Learner Centric Advanced Manufacturing Platform

D3.2 - M24 - Analysis of the Impacts and Evolution of jobs in Advanced Manufacturing

D3.2 - M24 - Türkiye Subreport

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GLOSSARY AND ACRONYMS

AFM - Asociación de Fabricantes de Máquina Herramienta- Machine Tool Manufacturers Association

AI - Artificial Intelligence

AR - Augmented Reality

B2B - Business to Business

B2C - Business to Consumer

CAD – Computer Aided Design

CMQEIf - Campus des Métiers et des Qualifications d'Excellence Industrie du futur

CNC - Computer Numerical Control

CAM - Computer-Aided Manufacturing

DT - Digital Twin

EQF - European Qualification Framework

ERP - Enterprise Resource Planning

ESCO - European Skills, Competences, Qualifications and Occupations

HVET - Higher Vocational Education and Training

IoT - Internet of Things

ISTMTAL İstanbul Havalimanı Mesleki ve Teknik Anadolu Lisesi – İstanbul Airport Vocational and Technical Anatolian High School

IT - Information Technology

IVAF-EEI - Instituto Vasco de Aprendizajes Futuros para la FP -Basque Institute of Future Learnings for VET

İŞKUR – Türkiye İş Kurumu – Turkish Employment Agency

LCAMP - Learner-Centric Advanced Manufacturing Platform

MARKA Marmara Kalkınma Ajansı - East Marmara Development Agency

MV - Mecanic Vallée

PLC - Programmable Logic Controller

SME - Small and Medium-sized Enterprises

TKNIKA - Centre for Applied Research in Vocational Training in the Basque Country.

VR - Virtual Reality

WP - Work Package

CONTENT TABLE

EXECUTIVE SUMMARY

The LCAMP (Learner-Centric Advanced Manufacturing Platform) project under the CoVE initiative aims to enhance regional skill ecosystems in Advanced Manufacturing.

LCAMP plans to establish a European Platform of Vocational Excellence for Advanced Manufacturing, promoting resilience and innovation across regions through collaboration.

This report is a result of the LCAMP Observatory, which is one of the services the LCAMP platform will put available for the final users. The Observatory is led by the French cluster *Mecanic Vallée* and the French VET centre CMQ.

During this second year of work, the Observatory work package launched an analysis on the impacts of digital and green transitions trends on jobs and skills of the workforce in the advanced manufacturing industry. The analysis focused on a selection of jobs occupied mainly by people qualified by European Qualification Framework (EQF) 3-6 studies.

These analyses are detailed in each regional / national sub-reports written by five countries (the Basque Country, France, Germany, Italy and Türkiye) on 28 jobs in the advanced manufacturing industry.

Although some disparities, specificities and differences in the way studies are conducted and the results presented can be highlighted, this year of work has also validated a common methodological approach and a common format/frame for presenting the results, to go further.

Drawing from literature review and interviews conducted with companies in the field, several key findings have emerged.

Here is a summary of the main lessons learned from this year of collaborative work.

In term of collaborative work process:

- **Methodology**: Each country relied on its own network of experts, with their differences in terms of areas of expertise and availability. Selection of jobs for each country were based on their geopolitical location and relevance to the Smart Specialisation Strategy policy.
- **Frame:** A detailed presentation, described within a structured database, allows quick cross analysis, based on different axis: trends, skills, jobs/tasks.
- **Results**: Major tendencies of digital and green transition trends' impact on jobs and related needed skills have been identified thanks to these analyses. Obtained results were presented to display the effects of these trends on the relevant jobs clearly.
- **Year 3:** To obtain complete, usable, and certified results in the future, it will be necessary to combine efforts on common analyses. This could result on analysing the impacts of common jobs and reporting in a harmonized frame. This analysis will be reproduced next year not only to check the validity of this year's report but also to observe the change in the jobs and skills over a time period of a year.

In conclusion, the report underscores the dynamic nature of jobs in advanced manufacturing, driven by digitalization, greening, and industrial contexts. Companies are increasingly seeking versatile, specialized, and proficient individuals equipped with a blend of technical and transversal skills to thrive in this evolving landscape.

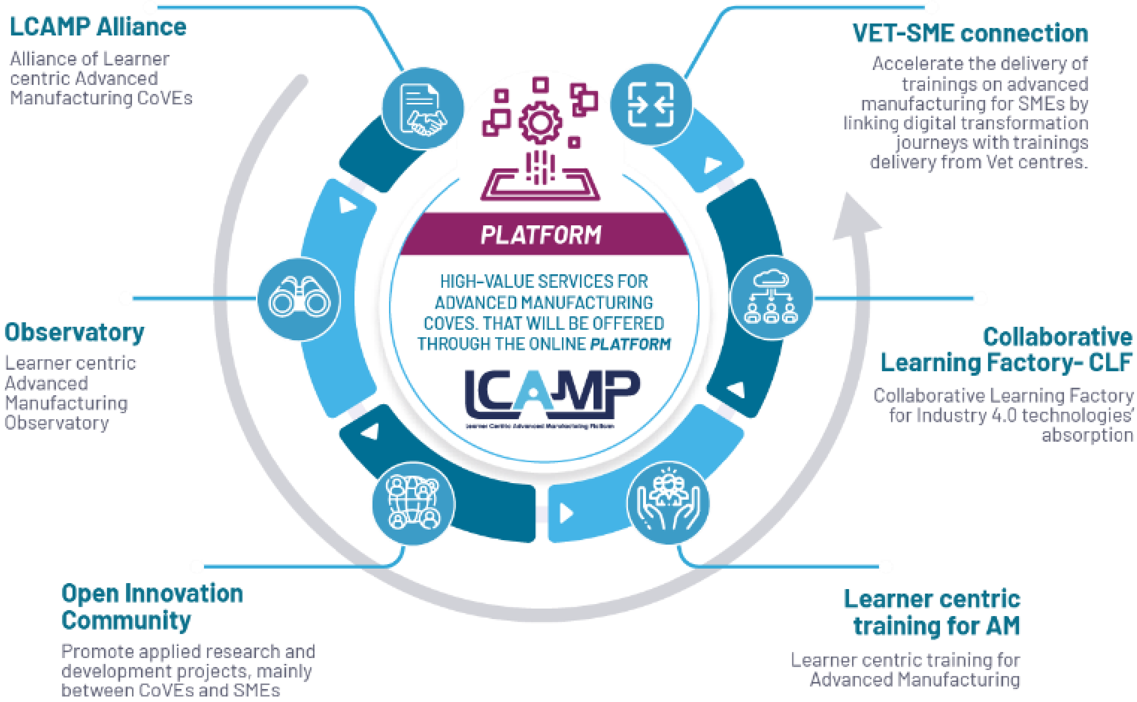

Figure 1 : Outputs and services to~~hat will~~ be delivered by the LCAMP platform

1. INTRODUCTION

The digital and green transitions are two of the most transformative trends shaping our contemporary world. The digital transition, characterized by the proliferation of digital technologies such as artificial intelligence, robotics, and the Internet of Things, is revolutionizing the way we live and work. Simultaneously, the green transition, driven by the urgent need to address climate change and environmental sustainability, is fostering the adoption of renewable energy sources, circular economy principles, and sustainable practices. These twin transitions are not only altering the industrial landscape but also significantly impacting societal norms and economic structures.

As these transitions progress, they bring about profound changes in the labor market, particularly in advanced manufacturing. Digital technologies are automating repetitive tasks, enhancing precision, and enabling new production methodologies. Concurrently, green technologies are reshaping manufacturing processes to minimize environmental impact and promote resource efficiency. These changes necessitate a shift in the skills and competencies required for the workforce. Jobs in advanced manufacturing are increasingly demanding a blend of digital literacy, technical proficiency, and sustainability awareness.

First report on this topic covering all jobs across all countries has been published in June 2023. This subreport delves into the intricate relationship between the digital and green transitions and their impact on jobs in advanced manufacturing. It systematically analyses how these trends are reshaping job roles, skill requirements, and competency frameworks. The broader study, carried out collaboratively by teams from various countries, provides a global perspective on these changes. However, this particular subreport focuses exclusively on the analysis conducted by the Turkish team, offering a detailed examination of the national context and its specific challenges and opportunities.

Through detailed analysis and expert insights, this subreport seeks to offer valuable insights for policymakers, educators, and industry leaders. It underscores the importance of proactive strategies to equip the workforce with the necessary skills to thrive in a digitally-driven and environmentally-conscious future. The relevance of this study extends to vocational education and training (VET) institutions and Centers of Vocational Excellence (CoVEs), highlighting their critical role in developing and implementing training programs that address the evolving needs of the labor market. By anticipating the changes brought about by these transitions, we can better prepare for the future, ensuring that the evolution of jobs in advanced manufacturing contributes to economic growth, social well-being, and environmental sustainability.

