Edited by
Nasser Rashad Al Mawali · Anis Moosa Al Lawati · Ananda S

Fourth Industrial Revolution and Business Dynamics

Issues and Implications

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Industry 4.0: The Human Resource Perspective

R. Nirmala and Neha Chitte

1 Introduction

The interface of technology and humans can be witnessed in different walks of life. Many emerging technologies like Artificial intelligence, Block chain, Internet of Things, etc. have made its way in human lives. The main objective of any new technology is basically to ease day-to-day life. One such example of technology is robotics. Recently, a restaurant in Chennai has successfully introduced robots as waiters. It is surprising to see the job that was considered to be completely person-centric being smoothly performed by such new "techno waiters" and also appreciated by the customers. Such reduction of human element in businesses processes has opened a new question, can machines replace human beings completely and if yes how? Is it feasible to install systems to perform range of tasks to reduce cost, time, and improve quality by completely bypassing humans? Probably not. However, today a smart tag is very

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common on different products and systems, including phones, televisions, vehicles, and even whole cities. SMART means "Self-Monitoring Analysis and Reporting Technology" Thus smart devices, smart systems, and smart infrastructure collectively can create a new eco-system of technology which significantly differs from earlier ones.

Once upon a time, not so long ago, "Business transformation" was considered a fashionable term and "Organisational Development/Business Process Re-Engineering" considered periodic interventions to be introduced by progressive organizations. But today, the applications of technology in businesses are far reaching and much sought after to ease business processes.

It is said that the World has witnessed three Industrial revolutions till recently.

1.1 The first industrial revolution started in sixteenth century was dominated by hydraulic and steam power. This revolution has its origin in Europe and covers the period from 1760 to somewhere in 1840. It was a complete transformation of manufacturing processes from hand production methods to machine production. Steam power, waterpower, mechanical power, mechanization, new chemical manufacturing, iron production, were the main features of this revolution. The main industry focussed and benefited from this revolution was textile industry. Hence it brought about significant socio, economic, and political changes. There was an emergence of working population, a significant increase in labor force. The job opportunities were generated to a great extent, but the working conditions were strict with long hours of labor set in accordance with the pace of machines. Comparatively, the wages earned by the labor were 20–40% less to lead a decent life. Other issues like unhygienic working conditions for women, children, and through organization of workers, trade unions, and even strikes at later period of time. The phenomenon of machine and human interaction then became the basis for next revolution. Child labor was prevalent then. On the other hand, labor found representation.

1.2 The second industrial revolution used electric energy and the assembly production lines. It was basically dominated by mass production. It began in late nineteenth century to early twentieth century; the phase of rapid industrialization. The famous

quote by Henry Ford about the Ford T model car, "You can have any color as long as it is black" indicates the same. Mass production without product differentiation is the feature of this revolution. The main sectors dominated by this revolution were iron, steel, coal, petroleum, paper making, railways, automobiles, etc. the productivity improved significantly. The prices of goods decreased significantly. Hence it caused lot of upheavals in industry giving rise to unemployment. Labor was displaced by machines and many factories, ships became obsolete. On the other hand, there was division of labor which made both skilled and unskilled labor more productive. This led to the creation of professional class and also considerable decrease in child labor.

1.3 The third industrial revolution included computers and information technology. It was dominated by electronics and nuclear technology. The two main components of electronics i.e., transistor and microprocessor gave emergence to telecommunications. This revolution focussed on microelectronics and flexible production. A variety of products were manufactured with programmable machines. But the limitation was it did not have flexibility concerning production quantity. There was shift in the kind of jobs. The knowledge of handling computer became a paramount skill which even created havoc among the aged employees. Hence need for retraining, voluntary retirements, etc. arose during this phase.

1.4 The fourth and current Industrial revolution involves ICT (Information and Communication Technology) wherein there is interface between cyber physical systems with automation and decentralized control. This leads us to "smart" manufacturing (Fig. 1).

