Industr4.0: Is Your Country Ready?

“God, grant me the serenity to accept the things I cannot change, the courage to change the things I can, and the wisdom to know the difference.”
Reinhold Niebuhr

Learning Objectives

The objectives of this chapter are to define the main preconditions and to give a roadmap for the implementation of Industry 4.0. Once you have mastered the materials in this chapter, you will be able to:

– Discuss the readiness of countries for the 4th industrial revolution.
– Explain the challenging tasks to be met in order to implement the concept.
– Identify the necessary preconditions and predispositions for being ready for Industry 4.0.
– Apply the evaluation steps to any country taking action plans.
– Analyze the countries and/or economies according to their readiness for Industry 4.0.

Chapter Outline

Industry 4.0 is the contemporary phenomenon of today’s world. Many of the leading economies make researches over the subject and prepare strategies in order to have a successful transition to this new era. Together with rapid technological developments, digitalization and mass customization, applications of Industry 4.0 get more attention in industrialized countries, especially in the last decade. Many industrialized countries have adapted their strategies according to Industry 4.0 in order to increase their competitive skills and to be efficient across the global production environments. There are challenging tasks that
have to be met as regards in order to implement this concept accurately. The Industry, Report and Energy Report which was requested by the European Parliament’s Committee on Industry, Research and Energy defines these tasks as standards, work processes and organization, availability of products, new business models, security and IP protection, availability of workers, research, training and professional development and the legal framework. Within the scope of this chapter, the readiness to this process, which is a strategic decision, is taken under consideration. The subject is evaluated, considering the necessary preconditions and predispositions of Turkey and any other country as well.

**Keywords**

Industry 4.0, Readiness for Industry 4.0, Roadmap, Preconditions, Industrial revolution, Digitalization.

### 1 Introduction

Industry 4.0 is a concept that emerged in Germany in 2011 and is considered as a rising trend all over the world because of the economic and social benefits it will provide and will directly affect the level of development of countries. The fourth industrial revolution has become one of the most popular topics the past few years, with governments and industries around the world realizing the rise in research on the Internet of Things (IoT) and Cyber-Physical Systems (CPS) and taking action to benefit from the advantages of this new wave of the industrial revolution. One of the most persuasive arguments in the emergence of Industry 4.0 lies in its ability to shift global production, which is directed at countries with low labor and other resource costs, especially in the Far East, due to production costs, to the developed western countries. Looking at the last 20 years, it can be seen that due to the low costs, the productions made in the west are transferred to countries where cheap labor is abundant. Depending on this situation, it is observed that western countries are experiencing global market share losses of around 10% due to low-cost economic transfers from some other sources. How can global production be possible again in the west, where the costs are quite high? Industry 4.0 is the term used for a digi-
tal revolution in which a highly qualified human resource plays a central role. At this point, one of the unique tricks of the battle is the presence of qualified human resources. Analyzes demonstrate that unit production costs can be inferior in productions made with highly qualified labor, intelligent robots, and autonomous systems and can be equalized, as is the case in countries where labor costs are low. In 2018, 2.3 million units of robots were expected to be used in the industry. It is stated that the developments in the field of robotics in particular trigger the formation of intelligent production systems in the production sector. With intelligent production systems, it is aimed to provide customized, intelligent production, improved production quality, less error production, less waste, more localized manufacturing processes, faster innovation processes and fewer resources that respond more and more quickly to customer preferences and needs. It is estimated that in 2020, approximately 50 billion devices will be in communication with each other. The network of intelligent manufacturing systems, intelligent cities, homes, logistics, networking, networking of device elements with social networks and e-commerce networks will result in a network of ecosystems that will use the internet environment of services, objects, and individuals, which is expected to affect about 46 percent of the global trade volume in the next quarter century. The European Union adopts the goal of 2020 to move the industry’s gross domestic product share from 15 percent of the current situation to 20 percent. The European Commission is investigating how the Fourth Industrial Revolution in industries transforms production, logistics, and consumption models. The prepared action plan includes the strategy that Europe will set on digitalization, cyber-physical systems, cloud computing, artificial intelligence, internet of things, and robotic systems. The European Union, which supports the digital transformation of the industry, has many initiatives to compete locally and nationally. The European Commission is developing the most appropriate strategy to bring these initiatives to the next level. Under the heading of digitalizing the European industry, the focus is on the action plan related to the following subjects: Facilitate access of all industrial companies to digital technology, to prepare the basis for the creation of digital industry platforms in Europe, to keep the workforce ready to
benefit from digital transformation to provide appropriate solutions for the widespread adoption of intelligent industry.

