

# Sustainable and Digital Development in Industry 4.0

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**Abstract-** In the present scenario, the manufacturing industries are expeditiously moving towards customized production and therefore the basic requirement for today's industry includes such processes of manufacturing which are intelligent along with being digital. The state-of-the-art revolution in this generation is known as Industry 4.0, which manages the complete life cycle of the product and thereby is having the capability to develop and invent new solutions and ideas for worldwide issues that are been faced in sustainable development. The economic aspect of sustainability basically targets the market, acquisition practices, economic performance, and indirect economic impact. The social aspect of sustainability pays attention on providing safety and equality to stakeholders, employees, and community in which they function. Whereas the ecological aspect of sustainability focuses on conserving the three important basic functions that are supply function, waste receiver and direct utility, in which the conventional resources must be replaced by non-conventional resources, and the intake of the renewable resources must be to an extent that they can be replenished in the upcoming future. Therefore this paper discusses about the various aspects and digital pillars of Industry 4.0 and how Industry 4.0 helps in maintaining a healthy relation among its various areas for sustainable development.

**Keywords –** Sustainable Development, Industry 4.0, Tools, Social Dimension, Economic Dimension, Ecological Dimension

## I. INTRODUCTION

Over the past few years Industry 4.0 has attracted the attention from all over the world. Industry 4.0 can be defined as taking into consideration the production and also how the creation and design of various products, programs, community, processes, and business take place because it's not just about the production, but also how creating and design of various products, processes, programs, community, society and business functions take place due to the inclusion of machine learning, Artificial intelligence, software, hardware, and the humans [1]. Figure 1 shows how the industries have evolved so far.

The coming of the fourth revolution in Industry 4.0 involves a number of technologies and tools [2] as depicted in Fig. 2. Robotics deals with the interactions of human - computer by keeping the information, as well as taking the chance of applying the information in a number of intelligent approaches with the aid of Artificial Intelligence Technique [3]. Modeling and Simulation includes virtual prototyping, modern design and automation in a number of manufacturing industries [4]. The modern technique of Internet of Things applied in the area of agriculture, mining, manufacturing, healthcare, transportation etc. develops a strong bond of these areas between computers and the humans [5]. A tool that keeps security at an adaptable level in the industry 4.0 is termed as Cyber Security [6]. Additive manufacturing [7] provides quick connection among the data, customer and production. Augmented reality [8] is basically the use of, designers, an efficient digital toolbox, engineers or technicians can increment their capabilities of solving problems, also expanding options for optimizing products and processes. Big data and analytics manage the data [9]. It mainly analyses the data quickly and efficiently and also inculcates the method for changing the learning, selling, manufacturing etc. [10].

