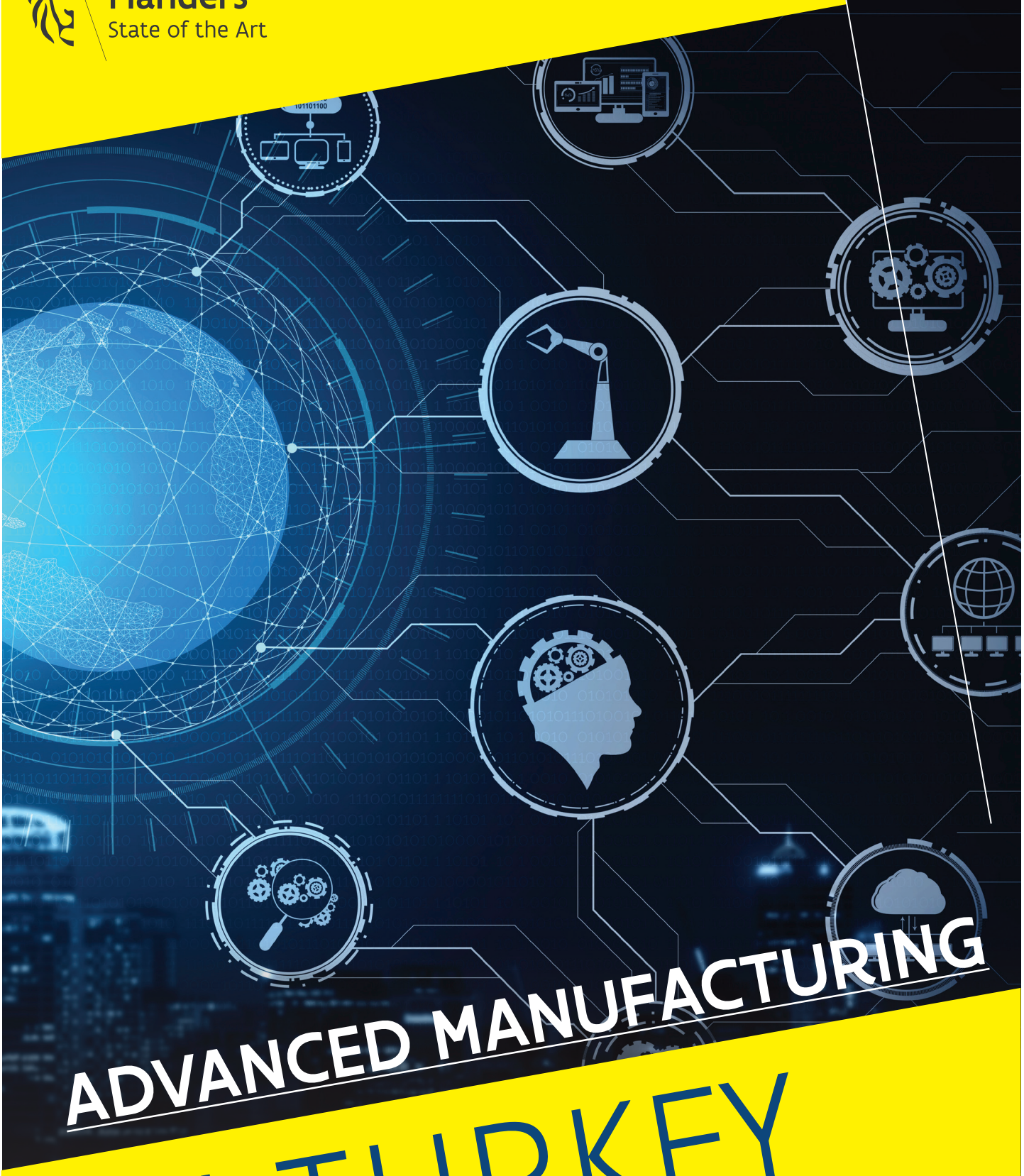
Flanders
State of the Art



ADVANCED MANUFACTURING IN TURKEY

FLANDERS INVESTMENT & TRADE MARKET SURVEY

FLANDERS
INVESTMENT
& TRADE

Marktstudie

ADVANCED MANUFACTURING IN TURKEY

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INHOUD

1. FOREWORD

The Industrial Revolution is a process that emerged between 1760-1840 in England, when a Scottish man named James Watt found the steam engine and included it in the production processes. The Second Industrial Revolution expresses the technological developments and the economic and social changes that took place in the period from 1870, when the first industrial revolution ended, until 1914, the period when the First World War began, and the economic and social changes brought about by them. In this way, the rapidly growing and accelerating trade gave birth to the supply of the railways to the production of durable steel, which played the role of the driving force for the new phase of the industrial revolution. The determining factors of the Second Industrial Revolution were the importance of petroleum and similar raw materials in the economy, the use of electricity, the internal combustion engines working with petroleum and the development of the automotive sector. According to most views, the 2nd Industrial Revolution had negative consequences. Excess carbon and natural resource consumption brought about by technological developments have negatively affected the world and the environment and paved the way for many environmental problems such as global warming to emerge.

Water and steam power in the First Industrial Revolution and oil & electricity in the Second Industrial Revolution are the main energy sources. In the Third Industrial Revolution, renewable energy sources such as solar energy and wind energy gained importance. It has often been called the digital revolution or computer revolution, as it developed around semiconductors, mainframes, personal computers, and the internet. Since the consumption of natural resources and raw materials increased rapidly after the first and second industrial revolutions, the resources in the world began to decrease at the same rate and to take risks. For