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Industry 4.0 and Labor Market in Iran as a Developing Country

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Abstract. Industry 4.0 is the description for the 4th industrial revolution that is based on the use of Cyber-Physical Systems (CPS) and originated in Germany. Industry 4.0 is especially beneficial in highly developed countries in terms of competitive advantage as wages are high. The aim of this paper is to find out the difference between the impacts that adoption of Industry 4.0 has on the labor markets in developing countries and advanced countries, and for this purpose Iran and Japan were selected for comparison. For a country like Iran that struggles with heavy unemployment, adopting Industry 4.0 is not wise, because the essence of industrial revolutions and specially the 4th one, is to reduce costs of production by eliminating or reducing the human interaction, in other words, automation; which would significantly affect the labor force, especially those occupied in the manufacturing and agricultural sectors. Iran has lots of problems with basic infrastructure, education, research and technologies that are needed for Industry 4.0. Adopting Industry 4.0 would have devastating effects on the Iranian labor market and specifically on the unemployment rate. It will be years before Iran could implement Industry 4.0. Japan has a much lower unemployment rate comparing to Iran, and unlike Iran has the needed infrastructure and science and technology for implementing Industry 4.0. Therefore, adopting Industry 4.0 by Japan would have some effects on the Japanese labor market but those effects wouldn't be as challenging as they are for Iran.

Key words: Industry4.0, Developing Countries, Iran, Labor force, Unemployment.

1 Introduction

The 1st industrial revolution took place in the late 18th century by utilizing water and steam to power mechanical production facilities. In the early 20th century the 2nd industrial revolution happened as mass production was introduced using electrical energy and relying on the division of labor. The 3rd industrial revolution is when information technologies and electronics were used for automation of production in beginning of 1970s.

Industry 4.0 (Industrie 4.0) is the description for the 4th industrial revolution that is based on the use of Cyber-Physical Systems (CPS) and originated in Germany. The

main aim of Industry 4.0 is to prepare the very strong German manufacturing industry for the future by integrated digitization, in order to be able to compete with USA, which is very dominant in the field of Information and Communication Technologies (ICT). [5]

The idea of industry 4.0 is appealing for other countries, and some of these countries are thinking about implementing Industry 4.0 in the near future, China is one of such countries. However, for developing countries, there are some challenges up the road towards implementing and using such advanced technologies as Industry 4.0, Iran would be a good example of developing countries in this matter.

The aim of this paper is to analyze how far Iran is from implementing such a thing like Industry 4.0 with the current science and technology policies, what would be challenging in that case, and also to describe and analyze the possible impacts that Industry 4.0 could have on the labor market in Iran and let's say in the developing countries in general, in comparison with advanced countries.

2 Methodology and Literature review

2.1 Methodology and Data

For the purpose of this paper, literature review, data analysis and synthesis, methods of description, comparison, SWOT analysis, and induction and deduction reasoning approaches are applied in order to compare Iran as a developing country to Japan as an advanced country, and to answer the following questions:

- How does Industry 4.0 affect the labor market and in particular unemployment rate?
- What is the difference between labor markets in Iran and Japan?
- What are the impacts of implementing Industry 4.0 on the labor markets of Iran and Japan?
- What factors appear to be challenging for Iran and Japan to adopt Industry 4.0?
- How far is Iran from being able to implement Industry 4.0?

The International Monitory fund (IMF), The World Bank (WB), and The Organization for Economic Co-operation and Development (OECD) didn't provide all the data needed to compare Iran with Japan or they didn't have comparable data. Therefore, relevant information and economic indicators about these countries were collected from the official webpage of the Central Intelligence Agency (CIA). Figures used in this paper however, are from Statista and are based on data from IMF and WB.