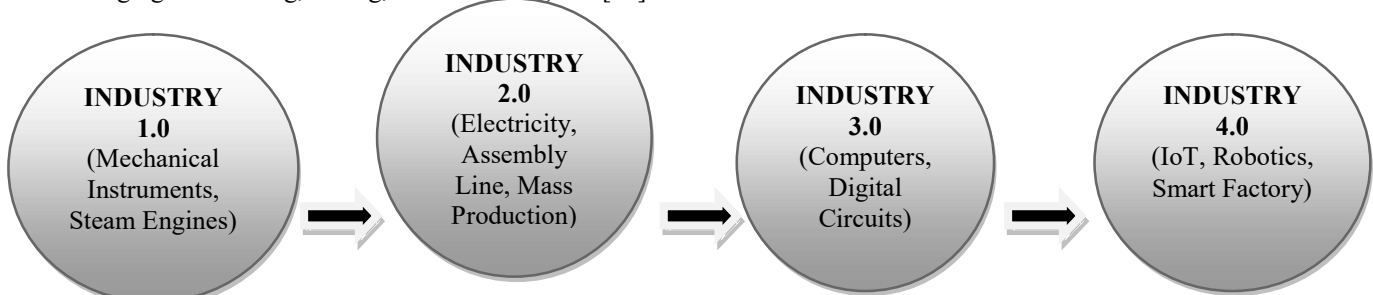


Figure 1. Evolution of Industries

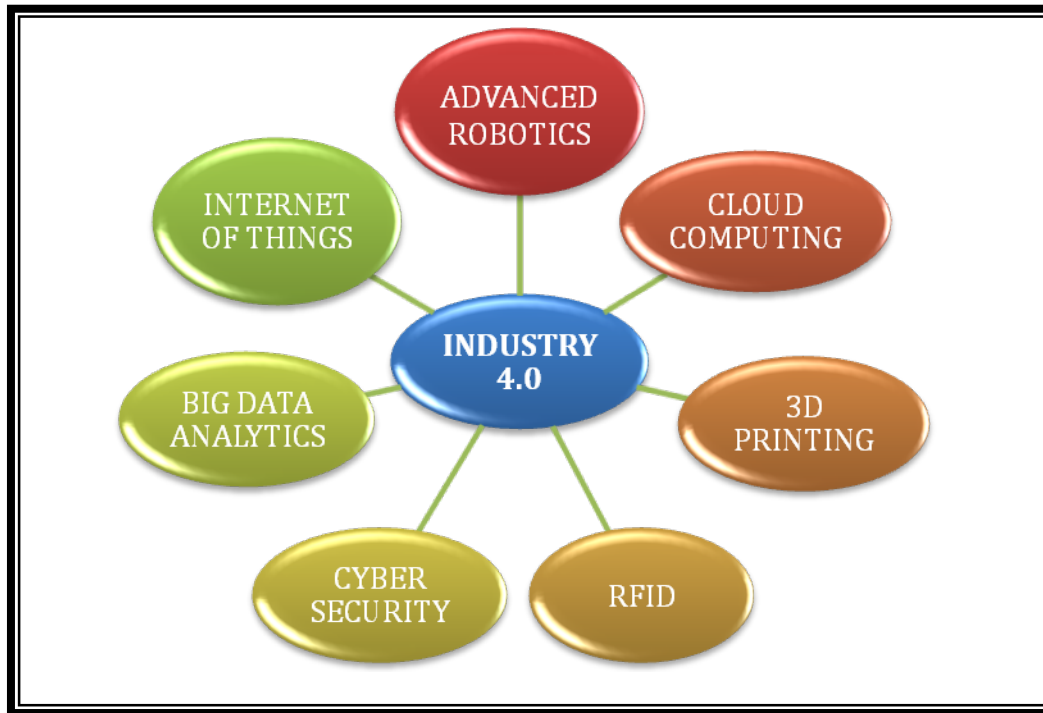


Figure 2. Tools of Industry 4.0

Sustainable Development refers to a development which accomplishes the demands and requirements of the present generation without forgoing the needs of the upcoming generation. Figure 3 shows the real motive of the sustainable development by depicting that it can be gained only by having a proper balanced relation among the planet, society and policies. If any one of them is missing, then the aim of Sustainable Development is difficult to achieve.

Industry 4.0 is a revolution that will modify on how a development process is viewed; it's not only making the process easy but is also changing and affecting our lives. It has till date increased the efficiency of working of machines and resulting in the mass production of components. Industry 4.0 uses the idea of Cloud Computing, Cyber Physical Systems (CPS), and the Internet of Things (IoT) [5]. In this, the machines have been equipped with Artificial intelligence whereas the products are having the RAID chips, which link the component with its process of development. It not only affects the economics, but the industries also. Therefore Sustainable development has been incorporated into it, so as to make use of these technologies very efficiently and effectively.

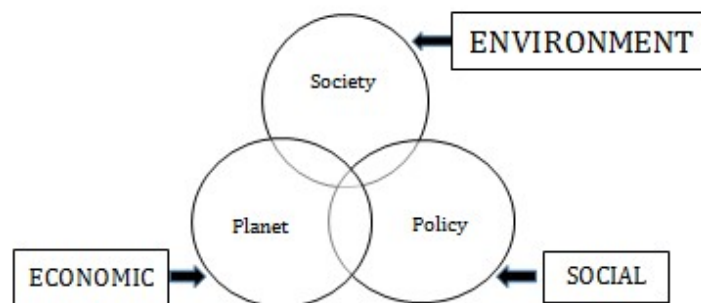


Figure 3. Parameters of Sustainable Development

## II. CHALLENGES OF SUSTAINABLE DEVELOPMENT

Sustainable Development takes into consideration some of the major challenges like hunger, poverty etc. discussed below as following:

### *Challenge 1 – No Poverty*

The Lack of meeting the basic personal needs such as food, shelter and clothing is termed as poverty. Ending the poverty in all forms is one of the biggest challenges.

### *Challenge 2—End Hunger*

Since the past 3 years, one is every nine person is suffering from hunger [11]. The repercussions of hunger may be very dangerous and serious. Small children may encounter stunted growth because of improper food and malnourishment because of which they can be highly affected.

### *Challenge 3—Ensure Healthy Lives*

As we know these days pollution is at the utmost peak which leads to a harmful environment and this in turn results in an undesirable effect on living organisms, which is one of the most concerned sector. The day is not far when there will be a need for buying the fresh air. Therefore it's very necessary to maintain healthy lives, thereby promoting goodness which is important to run everything properly.