2. METHODOLOGIES

The **D3.2-M24-Observatory Methodology** (Pichoutou, 2024) document describes methodology to produce this subreport. It includes:

- The methodology to select jobs to analyse,
- The methodology to analyse the impacts,
- The methodology to validate the Sub-Report.

3. JOB'S IMPACT ANALYSIS

This section deals with the analysis of the selected 5 jobs. As mentioned in the methodology it was analysed the changes faced by companies and identifying the **levers of those changes** affecting the specific jobs; then it was described the **changes in skills and knowledges** detected in the analysis.

3.1. LIST OF SELECTED JOBS

Here is the short list selected by Türkiye:

Table 1 : List of selected jobs

ESCO CODE	ESCO OCCUPATION	1 - INDUSTRY SECTORS	2 - DIGITAL AND GREEN TRANSITIONS NEW TRENDS IMPACTING	3 - EMPLOYABILITY	4.RELEVANCE FOR THE SMART SPECIALISATION STRATEGY – AT REGIONAL/COUNTRY?	5 - EDUCATION LEVEL.
7223.4	Computer Numerical Control Machine Operator	**Machine tools (Mechanical Engineering), Automotive, Aerospace**	"1-1 Internet of Things (IoT) / Smart Sensors / 5G technology, 1-2 Artificial Intelligence (AI) / Machine learning / Big Data Analytics, 4-2 Robotics and Automation, 4-3 Collaborative Robots (Cobots), 4-6 Predictive Maintenance, 5-3 Energy Efficiency, 5-6 Sustainable Material Innovation"	**April 2024 - Türkiye: CNC Operator: 64 job offers (İŞKUR) 373 job offers (kariyer.net) Sources: İŞKUR - Bilgisayarlı Makine (CNC Operatörü) https://esube.iskur.gov.tr/Istihdam/AciklsIlanAra.aspx https://www.kariyer.net/is-ilanlari/cnc+operatoru?pst=4150&pkw=cnc%20operat%C3%B6r%C3%BC**	Aligns with the S3 priorities of "Automotive plastics" and "Power units" https://s3platform.jrc.ec.europa.eu/region-page-test/-/regions/TR42	EQF Level 4
7543.9	Product Quality Controller	**Automotive, Aerospace, Electric and electronic Industries, Machine tools (Mechanical Engineering)**	"1-1 Internet of Things (IoT) / Smart Sensors / 5G technology, 2-2 3D scanning, 3-1 Cybersecurity, 4-2 Robotics and Automation, 4-3 Collaborative Robots (Cobots), 5-3 Energy Efficiency, 5-4 Waste Reduction"	**April 2024 - Türkiye: Quality Controller: 222 job offers (İŞKUR) 514 job offers (kariyer.net) Sources: İŞKUR - Kalite Kontrolcü https://esube.iskur.gov.tr/Istihdam/AciklsIlanAra.aspx https://www.kariyer.net/is-ilanlari/kalite+kontrol+elemani?pst=960&pkw=kalite%20kontrol%20eleman%C4%B1**	Aligns with most of the S3 priorities given for TR42 region. https://s3platform.jrc.ec.europa.eu/region-page-test/-/regions/TR42	EQF Level 6

2529.8	ICT Security Manager	**Transport, Electric and electronic Industries, Aerospace, Automotive**	"1-1 Internet of Things (IoT) / Smart Sensors / 5G technology, 1-2 Artificial Intelligence (AI) / Machine learning / Big Data Analytics, 3-1 Cybersecurity, 5-10 Sustainable IT Infrastructure, 5-12 Corporate Social Responsibility (CSR) Initiatives"	**April 2024 - Türkiye: ICT Security Specialist: 28 job offers (kariyer.net) https://www.kariyer.net/is-ilanlari/it+guvenlik+uzmani?pst=4558&pkw=%C4%B1t%20g%C3%BCvenlik%20uzman%C4%B1**	Although not directly addressed under S3, it is relevant to all businesses, especially ones affected more by the digital transition trends.	EQF Level 5
1213.8	Sustainability Manager	**Machine tools (Mechanical Engineering), Automotive, Aerospace, Electric and electronic Industries, Transport, Maritime**	"1-1 Internet of Things (IoT) / Smart Sensors / 5G technology, 1-2 Artificial Intelligence (AI) / Machine learning / Big Data Analytics, 5-1 Renewable Energy Integration, 5-3 Energy Efficiency, 5-4 Waste Reduction, 5-5 Green Logistics and Supply Chain, 5-6 Sustainable Material Innovation, 5-7 Carbon Footprint Management, 5-11 Environmental Monitoring and Reporting, 5-12 Corporate Social Responsibility (CSR) Initiatives"	**April 2024 - Türkiye: Sustainability Manager: 2 job offers (kariyer.net)** **https://www.kariyer.net/is-ilanlari?pst=12185&pkw=s%C3%BCrd%C3%BCr%C3%BClebilirlik%20m%C3%BCd%C3%BCr%C3%BC**	Although not directly addressed under S3, it is relevant to all businesses, especially ones affected more by the green transition trends.	EQF Level 6
3139.1	Automated Assembly Line Operator	**Automotive, Aerospace, Electric and electronic Industries**	"1-1 Internet of Things (IoT) / Smart Sensors / 5G technology, 4-2 Robotics and Automation, 4-3 Collaborative Robots (Cobots), 4-6 Predictive Maintenance, 5-6 Sustainable Material Innovation"	**This occupation is not directly listed in career sites, instead they are listed under assembly line operators for different types of sectors.**	Aligns with the S3 priority of "Automotive plastics" https://s3platform.jrc.ec.europa.eu/region-page-test/-/regions/TR42	**EQF Level 3**

3.2. SUSTAINABILITY MANAGER

3.2.1. JOB DESCRIPTION AND SCOPE

Job Description

Sustainability Manager (ESCO 1213.8) ESCO description: *“Sustainability managers are responsible for ensuring the sustainability of business processes. They helped in the design and implementation of plans and measures to ensure that the manufacturing processes and products comply with given environmental regulations and social responsibility standards and they monitor and report on the implementation of sustainability strategies within the company supply chain and business process. They analyse issues linked to manufacturing processes, use of materials, waste reduction, energy efficiency and products traceability to improve environmental and social impacts and integrate sustainability aspects into the company culture”* (ESCO, n.d.).

Business Area

Sustainability has become an important aspect on all kinds of business operations as the digital and green transition are gaining traction. Businesses are adapting their operations for long term success by following these trends. The Sustainability Manager is a key advocate for driving sustainability initiatives that have a profound impact on shaping a greener, more resilient future. They are instrumental in leading efforts to integrate sustainability into the core business practices of various industries, some of them are listed below (Coursera, 2024):

- **Renewable Energy:** Lead sustainability efforts in the renewable energy sector by promoting the development and adoption of clean energy technologies, such as solar, wind, and hydroelectric power.
- **Waste Management and Recycling:** Innovate sustainable solutions in waste management and recycling industries by implementing circular economy principles, reducing landfill waste, and promoting resource recovery and reuse.
- **Green Technology Manufacturing:** The green technology sector encompasses industries involved in renewable energy, energy-efficient technologies, and sustainable infrastructure. Sustainability Managers in green technology manufacturing lead efforts to reduce carbon emissions, promote renewable energy adoption, and develop eco-friendly products and solutions, driving sustainability in advanced manufacturing.
- **Advanced Materials Production:** Advanced materials are essential for innovation in various industries, including aerospace, automotive, and electronics. Sustainability Managers in advanced materials production focus on sustainable sourcing, recycling, and manufacturing processes to minimise environmental impact and enhance material efficiency, contributing to sustainable development in advanced manufacturing.
- **Smart Manufacturing and IoT:** Smart manufacturing technologies, including IoT (Internet of Things) and data analytics, are revolutionising production processes and supply chain management. Sustainability Managers in smart manufacturing industries prioritize energy efficiency, waste reduction, and resource optimisation, leveraging IoT and data-driven insights to enhance sustainability across manufacturing operations.
- **Industrial Automation and Robotics:** Industrial automation and robotics play a crucial role in enhancing efficiency and productivity in manufacturing. Sustainability Managers

in automation and robotics industries promote energy-efficient automation solutions, optimise resource use, and ensure responsible disposal of electronic waste, driving sustainability in advanced manufacturing processes.

The Sustainability Manager is responsible for leading and implementing sustainability initiatives across various industries, driving forward environmental conservation, social equity, and economic viability. They develop and execute tailored sustainability strategies, collaborate with stakeholders to foster collaborative efforts, and ensure compliance with environmental regulations and standards. By championing resource optimisation, risk management, and education, they play a pivotal role in shaping a greener, more resilient future for organisations and communities alike. The demand for sustainability managers in the near future is likely to increase (Coursera, 2024).