Countries should decide how best to use national strategies and production capacity as a capability in this new production paradigm. To this end, countries should consider the factors and conditions that are most influential in the transformation of production systems and assess whether they are ready for the future or not. After that, governments can work together with industry, academia, and civil society to implement appropriate actions. This chapter focuses on the factors that determine countries' readiness for the Industry 4.0 process. In Section 2, the issue is assessed, considering the prerequisites and trends related to this subject. In Section 3, an assessment is presented for Turkey. It is also possible that the evaluation can be applied to any other country. Section 4 is devoted to the final remarks and suggestions.

2 Readiness for Industry 4.0

Although Industry 4.0 has entered our lives as a concept, the existence of serious uncertainties surrounding the development and adoption of new technologies means that we do not yet know how transformations driven by this new industrial revolution will evolve. While there is a vast network of communication, numerous information and data, internet of things that is rapidly continuing to shape our whole life and the access to the big data that is obtained thanks to these developments; those who do not know how to use all of them will, unfortunately, be out of the system in the future. Mueller et al. argue that although there is no doubt about the probable advantages of Industry 4.0, there must be answers to questions such as "What are the application areas of the Industry 4.0", "How should the Industry 4.0 be implemented?" and "Which perspectives should be considered". When considered as a revolution, they argue that the concept of Industry 4.0 has been criticized for "inadequacy of details". Furthermore, another critical shortcoming is that; although joint research has been carried out, the conclusions of the Industry 4.0 surveys have stated that a reference architecture with a detailed view of the practical application is very generic. (Mueller et al., 2017). Gentner (2016) stated that even though
many countries have an action plan for Industry 4.0, the vast majority of ideas are still unclear. He discussed what is real, what ideas are likely to be real in the future, and what ideas will remain to be defined as science fiction. (Gentner, 2016). The final report of the Industry 4.0 Working Group, "Recommendations for Implementing the Strategic Initiative INDUSTRIE 4.0" is now the most cited and accepted reference study to Industry 4.0. Kagermann et al. discussed the three integration features required for Industry 4.0 (horizontal integration through value networks, end-to-end digital integration of engineering across the entire value chain, and vertical integration and networked manufacturing systems), and put forward eight priority business plans for these integrations to be realized. These areas are given as follows (Kagerman et al., 2013): Standardization and open standards for a reference architecture, managing complex systems, delivering a comprehensive broadband infrastructure for industry, safety and security as critical factors for the success of Industrie 4.0, work organization and work design in the digital industrial age, training and continuing professional development for Industrie 4.0, regulatory framework, resource efficiency. In recent years, governments and industries around the world are aware of this trend and are actively taking advantage of this new wave of the industrial revolution (Ridgway et al., 2013; Siemieniuch et al., 2015). In this framework, many countries have prepared action plans (Liao et al., 2017): From the government plans perspective, since 2011, the United States government has begun national-level discussions, actions, and recommendations to ensure that they are ready for the next generation of production (Rafael et al., 2014). In 2012, the government of Germany adopted an action plan, which sets a billion-euro budget each year for the development of the most advanced technologies (Kagermann et al., 2013). In 2013, the French government initiated a strategic review process called “La Nouvelle France Industrielle”, in which 34 sectoral enterprises defined as the industrial policy priorities of France (Foresight, 2013). In 2013, the government of the United Kingdom offered a long-term picture for the manufacturing sector, which is called “The Future of Manufacturing”, until 2050 (European Commission, 2016). In 2014, the European Commission published a new Public-Private Partnership (PPP) agreement on “Factories of the Future” (FoF). Under the “Horizon 2020”
program, it plans to raise about 80 billion euros for seven years (2014–2020) (Kang et al., 2016). In 2014, the government of South Korea announced “Innovation in Production 3.0”, highlighting new strategies and assignments for Korean production (Li, 2015). The government of China published the “Made in China 2025” strategy as well as the “Internet Plus” plan in 2015, prioritizing the manufacturing sectors to accelerate information and industrialization (Cabinet Office, 2015). In 2015, the government of Japan adopted a new plan, in which special attention was paid to the manufacturing sector to realize the world’s leading “Super Smart Society” (National Research Foundation, 2016). In 2016, the government of Singapore allocated 19 billion dollars to the RIE 2020 Plan (Research, Innovation, and Initiative) (Evans and Annunziata, 2012). From the industrial plans perspectives, in 2014, AT&T, Cisco, General Electric, IBM, and Intel set up the Industrial Internet Consortium (IIC) to catalyze and coordinate the priorities and opportunities of Industrial Internet (https://www.statista.com/statistics/667634/leading-countries-industry-4-0-worldwide). Meanwhile, other big firms such as Siemens, Hitachi, Bosch, Panasonic, Honeywell, Mitsubishi Electric, ABB, Schneider Electric and Emerson Electric have made significant investments in projects related to the Internet of Things and Cyber-Physical Systems (Rafael et al., 2014). The statistic given in Figure 1, shows the results of a survey conducted among 559 industrial organizations on the views on the leading country in Industry 4.0 by 2016. Twenty percent of respondents said that Japan was the leading country in Industry 4.0 (World Economic Forum (WEF), 2018).
The WEF released a report in 2018, analyzing how the changing nature of production shapes well-positioned countries and how these countries benefit from this change. The main components of this assessment, together with related drivers and sub-categories, are given in Figures 2 and 3 (European Parliament, 2016).