this reason, natural life and the environment have been negatively affected and resources have begun to lose their sustainability. When it was realized that sustainability was at risk, technology was directed to be environmentally friendly and studies were started to use renewable energy sources. The Third Industrial Revolution is the use of electricity in mass production and the development of the production line, and the replacement of mechanical and electronic technologies in production with digital technology. In short, this concept is called Industry 3.0 as the integration of electronics and information technologies into production.

Industry 4.0 refers to a process we are in today. Industry 4.0 in general; robots take over production, production with 3D printers, the development of artificial intelligence, big data studies and many other innovations. Kagermann's 2011 article is taken as a basis for the theoretical beginning of Industry 4.0. Kagermann (2011) states that the 4th Industrial Revolution includes not only the development in automation, but also intelligent observation and decision-making processes. These changes, also known as "Internet of Things", "Internet of Everything" or "Industrial Internet", distinguishes them from the first three industrial revolutions.

The important feature of the Fourth Industrial Revolution is that it introduces technologies that remove the boundaries of the physical, digital and biological worlds. Due to its comprehensive, complex and multidimensional nature, the Fourth Industrial Revolution has features that cannot be predicted before compared to other industrial phases. The Fourth Industrial Revolution (4IR)—is characterized by the fusion of the digital, biological, and physical worlds, as well as the growing utilization of new technologies such as artificial intelligence, cloud computing, robotics, 3D printing, the Internet of Things, and advanced wireless technologies.

In this report, we will focus on Turkey's current status of digital conversion, needs, capabilities and industry 4.0 applications.

We hope this report will be useful for Flemish companies.

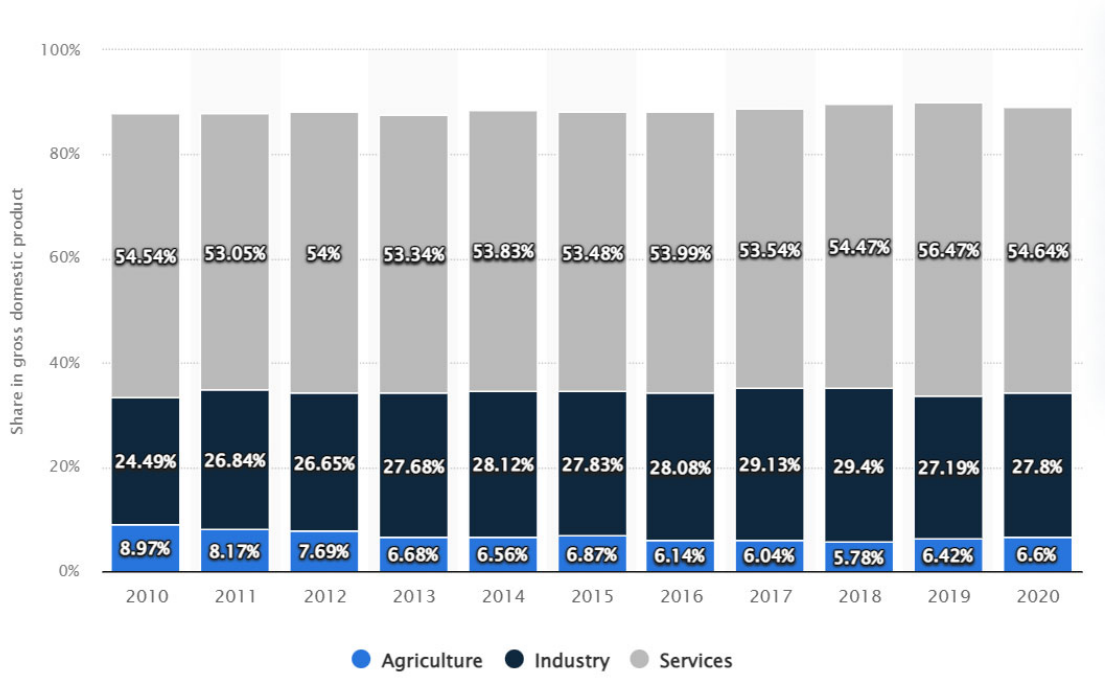
2. MANUFACTURING INDUSTRY OUTLOOK IN TURKEY