3.2.2. CONTEXT AND LIMITATIONS

Insights from global sustainability trends and regional initiatives can provide valuable context for understanding the evolving role of sustainability managers in driving organisational change. The global sustainability landscape is undergoing transformative shifts, with increasing emphasis on climate action, social responsibility, and sustainable development goals. Organisations across various industries are recognising the imperative to integrate sustainability into their core business strategies, reflecting growing societal expectations and regulatory pressures, (see webpage of the Türkiye's Directorate of Climate Change (iklim.gov.tr., n.d.).

In Türkiye, sustainability has become a key focus area, with businesses and government initiatives alike prioritizing green initiatives, circular economy principles, and carbon-neutral objectives. National policies and programs, such as the National Climate Change Strategy (iklim.gov.tr., n.d.) and the 11th Development Plan (iklim.gov.tr., n.d.) are driving significant investments in renewable energy, green infrastructure, and eco-friendly technologies, creating new opportunities and challenges for sustainability professionals.

While specific data on the demand for sustainability managers in Türkiye may vary, the broader trends in the region suggest a growing need for skilled professionals capable of leading sustainability initiatives, fostering stakeholder collaboration, and navigating complex regulatory landscapes. The increasing convergence of environmental, social, and governance (ESG) factors in business decision-making highlights the pivotal role of sustainability managers in driving organisational resilience, innovation, and long-term value creation.

Given the escalating global focus on sustainability and the strategic importance of sustainable practices across industries, professionals with expertise in sustainability management are likely to encounter expanding opportunities in Türkiye and beyond. The integration of sustainability into business operations, risk management, and stakeholder engagement underscores the importance of skilled leadership in advancing sustainable business practices and achieving meaningful impact.

3.2.3. FROM CURRENT SITUATION TO ON-GOING SITUATION

Here after the description of the main tasks impacted by **Digital** and/or **Green transition**, modifications and evolutions of the related needed skills.

Table 2 : Tasks and skills impacted related to sustainability manager occupation.

TASK	IMPACTING DİGİTAL TECHNOLOGY AND/OR GREEN TRANSİTİON	IMPACT DESCRİPTİON	RELATED NEEDED SKİLLS/ KNOWLEDGE	EXPECTED TENDENCY FOR SKİLL EVOLUTİON	SKİLL TYPE	MATURİTY LEVEL TO REACH	SKİLL ESCO URL	SKİLL DESCRİPTİON
Conducting sustainability audits and reporting	**5-11 Environmental Monitoring and Reporting**	Performing sustainability audits to assess environmental impact and compliance, and reporting findings to stakeholders.	**Lead the sustainability reporting process**	+	**Skill**	**L4**	http://data.europa.eu/esco/skill/bbcc7e1b-3d4d-4422-9fac-efd636eb9de4	Oversee the process of reporting on the sustainability performance of the organisation, according to established guidelines and standards.
		Performing sustainability audits to assess environmental impact and compliance, and reporting findings to stakeholders. With the new trends in environmental monitoring and reporting, related reports and audits have to be updated and enhanced.	**Global standards for sustainability reporting**		**Knowledge**		http://data.europa.eu/esco/skill/4300b453-9bcf-474c-9ee3-92ec2229720c	The global, standardised reporting framework that enable organisations to quantify and communicate about their environmental, social and governance impact.
Development of corporate sustainability strategies	**5-12 Corporate Social Responsibility (CSR) Initiatives**	Creating comprehensive sustainability strategies that align with corporate goals and reduce environmental footprint.	**Corporate social responsibility**				http://data.europa.eu/esco/skill/66db424f-2abe-420d-8e5b-186607266b61	The handling or managing of business processes in a responsible and ethical manner considering the economic responsibility towards shareholders as equally important as the responsibility towards environmental and social stakeholders.

Implementation of sustainable manufacturing and procurement strategies	**1-1 Internet of Things (IoT) / Smart Sensors / 5G technology**	The incorporation of IoT, smart sensors, and 5G technology into sustainable manufacturing and procurement strategies yields tangible results for Sustainability Managers. By harnessing real-time data insights from interconnected devices, they can optimize resource use, minimise waste, and enhance supply chain transparency. This enables them to achieve cost savings, reduce environmental impact, and ensure ethical sourcing practices, ultimately fostering a more sustainable and resilient manufacturing ecosystem.	**Energy efficiency**		**Knowledge**	**L4**	http://data.europa.eu/esco/skill/83fc0b2b-6cd2-46af-b1ff-d3fc83604c26	Field of information concerning the reduction of the use of energy. It encompasses calculating the consumption of energy, providing certificates and support measures, saving energy by reducing the demand, encouraging efficient use of fossil fuels, and promoting the use of renewable energy.
			Implement sustainable procurement	**+**	**Skill**	**L3**	http://data.europa.eu/esco/skill/6962058d-9808-4820-a6bc-d7cabce60cde	Incorporate strategic public policy goals into procurement procedures, such as green public procurement (GPP) and socially responsible public procurement (SRPP). Contribute to reducing the environmental impact of procurement, to achieving social goals and to improving value for money for the organisation and for society at large.
			Mitigate waste of resources				http://data.europa.eu/esco/skill/d2c81ad1-2439-43cf-9c63-204187b8f771	Evaluate and identify opportunities to use resources more efficiently with continuously striving to reduce waste of utilities.
	5-7 Carbon Footprint Management	Monitoring, handling and improving operations in a more efficient way, ultimately with the aim of reducing carbon footprint and environmental impacts.	**Manage environmental impact**				http://data.europa.eu/esco/skill/d3a8ef9c-8572-438c-91dc-010537070be3	Implement measures to minimise the biological, chemical and physical impacts of mining activity on the environment.

Implementation of sustainable manufacturing practices	**1-2 Artificial Intelligence (AI) / Machine learning / Big Data Analytics**	The implementation of sustainable manufacturing practices by Sustainability Managers is bolstered by leveraging AI, machine learning, and big data analytics. These technologies enable precise identification of resource inefficiencies and predictive model	**Energy efficiency**		**Knowledge**	**L4**	http://data.europa.eu/esco/skill/83fc0b2b-6cd2-46af-b1ff-d3fc83604c26	Field of information concerning the reduction of the use of energy. It encompasses calculating the consumption of energy, providing certificates and support measures, saving energy by reducing the demand, encouraging efficient use of fossil fuels, and promoting the use of renewable energy.
			Mitigate waste of resources		**Skill**	**L3**	http://data.europa.eu/esco/skill/d2c81ad1-2439-43cf-9c63-204187b8f771	Evaluate and identify opportunities to use resources more efficiently with continuously striving to reduce waste of utilities.
Implementation of sustainable manufacturing practices	**5-4 Waste Reduction**	Implementing sustainable manufacturing processes is a task affected by several aspects of digital and green transition trends. Waste reduction is an important practice for a more sustainable process; therefore, measures to reduce waste across all kinds of processes will be a task under the implementation of sustainable manufacturing practices.	**Mitigate waste of resources**		**Skill**	**L3**	http://data.europa.eu/esco/skill/d2c81ad1-2439-43cf-9c63-204187b8f771	Evaluate and identify opportunities to use resources more efficiently with continuously striving to reduce waste of utilities.
Implementation of sustainable materials in manufacturing	**5-6 Sustainable Material Innovation**	Adoption of sustainable and eco-friendly materials in manufacturing processes have a direct impact for more sustainable operations.	**Use environmentally friendly materials**	+			http://data.europa.eu/esco/skill/9438b0dc-062a-4893-b176-959706e4ae1e	Work with ecofriendly materials such as water-based finishing materials systems or formaldehyde free adhesives.

			Use sustainable materials and components				http://data.europa.eu/esco/skill/73576419-31c2-4e45-8e30-ab1afec3db4e	Identify, select environmentally friendly materials and components. Decide on the substitution of certain materials by the one that are environmentally friendly, maintaining the same level of functionality and other characteristics of the product.
Implementation of sustainable procurement practices	**5-5 Green Logistics and Supply Chain**	Implementing sustainable manufacturing processes is a task affected by several aspects of digital and green transition trends. Green logistics and supply chain is an eco-friendlier way against conventional logistics, and it's applied under the implementation of sustainable manufacturing practices.	**Implement sustainable procurement**				http://data.europa.eu/esco/skill/6962058d-9808-4820-a6bc-d7cabce60cde	Incorporate strategic public policy goals into procurement procedures, such as green public procurement (GPP) and socially responsible public procurement (SRPP). Contribute to reducing the environmental impact of procurement, to achieving social goals and to improving value for money for the organisation and for society at large.
Integration of more energy efficient operations	**5-3 Energy Efficiency**	Facilitating energy efficient operations into the organisation's strategies to reduce carbon footprint and environmental effects. Tendency towards more energy efficient operations affect this task not only in terms of importance but also new opportunities and applications of energy efficient systems are sought after.	**Energy efficiency**		**Knowledge**	**L4**	http://data.europa.eu/esco/skill/83fc0b2b-6cd2-46af-b1ff-d3fc83604c26	Field of information concerning the reduction of the use of energy. It encompasses calculating the consumption of energy, providing certificates and support measures, saving energy by reducing the demand, encouraging efficient use of fossil fuels, and promoting the use of renewable energy.
Integration of renewable energy sources	**5-1 Renewable Energy Integration**	Facilitating the integration of renewable energy sources into the organisation's energy mix to reduce carbon footprint.	**Renewable energy technologies**		**Knowledge**	**L4**	http://data.europa.eu/esco/skill/f8413360-6114-40de-a276-c59b764b9913	The different types of energy sources which cannot be depleted, such as wind, solar, water, biomass, and biofuel energy. The different technologies used to implement these types of energy to an increasing degree, such as wind turbines, hydroelectric dams, photovoltaics, and concentrated solar power.