Fig. 1. Leading nations in Industry 4.0 (WEF, 2018)

Fig. 2. Structure of Production: Concepts Measured (European Parliament 2016)
In the report, under the two drivers related to a country’s Structure of Production, two sub-categories are defined: Economic complexity and manufacturing value added, whereas the Drivers of Production includes six headings (European Parliament, 2016). "Technology & Innovation" evaluate the extent to which a country has an advanced, secure, and connected Information and Communication Technologies (ICT) infrastructure in order to support the adoption of new technologies in production. Under this heading the first category is the "technology platform" including the availability of ICT which has the data related to the number/percentage of individuals using mobile networks and the foreign direct investment (FDI); the use of ICT, giving the data related to what extent do ICTs enable new business models; and the digital security & data privacy which specify cybersecurity commitment. "Ability to innovate" is the second category including the industry activity which contains the data related to the investments of companies; research intensity that defines the research and development (R&D) expenditures and related outcomes; and available financing, including the information related to the average value of venture capital deals. Under the category of "Human Capital", "current labor force" including the labor force capabilities of manufacturing employment, female participation, scientists and engineers, and the data related to what extent does the active population possess sufficient digital skills; and "future labor force" including the migration, education outcomes, and agility and adaptability related issues, are included. "Global Trade & Investment" defines a country’s participation in international trade. The first issue under this heading is "trade" which is defined by the sum of exports and imports of goods and services measured as a share of Gross Domestic Product (GDP), trade-weighted average tariff rate, and the average score of components from the International Logistics Performance Index. The second component is "investment", including the investment and financing which is related to the greenfield FDI projects, FDI flows, and financial resources provided to the private sector by financial corporations. And the third one is "infrastructure", including the issues of the transport infrastructure and electricity infrastructure. "Institutional Framework" defines the effectiveness of the contribution of government institutions, rules, and regulations towards technological development and advanced manufacturing. This category is related
to governmental issues as; "efficiency & effectiveness" including the regulatory efficiency, and the future orientation of government, and the "rule of law" which is defined by the score for the Rule of Law dimension issued by the World Bank. "Sustainable Resources" assesses how production affects the environment, including the use of natural resources and alternative energy sources. "Sustainability" includes the alternative and nuclear energy use, intensity levels for CO2, CH4, and N2O, and score for Wastewater Treatment from the Yale Environmental Performance Index.

