Journal of Information & Optimization Sciences
ISSN 0252-2667 (Print), ISSN 2169-0103 (Online)
Vol. 45 (2024), No. 6, pp. 1663–1679
DOI : 10.47974/JIOS-1643

The conceptual understanding on the role of human factor in the era of industry 4.0

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Abstract

Each and every Industrial Revolution has influenced the society in different ways. The fourth Industrial Revolution has gained greater importance as it consists of wide range of

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disruptive technologies. The adoption of the digital transition has become very challenging for the organizations and particularly for its Human capital. There is very much need to adopt new set of skills in order to implement digitalized work process. So organizations and its HR should completely understand the concept of 4IR. The present paper has attempted to conduct conceptual understanding on the importance of 4IR in the manufacturing as well as service oriented process of the organizations. Along with that, the present paper attempted to understand the influence of 4IR on the work process and identify the challenges faced by the Human Resources in the implementation process and adoption of new digital and disruptive technologies in their work process. Systematic Review is conducted to understand the concepts by adopting Exploratory Research Design.

Subject Classification: *97P70.*

Keywords: *Fourth industrial revolution, Disruptive technologies, Systematic literature review, Workforce challenges.*

Introduction

We can observe an amazing evolution of industrial revolutions from its inception periods of 18th century. The industrial revolutions transformed our economy from agriculture to Industry with mechanized process, mass production and application of new technology. Now we are in the era of 4th industrial revolution which has led by some of the digital technologies like- Internet, Information and communication technologies, Artificial Intelligence, Big data Analytics, Block chain technologies, Internet of Things (IoT), which increases the performance [15],[52]. Usage of Bigdata, Machine learning and application of predictive analytics help in creating sustainable and quality Management [5],[6],[54]. Industrial Revolution 4.0 is explained as value creating business networks through people [49]. The decisions taken in the business through digital technologies relied on real time data collected through various digital environments [47] like social media networks, online shopping websites etc. The main resources that are necessary to get maximum benefits out of these digital technologies are the capabilities of the organizations The organization's capabilities can be enhanced by developing skills among the employees which inturn enhances the organizational performances [13]. From the research, it is identified that tangible resources and human skills occupies an important place adopting process of digital technologies [15].

Skill set with knowledge of varied discipline like statistics and its software, mathematical modeling, economics, accounting, coding and scripting knowledge, problem solving skills, marketing knowledge to identify market changing patterns are very much needed in the digital

age. Transformations through technologies of simulations, AIML, CPS, Virtual & Augmented Reality, IoT, cyber security and integrating these technologies with the business and work process [14],[39] is the main core of 4IR, and their demand will increase significantly [5]. Implementing and adopting these advanced technologies in the work process is a challenging task. Digitalization in the value chains of the business process created an edge towards the economic developments and operational efficiency [39]. Real time benefits have been experienced by analyzing huge data sets by the adoption of 4IR technologies .The usage of Bigdata with inbuilt intelligent systems has transformed the real time data analysis process. Due to these revolutionary changes, delivering customized quality products and services is possible and has become a highest priority. These applications have bought exceptional changes in the functionalities of organizations [3],[6]

Need of the study

Human capital of the organization is compelled to adopt IR 4.0 technologies to get success in the market. In this process, it become challenge for the organizations also to acquire talents relevant with IR 4.0 [29]. There is a possibility of tremendous growth with the adoption of 4IR technologies and simultaneously, organizations are facing challenges in the process of technology adoption [41]. Most of the organizations in the developing nations did not concentrated on the transformation of technologies as it involves in high investments. But the demand for customized high quality products forced the firms to adopt advanced technologies for the sustainable growth in the markets. This leads to the replacement of workers of normal skills with digitalized skills. Despite of having positive outcomes of 4IR technologies, there is a potential risk of shortage of skills and millions of low paid workers are affected due to automation and technology driven work process in the developing countries. The Job markets of semi and low skilled workers have been badly affected due to invasion of 4IR technologies in manufacturing sectors [20].

Manufacturing industries in the developed nations are shifting fast towards the era of 4IR and it became little slow in developing nations due to major challenges of developments of Human Resources with respect to up skilling them from the digitalization perspective. Successful adoption can be possible with the transformation in the organization's culture by

adopting changes in its structures, supply chain designs and also in the organization's functions [29],[47].

The adoption of digital culture in the emerging and developing economies is very difficult as it demands high investments and skills. From the perspective of Human capital Management, 4IR has encountered more complex challenges like acquiring talents with the dynamic digital skills, training according to the needs of the organization, engaging employees, motivating human capital, upskilling their skillset and so on [21],[31]. It becomes an essential part for the organizations of different sectors to acquire and equip human capital with digital skills to meet the demands of new process so that they can compete at global standards [10].