Turkey's sizeable population of 83 million (average age: 31), dynamic entrepreneurial class and advantageous geographic position as a bridge between Europe, Asia and Africa has made the country an important manufacturing and distribution hub.

Turkey's largely free-market economy is driven by its industry and, increasingly, service sectors, although its traditional agriculture sector still accounts for about 25% of employment. The automotive, petrochemical, and electronics industries have risen in importance and surpassed the traditional textiles and clothing sectors within Turkey's export mix.

The Turkish manufacturing industry plays an important role in the overall well-being of the country, accounting for 27,8 percent of the Turkish GDP in 2020.

Turkey: Share of economic sectors in gross domestic product (GDP) from 2010 to 2020



Source: © Statista 2021

This statistic shows the share economic sectors in gross domestic product (GDP) in Turkey from 2010 to 2020. In 2020, agriculture contributed 6.6 percent to the GDP, while industry and services accounted for 27.8 percent and 54.64 percent respectively.

Turkey offers the capability to manufacture a huge range of products. The biggest segments within manufacturing are: food products (16% of total production); basic metals (11%); motor vehicles, trailers and semi-trailers (9%); textile (8%); other non-metallic mineral products (6%);

rubber and plastic products (5%); chemicals and chemical products (5%); electrical equipment (5%); wearing apparel (5%); and fabricated metal products (5%). [1]

The top ten exports include vehicles, machinery (including computer components), gems and precious metals, knits and clothing, iron and steel, electrical machinery and other equipment, non-knit clothes and accessories, articles made of iron or steel, plastics, and related products, and mineral fuels including oil.

Exports of vehicles makes up 15.2% of Turkey's total exports, valuing the country's automotive manufacturing industry at USD 23.9 bln. While machinery makes up 8.8% of exports, at a value of USD 13.8 bln, number 10 in the export list – mineral fuels, including oil, alone comprises 2.8% of exports for an industry valued at USD 4.3 bln. Manufacturing production in Turkey increased 14.20 percent in August of 2021 over the same month in the previous year.

Turkish industry employs around 20% of the labour force. Its major industries are automotive, chemical, construction, technology & electronics, food processing, furniture & decoration, iron & steel & metallurgy, textile & apparel & ready wear, packaging & logistics, defence, energy & natural resources, industrial machinery & white goods, gold & jewellery process. The textile and clothing sector has a very high share in the total production, employment and exports in the country. Turkey is 7th largest textile products exporter and 4th largest clothing exporter in the world.

TUSIAD, the Turkish Industry and Business Association, is a voluntary organization of Turkey's leading entrepreneurs and executives who lead the way in the industrial sector.