2 What is Industry 4.0?

Industry 4.0 is basically the subset of fourth industrial revolution focussed on industry. Whereas fourth industrial revolution includes areas classified other than industry and includes range of fields that impact society like "Smart agriculture." The three fundamental technological drivers of this revolution are digital, physical, and biological technologies. Industry 4.0 and fourth industrial revolution are used inter-changeably. Industry 4.0

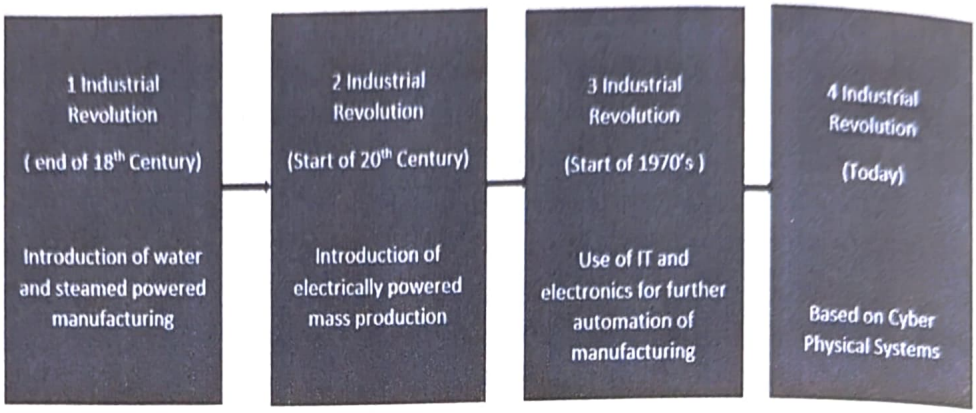

Fig. 1 Stages of Industrial Revolutions (*Source* Created by Authors based on Progression of Industrial Revolutions characterized by different technologies as proposed by Kagermann et al. [2013])

has its origins in Germany, one of the most competitive and advanced industries in the world. In 2011, at the Hanover trade fair, the term "Industry 4.0" was made known in public domain, as the name for the joint initiative of the representatives of business, policy, and science to strengthen the competitiveness of German industry. The Federal Government of Germany then undertook it as an important initiative "High-Tech Strategy 2020 for Germany."

Industry 4.0 includes the integration of cyber physical production systems (CPPS), wherein there is interface between humans and computer. In Industry 4.0 production floor, systems are integrated with ICT components. These are autonomous systems involved in decision making at real time which make use of machine learning algorithms and results based on past behavior.

Industry 4.0 includes vertical and horizontal integration of production systems connected on real time basis. In a smart factory, the tools like cloud computing, big data analytics are used as a source of data to kick start production. The production is based on this data which includes data from various stakeholders like customers, suppliers, competitors, etc. Then the digital to physical conversion takes place through human–machine, machine–machine, and human–human collaboration. Tools like artificial intelligence, machine learning, robotics, are used in this step. Similarly, both operations and control processes are performed using advanced tools like virtual reality, addictive manufacturing, etc. The interoperability of products in a smart factory takes place through sensors.

The processes and systems are decentralized, modular, autonomous, self-optimizing, and self-organizing in nature. Thus, a smart manufacturing configuration involves both smart machines and smart humans.

3 Definitions of Industry 4.0

3.1 As per Schumacher, Erol and Sihn (2016) Industry 4.0 is surrounded by a huge network of advanced technologies across the value chain. Service, Automation, Artificial Intelligence Robotics, Internet of Things, and Additive Manufacturing are bringing in a brand-new era of manufacturing processes. The boundaries between the real world and virtual reality are getting blurrier and causing a phenomenon known as Cyber-Physical Production Systems (CPPS).

3.2 Lu (2017) claims, that "Industry 4.0 can be summarized as an integrated, adapted, optimized, service-oriented, and interoperable manufacturing process which is correlate with algorithms, big data, and high technologies."