The present paper attempt to understand the concept of 4IR and importance of Human factor in the IR4.0 and challenges faced by the organizations and employees in the process of adoption of disruptive technologies. On the basis of the Need of the study following Research Questions have been formulated:

- What is the concept of Industry 4.O and the different Disruptive technologies considered under 4IR?
- How 4IR affects the work process and structure of the organizations?
- How is the role of workforce in the implementation of 4IR in the organizations?
- What are the challenges encountered by the workforce in the process of adoption of 4IR technologies?

The concept of Industry 4.0

The phenomenon shift in the paradigm of the business process can be experienced with Industrial revolution. The 4IR has began in 2011, when Industrial process has made digitalized with the integrated technologies in which machines coordinate itself and also with Humans [4], [34]. Industry 4.0 covers a series of digitalized process by grouping technologies such as – Cloud computing, Internet of Things, Machine learning, Block chain Technologies, Big data & Analytics, 3D printings, Robotics, Additive Manufacturing, AR&VR, Cyber-physical systems (CPS), Simulations, Cyber security, System Integrations etc.. The strategy behind the application of these disruptive technologies is to optimize the business process [5] and improve the organization's performance.

The main objective of IR4.0 is to provide technology based customizable manufacture products through flexible value chain [42] and

make whole business process as intelligent manufacturing systems. These systems depend on processing large amount of relevant data from every field to become flexible, smart and customizable to face dynamic business world.

From the various studies, the main feature of the 4IR are identified as optimization and customization of production process through automation, digitalization and Human-Machine Interactions (HMI) The major difference between Computer Integrated Manufacturing (CIM) and IR4.0 is Human role in which CIM involves personnel less production process where in IR4.0, human plays a great role in the production. Industry 4.0 is cyber physical system in which two dimensions of physical and digital systems are bought together in to a structure. Expanding CPS, cyber physical production systems (CPPS) has been emerged which consists of sub systems that are interconnected across all the levels of the production i.e. from the process through the machines and up to production and Logistics networks. The main characteristics of the CPSS can be explained as Intelligent or smartness in which elements can acquire information and act autonomously in a directed manner and maintaining connectedness with all the elements including human factor and responsive towards internal and external changes The main drivers of Industry 4.0 are Internet of Things (IoT), and the term IoT has been coined by Kevin Ashton and explained it as the connection of physical devices over the Internet through sensors [50]; Industrial Internet of Things (IIOT) which focus on Industry specific applications of IoT to improve existing process and systems. IIoT links the automation systems with enterprise planning and product life cycle; cloud based manufacturing, is a platform which is designed to handle Bigdata related to manufacturing operations and complex computational capacities in a protected environment. Organization runs its manufacturing software systems and databases on the clouds and access through Internet; Smart manufacturing systems is the collaboration of Humane and machine, and envisioned as an environment that make communication possible between Humans and machines. Big data technologies are supported by Internet of services (IoS), CPS facilitates the digital environment.

From the above reviews, it is clear that Industry 4.0 enhances the effectiveness of manufacturing industries by machine and Human-Machine interactions with real time data [55]. Adoption of these technologies provides different alternatives for sustainable production and consumption minimize the waste and safe guard the environment. Continuous monitoring is possible , so that performance of the products

can be analyzed by both customers and Industry so that reliability and quality of the products can be maintained [57]. Industry 4.0 give major importance to the enhanced customer service and it can be possible through continuous communication, exchange of knowledge and expertise [1],[23] and again with collaboration among various resources of the organization like Leadership skills, Human Resources, Big data & Analytics, Supply chain, Logistics that lead towards effective production and performance in the circular economy [15].

Industry 4.0 and Organizations

To enhance the manufacturing and service operations, most of the organizations in the developed countries have adopted Industry 4.0. In a survey conducted on 300 manufacturing companies by Mc Kinsey, it has been identified that nearly 50% of companies are ready to adopt IR 4.0 [45]. There is wide spread of defining features of IR4.0 in different sectors of agriculture, manufacturing, services, logistics etc... The major developments in terms of technology interventions not only include the automated work process and also include inclusive developments in terms of socio economic transformations. With the smart and connected production systems organizations can increase its productivity, energy efficiency and sustainability and can decrease its maintenance cost . Organizations can up scale their value chain life cycle with innovative operations, through which production optimization is possible.

