



Turkey's Smart Manufacturing Roadmap

The Turkish government aims to transform their economy into a knowledge economy based on the development of high tech products with a high added value. However, the current share of high added value high technology products in its export is only 4%. Whereas advanced economies see Smart Industry developments as an opportunity to increase their competitiveness (for example for reshoring purposes), for emerging economies such as Turkey Smart Industry provides an opportunity to increase the share of high technology products in the total volume of production. The Boston Consulting Group in cooperation with TUSIAD conducted a study which highlights four opportunities for Turkey ¹:

Efficiency: with a full application of Industry 4.0 concepts, the Turkish production industry is expected to save up to 50 billion Turkish Lira, whereas efficiency savings are expected to be around 4-7% with an expected productivity growth of between 5-15%.

Growth: with a full integration of the Turkish economy using Industry 4.0 concepts into the global value chain, Turkey will gain a competitive advantage that can lead up to 3% of yearly additional growth of industrial production, thereby adding 1% to Turkey's GDP, which translates to about 150-200 billion Turkish Liras in additional revenue.

Investment: For that to happen in the next ten years, yearly investments of about 10-15 billion Turkish Liras (in current prices and based upon current economic growth) need to be made (which amounts to 1 to 1,5 % of manufacturer's revenue). This can be a challenge, since Turkish investors generally expect a short return on investment.

Workforce: Assuming the abovementioned happens, the structure of the workforce needs to change. Industry 4.0 requires a highly educated workforce, whereas currently vocational education levels are quite low.

¹ http://tusiad.org/en/reports/item/download/7842_228febb7e929f192e0efad9dfccbfca

In order to capture abovementioned opportunities for change, Turkey needs to develop a roadmap that will form the basis for the implementation of Smart Industry applications in the Turkish industry. Furthermore, Turkey needs to prepare the labor force for additional requirements that such smart factories require. On February 17th 2016 during the meeting of the Higher Council of Science & Technology (BTYK), the BTYK decided to form a coordinating entity that will develop a strategic agenda and roadmap for Industry 4.0 in Turkey. According to the Turkish Minister of Science, Industry Mr. Işık 'In order to reach perfection in critical and pioneering technologies, in particular regarding smart industry, cyber-physical systems, artificial intelligence, sensors, robot technology, the Internet of Things, big data, cyber security and cloud computing it has been decided to increase R&D efforts in these fields²'. Furthermore, according to the BTYK, the transition of the Turkish industry towards increasing the international competitiveness in technology production focuses on³:

1. Developing an implementation and monitoring model for smart manufacturing in coordination with all stakeholders.
2. Increasing goal-oriented R&D efforts in critical and pioneering technology areas (cyber-physical systems, artificial intelligence, sensors, robotics, internet of things, big data, cyber security etc.).
3. Designing support mechanisms for manufacturing infrastructures to develop critical and pioneering technologies.

In the scope of the BTYK decision, TUBITAK conducted several studies and organized events between April and November 2016 to determine the key and pioneering technologies that serve Intelligent Manufacturing Systems. The following activities were undertaken:

- International and national reports were reviewed to define definitions and concepts, technology groups and scopes of intelligent production systems (not including the Dutch Smart Industry agenda).

² <http://www.sanayi.gov.tr/NewsDetails.aspx?newsID=18975&lng=tr>

³ Presentation Sinan Tandogan during Industrial Technologies Conference 22 June 2016, Amsterdam

- A comprehensive questionnaire was applied to approximately 1000 companies that received R & D support from relevant TÜBİTAK related technologies and their results were analyzed. The survey collects the opinions and answers of the private sector organizations in five sectors.
- Technology based national strategic targets, critical products / technologies, R & D issues as well as sectoral applications have been determined.
- Strategic targets, critical products / technologies, R & D issues, technological maturity levels, competence, added value of localization and commercialization potential were audited.

Awareness and trends

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 ways mostly in the machinery & equipment sector, the computers, electronics and optical devices sector as well as the automotive and white goods sector.