3.3 From management perspective, Industry 4.0 is defined as the integration of Internet of Things technologies into industrial value creation enabling manufacturers to harness entirely digitized, connected, smart, and decentralized value chains able to deliver greater flexibility and robustness to firm competitiveness and enable them to build flexible and adaptable business structures, acquiring the permanent ability for internal evolutionary developments in order to cope with a changing business environment as the result of a purposely formulated strategy implemented over time (Piccarozzi et al., 2018).

4 Components of Industry 4.0

4.1 Horizontal Integration

From the operational perspective, horizontal integration occurs when company's focus is primarily on its core competencies and its end-to-end value chain is established through partnerships. While with regard to business, horizontal integration means integration of organizations that targets the similar customer base with different products or services. In

Industry 4.0 context, it means there is a connected network of cyber physical systems which involves high level of automation, that is flexible and operationally efficient. It brings the concept of a new type of worldwide value chain networks.

4.2 *Vertical Integration*

From operational perspective, in vertical integration value chain is maintained within the in house as much as possible—from product development to sales. While in the context of business, it means integration with the companies that bring avenues of reduced manufacturing cost, better market opportunities, etc. In Industry 4.0 context, it refers to integration of all processes within the organization i.e., from production and marketing. Strategic and tactical decision making is enhanced due to the free flow of data.

4.3 *End to End Engineering*

This includes integration of entire value chain, to assist in customized production. In this the demands of customers, product design and development, recycling, maintenance is taken into consideration. Thus, there is free flow of information and customized product.

5 Characteristics of Industry 4.0

Automation drives Industry 4.0, which includes digitized factory and digitized products. Nevertheless, Industry 4.0 is still an emerging area hence the academic field finds it difficult to distinguish between its key features.

There are 10 characteristics of Industry 4.0:

- Artificial Intelligence—It is the way of making a computer, a computer-controlled robot, or software think intelligently, in the similar manner the intelligent humans think.
- Cloud Computing—These are basically data centers available to many users over the Internet. Cloud computing makes available computer system resources like data storage and computing power.