Some of the integrated technologies of 4IR like cloud systems, Big data, and predictive analytics can empower the organizations in handling and treating large data sets of the customers and aid in understanding the customers'/consumers' behaviors in both B to B and B to C markets [44]. This in turn enables the organizations to formulate the proactive strategies and produce products and services according to the needs and wants of the customer group. Enhanced customer satisfaction is attained not only with customized products and services but also by ensuring on safety of customers' sensitive and essential data by adopting advanced technologies of cyber security, Block chain technologies). More intelligent manufacturing process can be adopted by integrating new techniques and technologies through which new capabilities can be improved in terms of New product developments and Innovations, real time data analysis, product customization, agility [19]. The 4IR promotes the network systems that can respond promptly to the changes occurred in the current market situations. Along with these growth prospects, organizations face major

challenges while adopting 4IR in terms of managing and training its workforce.

Work force in IR4.0

We can observe major transition in the operations, organization structure and its work process due to Industry 4.0 [5],[38],[51]. With the digitalized dynamic environments, organizations can able to adopt improved strategic perspectives to make quality decisions [5]. Due to changes in the work structures and operations, there is very much need for the work force to adopt these digitalized changes [12].

To realize the benefits of IR4.0, there should be a proper integration between Human resources and technology [17],[5]. The three resources required to attain digital transition have been identified as Tangible (in terms of Technology and IT infra structure); Intangible (in terms of culture, knowledge and synergy); and third one is Human Resource (in terms of Technical and Human skill set) [2].

Human factor is considered as a key for the successful digital transformation in the occupational structures [22],[40] through which competitive advantage can be generated The concept of Industry 4.0 relied its focus on adoption and implementation of technologies in the work process by utilizing workers' skills and abilities in the better way [8].

A digital work space is a new paradigm in the organization's work in which employees plays a major role in adopting new technological Interventions [16]. The existing skills and competencies have become obsolete with the emergence of new technologies and demand for new skill set has evolved. Organization's performance can be enhanced through developing the workforce at three levels: Behavioral which concentrates on intra and inter personal aspects; organizational level that concentrates on matching skills and competence of the workforce with the strategic intent of the organization; and Technological level in order to fulfill the requirements of the work process during Implementation [24].

For the successful transformation, work force is the indispensable asset and key element to achieve operational excellence to realize the benefits of IR4.0 in the maximum extent, there should be a proper integration of HR practices with the technologies [43]. IR 4.0 extended the responsibilities of HR professionals in order to implement the Human Resource development practices that helps in integrating digital work process in the organizations [53]. It is the biggest challenge and

organizations should deal with all the hurdles that encounters in this process of workforce development in the phase of digital transition [28].

Work force Challenges

Most of the companies are unable to take full advantage of digital technologies. Because skilling of the employees with respect to the 4IR is not only limit to middle and upper level but also from the floor level employees [25]. The wide spread and application of the modern technologies have significantly altered working environments [7]. The wide application of emerging technologies vanish the work boundaries which may increases the risk of burnout syndrome or work life conflict [35]. Employees are expected to be available all the time and this reduces the time for their private and personal life [9],[24]. Due to this, work-life balance issues have been raised [26]. It has been observed from the research conducted in the manufacturing Industry that there was a weak relationship between Organizations' 4IR strategies and work-life Balance [18].

From the Research literature, it has been identified that studies had been carried out on the concept of Techno stress [46] and was first introduced by clinical psychologist Brod (1984) and described it as poor mental health among employees due to the usage of ICTs in the work process. Dependence on technologies and striving to adopt continuously leads to mental and psychological discomfort has been referred as Techno stress .

Tarafdar has conducted research on 'Techno stress' and identified five factors that leads to stress as – Techno Invasion, Techno overload, Techno complexities, uncertainties and Insecurities and also conducted study on effects of these five factors on Employees' performance [46], Further he described as the stress underwent by the workers due to their incompetence of meeting the organization's demand of technological applicability [46]. Some other reasons for the stress among the employees have identified in the literature were due to multitasking, information overload, Technical ambiguities, and uncertainty

From the history we can understand that Industrial Revolution results to an economic change and Economic growth. Further this leads to substantial changes in the work process [37]. The 4IR is the integration of huge set of new technologies and it is needed with varied skill set . If employees delay in adoption of these skills set, eventually experience the fear of job losses and undergoes extreme strain to retain employment in

the changing work environment [30]. This effect to the mental health among the employees. From the research, occupational health issues are determined relating to 4IR due to automated work culture as it provokes instability and insecurity among employees [48]. In every situation of Industrial transformation, re-skilling among workforce is the major challenge. Conventional wisdom is challenged by automated technologies, in which machines were made to perform specific tasks and workforce is expected to upskill themselves to handle and manage technological revolutions with complex cognitive process and creativity [34].

