medical robotics, nanobots, Tissue engineering, Drug delivery, cancer therapy, surgery, etc.

Apart from above, nanotechnology has its roots in many different areas to solve basic problems, advanced requirements, and dreamy desires along with other technologies including ICCT. Such breakthrough technologies of the 21st century include :

(i) Nanotechnology treated Seeds for Innovations in Agriculture

(ii) Universal drinking water system

(iii) Automobiles

(iv) Renewable energy system

(v) Optical computation

(vi) Embedded intelligence

(vii) Chameleon chips

(viii) Space Travel

(ix) Anticipated Immortality

Table 3 : Prominent applications of NT underlying technologies

S. No.	Underlying Technologies	Prominent Applications
1	Nanomaterials development Technology	Applications related to Nanometal chemistry, Nanostructured polymers, Nanocomposites, etc for cosmetics, textiles, consumer products, agriculture, food processing and packaging, water filters, etc.
2	Nanomechanics Technology	Deals with mechanical properties (kinetic, thermal, and elastic) of physical systems having nanometer material involved in them. Used in nanotribiology for friction, wears and contact mechanics at nano scale electromagnetic systems, and nanofluidics. Many kinds of chemical compounds, advanced mechanical motors, UPS and high-power batteries,horsepower, acidic fuels, rust disinfectants, Nanotubes and Carbon Nanowires, Nanolithography, Nanomanufacturing, Nanolithography, and other areas of manufacturing.
3	Nanoeletronics Technology	Nanofabrication, Nanoprocessors, nanotransistors, Nanoelectronic components for high temperature, ultra - low power, biologically friendly packaging, Nanoelectronic memories, etc.
4	Nanophotonics Technology	Nanocomputers, Nanosensors, Nanoprobes, fluorescent imaging, sensitization, nanolithography.All optical processors, Bio-imaging, Energy conversion, Molecular manipulation, Data storage, Display devices, etc.
5	Nanobiotechnology	Pre-clinical Testing of Novel Nano Medical tools, Diagnostic Tools and Applications, Tissue, Cell and

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		Genetic Engineering involving Nano Medical Tools, Protein detection, genome sequencing, proteomics, imaging,nanobots, and self-replicating; pesticide delivery systems through bioactive nanoencapsulation; biosensors to detect and quantify pathogens; organic compounds,etc.
6	Nanomedicine	Therapeutic advancements using Nano-medicine and Research Techniques, Development of Nano Drug Delivery Systems, Cancer treatment, Gene therapy, treatmentof neurodegenerative disorders, operative dentistry, Antibacterial treatment, Ophthalmology, Surgery, Tissue engineering, Regenerative medicine, Cell repair, Medicated textiles, etc.

6. UNIFICATION OF ICCT &NANOTECHNOLOGIES :

It can be argued that the nanotechnology underlying technologies and ICCT underlying technologies are related and depending on each other. Nanotechnology is manufacturing technology and ICCT is an application technology. The innovations in nanotechnology support innovations in ICCT and Opportunities in ICCT stimulates innovations in Nanotechnology. Thus, nanotechnology and ICCT are complementary and interdependent technologies. When these two technologies are studied together, the researchers will get a better idea to innovate in their thinking to solve many kinds of problems in society. The term unification is used to combine two or more things which can be used together to solve a problem. Unification of two technologies means these two technologies can be used together to get a complete solution to a real-world problem. Unification of ICCT and Nanotechnologies leads to an accelerated growth of these technologies and innovations in nanotechnology support further innovations in ICCT or vice versa. Such unified technology also allows them to solve basic problems, advanced problems and dreamy desires of the peoples of society. Such unification leads to universal technology as discussed in section 5.