[1] Trading Economics- Turkey Industrial Production Report

3. GENERAL OVERVIEW OF ADVANCED MANUFACTURING IN TURKEY

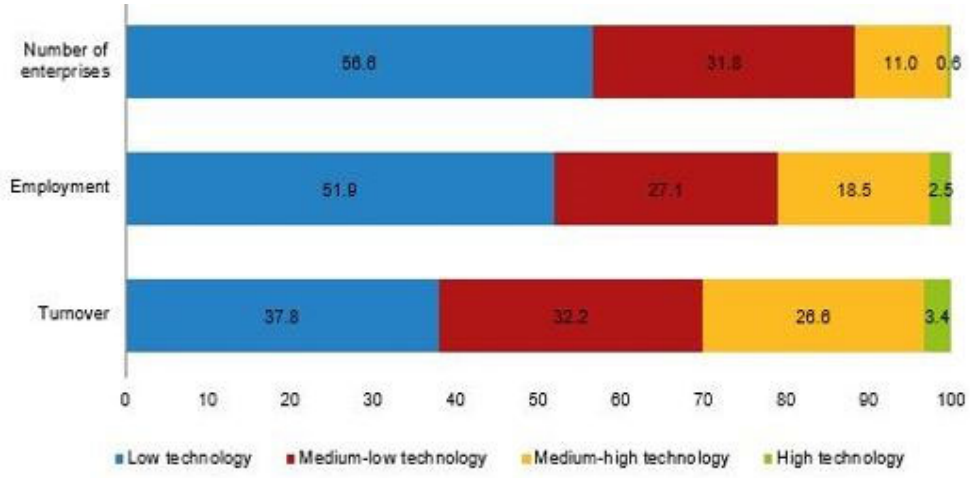
Manufacturing concepts are rapidly changing and manufacturing processes are completely being redefined in the last decade. Industry 4.0, digitalization and IoT are at the core of next-generation manufacturing technologies.

Although Turkey has shown significant achievements in the industry since the 1930s, it has not been able to establish a production mechanism that produces its own technology, except for a few traditional sectors.

Advanced manufacturing technologies are starting to be implemented across Turkey, with international companies leading the way. The early adaptive industries are automotive and aviation manufacturing, both dominated by major international companies with many local suppliers who must meet the latest standards and technological requirements. In addition, durable consumer goods, electronics, chemicals, machinery, steel, construction, textiles, energy and mining industries are focused on implementing advanced manufacturing technologies to remain competitive.

In 2020, 56.6% of enterprises in manufacturing took part in low technology activities, while 31,8% of Turkey's manufacturing exports consists of medium-low products and 0,6% high-tech products.

Percentage of basic indicators in the manufacturing industry by technology level, (%), 2020



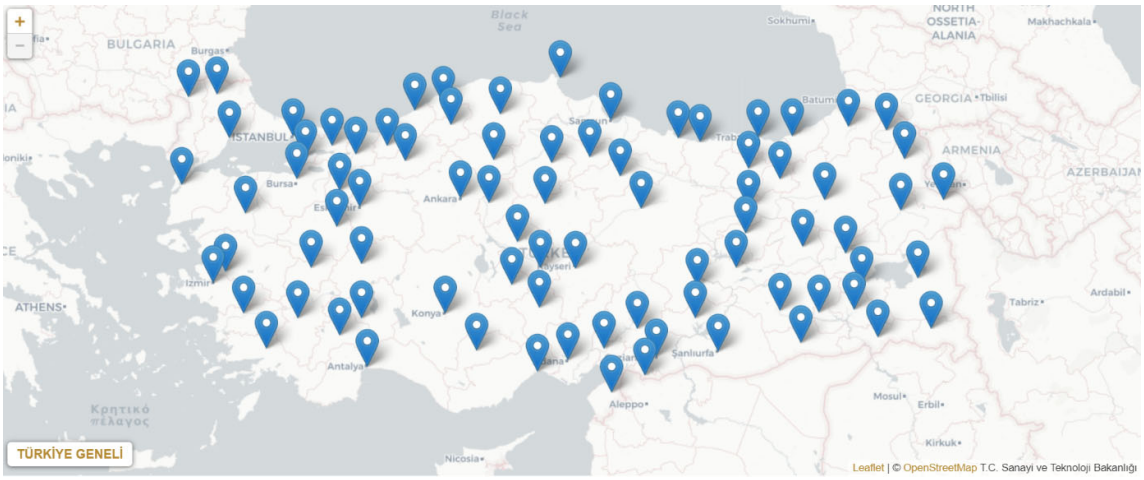
Source: TUIK- Turkish Statistical Institute

Considering the ratio of both high-tech product exports and R&D investments to GDP in Turkey, it is seen that there is a long way to go in order to catch up with the leading countries in the digital transformation race in the industry. For this reason, platforms and working groups consisting of civil society representatives led by the Ministry of Industry and Technology have been established in order to create policies and strategies for digital transformation in Turkey. As a result of this, Turkey's digital roadmap was prepared.