With the increasing use of complex information and communication technology in factory automation, employees are experiencing increase in the world load. There is a shift of physical workload to cognitive workload. As 4IR uses IoT (Internet of Things) to create cyber-physical production systems (CPPS) [27] which is the core of the 4IR, comprise of wireless embedded network systems and network cloud computing in manufacturing systems. So finally, most of the data will be supervised through IoT based human-computer Interaction (HCI) systems [33]. Though with the technological interventions in CPPS, which control and monitor the process on their own with machine learning algorithms, monitoring CPPS with rich interactive user interfaces is needed to operate machines and prepare and present complex information for real time decisions. The increasing load of information processing, demand for higher attentional requirements in the tasks, strains the brain is called as Cognitive Load [58]. To come out with real time decisions, employees have to analyze large amount of data which is relevant and irrelevant [36]. Due to this data overload, there is the possibility of occurrence of Human errors and leads to decrease in overall human performance [32]. One more challenge is addressed in the literature, on which major amount of research is carried which referred the relation between 4IR and Income inequality. Global inequality is the major concern now days [11]. These researches argue that technological changes widen the gap between high and low skilled workforces that results in to the expansion of inequality gap.

Union Bank of Switzerland (UBS), 2016 stated in its report that emerging economies experience more impact due to extended use of AI and other technologies as it will reduce the competitive advantage of low labor cost when compared to developed economies. Even in the global report of Deloitte 2018, stated that adoption of emerging technologies leads to a state of social uncertainty and disturbance due to increase in the income inequality.

Methodology

The present study has adopted exploratory research design. This design is adopted to gain better understanding on the phenomenon of interest or on the current problem .The main purpose of adopting exploratory research design is to explore the research problem in varying perspectives rather than coming to one final conclusion about the problem. This research design is a preliminary research which serves as a foundation to the future conclusive research [56]. The set of benefits identified by adopting exploratory research design are that it helps in getting valuable and insightful information of the study and the outcome of adopting this research design helps to answer the questions of 'What, How & Why [59]. Further, this research design helps to identify the possible causes of the problem identified which can studied in the future

Along with the positive points, exploratory research design holds some limitations. The primary data collected through this research design involves with small number of samples and it is in qualitative in nature which can be biased and may be judgmental. The interpretations drawn from the results can't be generalized. Another limitation identified is that secondary research conducted may be of old period where relevance might be misleaded Above mentioned limitations have been overcome in the present paper by adopting secondary research methods. Secondary data is collected by systematic literature review through online research. Maximum 90% of research articles are reviewed with the time frame of 7/8 years not to loose with credibility and relevance of the Research problem.

Analysis and Discussion

Systematic Literature review has been carried out by viewing different articles from the Indexes of Scopus, Web of science and Google Scholar, Social Science citation Index (SSCI), Science citation Index(SCI) which has open access. The search span was considered from 2015 to 2023 and total number of articles reviewed to get answers for the research questions formulated is 98 and among them some articles are screened due to irrelevance of the concepts, unavailability of complete data due to closed access and no proper and reliable identification of publisher's information. Final set of articles considered for the study are 54 research articles which are published by renowned publishers whose journals are indexed in Scopus, Web of Science, Social science citations (SSCI), Science citation

Index(SCI), Google scholar. Details of the number of articles along with the Publishers are provided in the Table 1 as follows.

Table 1

Details of journal publishers

S. No	Publishers	No. of Articles
1	ELSEVIER	21
2	EMERALD	15
3	TAYLOR & FRANCIS	11
4	SAGE	3
5	SPRINGER	1
6	WILEY	3
	Total	54

From the table, it is evident that all the articles are reviewed from the publishers whose most of the journals are indexed in Scopus and Web of Science. Remaining journals are considered for the review of the concepts on the basis of authencity and credibility of the information provided.

Conclusion

A conceptual study has been conducted in the present paper to understand the concepts of the Industry 4IR and challenges faced y the workforce to adopt. The 4IR has been introduced almost decade back, and still there is confusion with respect to the implementation and readiness towards the adoption of disruptive technologies because of its huge range of technological interventions. So there is very much need to understand the various technologies in depth by the organizations in order to fit these technologies in their value chain process. Organizations must focus on building work cultures that supports the environments of continuous learning in which employees can show enthusiasm to adopt new technologies. Companies should come out with the policies that encourages the workforce to upskill themselves in order to adopt the digital technologies. Companies and organizations should support each other to adopt and implement the new technologies successfully for the large benefit of the society.

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Received April, 2024