Fig. 3. Drivers of Production: Concepts Measured (WEF, 2018)

"Demand Environment“ evaluates foreign and local demand access to scale production. This heading includes the "foreign and domestic demand" related to the market size together with the "consumer base", including the buyer sophistication and the extent of market dominance. In the ‘Readiness for the Future of Production Report', the application was made to analyze 100 countries and economies. The top 10 countries/economies determined in this report are given in Table 1.
Table 1. Top 10 countries according to the “Readiness for the Future of Production Report” (European Parliament, 2016)

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<th>Structure of Production</th>
<th>Drivers of Production</th>
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<td>Rank</td>
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<td>Japan</td>
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<td>Korea, Rep.</td>
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These preconditions required for the successful implementation of Industry 4.0 are identified as follows (European Parliament, 2016): Standardization of systems, platforms, protocols, connections, interfaces are, and it seems that a reference architecture is needed that will facilitate the implementation of the Industry 4.0 processes by providing a technical description of these standards. Work organization reflects changes in business models. Complex systems should be managed with the help of planning and explanatory models. Real-time oriented control transforms business content, processes, and the environment, and this transformation results in increased responsibility and continuous improvement for the individuals. The availability of products used both in the production process and sold to various buyers is essential. New business models should be developed and implemented by investigating who is responsible for the costs and risks of unsuccessful initiatives. In the global competitive environment, know-how’s safety/protection is vital. Companies/governments will not be willing to make new investments if their innovations can be easily replicated by other companies that do not have to invest in R&D. It is expected that the costs of investing in equipment safety for workers’ protection to be proportional to potential gains. Manufacturers should protect themselves against misuse and unauthorized access, with the help of
unique identifiers and training of staff. The availability of skilled workers who can design and operate the industry 4.0 workplaces is important. The question of who will invest in the skills and training of these workers becomes essential. For those who do not have these skills, the effects of these developments need to be determined in terms of employment. Another critical issue is the life-long learning under this context where highly sophisticated technological systems exist, and particular skills are required. How to develop and implement a common EU legal framework to enable the digitalization of the industry is to be emphasized. This is a prerequisite for implementing Industry 4.0 in a Single Market so that companies can gather resources in order to undertake the investments they need to integrate their production systems.