Promoting a culture of sustainability within the organisation	**5-12 Corporate Social Responsibility (CSR) Initiatives**	Encouraging a culture of sustainability through employee engagement initiatives and sustainability education programs.	**Advise on corporate social responsibility**	**+**	**Skill**	**L3**	http://data.europa.eu/esco/skill/b2f05068-c409-43ec-ba58-b5dfe991ca5e	Inform others about the social responsibility of companies and organisations in society and advise about matters to prolong their sustainability.
			Implement corporate governance				http://data.europa.eu/esco/skill/f2c63b7a-ed6c-4890-9f8c-7685d172624c	Apply a set of principles and mechanisms by which an organisation is managed and directed, set procedures of information, control flow and decision making, distribute rights and responsibilities among departments and individuals, set corporate objectives and monitor and evaluate actions and results.

3.3. ICT SECURITY MANAGER

3.3.1. JOB DESCRIPTION AND SCOPE

Job Description

ICT Security Manager (ESCO 3512) ESCO description: *“ICT security managers propose and implement necessary security updates. They advise, support, inform and provide training and security awareness and take direct action on all or part of a network or system”* (*ICT security manager*.,n.d.).

Business Area

The ICT security manager plays a critical role in safeguarding the organisation's information assets and ensuring the integrity, confidentiality, and availability of data across all digital platforms. They are responsible for developing, implementing, and overseeing comprehensive cybersecurity strategies and practices to protect against internal and external threats, including cyberattacks, data breaches, and unauthorized access. Some of the sectors related to an ICT security managers (Apud Agency, n.d.) are:

- **Automotive Manufacturing:** The automotive industry relies heavily on advanced manufacturing processes. ICT Security Managers play a crucial role in safeguarding digital systems and production networks in automotive plants, ensuring the integrity and confidentiality of proprietary designs, production data, and supply chain information.
- **Electronics Manufacturing:** The electronics manufacturing sector is experiencing rapid growth, driven by demand for consumer electronics, telecommunications equipment, and semiconductor components. ICT Security Managers are essential in protecting intellectual property, sensitive customer data, and manufacturing processes in electronics factories, where cybersecurity risks can have far-reaching implications for product quality and market competitiveness.
- **Defence and Aerospace:** The defence and aerospace industries are increasingly reliant on advanced manufacturing technologies, including additive manufacturing, robotics, and digital twin simulations. ICT Security Managers play a critical role in safeguarding classified information, critical infrastructure, and sensitive data across the defence and aerospace supply chain, ensuring compliance with stringent cybersecurity standards and protecting national security interests.
- **Machinery and Equipment Manufacturing:** The machinery and equipment manufacturing sector encompasses a wide range of industries, including industrial machinery, agricultural equipment, and construction machinery. ICT Security Managers are instrumental in securing digital manufacturing systems, industrial IoT devices, and smart factory networks, mitigating cybersecurity risks and ensuring uninterrupted operations in manufacturing facilities.
- **Energy and Utilities:** The energy and utilities sector is undergoing digital transformation, with a growing emphasis on renewable energy, smart grids, and energy efficiency initiatives. ICT Security Managers play a vital role in protecting critical infrastructure, power generation facilities, and utility networks from cyber threats, ensuring the reliability and resilience of energy supply systems.

The role of an ICT Security Manager (Apud Agency, n.d.) is pivotal in establishing a robust cybersecurity posture, fostering resilience against evolving cyber threats, and ensuring the organisation's compliance with cybersecurity regulations and standards. As the digital landscape continues to evolve and cyber threats become increasingly sophisticated, the demand for skilled professionals in ICT security is expected to grow, making this role indispensable across various industries.

3.3.2. CONTEXT AND LIMITATIONS

Insights from the global and regional ICT security landscapes can provide valuable context for understanding the demand and challenges faced by ICT Security Managers in Türkiye. The global cybersecurity landscape is rapidly evolving, with increasing cyber threats, sophisticated attacks, and stringent regulatory requirements shaping the cybersecurity priorities of organisations worldwide.

In Türkiye, the digital transformation and rapid adoption of technology across various sectors have amplified the importance of cybersecurity. With the government's Digital Transformation Office initiatives (*Türkiye Cumhuriyeti Cumhurbaşkanlığı Dijital Dönüşüm Ofisi.*, n.d.-c) and the National Cybersecurity Strategy (*Türkiye Cumhuriyeti Cumhurbaşkanlığı Dijital Dönüşüm Ofisi.*, 2020) aiming to strengthen Türkiye's cyber resilience, there is a growing emphasis on enhancing cybersecurity measures, fostering collaboration between public and private sectors, and raising cybersecurity awareness among businesses and the general public.

Despite the growing recognition of cybersecurity's importance, Türkiye faces several challenges, including a shortage of skilled cybersecurity professionals, limited awareness of cybersecurity risks among SMEs, and the evolving nature of cyber threats targeting critical sectors such as finance, healthcare, and government institutions. The lack of comprehensive cybersecurity frameworks tailored to the Türkiye market and the need for greater investment in cybersecurity infrastructure and technologies further underscore the complexities and limitations in the current cybersecurity landscape.

While specific data on the demand for ICT Security Managers in Türkiye may vary, the broader trends suggest a growing need for skilled professionals capable of navigating the complex cybersecurity landscape, implementing robust cybersecurity strategies, and addressing the unique challenges and regulatory requirements specific to Türkiye. The increasing convergence of technology, data, and connectivity highlights the pivotal role of ICT Security Managers in safeguarding organisations' digital assets, ensuring compliance with cybersecurity regulations, and fostering a culture of cybersecurity awareness and resilience.

Given the escalating cyber threats and the strategic importance of cybersecurity in Türkiye's digital transformation journey, professionals with expertise in ICT security management are likely to encounter expanding opportunities and challenges. The integration of cybersecurity into business operations, risk management, and regulatory compliance underscores the critical role of skilled leadership in advancing cybersecurity practices and protecting organisations against evolving cyber threats in the Türkiye context.

3.3.3. FROM CURRENT SITUATION TO ON-GOING SITUATION

Here after the description of the main tasks impacted by **Digital** and/or **Green transition**, modifications and evolutions of the related needed skills.

Table 3 : Tasks and skills impacted related to ICT security manager occupation.

TASK	IMPACTİNG DİGİTAL TECHNOLOGY AND/OR GREEN TRANSİTİON	IMPACT DESCRİPTİON	RELATED NEEDED SKİLLS/ KNOWLEDGE	EXPECTED TENDENCY FOR SKİLL EVOLUTİON	SKİLL TYPE	MATURİTY LEVEL TO REACH	SKİLL ESCO URL	SKİLL DESCRİPTİON
Development of incident response plans	**5-10 Sustainable IT Infrastructure**	Creating and implementing incident response plans to quickly address and mitigate cybersecurity breaches.	**Cyber-attack countermeasures**	+	**Knowledge**	L4	http://data.europa.eu/esco/skill/5898d99a-62a4-4e10-a2e3-0d815ce44248	The strategies, techniques and tools that can be used to detect and avert malicious attacks against organisations' information systems, infrastructures or networks. Examples are secure hash algorithm (SHA) and message digest algorithm (MD5) for securing network communications, intrusion prevention systems (IPS), public-key infrastructure (PKI) for encryption and digital signatures in applications.
Ensuring cybersecurity in digital manufacturing environments	**1-1 Internet of Things (IoT) / Smart Sensors / 5G technology 3-1 Cybersecurity**	IoT and new forms of communication between devices and platforms require new safety measures to be taken and protocols created by the ICT security personnel. Moreover, smart sensors and 5G technology are other advancements where the flow of information changes, requiring new safety measures and procedures. Implementation of advanced cybersecurity measures to protect digital manufacturing data and systems.	**Internet of Things**	+	**Knowledge**	L4	http://data.europa.eu/esco/skill/f049d050-12da-4e40-813a-2b5eb6df6b51	The general principles, categories, requirements, limitations and vulnerabilities of smart connected devices (most of them with intended internet connectivity).
			Sensors				http://data.europa.eu/esco/skill/70a7b3b3-31ef-4b29-a30f-bb7299dff39b	Sensors are transducers that can detect or sense characteristics in their environment. They detect changes in the apparatus or environment and provide a corresponding optical or electrical signal. Sensors are commonly divided in six classes: mechanical, electronic, thermal, magnetic, electrochemical, and optical sensors.
			Cyber security				http://data.europa.eu/esco/skill/8088750d-	The methods that protect ICT systems, networks, computers, devices, services, digital information and people against illegal or unauthorised use.

