

Multiple Framework Contract for the Support to Structural Reforms in EU Member States

Lot 1: Support for the development and implementation of reforms

“Digital Transformation of the Greek Industry”

Deliverable 2: National Strategy for the 4th Industrial Revolution (Greece i4.0) (2021 -2027) for the Greek industry and manufacturing

February 2021

This project is funded by the EU via the Structural Reform Support Programme and implemented in collaboration with PwC and the European Commission



This project is funded by the EU via the Structural Reform Support Programme and implemented in collaboration with PwC and the European Commission

Contents

List of Abbreviations	iv
1 Introduction to Deliverable 2.....	1
2 Executive summary	3
3 Key takeaways of the report on the current situation (Deliverable 1)	14
4 Existing Strategies for Greece.....	26
4.1 Greece’s “National Growth Strategy” (NGS)	26
4.2 National Research and Innovation Strategy for Smart Specialisation (RIS3)	27
5 The European Industrial Strategy	31
6 European Commission financing initiatives for strategic value chains in the EU	33
7 SWOT analysis: Analysis & evaluation of the current situation for Greece	36
7.1 Chapter’s Summary: Greece’s Industry 4.0 “As-Is” anatomy.....	36
7.2 The implemented approach for designing Greece’s SWOT analysis.....	45
7.3 Strengths	50
7.3.1 Political & Economic Strengths	50
7.3.2 Technological Strengths.....	57
7.3.3 Innovation & R&D Strengths	67
7.3.4 Legal & Regulatory Strengths	72
7.3.5 Social & Environmental Strengths	73
7.3.6 How can Greece leverage its Strengths for its Industry 4.0 strategy?.....	75
7.4 Weaknesses.....	77
7.4.1 Political & Economic Weaknesses	77
7.4.2 Technological Weaknesses.....	80
7.4.3 Innovation & R&D Weaknesses	88
7.4.4 Legal & Regulatory Weaknesses	90
7.4.5 Social & Environmental Weaknesses.....	92
7.4.6 How can Greece address its weaknesses through the Industry 4.0 strategy?	97
7.5 Opportunities	98
7.5.1 Political & Economic Opportunities.....	98
7.5.2 Technological Opportunities	99
7.5.3 Innovation and R&D Opportunities	105
7.5.4 Legal & Regulatory Opportunities.....	108
7.5.5 Social & Environmental Opportunities	110

- 7.5.6 How can Greece exploit the global opportunities around Industry 4.0 through the Industry 4.0 strategy? 111
- 7.6 Threats 112
 - 7.6.1 Political & Economic Threats..... 112
 - 7.6.2 Technological Threats..... 116
 - 7.6.3 Innovation and R&D Threats 118
 - 7.6.4 Social & Environmental Threats 118
 - 7.6.5 How can Greece mitigate the global Industry 4.0 related threats through the Industry 4.0 strategy? 120
- 8 Greece’s Industry 4.0 Vision & Execution Strategy..... 121
 - 8.1 Chapter’s summary 121
 - 8.2 The rationale for Greece’s Industry 4.0 Strategy..... 126
 - 8.3 Greece’s Industry 4.0 vision..... 130
 - 8.4 Industry 4.0 strategic initiatives within the EU 132
 - 8.5 The six execution pillars for Industry 4.0 vision’s operationalisation..... 134
 - 8.6 Next Steps..... 141
- 9 Appendix I – How the Six Execution Pillars address the SWOT analysis..... 143
 - 9.1 Pillar 1: Digital skills & human capital qualifications 143
 - 9.2 Pillar 2: Innovation & start-ups in the Digital Age 145
 - 9.3 Pillar 3: Collaborations & synergies 148
 - 9.4 Pillar 4: Standardisation & Norms 150
 - 9.5 Pillar 5: Regulatory Environment 152
 - 9.6 Pillar 6: Acceleration of investment in digital technologies 154
- 10 Appendix I – Reader Friendly Graphs 157
 - 10.1 Strengths 157
 - 10.2 Weaknesses 178
 - 10.3 Opportunities 202
 - 10.4 Threats 204

- This has been prepared in the context of the project “Digital Transformation of the Greek Industry”, for the purposes of the Deliverable 2 in accordance with the signed contract No SRSS/SC2019/034 Lot 1, Implementing framework contract procedure SRSS/P2017/FWC001 Lot 1.
- This Report has been prepared by PricewaterhouseCoopers Business Solutions S.A. (PwC) for the exclusive use of DG Reform and the main beneficiary of the project, it being the General Secretariat for Industry, and should not be relied upon by any third party for any purpose. The authors do not assume and hereby disclaim any liability to any party for any loss or damage howsoever arising from the use of this Report or of the information contained herein by any person other than the DG Reform.
- PwC does not assume any audit responsibility, nor substitutes the appointed audit bodies, based on the National Audit Rules by an auditor.
- PwC is not liable for any use of the Deliverables for audit, accounting, tax, financial, legal, etc. purposes by third parties (e.g. public authorities, audit bodies, etc.).
- The product of this work is limited to supportive services offered to the Contracting Authority.
- The relevant Authorities are solely responsible for the final decisions made. PwC does not take decisions on matters that fall within the responsibility of the Administration or official bodies or executives of the Contracting Authority.
- For the implementation of the project, data and other relevant information were collected through interviews with stakeholders as discussed and agreed with the study’s beneficiary. The list of interviewees was agreed with DG Reform and PwC is not responsible for the statements the interviews and their accuracy and these have been taken as accurate and true without further verification.
- PwC bears no responsibility for the processing of the information and data that was never submitted or was submitted incorrectly or belatedly.
- The current study is valid in its entirety. The legal review, interviews with stakeholders, data analysis wherever applicable, as well as the conclusions of the study that are presented in this document are indissociable from one another and PwC bears no responsibility for any potential fragmented use, which can lead to misinterpretations.

List of Abbreviations

The following Abbreviations list contains all the key terms contained in the document in order to provide a clear view of the terminology used throughout.

3D	Three-dimensional
3G	Third generation mobile network
4G	Fourth generation mobile network
5G	Fifth generation mobile network
AI	Artificial intelligence
AR	Augmented reality
BLS	Bureau of labour statistics
CCAV	Clean, connected and autonomous vehicles
CEF	Connecting Europe facility
CO2	Carbon dioxide
COSME	Competitiveness of enterprises and SMEs
CRM	Customer relationship management
CVD	Chemical vapor deposition
DEI	Digitising European industry
DEOI	Digital economic opportunity index
DESI	Digital economy and society index
DIH	Digital innovation hubs
DMI	Digital manufacturing index
DT	Deutsche Telekom
e.g.	Example given
EC	European Commission
e-Commerce	Electronic commerce
ECS	Electronic components and systems
EGG	Enter, Grow, Go
e-Government	Electronic Government
EIB	European Investment Bank
EIF	European Investment Fund
EMFF	European Maritime and Fisheries Fund
EPAL	Technical vocational schools
EPAnEK	Operational Programme “Competitiveness, Entrepreneurship & Innovation”
EPO	European Patent Office
ERP	Enterprise Resource Planning
ESIF	European Structural and Investment Funds
etc.	Et cetera
ETEAN	Predecessor of the Hellenic Development Bank
EU	European Union
EUR	Euro(s)
EYSSA	Special Strategy, Planning and Evaluation Service

FC	Fixed capital
FDI	Foreign direct investment
FOP	Future of production
FTE	Full time equivalent
G&S	Goods and services
G20	Group of 20
GCI	Global cybersecurity index
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GG	Greek Government
GR	Greece
GSRT	General Secretariat for Research and Technology
GVA	Gross Value Added
HDB	Hellenic Development Bank
HPC	High-performance computing
HR	Human resources
i.e.	Id Est
i4.0	Fourth Industrial Revolution
ICT	Information and Communications Technology
IdF	Industrie du Futur
IIoT	Industrial Internet of Things
Industry 4.0	Fourth Industrial Revolution
IoT	Internet of Things
IP	Internet Protocol
ISA	Interoperability Solutions
IT	Information Technologies
ITER	International Thermonuclear Experimental Reactor
M2M	Machine-to-machine
MEMS	Microelectromechanical systems
MES	Manufacturing Execution System
NEMS	Nanoelectromechanical systems
NGA	Next Generation Access
NGS	National Growth Strategy
NIS	Network and Information Security
NPL	Non-Performing Loans
NSRF	National Strategic Reference Framework
PPP	Public-Private Partnerships
PVD	Physical Vapor Deposition
R&D	Research & Development
R&I	Research & Innovation
RFID	Radio-frequency identification technologies
RIS3 Strategy	Research and Innovation Strategy for Smart Specialisation
RTDI	Research, Technological Development and Innovation

SAP	SAP Software Solutions
SCADA	Supervisory control and data acquisition
SEV	Federation of Enterprises of Greece
SME	Small Medium Enterprises
STEM	Science, Technology, Engineering and Mathematics
SVC	Strategic value chains
SWOT	Strengths, Weaknesses, Opportunities, Threats
UK	United Kingdom
US	United States
USD	United States Dollar(s)
USTPO	United States Patent and Trademark Office
VC	Venture Capital
VET	Vocational Education and Training
YoY	Year-on-Year

1 Introduction to Deliverable 2

General Information

This report was prepared in the context of the project “Digital Transformation of the Greek Industry” funded by the EU via the Structural Reform Support Programme. This present document constitutes the first draft of the second Deliverable of the project, titled “*Deliverable 2: National Strategy for the 4th Industrial Revolution (Greece i4.0) (2021 -2027) for the Greek industry and manufacturing*”. This version was shaped based on the technical meeting with the Ministry’s team and DG Reform on the 20th of February, the technical meeting with the Ministry of Digital Governance on the 23rd of February, the technical meeting with SEV on the 24th of February as well as the 2nd Workshop of the project with the Minister of Development and Investments, the Deputy Minister as well as the General Secretaries of the Ministries on the 4th of March.

Greece is currently entering the new programming period 2021-2027, which will eventually lead to the restructuring and partial or complete change of current national policies or strategies. With regards to the work conducted for the current Deliverable and in order to perform a holistic study based on the already developed national/ EU material, the following documents were used as input in their current state: The National Growth Strategy document as published in 2018, as well as the National Research and Innovation Strategy for Smart Specialisation (RIS3) published in 2015. Both the aforementioned documents are expected to change in the following months. More specifically, a committee composed of national experts has been assembled by the Greek Government to reshape the National Growth Strategy and at the same time the RIS3 strategy is also being revised. On the same note, Europe is also reforming ahead of the new programming period. As a result, we have tried to take into account newly published documents, such as the European Industrial strategy analyses in Chapter 5.

Setting the scene

Key focus of Deliverable 2 is the definition of Greece’s Industry 4.0 vision and the design of the respective strategy that will operationalize this vision. Yet, each country builds its Industry 4.0 strategy on the basis of its own digital maturity levels, and in the backdrop of the continuous technology advancements that directly impact the market economics and the global society.

For this reason, in order to build an actionable and targeted Industry 4.0 strategy for Greece, we shall review as a first step the following areas:

- Key outcomes of EU’s Greece’s Industry 4.0 anatomy (key takeaways of Deliverable 1)
- The existing Greek National Growth Strategy and the National Research and Innovation Strategy for Smart Specialisation (RIS3)
- Industry 4.0-related focus areas and value-chains that the European Commission actively support and finance their digitisation
- A set of Industry 4.0-related political, economic, social, technological, regulatory, R&D related, social and environmental internal and external factors that may consist strengths, weaknesses, opportunities or threats for Greece’s rotation to Industry 4.0

The outcomes and key observations of the review, are used as input in order to structure an Industry 4.0 vision for Greece and its execution strategy, tailored to the specific needs and the strengths of the Greek Industry. At the same time, we are exploiting a number of areas of economic activity as well as

technological domains to identify and suggest pilot areas for targeted Industry 4.0 interventions. As per the project's RfS in the context of Deliverable 3, the contractor should make a proposal for the selection of three high priority cases (technologies, policies, sectors or group of firms) based on specific criteria set. After confirmation of these high priority cases by the Steering Committee, the contractor will proceed to a detailed plan for each of the cases interventions for three of the selected pilot areas will be analysed and described as part of Deliverable 3.

As agreed with the beneficiary and DG Reform during Workshop 2, the methodology and the proposal of the high priority cases was embedded in the current Deliverable.

Content of the report

The report is structured in the following way:

- **Chapter 2** provides a brief overview of this document's contents, with regards to its methodological approach, analysis and results.
- **Chapter 3** presents the key takeaways of Deliverable 1 with regards to the current Industry 4.0 state-of-play in Greece and in the Greek Industry.
- **Chapter 4** presents a high-level view of existing strategies for the Greek economy and research & innovation (National Growth Strategy (NGS), National Research and Innovation Strategy for Smart Specialisation (RIS3)) that can complement and support the Industry 4.0 strategy and its goals.
- **Chapter 5** presents an overview of the recently published European Industrial strategy.
- **Chapter 6** provides insight into the specific strategic value chains related to Industry 4.0, that the European Union (EU) has chosen as a primary focus and presents a summary table of various EU funding and support initiatives that Greece can take advantage of, in the context of its Industry 4.0 strategy.
- **Chapter 7** presents an in-depth analysis of Greece's Industry 4.0 related Strengths, Weaknesses, Opportunities and Threats (SWOT analysis) across five dimensions (Political & Economic, Technological, Innovation & R&D, Social and Environmental), that will act as key input for the formation of the Industry 4.0 strategy.
- **Chapter 8** presents the Industry 4.0 vision for Greece and analyses six execution pillars that will be leveraged to operationalize the Industry 4.0 vision.

2 Executive summary

Key outcomes of EU’s Greece’s Industry 4.0 anatomy (key takeaways of Deliverable 1)

Industry is a central pillar to the development of national economies and to the acceleration of economic growth. In fact, there is evidence that countries with strong industrial sector have shown more economic growth, had improved national income, promoted living standard of people and decreased unemployment.

Industry consists the backbone of the European economy. Europe’s global competitive advantage on the production of industrial products translated to 25% of the EU’s total value-added in 2018¹, while EU Industry’s employment accounted for 27% of total employment in the EU for 2018.² The EU is also one of the world’s largest players in global trade being the second largest exporter and importer of goods in the world, with only China exporting more goods and the United States importing more. In 2018, trade in goods represented 70% of total EU trade in goods and services.³ In this context, competitiveness is at the heart of the Commission’s agenda and, as we stand on the brink of a new industrial revolution, the Commission is committed to supporting the digital and green transformation of EU Industry.

Zooming into Greece, Industry also plays an important role in the overall Greek economy, as it generated 24,2% of the total Gross value added in 2017⁴ and employed 19% of the total Greek workforce in the same year.⁵ In addition, looking at the development of the Greek industrial production from 2013 – 2018 and its projections for 2019 and 2020, a continuous increase is noted since 2015. Projections estimate that the industrial production will continue to grow in 2019 (by 0,9%) and in 2020 (by 3%).⁶

Evidence therefore indicate that Industry is a central pillar of the national economy and its growth can have significantly positive spill over effects to other sectors and to the worldwide economy and society. Nevertheless, at the same time, Industry demonstrates the largest malleability to the underlying technological framework of each time period. As such, Industry is most likely to become the most rigorously transformed and become the driver and enabler of Industry 4.0 that will, in turn, be diffused across all other sectors in the economy.

But what do we mean exactly with the term “Industry 4.0”? According to our analysis of the As-Is situation, the concept of “Industry 4.0” is characterised by a fusion of technologies and the use of smart, fully connected devices that blur the lines between the physical, digital, and biological spheres. Industry 4.0 is “fuelled” by a set of foundational technology trends and creates a “tectonic” tilt on the industrial paradigm. In more detail Industry 4.0 “reinvents” and creates new, smart products, transforms all components of the Operating Model of organisations, introduces new Business Models (i.e. the “as-a-Service” and the “platform” business model), alters the notion of work, shifts value across value chains and surfaces ecosystems as the new force. In addition, Industry 4.0 can significantly support the circular economy.

¹ Eurostat, National accounts aggregates by industry (up to NACE A*64),

https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64&lang=en

² Eurostat, National accounts employment data by industry (up to NACE A*64),

http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64_e&lang=en

³ Eurostat, European Union and euro area balance of payments - quarterly data (BPM6),

https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=bop_eu6_q&lang=en

⁴ Eurostat, National accounts aggregates by industry (up to NACE A*64),

https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64&lang=en, Data 2018 not available for Greece

⁵ Eurostat, National accounts employment data by industry (up to NACE A*64),

http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64_e&lang=en

⁶ Eurostat, Stochasis Macroeconomic Trends -SectoralForecasts, December 2019. Forecasts have been provided by Stochasis

Nevertheless, at the same time, Industry 4.0 technologies open up ethical and societal issues and concerns, such as workforce displacement, loss of privacy, potential biases in decision-making and lack of control over automated systems and robots.

Countries around the world have started responding to this new Industry 4.0 paradigm, albeit at a variable degree. This Industry 4.0 rift surfaces through the review of multiple Industry 4.0 related indexes both at a national and at an industry level (i.e. the World Economic Forum's Future of Production (FOP)⁷, the European Union's Digital Economy and Society Index (DESI)⁸, Accenture's Digital Economic Opportunity Index (DEOI)⁹, the European Union's Digital Transformation Scoreboard¹⁰. To further support and accelerate the digitisation of their industries, the majority of Governments all over Europe have architected national Industry 4.0 strategies and adopted relevant initiatives.

In parallel to national Industry 4.0 initiatives, the European Commission acknowledged the new, tremendous opportunities that Industry 4.0 can bring to the European industry. In this context, it launched the Digitising European Industry initiative (DEI) in April 2016. The DEI initiative introduces a framework for the effective coordination between national and EU-level initiatives and promotes relevant policy actions including investments in digital innovation capabilities. In addition, it focuses on the development of ICT standards, explores the creation of favourable regulatory conditions and promotes specific initiatives for the upskilling and reskilling of the human capital.

Zooming-into Greece's Industry 4.0 state of play, Greece appears to lag behind across all Industry 4.0 and digital indicators. According to EU's DESI index, in 2019, Greece ranked 26th out of 28 EU member states with regards to its digital maturity and was positioned at the tail end of the index. Greece's unfavourable rating in the DESI index is aligned with the country's low ranking across all other digital indexes we reviewed (i.e. EU's Digital Transformation Scorecard, Accenture's Digital Economic Opportunity Index (DEOI), etc.)

With regards to the digital “enablers” (i.e. digital infrastructure, digital skills, digital Public Services) that drive Greece's Industry 4.0 transformation in Greece, the country is also suboptimally positioned. Despite its overall low position, Greece demonstrates “pockets” of technological strength in the area of data analytics and an adequate STEM-oriented human capital that if appropriately supported could be used as the basis for the setup of a “knowledge-intensive” Industry 4.0 economy.

Hard-data evidence was aligned with the outcomes of the Industry 4.0 survey that we ran as part of the As-Is analysis.¹¹ In fact, the outcomes of the survey enabled us to capture the pulse of the Greek industrial enterprises and to overlay the executives' opinions against “hard data”, in order to extract additional insights.

According to the survey, Greek executives recognise the significance of Industry 4.0 and the changing of the industrial paradigm and perceive their organisations' increased productivity as the most important direct benefit from implementing Industry 4.0 technologies. In this context, Greek organisations appear to have initiated their Industry 4.0 transformation, albeit at a variable degree, across different functions of

⁷ WEF, Readiness for the Future of Production Report 2018, http://www3.weforum.org/docs/FOP_Readiness_Report_2018.pdf

⁸ <https://ec.europa.eu/digital-single-market/en/desi>

⁹ "Digital Greece: The Path to Growth". Accenture, 2017

¹⁰ Digital Transformation Scoreboard 2018, <https://op.europa.eu/en/publication-detail/-/publication/683fe365-408b-11e9-8d04-01aa75ed71a1>

¹¹ The performed analysis and the respective conclusions were based on data recorded through the “Industry 4.0” survey ran by the Ministry of Development, PwC and Accenture, with 152 Greek executives across the following sectors: B: Mining & Quarring, C: Manufacturing, E: Water supply; sewage, waste management and remediation activities, F: Constuction, H: Transportation, J: Information & Communication, which was launched on November 2019 and closed in February 2020.

their organisations and by experimenting with different technologies (i.e. cloud, cybersecurity, big data analytics and manufacturing-dedicated systems).

At the same time, the Greek surveyed executives face multiple challenges during their rotation to Industry 4.0, with the lack of digital skills for implementing and using Industry 4.0, the limited time to experiment, test and implement new Industry 4.0 technologies, the low level of clients' readiness with regards to Industry 4.0 practices and the lack of technical knowhow in implementing and using Industry 4.0 capabilities being identified as the four top-of-mind challenges.

Finally, in order to accelerate their digitisation efforts, Greek executives would highly appreciate the support of the Greek Government. This could be achieved through the provision of modern infrastructure, the introduction of relevant tax incentives and the provision of technical expertise for the design and implementation of Industry 4.0 initiatives.

Although Greece is only at the beginning of a long and demanding effort, in order to achieve the Digital Transformation in the Industry sector, a set of measures have already been taken towards this direction, i.e. the establishment of the Ministry of Digital Governance and the redrafting of the National Digital Strategy (through the design of the “Bible of Digital Transformation”), the memorandum of cooperation regarding the setup of a digital Industry 4.0 platform, between the General Secretariat for Industry and the Ministry of Digital Governance, the introduction of law 4622/2019, that seeks to re-organize the way the country's public administration is conducted, by simplifying the process of decision making (which from now on will be operated centrally from the Government), and the law 4635/2019 (the new multibill) voted by the Greek Parliament on the 24th of October 2019, that seeks amongst others to simplify the issuing of licenses for businesses in the Industry sector, as well as offer financial incentives to businesses that seek to operate in the context of business clusters, etc..

Besides political actions and initiatives, other non-public sector stakeholders promote and stress out the importance of a digital industry, state and economy in general. For example, the Federation of Enterprises (SEV) of Greece, that consists a strategic stakeholder that promotes the competitiveness of the Greek Industry, has drafted an Industry 4.0 strategy. Acknowledging that industry federations (i.e. the Federation of Enterprises, etc.) have an important role to play in the design of Greece's national Industry 4.0 strategy, as they act as the interface between the Greek organisations and the Public Administration, SEV's Industry 4.0 strategy is considered an important input and will be leveraged accordingly, for the formulation of this Deliverable/ National Strategy for the 4th Industrial Revolution (Greece i4.0) (2021 -2027) for the Greek industry and manufacturing.

In addition, Government's policies for the digitisation of the enterprises in the industrial sector are supported through a set of funding schemes, the two of them being the Operational Program “Competitiveness, Entrepreneurship & Innovation” (EPAnEK) and the Hellenic Development Bank (former ETEAN).

The existing National Strategies

Two Greek strategies already have been also reviewed to collect important sources of information and use them as the soundboard for evaluating the introduced Industry 4.0 strategy for Greece and its execution pillars. These are Greece’s National Growth Strategy (NGS) and the National Research and Innovation Strategy for Smart Specialisation (RIS3).

Greece’s National Growth Strategy (NGS) is a strategy published in 2018 by the former Greek Ministry of Development, that outlines a set of measures to be taken across 5 different dimensions (Ensuring fiscal sustainability, Fostering sustainable growth, Establishing structural conditions for growth, Ensuring fair and inclusive growth and Making use of available financing tools), in order to enable high and prolonged growth of the Greek economy over the next decade.¹² For the purposes of the Industry 4.0 strategy, the most relevant dimensions are “Fostering sustainable growth”, “Establishing structural conditions for growth” and “Ensuring fair and inclusive growth”.

Within the context of “fostering Sustainable Growth” the Government has identified 10 key sectors it seeks to develop: Transport and Logistics, Energy, Agri-food, Manufacturing, Shipping, Pharmaceutical sector, Health, Circular economy and sustainable natural resources management, Tourism and Culture. The NGS looks to support these 10 key industries by:

- Stimulating Interconnections and Public-Private Partnerships (PPPs)
- Supporting Start-ups & SMEs
- Increasing R&D&I
- Promoting innovative entrepreneurship

The NGS also promotes the improvement of the business environment to boost investment, through improving the efficiency of the public administration and its functions with initiatives that focus on simplification of processes, increased transparency, reduced bureaucracy and more.

Currently, the NGS is under revision from the Ministry of Development and Investments and is expected to be further enhanced or modified where appropriate. Nevertheless, NGS remains an important source of information for the design of the Industry 4.0 strategy for Greece and its execution pillars.

The Research and Innovation Strategies for Smart Specialisation (RIS3) is a comprehensive economic transformation agenda of the European Commission, tailored to the specifics of each region, which:

- focuses political support and investment on national/regional key-priorities, challenges and needs for knowledge-based development
- builds on the strengths and comparative advantages of the country/ region and the potential for excellence
- supports technological innovation and innovation based on practice and aims to stimulate private investment
- ensures the full participation of stakeholders and encourages innovation and experimentation
- is defined by an evidence based and solid monitoring and evaluation system

¹² <https://www.nationalgrowthstrategy.gr/en/>

Overall, 1 national and 13 regional research and innovation strategies for smart specialisation were developed in Greece covering the period 2015-2020. The national strategy was developed by the General Secretariat for Research and Technology (GSRT) of the Ministry of Education, Research and Religious Affairs while each Region was responsible for the preparation of its own strategy. The Special Strategy, Planning and Evaluation Service (EYSSA) of the Ministry of Economy, Development and Tourism had a coordinating role in the overall process.