2.2 Industry 4.0

Industry 4.0 affects all areas of the industrial production process including order management, manufacturing, research and development, commissioning, delivery, utilization, and even recycling of the products. They note that the availability of

relevant information at any time and place is the basis for new opportunities, and in order to achieve this, all of resources that are involved in the process, such as humans, objects and systems, must to be integrated as an autonomously optimized value adding system that is self-organized and dynamic. [5]

Industry 4.0 is used for the following factors that are mutually interconnected: Integration, and digitalization of simple technical-economical relations to complex technical-economical networks, digitalization of offers of products and services, and it is used for new market models. Nowadays communication systems are interconnecting these activities. In industry 4.0, Internet of Things (IoT), Internet of Services (IoS), and Internet of People (IoP) would be the most promising communications technologies that would be in charge of communications between communication entities in order to utilize data. [12]

Cyber Physical Systems (CPS), are technical solutions that are connected by IoT. The aim of these systems is to reduce the gap between the physical and the digital domains. For this purpose smart solutions are needed on top of the infrastructure, such as the interaction between humans and physical systems. [5]

The main aim of Industry 4.0 is to optimize value chains, and for this purpose a dynamic production is implemented, which is autonomously controlled. This is where CPS are found to be especially helpful instruments to reach high levels of automation. CPS combined with other technologies such as microcontrollers, actuators, sensors, and means of communication create a smart factory. [2]

Germany has developed two models for digitization of industrial production, which are considered to be the most important models for the purposes of Industry 4.0, and they are called Reference Architecture Model Industry 4.0 (RAMI 4.0), and Industry 4.0 Component Model. [12]

With the current rate of advancements in science and technologies, the factory of the future would be like an interacting organism that is smart and is able to learn, unlike current factories which have a set of processes, machineries and a precise division of labor. [5]

2.3 Unemployment

The labor force is the total number of workers in the country, categorized as employed and unemployed. People who have jobs, are called employed and those who don't, unemployed. But of course, there are other people in the country, which don't fit neither one of the categories mentioned above (for example homemakers, retirees, and full-time students), these are considered as "not in the labor force". The unemployment rate is the percentage of the labor force that is unemployed. So, measuring the unemployment rate is basically the number of unemployed over the labor force multiplied by 100. Unemployment is one of obvious determinants of the country's standard of living. People who cannot find jobs or lost their jobs are not contributing to the country's production of goods and services. When a country keeps its workers as fully employed as possible, it would have a higher GDP and growth rate. [4]

2.4 Iran's policies towards science and technology

Based on the Iranian 20-year development plan, Vision 2025, it is clear that Iran's government desires to move from its resource-based economy to an economy that is based on knowledge. For this purpose Iran's policy-makers focused their attention to the country's human capital instead of industries in order to create wealth. Incentive measures were adopted firstly to increase the number of academics and university students, and secondly to stimulate problem-solving and industrial research. [1]

According to the author of "Evaluation of national science and technology policies in Iran", Iran is in a good situation in the world mostly in basic sciences like mathematics, physics, and chemistry, and has considerable achievements in science production but there is still a lot of potential in producing science. There are many underdevelopments when it comes to innovation, and Iran is considered to be very weak in management of knowledge and research. Knowledge-based industries and services have received little if no supports for their development. Based on such small support we cannot hope that Iran would be able to develop and export knowledge-based products and services in the near future. [3]

It seems unlikely that Iran would have a leading place in the world in science and technology with the conditions and underdevelopments that exist now. Iran has taken basic steps towards new and advanced technologies like nanotech, nuclear, and aerospace; but even thou they are in the Iran's 20-year plan, vision 2025, there are no evident results of these developments on people's lives. One reason for this is that the annual research budget in Iran is less than 1% of Iran's GDP and increasing, but highly unlikely to reach 4% of GDP by 2025, which is considered very low to improve weaknesses in fundamental research. With this low budget we cannot expect miracles in the field of research. [3]

Iran's educational system needs more attention; interaction of education with occupation has been the focus of Iran's science and technology planners and policy-makers for a little over a decade now, but serious and effective steps have not yet been taken. Courses and educational degrees have little or no regard for Iran's total scientific map and development of higher education in Iran has little regards for occupation, production, and society. [3]