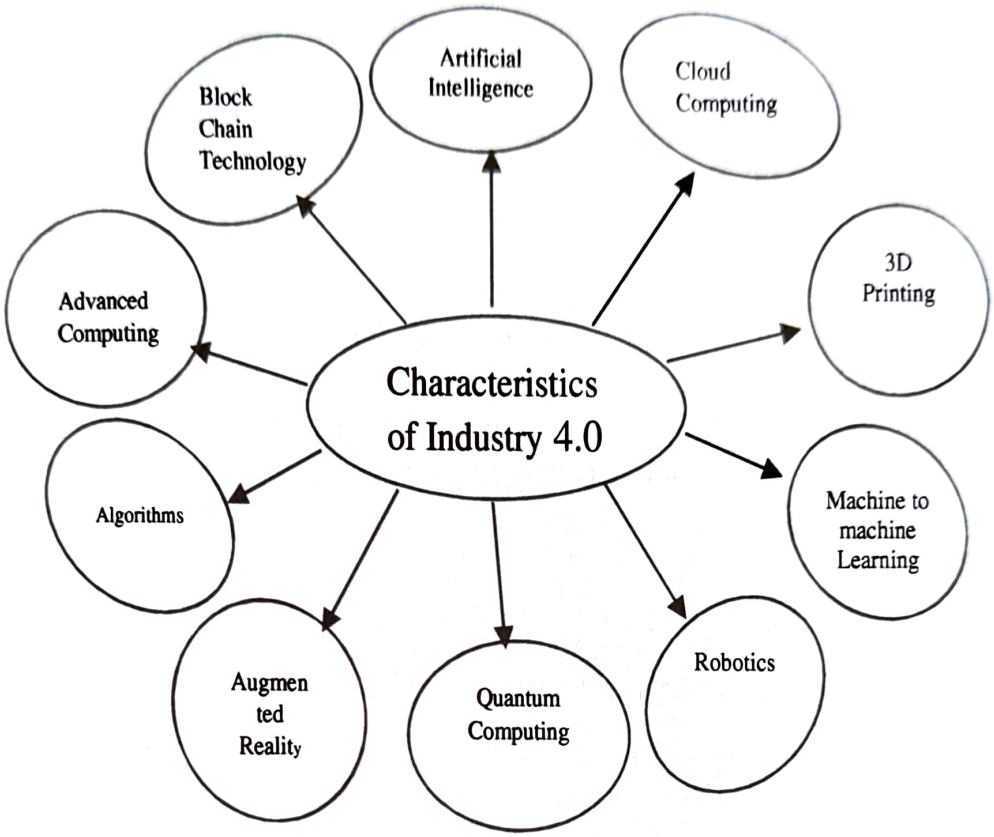

Fig. 2 Characteristics of Industry 4.0 (*Source* Created by authors based on Morteza Ghobakhloo, 2018)

- Block Chain Technology—Block chain is a decentralized technology. A global network of computers uses block-chain technology to jointly manage the database. It is also used as a distributed ledger.
- Machine to Machine Learning—Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.
- 3 D printing—3D printing is any of various processes in which material is joined or solidified under computer control to create a three-dimensional object, with material being added together, typically layer by layer.
- Robotics—Robotics deals with the design, construction, operation, and use of robots, as well as computer systems for their control, sensory feedback, and information processing.
- Quantum Computing—It is computing using quantum mechanical phenomena, such as superposition and entanglement. Quantum

computation uses quantum bits, qubits unlike binary bits used in computers.

- Augmented Reality—A technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view.
- Algorithms—Algorithms can perform calculation, data processing, and automated reasoning tasks. A process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer.
- Advanced Analytics—Determined to create business perceptions from an accumulation of data by pinpointing patterns and interdependencies (Fig. 2).

6 Relation of Industry 4.0 to Human Resource Management

Industry 4.0 is perceived to be a disruptive innovation but a necessary evil, indeed poses many impacts on the way humans work in an organization. Though it provides for many opportunities like performing complex task swiftly through automation, its real interaction with humans at work needs a thorough analysis.

The relationship between humans and machines is changed in Industry 4.0 environment. The repetitive, monotonous, dull activities are performed by machines. While activities like strategic decision making, agile working, smart working is expected by the humans of this era.

But another perspective in this area is the growing prophesies that machines would replace humans not only in routine jobs but even in the cognitive ones. Thus, it creates questions like what would be the new number and types of jobs created and what would be the jobs in which humans can excel?

This indicates that HRM 4.0 needs to shift its focus on tasks which are non-routine in nature, based on evidence, value addition, and derive its inspiration from science. Work, creativity, and technology need to go hand in hand. Thus, Smart Human Resource (SHR 4.0) becomes a promising solution. It is a recent concept evolved as a part of Industry 4.0 HR domain, wherein the focus is on innovations, adoption of recent technologies to solve HR problems. It is basically the digital transformation

of HR functions like recruitment, training, performance, etc. based on "People's sciences."

HR department in any organization is the one responsible for everything in and out about its workforce. Beginning from the recruitment till the exit of an employee, the role of HR department is very important. But today HR departments across the organizations are seen playing majorly the operational role with the obsolete technology and traditional skill sets. On the other hand, the exponential growth of technology, transmission of Big data, and Artificial intelligence (AI) demands data analysis precisely and on real time basis. Also, along with the technological transformation, the generation of employees entering the workforce is also witnessing a significant drift. Gen Y (birth year between 1980 and 2000) employees would be half of the workforce by 2020. Gen Y and Gen Z (birth year after 2000) are the ones grown amidst the technology (internet, Mobiles, social media, smart gadgets). Thus, these current or potential employees have different set of expectations from their employers like flexible working, work-life balance, anytime anywhere communication, real time feedback, free and open work culture, opportunities for career growth through data driven technologies, etc.