The National RIS3 Strategy for Greece is setting the foundations for improving Research, Technological Development and Innovation (RTDI) in Greece across a several metrics (Percentage of spending on Research and Development in relation to GDP, Enterprise expenditure on Research & Development in relation to GDP) and sectors (Agri-food, Health–Pharmaceutical, Information and communication technologies, Energy, Environment and sustainable development, Transport, Materials-Construction, Tourism – Culture – Creative industries) for Start-ups, SME's and other innovative businesses.

These initiatives introduced by the National RIS3 Strategy for Greece, as well as the specific areas of economic activities that the strategy indicates will be leveraged as valuable input to architect the Industry 4.0 strategy for Greece.

The European Industrial Strategy

In March 2020, the European Commission introduced the EU Industrial Strategy which aims at facilitating transition of European industry into the Industry 4.0 paradigm. The Strategy is predicated around three key strategic priorities: **maintaining the EU industry's competitiveness at home and globally, making Europe climate neutral by 2050**, and **shaping the continent's digital future**.

To realise its objectives, the EU Industrial Strategy outlines several actions and policy initiatives which enable member states to better leverage the growth opportunities ahead while overcoming current obstacles to sustainability, fair competition, and digital integration. The EU's Industrial Strategy includes actions to accelerate competition globally and locally, such as an Intellectual Property Action Plan, the comprehensive review of current EU competition rules, a white paper to address the distorted effects caused by foreign subsidies and an action plan on Critical Raw Materials, to secure their steady supply to EU industrial companies. Furthermore, the Strategy includes a significant number of initiatives focusing to promote the modernisation and decarbonisation of energy intensive industries such as the Clean Hydrogen Alliance and new green public procurement legislations. Sector specific actions have also been introduced, such as new EU Pharmaceutical Strategy while innovation, investment and skills are supported on a cross-sectoral level within the Strategy. The EU Industrial Strategy also places weight on the support of industrial ecosystems, indicating that the Commission understands their centrality to Industry 4.0. In this context, the Strategy devises is the creation of an industry forum aimed at analysing the risks and needs of different industrial ecosystems¹³.

In addition, the European Commission supports multiple financing initiatives for strategic value chains (SVC) in the EU. The value chains selected by the Commission shall demonstrate the following traits:

- **technological innovativeness**, i.e. the value chain is based on the exploitation of strategic key enabling technologies, technological breakthroughs, major outcome of R&D or disruptive innovation (e.g. autonomous driving, low carbon technologies).

¹³ https://ec.europa.eu/commission/presscorner/detail/en/fs_20_425

- **economic and market potential**, i.e. the value chain has considerable economic weight, actual or potential.
- **societal and political importance for Europe**, i.e. the value chain makes an important contribution to European societal challenges and/or policy goals (e.g. climate change, ageing population). The value chain is also instrumental to Europe's security and autonomy. In a world where more and more industrial processes are fully interconnected, certain key technologies need to be produced and intellectually owned in Europe to achieve a degree of technological independence for example in critical infrastructure, components or intellectual property sets in order to ensure economic security.

The European Commission has identified the following nine value chains as its key SVCs:

- Clean, connected and autonomous vehicles (CCAV)
- Smart Health
- Low CO2 emissions Industry
- Hydrogen technologies and systems
- Industrial Internet of Things
- Cybersecurity
- Batteries
- High-performance computing
- Microelectronics

SWOT analysis: Analysis & evaluation of the current situation for Greece

By combining outcomes of the previous steps with macro-trends on the political and financial situation worldwide, in EU and Greece, innovation and R&D related observations, social macro-trends (with specific emphasis to the European and Greek Human Capital) and environmental macro-trends that affect the world, EU & Greece, we elicited a first set of strengths and weaknesses that refer to Greece's internal environment and a second set of opportunities and threats that relate to Greece's external environment. We combined Greece's strengths, weaknesses, opportunities and threats, and we built Greece's Industry 4.0 SWOT analysis. The following table presents a high-level overview of the results surfaced by the SWOT analysis conducted. A more in-depth analysis supported by data for the individual statements presented below is performed in the following chapters.

Strengths

1. The Greek economy demonstrated signs of recovery until recently; nevertheless, moving forward the coronavirus may severely affect the Greek economy
2. The Greek industry plays an important role in the Greek economy, generating more than 24% of its Gross Value Added (for 2018)
3. Increased interest and focus are placed on digital and Industry 4.0 from the higher levels of the Greek Government and industry federations, as well as from the European Commission
4. Greek surveyed executives recognize the significance of Industry 4.0 for their enterprises and primarily aim to implement Industry 4.0 technologies to increase their internal efficiencies and productivity
5. Greek executives appear to have initiated their Industry 4.0 transformation, starting mainly from the digitisation of their organisations' support functions, their Marketing & Sales and their production divisions. Moving forward, the majority of them plan to dedicate additional funding on the digitisation of their production and product development divisions
6. Greek enterprises claim to have initiated a close collaboration with their clients and suppliers to co-create customized products & services. Small and very small enterprises appear to lead the way in product co-creation
7. Greek enterprises appear to already invest in specific Industry 4.0 technologies, i.e. cloud, cybersecurity, big data analytics, SCADA and MES systems. In the future, they aim to continue investing in Cloud, Cybersecurity and big data analytics, while they also aim to actively experiment with IIoT, industrial robots and AI
8. Greek enterprises place specific emphasis on big data analytics and actively exploit its potential
9. Greece is home to a burgeoning start-up & Digital Innovation Hubs scene
10. Both the European Commission and the Greek Government actively support the innovation in the Greek Industry through the provision of targeted funding schemes
11. The Greek Government has already undertaken a set of measures to transform Greece's regulatory environment through the introduction of a set of directives on digital technologies and a set of laws (i.e. 4622/2019 and 4635/2019) for the simplification and reorganisation of Greece's public administration and for boosting and assisting the Greek business environment
12. Greece demonstrates a technically adept human capital, with an overall high number of tertiary graduates, an adequate number of ICT and STEM graduates & a high diaspora around the world
13. The Greek Government has already undertaken some key initiatives for the digital upskilling and reskilling of the Greek human capital

Weaknesses

1. The significant hit in fixed capital investments during the last years decelerated investments in Industry 4.0 technologies and applications
2. Money supply in the Greek economy has undergone major shocks, preventing enterprises from investing in Industry 4.0 technologies
3. The Greek Manufacturing is fragmented, with a very high number of enterprises (more than 90%) having a very small number of employees (less than 10)
4. Greece lacks a holistic national Industry 4.0 strategy and a structured mechanism to coordinate Industry 4.0 programmes and initiatives
5. The Greek enterprises lag across the adoption of Industry 4.0 and digital technologies and applications
6. Greece's suboptimal position with regards to its digital infrastructure and the provision of digital public services, prevent the Greek enterprises from rapidly adopting new Industry 4.0 technologies and supporting their technology needs
7. The surveyed Greek enterprises have initiated their Industry 4.0 rotation, albeit they are still at the beginning of their transformation journey. In fact, an alarmingly high percentage of them (especially across the very small enterprises, the national enterprises and those with less than 10 years of operation) have not invested yet in any Industry 4.0 technology
8. Despite their recent revamping of their production IT landscape, the surveyed enterprises demonstrate a low level of digitisation across their production lines. Out of these, the very small and small enterprises, the national ones and those with less than 20 years of operation appear to be the worst positioned
9. Greece ranks low in terms of innovation and R&D, both with regards to their R&D intensity and with regards to the overall number of the issued Greek patents
10. R&D appears disassociated with applied research & industry implementation, as contrary to the EU average, where the business sector appears highly involved in R&D, the Greek R&D is mainly dominated by the higher education sector, while Greek organisations appear reluctant to invest in applied R&D
11. Greek enterprises face structural and regulatory obstacles during their setup and operations, with areas of "dealing with construction permits", "registering property", "getting credit" and "enforcing contracts" scoring particularly low across the annual report on the ease of "Doing Business" for 2020
12. The surveyed Greek executives place the provision of Industry 4.0 related tax incentives and the development of a flexible, digital-friendly regulatory framework as top incentives that could accelerate their organisations' digital transformation
13. Greece has performed limited investments in the digital upskilling and reskilling of its industrial workforce and does not have in place a structured mechanism to measure the effectiveness of the undertaken digital skills initiatives
14. Greek surveyed executives verify the limited digital skills currently existing in the Greek market. This challenge appears even greater for the very small and small enterprises that we surveyed.
15. The most highly sourced digital skills in the future appear to be around Artificial Intelligence, Cloud, Big Data Analytics and Cybersecurity
16. Greece is Europe's lowest ranking country, with regards to the average circular use of materials

Opportunities

1. Global changes in the distribution and nodes of power enable Greece to become part of wider global ecosystems
2. The European Industrial Strategy can significantly benefit Greece's rotation towards Industry 4.0
3. The "smartification" of products can enable Greek enterprises to produce products & services of higher added value and to become more competitive
4. The emergence of new business models can support Greek enterprises in tapping new sources of value creation
5. The massive explosion of digital data at a global scale introduces a set of favourable conditions that can further boost Greece's big data & analytics national strengths
6. Artificial intelligence is changing the current status quo and can significantly benefit the Greek economy
7. 5G and the "IoT-isation" economy can become game changers for "unlocking" innovation and growth for the Greek economy
8. Industry 4.0 can significantly benefit Greece in increasing its economy's circularity

Threats

1. The rise of economic nationalism and the shaking up of Global Trade may prohibit Greece's cooperation with other countries in the Industry 4.0 field
2. The COVID-19 pandemic may severely impact the global and the Greek economy
3. Industry 4.0 disrupts the traditional linear value chains & redefines the Greek industries
4. Techno-centricity of industrial production may disrupt the Greek labour market
5. Industry 4.0 poses new, wider and deeper cybersecurity threats for the Greek Industry
6. EU counterparts' rapidly progress with regards to their digitisation both at a national and at an industry level, continuously increase their digital "riff" with Greece and makes Greece's digitisation a necessity rather than a wishful thinking
7. EU counterparts' progress regarding targeted measures to support and enhance digital innovation and R&D, indicates that Greece's R&D capabilities are threatened to curb, if the country does not timely undertake similar initiatives
8. EU countries progress with regards to the digital upskilling and reskilling of their human capital, leaves Greece behind in terms of its digital human capital
9. Climate Change and Global Warming significantly affects the Greek environment and necessitates the use of Industry 4.0 technologies across the Greek Industry

Greece's Industry 4.0 Vision & Execution Strategy

We are now amid a major technology revolution, specifically an Industry 4.0 revolution and the Greek industry appears to have done little thus far to grasp the opportunities that Industry 4.0 offers. All indicators position the Greek Industry at the lower end of the maturity curve, and it seems that it has lost significant time with regards to its rotation to Industry 4.0.

A pressing question is born: "What can the Greek industry do to reverse the current situation and make the most out of Industry 4.0?"

The Greek Industry's unfavourable position creates a **burning platform** for the country to act fast, do many and perform them in sync within a tight timeframe. In order not to lose momentum, Greece needs to adopt a holistic Industry 4.0 strategy, tailored to the specific needs of the Greek Industry.

In fact, our performed SWOT analysis, combined with the outcome from stakeholder interactions surface a set of questions, that Greece's Industry 4.0 strategy needs to address:

- What actions shall the Government, supported by the Industry, undertake to ensure the digital upskilling and reskilling of existing and future Industry workforce?
- How can the Greek Government, Industry, Research & Academia strengthen their collaboration and make it more targeted to ensure the conduct of applied R&D, directly associate with industry implementation?
- Which are the appropriate measures and mechanisms that shall be put in place to further incentivize and support the Greek enterprises' innovation capabilities as well as the Greek start-up ecosystem?

- Which are the levers that can promote the collaboration between Greek and international enterprises to address specific needs of Greek value chains, foster the development of Greek enterprises and position them as part of international ecosystems?
- Which are the key ICT standardisation priorities that the Greek Government, Industry and academia shall address to the implementation of interoperable and interconnected Industry 4.0 technologies, products and services?
- How can the Greek Government improve the regulatory environment to decrease regulatory hurdles, restrictions, and red tape and enhance Industry’s digitisation and innovation?
- Which are the direct and indirect financial incentives that shall be provided to Greek enterprises to accelerate their investments in Industry 4.0 technologies, applications and relevant digital skills? Which are the tailored mechanisms that can address Greek SMEs digitisation needs?
- How can the Greek Industry become incentivized to leverage Industry 4.0 to enhance the organizations’ average circular use of materials and enable the Greek industry to actively participate in the circular economy ecosystem?
- Finally, what actions shall the Government undertake to ensure that the key digital foundations (including the deployment of nation-wide digital infrastructure (5G) and the provision of “digital by default” public services) are in place to horizontally enable the digitisation of the Greek Industry?

The national Industry 4.0 strategy will aim to introduce a cohesive and comprehensive national agenda, under which all key stakeholders, i.e. the Greek Public Administration, the Greek Industry and the Greek research and academia will streamline their efforts to achieve the Greek Industry’s Industry 4.0 transformation and to successfully realize the Greek Industry 4.0 vision. That is to:

Greece’s Industry 4.0 Vision

“An innovative, internationally competitive and extrovert Greek Industry with the leverage of digitisation and the continuous integration of new Industry 4.0 technologies & applications”

The operationalization of the Greek Industry 4.0 vision shall support the Greek Industry to accomplish a set of goals. These are listed below:

- Increase the Greek Industry’s overall digital maturity.
- Digitally upskill and reskill the human workforce in the Greek industry.
- Enhance the Greek Industry’s applied R&D and the innovation capabilities.
- Support the Greek Industry to transition into the zero-carbon and low environmental footprint economy.
- Develop a collaborative industrial ecosystem to accelerate the digitization and scale up of the Greek SMEs and mid-caps.

- Increase the Greek Industry’s potential to meet personalized needs and imminently respond to emergencies and crises (flexible processing).
- Enhance the internationalization and extroversion of the Greek Industry and strengthen its active participation in global, European and regional value chains and ecosystems.
- Increase the overall contribution of Greek industry to the Greek economy.

The implementation of the Greek Industry 4.0 vision shall be based upon six execution pillars. There are the following:

1. **Digital skills & human capital qualifications:** The provision of the current and future Greek industrial workforce with the appropriate digital knowledge and skills. The pillar focuses both on the digital upskilling and reskilling of the current workforce (with particular attention to be given to the reskilling and upskilling of lesser-skilled workers and SME’s workforce), as well as on attracting and developing the future talent pipeline for the Greek Industry. In addition, the pillar includes targeted initiatives for the repatriation of Greek human capital and the attraction of international human capital.
2. **Innovation & start-up supporting mechanisms in the Digital Age:** The pillar’s focus is threefold. First, it focuses on the enhancement and promotion of innovation across the Greek Industry, through the closer and targeted collaboration of the Greek Government, Industry and Research & Academia (triple helix innovation model) and the design of new or the enhancement of existing Digital Innovation Hubs (DIHs) and Innovation Districts. Second, the pillar focuses on the targeted mechanisms for the support of the booming start-up ecosystem in Greece. Third, the pillar targets on incentives to foster investment in innovation and applied R&D within the Greek enterprises to contribute to the solution of industrial and societal problems (i.e. circular economy).
3. **Collaboration & synergies:** The pillar focuses on the development of a collaborative industrial ecosystem, where Industry stakeholders shall cooperate and utilise each other’s expertise in order to achieve greater goals. Collaborations shall be pursued across many different levels ranging from the provision of technical know-how and expertise from large, digitally-advanced enterprises to Greek SMEs and mid-caps, to increase their thus far limited awareness on digital and Industry 4.0, to the setup of industrial platforms on specific areas of economic activity that will enable the creation of ecosystems of market actors in a multi-sided marketplace. Moreover, this pillar shall promote the internationalization of the Greek enterprises and their participation in EU value chains and global emerging ecosystems.
4. **Standardisation & Norms:** The pillar aims at setting key ICT standardisation priorities, in accordance to the European Commission’s ICT Standards plan and communication¹⁴, to help ensure that the implemented Industry 4.0 technologies, systems and services retain the ability to connect and interoperate with each other, boosting innovation, and keeping the Greek ICT market open, competitive and interconnected with the rest of the Europe.
5. **Regulatory Environment:** The pillar focuses on improvements of the Greek regulatory environment, primarily in the areas of cybersecurity, data protection, free flow of data and Artificial Intelligence in order to provide a more flexible and digital-friendly environment within which the Greek Industry can accelerate its digitisation.

¹⁴ <https://ec.europa.eu/digital-single-market/en/news/communication-ict-standardisation-priorities-digital-single-market>

6. **Acceleration of investment in digital technologies:** The last pillar focuses on the financial incentivisation of Greek enterprises in order to invest and leverage Industry 4.0 technologies and applications. In that context, tailored financial instruments will be developed, targeted at upgrading and modernising enterprises with regards to Industry 4.0 on multiple areas (i.e. both adoption of new technologies, the upskilling/reskilling of employees and the use of circular material). This effort will be pursued in the lines of a “holistic” upgrade of enterprises, and in total coordination with all other actions of the strategy.

Having concluded the analysis of the six execution pillars, it is finally important to mention that the Greek Industry 4.0 strategy shall also focus on the **enhancement of the key digital foundations** that consist prerequisite for the Greek Industry’s rotation to Industry 4.0. These foundations include:

- the deployment of nation-wide digital infrastructure (5G)
- the digitisation of the Greek Public Administration and the provision of “digital by default” public services

Although the identification of initiatives for digital infrastructure and digital public services consists part of the National Digital Strategy and will be included in the Bible of Digital Transformation, to be issued by the Greek Ministry of Digital Governance, the Industry 4.0 strategy shall describe at a high level key initiatives regarding the key digital foundations that shall be introduced to enable the Greek Industry’s digitisation. The implementation of these digital foundations shall be performed in parallel with the initiatives to be included in the six execution pillars to achieve the highest possible results from implementing the Industry 4.0 strategy.

3 Key takeaways of the report on the current situation (Deliverable 1)

Below we present the key takeaways of the report on Greece's Industry 4.0 anatomy. These takeaways are presented in a conceived way. Further information on background information and an extensive analysis of these key takeaways can be found in Deliverable 1.

Industry is vital for the global, EU & Greek economy

Industry is a central pillar to the development of national economies and to the acceleration of economic growth. Historically, manufacturing has been “the driver of economic growth, structural change, and catch-up”.¹⁵ World Economic Forum highlights that manufacturing is significantly important to the prosperity of nations “with over 70% of the income variations of 128 nations explained by differences in manufactured product export data alone”.¹⁶ Industry indeed matters for countries' economic performance and manufacturing proves to be directly linked to national competitiveness.¹⁷ According to the World Bank, Industry in 2017 contributed 25,4% of the world's total GDP, while the employment in the industry sector reached 23,08% of the worldwide employment.¹⁸ At the same time, exports of goods, which is the key output of Industry, reached the \$17,52 trillion.¹⁹

Industry consists the backbone of the European economy. Europe's global competitive advantage on the production of industrial products translated to 25% of the EU's total value-added in 2018²⁰, while EU Industry's employment accounted for 27% of total employment in the EU for 2018.²¹ The EU is also one of the world's largest players in global trade being the second largest exporter and importer of goods in the world, with only China exporting more goods and the United States importing more. In 2018, trade in goods represented 70% of total EU trade in goods and services.²² In this context, competitiveness is at the heart of the Commission's agenda and, as we stand on the brink of a new industrial revolution, the Commission is committed to supporting the digital and green transformation of EU Industry.

Zooming into Greece, Industry also plays an important role in the overall Greek economy, as it generated 24,2% of the total Gross value added in 2017²³ and employed 19% of the total Greek workforce in the same year.²⁴ In addition, looking at the development of the Greek industrial production from 2013 – 2018 and its projections for 2019 and 2020, a continuous increase is noted since 2015. Projections estimate that the industrial production will continue to grow in 2019 (by 0,9%) and in 2020 (by 3%).²⁵

¹⁵ Naudé W., Szirmai, A. The importance of manufacturing in economic development: Past, present and future perspectives. UNU-MERIT Working Papers , 2012-041, 2012

¹⁶ World Economic Forum (WEF). The Future of Manufacturing Opportunities to drive economic growth. A World Economic Forum Report in collaboration with Deloitte Touche Tohmatsu Limited, April 2012

¹⁷ Pitelis, Christos & Antonakis, Nicholas. (2003). Manufacturing and competitiveness: The case of Greece. Journal of Economic Studies. 30. 535-547. 10.1108/01443580310492826.

¹⁸ World Bank, <https://data.worldbank.org/indicator/NV.IND.TOTL.ZS?view=chart>, <https://data.worldbank.org/indicator/SL.IND.EMPL.ZS>

¹⁹ World Bank, <https://data.worldbank.org/indicator/BX.GSR.MRCH.CD>

²⁰ Eurostat, National accounts aggregates by industry (up to NACE A*64), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64&lang=en

²¹ Eurostat, National accounts employment data by industry (up to NACE A*64), http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64_e&lang=en

²² Eurostat, European Union and euro area balance of payments - quarterly data (BPM6), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=bop_eu6_q&lang=en

²³ Eurostat, National accounts aggregates by industry (up to NACE A*64), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64&lang=en, Data 2018 not available for Greece

²⁴ Eurostat, National accounts employment data by industry (up to NACE A*64), http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64_e&lang=en

²⁵ Eurostat, Stochasis Macroeconomic Trends -SectoralForecasts, December 2019. Forecasts have been provided by Stochasis

Nevertheless, the comparison of the Greek Industry to the German, French and Portuguese ones, highlights that despite Industry's key role across all countries, each country is unique in terms of the structure of its economy. In fact, Industry contributes the highest to the German economy with a 35% share on the country's total Gross Value Added and a 29% share on the country's overall employment in 2018.

At the same time, looking at the Industries' GVA and employment growth, Portugal demonstrated the highest Industry GVA growth rate (21% growth) between 2013 – 2018. At the same time, the Portuguese Industry employment also increased by 12% during the same time-period. This combined with the significant increase of 48% in Gross Capital Formation, signifies the great focus and efforts that Portugal has demonstrated during the last years to recover from its recent financial crisis, boost its industry and enhance its productivity and competitiveness. Zooming into the exporting capacity of goods for each country, Greece demonstrated the highest increase in exporting goods during the last years (24%). However, it still held the lowest percentage of exports of goods as % of GDP in 2018 with 18%. In terms of high-tech exports as a percentage of the country's overall exports, France came first in 2018 with 20,5%, contrary to Greece and Portugal, where high-tech products only hold 4,5% and 4% of their overall exports.

Countries' unique characteristics and focus across different areas of their Industries, indicate that moving forward their national Industry 4.0 strategies shall also be tailored to their Industries' specific needs and strengths.

Introduction of the concept “Industry 4.0” and explanation of how Industry 4.0 changes the industrial paradigm

The concept of “Industry 4.0” is used to describe the fourth industrial revolution, characterised by a fusion of technologies and the use of smart, fully connected devices that blur the lines between the physical, digital, and biological spheres.

Industry 4.0 is “fuelled” by a set of foundational technology trends that radically transform the industrial production and manufacturing²⁶.

Industry 4.0 creates a “tectonic” tilt on the industrial paradigm. In more detail:

- **Industry 4.0 “reinvents” the products.** The new, smart products are constantly connected to other devices and to the cloud, become “smart” through the incorporation of sensors and on-board processing capability and evolve through the use of Artificial Intelligence.
- **Industry 4.0 transforms all components of the Operating Model of organisations;** it reshuffles how organisations are organised, which processes are automated, what talent organisations need and to which ecosystems organisations shall become part of.
- **Industry 4.0 introduces new Business Models:** The emerging “as-a-Service” or “pay-as-you go” models enable customers to pay for products' uses on a use-based principle. At the same time, in the Industry 4.0 era, companies need to work out whether they also need a platform strategy.
- **Industry 4.0 “democratises” Work:** As more areas of labour-intensive activity become automated, new roles will be introduced to ensure the proper deployment and function of

²⁶ Additive Manufacturing (also defined as 3D printing), Artificial Intelligence (AI), Augmented Reality (AR), Big Data Analytics, Blockchain, Cloud computing, Cybersecurity, Distributed Intelligence systems, Electronic Components & Systems (ECS), High Performance Computing (HPC), Industrial Robots, Machine-to-Machine (M2M), Manufacturing Execution Systems (MES), new materials and nano-structures (e.g. graphene, composites, PVD, CVD), Simulation techniques, Supervisory control and data acquisition systems – SCADA, The Industrial Internet of Things and Photonics, Automations, Sensors and Applications

automation, while more transactional and routine tasks will become defunct. At the same time, the increasing digitalisation and techno-centricity of industrial production will require new skills from industrial employees, making their constant reskilling and training the new standard. Finally, the rise of machine-assisted work, will enhance human productivity and create new capabilities in the domain of human-machine interaction.

- **Industry 4.0 shifts value across value chains and surfaces ecosystems as the new force:** The rise of smart and connected products significantly disrupts traditional linear value chains defined by clear beginnings and endings within siloed organisations and reshuffle the fundamentals of industries and will blur their boundaries.
- **Industry 4.0 impacts the wider society:** Industry 4.0 technologies are maturing rapidly with seemingly limitless applications. This opens up ethical and societal issues and concerns, such as workforce displacement, loss of privacy, potential biases in decision-making and lack of control over automated systems and robots.
- **Industry 4.0 “realises” the circular economy:** The circular economy is more than a sustainability initiative – it’s about helping industrial companies make and save money by better managing their resources and waste efficiently. As industrial companies continue down this path, they will need digital solutions that can support their business and operating models – which is why Industry 4.0 is so important. The technologies that underpin Industry 4.0 can make this happen.