Table 4 : ICCT and NT underlying technologies which show complementary properties for unification

S. No.	NT Underlying Technologies	ICCT Underlying Technologies
1	Nanomaterials development Technology	Artificial Intelligence, 3D Printing, Blockchain,
2	Nanomechanics Technology	Internet of Things, Artificial Intelligence
3	Nanoeletronics Technology	Artificial Intelligence Data & Business Analytics, Internet of Things, Blockchain,
4	Nanophotonics Technology	Optical Computing, Blockchain,
5	Nanobiotechnology	Artificial Intelligence, 3D Printing,
6	Nanomedicine	Artificial Intelligence, Virtual Reality

7. REDEFINING THE MANUFACTURING INDUSTRY BASED ON UNIFIED UNIVERSAL TECHNOLOGY :

Manufacturing industry converts raw materials into finished products for basic needs, comfortable wants, and even for dreamy desires of human beings. The usage of special raw materials with ideal characteristics or improved characteristics may lead to ideal or improved products having improved properties. Similarly automating manufacturing processes with high precision and for negligible maintenance cost. Further, the final product manufactured should be an innovative product and have multi features compared to similar products available in the market. Using nanomaterials and devices as raw materials, ICCT underlying technologies like Artificial intelligence, IoT, 3D printing, etc. in the manufacturing industry sector can fulfil these possibilities. It is argued that most of the future products produced in the manufacturing industry will use nanotechnology and ICCT underlying technologies as universal technology to redefine the manufacturing industry (figure 2).
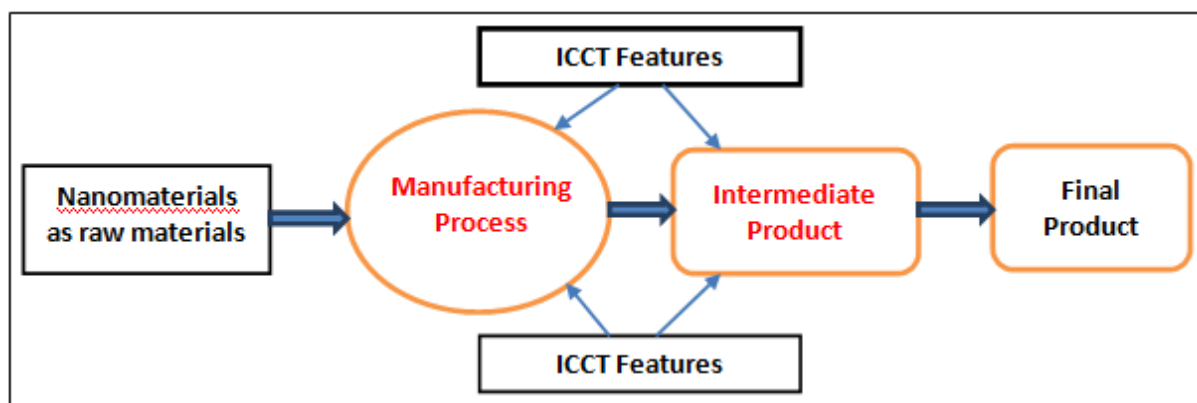
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Fig. 2 : Schematic representation of redefining the Manufacturing Industry based on Universal Technology