Hence SHR 4.0 with its data driven technologies and its new technologically oriented employees indeed has the capacity to transform the entire HR systems and processes.

The various functions of HRM can be analyzed through the prism of Industry 4.0 as follows:

6.1 Recruitment and Selection

As smart phones are equipped with the precise app settings Gen Y and Gen Z employees can be tactically reached using targeted advertisements based on their profiles and preferences saved in those settings. Using tools like Artificial intelligence, Big data, Cloud Computing, and Block chain technology the resumes can be sorted out with those fulfilling the job description and job requirements. Interviews can be conducted using faster data networks like 4G and 5G and AI chat bots can help in real time assessment of the candidate's responses. Finally, the new joiners can be guided through the Virtual Reality (VR) and Augmented Reality (AR) . Similarly, soft computing can assist in personnel assessment and selection as well as job assignment of personnel. Machine learning is another tool that has shown significant rise in internal hiring from 4 to 60% in Canada

and US. Hence such talent on boarding performed using advanced tools promises precision and effectiveness in hiring.

6.2 *Training and Development*

The next important step after on boarding is to enhance the knowledge, skills, and abilities of employees through appropriate training and development methods. This requires proper assessment of competencies like technical, methodical, social, and personal competencies. Artificial Intelligence can help in identifying the skill gaps and help in competency mapping. Similarly, Virtual trainings can be imparted to the Gen Y and Gen Z employees. Also, the technology of cloud computing would enhance the speed and accuracy of training needs assessment and career development. In this dynamic environment the need for retraining is likely to arise which can be done using such data driven technologies. Thus, Human capital should be adapted, and digital skills are compulsory.

6.3 *Performance Management*

In traditional HR practices, performance management is once in a year ritual wherein the one size fits all approach is followed. But for transformation of HR to SHR 4.0, performance targets need to be set up on individual basis. Thus, artificial intelligence can assist in setting up individual performance goals. Promotions can be based on the KPI (key performance indicators) rather than only on the basis of seniority. Also using cloud computing and big data analytics, performance feedbacks can be managed to derive appropriate performance indicators and results. Similarly, the wearable IOT (Internet of Things) technology equipped with its "sensitive digital electronic-network built-objects" can help monitor and measure data to improve performance. This may also assist in off boarding, by tracking the high and low performers' thereby giving internal opportunity for high performers leaving the organization.

6.4 *Motivation*

The advent of sophisticated tools and technologies such as robotics solving complex tasks may Undermine the role played by humans thereby affecting their morale and motivation. But studies point out that the

adoption of technology can have both negative and positive impact on motivation. Motivation in context of Industry 4.0 can be studied as:

1. Process motivation factor-It is achieved by properly formulated demands process operation, its inputs and outputs. This system assumes the correct and straightforward e-communication between the workers concerned by production planning and organization processes. Here the role of mutual communication among the workers and their teamwork plays an important role.
2. Product motivation factor—In Man-Man systems the worker is responsible for particular tasks. Also, it's necessary to have required competence to spark necessary changes without the occurrence of conflicts in the integrated systems. Thus, motivated staff plays an important role and are source of innovations in complex e process environment.
3. Personality motivation factor—Here the rotation of employees in the manufacturing process, skilling, providing avenues for cooperation, knowledge sharing and learning, teamwork is considered important parameters.

Thus, the core motivation for implementation of Industry 4.0 concept is relevant data and information available in real time for flexible process management.

6.5 *Employee Welfare*

The compensation management can be done from the database available. Similarly, employee health and wellness can be monitored using the wellness applications and smart wearable devices. Such devices are based on the technology of Internet of Things (IoT) . This fitness parameters can be tracked on real time basis and could reduce the number and frequency of sick leaves.