The Industry 4.0 state of play in EU countries

Countries around the world have started responding to this new Industry 4.0 paradigm, albeit at a variable degree. This Industry 4.0 rift surfaces through the review of multiple Industry 4.0 related indexes both at a national and at an industry level, namely the World Economic Forum’s Future of Production (FOP)²⁷, the European Union’s Digital Economy and Society Index (DESI)²⁸, Accenture’s Digital Economic Opportunity Index (DEOI)²⁹, the European Union’s Digital Transformation Scoreboard³⁰.

To further support and accelerate the digitisation of their Industries, Governments all over Europe have architected national Industry 4.0 strategies and adopted relevant initiatives. In this context, we have collected, reviewed and analysed sixteen national strategies & initiatives across different dimensions. Although, every country’s plan differs significantly with regards to its strategic focus, key audience, policy design, implementation approach, and funding approaches, there are some common traits and characteristics with regards to how these 16 countries have architected their Industry 4.0 strategies.

- With regards to countries’ Industry 4.0 vision, almost all countries aim to strengthen the country’s industrial competitiveness and accelerate its digitisation. Nevertheless, besides their common vision, each country appears to have followed a different approach in architecting, implementing and funding their Industry 4.0 strategies and have avoided the single country imitation.
- The focus of the designed national Industry 4.0 strategies also varies significantly. In terms of sectoral focus, almost none of the national strategies focuses on specific sectors of their economy for their digitisation. Nevertheless, the concept of enhancing wider areas of economic activity and relevant value chains is highlighted in some of those (i.e. the Portuguese Industry 4.0 strategy).

²⁷ WEF, Readiness for the Future of Production Report 2018, http://www3.weforum.org/docs/FOP_Readiness_Report_2018.pdf

²⁸ <https://ec.europa.eu/digital-single-market/en/desi>

²⁹ “Digital Greece: The Path to Growth”. Accenture, 2017

³⁰ Digital Transformation Scoreboard 2018, <https://op.europa.eu/en/publication-detail/-/publication/683fe365-408b-11e9-8d04-01aa75ed71a1>

- A set of strategies focus their efforts on the implementation and integration of specific Industry 4.0 technologies (i.e. Internet of Things, analytics, etc.)
- In terms of the audience to which national Industry 4.0 strategies refer to, it is worth mentioning that all countries have designed dedicated incentives for the digitisation of their SMEs.
- The facilitation of collaboration between industry, research, and public authorities is another major theme met within different Industry 4.0 approaches.
- While all EU member Industry 4.0 strategies give a clear priority to the deployment and application of Industry 4.0 technologies, there are few strategies that also focus on the R&D enhancement for the development of new technologies (i.e. Italian Industry 4.0 strategy). In addition, Industry 4.0 strategies tend to focus equivalently on the design of digital infrastructure and the implementation of digital technologies as well as on digital upskilling and reskilling.
- In terms of governance and implementation of their designed Industry 4.0 strategies most countries adopt a top-down approach, with national governments being positioned clearly in the driver's seat.
- While the major national Industry 4.0 strategies significantly rely on public funding, complementary private investments are also important with the leverage effect being considerable.
- Most of the Industry 4.0 strategies have been designed recently, therefore limited measurable outcomes have been provided yet, with regards to the progress of their implementation and the enhancement of innovation and integration of Industry 4.0 technologies.

In parallel with national Industry 4.0 initiatives, the European Commission acknowledged the new, tremendous opportunities that Industry 4.0 can bring to the European industry. In this context, it launched the Digitising European Industry initiative (DEI) in April 2016. The DEI initiative introduces a framework for the effective coordination between national and EU-level initiatives and promotes relevant policy actions including investments in digital innovation capabilities. In addition, it focuses on the development of ICT standards, explores the creation of favourable regulatory conditions and promotes specific initiatives for the upskilling and reskilling of the human capital.

The Industry 4.0 state of play in Greece

To evaluate Greece's Industry 4.0 state of play, we identified the underlying factors that can drive economic growth in the new digital economy and provided valuable insight into the digital dimensions on which the country has already focused its efforts.

In more detail, Greece appears to lag behind across all Industry 4.0 and digital indicators. In more detail, according to EU's DESI Index, in 2019, Greece ranked 26th out of 28 EU member states with regards to its digital maturity and was positioned at the tail end of the index, with a score 28% lower than that of the European average. Greece's unfavourable rating in the DESI index is aligned with the country's low ranking across Accenture's Digital Economic Opportunity Index (DEOI), where Greece scored at the lowest end of the digital maturity curve in 2018 (22nd out of the 22 countries of the sample) and EU's Digital Transformation Scorecard.

If we further examine the level of adoption of a set of digital technologies that underpin the Industry 4.0 rotation of an economy, it is evident that Greece is suboptimally positioned very low across all areas below:

- In terms of the adoption of cloud computing technologies, Greece's enterprises show low rates of adoption, with only 13% of enterprises making use of the technology, half the EU average of 26%.

Greece ranks 25th in Europe, with a mere five percentage points above the lowest ranked country, Bulgaria (8%).³¹

- With regards to RFID technologies, Greek enterprises also recorded the lowest levels of adoption in the EU along with Hungary and Romania, reporting 7% RFID adoption in 2017.
- In addition, just 2% of Greece's enterprises used industrial robot technology in 2018, demonstrating the country's slow rate of adoption in terms of industrial robotics.³²
- Greek enterprises have also been moderately too slow in their adoption of Customer Relationship Management (CRM) systems, with just 20% of Greek enterprises using the technology (EU average 33%).
- In addition, just 2% of Greece's enterprises used industrial robot technology in 2018, demonstrating the country's slow rate of adoption in terms of industrial robotics.
- Greece has also been slow to bring nanotechnology into its industrial landscape, reporting just 52 nanotechnology job positions in 2016. At less than 1 basis point of the total workforce, the Greek economy has yet to make any measurable contributions to the nanotechnology sector.³³
- With regards to additive manufacturing, 924 job positions are currently classified as additive manufacturing related jobs. This is a small part of the total workforce, at 0,03%, which indicates that the Greek industry has made some initial steps, in terms of adopting this technology.³⁴
- On the cybersecurity front, Greece appears to also perform suboptimally. According to the Global Cybersecurity Index (GCI)³⁵ Greece scores on the 77th position against the overall, worldwide sample, that consisted of 193 countries.
- If we shift our focus on circular economy, Greece is Europe's lowest ranking country, with regards to the average circular use of materials as a percentage of total material use, reporting only 1% circular material use. The average circular use of materials as a percentage of total material use was 12% in the EU in 2016.³⁶

Zooming into the **Innovation and R&D areas**, Greece also ranks significantly below its EU peers. In more detail, with regards to Research & Development (R&D) intensity, defined as the gross domestic spending on R&D as a percentage of GDP, Greece ranks significantly below its EU peers, at 1,18% in 2018, compared to an EU average of 2,12% in the same year.³⁷ The overall technological development remains also low, as this is reflected in the very low number of Greek patents compared with other countries. While the EU-28 average was 107 patents per million inhabitants in 2017, Greece reported eight patent applications, 97% less patents than Sweden, the European leader (283 patents).³⁸

The most alarming finding in the innovation field, is the fact that the current Greek R&D investments appear disassociated to applied research and industrial implementation. This is evident from the distribution of the Greek R&D personnel across the different sectors of the economy. Namely, contrary to the EU average, where the business sector appears highly involved in R&D (58% FTE), the Greek R&D is mainly dominated by the higher education sector (46% FTE). This highlights that Greek organisations appear hesitant to

³¹ Eurostat https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_cicce_use&lang=en

³² No data was available with regards to the use of industrial robots by Greek manufacturers

³³ https://ec.europa.eu/growth/tools-databases/kets-tools/sites/default/files/library/kets_observatory_second_report.pdf

³⁴ KET's observatory - https://ec.europa.eu/growth/tools-databases/kets-tools/sites/default/files/library/kets_observatory_second_report.pdf

³⁵ <https://www.itu.int/en/ITU-D/Cybersecurity/Pages/global-cybersecurity-index.aspx>

³⁶ <https://ec.europa.eu/environment/circular-economy/>

³⁷ OECD Data - <https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm>

³⁸ EPO Data - https://ec.europa.eu/eurostat/web/products-datasets/product?code=sdg_09_40

invest in research of new technologies, as well as in active experimentation of how these could be implemented to drive new sources of revenues.

Despite its overall low **position, Greece demonstrates “pockets” of technological strength.** In more detail:

- Greek companies have understood that data is the new digital capital and increasingly exploit the potential of Big Data Analytics. This is evidenced by the fact that 13% of Greek enterprises (compared with 12% of the EU average) invest in data collection and Big Data analytics.
- Leveraging the availability of high calibre human capital, global leaders in the ICT industry increasingly invest in the Greek workforce creating global Analytics Centres of Excellence (i.e. Accenture, Cosmote, SAP, Nokia, Microsoft, IBM etc.) across Greece.
- Greece is home to a burgeoning start-up scene. From 2012 to 2016, investment in Greek Start-ups grew by a factor of 18, from 5 to 90 million Euros in annual start-up funding per year in 2012 and 2016 respectively, totalling 250 million in the span of five years.
- Greece is also home to 14 Digital Innovation Hubs (9 fully operational and 5 in preparation status) which cover various market domains within manufacturing such as food processing, basic metals, and textiles, and in other sectoral groups, such as agriculture, fishing and construction. While leading EU innovators such as Germany, the Netherlands and France have a significantly higher number of hubs, with 54, 40 and 41 Digital Innovation Hubs respectively, Greece reports a disproportionately high number of DIHs for a country of its size and digital transformation rankings. Notably, as of 2019, Greece reported more Digital Innovation Hubs than Ireland (11), Portugal (4), Denmark (8), and Sweden (12), all of which significantly outrank Greece in terms of most digitalisation metrics. While quantity does not necessarily imply quality, Greece’s relatively high number of DIHs is a positive indicator of the country’s potential and promising track record with regards to efforts at fostering innovation in its industry. Detailed information about Greece’s Digital Innovation Hub ecosystem is provided in Chapter 0 of this report.

With regards to the **digital “enablers”** (i.e. digital infrastructure, digital skills, digital Public Services) that drive Greece’s Industry 4.0 transformation in Greece, the country is also suboptimally positioned. Nevertheless, Greece demonstrates an adequate STEM-oriented human capital that if appropriately supported could be used as the basis for the setup of a “knowledge-intensive” Industry 4.0 economy. In more detail:

- With regards to the **digital infrastructure**, in 2019 Greece ranked last among all EU countries (28 out of 28 member-states) according to EU’s DESI Index. In fact, Greece’s connectivity score was 31% lower than the European average and 44% lower than Denmark, the EU leader, which recorded a score of 0,74 (out of 1) in 2019.
- Greece’s limited **digital skills** is also considered a structural inhibitor towards the country’s rotation towards Industry 4.0.
 - In particular, in 2019 Greece ranked 25th in DESI’s human capital dimension, with an overall score of 0,33 units, which is 32% lower than the European average. During the past 6 years, Greece’s score in the human capital dimension has remained stable. The relatively stagnant performance of the country combined with the evolution of digital skill capabilities within other EU member states is creating a widening gap between Greece and EU average in the human capital dimension.
 - Nevertheless, Greece has a significant number of people with a track record in tertiary education. In fact, for 2017, Greece contributed 4% of the overall tertiary education

students across the EU. In addition, Greece's share of ICT graduates is on par with the average EU country, with 3% ICT graduates, when compared to 4% reported on average in the continent. Finally, with regards to the number of graduates in tertiary education in science, math, computing, engineering, manufacturing, and construction, Greece is also in sync with the EU average, with 18% of Greek graduates pursuing tertiary education in the abovementioned fields. These observations indicate that Greece has an adequate percentage of ICT & STEM graduates that could be “infused” in the Greek industry to accelerate its digitisation. This opportunity can be further enhanced, as an important number of domestic enterprises employ ICT specialists as their workforce. In 2018, 22% of Greek enterprises had ICT specialists on their payroll, ranking the country above the EU average (20%).

- Despite their appetite to employ ICT-oriented employees, the Greek enterprises appear unwilling to further invest in their human capital's digital upskilling. Only 12% of Greek enterprises offered ICT skills training to their employees in 2018, compared to the EU average of 23%. If we turn our attention to the country's industrial workforce, it appears that with only 13% of manufacturers providing ICT training to their personnel, Greece's industry ranks low among its EU peers, nine points below the EU average (EU average 22%).
- Finally, with regards to the state of eGovernment applications for Greece, according to **EU's DESI Index 5th pillar of Digital Public Services**, Greece is among the lowest ranking EU countries, positioned at the 27th place among the EU 28.
 - Focusing on the level of eGovernment use, Greece, performs poorly, scoring last among all 28 EU countries, with just 36% of Greek citizens submitting forms to public authorities over the internet during 2018.
 - In terms of the digital public services for businesses, Greece also scores poorly, indicating that the country must significantly upgrade its current framework for accommodating the eGovernment needs. Greece's score was 65 points in 2018, 20 points below the EU average.

Organisations' perception on their Industry 4.0 capabilities

In order to capture the perception of the Greek Industry with regards to their Industry 4.0 capabilities, we performed the Industry 4.0 survey.³⁹ Before analysing its key messages, it is important to state here that the Industry 4.0 survey was distributed to over 30 federations and associations from the Greek Industry, which in turn distributed it to the enterprises of their sector(s). The 152 surveyed executives that responded belong mainly to organisations that are the frontrunners of the Greek Industry, which may imply that the actual layout of the Greek Industry 4.0 scene may differ from what was depicted in the survey. The outcomes of the survey though, enabled us to capture the pulse of the Greek industrial enterprises and to overlay the executives' opinions against “hard data”, in order to extract an additional layer of insight.

The surveyed Greek executives recognise the significance of Industry 4.0 and the changing of the industrial paradigm – 1 out of 2 of the surveyed executives recognise that their respective organisations have understood the significance of Industry 4.0 and acknowledge the fact that this will disrupt their

³⁹ The performed analysis and the respective conclusions were based on data recorded through the “Industry 4.0” survey ran by the Ministry of Development, PwC and Accenture, with 152 Greek executives across the following sectors: B: Mining & Quarring, C: Manufacturing, E: Water supply; sewage, waste management and remediation activities, F: Constuction, H: Transportation, J: Information & Communication, which was launched on November 2019 and closed in February 2020.

industries in the next years. Adding to the above, in terms of new opportunities that will arise from the introduction of Industry 4.0 technologies, most of the respondents expect Industry 4.0 to pave the way for “New Services”, “New Business Models” and “New Markets”.

Greek executives perceive their organisations’ increased productivity as the most important direct benefit from implementing Industry 4.0 technologies: Business leaders currently direct their Industry 4.0 attention in areas where they expect to see wider benefits. 2 out of the 3 the respondents perceive that, primarily, Industry 4.0 will increase productivity, while 1 out of 2 believe that Industry 4.0 will improve decision making and decrease operational costs. This indicates that Greek executives appear to primarily use Industry 4.0 technologies within their organisations to “become digital”, optimise their internal operations and reap direct benefits. The use of digital technologies to create new, smart, connected products currently comes as a second priority.

Greek organisations appear to have initiated their Industry 4.0 transformation, albeit at a variable degree: The majority of the surveyed organisations appear to have initiated their digital transformation across specific functions of their organisations. In fact, 7 out of 10 participants cited that their support functions demonstrate the highest level of digitisation, while Warehouse & Logistics and Marketing & Sales also demonstrate a relatively high degree of digital maturity. This verifies the abovementioned finding, that organisations primarily focus on internal efficiencies instead of aiming at the “smartification” of their products and services. In fact, according to the survey, the percentage of the surveyed organisations that produce “smart” products is still very low. Currently 1 out of 2 of them cite that their products have no interface or ability to communicate with any other machine, or that they can just send or receive only basic input/output signals (one-way communication).

Out of the total set of technologies that underpin the concept of Industry 4.0, Greek organisations appear to currently focus their attention to cloud, cybersecurity, big data analytics and manufacturing-dedicated systems, i.e. SCADA and MES: In terms of the Industry 4.0 technologies that Greek organisations implement, our survey indicates that during the last years, our respondents have focused their attention on the cloud, cybersecurity, big data analytics and SCADA and MES systems.

Evidence also indicates that organisations intend to invest intensively in Industry 4.0 initiatives over the next 5 years. Respondents cited that in the near future they plan to continue their investments in Cloud, Cybersecurity and big data analytics, while they also aim at actively experimenting with IIoT, industrial robots and AI. These investments in the latter technologies are expected to further increase Greece’s ranking across the respective indexes (i.e. % of Greek enterprises/ manufacturers implementing industrial robots).

At the same time, a quite alarming finding is surfaced. 20% of the respondents appear not to have implemented any Industry 4.0 technology in their organisations.

Participants’ production lines demonstrate a variable degree of digitisation, although the majority of the respondents claim to have revamped their production equipment during the last two years: With regards to the digitisation of the surveyed organisations’ production lines, an interesting finding emerges. Almost 4 out of 10 of the participants indicated that their organisations’ production lines demonstrate a very low degree of digitisation. Nevertheless, at the same time 7 out 10 of the same sample claim that they have modernised their production lines within the last two years.

The Greek surveyed executives face multiple challenges during their rotation to Industry 4.0: Our survey results suggest that the lack of digital skills for implementing and using Industry 4.0, the limited time to experiment, test and implement new Industry 4.0 technologies, the low level of clients' readiness with regards to Industry 4.0 practices and the lack of technical knowhow in implementing and using Industry 4.0 capabilities are being identified as the four top-of-mind challenges. These challenges confirm Greece's low position, both across the integration of digital technologies (DESI Index's 4th pillar) and across the digital skills of the Greek Human Capital (DESI Index's 2nd pillar).

Greek surveyed executives verify the limited digital skills currently existing in the Greek market: Only 15% of the Greek executives believe that their workforce is currently digitally adept, with major upskilling required mainly on new technologies, complex problem-solving and soft skills. In addition, the majority of Greek executives perceive that "Expertise in new technologies" will be the most sought-after skill when hiring employees for Industry 4.0 activities over the next 5 years, while "Soft skills" and "Problem solving skills" appear to also be important for about half of them.

Greek executives welcome the support of the Greek Government to further enable their organisations' digitisation: Greek organisations also cited that the Greek Government has an important role to play in abolishing the abovementioned structural inhibitors and accelerate Industry 4.0 adoption within the Greek industry, through the provision of relevant financial and non-financial incentives. To start with, almost 9 out of 10 Greek executives believe that the provision of a modern technological infrastructure (e.g. 5G, integrated national fibre optic broadband and wireless networks) could catalyse the implementation of Industry 4.0 initiatives within Greek organisations. In addition, 8 out of 10 of the respondents perceive the provision of relevant tax incentives as an important motive for organisations' digital transformation. Next to tax incentives, the provision of technical expertise for the design and implementation of Industry 4.0 initiatives and for tackling cybersecurity issues feature high on the agenda of 8 out of 10 respondents. These results suggest that the breadth and depth of the digital interventions required to be implemented by the Greek Government shall be significantly deep and wide, to ensure the setup of a holistic support mechanism for the Industry's rotation to Industry 4.0.

Strategic review of the present mechanisms, the policy mix and measures governing the digital transformation of the Greek Industry

Greece is only at the beginning of a long and demanding effort, in order to achieve Digital Transformation in the Industry sector. Up until today, there has been no official policy or action in the form of a strategy/initiative etc. from the side of the Greek state in order to support the transition of the Greek industry to the new digital era, i.e. towards Industry 4.0. Nevertheless, a set of measures have already been taken towards the right direction.

- The establishment of the Ministry of Digital Policy, Telecommunications and Media in 2016 was a first positive step towards assisting the digitalisation of the country and the economy overall. On the 8th of July 2019, the Ministry of Digital Governance was established in the place of the former Ministry of Digital Policy, Telecommunications and Media. The new Ministry currently updates the National Digital Strategy 2016-2021, in order to produce an enhanced and improved version that will be officially published within the first half of 2020.
- At the same time, an important step has also been taken by the signing of a memorandum of cooperation (in May 2019) regarding the setup of a digital Industry 4.0 platform, between the

General Secretariat for Industry and the Ministry of Digital Governance. However, up until now and as verified by the Ministry's team throughout our technical meetings, no action has been taken with regards to the establishment and the operationalisation of the platform.

Besides the aforementioned, in the latest months, two initiatives have been taken up by the Greek government in order to simplify and promote the regulatory environment of the country:

- Law 4622/2019, that seeks to re-organise the way the country's public administration is conducted, by simplifying the process of decision making (which from now on will be operated centrally from the Government).
- Law 4635/2019 (new multibill), that seeks to address the growth of the economy and the country at multiple levels. With respect to the Greek Industry, the multibill seeks to simplify the issuing of licenses for businesses in the Industry sector as well as offer financial incentives to businesses that seek to operate in the context of business clusters. This latter provision can drastically create value chains among business, leading to greater synergies and better results.

Besides political actions and initiatives, other non-public sector stakeholders promote and stress out the importance of a digital industry, state and economy in general. One of the main supporters of Industry 4.0 and its strategic importance for the competitiveness of the country and Greek enterprises in the future is the Federation of Enterprises (SEV) of Greece.

SEV, since February 2019, established the Observatory of Digital Transformation for the country. In the lines of this venture, the Digital Manufacturing Index (DMI) has been developed in order to monitor the digital results of the country as a whole, compared to its EU counterparts within the EU-28. In addition, currently, the NGS is under revision from the Ministry of Development and Investment and is expected to be further enhanced or modified where appropriate. Nevertheless, NGS remains an important source of information and can act as the soundboard for evaluating the introduced Industry 4.0 strategy for Greece and its execution pillars. Namely, as this will be presented below, NGS's key priorities (relevant to Industry 4.0) are also reflected in our proposed Industry 4.0 strategy

Currently the Government's policies for the digitisation of the enterprises in the industrial sector are supported through two main funding streams, the Operational Program "Competitiveness, Entrepreneurship & Innovation" (EPAnEK) and the Hellenic Development Bank (former ETEAN).

The operational programme EPAnEK constitutes one of the seven sectoral Operational Programmes of the Partnership and Cooperation Agreement (former NSRF) for the period 2014-2020. The pivotal strategic objective of EPAnEK is to enhance the competitiveness and extroversion of enterprises, to facilitate transition to quality entrepreneurship with innovation and the growth of domestic added value as the cutting edge. The total public expenditure for EPAnEK is set at €4,66 billion.

EPAnEK funds the support measure " Research – Create – Innovate " (total of €542,5 million) and also provisions the use of financial instruments (loans, guarantees, microfinance and equity financing) that could support its purposes. The measure "Research – Create – Innovate"⁴⁰ is managed by the General Secretariat for Research and Technology and aims to support:

⁴⁰ Source: http://www.antonistikotita.gr/epanek_en/news.asp?id=7

- research and innovation
- technological development and demonstration at operating enterprises for the development of new or improved products
- the development of synergies among enterprises
- research and development centres and higher education sector as well as to support
- the patentability of research results and industrial property.

EPAnEK has also published two actions that promote the digital transformation of enterprises and organisations., the “Digital Step” that aims at the digital upgrading of very small, small and medium sized enterprises with business plans from €5.000 to €50.000 and the “Digital Jump”, that aims at the digital transformation of very small, small and medium sized enterprises with business plans from €55.000 to €400.000. The funding scheme was co-financed by Greece and the European Union – European Regional Development Fund with a budget of €51,6 million.

The Hellenic Development Bank (HDB) aims to support the design, implementation and management of specialised financial actions, delivered by financial institutions to small and medium sized enterprises. The Hellenic Development Bank created two funding schemes that aim to support digital development of enterprises, the programme “Business Innovation Greece” and the programme “4th Industrial Revolution”.

- The programme “Business Innovation Greece”, aims to support the general objectives of European Economic Area and Norway Grants 2014-2021. The programme targets to increase value creation and sustainable growth in the Greek business sector and to allocate 75% of the funding to SMEs. The total budget of the programme for the ICT sector is €3 million and it is divided in two grant schemes, the “Individual Project Scheme” concerning SMEs and large enterprises with no more than 25% public ownership, and the “Small Grants Scheme 1” concerning SMEs.
- The Investment Scheme “4th Industrial Revolution”, aims to invest in new or existing SMEs that retain an establishment in the Greek territory at the time of the investment and are active in the field of the 4th Industrial Revolution. The budget of “4th Industrial Revolution” is set at €50 million from public funding and €15 million from private equity.

Besides the abovementioned funding sources and initiatives, there are additional funding sources that are used to support enterprises towards digital transformation:

- EquiFund⁴¹: An initiative created by the Greek Government in cooperation with the European Investment Fund (EIF) that supports research projects of SMEs and start-ups.
- COSME⁴²: The EU program for the Competitiveness of Enterprises and SMEs, running from 2014 to 2020, with a budget of €2.3 billion.
- InnovFin⁴³: With InnovFin – EU Finance for Innovators, the EIB Group (the European Investment Bank and the European Investment Fund) can provide financing starting at €25.000 for investments in research and innovation to companies and other entities of all sizes and age. InnovFin supports start-ups, SMEs, mid-caps, larger private companies, research institutes/ organisations and universities or R&I-driven entities.