### *Challenge 4—Lifelong Learning*

Due to the change in technology, there is a growing issue for quality in education [12]. Education is linked to each and every section of society like health, social participation, good employment etc. Therefore opportunity should be given to every section to improve itself in education and reduce the discrimination factor.

### *Challenge 5—Sustained Economic Growth and Productive Employment*

The annual GDP got down from 4.4% in the year 2000 to 3.2% in the year 2017. It is also important that every person is given equal opportunity at workplace [13]. The young generation should invest themselves at a maximum pace and develop skills and competencies inside themselves. This will thereby help them in attaining the best possible employment.

## III. INDUSTRY 4.0 SOLUTION TO SUSTAINABLE DEVELOPMENT CHALLENGES

Industry 4.0 gives various different solutions to deal with various situations and problems. This fourth Industrial revolution is reliant on some recent technologies, and these recent technologies can be used to overcome and improve the issues and challenges encountered by sustainable development. The Practical Industry 4.0 Solution—for helping farmers are industry 4.0 technology creations such as drones, sensors, micro-robotics [14] etc. which may be helpful to produce food in a better and précised form, developing export-related manufacturing works in developing countries, already increasing the number of works is being taken care by robotics. Also, equipments such as drones based surveillance helps in providing real time data to support the management and maintenance of forests, protections from deforestation, and maximizing afforestation and reforestation. Additive manufacturing, software, AI and 3D printing, can help reduce wastage, and emission could be reduced. Smart phones can be used to train the people to increment their income level, have the probability to enable growing countries to increase innovation resulting in their economies much efficient and productive. Other tools such as by adopting smart water policy and programs, the opportunities to develop profitable means for lowering water pollution and wastage is incremented, innovative ideas to manage urban traffic [15]. The use of Nanotechnology [16], fog computing [17] and various technologies in food harvesting, distribution and processing has much potential to lower this wastage. Advancements are being done in creating solar and wind as the relevant electrical energy sources.

## IV. TECHNOLOGY DEVELOPMENT IN INDUSTRY 4.0

Industry 4.0 also known as the 'Fourth Industrial Revolution' decreases the future industrial developments mania for attaining additional intelligent technological facets of Industry 4.0 by adding various major technical changes that is anticipating to shift the landscape of the industries. The important aspect of Industry 4.0 is mainly to make the process of manufacturing forward, fast, quick, reliable, efficient and customer oriented so as to discover innovative

opportunities and business models [18]. Industry 4.0 mainly focuses on the digitization of the manufacturing [19]. And all these things have made it necessary to develop smart industries that involve smart services also [20]. Fig. 4 shows the various key objectives of Industry 4.0.

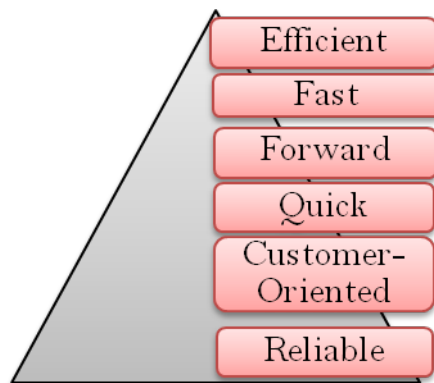


Figure 4. Key Objectives of Industry 4.0

## V. TALENT DEVELOPMENT IN INDUSTRY 4.0

Fourth Industrial revolution is an era of data i.e. it inculcates processed data and huge quantity of data i.e. the complete knowledge is available there on Web. It deals with the arrival of this enormous data and extension of the systems that are connected. This adaptive, real time based and intelligent interlinked systems play as important key factors for achieving the target of Industry 4.0 successfully. With the expansion of Web 2.0 techniques and tools, the data is shared and distributed on real time basis. This dynamically interchanging of real time information and knowledge between the systems, humans and materials is raising the need of autonomous and automatic production systems and technologies so as to manufacture them [21, 22]. This is seriously putting an effect on the overall dynamism of the manufacturing industries in this scenario.