6.6 *Reward Management*

In context of Industry 4.0 rewards should be the basis of motivation and a retention tool for human capital. Human Resource can be tranformend into human capital when it is acquainted with Internet of Things (IoT),

human-machine interations, and well versed in understanding network systems.

7 Advantages of Adopting Industry 4.0 Tools in HRM

a) Customized cost and time effective HR operations.
b) An improved employee-employer experience.
c) Helps for mass production without increasing overall human resource costs.
d) Increasing flexibility, open, innovative, and better working environment.
e) Sustainable use of energy and resources for better talent management.
f) Leaner HR departments focusing on key strategic areas with precision.
g) Efficient talent management.
h) Shift of focus from operational to strategic policy formulations and implementations.
i) May reduce in employee attrition by promoting the principles of job fit theory.
j) Improvement in job satisfaction due to enhanced learning, career development, and effective work-life balance.

8 Challenges in Implementation of Industry 4.0 with Respect to HRM

Numerous studies have pointed out the changing dynamics of HRM in Industry 4.0 environment. The types of jobs, skills, competence, training, etc. considerably need a relook in the new workplace equipped with cyber physical systems.

8.1 Change Management

Change is the law of the nature. While resistant to change is omnipresent, but the intiators of new technology are humans themselves. Though top management is primarily associated with the transition, every worker needs to be taken into consideration for sustainable change management.

It thus challenges the traditional job design. These challenges require both people and organizational change. Also, there is a need to deal with increase work stress, effect on critical thinking ability due to the use of machines. Thus, it provides for another challenge for HRM domain to opt for digital means of managing, organizing, and leading change. Additionally, overcoming existing work culture, and managing multi-generational employee expectations is another factor.

8.2 Decentralization and Standardization

As Industry 4.0 involves free flow of information on real time basis there is decentralization wherein multiple stakeholders contribute through their insights. Thus, this environment demands real time, analytical, and complex role of humans. As manual and repetitive tasks are automized, humans are more required in decision making, R&D, and control. Hence this poses challenges like resistance from workers, threat to intrinsic motivation of workers, fear of losing current position, etc. Hence continuous and comprehensive training plays an important role in maintaining the morale of workers.

8.3 Education, Training

New working sphere demands new skills and knowledge from the worker. Conventional rote learning method does not suffice the need of technologically advanced job roles. Thus, the application of theoretical knowledge, and innovation is the need of the hour. Humans have to be ready to adapt to the constant changes taking place in the market, technology, systems, etc. Thus, company training and development measures ensure smooth shift from lean learning factory to Industry 4.0 learning factory.

8.4 Human Machine, Human–Human and Machine–Machine Interactions

Humans perceive machines as a threat to their jobs. But the manual repetitive jobs would be taken over by machines leaving the analytical, complex tasks to humans. Hence the role of humans does not become redundant rather it becomes more interactive. This interaction may seem unpleasant initially mainly for the older workers, but the ones who know how to

deal with machines and optimize their work would survive. The Human–Human interaction in Industry 4.0 is done via special social networks which give different social aspect to the company. The machine–machine interaction is based on automation wherein the systems take decisions independently are expected to warn humans of the needed requirements through controlling. Hence the role of humans remains important to ensure that the processes do not do more harm than benefits.

8.5 Decision Making

In industry 4.0 work environments, decision making is a decentralized phenomenon unlike traditional method. Thus, quick and prompt decisions have to be made. The data derived from various systems is complex and have to be incorporated wisely to arrive at decisions. This is analytical human tasks which becomes more complex in Industry 4.0 scenario. The data interpretation also needs to be accurate. Thus, the competence of using the DSS, the ease of DSS systems to simplify the complex tasks given to humans becomes a challenge.