⁴¹ EquiFund Brochure (<https://equifund.gr/wp-content/uploads/2018/02/EquiFund-Brochure.pdf>)

⁴² COSME – Leaflet (<https://ec.europa.eu/docsroom/documents/9783>)

⁴³ InnovFin (<https://www.eib.org/en/products/blending/innovfin/products/index.htm>)

- EIB⁴⁴: Offers loans, guarantees, equity investments and advisory services. The most suitable tool will depend on the objectives of the project and on various other factors.
- Tax incentives for investment⁴⁵: General Secretariat of Research and Technology provides certifications of scientific and technological research expenditure and deduction of 30% surcharge.

⁴⁴ EIB (<https://www.eib.org/en/products/index.htm>)

⁴⁵ Source: General Secretariat for Research and Technology

4 Existing Strategies for Greece

4.1 Greece’s “National Growth Strategy” (NGS)

Greece’s National Growth Strategy (NGS) is a strategy published in 2018 by the former Greek Ministry of Development, that outlines a set of measures to be taken across 5 different dimensions (Ensuring fiscal sustainability, Fostering sustainable growth, Establishing structural conditions for growth, Ensuring fair and inclusive growth and Making use of available financing tools), in order to enable high and prolonged growth of the Greek economy over the next decade.⁴⁶ For the purposes of the Industry 4.0 strategy, the most relevant dimensions are “Fostering sustainable growth”, “Establishing structural conditions for growth” and “Ensuring fair and inclusive growth”.

To foster Sustainable Growth the Government has identified 10 key sectors it seeks to develop: Transport and Logistics, Energy, Agri-food, Manufacturing, Shipping, Pharmaceutical sector, Health, Circular economy and sustainable natural resources management, Tourism and Culture. The NGS looks to support these 10 key industries by:

- Stimulating Interconnections and Public-Private Partnerships (PPPs)
- Supporting Start-ups & SMEs
- Increasing R&D&I
- Promoting innovative entrepreneurship

The NGS also promotes the improvement of the business environment to boost investment, through improving the efficiency of the public administration and its functions with initiatives that focus on simplification of processes, increased transparency, reduced bureaucracy and more.

Further, to establish the structural conditions for growth the NGS underlines the importance of creating a national digital strategy for Greece and upgrading the current digital infrastructure, with faster and more reliable broadband access and the deployment of 5G network. It also outlines key points of action to be taken in the financing, regulatory and e-government frameworks that could enable further digital transformation of Greece.

Additionally, to ensure fair and inclusive growth the NGS promotes a range of reforms in the educational system of Greece and suggests connecting education institutions to research centres. The main objectives of this policy are, the continuous modernisation of educational structures, the improvement of the educational outcomes, and the integration and development of graduates in the labour market. It also proposes measures to reinforce vocational training Technical vocational schools (EPAL) with psychology experts, digital infrastructure and more.

Currently, the NGS is under revision from the Ministry of Development and Investment and is expected to be further enhanced or modified where appropriate. Nevertheless, NGS remains an important source of information and can act as the soundboard for evaluating the introduced Industry 4.0 strategy for Greece and its execution pillars.

⁴⁶ <https://www.nationalgrowthstrategy.gr/en/>

Namely, as this will be presented below, NGS’s key priorities (relevant to Industry 4.0) are also reflected in our proposed Industry 4.0 strategy:

NGS Areas of Focus	Industry 4.0 Areas of Focus
<ul style="list-style-type: none"> Stimulating Interconnections and Public-Private Partnerships (PPPs) 	<ul style="list-style-type: none"> This will be covered by Execution Pillar 3: Collaborations & synergies
<ul style="list-style-type: none"> Supporting Start-ups & SMEs 	<ul style="list-style-type: none"> This will be covered by Execution Pillar 2: Innovation & start-ups in the Digital Age
<ul style="list-style-type: none"> Increasing R&D&I 	<ul style="list-style-type: none"> This will be covered by Execution Pillar 2: Innovation & start-ups in the Digital Age
<ul style="list-style-type: none"> Promoting innovative entrepreneurship 	<ul style="list-style-type: none"> This will be covered by Execution Pillar 2: Innovation & start-ups in the Digital Age
<ul style="list-style-type: none"> Focus on 10 key sectors: Transport and Logistics, Energy, Agri-food, Manufacturing, Shipping, Pharmaceutical sector, Health, Circular economy 	<ul style="list-style-type: none"> This will be covered by the pilot areas on which the Industry 4.0 strategy will focus
<ul style="list-style-type: none"> Investing in Infrastructure 	<ul style="list-style-type: none"> This will be covered by initiatives to be proposed for the digitisation of the key digital foundations
<ul style="list-style-type: none"> Investing in Education 	<ul style="list-style-type: none"> This will be covered by Execution Pillar 1: Digital skills & human capital qualification
<ul style="list-style-type: none"> Simplifying the regulatory system 	<ul style="list-style-type: none"> This will be covered by Execution Pillar 5: Regulatory Environment
<ul style="list-style-type: none"> Building a modern state & modernize the Greek Public Administration 	<ul style="list-style-type: none"> This will be covered by initiatives to be proposed for the digitisation of the key digital foundations

4.2 National Research and Innovation Strategy for Smart Specialisation (RIS3)

The Research and Innovation Strategies for Smart Specialisation (RIS3) is a comprehensive economic transformation agenda of the European Commission, tailored to the specifics of each region, which:

- focuses political support and investment on national/regional key-priorities, challenges and needs for knowledge-based development
- builds on the strengths and comparative advantages of the country/ region and the potential for excellence
- supports technological innovation and innovation based on practice and aims to stimulate private investment
- ensures the full participation of stakeholders and encourages innovation and experimentation
- is defined by an evidence based and solid monitoring and evaluation system

Overall, 1 national and 13 regional research and innovation strategies for smart specialisation were developed in Greece covering the period 2015-2020 . The national strategy was developed by the General Secretariat for Research and Technology (GSRT) of the Ministry of Education, Research and Religious Affairs while each Region was responsible for the preparation of its own strategy. The Special Strategy, Planning and Evaluation Service (EYSSA) of the Ministry of Economy, Development and Tourism had a coordinating role in the overall process.

The investigation carried out in the context of the preparation of the National Strategy led to the identification of 8 industries in which research and innovation can contribute to the development of a significant competitive advantage.

- Agro-food
- Health–Pharmaceutical
- Information and communication technologies
- Energy
- Environment and sustainable development
- Transport
- Materials-Construction
- Tourism – Culture – Creative industries

The main aim of Greece’s national RIS3 strategy is the effort to reinforce Research, Technological Development and Innovation (RTDI) activity in the private sector by strengthening employment, by developing new businesses and clusters and by strengthening the institutional framework, while mitigating regional disparities and creating sustainable employment.⁴⁷

Thus, RIS3 ensures the development of all RTDI types:

- Innovation produced by "market needs" (demand driven)
- Innovation produced by research from scientific curiosity (curiosity-driven)
- Innovation produced to fulfil strategic mission (mission-led)

To fulfil the afore presented vision, the country has set a target, in the context of the Medium-Term Financial Strategy and the National Reform Program, that investments in research will reach 1.2% of GDP in 2020 from the current (2013) 0.80%. Respectively, investment in research from businesses is expected to rise from 0.27% of GDP in 2013 to around 0.38%.

Indicators for measuring objectives of the strategy for Research and Innovation	2013	2020
Percentage of spending on Research and Development in relation to GDP	0,80%	1,20%
Enterprise expenditure on Research & Development in relation to GDP	0,27%	0,38%

Table 1: Research and technological development objectives, of Greece’s National RIS3 Strategy, for 2020

Greece’s national RIS3 strategy, is constructed upon a SWOT analysis performed on the country that surfaced the following results:

- Greece has excellent human resources and RTDI structures, but they are not well exploited
- The private sector lags seriously behind in RTDI investment, especially in product innovation and use of new knowledge. However, critical masses of dynamic SMEs are found in both "old" and new production sectors.

⁴⁷ <http://www.gsrt.gr/News/Files/New1034/Executive%20Summary-2015-09-17-v04.pdf>

- The economic crisis complicates the possibility of exploitation of human resources and the overall development of a national RTDI strategy.
- There are strong challenges and resistances on the role of state and on the mentality towards innovation of both the state and the private sector.

Based on the challenges and objectives emerging from the SWOT Analysis, the following 3 Strategic Pillars and 4 Axes for Intervention outline the framework of the Smart Specialisation Strategy:

Pillar 1 (Digital skills & human capital qualifications): Investing in the creation and dissemination of new knowledge to promote excellence in research. Strengthening mechanisms, networking, human resources in research, research infrastructure and innovation support of RTDI structures (capacity building), promotion of access to information and research results.

Pillar 2 (Innovation & start-ups in the Digital Age): Strengthening investment in research and innovation, supporting innovative enterprises in international markets through research and innovation, and development of new innovative “players”

Pillar 3 (Collaborations & synergies): Developing innovative attitudes, institutions and RTDI links with the society to address social challenges.

1. Develop RTDI potential in specific areas of expertise (capacity building):
 Development of public RDTI institutions, their personnel, partnerships with businesses, provision of RTDI services, and strengthening of the production ecosystem with new players and financial mechanisms.
2. Strengthening RTDI activities: Supporting SMEs and business clusters and RTDI bodies to develop targeted collaborations. Development of RTDI projects and innovative capacity in the business sector.
3. Mechanisms and support structures for networking and communication, hatching new players, support of the innovative effort of businesses and shaping entrepreneurial discovery mechanisms.
4. Develop openness and networking to exploit the productive and innovative potential and the connection to the global RTDI activities, liaison with the Greek society and exploration of the effects of technological change on social cohesion and development.

Strategic Pillars of RIS3/ National Intervention Axes	Investing in the creation and dissemination of new knowledge	Investing in research and innovation	Develop innovative attitudes, institutions and RTDI interfaces with society
Resources development (capacity building)	Develop RTDI potential in the areas of specialisation	Hatching new business players	Strengthening mechanisms and institutional framework
Strengthening RTDI activities	Strengthening RTDI activities and islands of excellence	Strengthening endogenous research and innovation in businesses	Strengthening demand for innovation from the public administration

Mechanisms and support structures	Aid to (Sub)- networking structures	Infrastructure and innovative entrepreneurship support mechanisms	Mechanisms for Business Discovery and Documentation
Extraversion and networking	Interface and cooperation in RTDI	Business extroversion	Developing innovative culture

The National RIS3 Strategy for Greece is setting the foundations for improving RTDI in Greece across a several metrics (Percentage of spending on Research and Development in relation to GDP, Enterprise expenditure on Research & Development in relation to GDP) and sectors (Agri-food, Health-Pharmaceutical, Information and communication technologies, Energy, Environment and sustainable development, Transport, Materials-Construction, Tourism – Culture – Creative industries) for Start-ups, SME’s and other innovative businesses.

These initiatives introduced by the National RIS3 Strategy for Greece, as well as the specific areas of economic activities that the strategy indicates will be leveraged as valuable input to architect the Industry 4.0 strategy for Greece. Namely, they will be used as input across the following dimensions:

- Execution Pillar 2 (Innovation & Start-ups), Execution Pillar 4 (Standardisation & Norms), Execution Pillar 6 (Acceleration of Investment in digital technologies)
- The pilot areas selected for further analysis within Deliverable 3

Both the NGS and the national RIS3 Strategy are also included under the “Increased interest and focus on digital from the higher levels of government and industry federations, as well as from the European Commission“ strength in the SWOT analysis presented below (paragraph 7.2.1).

5 The European Industrial Strategy

In March 2020, the European Commission introduced the EU Industrial Strategy which aims at facilitating transition of European industry into the Industry 4.0 paradigm. The Strategy is predicated around three key strategic priorities: maintaining the EU industry's competitiveness at home and globally, making Europe climate neutral by 2050, and shaping the continent's digital future.

To realize its objectives, the EU Industrial Strategy outlines several actions and policy initiatives which enable member states to better leverage the growth opportunities ahead while overcoming current obstacles to sustainability, fair competition, and digital integration. The EU's Industrial Strategy includes actions to accelerate competition globally and locally, such as an Intellectual Property Action Plan, the comprehensive review of current EU competition rules, a white paper to address the distorted effects caused by foreign subsidies and an action plan on Critical Raw Materials, to secure their steady supply to EU industrial companies. Furthermore, the Strategy includes a significant number of initiatives focusing to promote the modernisation and decarbonisation of energy intensive industries such as the Clean Hydrogen Alliance and new green public procurement legislations. Sector specific actions have also been introduced, such as new EU Pharmaceutical Strategy while innovation, investment and skills are supported on a cross-sectoral level within the Strategy. The EU Industrial Strategy also places weight on the support of industrial ecosystems, indicating that the Commission understands their centrality to Industry 4.0. In this context, the Strategy is the creation of an industry forum aimed at analysing the risks and needs of different industrial ecosystems⁴⁸.

In addition to promoting competition, innovation and sustainability for EU's industry, a significant segment of the Industrial Strategy is dedicated to the removal of entrenched barriers in the European single market, which, if overcome, are estimated to unlock €713 billion by the end of the decade. The Single Market Enforcement Action Plan aims at removing structural barriers to the single market such as lack of access to information, burdensome administrative procedures, uneven access to public procurement, market access denial due to byzantine technical standard requirements, and obstacles to cross-border purchases and deliveries, due to practices such as geo-blocking, language barriers, and different between administrative and tax regimes⁴⁹.

Finally, perhaps one of the most central elements of the Industrial Strategy is the newly introduced EU SME Strategy, which aims at supporting SMEs as they undergo the twin transition of digital and green transformation. Its main priorities include removing regulatory and practical obstacles to SME growth, supporting SME initial public offerings through the InvestEU SME window, and introducing the EU Start-up Nations Standard, which will share and adopt best practices to accelerate growth of high-tech SMEs and start-ups. To ensure efficient cross-country cooperation, the European Commission will introduce a high-level EU SME Envoy to guarantee the close partnership and coordination between EU Member States through respective national SME Envoys. Finally, the EU SME Strategy will utilize three key supporting structures to execute the aforementioned initiatives: Sustainability advisors, Digital Innovation Hubs, and the European Innovation Council (EIC). Sustainability advisors are appointed within the existing Enterprise Europe Network to help SMEs with environmental and social challenges and improve their access to skills. Digital Innovation Hubs, covered earlier in this report, will be tasked with advising SMEs

⁴⁸ https://ec.europa.eu/commission/presscorner/detail/en/fs_20_425

⁴⁹ https://ec.europa.eu/commission/presscorner/detail/en/fs_20_427

on the integration of digital innovations into their products, business models, and processes. The European Innovation Council (EIC) will provide €300 million to encourage breakthrough innovations delivering Green Deal objectives⁵⁰.

The EU Industrial Strategy focuses on accelerating EU's path towards an advanced, competitive and environmentally friendly industry. The Greek Industry 4.0 strategy can greatly benefit by all the focus areas and initiatives that the EU Industrial Strategy provides. Greek SMEs can take advantage of the multitude of enabling tools and assets that the EU SME strategy provides, the Greek Pharmaceutical industry can similarly take advantage of its corresponding EU strategy and the Greek industry as a whole can benefit from support towards its efforts for cleaner and more sustainable production and operation practices. The Intellectual Property Action Plan and other standardisation initiatives will enable trustworthiness and increase cross-border trade and collaboration across the EU, while the recognition and efforts of eradicating rigid and cumbersome regulations that stifle innovation, investments and the further development of the European industry can be mirrored by corresponding initiatives at a national level in Greece, by simplifying regulatory procedures and removing unnecessary bureaucratic obstacles.

The EU Industrial Strategy will also be mentioned as an opportunity in the SWOT analysis presented below.

⁵⁰ https://ec.europa.eu/commission/presscorner/detail/en/fs_20_426

6 European Commission financing initiatives for strategic value chains in the EU

The term “value chain” is associated with both a set of interdependent economic activities creating added value around a product, process or service, and a group of interlinked economic actors, operating in a strategic network across firms of different sizes, including SMEs, sectors and borders. Strategic value chains (SVCs) are of systemic importance and make a clear contribution to growth, jobs and competitiveness. They are characterised by the following three dimensions⁵¹:

- technological innovativeness, i.e. the value chain is based on the exploitation of strategic key enabling technologies, technological breakthroughs, major outcome of R&D or disruptive innovation (e.g. autonomous driving, low carbon technologies).
- economic and market potential, i.e. the value chain has considerable economic weight, actual or potential.
- societal and political importance for Europe, i.e. the value chain makes an important contribution to European societal challenges and/or policy goals (e.g. climate change, ageing population). The value chain is also instrumental to Europe's security and autonomy. In a world where more and more industrial processes are fully interconnected, certain key technologies need to be produced and intellectually owned in Europe to achieve a degree of technological independence for example in critical infrastructure, components or intellectual property sets in order to ensure economic security.

The European Commission has identified the following 9 value chains as its key SVCs:

- Clean, connected and autonomous vehicles (CCAV)
- Smart Health
- Low CO2 emissions Industry
- Hydrogen technologies and systems
- Industrial Internet of Things
- Cybersecurity
- Batteries
- High-performance computing
- Microelectronics

Depending on the capital needs, state of activities and R&D development in an SVC, a range of funding schemes at EU and national level can be mobilised in order to incentivise, leverage and/or ‘de-risk’ private investment. The support to SVC should build on an innovative approach, enabling multilevel funding synergies (regional, national, European), and the basic principle should be using public resources to leverage private investments in cases where private investment is insufficient. In the next Multiannual Financial Framework, the relevant funding opportunities include:

- The InvestEU program, bringing together all EU financial instruments, with relevant windows for research, innovation and digitalisation; sustainable infrastructure; small and medium-sized businesses; social, investment and skills.

⁵¹ <https://ec.europa.eu/docsroom/documents/37824>

- The Horizon Europe program for research, development and innovation. European Public-Private Partnerships (institutionalised, co-funded, and co-programmed) have proven to increase R&I investments around a commonly agreed long-term agenda and create cross-sector cooperation. They should therefore be closely involved in the process and strengthen research and development and the deployment of innovative technologies in the SVCs.
- The Digital Europe program for capacity building in key digital sectors such as cybersecurity and artificial intelligence.
- The Connecting Europe Facility will support infrastructure projects and can be relevant for strategic value chains with infrastructure needs (e.g. autonomous mobility).
- The European Structural and Investment Funds (ESIF) implemented in partnership with Member States and their regions. The bulk of the investments will go towards innovation, support to small businesses, digital technologies and industrial modernisation and the shift towards a low-carbon, circular economy and the fight against climate change. Often, these investment objectives overlap, increasing the added value of investments (e.g. innovative solutions to fight climate change).

Name	Description	Focus Areas	Budget (€)	Until
Competitiveness of SMEs (COSME)⁵²	Supporting SME's and encouraging competitiveness	<ul style="list-style-type: none"> • SMEs • Competitiveness 	2,3 Billion	2020
Connecting Europe Facility (CEF)⁵³	Connecting Europe through interconnected trans-European networks	<ul style="list-style-type: none"> • Transportation • Energy • Digital Services 	30,4 Billion	2020
LIFE Program⁵⁴	Funding for climate action	<ul style="list-style-type: none"> • Climate & Environment 	3,4 Billion	2020
European Structural & Investment Funds (ESIF)⁵⁵	Supports the development of Regional and Social initiatives across Europe in a multitude of areas	<ul style="list-style-type: none"> • Development & Innovation • Access, Use and Quality of ICT • Low-carbon economy • Climate & Environment • Resource efficiency • Sustainable transport • Network infrastructures 	351,8 Billion	2020
European Maritime and Fisheries Fund (EMFF)⁵⁶	Supporting the maritime industry to diversify their economies and to adopt more sustainable processes	<ul style="list-style-type: none"> • Fishermen • Coastal cities • Aquacultures 	6,4 Billion	2020
Horizon Europe⁵⁷	Biggest European Research and Innovation program, designed to succeed Horizon 2020 with 5 Mission Areas	<ul style="list-style-type: none"> • Climate Change • Cancer • Climate neutral and smart cities • Healthy oceans, seas, coastal and inland waters • Soil, Health and Food 	100 Billion	2024
Interoperability Solutions (ISA²)⁵⁸	Funding to enable digital transactions between Europeans	<ul style="list-style-type: none"> • Digital Solutions for cross-border and cross-sector public services 	131 Million	2020
Invest EU⁵⁹	Designed to succeed the Juncker Plan and further boost investment, innovation and job creation in Europe	<ul style="list-style-type: none"> • Sustainable Infrastructure • Research & Innovation • Digitisation • SME's • Social Investment & Skills 	650 Billion	2027

⁵² <https://ec.europa.eu/easme/en/cosme-0>

⁵³ <https://ec.europa.eu/inea/en/connecting-europe-facility>

⁵⁴ <https://ec.europa.eu/easme/en/life>

⁵⁵ https://ec.europa.eu/eip/ageing/funding/ESIF_en

⁵⁶ <https://ec.europa.eu/fisheries/cfp/emff/>

⁵⁷ https://ec.europa.eu/info/horizon-europe-next-research-and-innovation-framework-programme_en

⁵⁸ https://ec.europa.eu/isa2/isa2_en

⁵⁹ https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/investment-plan-europe-juncker-plan/whats-next-investeu-programme-2021-2027_en

Digital Europe⁶⁰	Focuses on facilitating the wide deployment of digital technologies, to be used by Europe's citizens and businesses	<ul style="list-style-type: none"> • Supercomputing • Artificial Intelligence • Cybersecurity • Advanced digital Skills 	9,2 Billion	2027
------------------------------------	---	---	-------------	------

The EU’s commitment to support the development of a modern, sustainable and innovative industry network across the EU is clear and the Greek Industry 4.0 strategy should consider how these EU priorities shall be met through the introduced initiatives, as well as how the various EU funding schemes can support the digitisation of the Greek industry.

The EU financing initiatives will also be mentioned as an opportunity in the SWOT analysis presented below.

⁶⁰ <https://ec.europa.eu/digital-single-market/en/news/digital-europe-programme-proposed-eu92-billion-funding-2021-2027>

7 SWOT analysis: Analysis & evaluation of the current situation for Greece

7.1 Chapter's Summary: Greece's Industry 4.0 "As-Is" anatomy

Greece's Strengths

During the recent years, and up until the COVID-19 pandemic started to unfold on a global scale, Greece had demonstrated signs of economic recovery, it being depicted both in the country's GDP and employment growth (1,9% and 2% in 2019).⁶¹ At the same time, the Greek industry significantly contributes to the national economy, generating more than 24% of the country's Gross Value Added (for 2017)⁶², employing the 19% of Greek employees in 2017 (-6% from 2000)⁶³ and increasing its production by 3% by 2020 compared to 2015.^{64, 65} The aforementioned introduce a set of favourable conditions for the country to leverage Industry 4.0 so as to accelerate its Industry's transformation and enhance its growth, productivity and competitiveness. The transformative power and the benefits that digital and Industry 4.0 can bring to the Industry sector and the economy as a whole have also been recognised by the European Commission, the Greek Government and the Industry federations. All these key stakeholders demonstrate a reinvigorated interest and focus on the digitisation of the Greek economy and society and have undertaken a set of initiatives (i.e. the introduction of the Digital Single Market strategy⁶⁶ by the European Commission, the design of the "Bible of Digital Transformation" from the Greek Ministry of Digital Governance and the design of the "Industry 4.0" program by the Federation of Enterprises of Greece (SEV)⁶⁷) to enable this.

At the same time, the Greek Industry also appears to recognise the significance of Industry 4.0 according to the responses that we received through our Industry 4.0 survey.⁶⁸ Questioned Greek executives aim to implement such technologies to increase their internal efficiencies and productivity. Most of the surveyed executives stated that they initially have focused on the digitisation of their organisations' support functions, their marketing & sales and production divisions. Acknowledging the significant efficiencies that Industry 4.0 can bring to their production lines, as well as the new revenue streams that can be generated by the "smartification" of their products, the majority of them plan to dedicate additional funding to primarily transform their production and product development functions.

The survey also surfaced that Greek enterprises claim to have already initiated their collaboration with their clients and suppliers to co-create their products & services, a task which appears to be primarily led

⁶¹ Hellenic Statistical Authority, Stochasis Macroeconomic Trends -SectoralForecasts, December 2019. Forecasts have been provided by Stochasis

⁶² Eurostat, National accounts aggregates by industry (up to NACE A*64), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64&lang=en

⁶³ Eurostat, National accounts employment data by industry (up to NACE A*64), http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64_e&lang=en

⁶⁴ Eurostat, Production in industry - annual data, https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=sts_inpr_a&lang=en

Data are compiled according to the Statistical classification of economic activities in the European Community, (NACE Rev. 2, Eurostat). Data and weights are available for the following NACE categories: B) Mining and Quarrying, (C) Manufacturing, (D) Electricity, Gas Steam and Air Conditioning supply, (E36) Water Supply and collection

⁶⁵ Stochasis report: Stochasis Macroeconomic Trends – Sectoral Forecasts, December 2019

⁶⁶ <https://ec.europa.eu/digital-single-market/en/policies/shaping-digital-single-market>

⁶⁷ Additional information on initiatives undertaken by the Greek Government and Industry Federations can be found in Deliverable 1.