In the Digital Transformation Report published by the Ministry of Industry and Technology, when the country practices on digital transformation are examined, it is seen that four factors come to the fore: developing the education infrastructure, supporting the users, supporting the national suppliers and strengthening the data communication infrastructure.

In line with the target of turning Turkey's economy into an economy with high added value, the government supports technology initiatives and major procurements, creating new opportunities for international technology companies. To this end, Technology Development Zones were established in Turkey with Law No. 4691 published in 2001. The main purpose of these regions is production of technological information, commercialization of the produced information, raising product quality and standards in the product and production methods, developing innovation that will increase efficiency and reduce production costs, adapting small and medium-sized enterprises to new and advanced technologies, and providing job opportunities for researchers. In this way, it is aimed to increase the competitiveness of the industry.

As of October 2021; A total of 89 Technology Development Zones were established. 73 of the 89 Technology Development Zones continue to operate, and 16 of them are not operational yet due to the ongoing infrastructure works.[2]



1250 **R&D Centers**

335 **Design Center**

89 **Technoparks**

In the report published by the Ministry of Industry and Technology, the distribution of digital technology projects carried out in Technology Development Zones and R&D Centers is as follows:

[2] Ministry of Industry and Technology

Distribution of digital technology projects	Techno parks	R&D Centers
Artificial intelligence	94	22
Big data and advanced analytics	70	32
Virtualization (augmented virtual reality)	62	15
Cloud computing	46	8
Internet of Things	27	15
Cyber security	22	4
Industrial automation and robotic technologies	13	7
Next generation sensor technologies	13	8
Additive manufacturing	7	14

In 2019, the Ministry of Science, Industry and Technology announced Turkey's 2023 Industry and Technology Strategy detailing incentives for R&D and digital transformation of industrial enterprises. Turkey plans to invest heavily in over 300 product groups in the machinery, semiconductor, aerospace, defence, transportation technology, software, electronics, chemistry, and pharmaceutical industries. Incentives will be provided for the development of new technologies involving artificial intelligence, 5G, big data and data analytics, IoT, blockchain, robotics and autonomy, UAV's, biotechnology, nanotechnology, cybersecurity, additive manufacturing, quantum computing, ag-tech, and energy technologies.

The awareness amongst Turkish companies regarding Industry 4.0 developments is relatively low. 22% of the companies have extensive knowledge, 59% has general knowledge and 19% have no knowledge about such developments. Awareness is highest in the electronics, software and materials sector and in general 50% of firms expect to integrate related technologies within 3 to 5 years.

Regarding the level of digital maturity, the Turkish industry sits between the 2nd and 3rd industrial revolution and the most mature sectors are the materials sector (rubbers & plastics), computers, electronics and optical devices as well as the automotive and white goods sector. The three technologies that will provide the most added value according to Turkish firms, are automation & control systems, advanced robotic systems as well as additive manufacturing. The expectation is that these technologies will find their way mostly in the machinery & equipment sector, the computers, electronics and optical devices sector as well as the automotive and white goods sector.

4. MOST PROMISING ADVANCED MANUFACTURING TECHNOLOGIES IN TURKEY

4.1 ADDITIVE MANUFACTURING

Since additive manufacturing has a high manufacturability potential compared to traditional methods and provides an advantage in producing optimized complex designs, it is one of the applications that tend to be produced in current trends. Widely used in Aerospace, Bio-Medical, Medicine, Automotive, Energy sectors. The "Additive Manufacturing" global market, which has a size of 11.2 billion USD in 2020, is expected to reach 30.6 billion USD by 2028.

In 2014, the automotive, aerospace and defence, white goods, machinery, jewellery and medical/dental sectors started to use additive manufacturing in Turkey. SMEs primarily seek additive manufacturing for the moulding/sampling process and often outsource this service. With a market size of 300 million dollars, Turkey accounts for 1.3% of global additive manufacturing use by 2020. More than 500, mostly polymer-based 3D printers are used in production. There is a growing demand for advanced 3D printers and CAD and CAM programs, advanced printing materials (including biomaterials), and large-scale additive manufacturing capabilities.

4.2 INDUSTRIAL AUTOMATION

The number of automation companies in Turkey is around 200. Some of these companies import and others provide engineering services. Among these two hundred companies, all of the world's automation giants such as Siemens, Mitsubishi Electric, Schneider Electric, Honeywell and Festo also have offices in Turkey. Few of these international companies carry out their activities through their representative offices.