3 A Roadmap for Industry 4.0

Focusing on the countries’ readiness for Industry 4.0, it is essential to understand what the primary purpose of the transition to Industry 4.0 is. Countries are in constant competition with each other in the current situation they are in and try to find ways to pass themselves on advantage. This quest is ongoing and requires constant improvement. The Global Competitiveness Index (GCI), which is announced annually by WEF, is a broad base for measuring the competitiveness of nations. This index is created using a sophisticated methodology as well as the views of industry representatives. Global competitiveness is a field of economic theory that analyzes politics that allow a nation to create more value for its own business and to provide more prosperity for its people. The index contains data sets built on twelve primary headings in three main groups. These three main groups consist of several topics, including basic requirements, productivity enhancers, and the sophistication of the innovation & business world. The 12 main topics are: Institutions, which defines the institutional environment of a country, including the legal and administrative framework within which individuals, firms, and governments interact. Infrastructure, i.e., active modes of transport, efficient electricity supplies, and a robust and extensive telecommunications network. Macroeconomic environ-
ment, meaning the stability of the macroeconomic environment. Health and primary education, which is descriptive of a healthy workforce, and the quantity and quality of the primary education received by the population. Higher education and training, indicating the quality of higher education and training, and the extent of staff training. Product market efficiency, which states efficient goods markets, healthy market competition, and customer orientation and buyer sophistication. Labor market productivity, including the efficiency and flexibility of the labor market. Financial market development which points out a trustworthy and transparent banking sector, and appropriate regulations for investors and other actors in the economy. Technological preparation, measuring the agility with which an economy adopts existing technologies to enhance the productivity of its industries. Market size, defining the markets available to firms. Business sophistication, which concerns the quality of a country’s overall business networks and the quality of individual firms’ operations and strategies. Innovation, which means adequate investment in R&D, the existence of high-quality scientific research institutions, comprehensive collaboration in research and technological developments between universities and industry, and the protection of intellectual property. It is only through proper planning that countries can achieve improvements in these competitive values. This may be at the level of material or product production, or the level of technology or information production. Industry 4.0 is a concept designed to compete with the far eastern countries that produce high quantities, as mentioned before. It is essential to pay attention to the above competition indices, which are approved by the WEF, in order to be able to adapt to this concept correctly. Looking at the indicators used in the ‘Readiness for the Future of Production Report’ presented in Section 2, and/or the preconditions given in the European Parliament’s ITRE report prepared by the EP, the readiness conditions are highly related to the competitiveness indices presented by the WEF. The ability to increase the competitiveness of the number (1) competitive index, "Institutions", will be achieved through improvements in business freedom, labor freedom, and monetary freedom, as set out in the WEF’s heading of "institutional framework", and improvements in the "rule of law" scoring set by the World Bank. Besides, the three preconditions defined in the ITRE report, i.e.,
"standardization", "security/know-how protection", and "legal framework", are related to this topic. "Infrastructure", the number (2) competitive index, is taken into account under the heading of "global trade & investment" in the report of WEF. "Macroeconomic environment", the number (3) competitive index, defines the "structure of production" including the headings of "complexity" and the "scale" of the manufacturing. The term ‘standardization’ is also valid under this heading. "Health and primary education", the number (4) competitive index, can be considered in collaboration with the number (5) competitive index, "Higher education and training", and the number (7) competitive index, "Labor market productivity". These three topics are focused on under the heading of "human capital", defining the current and labor workforces. Furthermore, the preconditions of "process/work organization", "available skilled workers", and "training/professional development" are included in the ITRE report. “Product market efficiency”, the number (6) competitive index, and “Market size”, the number (10) competitive index, are related to the “demand environment”, including the supply and demand conditions of the market. “Financial market development”, the number (8) competitive index, mostly depends on the topics of “trend”, “investment” under the heading of “global trade & investment”. In the ITRE report, the precondition of “research” also defines the owner of the business investment. “Technological preparation”, the number (9) competitive index, is related to the preconditions of “available products” and “new business models”. Together with the number (11) competitive index, “Business sophistication” and the number (12) competitive index, “Innovation”, these three topics are pointed out under the headings of “technology platform” and the “ability to innovate”.

Considering all of these indicators, preconditions, and indices; the following six headings are proposed: Macroeconomic environment: Defining ‘the stability of the macroeconomic environment’, production complexity and the manufacturing scale are considered, together with the level of standardization that is observed throughout the systems. Institutional framework: The institutional environment of a country includes the efficiency and effectiveness of the government, together with the legal framework. The rule of law and security/know-how protections are also counted under this heading. Labor market: Human
capital is of high importance in the process of transition and adaptation to Industry 4.0. As the systems to be used are highly advanced, available skilled workers, as well as the training / professional development opportunities, are also important. Product market: The efficiency of a product market, the size of the market including the foreign and domestic demand, and the customer and/or buyer sophisticateds affect the industry activities of a country. Financial remarks: A country’s financial situation depends on the trade, the investments and the infrastructure, together with the development of the financial market. Technological preparation: In order to adapt existing technologies to Industry 4.0; the available products and the technology platforms need to be observed. Besides, new business models and the ability of the systems for innovation, including the research and development opportunities, should be considered.