⁶⁸ The performed analysis and the respective conclusions were based on data recorded through the "Industry 4.0" survey ran by the Ministry of Development, PwC and Accenture

by small and very small enterprises⁶⁹. It is also quite encouraging that Greek enterprises already invest on selected Industry 4.0 technologies (i.e. cloud, cybersecurity and big data analytics). At the same time, moving forward, they plan to actively experiment more with the IIoT, industrial robots and Artificial Intelligence. The specific emphasis that Greek enterprises currently place on data and big data analytics capabilities is also confirmed by relevant 3rd party indexes, according to which 13% of Greek enterprises (compared with 12% of the EU) invest in the collection and Big Data.⁷⁰

Greece is also home to a burgeoning start-up & Digital Innovation Hubs scene. From 2012 to 2016, investment in Greek Start-ups grew by a factor of 18, from 5 to 90 million €⁷¹. In addition, Greece currently has 14 Digital Innovation Hubs (9 fully operational and 5 in preparation status) covering various market domains through a large spectrum of technology areas (ranging from additive manufacturing and AI and cognitive systems to sensors, actuators and simulation and modelling). To further boost this area, both the European Commission and the Greek Government have introduced a set of targeted funding mechanisms (i.e. the Operational Program “Competitiveness, Entrepreneurship & Innovation” (EPAnEK), the Hellenic Development Bank (former ETEAN), etc.). The Greek Government has also undertaken a set of measures to transform Greece’s regulatory environment through the introduction of a set of directives on digital technologies and a set of laws (i.e. 4622/2019 and 4635/2019) for the simplification and reorganisation of Greece’s public administration and for boosting and assisting the Greek business environment.

Finally, Greece’s technically adept human capital can prove a great strength for its digitisation. Greece’s overall high number of tertiary graduates⁷², its adequate number of ICT and STEM graduates^{73, 74} and its high diaspora around the world shall become the cornerstone of Greece’s Industry 4.0 rotation and shall act as the catalyst for unlocking the Greek Industry’s digital potential.

The aforementioned Industry 4.0 strengths that Greece demonstrates introduce a set of favourable conditions for Greece’s rotation to Industry 4.0 and highlights key levers that could be further exploited to accelerate the country’s digital transformation. Greece’s financial recovery (prior to the COVID-19 pandemic), the important role that the Greek Industry plays in the Greek economy and the reinvigorated interest of the Greek Government and Greek enterprises in digital indicates that this is the right time for Greece to design and implement a holistic Industry 4.0 strategy. This strategy shall incorporate initiatives that will further enhance the investments of Greek enterprises in the digitization of their production and product development functions, will accelerate the “smartification” of their products and will enable the Greek Industry to experiment and deploy emerging Industry 4.0 technologies like IIoT, industrial robots and Artificial Intelligence. Applied research on big data analytics shall also be promoted, while potentially the setup of a relevant competence centre or digital hub on Artificial Intelligence and analytics can further stimulate the broad uptake of Artificial Intelligence and analytics in both industries (in particular SMEs and midcaps) and public sector organisations. Finally, the burgeoning Greek start-up scene should further be

⁶⁹ Based on characterisation of company size by number of employees from Eurostat (Very Small – <10, Small – <50, Medium – <250, Large – >250)

⁷⁰ Eurostat, Big data analysis, https://ec.europa.eu/eurostat/web/products-datasets/product?code=isoc_eb_bd

⁷¹ SEV & BCG, „The Greek startup Ecosystem” Report, http://www.sev.org.gr/Uploads/Documents/50906/BCG_Greeces_Startup_Ecosystem_Apr_2018.pdf

⁷² Eurostat: Students enrolled in tertiary education by education level, programme orientation, sex, type of institution and intensity of participation, https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=educ_uae_enrt01&lang=en

⁷³ Eurostat, Employed persons with ICT education by educational attainment level, https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_ski_itedu&lang=en

⁷⁴ Eurostat, Graduates in tertiary education, in science, math., computing, engineering, manufacturing, construction, by sex - per 1000 of population aged 20-29, https://ec.europa.eu/eurostat/web/products-datasets/product?code=educ_uae_grad04

supported through targeted measures to ensure the creation of the right conditions for ambitious entrepreneurs of the Greek Industry.

Greece’s weaknesses

The country’s limited capital investments and the major money supply shocks constitute the most important weaknesses for Greece from an economic standpoint. Also, a key reason for the country’s limited, fragmented, dispersed and not structured Industry 4.0 initiatives thus far has been the lack of a holistic national Industry 4.0 strategy and a structured mechanism to coordinate Industry 4.0 programmes and initiatives. The first structured approach for Greece’s digital transformation was only introduced in 2016 by the Ministry for Digital Policy, Telecommunications, and Media through the design of the Greek National Digital Strategy (2016-2021), nevertheless without providing the expected outcomes, since it did not propose a concrete strategy and a structured action plan that would engage all responsible stakeholders for the country’s digital transformation. Furthermore, Greece has not designed yet an Industry 4.0 platform, through which the Greek Public Administration could monitor, manage and coordinate the different Industry 4.0 programmes.

According to EU’s DESI Index, in 2019, Greece ranked 26th out of 28 EU member states with regards to its digital maturity and was positioned at the tail end of the index, with a score 28% lower than that of the European average. The lack of a structured Industry 4.0 strategy has led to the Greece’s suboptimal position against their EU counterparts with regards to all Industry 4.0 and digital indicators. Greece’s unfavourable rating in the DESI index is aligned with the country’s low ranking across Accenture’s Digital Economic Opportunity Index (DEOI), where Greece scored at the lowest end of the digital maturity curve in 2018 (22nd out of the 22 countries of the sample) and EU’s Digital Transformation Scorecard.

Greek enterprises are also suboptimally positioned regarding their adoption of a set of Industry 4.0 technologies (i.e. cloud computing⁷⁵, RFID technologies⁷⁶ and other^{77,78,79,80,81,82}). In addition, Greece’s suboptimal position with regards to its digital infrastructure⁸³ and the provision of digital public services⁸⁴, prevent the Greek enterprises from rapidly adopting new Industry 4.0 technologies and supporting their technology needs. Looking at an enterprise level an alarmingly high percentage of the enterprises we surveyed (especially across the very small enterprises⁸⁵, the national⁸⁶ enterprises and those with less than 10 years of operation) state to not have invested yet in any Industry 4.0 technologies. In addition, despite the recent revamping of their production IT landscape, the surveyed enterprises demonstrate a low level of digitisation across their production lines.

⁷⁵ Eurostat, Cloud computing services, https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_cicce_use&lang=en

⁷⁶ Eurostat, Enterprises using radio frequency identification (RFID) instrument, <https://ec.europa.eu/eurostat/web/products-datasets/-/tin00126>

⁷⁷ No data was available with regards to the use of industrial robots by Greek manufacturers

⁷⁸ Eurostat, Integration of internal processes, <https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do>

⁷⁹ https://ec.europa.eu/growth/tools-databases/kets-tools/sites/default/files/library/kets_observatory_second_report.pdf

⁸⁰ KETs observatory - https://ec.europa.eu/growth/tools-databases/kets-tools/sites/default/files/library/kets_observatory_second_report.pdf

⁸¹ <https://www.itu.int/en/ITU-D/Cybersecurity/Pages/global-cybersecurity-index.aspx>

⁸² <https://ec.europa.eu/environment/circular-economy/>

⁸³ Digital Economy and Society Index Indicators 2019, Connectivity, <https://digital-agenda-data.eu/datasets/desi/indicators>

⁸⁴ The Digital Economy and Society Index 2019, Digital Public Services, https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=59975

⁸⁵ Based on characterisation of company size by number of employees from Eurostat

(Very Small – <10, Small – <50, Medium – <250, Large – >250)

⁸⁶ Greek: the company operates exclusively in Greece, Multinational: the company operates in at least one country other than its home country

Greece also ranks low in terms of innovation and R&D, both with regards to their R&D intensity (19th among the EU 28 in 2018⁸⁷) and with regards to the overall number of the issued Greek patents (24th among the EU 28 in 2017⁸⁸). In addition, R&D appears disassociated with applied research & industry implementation, as contrary to the EU average the Greek R&D is mainly dominated by the higher education sector, while with many Greek organisations appearing reluctant to invest in applied R&D.

Greek enterprises currently face structural and regulatory obstacles during their setup and operations, with areas of “dealing with construction permits”, “registering property”, “getting credit” and “enforcing contracts” scoring particularly low across the annual report on the ease of “Doing Business” for 2020⁸⁹. The Industry 4.0 survey verifies this finding, as most of the surveyed executives place the provision of Industry 4.0 related tax incentives and the development of a flexible, digital-friendly regulatory framework as the top incentives that the Greek Government should undertake to enable the Greek organisations’ digital transformation.

Finally, despite Greece’s technically adept human capital, the Greek Government and enterprises have only performed limited investments regarding the digital upskilling and reskilling of their industrial workforce. Despite organisations’ appetite to employ ICT-oriented employees, the Greek enterprises appear unwilling to further invest in their human capital’s digital upskilling, since only 14% of them offered ICT skills training to their employees in 2018, compared to the EU average of 23%.⁹⁰ In addition, according to interviews we had with Government representatives, the initiatives currently undertaken within the Greek ecosystem (by the Public Administration, academia, federations businesses) have been dispersed and are not underpinned by any common digital skills vision and strategic guidelines. The Greek surveyed executives also verify the limited digital skills currently in the Greek market, especially regarding capabilities around Artificial Intelligence, Cloud, Big Data analytics and Cybersecurity.⁹¹ Finally, from an environmental and circular economy perspective, Greece has been Europe’s lowest ranking country, with regards to the average circular use of materials, with only 1% circular material use as a share of total material use in 2016.⁹²

How can Greece address its weaknesses through its Industry 4.0 strategy? The fragmented and dispersed Industry 4.0 and digital initiatives, that have taken thus far place regarding the Greek industry, shall become consolidated under the holistic Industry 4.0 strategy for Greece and shall be monitored through the introduction of the Industry 4.0 platform. In addition, the thus far low adoption of digital technologies by the Greek enterprises, sets also as a prerequisite for the Industry 4.0 strategy to introduce and prescribe a set of measures and relevant funding mechanisms to ensure the increase of the Industry 4.0 awareness across the Greek industry, as well as to enhance the incentivization of the firms to actively invest in new technologies and technological equipment and improve their digital maturity. At the same time, the limited investments in R&D and its disassociation with the applied research asks for targeted strategic initiatives that shall aim to strengthen the collaboration between the Greek Government, Industry, Research & Academia.

⁸⁷ OECD, Gross domestic spending on R&D, <https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm>

⁸⁸ Eurostat, Patent applications to the European Patent Office, https://ec.europa.eu/eurostat/web/products-datasets/product?code=sdg_09_40

⁸⁹ <https://www.doingbusiness.org/>

⁹⁰ Eurostat, Enterprises that provided training to develop/upgrade ICT skills of their personnel, https://ec.europa.eu/eurostat/en/web/products-datasets/-/ISOC_SKE_ITTN2

⁹¹ The performed analysis and the respective conclusions were based on data recorded through the “Industry 4.0” survey ran by the Ministry of Development, PwC and Accenture

⁹² Eurostat, Circular material use rate, https://ec.europa.eu/eurostat/databrowser/product/view/cei_srm030?lang=en

Despite Greece’s technically adept human capital, the Greek Government and enterprises have only performed limited investments regarding the digital upskilling and reskilling of their industrial workforce. As such, a set of initiatives shall be introduced with the aim to ensure the digital upskilling and reskilling of existing and future Industry workforce, with special emphasis to be given to the workforce’s upskilling in specific capabilities around Artificial Intelligence, Cloud, Big Data analytics and Cybersecurity. In addition, the introduction of a flexible, digital-friendly regulatory environment and an ICT standardization framework, as part of Industry 4.0 strategy, shall abolish the existing regulatory hurdles, restrictions, and red tape and prevent the exit of capital, labour and entrepreneurship from Greece.

Greece’s suboptimal position with regards to its digital infrastructure and the provision of digital public services indicates that the Industry 4.0 strategic plan shall also prescribe a set of foundational initiatives regarding the establishment of digital infrastructure and public digital services, to act as the accelerators for the Greek Industry’s rotation. Last but not least, Greece’s low ranking with regards to the average circular use of materials, indicates that the Industry 4.0 strategy shall also zoom into targeted actions that will enable the Greek industry to actively participate in the circular economy ecosystem and enhance their adoption of “greener” policies and technological solutions.

Greece’s Opportunities

Global changes that currently take place in the distribution and nodes of power and EU’s competitive positioning within the global market and ecosystem, enable Greece to become part of wider global ecosystems. Countries will form “nodes” of wider, multi-country ecosystems to tackle major global challenges as a union, determined by the number and quality of bi- and multilateral relationships formed between them. Influence will be determined by trade and aid flows rather than economic power, and by arms and technology transfers rather than military spending. Alliances of international organisations will constitute capital, as will connectivity – especially in the form of new technologies.⁹³ EU’s competitive positioning within the global market and ecosystem, as well as the “open” and “free flow” market that has established amongst its member-states, enables Greece to become part of wider European ecosystems.

Greece shall also leverage the EU’s policies and schemes that favour the country’s digitisation and tap into a wealth of initiatives and support mechanism available on the EU level. On that note, the European Industrial Strategy⁹⁴ shall enable Greek enterprises of all sizes to increase their competitiveness by integrating further within the single market and utilising the Commission’s support to innovate in their field.

Industry 4.0 will bring about radical shifts in industrial products’ form and functionalities. This “smartification” of products can enable Greek enterprises to produce products & services of higher added value and become more competitive; high performers that produce smart, personalised products, are able to achieve a significant increase on their return of investment (up to 14%), cost savings (up to 6%) but also differentiation (up to 22%) and customer satisfaction (up to 16%).⁹⁵ The emergence of new business models (e.g. “As-a-Service”, “pay-as-you go”, platform-based) can also support Greek enterprises in tapping new sources of value creation. In fact, the emergence of new business models offers an unprecedented opportunity for the growth of domestic industrial enterprises and the setup of cross-sectoral

⁹³ ESPAS: European Strategy and Policy Analysis System – Global Trends to 2030, Challenges and Choices for Europe,

https://ec.europa.eu/epsc/sites/epsc/files/espas_report2019.pdf

⁹⁴ https://ec.europa.eu/commission/presscorner/detail/en/fs_20_427

⁹⁵ Forrester Consulting (2016) Expectation vs. Experience: the good, the bad, the opportunity, Accenture [online], <https://www.accenture.com/acnmedia/pdf-23/accenture-expectations-vs-experience-infographic-june-2016.pdf>

platform plays. Platform-based business models empower Greek enterprises to access a more seamlessly connected industrial ecosystem, which will rely more on the ability of each partner to innovate within the platform rather than on their underlying geographical proximity.

The massive explosion of digital data at a global scale (the total amount of data created in the world is forecast to increase dramatically in the coming years, reaching 175 zettabytes⁹⁶ in 2025) introduces a set of favourable conditions that can further boost Greece's big data & analytics national strengths and can underpin Greece's decision to further invest on big data analytics technology through the potential setup of dedicated digital analytics innovation hubs.

AI is also a technology that changes the current status quo and can significantly benefit the Greek economy; Accenture research has indeed indicated that AI has the potential to lead to a cumulative \$195 billion GDP uplift over a 15-year period (from 2020 to 2035) in Greece⁹⁷. At the same time, the 5G and the "IoT-isation" economy can become game changers for "unlocking" innovation and growth for the Greek economy and Greece's industrial and manufacturing enterprises by achieving cost efficiencies, by providing higher visibility across their production lines and by allowing them to better manage their inventory and industrial equipment. These Industry 4.0 technologies can also increase the Greek economy's circularity, from waste reduction in production process management to data driven energy efficiency and align their products' waste and use-life with their organisation's core profits.

When it comes to innovation and R&D, Greece can significantly benefit from the European Commission's active investment in the development of digital innovation capabilities across the EU member-states and enhance its aforementioned burgeoning start-up & Digital Innovation Hubs scene. The development of Greek platforms and Public-Private Partnerships on areas of competitive advantage can be further encouraged by European Commission's support for the setup of Industrial Platforms and Partnerships. The EU has secured around €1 billion in funds over the past years for the establishment of strategic next-generation industrial platforms and currently it is investing more than €3 billion in these areas.⁹⁸

The Greek Industry's innovation & digitisation can also be further backed financially by the European Commission's Horizon Europe Initiative & other EU funding schemes. The EC's Horizon Europe⁹⁹ initiative is the Commission proposal for a €100 billion research and innovation funding program for seven years (2021-2027) to strengthen the EU's scientific and technological bases to boost Europe's innovation capacity, competitiveness and jobs to deliver on citizens' priorities and sustain our socioeconomic model and values. In addition, a set of additional funding schemes (i.e. InvestEU, EU Cohesion Policy, the European Defence Fund, etc.) can further support the Greek Research and Innovation.¹⁰⁰ In this context, Greece shall also leverage EU's the European Commission's updates of the EU regulatory framework in fields such as cybersecurity and the free flow of data to enable the digitisation of its economy and society.

Finally, EU's emblematic initiatives for the acceleration of the digital upskilling and reskilling of the European human capital (i.e. the Digital Skills and Jobs Coalition¹⁰¹, the Digital Opportunity

⁹⁶ 1 Zettabyte = 1000⁷bytes

⁹⁷ Accenture, „With an AI to the Future“, 2019, <https://www.accenture.com/gr-en/insights/digital/greece-an-ai-future>

⁹⁸ <https://ec.europa.eu/digital-single-market/en/industrial-platforms-and-large-scale-pilots>

⁹⁹ https://ec.europa.eu/info/horizon-europe-next-research-and-innovation-framework-programme_en

¹⁰⁰ https://ec.europa.eu/commission/sites/beta-political/files/budget-proposals-research-innovation-may2018_en.pdf

¹⁰¹ <https://ec.europa.eu/digital-single-market/en/digital-skills-jobs-coalition>

Scheme¹⁰²,etc.), as well as initiatives to boost the circular economy and facilitate the sustainable growth (i.e. The EU Green Deal¹⁰³, the EU Plastics Strategy¹⁰⁴, etc.) shall also be leveraged by the Greek Government to achieve the digital upskilling and reskilling of the Greek Human Capital and support the Greek circular economy.

The abovementioned opportunities shall not remain untapped by the Greek industry. The Industry 4.0 strategy shall incorporate initiatives targeted in increasing the collaboration and synergies between different Greek industries, but also between Greek enterprises and their EU counterparts. These initiatives are also expected to promote the internationalization of the Greek industry and position it as a valuable partner within the emerging EU ecosystems.

In addition, the global explosion in the use of emerging Industry 4.0 technologies (i.e. the Internet of Things, Artificial Intelligence, 5G and big data analytics) introduces a set of optimal conditions that can further boost the Greek Industry's investment in these technologies. As such, the Industry 4.0 strategy shall introduce tailored initiatives towards this direction, that can favor the creation of innovation districts or innovation hubs or could be translated into incentivization initiatives that will enable enterprises of all sizes to further experiment with these technologies.

All in all, the Greek Industry 4.0 strategy shall take into consideration and exploit the European Commission's active investment both for the development of digital innovation capabilities across its EU member-states (through the setup and support of the digital innovation hubs), but also for the setup of Industrial Platforms and Partnerships to encourage the development of Greek platforms and Public-Private Partnerships on areas of competitive advantage. Additionally, the digitisation of the Greek economy & society shall be further supported by the European Commission's updates of the EU regulatory framework. As such, initiatives prescribed with regards to the revamping of the Greek regulatory environment shall leverage the respective EU regulation as a guidance and leading practice. Finally, EU's emphasis placed on the circular and green economy verifies the need mentioned also earlier for the Greek Industry 4.0 to focus on initiatives that will support the Greek circular economy.

Greece's Threats

A set of external parameters that may negatively affect Greece and the digitisation of its Industry should be taken into account. For instance, economic nationalism is rising globally, with Governments around the world favouring protectionism and domestic production and imposing sanctions in trade of products and goods. This rising protectionism across several developed countries, including the United States, the uncertain impact of Brexit on both British and European markets, the escalation of US-China trade tensions and the higher or additional US tariffs on car imports, are only some of the causes that jeopardize the progressive integration of the global trade system acting as a structural inhibitor to Greece's cooperation with other countries within and outside Europe.

At the same time, the COVID-19 pandemic is expected to severely impact the global and the Greek economy. While the economic aftermath of the COVID-19 pandemic cannot be forecasted with certainty due to a vast number of unknowns, an imminent economic shock appears inevitable. It uniquely produces

¹⁰² <https://ec.europa.eu/digital-single-market/en/digital-opportunity-traineeships-boosting-digital-skills-job>

¹⁰³ https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

¹⁰⁴ https://ec.europa.eu/environment/waste/plastic_waste.htm

a dual shock felt at once by the financial system and the real economy. As financial markets collapse, businesses are in a standstill, with social distancing measures halting a sizeable portion of the economy's productive capabilities.¹⁰⁵ Both shocks are currently liquidity problems, but as the crisis deepens, they could develop into capital problems, leading to the shutdown of credit channels and widespread bankruptcy events in real economy. Moreover, the interrelated relationship between the real economy and the financial markets further complicates the situation, as issues in one could affect the other.¹⁰⁶

Greece's financial institutions face a vast array of capital formation problems. The likelihood that Greece will experience a strong shock to its financial system is very high. Moreover, the low liquidity and highly indebted profile of the average Greek business points to a strong likelihood of significant shocks in the real economy, especially if one factors the criticality of tourism-related income to Greece's GDP¹⁰⁷. Towards this direction, OECD has recently published some illustrative numbers, according to which the overall direct initial hit to the level of GDP for Greece may be even up to 35%.¹⁰⁸

Industry 4.0 technologies disrupt traditional linear value chains in an unprecedented way which often does not come from direct competitors in the same industry or even from companies with a remotely similar business model. Digital disruptors leverage scaled and divergent business models to write off incumbents' positions of strength, hence redefining the industries both at a global and a national scale. At the same time, the techno-centricity of industrial production may also disrupt the Greek labour market.

As more areas of labour-intensive activity become automated, new roles will be introduced to ensure the proper deployment and function of automation, while more transactional and routine tasks will become defunct. Digital advances may indeed displace certain types of work. Typically, highly repetitive, predictable and transactional activities are the prime candidates. The limited digital skills of the Greek industrial workforce make this threat especially perilous. The fact that about half of Manufacturing workers (43%) are skilled craftsmen and practitioners while about 1 in 5 (19%) are industrial plant, machinery and equipment operators and assemblers, followed by 8% of those who are unskilled workers, manual laborers and small businessmen, indicates that there is a high probability that Industry 4.0 may displace many of these manual labour job positions.¹⁰⁹

As the adoption of use of connected technologies increases, cyber risks are expected to grow and change. Greek enterprises, performing their first steps towards their digital transformation, can in fact become particularly cyber vulnerable. Looking at Greece's EU counterparts and their digitisation efforts, their rapid progress in this area both at a national and an industry level, continuously increase their digital "rift" with Greece and makes Greece's digitisation a necessity rather than a wishful thinking. In parallel, EU member-states' progress regarding targeted measures to support and enhance digital innovation and R&D, indicates that Greece's R&D capabilities are threatened to curb, if the country does not timely undertake similar initiatives. The same holds for EU countries' extended efforts with regards to the digital upskilling

¹⁰⁵ <https://hbr.org/2020/03/understanding-the-economic-shock-of-coronavirus>

¹⁰⁶ <https://hbr.org/2020/03/understanding-the-economic-shock-of-coronavirus>

¹⁰⁷ <https://hbr.org/2020/03/understanding-the-economic-shock-of-coronavirus>

¹⁰⁸ OECD, „Evaluating the initial impact of COVID-19 containment measures on economic activity”, [https://read.oecd-ilibrary.org/view/?ref=126_126448-kcr0cs6ia&title=FFEVALUATING THE INITIAL IMPACT OF COVID CONTAINMENT MEASURES ON ECONOMIC ACTIVITY](https://read.oecd-ilibrary.org/view/?ref=126_126448-kcr0cs6ia&title=FFEVALUATING_THE_INITIAL_IMPACT_OF_COVID_CONTAINMENT_MEASURES_ON_ECONOMIC_ACTIVITY)

¹⁰⁹ IOBE Report, <https://hellenicproduction.org/meleti-iove-2018/>

and reskilling of their human capital, which threatens to leave Greece behind, in this area of extreme significance for its digital rotation.

Finally, it is evident that the climate change and global warming is a worldwide threat that is expected to also significantly affect the Greek environment. According to recent estimates, rising sea levels may lead to a loss of 3,5% of the country's land, resulting in a loss of 2% of the country's GDP¹¹⁰. In this direction, Greece, as well as its global counterparts, shall evaluate the use of Industry 4.0 technologies, like the IIOT to establish a circular economy and a greener industry.

The Greek Industry 4.0 strategy shall not only exploit the global Industry 4.0 related opportunities, but at the same time shall address and mitigate the global threats imposed by or related to digital. In more detail, the introduction of initiatives related to the internationalization of the Greek enterprises and their participation in EU value chains shall aim to prevent Greece's exclusion from EU ecosystems due to the rise of the economic nationalism and will focus on supporting the Greek enterprises to turn the disruption of the traditional linear value chains from a threat into an advantage.

In addition, proactive skill-related initiatives shall be introduced in the Greek Industry 4.0 strategy, that will focus on identifying jobs in select professions, that will be affected by digitisation, and on introducing training initiatives to focus on digitally upskilling and reskilling this type of workforce. Circular economy and green Industry 4.0 initiatives also proposed above, shall contribute at decreasing the global Climate Change and Global Warming threat.