Another problem is that intellectual properties are not protected strongly in Iran. Infrastructure and regulations for protection of intellectual properties are needed in Iran more than ever, to protect intellectual properties of other countries as well as domestic ones. This weak protection of intellectual properties limits the policies that already exist towards interaction and cooperation of Iran with other countries and regional and global centers in the field of science and technology as emphasized in vision 2025. These policies were evaluated as ineffective in the first place due to regional competition and political issues. Transfer of technology, capturing, design, and manufacturing knowledge is very low in Iran; low levels of cooperation and interaction of Iran with industrial countries based on political problems is the main reason behind this problem. [3]

Iran could use the scientific and technical capabilities of Iranian specialists who live abroad but policies towards it have produced no result yet. Unfortunately currently Iran has no policies or programs to attract foreign specialists. [3]

3 Results and discussion

Iran's Gross Domestic Product (GDP) was estimated to be $1.459 trillion in 2016 ($18,100 per capita) with a real growth rate of 4.5%; GDP was composed by 9.1 % from agriculture sector, 39.9% from industrial sector, and 51% from services sector. Among the main agricultural products we can name wheat, rice, sugar beets, fruits, nuts, and cotton. [8]

Petroleum, petrochemicals, gas, fertilizers, caustic soda, textiles, cement and other construction materials are considered to be some of the main industries. The government budget was $65.87 billion mostly from oil and gas exports and the rest from taxes with 1.6% deficit. [8]

Japan's Gross Domestic Product (GDP) was estimated to be $ 5.238 trillion in 2016 ($41,300 per capita) with a real growth rate of 1%; GDP was composed by 1.2 % from agriculture sector, 27.7% from industrial sector, and 71.1% from services sector. Among the main agricultural products we can name vegetables, rice, fish, poultry, fruit, dairy products, pork, beef, flowers, potatoes/taros/yams, sugarcane, tea, legumes, wheat and barley. [9]

Motor vehicles, electronic equipment, machine tools, steel and nonferrous metals, ships, chemicals, textiles, processed foods are considered to be some of the main industries. The government budget was $1.696 trillion with 5% deficit. [9]

In 2016 the population of Iran was estimated to be 82,801,633 inhabitants with a growth rate of 1.18% and median age of 29.4 years. From this number, 29.75 million (36% of the total population) are in the labor force, and there is a shortage of skilled labor. According to 2013 estimates, 16.3% of the labor force is occupied in agriculture, 35.1% in industry, and 48.6% in services sectors. Iran has continually suffered from high unemployment and underemployment and due to the lack of job opportunities many young educated Iranians were forced to seek jobs overseas. This has resulted in a significant brain drain. [8]

In 2017 population of Japan was estimated to be 126,451,398 inhabitants with a growth rate of -0.2% and median age of 46.9 years. 2016 estimates show that 65.93 million people (52% of total population) of Japan's population are in the labor force. According to 2015 estimates, 2.9% of the labor force is occupied in agriculture, 26.2% in industry, and 70.9% in services sectors. Japan has a relatively a low unemployment rate. [9]

3.1 Unemployment rate

Figure 1 shows the unemployment rate in the resent years as well as the forecasted unemployment rate for the following years. We can see that Iran has been

continuously suffering from a high unemployment rate and as the forecast shows this high unemployment rate will continue to be high in the near future.

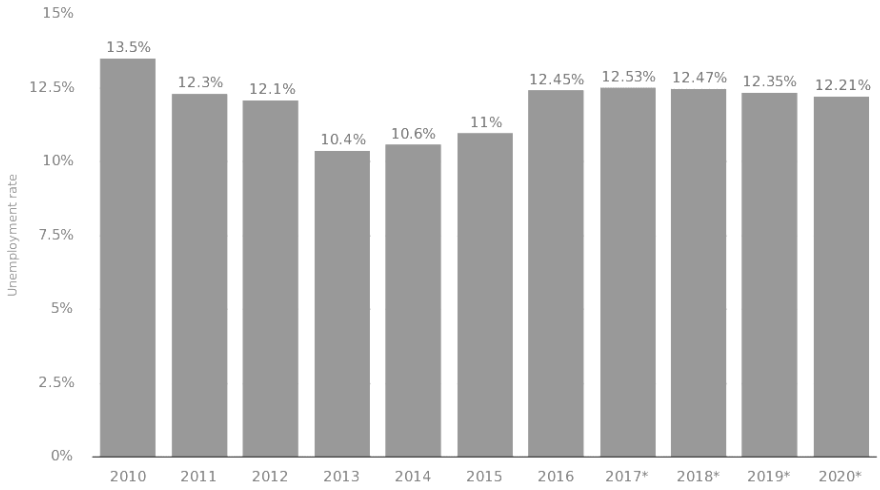

Fig. 1. Unemployment rate 2010-2020 in Iran [11]