About two-fifths of Turkish automation companies work for the process industry and three-fifths work for the discrete manufacturing industry. This rate is compatible with the world. However, the turnover is the exact opposite of this ratio. Companies that offer solutions to the process industry gain the largest share of the market. The reason for higher turnovers in the process industry lies in the harsh and challenging manufacturing environment. The transmitters used in this sector therefore have a shorter lifespan and need to be renewed frequently in short periods. There are few examples that can be shown as new investments within the scope of the process industry.

As a result of these features in its industrial structure, the automation market, which varies between 0.5% and two percent of the gross national product of developed countries, is at a very low level, such as one eight percent in Turkey.

4.3 ROBOTICS

According to The World Robotics 2020 Report prepared by International Federation of Robotics, industrial robots report shows a record of 2.7 million industrial robots operating in factories around the world – an increase of 12%. Sales of new robots remain on a high level with 373,000

units shipped globally in 2019. This is 12% less compared to 2018, but still the 3rd highest sales volume ever recorded. "The stock of industrial robots operating in factories around the world today marks the highest level in history," says Milton Guerry, President of the International Federation of Robotics. "Driven by the success story of smart production and automation this is a worldwide increase of about 85% within five years (2014-2019). The recent slowdown in sales by 12% reflects the difficult times the two main customer industries, automotive and electrical/electronics, have experienced."

There are 14,000 operational industrial robots in Turkey, approximately half of which are in the automotive industry. According to 2019 statistics, countries with robot technology in production use an average of 80 robots per 10,000 workers. This average is only 20 for all sectors combined in Turkey, leaving significant potential growth opportunities for robotics in manufacturing. In Turkey, the most robots are used in the automotive industry with more than 200 robots per 10,000 workers, making Turkey the top ten global market for robots used in automotive.

4.4 IOT / BIG DATA AND ANALYTICS

In future digital technologies, big data, Internet of Things (IoT), artificial intelligence (AI) .etc will be at the heart of the industrial sector and production. The integration of production, design and administrative processes in the manufacturing sector with software, machines and robots is defined as industry 4.0. Industry 4.0 uses cyber physical systems, sensors, artificial intelligence, analysis algorithms, IoT, cloud computing and cognitive analysis software.

Informatics Industry Association - TÜBİSAD announced the "Information and Communication Technologies Sector 2020 Market Data and Trends". According to the report, the sector grew by 22% in TL terms compared to the previous year and reached a volume of TL189 billion. The employment of the sector increased to 158 thousand people and the exports reached TL10.52 billion. According to the report, 5G and fiber internet, internet of things, smart edge computing, artificial intelligence, cyber security and data privacy technologies were evaluated as the technologies that stand out with both market growth expectation and adaptation and transformative impact on the sectors.[3]

Industry analysts estimate that the Turkish market will grow to $50 billion in next 3 years, to include investments in sensors, optronics, M2M software, and hardware, artificial intelligence, modelling and simulations, cloud services and cybersecurity applications.

4.5 ARTIFICIAL INTELLIGENCE

Technologies such as machine learning, natural language processing and machine vision are among the prominent artificial intelligence technologies today. While these technologies enable companies to increase their efficiency and reduce their operational costs, artificial intelligence is expected to transform companies and industries in the next 3 years. Companies that want to keep up with this change and gain a competitive advantage are investing in the field of artificial intelligence. While investments made in the field of artificial intelligence in the world reached

[3] Tübisad Report 2020

67.9 billion dollars in 2020 with an increase of 39%, half of the companies benefit from artificial intelligence in at least one department. Despite COVID-19, companies continued to invest in artificial intelligence, while the prominent sector was the life sciences and health services sector. Between the years 2020-2024, it is predicted that the artificial intelligence market will reach 110 billion dollars with an annual growth of 21.7%.

The number of artificial intelligence initiatives in Turkey continued to increase and reached 145 in 2020, and image processing with 39 companies and machine learning with 28 companies came to the fore among the areas in which start-ups showed the most interest. In addition to these two areas, chatbot, data analytics and natural language processing are the areas that Turkish start-ups are most interested in. In addition, robotic process automation, autonomous vehicles, search engines and search assistants, optimization and smart platform areas are areas where Turkish enterprises do not show great interest.[4]

4.6 CYBER SECURITY AND DATA PRIVACY

Cases caused by ransomware, data theft and server access stand out as the most common types of cyber-attacks in 2020, while cyber breaches have important consequences for companies, especially loss of income.