4 Case Study: Current Situation in Turkey

The upcoming digital revolution is a crucial issue for Turkey, which is in the category of developing countries. Industry 4.0, above all, should be considered as an important opportunity and seen as a chance for countries to be removed from the middle-income quintile and to be among the countries that produce and develop high value-added products and services in the upper-income group. In this direction, it is inevitable that radical reforms are being realized. Industry 4.0 transformation has already begun in the world. If Turkey wants to consolidate its place as a regional center, it should not lag behind in the manufacturing technology transformation of the Industry 4.0. Almost half of the production in Turkey is carried out with low technology. In addition to this, more than half of the nationwide initiatives are made up of low technology entrepreneurs. On the other hand, the share of high technology products in exports is around 4% (this rate is 30% in South Korea and 15% in the European Union). The majority of factories in Turkey, depending on the use of automation in industrial processes, are located between Industry 2.0 and 3.0. Nevertheless, in sectors such as automotive, pharmaceutical, defense, and aerospace, it can be said that Industry 4.0 has already been passed. Some of the decisions taken
by the institutions in Turkey, together with the reports and their contents, are as follows; Turkish Industry and Business Association (TUSIAD) carried out extensive research with 108 technology users and 110 technology suppliers in order to measure the competency levels of companies' digital transformation in Turkey, to identify the areas of competence of technology supplier companies, and to determine the missing points to be focused. In February 2016, the High Council for Science and Technology decided to carry out studies on intelligent production systems. Within the scope of this decision, TUSIAD prepared "Intelligent Production Systems Technology Road Map" and identified critical technologies, strategic targets, and critical products under the main headings of Digitalization, Interaction and Factories of Future. Tenth Development Plan (2014–2018) Special Commission Conversion Report on Manufacturing, states that the role of the public has become increasingly critical in order for the country to transform its industry in order to achieve its goal of becoming a high-income economy in 2023. In the Medium-Term Program prepared by the Ministry of Development for the years of 2018 to 2020, the aims of digital transformation of the industry (layered production, robotics, internet, big data, artificial intelligence, efficient use of enhanced reality technologies and their domestic production), and design and establishment of digital transformation centers are presented. According to the Measures 240 and 241 of the Program of 2018, it is envisaged that studies on these targets will be completed by December 2018 under the coordination of the Ministry of Science, Industry, and Technology (Measure 240: The roadmap of digital transformation of the industry will be completed. Measure 241: Design and digital conversion centers will be established.) The citations to the digital conversion of the industry, made in the documents of Industry Strategy Paper (2015–2018), Efficiency Strategy and Action Plan (2015–2018) and Turkey Software Sector Strategy and Action Plan (2017–2019) of Science, Industry and Technology Ministry of Turkey (2015- 2018), are noteworthy. Digital Transformation Platform was established in January 2017, under the leadership of the Ministry of Science, Industry and Technology, together with the participation of organizations such as The Union of Turkey Chambers and Commodity Exchanges (TOBB), Turkey Exporters Assembly (TIM), TUSIAD, Independent Industrial-
ists’ and Businessmen’s Association (MUSIAD), the International Investors Association (YASED) and Technology Development Foundation of Turkey (TTGV). Besides, the "Fourth Industrial Revolution Office" was established under the General Directorate of Science and Technology of the Ministry of Science, Industry, and Technology. Accenture consulting firm carried out a survey, regarding the "Accenture Digitalization Index" which has been implemented in many countries. The firm did its research with over 100 companies of different sectors in Turkey and calculated the average index score of digitization for the country. The calculated score is found to be around 60%. Industry 4.0 means competitiveness in the manufacturing economy, sustainability, and producing value-added products and services, for Turkey. It is possible to say that using these steps can provide increased efficiency in the manufacturing sector. It is also expected that the competitive advantage to be gained through the economy around Industry 4.0 will increase industrial production. In order to incorporate the Industry 4.0 technologies into the production process, the producers are expected to invest in high amounts of money in the coming periods. The realization of growth in Turkey’s economy may be possible with the effective and efficient use of technology. First of all, the work processes in which the IoT is used should be managed correctly. Besides, giving a higher emphasis on IT training, educating programmers, and accelerating the search for IoT, are some of the first steps that can be taken to take place on the side of innovations. Turkey already has a strong production structure but exhibits a low level of readiness for the future of manufacturing. Having a growing labor force and using the advantages of Industry 4.0, Turkey is able to create a significant transformation that will change its role around the global economy. In order for the industry to grow and to become a pioneer country, all stakeholders need to work by focusing on a common country plan and target. Historically, many of the countries like Turkey, as the more developed economies supply fewer valuable pieces with lower labor costs, has benefited from globalization. As a result, these countries increased foreign investments and market access. However, with increasing production costs, these countries are faced with the danger of losing their traditional share of production against countries that can offer cheaper labor. These countries are at risk because they are not prepared to catch up
with advanced production in the future. Turkey and some other countries need to create a strategy for the future. These countries today have a stable production base, but they need to re-educate and improve the workers, upgrade their technology platforms, and shift towards conservative innovations. Studies performed to date in Turkey are set out in this section. A road map should be drawn to assess the criteria given in Section 3.