8. REDEFINING THE SERVICE INDUSTRY BASED ON UNIFIED UNIVERSAL TECHNOLOGY :

Service sector is another important sector in business management and is mainly dependent on technology. Both nanotechnology and ICCT are expected to impact heavily and creates many breakthroughs in service sectors. The nanotechnology underlying technologies like nanomedicine, nanobiotechnology, nanodevices of nanomechanics, nanoelectronics, and nanophotonics are expected to support service industry along with their complementary ICCT underlying technologies like artificial intelligence, IOT, cloud computing, optical computers, virtual realities etc. It is strongly believed that both nanotechnology and ICCT together as universal technology will redefine the service sector present models and contribute heavily on solving problems related to the basic needs, comfortable wants, and even for dreamy desires of human beings. Thus, service industry has opportunity to adopt NT and ICCT components to improve the service quality and service features (figure 3).
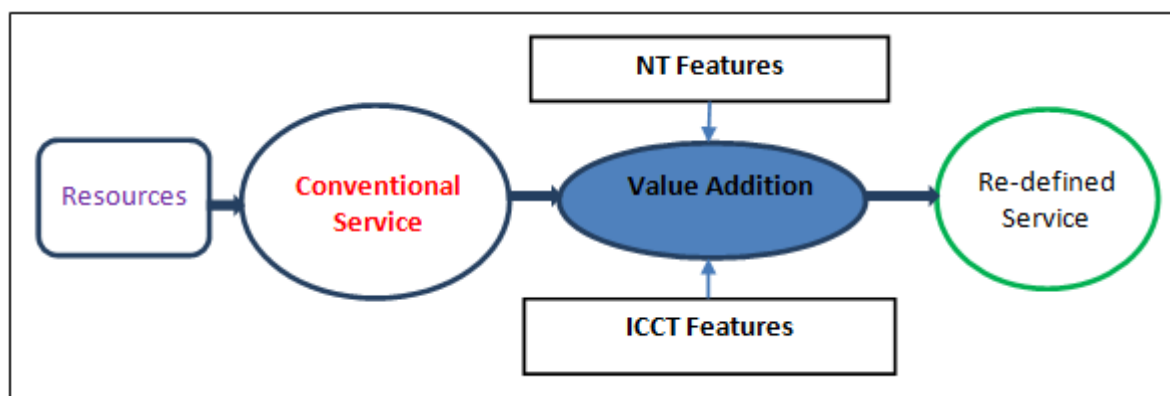

Fig. 3 : Schematic representation of redefining the Service Industry based on Universal Technology

9. MANAGEMENT OF UNIVERSAL TECHNOLOGY :

The identification and implementation of suitable technologies in various business processes for a given organization is possible by means of (1) predicting future technologies, (2) anticipating the breakthrough technologies, (3) Choosing a suitable emerging technology, (4) Analysing for organizational business & corporate innovation, (5) Planning for adoption of emerging technology, (6) Analysing the cost-benefit of new technology, (7) Technology adoption, (8) Technology customization, (9) Technology monitoring & control, (10) Verifying productivity or performance, and (11) Scanning the environment for further technology breakthroughs. The systematic study of using these steps for the strategic management of technology for enhancing and controlling the productivity and performance of a given organization.

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(1) Predicting future technologies :

The managers at the executive level have the responsibility of setting the future plans called the strategic plans of the organization. They should continuously monitor the changes in technology, changes in business models, and changes in customers perception with time. Predicting future technologies is a very important requirement of managing the business for sustainability.

(2) Anticipating the breakthrough technologies :

Managers while predicting future technologies need to anticipate the major breakthroughs in technology in a given time frame and plan their business investments and expansion accordingly. Breakthrough technologies may convert into killer technologies and may make the present business model or products or services obsolete.

(3) Choosing a suitable emerging technology :

Managers as decision makers to lead the organization or departments take responsibility of monitoring the external environment for possible changes in the business environment and adopt changes accordingly. When they realize the advents of technologies are going to affect the organizational performance, they should adopt such changes and if the changes are technology driven, they have a responsibility to identify an alternative which is optimum for their organizations within their constraints by choosing a suitable emerging technology as strategic alternative.

(4) Analysing for organizational business & corporate innovation :

While choosing an emerging technology as a strategic alternative, managers have to analyse their present business, historical changes in their business model and its effect on their organizational performance, using various internal analysis and external analysis techniques [29]. This analysis should also involve the various innovations implemented and expected in the same industrial sector.

(5) Planning for adoption of emerging technology :

Based on the analysis of various alternative technologies and choosing one optimum technology, the manager should plan for adopting the new technology in organizational processes. This include short term plan and long term plan and the systematic procedure of adoption to various sections, branches, and subsidiaries.