The Turkish Intelligent Manufacturing Systems Technology Roadmap

In order to capture aforementioned trends and to ready the Turkish industry for Industry 4.0 developments, TUBITAK has developed a roadmap that should prepare the Turkish industry for adoption and development of Industry 4.0 concepts. The roadmap identifies three technology groups, which are digitalization, connectivity and future factories. Under these groups, 8 critical technologies, 10 strategic targets and 29 critical products have been identified to which Turkish industry should devote its attention to. The technology groups, strategic targets and underlying technologies are as follows:

- **Digitalization**, with a focus on big data & cloud computing, virtualization and cyber security. The following targets are being defined:
 - *Secure, private cloud service platform*: develop secure, private, intelligent and scalable cloud service platforms for end devices, algorithms and applications.
 - *Big data analytics*: collect, process, correlate, analyze, report and use in decision support systems.
 - *Cyber security solutions*: develop cyber security solutions Industry 4.0 applications.
 - *Modeling and simulation*: development of modeling and simulation technologies
- **Connectivity**, with a focus on the Internet of Things (IoT) and sensor technologies. The following targets are being defined:
 - *Industrial IoT platform*: Establishment of digital platform of industrial IoT with interoperability, increased security and reliability, and development of software and hardware for industrial endpoint equipment.
 - *M2X software and equipment*: development of data storage technologies suitable for data emerging with reliable and innovative M2X (Machine-Machine, Human-Machine, Machine-Infrastructure) software and / or hardware that will increase the quality and productivity during the product life cycle.
 - *Innovative sensors*: development of industrial, physical, chemical, biological, optical, micro-nano sensors; intelligent actors; industrial, wireless, digital sensor

networks; artificial vision, image processing, innovative sensor applications and heavy conditions resistant sensors.

- **Future factories**, with a focus on additive manufacturing, advanced robotic systems and automation & control systems.
 - *Robotic, automation, equipment, software and management systems*: developing intelligent production robots, equipment and software / management systems that can compete in the international markets in terms of technology and cost, also accessible by SMEs.
 - *Supplementary manufacturing materials, equipment and software*: development of raw materials, production equipment and necessary software and automation systems used in additive manufacturing.
 - *Intelligent factory systems*: development of intelligent factory systems and components and middleware software technologies.

TUBITAK's national call for research proposals topics for 2016 and 2017 already reflect a focus on advanced manufacturing technologies as well as the Internet of Things. Specific focus is on:

- Additive Manufacturing:
 - Multilayer additive manufacturing
 - Rapid prototyping and 3D printing technologies
 - CAD/CAM, simulation & modelling software
 - Robotics and mechatronics
 - Flexible manufacturing
- Internet of Things
 - Sensors and sensing systems
 - Virtualization
 - M2M communication
 - Cloud computing



Opportunities for Dutch organizations

There seems to be a sense of urgency in Turkey to not miss the boat regarding Industry 4.0. Combined with the fact that over the coming decade substantial investments are needed and that the technology level of the Turkish industry in general sits between the 2nd and 3rd industrial revolution, there is substantial opportunity to work together with Turkish stakeholders. That can be in the form of collaboration in multilateral research projects (Horizon 2020, EUREKA, Eurostars), but also in the form of bilateral collaboration with specific Turkish partners. In order to gauge the potential for Dutch and Turkish collaboration in these field, the Dutch economic network in Turkey will organize a series of events about Industry 4.0 developments at the Consulate General in Istanbul. These events are proposed to be as follows:

1. **Introductory event** in which specific Turkish developments and challenges will be highlighted, as well as the Dutch Smart Industry action agenda.
2. **Industry 4.0's underlying technology and its impact on society.** In this event we target question such as: what are the technology developments that make Smart Industry a reality? What will be the future trends in the Internet of Things, robotics, logistics etcetera and how will that change society? Are our countries up for that challenge and what do The Netherlands and Turkey have to offer to each other to make the societal change fed by these technology developments go smooth?
3. **Smart agriculture.** Smart agriculture is a good example of cross over fertilization between different economic sectors and is an expertise area where The Netherlands has a lot to offer. Turkey's biggest national research program revolves around precision agriculture using remote sensing techniques. This event can serve as a basis to find common ground in collaboration in smart agriculture.
4. **Vocational education / creation of new jobs.** One major Turkish challenge is educating the existing and future workforce for the changes that will be brought about by the Industry 4.0 revolution as well as the new jobs it will create. How can Dutch expertise contribute to this challenge?
5. **Concluding event.** This series of events will be concluded with a final, bigger event targeted at a larger audience, where we discuss the future societal implications of the Industry 4.0



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transformation. What will our future society look like and what will the consequences be? How can Dutch-Turkish collaboration reinforce and/or strengthen this revolution in both our countries and, based on the previous events, what activities can we undertake together?

In case you would like more information about aforementioned developments and/or about the events, please contact the Advisor for Innovation, Technology and Science Mr. Rory Nuijens via rory.nuijens@minbuza.nl.