Finally, although COVID-19 may severely impact the global and the Greek economy, this pandemic shall also be seen as a global opportunity for the acceleration of countries' and industries' digitisation. It is evident that the COVID-19 pandemic has already "forced" the Greek businesses to immediately deploy digital technologies to deal with such an emergency. The Industry 4.0 strategy initiatives shall further contribute towards the digitization of the Greek enterprises, promote their workforce's remote working and safety, while ensuring the organizations' viability.

¹¹⁰ <https://www.dianeosis.org/en/2017/08/impact-climate-change-greek-economy/>

7.2 The implemented approach for designing Greece’s SWOT analysis

In order to design a holistic and complete SWOT analysis for Greece, which shall identify the external opportunities and threats that Greece faces with regards to its digitisation and at the same time highlight Greece’s Industry 4.0 related strengths and weakness, we followed a four-stepped approach:

1. **Step 1:** We collected and analysed the main outcomes of Deliverable 1, as these are also presented in Chapter 3 of the current deliverable. These outcomes refer mainly to technological observations as well as to business trends created due to Industry 4.0 and the digital era. In more detail, outcomes of Deliverable 1 are focused on the following dimensions:
 - The role of the Industry and manufacturing in the global, European and Greek economy
 - Macro-trends on how Industry 4.0 affects the Industry, economy and society and changes the industrial paradigm
 - The digital state and level of adoption of Industry 4.0 technologies and applications across the European Union and Greece. The digital state of the EU and Greece was mainly derived by the analysis of a set of Industry 4.0 and digital indicators from reliable 3rd party sources (i.e. Eurostat, Hellenic Statistical Authority, World Economic Forum, etc.)
 - The current digital maturity of a set of key foundations for countries’ digitisation, namely:
 - Digital skills
 - Digital Infrastructure
 - eGovernment
 - Analysis of 16 European Industry 4.0 strategies already implemented by the respective Governments
 - Policy measures, relevant strategies and supporting mechanisms that have been established to enable EU’s and Greece’s rotation to Industry 4.0
 - Greek industrial organisations’ perception on their Industry 4.0 capabilities
2. **Step 2:** The design of a national Industry 4.0 strategy for Greece shall not be based solely on the abovementioned observations. The Industry 4.0 strategy for Greece shall take into consideration, the set of the global and European political, economic, social, legal & regulatory and environmental trends within which Greece currently operates. In addition, an evaluation of Greece’s internal political and socio-economic situation shall be performed. To achieve these, we analysed more than more than 100 sources and elicited approximately 400 observations on the following areas:
 - Macro trends on the political situation worldwide, in EU and Greece
 - Macro-economic observations for the EU and Greece
 - Innovation and R&D related observations and key measures taken at European and Greek levels, as these were introduced through the Greek strategies (i.e. NGS, RIS3 Strategy) and the EU Industrial Strategy and relevant funding schemes

- Social macro-trends. Specific emphasis was given to the European and Greek Human Capital
 - Environmental macro-trends that affect the world, EU & Greece
3. **Step 3:** Out of the collected 400 observations and trends of step 2, we filtered out the first focus observations by applying an Industry 4.0 lens and our professional judgement. These first focus observations and trends are essential not only for designing Greece's SWOT analysis, but also to be used as the primary input for the design of a specific Greek Industry 4.0 strategy, tailored to the country's strengths and needs.
4. **Step 4:** We combined the key outcomes of Deliverable 1 and the first priority observations from Step 3, and we categorized which of the total number of the identified observations:
- With regards to observations that relate to Greece's **external environment**:
 - We evaluated which of those refer to external factors that may contribute to Greece's Industry 4.0 rotation and we classified them as **Opportunities for Greece**
 - We evaluated which of those refer to external factors that may impose risks and act as inhibitors for Greece's Industry 4.0 rotation and we classified them as **Threats for Greece**
 - With regards to observations that relate to Greece's **internal environment**:
 - We evaluated which of those refer to Industry 4.0 related areas where Greece performs well or demonstrates a strength and we classified them **as Greece's Strengths**
 - We evaluated which of those refer to areas where Greece underperforms, and we classified them **as Greece's Weaknesses**
5. **Step 5:** We combined Greece's opportunities, threats, strengths and weaknesses and we built Greece's Industry 4.0 SWOT analysis (see Figure 1). Each group (i.e. opportunities, threats, strengths, weaknesses) will be structured around five pillars:
- Political & Economic
 - Technological
 - Innovation & R&D
 - Legal & Regulatory
 - Social & Environmental

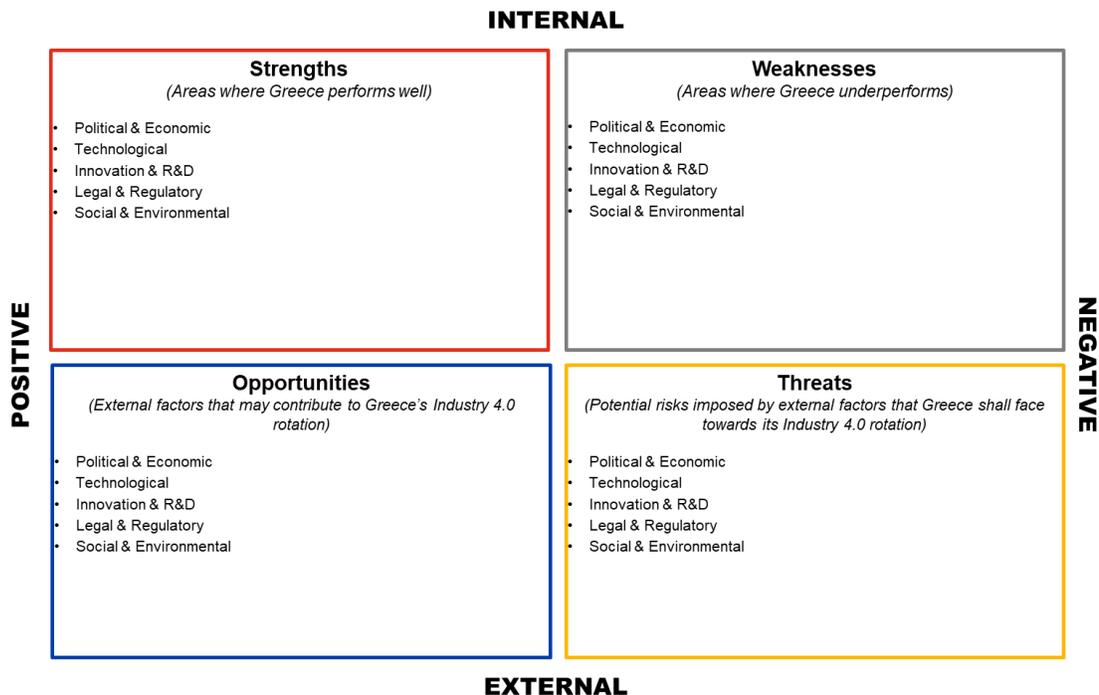


Figure 1: Outline of Greece's SWOT analysis

Strengths

1. The Greek economy demonstrated signs of recovery until recently; nevertheless, moving forward the coronavirus may severely affect the Greek economy
2. The Greek industry plays an important role in the Greek economy, generating more than 24% of its Gross Value Added (for 2018)
3. Increased interest and focus are placed on digital and Industry 4.0 from the higher levels of the Greek Government and industry federations, as well as from the European Commission
4. Greek surveyed executives recognize the significance of Industry 4.0 for their enterprises and primarily aim to implement Industry 4.0 technologies to increase their internal efficiencies and productivity
5. Greek executives appear to have initiated their Industry 4.0 transformation, starting mainly from the digitisation of their organisations' support functions, their Marketing & Sales and their production divisions. Moving forward, the majority of them plan to dedicate additional funding on the digitisation of their production and product development divisions
6. Greek enterprises claim to have initiated a close collaboration with their clients and suppliers to co-create customized products & services. Small and very small enterprises appear to lead the way in product co-creation
7. Greek enterprises appear to already invest in specific Industry 4.0 technologies, i.e. cloud, cybersecurity, big data analytics, SCADA and MES systems. In the future, they aim to continue investing in Cloud, Cybersecurity and big data analytics, while they also aim at actively experimenting with IIoT, industrial robots and AI
8. Greek enterprises place specific emphasis on big data analytics and actively exploit its potential
9. Greece is home to a burgeoning start-up & Digital Innovation Hubs scene
10. Both the European Commission and the Greek Government actively support the innovation in the Greek Industry through the provision of targeted funding schemes
11. The Greek Government has already undertaken a set of measures to transform Greece's regulatory environment through the introduction of a set of directives on digital technologies and a set of laws (i.e. 4622/2019 and 4635/2019) for the simplification and reorganisation of Greece's public administration and for boosting and assisting the Greek business environment
12. Greece demonstrates a technically adept human capital, with an overall high number of tertiary graduates, an adequate number of ICT and STEM graduates & a high diaspora around the world
13. The Greek Government has already undertaken some key initiatives for the digital upskilling and reskilling of the Greek human capital

Weaknesses

1. The significant hit in fixed capital investments during the last years decelerated investments in Industry 4.0 technologies and applications
2. Money supply in the Greek economy has undergone major shocks, preventing enterprises from investing in Industry 4.0 technologies
3. The Greek Manufacturing is fragmented, with a very high number of enterprises (more than 90%) having a very small number of employees (less than 10)
4. Greece lacks a holistic national Industry 4.0 strategy and a structured mechanism to coordinate Industry 4.0 programmes and initiatives
5. The Greek enterprises lag across the adoption of Industry 4.0 and digital technologies and applications
6. Greece's suboptimal position with regards to its digital infrastructure and the provision of digital public services, prevent the Greek enterprises from rapidly adopting new Industry 4.0 technologies and supporting their technology needs
7. The surveyed Greek enterprises have initiated their Industry 4.0 rotation, albeit they are still at the beginning of their transformation journey. In fact, an alarmingly high percentage of them (especially across the very small enterprises, the national enterprises and those with less than 10 years of operation) have not invested yet in any Industry 4.0 technology
8. Despite their recent revamping of their production IT landscape, the surveyed enterprises demonstrate a low level of digitisation across their production lines. Out of these, the very small and small enterprises, the national ones and those with less than 20 years of operation appear to be the worst positioned.
9. Greece ranks low in terms of innovation and R&D, both with regards to their R&D intensity and with regards to the overall number of the issued Greek patents
10. R&D appears disassociated with applied research & industry implementation, as contrary to the EU average, where the business sector appears highly involved in R&D, the Greek R&D is mainly dominated by the higher education sector, while Greek organisations appear reluctant to invest in applied R&D
11. Greek enterprises face structural and regulatory obstacles during their setup and operations, with areas of "dealing with construction permits", "registering property", "getting credit" and "enforcing contracts" scoring particularly low across the annual report on the ease of "Doing Business" for 2020
12. The surveyed Greek executives place the provision of Industry 4.0 related tax incentives and the development of a flexible, digital-friendly regulatory framework as top incentives that could accelerate their organisations' digital transformation
13. Greece has performed limited investments in the digital upskilling and reskilling of its industrial workforce and does not have in place a structured mechanism to measure the effectiveness of the undertaken digital skills initiatives
14. Greek surveyed executives verify the limited digital skills currently existing in the Greek market. This challenge appears even greater for the very small and small enterprises that we surveyed.
15. The most highly sourced digital skills in the future appear to be around Artificial Intelligence, Cloud, Big Data Analytics and Cybersecurity
16. Greece is Europe's lowest ranking country, with regards to the average circular use of materials

Opportunities

1. Global changes in the distribution and nodes of power enable Greece to become part of wider global ecosystems
2. The European Industrial Strategy can significantly benefit Greece's rotation towards Industry 4.0
3. The "smartification" of products can enable Greek enterprises to produce products & services of higher added value and to become more competitive
4. The emergence of new business models can support Greek enterprises in tapping new sources of value creation
5. The massive explosion of digital data at a global scale introduces a set of favourable conditions that can further boost Greece's big data & analytics national strengths
6. Artificial intelligence is changing the current status quo and can significantly benefit the Greek economy
7. 5G and the "IoT-isation" economy can become game changers for "unlocking" innovation and growth for the Greek economy
8. Industry 4.0 can significantly benefit Greece in increasing its economy's circularity

Threats

1. The rise of economic nationalism and the shaking up of Global Trade may prohibit Greece's cooperation with other countries in the Industry 4.0 field
2. The COVID-19 Pandemic may severely impact the global and the Greek economy
3. Industry 4.0 disrupts the traditional linear value chains & redefines the Greek industries
4. Techno-centricity of industrial production may disrupt the Greek labour market
5. Industry 4.0 poses new, wider and deeper cybersecurity threats for the Greek Industry
6. EU counterparts' rapidly progress with regards to their digitisation both at a national and at an industry level, continuously increase their digital "rift" with Greece and makes Greece's digitisation a necessity rather than a wishful thinking
7. EU counterparts' progress regarding targeted measures to support and enhance digital innovation and R&D, indicates that Greece's R&D capabilities are threatened to curb, if the country does not timely undertake similar initiatives
8. EU countries progress with regards to the digital upskilling and reskilling of their human capital, leaves Greece behind in terms of its digital human capital
9. Climate Change and Global Warming significantly affects the Greek environment and necessitates the use of Industry 4.0 technologies across the Greek Industry

Before, we move to the detailed SWOT analysis, it is important to state the following: The majority of the observations we have collected either from Deliverable 1 with regards to Greece's external environment or through our additional analysis of macro trends, can be translated both as potential opportunities and threats for Greece. This is particularly applicable for technology-related observations. For instance, the observation "EU counterparts rapidly progress with regards to their digitisation both at a national and at an industry level" can be considered as an opportunity for Greece, as the country can use leading examples from other digitally advanced countries and infuse technical know-how for its digital transformation. At the same time this can be considered also a threat for Greece, as the digital "rift" between Greece and its EU counterparts widens, positioning Greece as a digital laggard amongst other EU member-states. During our SWOT analysis, we have implemented the guiding principle of categorizing each observation only as an opportunity or a threat, in order not to confuse the reader. Nevertheless, where necessary, the positive and negative effect of each analysed observation is stated.

7.3 Strengths¹¹¹

Below we present Greece’s key Industry 4.0 related strengths. These are areas where Greece performs well or demonstrates an advantage that could be further enhanced by Greece’s rotation to Industry 4.0.

7.3.1 Political & Economic Strengths

The Greek economy demonstrated signs of recovery until recently; nevertheless, moving forward the coronavirus may severely affect the Greek economy

The Greek GDP recovered by 0,7% in 2014 following its fall by -9,8% during the period of fiscal derailment and the Greek Government (GG) Debt crisis 2008 - 2010 and the consecutive fall by -18,5% in the period of adjustment 2011 – 2013. Then, following the January - July 2015 economic policy debacle and the imposition of capital controls, GDP registered a slight fall by -0,4% in 2015 and by -0,2% in 2016. In fact, in the period 2016 - 2017 GDP growth was depressed by the substantial negative effects from the extensive delays of, and excessive tax burden implied by, the 1st and the 2nd Reviews. The conclusion of the Reviews, allowed the Greek economy to resume its headline GDP growth, reaching 1,51% in 2017, 1,93% in 2018 and 2,16% in Jan - Sept 2019. Projections indicate that the GDP could continue to grow, GDP growth in the following years, reaching 2,4% in 2019 and 2,9% in 2020 (see Figures 2, 3).¹¹²

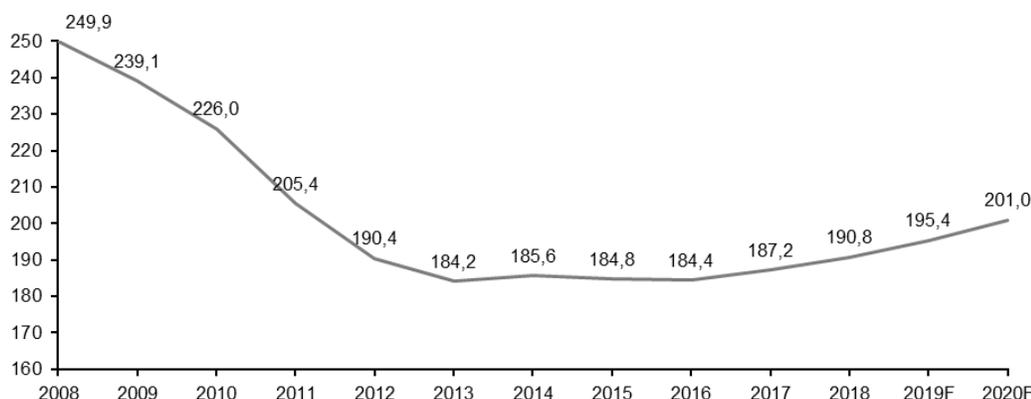


Figure 2: Greek GDP at Fixed 2010 prices (in billion €) – Source: Hellenic Statistical Authority, Stochasis Macroeconomic Trends -Sectoral Forecasts, December 2019. Forecasts have been provided by Stochasis

¹¹¹ All graphs included in Chapter 6 are also presented in 8. Appendix in full resolution and in a reader-friendly way.

¹¹² Hellenic Statistical Authority, Stochasis Macroeconomic Trends -Sectoral Forecasts, December 2019. Forecasts have been provided by Stochasis

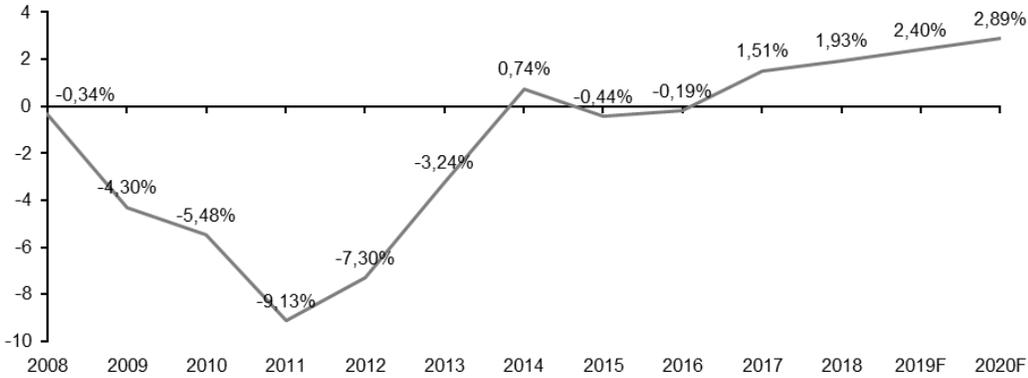


Figure 3: YoY % GDP Change, 2008 - 2020F (%) – Source: Hellenic Statistical Authority, Stochasis Macroeconomic Trends - Sectoral Forecasts, December 2019. Forecasts have been provided by Stochasis

After a severe drop between 2010 – 2013, employment also demonstrates signs of recovery, as during the last years it demonstrates a growth of approximately 2%. This growth is expected to continue also in 2019 (see Figures 4, 5). According to projections, employment is expected to experience its biggest increase in the distribution & transportation sector (over the period 2016-21) and in the manufacturing sector (over the period 2021-30). In terms of sub-sectors, hotels and catering, and the rest of manufacturing (i.e. pharmaceuticals, metal products, motor vehicles, sewerage and waste) are those where the greatest increase is expected.¹¹³

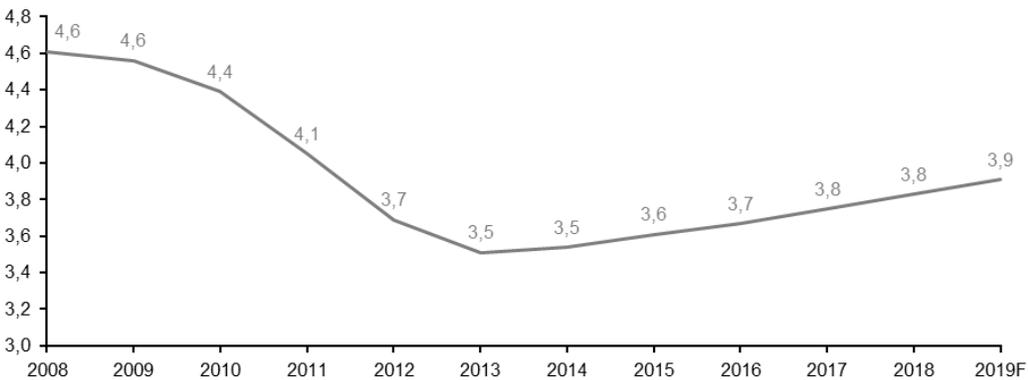


Figure 4: Greek employment 2008 - 2019F (in millions) – Source: Eurostat/ Hellenic Statistical Authority. Until 2018, Forecast from Stochasis report: Stochasis Macroeconomic Trends – Sectoral Forecasts, December 2019

¹¹³ Stochasis Macroeconomic Trends -SectoralForecasts, December 2019. Forecasts have been provided by Stochasis

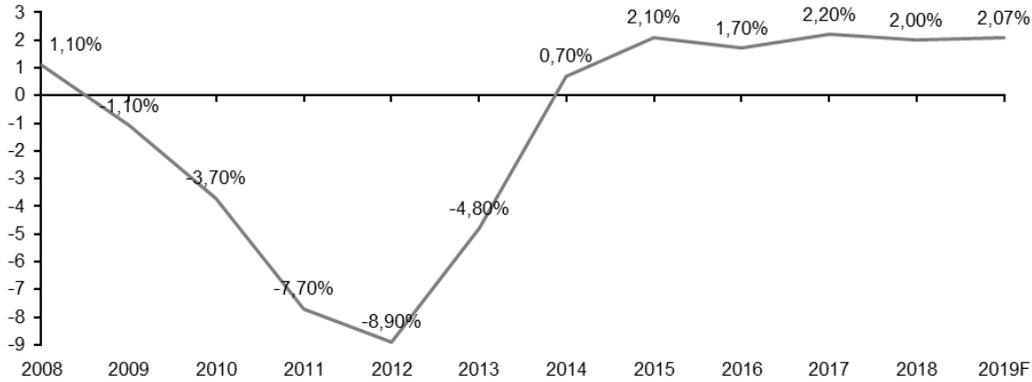


Figure 5: YoY % Employment Change, 2008 - 2019F (%)– Source: Eurostat/ Hellenic Statistical Authority. Until 2018, Forecast from Stochasis report: Stochasis Macroeconomic Trends - Sectoral Forecasts, December 2019

Exports of Goods and Services registered a substantial increase from 19,9% of GDP in 2009 to 31,9% of GDP in 2017 and to 34,0% of GDP in 2018 reflecting the fundamental improvement of Greece’s international competitiveness. In fact, they are expected now to reach 35,5% of GDP in 2021 and 36,4% in 2023. Therefore, the external Goods and Services (G&S) deficit (net exports) has improved drastically to -1,3% of GDP in 2018 from -13,0% of GDP in 2007. It is now expected to fall further to -0,7% of GDP in 2019 to -0,6% of GDP in 2020 and to -0,4% of GDP in 2021 (see Figures 6, 7).

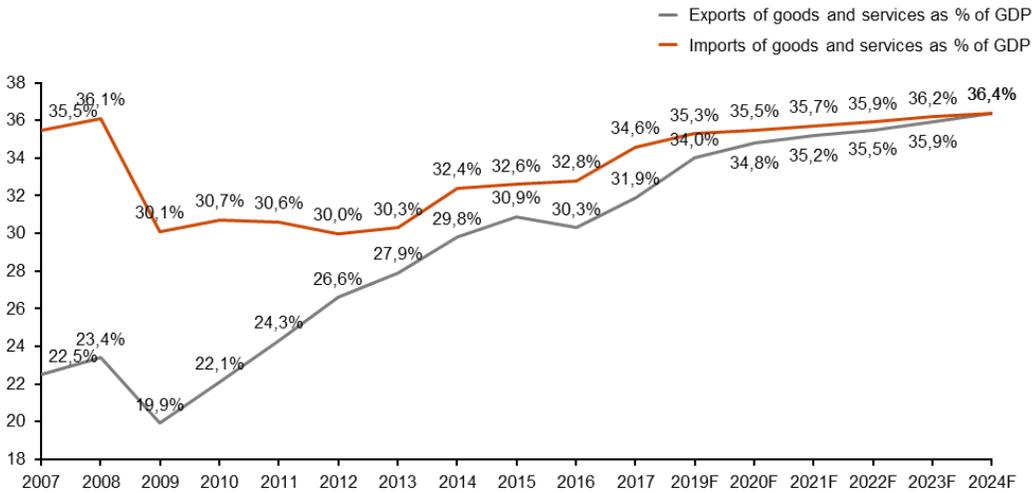


Figure 6: Imports and exports of goods and services as a percentage of GDP (in fixed 2010 prices)– Source: Eurostat/ Hellenic Statistical Authority. Until 2018, Forecast from Stochasis report: Stochasis Macroeconomic Trends - Sectoral Forecasts, December 2019

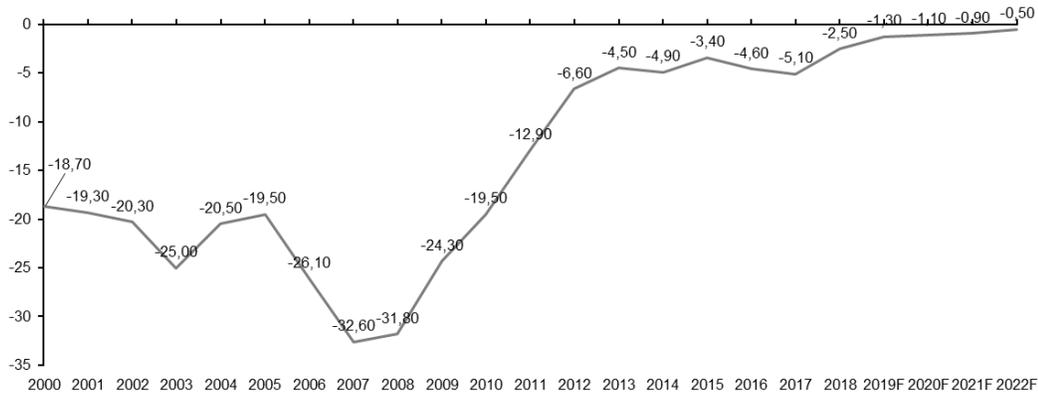


Figure 7: External Balance of Goods and Services in fixed 2010 prices (in billion Euros) – Source: Eurostat/ Hellenic Statistical Authority. Until 2018, Forecast from Stochasis report: Stochasis Macroeconomic Trends - Sectoral Forecasts, December 2019

The increasing spread of the coronavirus across countries has prompted many governments to introduce unprecedented measures to contain the epidemic, one of these being the Greek Government. These measures have led to reduced economic activity, widespread restrictions on travel and mobility, financial market turmoil, an erosion of confidence and heightened uncertainty. In this rapidly changing environment, it is extremely difficult to quantify the exact magnitude of the impact of these measures on the Greek GDP growth, but it is clear that they imply sharp contractions in the level of output, household spending, corporate investment and trade. Greece being a country, whose economy is heavily dependent on tourist and leisure activities, is expected to be severely hit by the coronavirus. OECD has recently published some illustrative numbers, according to which the overall direct initial hit to the level of GDP for Greece may be even up to 35%.¹¹⁴ The spread of the coronavirus is highlighted as a discrete threat in paragraph 7.5.1.