9 Managerial Implications

a) ***Changes in the organizational structure***—Industry 4.0 demands some change in overall organizational design like a flat hierarchy-based agile organization structure from the traditional model.
b) ***Decentralization of power***—A shift from top-down approach to a decentralized approach due to vertical and horizontal integration.Leadership styles- A less of an authoritarian and more inclined towards participative and delegative leadership style is preferable in Industry 4.0 management settings. Leadership should promote more learning and innovation culture.
c) ***Efficient grievance redressal mechanism***—Management must be vigilant towards the conflicts that may arise due to multi generation employees and the disruption caused by the advent of new technology.
d) ***Strategic Management***—The management needs to emphasis upon the technology oriented, practically feasible, human resource friendly, sustainable policy formulations and implementations. Management needs to change its focus on strategic workforce planning.

e) ***Implication on HR department***—Reduction in HR team size and increased opportunity for HR department to focus on more strategic areas.

10 Overall Impact of Industry 4.0

The implementation of Industry 4.0 has both positive and negative impact on human resource management. The changes in the job structure, skills, and competencies have both positive and negative dimensions.

10.1 Positive Impacts

Adoption of Industry 4.0 has positive impact on human resource productivity. It means with the use of advanced tools and new technologies works are done at a faster pace as compared to the traditional techniques and tools. For e.g., robots have better working ability and high potential of doing work as compared to humans. Robots can do jobs faster and better. Along with the time factor procurement and maintenance of machines is cost effective than hiring, training, and retaining the employees. Similarly in the countries with high number of ageing populations, machines are better alternative as compared to humans. The implementation of sophisticated machines gives competitive edge to the organization. Due to new technology the training needs arise thus maintaining a well-trained, professionally skilled, and technologically competent workforce in an organization. In case of MSME's, assistance from the government agencies, international authorities are available for implementation of advance technologies. Similarly, there are positive changes in education, work infrastructure resources, and work meaning. Industry 4.0 increases the demand for employees with competence in mechatronics. Industry 4.0 would create new kinds of jobs. New jobs may shift from the full-time employment model to non-routine jobs (i.e., part-time, temporary, on-call, etc.). A renewed training policy would be demanded and new approaches to training may be visible. Organizations will build their human capital on the basis of new skill sets. Opportunities for more work flexibility and better work-life balance and lowering cultural barriers could arise. In Industry 4.0 humans are more important than ever. Job transformation instead of job losses can be witnessed. New roles will demand

more complex tasks. Know-how will be the determining factor at the market. There would be significant decrease in lower skilled jobs.

10.2 Negative Impacts

A high level of digital skills is required for survival in Industry 4.0. Automation will have a negative impact on white-collar jobs in multiple areas from HR to Finance. It would impact health care, education, and law firms. HR departments would be streamlined as most of the white-collar jobs will be replaced by AI. Demand for new skills is an area of potential threat for implementation of Industry 4.0. In addition, training the existing workforce in a specific skill set is also a challenge. On the other hand, motivation, training, retraining skilling, has a cost. Similarly, higher level of employee adaptation to new order skills is important for the success of Industry 4.0. A potential unstable shift in the labor market is another threat. Greater automation will lead to displacement of some of the often low-skilled laborers who perform simple, repetitive tasks. Automation will no longer be restricted to manual, the risky, or dull jobs, but may put at risk many white-collar jobs. Various job positions will become redundant, and some will be newly created. Initially, retraining and qualifications will be a problem factor. In subsequent stages, more educated and skilled workforce in the field of computing, self-learning, and innovation would be in demand. Also, the need for new curricula and disciplines within tertiary education would be required.

11 Conclusion

Thus, a thorough analysis of Industry 4.0 from human resource perspective highlights many important aspects and points out to a fact that technology is a double-edged sword. Its consequences on humans and particularly human work depend upon how we humans embraced it using it as a complementary and sustainable solution rather than perceiving it as a threat to our existence. Use of technology in HR can never be a complete substitute to humans at work. Only need is to further boost our capabilities and cognition to cope up and work hand in hand with this marvellous technology. If still doubtful, ask a HR if she/he would enjoy working with the data on employee's health gathered through wearable sensors or a bunch of papers from hospital.

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