							8388-4170-a76f-48354c469c44	
		Implementation of advanced cybersecurity measures to protect digital manufacturing data and systems. To ensure cybersecurity, cyber attack counter-measures should be improved by collecting and processing related data.	**Maintain database security**		**Skill**	L4	http://data.europa.eu/esco/skill/ec85cc63-4e24-4631-bf92-8789db2605c0	Master a wide variety of information security controls to pursue maximal database protection.
		Implementation of advanced cybersecurity measures to protect digital manufacturing data and systems. To ensure cybersecurity, defence mechanisms should be improved by collecting and processing related data.	**Manage system security**	+	**Skill**		http://data.europa.eu/esco/skill/2a3a96a3-709e-4d60-81f6-d247d6933f13	Analyse the critical assets of a company and identify weaknesses and vulnerabilities that lead to intrusion or attack. Apply security detection techniques. Understand cyber-attack techniques and implement effective countermeasures.
Integration of AI and machine learning in threat detection	**1-2 Artificial Intelligence (AI) / Machine learning / Big Data Analytics**	Implementation of advanced cybersecurity measures to protect digital manufacturing data and systems. To ensure cybersecurity, cyber-attack countermeasures should be improved by collecting and processing related data. Implementation of advanced cybersecurity measures to protect digital manufacturing data and systems. To ensure cybersecurity, defence mechanisms should be improved by collecting and processing related data.	**Cyber-attack counter-measures**		**Knowledge**	L4	http://data.europa.eu/esco/skill/5898d99a-62a4-4e10-a2e3-0d815ce44248	The strategies, techniques and tools that can be used to detect and avert malicious attacks against organisations' information systems, infrastructures or networks. Examples are secure hash algorithm (SHA) and message digest algorithm (MD5) for securing network communications, intrusion prevention systems (IPS), public-key infrastructure (PKI) for encryption and digital signatures in applications.
			Collect cyber defence data	+	**Skill**	L4	http://data.europa.eu/esco/skill/fcbb3a90-cdde-49ff-9ecc-8e2c0a6dfca2	Collect data for cyber defence using various data collection tools. Data may be gathered from a number of internal or external sources such as online trade records, DNS request logs, email servers' logs, digital communications packet capturing, deep web resources, etc.
Integration of AI and machine learning in threat detection	**1-2 Artificial Intelligence (AI) / Machine learning / Big Data Analytics**	Utilizing AI and machine learning technologies to enhance threat detection and predictive cybersecurity measures.	**Principles of artificial intelligence**		**Knowledge**	L3	http://data.europa.eu/esco/skill/e465a154-93f7-4973-	The artificial intelligence theories, applied principles, architectures and systems, such as intelligent agents, multi-agent systems, expert systems, rule-based systems, neural networks, ontologies and cognition theories.

							9ce1-31659fe16dd2	
			Utilise machine learning		**Skill**	L3	http://data.europa.eu/esco/skill/8369c2d6-c100-4cf6-bd83-9668d8678433	Use techniques and algorithms that can extract mastery out of data, learn from it and make predictions, to be used for program optimisation, application adaptation, pattern recognition, filtering, search engines and computer vision.
Training and awareness programs for employees	**5-12 Corporate Social Responsibility (CSR) Initiatives**	Conducting training and awareness programs to educate employees about cybersecurity threats and best practices.	**Educate on data confidentiality**	+	**Skill**	L3	http://data.europa.eu/esco/skill/6aef2baa-5fa7-4c16-bd28-3e070ec4e4df	Share information with and instruct users in the risks involved with data, especially risks to the confidentiality, integrity, or availability of data. Educate them on how to ensure data protection.
			Train employees				http://data.europa.eu/esco/skill/e54ff029-1ce9-447d-a5b2-eb7283a23e6e	Lead and guide employees through a process in which they are taught the necessary skills for the perspective job. Organise activities aimed at introducing the work and systems or improving the performance of individuals and groups in organisational settings.

3.4. CNC MACHINE OPERATOR

3.4.1. JOB DESCRIPTION AND SCOPE

Job Description

CNC Machine Operator (ESCO 7223.4) ESCO Job description: Computer numerical control machine operator's (*Computer numerical control machine operator.,* n.d.) set-up, maintain and control a computer numerical control machine in order to execute the product orders. They are responsible for programming the machines, ensuring the required parameters and measurements are met while maintaining the quality and safety standards. (*ESCO*, n.d.)

Business Area

CNC operators typically work in the manufacturing industry, managing the production of parts using computerized numerical control (CNC) machines. Areas of work and job duties may include:

- **CNC Machine Machining:** Machining and producing parts on various CNC machines, such as CNC milling, CNC turning, and CNC laser cutting.
- **Programming and Tuning:** Writing the programs necessary to operate CNC machines or making adjustments by loading existing programs.
- **Machine Control:** Monitoring the operation of CNC machines, identifying and responding to possible errors during operation.
- **Part Quality Control:** Measuring the machined parts, checking whether they comply with quality standards and taking corrective actions when necessary.
- **Material and Tool Selection:** Selection of the material to be processed and the tools to be used, determining the most appropriate techniques for the process.
- **Following Work Orders and Instructions:** Working in accordance with customer orders or production instructions.
- **Machine Maintenance:** Performing regular maintenance of CNC machines and troubleshooting minor malfunctions.
- **Following Safety Standards:** Working in accordance with occupational health and safety standards, ensuring machine and personnel safety.

CNC operators can generally work in factories, manufacturing workshops, the automotive industry, the aerospace industry and metalworking facilities. With the advancing technology, the working areas of CNC operators are also expanding and diversifying.

3.4.2. CONTEXT AND LIMITATIONS

The working context and limitations of CNC operators often vary according to the size of the business, the industry and the characteristics of the equipment used. Here are some examples that can be considered in this context:

- **Technological Limitations:** The CNC machines used have specific machining capabilities and may not be able to perform some operations. For example, a particular CNC milling machine may not be able to process very complex geometries or may not have the capacity to process a particular material.
- **Machine Capacity:** Every CNC machine has a certain machining capacity. This includes limitations in terms of material sizes that can be machined, maximum speeds and other machining parameters. Operators must plan and optimize jobs with these capacities in mind.
- **Programming Skills:** CNC operators must have a certain level of knowledge and ability to program the CNC machines they use. Programming complex parts can depend on the operators' programming skills, and these limitations can affect work processes.
- **Machine Maintenance and Breakdown:** CNC machines require regular maintenance and may experience breakdowns. When this happens, work processes can be disrupted or halted. Operators must intervene quickly and effectively in maintenance and breakdown situations and plan to ensure business continuity.
- **Production Standards and Quality Control:** CNC operators must adhere to certain production standards and quality control procedures. This may include certain limitations on tolerances, surface quality and other characteristics of workpieces.
- **Safety and Health Standards:** CNC operators must comply with occupational health and safety standards. This includes factors such as machine safety, use of personal protective equipment and workplace organisation. Operators must conduct their work safely by working in accordance with these standards.

These limitations are important factors that CNC operators must consider when planning and managing their work processes.

3.4.3. FROM CURRENT SITUATION TO ON-GOING SITUATION

Here after the description of the main tasks impacted by **Digital** and/or **Green transition**, modifications and evolutions of the related needed skills.

Table 4 : Tasks and skills impacted related to CNC machine operator occupation.

TASK	IMPACTİNG DİGİTAL TECHNOLOGY AND/OR GREEN TRANSİTİON	IMPACT DESCRİPTİON	RELATED NEEDED SKİLLS/ KNOWLEDGE	EXPECTED TENDENCY FOR SKİLL EVOLUTİON	SKİLL TYPE	MATURİTY LEVEL TO REACH	SKİLL ESCO URL	SKİLL DESCRİPTİON
Advanced programming and operation of CNC machines	**1-2 Artificial Intelligence (AI) / Machine learning / Big Data Analytics**	With the changes coming from AI and machine learning, operations of CNC machinery become more time, energy and material efficient. To implement the advancements in AI and ML to CNC operations, the operators must understand these concepts and interpret current data, eventually coming up with solutions.	**Analyse big data**	+	**Skill**	L3	http://data.europa.eu/esco/skill/47a49cd6-097d-457a-9f7b-c290c14930d5	Collect and evaluate numerical data in large quantities, especially for the purpose of identifying patterns between the data.
			Principles of artificial intelligence		**Knowledge**		http://data.europa.eu/esco/skill/e465a154-93f7-4973-9ce1-31659fe16dd2	The artificial intelligence theories, applied principles, architectures and systems, such as intelligent agents, multi-agent systems, expert systems, rule-based systems, neural networks, ontologies and cognition theories.
			Utilise machine learning		**Skill**		http://data.europa.eu/esco/skill/8369c2d6-c100-4cf6-bd83-9668d8678433	Use techniques and algorithms that can extract mastery out of data, learn from it and make predictions, to be used for program optimisation, application adaptation, pattern recognition, filtering, search engines and computer vision.