¹¹⁴ OECD, „Evaluating the initial impact of COVID-19 containment measures on economic activity”, https://read.oecd-ilibrary.org/view/?ref=126_126448-kcrc0cs6ia&title=FFEVALUATING_THE_INITIAL_IMPACT_OF_COVID_CONTAINMENT_MEASURES_ON_ECONOMIC_ACTIVITY

The Greek industry plays an important role in the Greek economy, generating more than 24% of its Gross Value Added (for 2018)

The Greek Industry plays an important role in the overall Greek economy, as it generated 24,2% of the total Gross value added in 2017 (contrary to 29,4% of the EU average) (see Figure 8).^{115, 116}

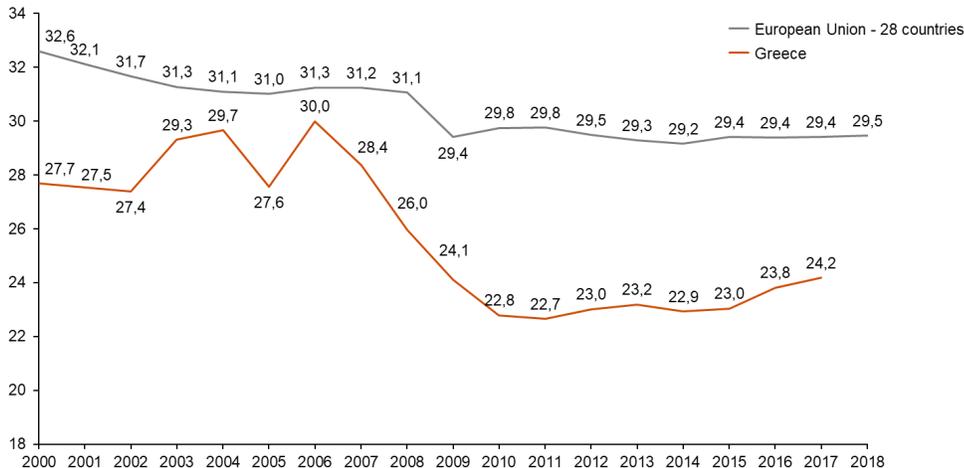


Figure 8: EU & Greek Industry Gross Value Added as % of total EU & Greece's Gross Value Added (%) – Source: Eurostat, National accounts aggregates by industry (up to NACE A*64)

Employment in the Greek Industry took a severe hit during the last 17 years, as it decreased from 25% of the total Greek employment in 2000 to 19% in 2017. On the contrary, the percentage of employment in services has been increased by 11% in the last 17 years, while the percentage of employment in agriculture has also been decreased by 5% (see Figure 9).^{117, 118}

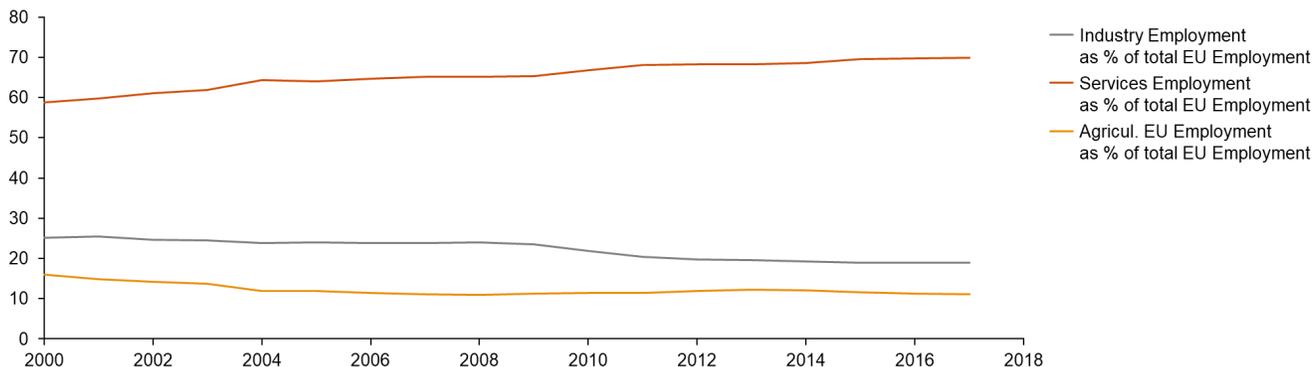


Figure 9: Greece's Industry, Services & Agriculture Employment as % of total Greece's Employment (%) – Source: Eurostat, National accounts employment data by industry (up to NACE A*64)

¹¹⁵ Eurostat, National accounts aggregates by industry (up to NACE A*64), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64&lang=en

¹¹⁶ Data 2018 not available for Greece

¹¹⁷ Eurostat, National accounts employment data by industry (up to NACE A*64), http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64_e&lang=en

¹¹⁸ 2018 Data not available for Greece

Looking at the development of the **Greek industrial production** from 2013 – 2018 and its projections for 2019 and 2020, we observe that continuously increases since 2015. In fact, in 2017, the industrial production demonstrated its highest growth (by 3,9%). Projections estimate that the industrial production will continue to grow in 2019 (by 0,9%) and in 2020 (by 3%) (see Figure 10).^{119, 120}

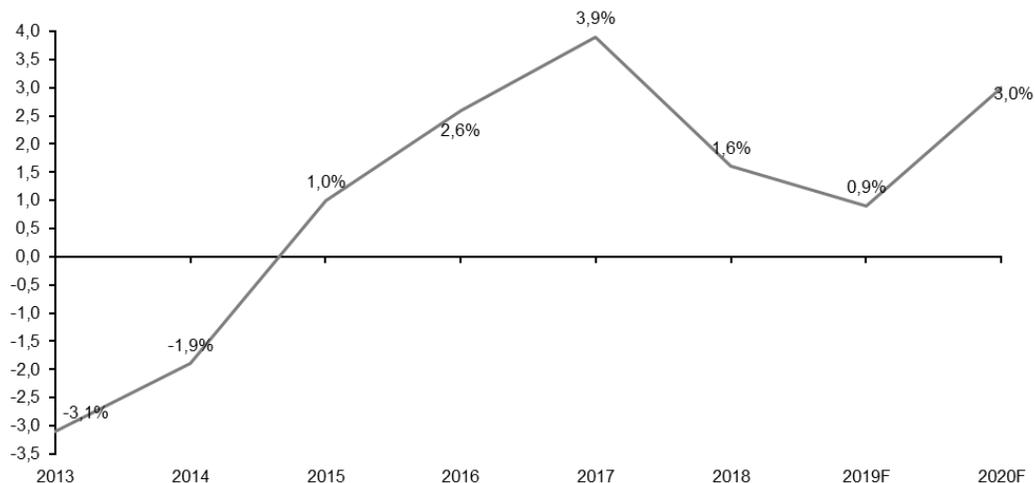


Figure 10: YoY change (%) of Greece’s industrial production index, 2013 – 2020F (2015=100) - Source: Eurostat, Production in industry - annual data / Stochasis Macroeconomic Trends -Sectoral Forecasts, December 2019. Forecasts have been provided by Stochasis

Increased interest and focus are placed on digital and Industry 4.0 from the higher levels of the Greek Government and industry federations, as well as from the European Commission

Governmental changes during the summer of 2019 led to a reinvigorated interest and focus on the digitisation of the Greek economy and society. The new Ministry of Digital Governance is in the process of redrafting the National Digital Strategy (and issuing the Bible of Digital Transformation) and plans the undertaking of emblematic initiatives (i.e. Gov.gr, Digital Academy) to achieve Greece’s accelerated rotation to digital. In addition, Greece already participates in several European digital initiatives, to enhance cross-border collaborations, which have proven to be at an EU level and therefore are crucial for the digital transformation of the Greek economy as well.

At the same time, an important first step has been taken by the signing of a memorandum of cooperation (in May 2019) regarding the setup of a digital Industry 4.0 platform, between the General Secretariat for Industry and the Ministry of Digital Governance.¹²¹ In addition, in December 2019, the European Commission approved an ultrafast broadband project in Greece, worth €223 million in EU funds.¹²²

Moreover, the National Growth Strategy (issued in 2018 by the former Greek Ministry of Development) and the National Research and Innovation Strategy for Smart Specialisation – (covering the period 2015-2020), can act as valuable input for the design of the national Industry 4.0 strategy (more information can

¹¹⁹ Eurostat, Production in industry - annual data, https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=sts_inpr_a&lang=en
 Data are compiled according to the Statistical classification of economic activities in the European Community, (NACE Rev. 2, Eurostat). Data and weights are available for the following NACE categories: B) Mining and Quarrying, (C) Manufacturing, (D) Electricity, Gas Steam and Air Conditioning supply, (E36) Water Supply and collection

¹²⁰ Stochasis report: Stochasis Macroeconomic Trends – Sectoral Forecasts, December 2019

¹²¹ Additional information on initiatives undertaken by the Greek Government and Industry Federations can be found in Deliverable 1.

¹²² <https://greece.greekreporter.com/2020/02/01/eu-approves-e233-million-fund-to-boost-greeces-ultrafast-broadband/>

be found on these strategies in paragraphs 4.1 and 4.2). Although currently in a phase of re-evaluation, both strategies can act as a soundboard with regards to the execution levers that will be introduced in the Greek Industry 4.0 strategy. In more detail, the Greek Industry 4.0 strategy shall cover the key focus areas of the National Growth Strategy (i.e. stimulating Interconnections and Public-Private Partnerships (PPPs), supporting Start-ups & SMEs, increasing R&D&I, etc.) and shall also cover the innovation pillars & initiatives introduced by the National Research and Innovation Strategy for Smart Specialisation.

Furthermore, Federations and other non-public sector stakeholders have been eager to promote and support the digitisation of the Greek industry. One of the main supporters of Industry 4.0 and its strategic importance for the competitiveness of the country and Greek enterprises in the future is the Federation of Enterprises of Greece (SEV). Since February 2019, SEV has established the Observatory of Digital Transformation for the country. It refers to a mechanism aiming to monitor consistently, through the collection of data, the level of digital maturity of the Greek enterprises, as well as the Greek economy in general. In the lines of this venture, the Digital Manufacturing Index (DMI) has been developed in order to monitor the digital results of the country, compared to its EU counterparts within the EU-28. In addition, in 2019 SEV introduced the program “Industry 4.0”, which constitutes SEV’s proposal for a national strategy and is elaborated on an action plan regarding the digital transformation of Greece.¹²³

Finally, during the last years the EC has undertaken significant initiatives and have introduced key regulations for the digitisation of the EU economy and society. Namely, the Commission has designed the following strategies:

- The Digital Single Market strategy¹²⁴
- The connectivity for a European Gigabit Society strategy¹²⁵
- The 5G Action Plan¹²⁶
- IoT policies¹²⁷
- The European High-Performance Computing strategy¹²⁸

In addition, the EC launched the Digitising European Industry initiative (DEI) in April 2016¹²⁹. Its goal is to reinforce the EU's competitiveness in digital technologies and ensure that all European businesses can draw the full benefits from digital innovation. The DEI initiative introduces a framework for the effective coordination between national and EU-level initiatives and promotes relevant policy actions including investments in digital innovation capabilities. In addition, it focuses on the development of ICT standards, explores the creation of favourable regulatory conditions and promotes specific initiatives for the upskilling and reskilling of the human capital.

All these strategies and initiatives have already adopted or are currently being implemented by Greece and introduce a set of favourable conditions for the country’s accelerated digitisation.

¹²³ Additional information on initiatives undertaken by the Greek Government and Industry Federations can be found in Deliverable 1.

¹²⁴ <https://ec.europa.eu/digital-single-market/en/policies/shaping-digital-single-market>

¹²⁵ <https://ec.europa.eu/digital-single-market/en/policies/improving-connectivity-and-access>

¹²⁶ <https://ec.europa.eu/digital-single-market/en/5g-europe-action-plan>

¹²⁷ <https://ec.europa.eu/digital-single-market/en/policies/internet-things>

¹²⁸ <https://ec.europa.eu/digital-single-market/en/policies/high-performance-computing>

¹²⁹ <https://ec.europa.eu/digital-single-market/en/pillars-digitising-european-industry-initiative>

7.3.2 Technological Strengths

The list of technological strengths presented below are the outcomes of the Industry 4.0 survey, ran by the Ministry of Development, PwC and Accenture across a total sample of 152 Greek executives across several sectors.¹³⁰ Although some of the survey outcomes, presented below, indicate that the surveyed Greek organizations have already progressed with regards to their digital transformation, these strengths shall be read with caution, since the sample participating in the survey cannot be considered to represent the overall Greek Industry and does not depict the Industry’s overall digital maturity.

Greek surveyed executives recognize the significance of Industry 4.0 for their enterprises and primarily aim to implement Industry 4.0 technologies to increase their internal efficiencies and productivity

1 out of 2 of the surveyed executives recognise that their respective enterprises have understood the significance of Industry 4.0 and acknowledge the fact that this will disrupt their industries in the next years (see Figure 11).¹³¹

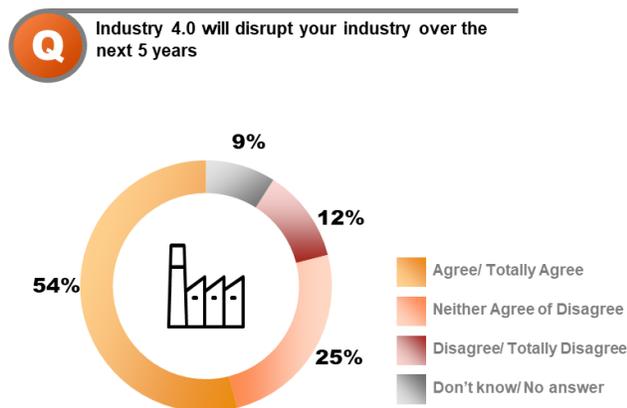


Figure 11: Greek executives’ level of agreement regarding the disruption of their industry due to Industry 4.0, (%) - Source: Industry 4.0 Survey

¹³⁰ The performed analysis and the respective conclusions were based on data recorded through the “Industry 4.0” survey ran by the Ministry of Development, PwC and Accenture, with 152 Greek executives across the following sectors: B. Mining & Quarring, C: Manufacturing, E: Water supply; sewage, waste management and remediation activities, F: Constuction, H: Transportation, J: Information & Communication, which was launched on November 2019 and closed in February 2020. More details on the Survey can be found in Deliverable 1

¹³¹ The performed analysis and the respective conclusions were based on data recorded through the “Industry 4.0” survey ran by the Ministry of Development, PwC and Accenture, with 152 Greek executives across the following sectors: B. Mining & Quarring, C: Manufacturing, E: Water supply; sewage, waste management and remediation activities, F: Constuction, H: Transportation, J: Information & Communication, which was launched on November 2019 and closed in February 2020. More details on the Survey can be found in Deliverable 1

In addition, in terms of expected benefits that will arise from the introduction of Industry 4.0 technologies, most of the respondents at an aggregated level expect Industry 4.0 to increase their organisations' productivity and internal efficiencies (see Figure 12).

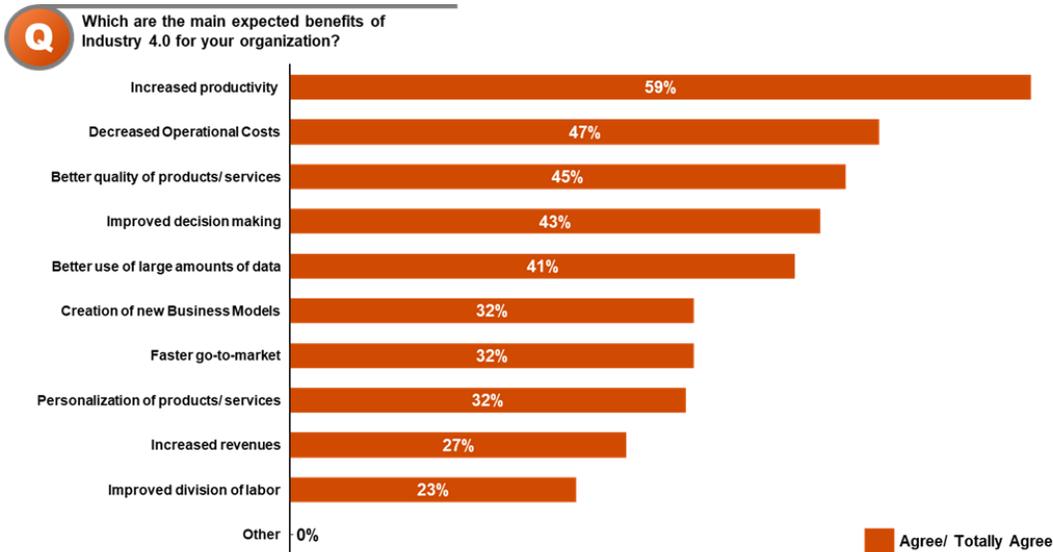


Figure 12: Greek executives' level of agreement regarding the benefits that Industry 4.0 will bring to their organisations, (%) – Source: Industry 4.0 survey

Our detailed analysis of the Industry 4.0 survey responses based on the number of the organisations' number of employees indicates that enterprises of different size place a different emphasis on the expected benefits from leveraging Industry 4.0. Namely, executives of very small and small enterprises aim to leverage Industry 4.0 to improve their products' quality and increase their top line. At the same time, executives of medium and large enterprises aim to implement Industry 4.0 technologies to optimize their productivity and improve their decision making (see Figure 13).¹³²

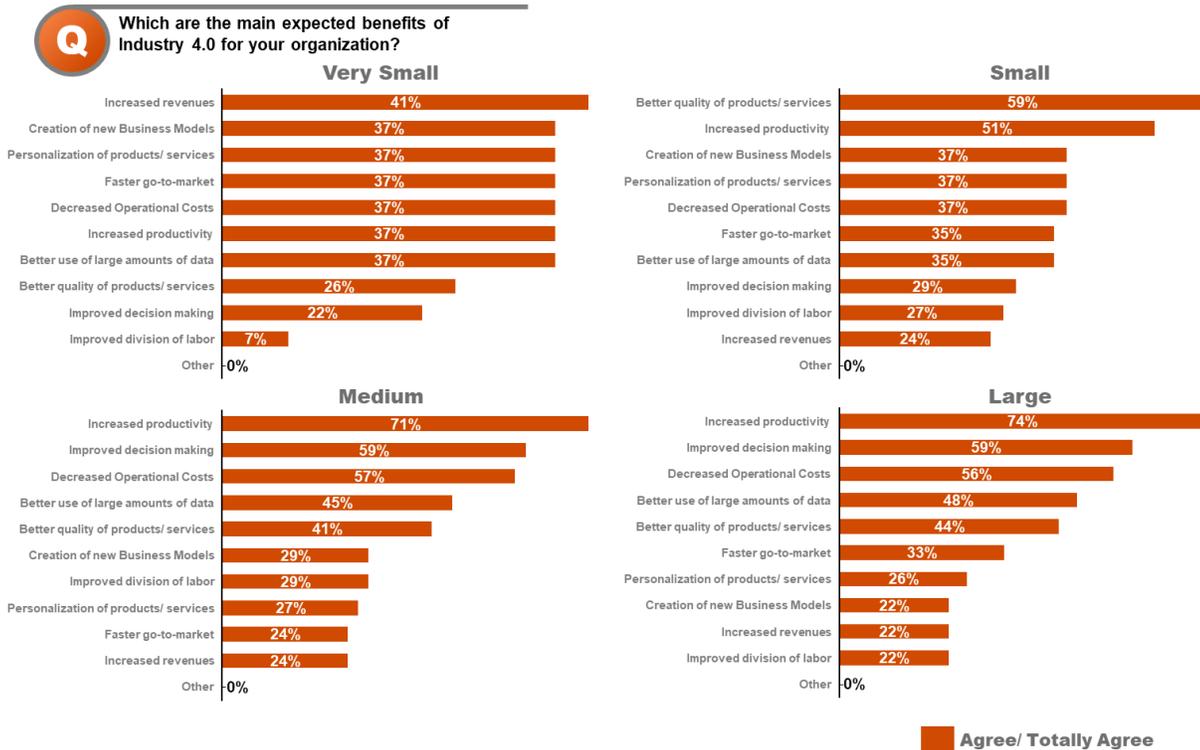


Figure 13: Greek executives' level of agreement regarding the benefits that Industry 4.0 will bring to their organisations, by Size, (%) – Source: Industry 4.0 survey

Greek executives appear to have initiated their Industry 4.0 transformation, starting mainly from the digitisation of their organisations' support functions, their Marketing & Sales and their production divisions. Moving forward, the majority of them plan to dedicate additional funding on the digitisation of their production and product development divisions.

The majority of the surveyed executives appear to have initiated their digital transformation across different divisions of their enterprises. In fact, 7 out of 10 participants cited that their support functions demonstrate the highest level of digitisation, while Marketing & Sales and Production also demonstrate a relatively high degree of digital maturity (see Figure 14). Moving forward additional funding appears to be required by the majority of the executives to further digitise their production and product development divisions (see Figure 15).¹³³ The current organizations' investment for their supporting functions' digitization also indicates a “start small” mentality that Greek executives have, seeking to “test the waters” and move onwards from

¹³² The performed analysis and the respective conclusions were based on data recorded through the “Industry 4.0” survey ran by the Ministry of Development, PwC and Accenture

¹³³ The performed analysis and the respective conclusions were based on data recorded through the “Industry 4.0” survey ran by the Ministry of Development, PwC and Accenture

that point on. Organisations’ executives appear to start their experimentation with Industry 4.0 technologies from their organizations’ supporting functions. Then, having tested and realized the value of Industry 4.0 technologies in these areas, they plan to continue their digitization efforts in their organizations’ “core business”.

It should be mentioned at this point that when hard data overlays the executives’ perception, a different picture emerges. Although our sample indicates that they have already initiated their organizations’ digital transformation, the DESI Index indicates that while Greek companies seem to have started their digital transformation, they still lag behind the EU average by 20 percentage points, with a score of 0,33 points (out of 1) and the 22nd position amongst its EU counterparts.¹³⁴

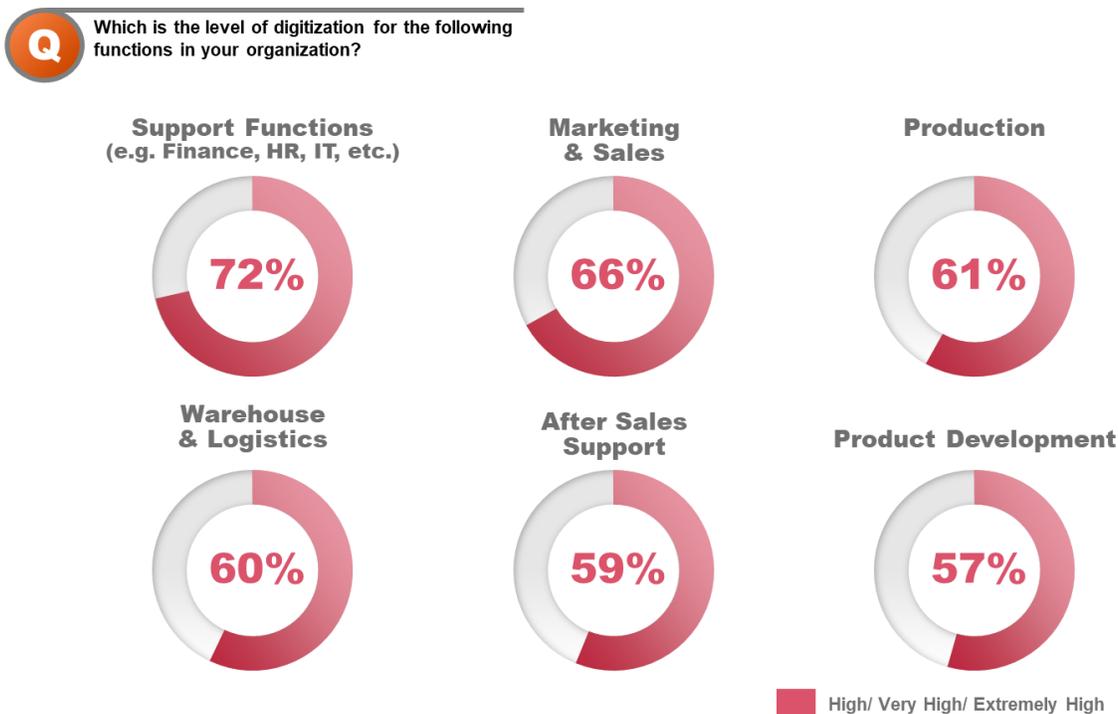


Figure 14: Greek executives’ perception with regards to the level of digitisation of their organisation’s functions, (%) - Source: Industry 4.0 Survey

¹³⁴ The Digital Economy and Society Index 2019, Integration of Digital Technology, <https://ec.europa.eu/digital-single-market/en/desi>

Q Which business functions require a greater percentage of funding, in order to become further digitized in your organization?