There are many factors contributing to the unemployment rate of a country. In Iran, a large contributing factor to the total unemployment rate is the youth unemployment (ages 15-24), and was estimated in 2014 to be 24.0% in total, 21% male, and 42.8% female. [8]

Youth unemployment is currently the biggest socioeconomic concern in Iran. Religion and cultural issues and limitations could explain why female youth unemployment is significantly higher than male youth unemployment rate.

With the current unemployment rate and the positive population growth rate, and in the other hand, with the brain drain problem and lack of skilled workers in Iran, it is highly unlikely that the unemployment problem will be solved any time soon.

In the other hand Japan has a low unemployment rate that has been decreasing in the recent years, and it will be kept low according to the forecasts we see in figure 2.

One reason why the unemployment rate is low in Japan could be because Japanese policy makers have good policies towards keeping the unemployment rate as low as possible; but we cannot ignore the fact that Japan has a negative growth rate (Figure 4) and an older population than Iran. In 2016, the median age was 46.9 [9] in Japan, and 29.4 years [8] in Iran. Therefore, youth unemployment cannot be considered as a significant contributing factor in Japan's total unemployment rate if compared with Iran's unemployment rate.

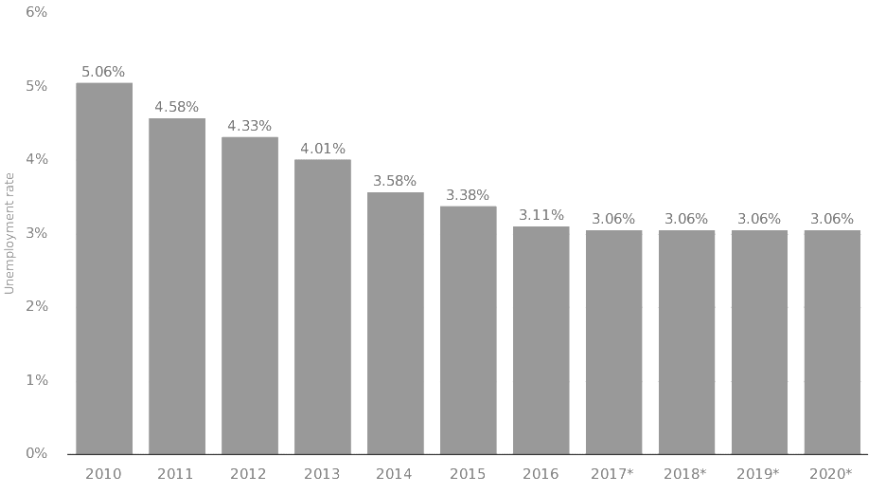

Fig. 2. Unemployment rate from 2010 to 2020 in Japan [10]

3.2 Population growth

Figure 3 shows that the population of Iran has been growing at a consistent, positive rate between the years 2005 and 2015.

With the positive growth rate, there will be more people joining the labor market every year increasing the number of people searching for jobs. This requires the policy makers to have and make better polices towards creating jobs and keeping the unemployment rate low, and if new job opportunities cannot be created accordingly, the unemployment rate will continue to be high and it might even increase.