**Conclusion**

Industry 4.0 offers companies a large number of opportunities while bringing new threats that need to be solved. First of all, it means that the way the companies do business has changed, the operations teams have to realize that and rebuild their processes. Beyond the change of a serious and radical business mentality, it offers a whole new understanding of the transition to Industry 4.0 concerning the labor force. With full automation and smart factories, most of the work will be carried out untouched, so there is a big debate about the possibility of unemployed workers. The vision of smart factory also requires the reorganization of traditional education structures, strategies, and policies, and even restructuring with multifaceted participation; as it is inevitable to develop new skills, abilities and competencies appropriate to these technologies. Unfortunately, there may be a rise in unemployment in some sectors and professions. Without reaching this level of distress, it is necessary to adapt the internal and external education processes to the needs of the new technological situation. It is necessary once again to underline that it is crucial for all stakeholders, especially the government and non-governmental organizations, to act holistically and in harmony with each other for this transformation in the industry. In particular, the provision of appropriate infrastructure and education is emerging as the main factors. The producers have to determine their priorities in the production process and improve their labor competencies. For this purpose; first, key areas to be improved, such as flexibility, speed, efficiency, and quality, should be identified. Then, it should be assessed how the nine bases of technological progress will be beneficial in the designated areas. Rather than focus-
ing on small-scale improvements at this point, the ways to make fundamental changes must be sought. Long-term impact on the workforce should be analyzed, and strategic workforce planning should be done. Together with job descriptions, recruitment and work-training should be updated, considering the additional information technology competencies needed by the workforce. With these improvements delivering a significant development potential for existing industries, building innovative factory and production processes using Industry 4.0 technologies can open up new approaches. However, these new ways of doing business should be built on the right basis taking into account the necessary preconditions: Determining which sectors have leading effect for new or improved models, establishing technological bases such as the applications required for analysis, establishing the right organizational structure and capabilities, establishing business partnerships that are essential in the digital world, establishing standards and increasing participation in technology use, creation of a supplier ecosystem for new technologies. Policy makers and the public should define the framework of the particular infrastructure, education, regulation, and investment. The best way to achieve this is through collaborative efforts of the business world, the public sector, the sector organizations, and the companies realizing the following: The technological infrastructure, mainly fixed and mobile broadband services need to be updated. Infrastructures should be at the speed and reliability level that companies can use to provide real-time data flow. Curricula, vocational education, and higher education programs need to be appropriately adapted in order to increase the workforce's skills and innovation competencies related to IT, and entrepreneurial approaches should be enhanced. An incentive system designed to enable not only large but also small or medium-sized businesses to realize the necessary investments in areas such as new technologies, production / operating methods, and access to a more competent workforce is vital. In addition to the stakeholders mentioned above, it is also possible to make critical inferences for the service sector. Naturally, the emerging value chains around Industry 4.0 will also trigger a transformation in the service sectors. In this framework, logistics, software and system integration and finance should be considered as vital areas. Applications that will strengthen the integration of the logistics industry into the value chain...
according to Industry 4.0 needs, the competencies and innovation needs of solution partners, which are suppliers of the industry, to develop on new technologies, financing and risk appraisals of the financial sector’s related to the investment items with much higher balance sheets, are some of the examples of future issues in service sectors in the coming period. As mentioned, the ‘Readiness for the Future of Production Report’ states that The Fourth Industrial Revolution is thought to trigger selective revitalization, convergence, and other structural changes in the global value chains. Developing technologies will change the cost-benefit equation and ultimately, the impact of attraction to shift production activities. For this reason, all countries should develop skills to make attractive production targets and to benefit from these shifts (WEF, 2018). Together with all of these observations, it is possible to say that all countries have the opportunity to heal. Although no matter what the leader is, no country has fully achieved any preparation. Leading countries need to design, test, and pioneer and push their boundaries in the preparation of real transformations and technologies. Weaker countries can make more advanced production and offer lower cost labor and can choose to strengthen the production structure and diversify their economies. As a result, being ready for the Industry 4.0 necessitates not only national but also global solutions. Globally connected manufacturing systems need sophisticated technology, standards, norms, and regulations that transcend technical, geographical, and political boundaries. This will be necessary to release productivity and facilitate business in global value chains. Each country is confronted with difficulties that can be solved by the integrated efforts of the private and the public sectors. New approaches to public-private partnerships can help governments build these partnerships quickly and effectively. Besides, the cooperation between the public-private sector and the education sector is necessary to accelerate transformation. It is also proposed to investigate new and innovative approaches for this aim.
References