Implement Sustainability Practices	**4-3 Collaborative Robots (Cobots)**	The incorporation of collaborative robots (cobots) into CNC machine operations streamlines repetitive tasks, such as material handling and part loading, previously performed by CNC operators. This shift allows operators to allocate their time and expertise towards fine-tuning programming parameters, optimizing toolpaths, and troubleshooting complex machining operations.	**Human-robot collaboration**		**Knowledge**	L4	http://data.europa.eu/esco/skill/0f5374e3-0b9b-4b16-af7a-49654ce0bb15	Human-Robot Collaboration is the study of collaborative processes in which human and robot agents work together to achieve shared goals. Human-Robot Collaboration (HRC) is an interdisciplinary research area comprising classical robotics, human-computer interaction, artificial intelligence, design, cognitive sciences and psychology. It is related to the definition of the plans and the rules for communication to perform a task and achieve a goal in a joint action with a robot.
Implement Sustainability Practices Troubleshoot and maintain CNC machines	**5-3 Energy Efficiency 1-1 Internet of Things (IoT) / Smart Sensors / 5G technology**	By increasing predictive maintenance capabilities, possible malfunctions are prevented, and efficient energy use is ensured. Also, the energy efficiency trend causes the current machinery and operations methods and the operators most likely must adapt to this trend in terms of both physical changes as well as operational behaviour. Increased data collection from connected CNC- Real-time monitoring of CNC and health is possible via the implementation of IoT and smart sensors to current CNC lines. This impact changes the way how data is collected and interpreted and enhance the production and maintenance processes.	**Energy efficiency**			L4	http://data.europa.eu/esco/skill/83fc0b2b-6cd2-46af-b1ff-d3fc83604c26	Field of information concerning the reduction of the use of energy. It encompasses calculating the consumption of energy, providing certificates and support measures, saving energy by reducing the demand, encouraging efficient use of fossil fuels, and promoting the use of renewable energy.
			Internet of Things			L3	http://data.europa.eu/esco/skill/f049d050-12da-4e40-813a-2b5eb6df6b51	The general principles, categories, requirements, limitations and vulnerabilities of smart connected devices (most of them with intended internet connectivity).
	4-6 Predictive Maintenance	Use predictive analytics for timely maintenance and reducing downtime. Predictive maintenance trend affect the conventional maintenance timeline and procedure.	**Sensors**			L3	http://data.europa.eu/esco/skill/70a7b3b3-31ef-4b29-a30f-bb7299dff39b	Sensors are transducers that can detect or sense characteristics in their environment. They detect changes in the apparatus or environment and provide a corresponding optical or electrical signal. Sensors are commonly divided in six classes: mechanical, electronic, thermal, magnetic, electrochemical, and optical sensors.

Use of sustainable materials and practices	**4-6 Predictive Maintenance**	Use predictive analytics for timely maintenance and reducing downtime. Predictive maintenance trend affect the conventional maintenance timeline and procedure.	**Predictive maintenance**		**Knowledge**	L4	http://data.europa.eu/esco/skill/7d913551-e17a-40ba-baf7-48d0c3b12e50	The use of data analytics and mathematical calculation to manage and monitor the conditions of machines and production processes.
Use of sustainable materials and practices	**5-6 Sustainable Material Innovation**	With the innovations in sustainable material technology, the materials used in CNC operations will be more environment friendly materials with different physical, thermal properties or other important properties such as brittleness or ductility, which needs to be studied before using materials in manufacturing. The operator must follow the recent developments and trends in sustainable materials to adapt CNC operations to these kinds of new materials accordingly.	**Use sustainable materials and components**		**Skill**	L3	http://data.europa.eu/esco/skill/73576419-31c2-4e45-8e30-ab1afec3db4e	Identify, select environmentally friendly materials and components. Decide on the substitution of certain materials by the one that are environmentally friendly, maintaining the same level of functionality and other characteristics of the product.
Use of advanced design and simulation software	**4-2 Robotics and Automation**	Adoption of advanced software for design and simulation in CNC machining to improve efficiency and product quality more likely raise the needed proficiency level of operators in using and programming CAM software.	**Use CAM software**			L4	http://data.europa.eu/esco/skill/7a757fa5-9a6f-43ab-9e66-f8f4dba1ffcb	Use computer-aided manufacturing (CAM) programmes to control machinery and machine tools in the creation, modification, analysis, or optimisation as part of the manufacturing processes of workpieces.

3.5. PRODUCT QUALITY CONTROLLER

3.5.1. JOB DESCRIPTION AND SCOPE

Job Description

Product Quality Controllers (ESCO 1213.8) ESCO Job description: “*check the quality of manufactured products. They work in manufacturing facilities where they perform basic inspection and evaluation of products before, during or after the production process. They track production problems and send inferior or malfunctioning items back for repair”* (*Product Quality Controller*, n.d.).

Business Area

The role of a Product Quality Controller is critical across various industries where maintaining high standards of product quality is essential. These professionals are responsible for inspecting and testing products to ensure they meet established quality standards, regulatory compliance, and customer satisfaction. Here are some of the key industries within scope that employ Product Quality Controllers:

- **Manufacturing:** This is one of the largest sectors employing Product Quality Controllers. They work in different manufacturing industries, including automotive, electronics, consumer goods, textiles, and machinery, ensuring products are manufactured to specifications and quality standards.
- **Aerospace and Defence:** Given the critical nature of products in the aerospace and defence industry, Product Quality Controllers ensure that components, systems, and final products meet strict quality and safety standards.
- **Construction Materials:** In the construction industry, Product Quality Controllers ensure that materials like cement, steel, and glass meet required quality standards and specifications for safety and durability.
- **Technology and Electronics:** Product Quality Controllers in the technology sector work with electronic devices, software, and hardware products to ensure they meet quality standards, functionality, and user experience requirements.

Across these industries, Product Quality Controllers use a variety of tests and inspection methods to ensure products meet quality standards, including visual inspections, performance tests, durability tests, and regulatory compliance checks. Their work is essential for protecting consumers, maintaining brand reputation, and ensuring the long-term success of products in the market.

3.5.2. CONTEXT AND LIMITATIONS

The general trends and importance of quality control and assurance roles across various industries provide useful insights. Quality controllers ensure products meet specifications and quality standards, a critical function in manufacturing and production processes. Their roles encompass monitoring manufacturing processes, ensuring compliance with standards, maintaining quality documentation, evaluating and maintaining quality management systems, and more.

The skillset for quality control roles has evolved, with an increased emphasis on technical skills, problem-solving, and familiarity with industry standards like ISO regulations. Demonstrating precision, consistency, analytical skills, and a practical approach to problem-solving is essential. These trends suggest a growing need for skilled professionals in quality control and assurance, reflecting the broader demand for roles that support operational excellence and product integrity.

Related skills and roles of “Product Quality Controller” in industries sectors indicate the importance of quality control functions. These sectors are significant employers of quality control expertise to maintain product standards and compliance. Thus, individuals with experience in quality control and a deep understanding of industry-specific regulations are likely to find opportunities in France's diverse industrial landscape.

3.5.3. FROM CURRENT SITUATION TO ON-GOING SITUATION

Here after the description of the main tasks impacted by **Digital** and/or **Green transition**, modifications and evolutions of the related needed skills.

Table 5 : Tasks and skills impacted related to product quality controller occupation.