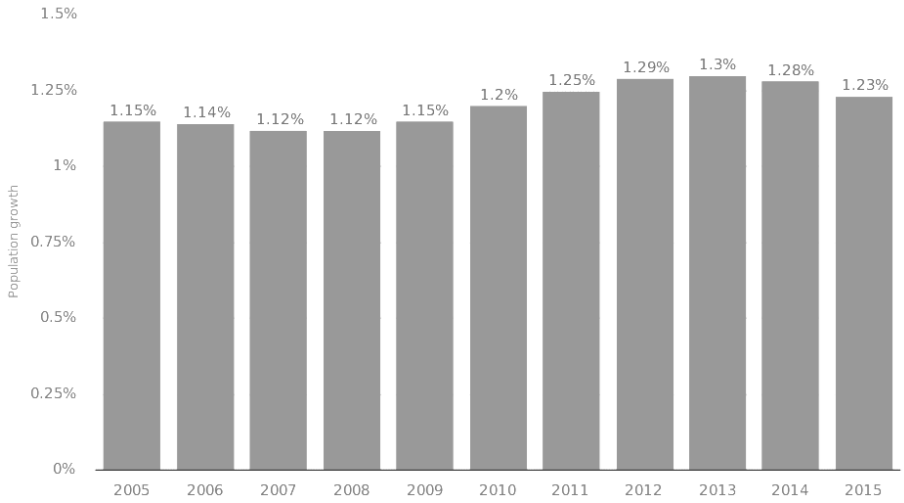

Fig. 3. Population growth from 2005 to 2015 in Iran [7]

In the case of Japan (Figure 4) however, we can see that the population is not growing at a steady rate, in the highest case Japan's population had a positive growth rate of 0.11% in 2007 and from 2011 Japan has had a negative growth rate. The impact of negative population growth in Japan's labor market, in the case that this negative growth continues in the near future, is that the labor market will get older and smaller every year, decreasing the unemployment rate slowly. However these changes are very small but still important.

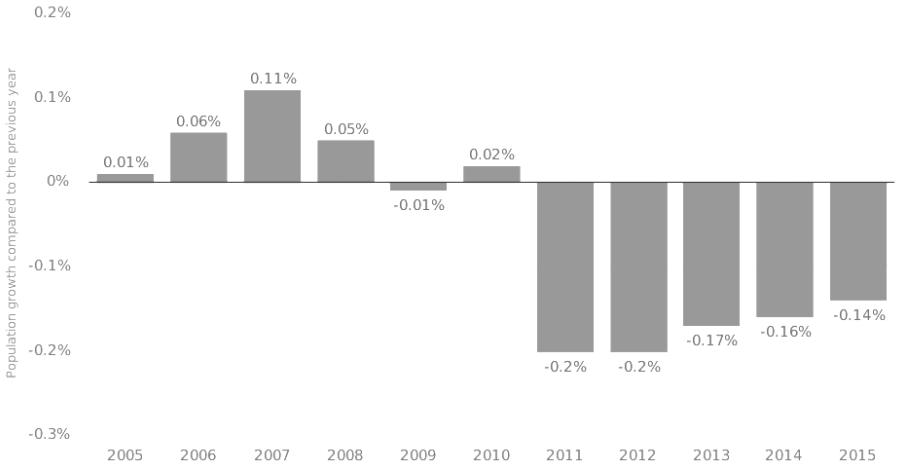

Fig. 4. Population growth from 2005 to 2015 (compared to the previous year) in Japan [6]

With 35.1% of Iranian labor market occupied in the industrial sector making 39.9% of Iran's GDP, and 26.2% of Japanese labor market occupied in the industrial sector making 27.7% of Japan's GDP, it looks like Iran's industrial sector and GDP will be more affected by Industry 4.0 in percentage.

Attracting Iranian specialists has been unsuccessful and there are no plans to attract foreign specialists, so the problem of lack of skilled workers will continue in the next few years and this could also negatively affect the unemployment rate, unless necessary measures towards eliminating the problem are taken. Japan however, is not dealing with such a problem.

The education system of Iran needs some more attention from Iran's science and technology planners and policy-makers, they have to improve the scientific map and adjust the courses and educational degrees to be according to the occupation, production, and social needs.

With a budget deficit, Iran has not been able to support the research programs that are in vision 2025. Foreign Direct Investment (FDI) would be a suitable solution in this case to build the infrastructure and to improve research towards having a knowledge-economy. However this is also less likely to happen due to inconvenient international relations.