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**Key Terms**

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<th>Industry 4.0</th>
<th>Readiness for Industry 4.0</th>
<th>Roadmap</th>
<th>Preconditions</th>
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<td>Industrial revolution</td>
<td>Digitalization</td>
<td>Cyber-physical systems</td>
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<td>Big data</td>
<td>Artificial intelligence</td>
<td>Internet of things</td>
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**Questions for Further Study**

In the transformation to Industry 4.0, it was stated that especially the administrations and non-governmental organizations should work in harmony and communication with each other. Draw a relationship diagram by developing a model for this communicative / adaptive work environment.

With developing technology, it is estimated that approximately 50 billion devices will interact with each other in 2020. As a result, 46% of the global trade volume is expected to be affected. Estimate what will be the share of imports and exports within this global trade volume.

How will the implementation of Industry 4.0 affect human resources? How will this change affect the production and labor costs? What is the place of artificial intelligence in Industry 4.0? Explain with examples.
How will the developments in robotics affect production systems, the environment, living conditions, and information technologies? Explain with examples.

How will Industry 4.0 particularly affect the logistics sector? What will be the role of Logistics 4.0 in achieving the success of Industry 4.0? What can be the criteria determined for Logistics 4.0?

Exercises

Explain the relationship between the competitiveness index and the prerequisites for preparation for the future.

What is the role and importance of lifelong learning to successfully implement and sustain Industry 4.0?

Which country can be selected as the leading country in Industry 4.0? Which criteria can this choice be based on?

Which countries have action plans for Industry 4.0? Why?

Industry 4.0 is a concept that was designed and presented in 2011 in Hannover, Germany, in order to compete with the Far East countries, which are producing high amounts. What are the developments in the US and English-speaking world during these years? Discuss.

Compare developing countries and developed countries in terms of their preparation for Industry 4.0. (Take two countries for each sample.)

Further Reading