(6) Analysing the cost-benefit of new technology :

The managers have responsibility on analysing the cost of such new technology based investment. In order to make use of emerging new technologies for organizational benefits, one of the techniques is to analyse the cost of adopting and implementation and its future benefits for the organization for a fixed period of time. Strategical analysis of cost-benefit will allow managers to make a decision related to the investment in new emerging technology and the speed of adoption in the organization.

(7) Technology adoption,

One, the organization decides to adopt a particular technology based on cost-benefit analysis, it has to identify suitable vendors to supply or to develop such technological applications.

(8) Technology customization :

The organization should effectively utilize the newly adopted technology as per their requirement by customizing them to be suitable for organizational use.

(9) Technology monitoring &control :

The purpose of technology monitoring and control is to gather information about the operational status and the capability of new technology adopted to improve the quality and efficiency of various processes and the product or service developed. A proper feedback mechanism and control based on feedback on effect of new technology should be in place to monitor organizational performance.

(10) Verifying productivity or performance :

This step includes the study of the effect of newly adopted technology on the efficiency and effectiveness of various organizational processes or new processes developed. The organization should develop a suitable mechanism to determine and compare the efficiency and effectiveness after the adoption of new technology with previous technology. In this process, the organization should try to measure the improvement in productivity and performance as well as the implication of such innovation on the organizational value chain as well as the brand for future growth and prosperity.

(11) Scanning the environment for further technology breakthroughs :

The strategic management of the universal technology model involves continuous monitoring the emerging technologies and possible technology breakthroughs in society. A strategic organization

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involves itself or through collaboration, involves in development of new technology which is relevant to its business area. Scanning the environment to watch the progress and foresee the changes is a continuous process for every organization competing in the global business environment.

The above eleven steps are essential as "Lifecycle stages of the model on strategic management of technology" in any organization for enhancing and controlling the productivity and performance. These lifecycle stages are essential in strategic management of technology in any organization for growth and prosperity.

10. REACHING TECHNOLOGICAL SINGULARITY :

Super intelligent machines are expected to be developed using ICCT underlying technologies and nanotechnology [36]. Similarly, nanotechnology along with ICCT underlying technologies are expected to create super human beings by modifying gene and body cells which may give rise to human immortality [37]. It is also predicted that the super intelligent machines are capable to replicate in any level of accelerated pace using a process called self-replication. The ability of self-replication of nanomachines and their super human intelligence leads to a stage so called technological singularity. It is defined as a hypothetical event in which artificial intelligence technology would be capable to build intelligent machines in the process of an intelligence explosion, that yields a super-intelligent machinewhich surpasses all current human control or understanding [38], [39], [40].

Thus, technological singularity is a point in the future time scale where (1) machines can think, work, and decide faster than human beings, (2) Some human beings converts themselves as super human beings using technology and achieve immortality, and (3) Direct interactions between computers and human brains leads to human- machine ubiquitous interaction. It is predicted that by the year 2050, scientists will achieve technological singularity and its consequences both positive and negative. The strategic management of technological singularity which is the consequences of Nanotechnology underlying technologies and ICCT underlying technologies is expected to play a major role in managing disasters and offering advantages related to the growth and prospers to the society.

11. CONCLUSION :

Managing technology is an important area of business management. Managing business in different industrial sectors needs the knowledge of technologies and knowledge of changes in technologies. Many general purpose technologies developed during the last few decades and supported to various industrial sectors for fast contribution to the civilized society. Technology which is an application of science to solve different problems in society is expected to reach its highest expected stage in the 21st century and gave rise to two general purpose technologies called ICCT and Nanotechnology. These two technologies are capable to solve many problems leading to optimized solutions at basic, advanced, and desired level of the society. This paper made an elaborative analysis on how the emerging generalpurpose technologies can grow and integrate themselves into universal technology to solve many problems in society to give a comfortable life to everyone in society. Adding further, it is essential to plan and manage these technologies in organizations systematically using our lifecycle model of technology implementation and management due to the fact that these integrated universal technologies have both positive and negative effects while using in different industries due to their anticipated capability of elevating to the technological singularity.

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