Improving the protection of intellectual property has a significant importance and needs the attention of policy makers; new rules and regulations must be made not only to protect the domestic intellectual properties but also those that belong to other countries. Doing so will help foreign countries feel protected and in return it would be possible that would increase their cooperation with Iran in different fields of science, technology, and research. In Japan intellectual properties are protected and there is a lot of scientific cooperation with other countries.

For a country that struggles with unemployment to this degree, adopting Industry 4.0 is not wise and not recommended, because the essence of industrial revolutions and especially the 4th one, is to reduce costs of production (good for Iran) by

eliminating or reducing the human interaction, in other words automation, which would significantly affect the labor force occupied in the manufacturing and agricultural sectors. Given the fact that more than half of the Iran's labor force is occupied in these two sectors, it would have a huge impact on the existing unemployment problem, and many people would lose their jobs. This doesn't mean that services sector wouldn't be affected; just the impact of it would be much larger on the agriculture and manufacturing sectors.

On the other hand, Iran has lots of problems with basic infrastructure, education, research and technology that are needed for Industry 4.0. Even if Iran didn't have an unemployment problem, eliminating these obstacles and providing preconditions for Industry 4.0 would take many years with Iran's current policies and international relations.

The labor force in Japan would be affected by adopting Industry 4.0 as well, but the difference is that first of all, they don't have unemployment problems like Iran; they have skilled workers and the science and technologies to support this change, a much higher budget and better international relations to help them with this transition.

3.3 SWOT Analysis

Based on the information and analysis above, the SWOT analysis was made for Iran and Japan to have a better perspective when dealing with Industry 4.0.

Iran

- Internal factors:
  - Iran has a large and young labor force (about 36% of the population).
  - There is a lack of skilled workers in Iran.
  - Relatively high unemployment rate.
  - Positive population growth rate.
  - Young population.
  - Intellectual properties are not protected strongly in Iran.
  - Very weak in management of knowledge and research.
- External factors:
  - Opportunity to attract FDI.
  - Opportunity to develop infrastructures.
  - Risk of increasing unemployment.
  - Weak international relations.
  - Risk of new international sanctions.

Japan

- Internal factors:
  - Japan has a large labor force (about 52% of the population).
  - Strong infrastructure.
  - Strong protection of intellectual properties.

- Low unemployment rate.
- Negative population growth rate.
- Old population.

- External factors:
  - Strong international relations.
  - Opportunity to replace old workers.
  - Opportunity to increase competitive advantage.

4 Conclusions

Industry 4.0 is especially beneficial in highly developed countries in terms of competitive advantage as wages are high. [5] In developing countries such as Iran, wages are cheap, levels of unemployment are relatively high, and considerable developments are required in other basic infrastructures of such countries.

Industry 4.0 uses CPR to reach high levels of automation. Automation increases the unemployment rate regardless of how developed a country is. The only difference is how big the impact of this change would be on the economy of that country, and whether or not that country could cope with such a change. SWOT analysis show that implementing Industry 4.0 would involve more risks for Iran compared with Japan.

Iran has a relatively young population with a positive growth rate and unemployment challenges that are less likely to be solved any time in the near future. Adopting Industry 4.0 would have devastating effects on the Iranian labor market and specifically on the unemployment rate.

On the other hand, Japan has an older population and much lower unemployment rate comparing to Iran, and unlike Iran has the needed infrastructure and science and technology for implementing Industry 4.0. Therefore, adopting Industry 4.0 by Japan would have some effects on the Japanese labor market but those effects wouldn't be as challenging as they are for Iran.

In order to successfully manage to increase research and development in knowledge management and applied sciences and successfully manage to develop the infrastructure for using Industry 4.0, Iran has to take some serious steps towards developing better international relations and cooperation.

Better protection of intellectual properties, and making better policies and programs are needed to attract foreign specialists and Iranian specialist who live abroad. Brain drain is another problem Iran has that must be dealt with as soon as possible.

The research budget in Iran has to increase in order to increase research and development in the knowledge management and applied sciences. For this purpose Foreign Direct Investment is a suitable solution.

With the current position of Iran in science, technology, and economy, it will be years before Iran could, or better say should, implement Industry 4.0.

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