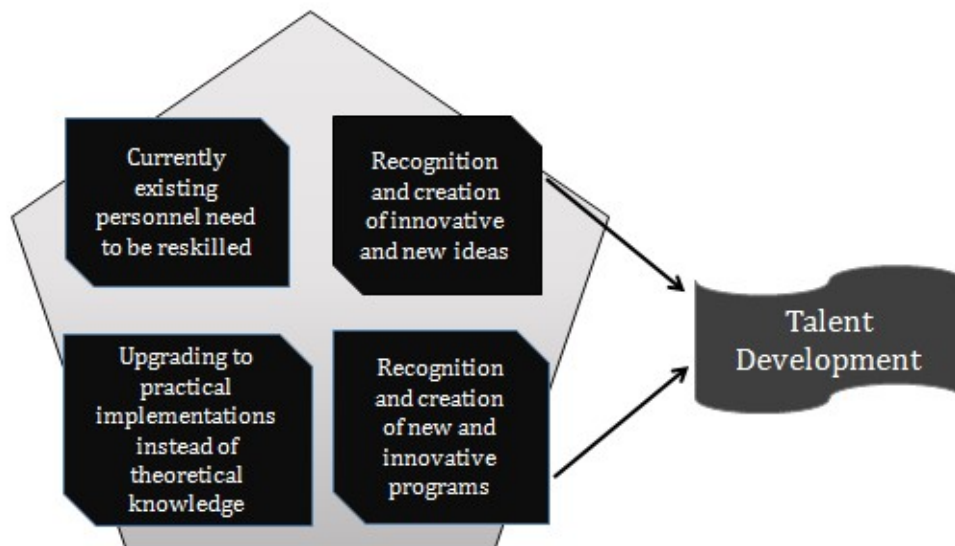


Figure 5. Talent Development Skills

Hence it is seen that the current scenario is an era of automation, having its roots from Artificial Intelligence, Robotics, machine learning, real time systems, cloud computing, big data etc [23]. Fig. 5 shows the various talent development skills.

Requirement of Skilled workforce in digitized world – According to a famous African proverb, ***“An army of lions headed by a sheep can be conquered by an army of sheep headed by a lion”.***

## VI. BUSINESS DEVELOPMENT IN INDUSTRY 4.0

Industry 4.0 is marked by a series of events that are triggered by a number of interconnected digitization technologies. The combination of different techniques encrypts the integration and interconnection of the real system into the virtual system [24]. This global path makes the way forward for emergence and extension of business ideas, framework, production equipments and production companies [25-29]. Industry 4.0 has paved the way for technological advancements of several tools and technological strategies which provides enormous advantages to the companies, entrepreneurs, manufacturers and service providers [30].

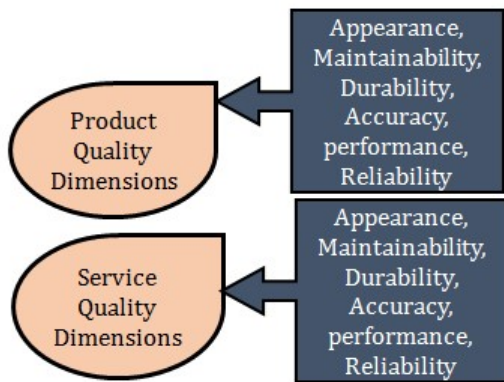


Figure 6. Business Development Dimensions in Industry 4.0

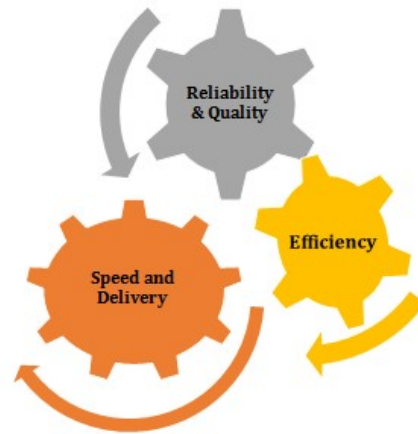


Figure 7. Business Development impact in Industry 4.0

It is always advantageous to think strategically towards attaining long term goal for breeding manufactures. It is continually re-modeling, re-correcting and re-shaping the traditional procedures supply and manufacturing [31]. Consequently, it is suggested to take profit from it and transform the challenges and opportunities into competitive advantages. The overall consequence of this collision will improve the business prospects and make sure higher quality, efficiency, reliability, speed and delivery [32-36]. These are shown with the help of Fig. 7. Now-a-days businesses take into consideration the automation and digitization of manufacturing production and processes also. These are further divided into two broad categories i.e. Service Quality and Product Quality as shown in fig. 6 and fig. 7. The various strategies for business development are shown in the fig. 8.