The cyber security market, which was worth USD 173 billion in 2020, is expected to reach USD 270 billion in 2026, while web and e-mail security applications are expected to be the fastest growing areas in 2021.

Establishment of a cyber security management system structure, identity and access management, data security and cloud security are foreseen to be the areas where priority action should be taken in order to increase the maturity of cyber security and data privacy in Turkey. With the development of artificial intelligence, IoT and 5G, the increase in the number of devices using cloud and edge computing systems increases the security requirements of the devices. It is estimated that investments to combat potential threats in these areas will increase in the near future.

4.7 INNOVATIVE MATERIALS / TECHNICAL TEXTILES

Innovative materials/technical textiles are used in sectors such as aviation, agriculture, construction and infrastructure, medical, energy, transportation, marine and defence. Turkey's total imports in this category (including composites) is around USD 2.5 billion. The market is expected to grow between 4-7% annually.[5]

[4] Turkish Artificial Intelligence Initiative (TRAI)
[5] Export.gov

4.8 AUGMENTED AND VIRTUAL REALITY

The use of AR- and VR-based systems in manufacturing in Turkey is still in its infancy; however, there is great interest in the market to adopt these technologies. In the aviation, defence, automotive, electronics, durable goods and textile industries, a number of large companies use AR and/or VR to select parts in their respective warehouses, transmit repair instructions over mobile devices, simulate products and production processes and train workers.[6]

5. OPPORTUNITIES

The rapid change in technological developments enables the emergence of different trends and new markets in the global world. Organizations need to innovate in order to survive and to grow in their market. Continuously changing, developing and renewed markets operating in the world can sustain their existence by innovating or keeping up with the expectations of consumers. It is not possible for a person, a business, a market, an environment or the world to remain unchanged and survive without adapting. They have to adapt and use it in the best way as long as they exist.

The highest demand for advanced production technology solutions in Turkey is companies operating in the automotive, aerospace, defence, durable consumer goods, electronics, chemistry, machinery, steel, construction, textile, food processing, energy and mining sectors.

Opportunities for Industry 4.0 applications can be seen in information and material flows, supplier integration, product simulation and modelling at the design stage, and the manufacturing process, advanced materials, flexible manufacturing, big data analytics, advanced cybersecurity, and smart product and production lines. There is also a significant need for qualified solution partners and system integrators. A report by the Turkish Informatics Foundation states that 50% of manufacturers in Turkey plan to invest in industry 4.0 in the next 3 to 5 years, 20% still do not have any knowledge/strategy and the remaining 30% shows that it plans to invest in 5 to 10 years.

6. KEY ORGANIZATIONS

- Ministry of Industry and Technology: www.sanayi.gov.tr
- Scientific and Technological Research Council of Turkey (TUBITAK): www.tubitak.gov.tr/en
- Turkish Industrial Automation Association (ENOSAD): www.enosad.org.tr
- Informatics Industry Association (TUBISAD): https://tubisad.org.tr/en/
- Turkey Artificial Intelligence Initiative (TRAI): https://turkiye.ai/

[6] Export.gov

7. SELECTED EVENTS

- Robot Investments Forum and Exhibition: www.robotyatirimlari.com/en
- Process Automation Forum and Exhibition: https://prosesotomasyonu.com/
- Eurasian Composites Show: www.eurasiancomposites.com
- ANKIROS-ANNOFER-TURKCAST: www.ankiros.com/home-en
- MAKTEK Eurasia: www.maktekfuari.com/en
- WIN Eurasia: www.win-eurasia.com/en
- IDC Smart Manufacturing Summit: https://www.idc.com/mea/events/69380-idc-cio-summit
- Smart Production Technologies and Digitalization Conference: https://www.prontoeventi.com/event/utk/

For further information on this section or for more on potential opportunities, contact: istanbul@fitagency.com

8. SOURCES

- Ministry of Industry and Technology: www.sanayi.gov.tr
- Turkish Industrial Automation Association (ENOSAD): www.enosad.org.tr
- Statista : https://www.statista.com/
- Trading Economics- Turkey Industrial Production Report
- TUIK- Turkish Statistical Institute
- Tübisad Report 2020
- Turkish Artificial Intelligence Initiative (TRAI)
- International Trade Administration : https://www.trade.gov/

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