<table>
<tr><th>TASK</th><th>IMPACTİNG DİGİTAL TECHNOLOGY AND/OR GREEN TRANSİTİON</th><th>IMPACT DESCRİPTİON</th><th>RELATED NEEDED SKİLLS/KNOWLEDGE</th><th>EXPECTED TENDENCY FOR SKİLL EVOLUTİON</th><th>SKİLL TYPE</th><th>MATURİTY LEVEL TO REACH</th><th>SKİLL ESCO URL</th><th>SKİLL DESCRİPTİON</th></tr>
<tr><td>Analyze product performance data from sensors</td><td>1-1 Internet of Things (IoT) / Smart Sensors / 5G technology</td><td>Integrate sensors into production tools for real-time performance monitoring, improving process control through quality defect detection</td><td>Sensors</td><td rowspan="3">+</td><td rowspan="3">Knowledge</td><td rowspan="3">L3</td><td>http://data.europa.eu/esco/skill/70a7b3b3-31ef-4b29-a30f-bb7299dff39b</td><td>Sensors are transducers that can detect or sense characteristics in their environment. They detect changes in the apparatus or environment and provide a corresponding optical or electrical signal. Sensors are commonly divided in six classes: mechanical, electronic, thermal, magnetic, electrochemical, and optical sensors.</td></tr>
<tr><td rowspan="2">Application of Lean Six Sigma methodologies</td><td rowspan="2">5-4 Waste Reduction</td><td rowspan="2">Applying Lean Six Sigma methodologies to improve efficiency and reduce waste in quality control processes. This task will have to be reasssed through the improvements coming from changes in energy optimisation field.</td><td>Continuous improvement philosophies</td><td>http://data.europa.eu/esco/skill/0550431f-9c8b-4204-9c45-59bc5feacf06</td><td>Underlying ideas of quality management systems. Implementation process of lean manufacturing, Kanban, Kaizen, Total Quality Management (TQM) and other continuous improvement systems.</td></tr>
<tr><td>Total quality control</td><td>http://data.europa.eu/esco/skill/8af372fa-7b85-4bab-ab20-3f2eb980c400</td><td>The quality control philosophy that expects each part to be of top quality, without any tolerance for subpar materials or methods. The mindset of striving to deliver top quality work without compromises.</td></tr>
</table>

	5-3 Energy Efficiency		**Continuous improvement philosophies**				http://data.europa.eu/esco/skill/0550431f-9c8b-4204-9c45-59bc5feacf06	Underlying ideas of quality management systems. Implementation process of lean manufacturing, Kanban, Kaizen, Total Quality Management (TQM) and other continuous improvement systems.
			Total quality control				http://data.europa.eu/esco/skill/8af372fa-7b85-4bab-ab20-3f2eb980c400	The quality control philosophy that expects each part to be of top quality, without any tolerance for subpar materials or methods. The mindset of striving to deliver top quality work without compromises.
Inspect products for visual and dimensional defects	**2-2 3D Scanning**	Thanks to the advancements in 3D scanning technology, the visual inspections for quality control processes of a product are enriched by using 3D scanning for automated, high-precision inspection and defect detection, including complex geometries, for detailed and accurate quality inspections. Visual inspection task of the controller becomes more digitalized through 3D scanning practices.	**Apply 3D imaging techniques**		**Skill**	L4	http://data.europa.eu/esco/skill/1859883d-c047-4fe1-8e74-7bb4385d6ad2	Implement a variety of techniques such as digital sculpting, curve modelling and 3D scanning to create, edit, preserve and use 3D images, such as point clouds, 3D vector graphic and 3D surface shapes.
Maintain accurate and complete quality control records	**3-1 Cybersecurity**	Implementation of robust cybersecurity measures to protect sensitive quality control data, including production information and intellectual property.	**Cybersecurity principles**		**Knowledge**	L3	http://data.europa.eu/esco/skill/8088750d-8388-4170-a76f-48354c469c44	The methods that protect ICT systems, networks, computers, devices, services, digital information and people against illegal or unauthorised use.

Perform destructive and non-destructive testing	**4-2 Robotics and Automation**	Automation of repetitive, hazardous or high-volume testing procedures using robots increases efficiency and consistency have an impact on the job of a quality controller thanks to the advancements in robotics and automation fields.	**Human-robot collaboration**			L4	http://data.europa.eu/esco/skill/0f5374e3-0b9b-4b16-af7a-49654ce0bb15	Human-Robot Collaboration is the study of collaborative processes in which human and robot agents work together to achieve shared goals. Human-Robot Collaboration (HRC) is an interdisciplinary research area comprising classical robotics, human-computer interaction, artificial intelligence, design, cognitive sciences and psychology. It is related to the definition of the plans and the rules for communication to perform a task and achieve a goal in a joint action with a robot.
			Robotics			L3	http://data.europa.eu/esco/skill/e87ec79a-c9ff-46f5-84fa-7a0f394cdf40	The branch of engineering that involves the design, operation, manufacture, and application of robots. Robotics is part of mechanical engineering, electrical engineering, and computer science and overlaps with mechatronics and automation engineering.
	4-3 Collaborative Robots (Cobots)		**Human-robot collaboration**			L4	http://data.europa.eu/esco/skill/0f5374e3-0b9b-4b16-af7a-49654ce0bb15	Human-Robot Collaboration is the study of collaborative processes in which human and robot agents work together to achieve shared goals. Human-Robot Collaboration (HRC) is an interdisciplinary research area comprising classical robotics, human-computer interaction, artificial intelligence, design, cognitive sciences and psychology. It is related to the definition of the plans and the rules for communication to perform a task and achieve a goal in a joint action with a robot.

3.6. AUTOMATED ASSEMBLY LINE OPERATOR

3.6.1. JOB DESCRIPTION AND SCOPE

Job Description

Automated Assembly Line Operators (ESCO 3139.1) ESCO description: *“operate, maintain and clean production machines. They are responsible for the assembly of a whole product or a part of a product. Automated assembly line operators perform all tasks in a production process via a rotation system”* (*Automated Assembly Line Operator*, n.d.).

Business Area

The job scope of an automated assembly line operator includes working with a variety of machines and tools to assemble products. They are responsible for the proper functioning of machinery and equipment and for products to meet quality standards.

Automated assembly line operators are the people responsible for the operation of automated assembly lines in production facilities. Job areas may include:

- **Operating in Manufacturing Plants:** Automated assembly line operators operate and manage assembly lines in manufacturing plants. This includes assembling products, placing components and overseeing the flow of production processes.
- **Line Maintenance and Troubleshooting:** Operators perform regular maintenance to ensure the assembly line is running properly. They also identify and fix any malfunctions encountered during production.
- **Quality Control:** Automated assembly line operators control the quality of the products. This involves conducting quality control tests at each stage of the assembly process and may be related to detecting defective products.
- **Productivity and Process Improvement:** Operators continuously review processes to improve the efficiency of the assembly line. They identify potential improvements and help optimize production processes.
- **Equipment and Technology Upgrades:** Automated assembly line operators can be involved in introducing new equipment and technologies and updating existing systems. This can include the adoption of more efficient and innovative production methods.
- **Training and Experience Development:** Operators can provide training to assembly line personnel and participate in training programs to continuously improve their own knowledge and skills.

Automated assembly line operators play an important role in manufacturing plants and ensure that the production process runs efficiently. They need to have strong technical skills, a careful work style and troubleshooting abilities.

3.6.2. CONTEXT AND LIMITATIONS

Automated assembly line operators may face specific contexts and limitations as they are responsible for the operation of automated assembly lines in production facilities:

- **Technological Limitations:** Automated assembly lines are supported by a specific set of technology and equipment. Therefore, the operators' workspace may be within the limits of the available technology and equipment. Innovative technologies may need to be adopted or existing systems may need to be updated.
- **Product Variety and Flexibility:** Automated assembly lines are often optimized for a specific product or product line. In this case, the operators' workspace may be limited to the assembly and production of specific products. Lines may need to be reconfigured or adjusted to produce different products.
- **Safety and Health Regulations:** Automated assembly line operators must comply with safety and occupational health regulations when working in production facilities. This may include issues such as the use of safety equipment, handling of hazardous materials and machine safety.
- **Productivity and Production Targets:** Operators are often responsible for achieving specific production targets. This means that a certain amount of product needs to be produced at a certain time. To achieve these targets, it is important that operators work efficiently and that production processes are optimized.
- **Quality Control and Defective Products:** Operators on automated assembly lines are responsible for controlling the quality of products and detecting defective products. It is important to pay attention to quality control processes to minimize the number of defective products and ensure compliance with quality standards.
- **Equipment Maintenance and Breakdowns:** Operators are responsible for performing regular maintenance to ensure the proper functioning of the automated assembly line. They may also need to intervene quickly to detect and remedy malfunctions that occur during production.

3.6.3. FROM CURRENT SITUATION TO ON-GOING SITUATION

Here after the description of the main tasks impacted by **Digital** and/or **Green transition**, modifications and evolutions of the related needed skills.

Table 6 : Tasks and skills impacted related to automated assembly line operator occupation.