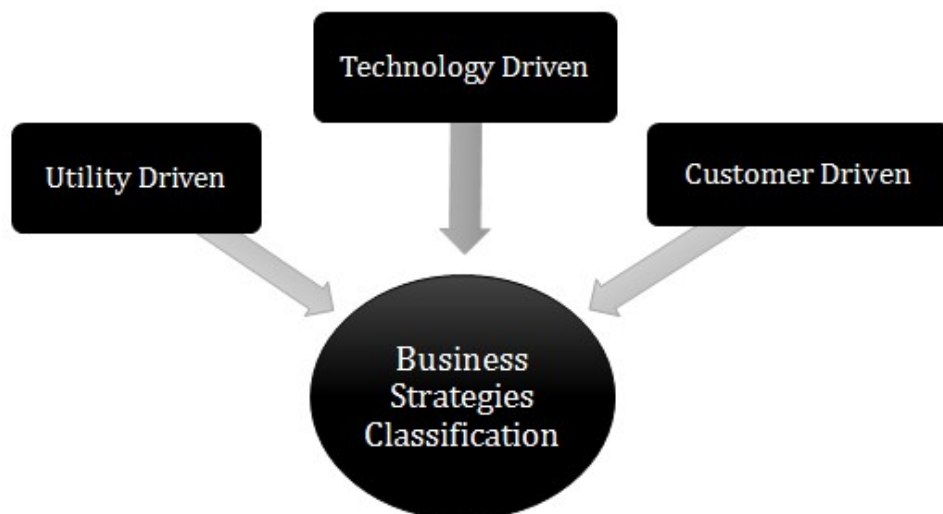


Figure 8. Business Development Strategies in Industry 4.0

## VII. THE FUTURE OF SUSTAINABLE DEVELOPMENT

The bright future of Sustainable Development has made a way through Industry 4.0. A number of various new opportunities have paved the way through Industry 4.0. A political and ethical principle forms the base for sustainable development which shows that social and economic characteristics of current economy is in tune with the ability of natural resources to replenish in an infinite way and upliftment of real life situations. The idea of Sustainable Development is achievable only if the three pillars i.e. society, Environment and economy have an inclusive interaction among themselves.

There are a number of instances where Industry 4.0 has proven to be very effective. One such instance is the development of Machine Learning, which was developed for data collection and its analysis, and has been successful in accomplishing that. Another instance is the development of Artificial Intelligence which deals with the overall and adaptive intelligence for drawing out important scope of real time particulars and facts as and when required with the help of efficient strategies, tools and techniques such as machine learning, deep learning, and population based heuristic algorithms, etc.

When sustainable development introduced itself as a new model for civilization, no one lay holded it as a simple goal to achieve. Also, none of them doubted that this can be too difficult to take real steps forward to the target. Many ways and perspectives had been tried like, mega-conferences, independent commissions, broad scientific assessments, and campaigns. And, the advancement has been observed and that is also very heartening in few regions. To get a improved judgment of what may be the environmental effect of Industry 4.0, suitable methodologies and techniques should be inculcated like for example, life cycle assessment, material intensity [37], or energy accounting [38, 39]. Finally, it can be seen that Industry 4.0 is the future for several areas, whether not for every aspect of life that incorporates the target of sustainable development. Many gateways, connecting the increasing prospective of technology and human renovation can bring about unlimited opportunities for growing and success in realizing the targets set by humans. The future has set about to grow and expand rapidly, drawing in various facets of life and showing in further signs of arriving bright future.

## VIII. CONCLUSION

The aim of sustainable development provides a set of objectives, making a structure for both national as well as local governments to think and move in a particular direction. The five P's that sustainable development involves includes—planet, people, prosperity, partnership and peace which cover every aspect for developing sustainable and healthy relationship among the social, economic, and ecological system.

Progress of Industry 4.0 basically is an era of automation, smart factories, cyber-physical-systems, and IoT [40]. All of this has promoted this Industrial revolution at a much higher level. In this paper, we have seen the how the evolution of industries have taken place from Industry 1.0 to Industry 4.0 and how these technological evolutions have helped in automating, supporting and reconfiguring the process of manufacturing that upgrades the business and talent development.

The several technologies of Industry 4.0 that are — Drones, Sensors, Robotics, augmented and virtual reality, reconfigurable manufacturing, cyber security, data analytics, machine learning, artificial intelligence, cloud computing, and IoT provides effective ways and solutions to the problems and challenges of Sustainable development. These developments, expansions, and manufacturing are highly managed by recent technologies such as, cloud computing, Artificial intelligence, big data analytics, machine learning etc. The collision of all these has driven sharply to the steady and smart automation. In this paper, we also have gone through the paradigms of Industry 4.0, its main purpose and objectives as well as interlinked point of view in the present situation. We shall thereby say that Industry 4.0 is growing rapidly because of its digital pillars and is in state of transition, but not yet completely developed. Because of increasing technological needs of the people and today's generation, learning skills from the intelligent facets of Industry 4.0, we are focusing to reach into an era of Industry 5.0 which is going to be more determined on the customized manufacturing, depending upon the collaboration and integration among the machines and the men.

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