TASK	IMPACTİNG DİGİTAL TECHNOLOGY AND/OR GREEN TRANSİTİON	IMPACT DESCRİPTİON	RELATED NEEDED SKİLLS/ KNOWLEDGE	EXPECTED TENDENCY FOR SKİLL EVOLUTİON	SKİLL TYPE	MATURİTY LEVEL TO REACH	SKİLL ESCO URL	SKİLL DESCRİPTİON
Automation in assembly processes	**1-1 Internet of Things (IoT) / Smart Sensors / 5G technology**	In assembly automation, the integration of IoT, 5G, and smart sensors empowers operators with sensor expertise to optimize assembly processes. By leveraging real-time data from smart sensors, operators can monitor equipment performance, detect anomalies, and fine-tune assembly parameters, ensuring efficient and error-free production. This seamless integration enhances productivity, reduces downtime, and drives continuous improvement in assembly operations.	**Sensors**	+	**Knowledge**	L3	http://data.europa.eu/esco/skill/70a7b3b3-31ef-4b29-a30f-bb7299dff39b	Sensors are transducers that can detect or sense characteristics in their environment. They detect changes in the apparatus or environment and provide a corresponding optical or electrical signal. Sensors are commonly divided in six classes: mechanical, electronic, thermal, magnetic, electrochemical, and optical sensors.
Automation in assembly processes	**4-2 Robotics and Automation**	Increased use of robotics and automation in assembly processes for efficiency and precision is a trend expected through digital transition. Operators have to adapt to advances in the assembly line technology by mastering the new implementations of more advanced robots and more automation than before.	**Operate automated process control**	+	**Skill**	L3	http://data.europa.eu/esco/skill/0a0532c2-ee60-4410-8e07-70e4d69370ec	Operate process control or automation system (PAS) used to control a production process automatically.
		Transitioning to sustainable, bio-based, or recycled materials to reduce environmental impact and meet sustainability goals is an expected trend to impact this task. Operators have to learn more about eco-friendly materials and implement them in the processes as much as possible. .	**Knowledge of robotics**		**Knowledge**		http://data.europa.eu/esco/skill/e87ec79a-c9ff-46f5-84fa-7a0f394cdf40	The branch of engineering that involves the design, operation, manufacture, and application of robots. Robotics is part of mechanical engineering, electrical engineering, and computer science and overlaps with mechatronics and automation engineering.

	4-3 Collaborative Robots (Cobots)	For automated assembly line operators, the integration of cobots and automation into the assembly process represents a transformative shift in operations. By working alongside cobots, operators oversee and optimize automated assembly tasks, ensuring seamless collaboration between humans and machines	**Human-robot collaboration**		**Knowledge**	L4	http://data.europa.eu/esco/skill/0f5374e3-0b9b-4b16-af7a-49654ce0bb15	Human-Robot Collaboration is the study of collaborative processes in which human and robot agents work together to achieve shared goals. Human-Robot Collaboration (HRC) is an interdisciplinary research area comprising classical robotics, human-computer interaction, artificial intelligence, design, cognitive sciences and psychology. It is related to the definition of the plans and the rules for communication to perform a task and achieve a goal in a joint action with a robot.
Automation in assembly processes	**4-6 Predictive Maintenance**	Automated assembly line operator's adept at maintaining and cleaning production machines leverage predictive maintenance techniques for optimal performance. By utilizing predictive analytics, they proactively address potential equipment failures, minimizing downtime and maximizing productivity in manufacturing operations.	**Maintain machinery**	+	**Skill**	L3	http://data.europa.eu/esco/skill/61d9ad65-6a78-4c72-9824-aeca20d9a102	Maintain machinery and equipment to ensure that it is clean and in safe, working order. Perform routine maintenance on equipment and adjust or repair when necessary, using hand and power tools. Replace defective parts components or systems.
Implementation of eco-friendly materials	**5-6 Sustainable Material Innovation**	Transitioning to sustainable, bio-based, or recycled materials to reduce environmental impact and meet sustainability goals is an expected trend to impact this task. Operators have to learn more about eco-friendly materials and implement them in the processes as much as possible.	**Types of plastic**		**Knowledge**	L3	http://data.europa.eu/esco/skill/9c66b182-96ec-43b3-8821-2aeb7df66f12	Types of plastic materials and their chemical composition, physical properties, possible issues and usage cases.
Implementation of eco-friendly materials	**5-6 Sustainable Material Innovation**	Transitioning to sustainable, bio-based, or recycled materials to reduce environmental impact and meet sustainability goals is an expected trend to impact this task. Operators have to learn more about eco-friendly materials and implement them in the processes as much as possible.	**Use sustainable materials and components**	+	**Skill**	L3	http://data.europa.eu/esco/skill/73576419-31c2-4e45-8e30-ab1afec3db4e	Identify, select environmentally friendly materials and components. Decide on the substitution of certain materials by the one that are environmentally friendly, maintaining the same level of functionality and other characteristics of the product.

4. EXPERTS' COMMENTS

The findings presented in Turkish sub-report were validated by the experts from various backgrounds and sectors but are all related to advanced manufacturing, digital and green transition. Feedback provided by the experts were collected through a survey tool in May 2024.

Participants

- **Candan Umut OZDEN**, MARKA, Monitoring and Evaluation Unit Specialist
- **Kadir OZKAN**, ZEISS, Application Specialist
- **Zeynep DERELI**, Teknoloji ve İnsan Kolejleri, Founder
- **Talha BEKTAS**, ISTMTAL, School Principal
- **Deniz AYGAN,** IMES CoVE, General Manager.

The main consideration when reaching out to experts was to approach people with different experiences and careers, to evaluate the opinions on the multi-faceted vocational analysis from whole advanced manufacturing ecosystem more accurately. With this concern, findings in this report were evaluated by a wide array of experts, including private sector specialists, VET center and high school executives and CoVE’s.

The study for evaluation had to be carried out in a simplified manner in terms of a survey tool for two reasons; to standardise the input and outputs and have a comparable and meaningful feedback and to offer the experts a smooth validation experience where they could pick the occupations they want to evaluate and skip ones they are not an expert of.

Statements regarding **CNC machine operator** were widely accepted by the experts and in line with their responses. There was only a slight disagreement, or to be precise not a strong agreement, in the statement that claims improving the skill of using sustainable material and components is required for a CNC operator to face the impact of adapting to sustainable materials in manufacturing by also following recent trends.

There was a gap between findings presented for **sustainability manager** occupation and the expert comments. Experts were slightly against the statement that corporate social responsibility knowledge must be improved in order to create comprehensive sustainable strategies, yet they approved that knowledge was needed to accomplish this task. Moreover, sustainable managers needs to improve their mitigating waste of resources skill to implement sustainable manufacturing processes but the trend impact for the same task was only mildly agreed upon.

ICT security managers’ impact analysis was also mostly agreed on by the experts with a few statements that they slightly or partially agreed. Collecting cyber defence data, implementing cyber-attack counter measures, implementation of cybersecurity measures to protect data and systems, principles of AI were the skills and knowledges that are needed to be improved to cover respective tasks, all strongly agreed upon. Managing system security, maintaining database security and knowledge of IoT, smart sensors and 5G technology were the skills and knowledges experts barely agreed that are affected and needed to be improved after digital and green transition trends.

Findings related to **product quality controller** were also mostly aligned with the evaluation with a few statements that the experts only mildly agreed with. Performing destructive and non-destructive testing, robotics knowledge and continuous improvement philosophies were all skill and knowledge that are forecasted to be impacted by new trends, both by experts and the report's authors. Experts were also supporting the statements regarding human-robot collaboration, 3D scanning and application of Six Sigma principles, but they were not in complete agreement.

Automated assembly line operator was the last occupation within the scope of this report. There was not any conflict between statements in the report and reviewers' responses.

Overall, expert review process was carried in a simple, yet effective manner and the results were mostly in line with experts' comments, responses and insights about the expected outcomes of digital and green transition trends on occupations, skills and tasks related to advanced manufacturing.

5. CONCLUSION AND OUTLOOKS

The green and digital transitions are fundamentally transforming the job landscape within advanced manufacturing, particularly within Türkiye's strategic industrial sectors. These transitions are not only driving technological advancements but are also fostering the need for a workforce adept in new digital and sustainable practices, aligning with Türkiye's Smart Specialisation Strategy.

In the realm of manufacturing, the integration of collaborative robots (cobots), predictive maintenance, IoT, 5G, and smart sensors is revolutionizing production processes. These technologies are enhancing operational efficiency, minimizing downtime, and optimizing resource use, all while ensuring high product quality. The ability to leverage real-time data and advanced analytics is critical, enabling industries to anticipate and address issues proactively, thus maintaining a competitive edge in the global market.

Sustainability is another cornerstone of this transformation. The implementation of sustainable manufacturing and procurement strategies is crucial for reducing environmental impact and promoting resource efficiency. By embracing AI, machine learning, and big data analytics, industries can develop more eco-friendly practices, reducing waste and ensuring that operations align with global sustainability standards. This is particularly relevant for Türkiye, where environmental considerations are increasingly influencing industrial policies and practices.

The convergence of digital and green technologies also underscores the importance of cybersecurity. As industries become more interconnected and reliant on digital systems, protecting these systems from cyber threats is paramount. Robust ICT security measures are essential to safeguard sensitive information and ensure the continuity of operations, which is vital for maintaining trust and stability in the industrial sector.

In conclusion, the green and digital transitions are driving a profound evolution in the manufacturing landscape, with significant implications for the workforce. Professionals who can navigate and harness these technological advancements are essential for fostering sustainable growth and innovation. Türkiye's emphasis on smart specialisation and alignment with these global trends positions it well to capitalize on these shifts, ensuring its industries remain competitive and resilient. As the country continues to integrate these advanced technologies, it, not only, enhances its manufacturing capabilities but also contribute to a more sustainable and secure industrial future.

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8. INDEX OF TABLES

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