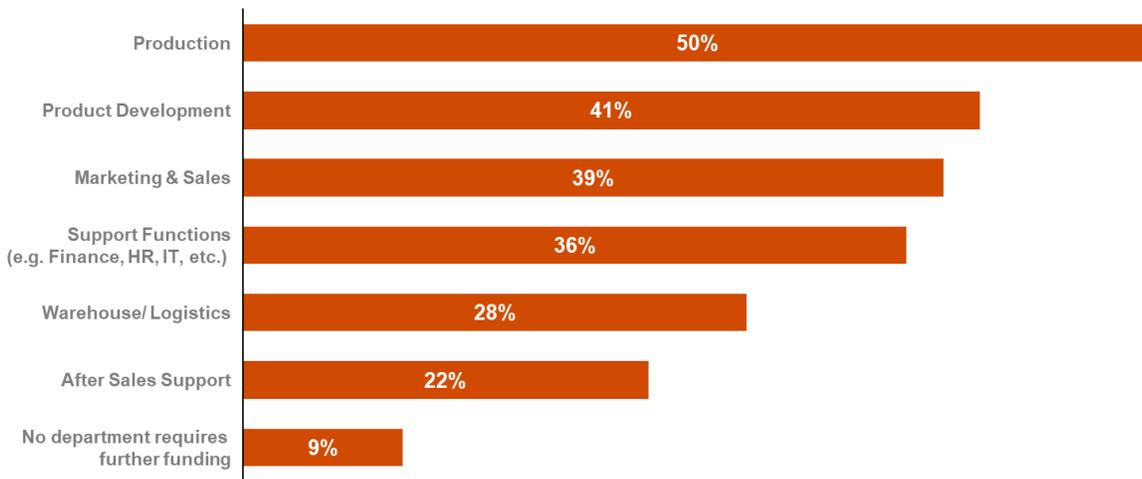


Figure 15: Funding required for further digitisation across different business functions of organisations, (%) – Source: Industry 4.0 survey

Greek enterprises claim to have initiated a close collaboration with their clients and suppliers to co-create customized products & services. Small and very small enterprises¹³⁵ appear to lead the way in product co-creation.

Currently 1 out of 2 and 1 out of 3 of the survey’s participants claim to closely collaborate with their clients and suppliers respectively for the development of customized products and services (see Figure 16).¹³⁶

¹³⁵ Based on characterisation of company size by number of employees from Eurostat (Very Small – <10, Small – <50, Medium – <250, Large – >250)

¹³⁶ The performed analysis and the respective conclusions were based on data recorded through the “Industry 4.0” survey ran by the Ministry of Development, PwC and Accenture

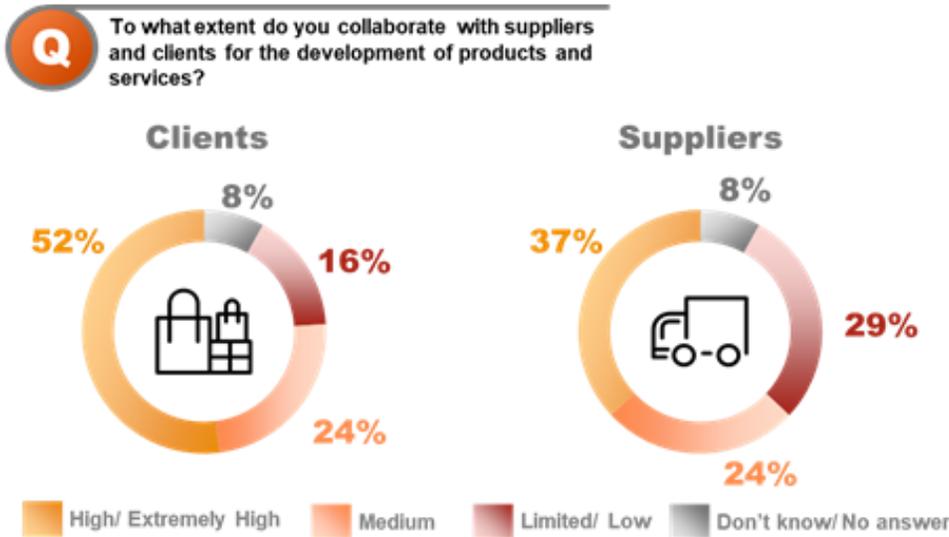


Figure 16: Degree of collaboration with partners/ suppliers for product/service development, (%) - Source: Industry 4.0 Survey

Small and very small enterprises appear to lead the way and collaborating closer than their larger peers with their clients and customers for the co-creation of their products and services (see Figure 17). This finding appears to be in line with the reviewed third-party indexes. According to the EU’s Innovation Scoreboard 2019, Greece ranks significantly well in terms of the number of Greek SMEs that demonstrate innovation capabilities and that collaborate with their partners to design new, innovative products.¹³⁷

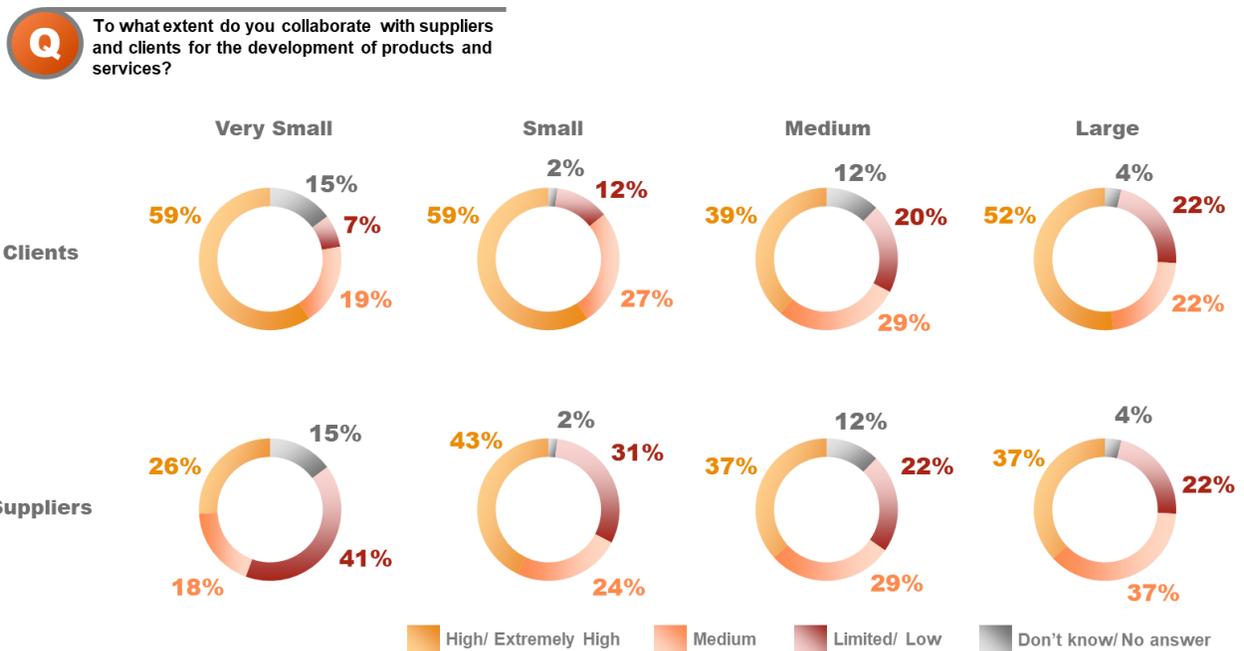


Figure 17: Degree of collaboration with partners/ suppliers for product/service development, by Size, (%) – Source: Industry 4.0 survey

¹³⁷ European Commission, European Innovation Scoreboard 2019, https://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_en. For more information please refer to Deliverable 1.

Greek enterprises appear to already invest in specific Industry 4.0 technologies, i.e. cloud, cybersecurity, big data analytics, SCADA and MES systems. In the future, they aim to continue investing in Cloud, Cybersecurity and big data analytics, while they also aim at actively experimenting with IIoT, industrial robots and AI.

In terms of the Industry 4.0 technologies that Greek organisations implement, our survey indicates that during the last years, our respondents have focused their attention on the cloud, cybersecurity, big data analytics and SCADA systems. The focus on these technologies comes as a surprise, since these are the most advanced, mature and well-implemented at a global scale, contrary to other emerging technologies (i.e. Artificial Intelligence and IIoT) that are now gaining traction and a large number of organizations worldwide still experiments with their use. In fact, the active investment of the surveyed organisations in big data analytics confirms that the Greek Industry demonstrates a “pocket” of technological strength in the analysis of big data. On the other hand, the low current investment in IIoT and industrial robots that the executives have reported, appear also in line with the hard data that positions Greece’s at the lower position amongst their EU counterparts with regards to their use of industrial robots. An important contradiction is also highlighted from the Industry 4.0 survey findings. Although 47% of the surveyed executives indicated that their organizations already invest in cloud capabilities, hard data sourced from Eurostat surfaces that only 13% of Greek enterprises currently make use of the technology, half the EU average (26%). This places Greece on the 25th position against its EU counterparts, with a mere five percentage points above the lowest ranked country.¹³⁸

Evidence also indicates that organisations intend to invest intensively in Industry 4.0 initiatives over the next 5 years. Respondents cited that in the near future they plan to continue their investments in Cloud, Cybersecurity and big data analytics, while they also aim at actively experimenting with IIoT, industrial robots and AI. These investments in the latter technologies are expected to further increase Greece’s ranking across the respective indexes (i.e. % of Greek enterprises/ manufacturers implementing industrial robots) (see Figure 18).¹³⁹

¹³⁸ Eurostat, Cloud computing services, https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_cicce_use&lang=en

¹³⁹ The performed analysis and the respective conclusions were based on data recorded through the “Industry 4.0” survey ran by the Ministry of Development, PwC and Accenture

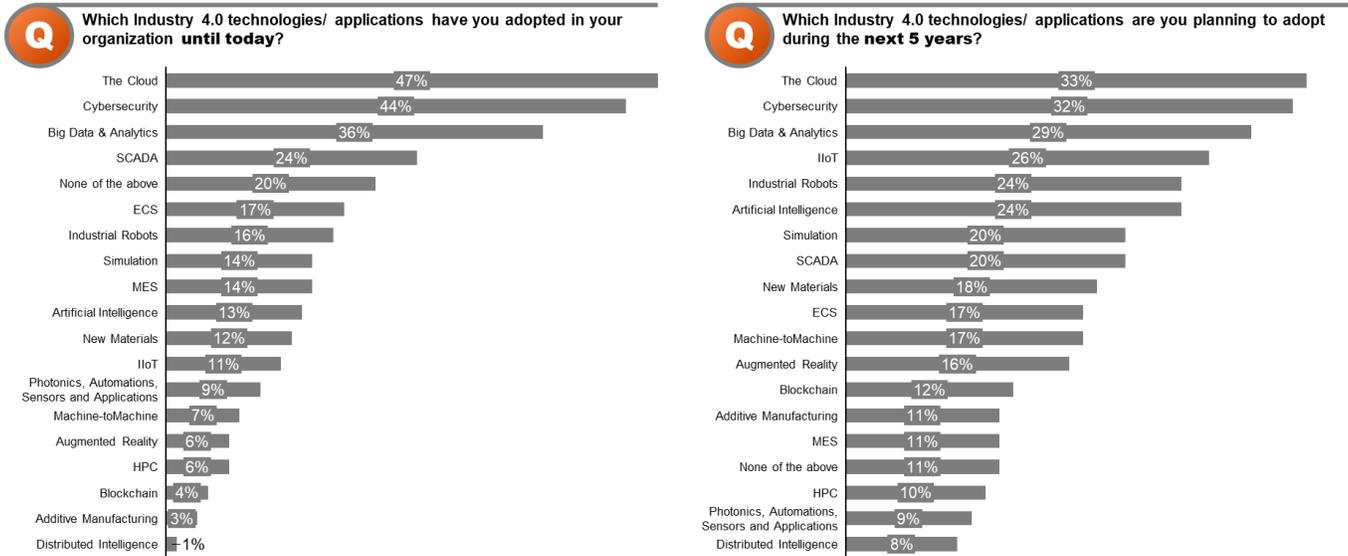


Figure 18: Key Industry 4.0 technologies/ applications that Greek executives have adopted in their organisations or plan to adopt within the next five years, (%) - Source: Industry 4.0 Survey

Greek enterprises place specific emphasis on big data analytics and actively exploit its potential

Greece has surfaced notable strengths with regards to technology in data and data analytics. Greek companies have understood that data are the new digital capital and increasingly exploit the potential of Big Data Analytics. This is evidenced by the fact that 13% of Greek enterprises (compared with 12% of the EU) invest in the collection and Big Data analytics (see Figure 19).¹⁴⁰

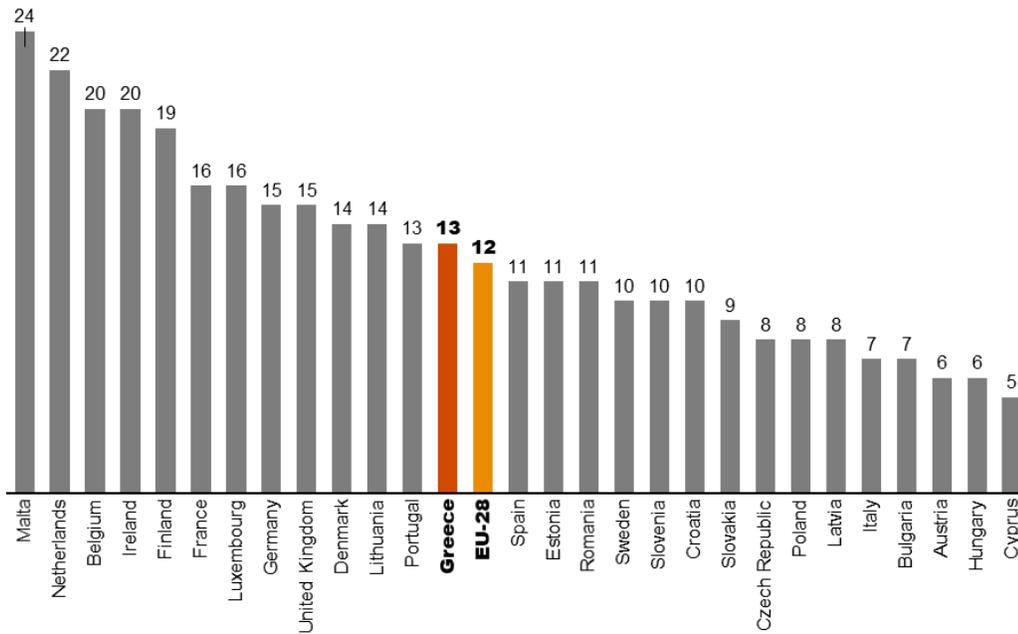


Figure 19: % of Enterprises analysing big data from any data source, EU, 2018 (%) – Source: Eurostat, Big data analysis

Additionally, global leaders in the ICT industry are increasingly investing in the Greek workforce creating global Analytics Centres of Excellence (i.e. Accenture, Cosmote, SAP, Nokia, Microsoft, IBM etc.) and are leveraging the availability of high calibre human capital.

In addition, the Government appears to provide high-quality Open Data, either directly, through the National Data Portal and the Hellenic Statistical Authority, or indirectly by supporting Foundations such as the Open Knowledge for Greece which has developed and hosts the Greek Open Data Hub. In fact, Greece scores moderately well along the Open Data dimension, demonstrating that the government’s data is accessible to its citizens to a significant degree (see Figure 20).¹⁴¹

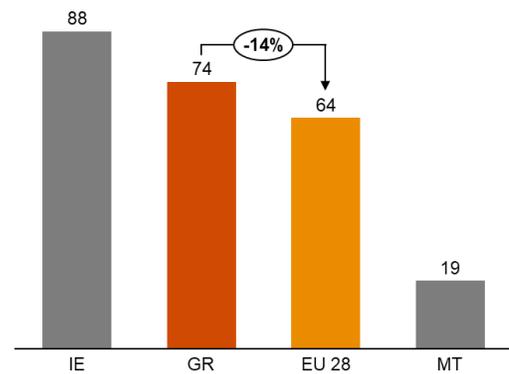


Figure 20: Open Data, 2018 (% of the maximum open data score) – Source: Digital Economy and Society Index Indicators 2019, Digital Public Services

¹⁴⁰ Eurostat, Big data analysis, https://ec.europa.eu/eurostat/web/products-datasets/product?code=isoc_eb_bd

¹⁴¹ Digital Economy and Society Index Indicators 2019, Digital Public Services, <https://digital-agenda-data.eu/datasets/desi/indicators>

In addition, according to the Industry 4.0 survey, half of the respondents cited that their IT infrastructure appears advanced in terms of data collection and processing. In fact, 1 out of 3 of the respondents claim that their organisations possess systems that are of high or very high maturity regarding collecting and analysing production and operations data, product and services data and client data (see Figure 21).¹⁴²

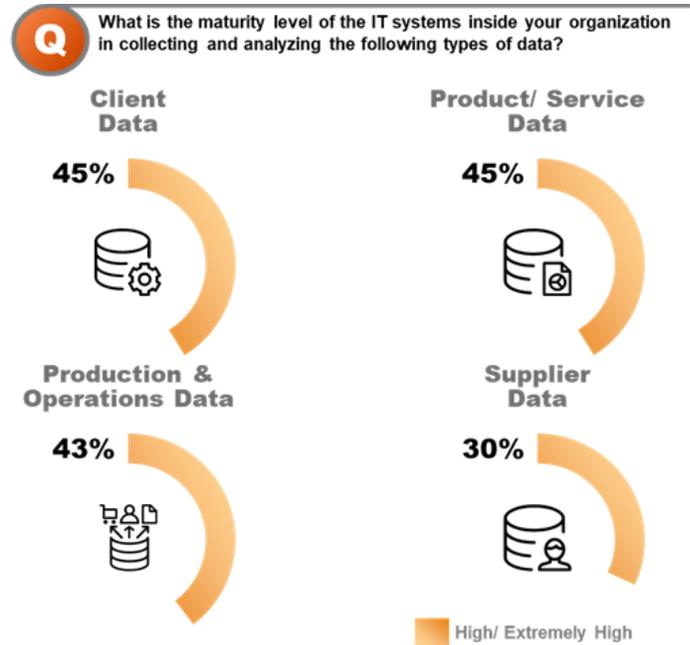


Figure 21: Level of IT systems maturity with regards to their capacity to collect and analyse data generated from different sources, (%) - Source: Industry 4.0 Survey

According to the Industry 4.0 survey results, the Greek Industry has initiated its digital transformation, however this is still in an inaugural state. The majority of Greek enterprises currently invest in the most advanced, mature and well-implemented Industry 4.0 technologies (i.e. cloud, big data analytics, cybersecurity, SCADA systems), contrary to other emerging technologies (i.e. Artificial Intelligence and IIoT) that are now gaining traction and a large number of organizations worldwide still experiments with their use. In addition, Greek executives appear to demonstrate a “start small and play it safe” mentality, initiating their organizations’ digital transformation from the digitization of their internal operations and supporting functions and then planning to proceed with the digitization of their “core business”.

¹⁴² The performed analysis and the respective conclusions were based on data recorded through the “Industry 4.0” survey ran by the Ministry of Development, PwC and Accenture

7.3.3 Innovation & R&D Strengths

Greece is home to a burgeoning start-up & Digital Innovation Hubs scene

Greece is home to a burgeoning start-up scene. From 2012 to 2016, investment in Greek Start-ups grew by a factor of 18, from 5 to 90 million Euros in annual start-up funding per year in 2012 and 2016 respectively, totalling 250 million in the span of five years (see Figure 22).¹⁴³

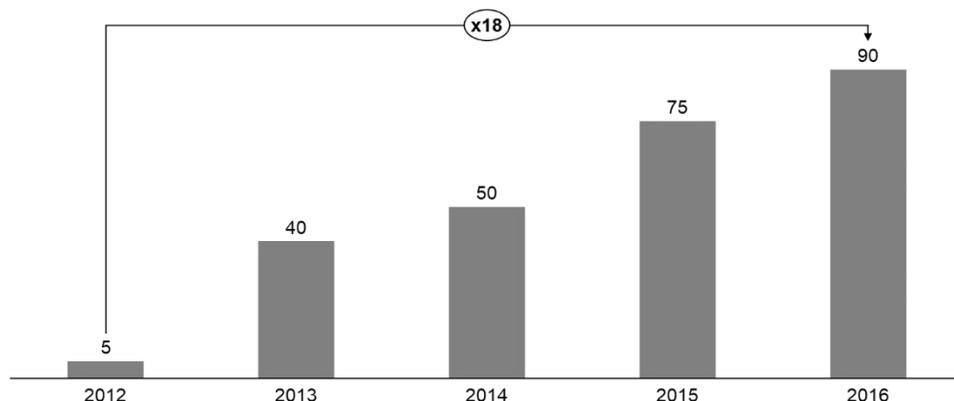


Figure 22: Annual start-up funding in Greece, € Millions, 2012-2016 – Source: SEV& BCG, “The Greek start-up Ecosystem” Report

A significant portion of this growth is due to Equifund, an investment platform developed by the ministry of Economy and Development and the European Investment Fund. Equifund have invested a total of €1 billion into Greek start-ups through intermediary Venture Capital (VC) and private equity funds.

Another portion of growth comes through the acquisition of majority stakes in start-ups - with notable examples including Delivery Hero's investment in Efood, Daimler's investment in Taxibeat, and Samsung's investment in Innoetics. In addition, the last few years have seen a strong growth in incubators, with the likes of Corallia, the EGG, iQbility, and Orange Grove supporting start-ups through seed funding and the facilitation of strategic partnerships. Coupled with the growth of VC groups like Venture Friends and Marathon Venture Capital and the increasing presence of co-working spaces, these developments signify that the Greek Start-up ecosystem withholds significant potential.¹⁴⁴

When it comes to sectoral focus, most Greek start-ups are operating within the Life Sciences (9,25%), Lifestyle/Social/Entertainment (8,22%), Tourism/Hospitality (7,93%), ICT (7,05%), Energy/Infrastructure (6,31%) sectors. Finally, the vast majority of start-ups are in the pre-seed stage (77,6%), indicating the need to expand the amount of capital allocated to the ecosystem's growth.¹⁴⁵

With regards to Digital Innovation Hubs, as of January 2020, on a national level Greece has 14 of them (9 fully operational and 5 in preparation status covering various market domains (agriculture, fishing, construction, manufacturing (food products, textiles, chemicals, basic and fabricated metal products,

¹⁴³ SEV& BCG, „The Greek startup Ecosystem” Report, http://www.sev.org.gr/Uploads/Documents/50906/BCG_Greeces_Startup_Ecosystem_Apr_2018.pdf

¹⁴⁴ SEV & BCG, „The Greek startup Ecosystem” Report - http://www.sev.org.gr/Uploads/Documents/50906/BCG_Greeces_Startup_Ecosystem_Apr_2018.pdf

¹⁴⁵ Found.aution : technology breakdown of Greek Startup Sector - <http://thefoundation.gr/wp-content/uploads/2018/12/Startups-in-Greece-2018-by-EIT-Digital-and-Foundation.pdf>

electrical and optical equipment, machinery, electrical equipment), transport, electricity, public administration, education and health) through a large spectrum of technology areas presented as follows:

- Additive manufacturing (3D printing)
- Advanced or High-performance computing
- Artificial Intelligence and cognitive systems
- Augmented and virtual reality, visualisation
- Broadband and other communication networks (e.g. 5G)
- Cloud computing
- Cyber physical systems (e.g. embedded systems)
- Cyber security (including biometrics)
- Data mining, big data, database management
- Gamification
- ICT management, logistics and business systems
- Interaction technologies (e.g. human-machine Interaction, motion recognition and language technologies)
- Internet of Things (e.g. connected devices, sensors and actuators networks)
- Internet services (e.g. web development, web production, design, networking, and e-commerce)
- Laser based manufacturing
- Location based technologies (e.g. GPS, GIS, in-house localisation)
- Micro and nano electronics, smart system integration
- New Media technologies
- Organic and Large Area Electronics (OLAE)
- Photonics, electronic and optical functional materials
- Robotics and autonomous systems
- Screens and display technologies
- Sensors, actuators, MEMS, NEMS, RF
- Simulation and modelling
- Software as a service and service architectures

On a regional level, each hub’s activities appear aligned with the RIS3 strategies. A concise list of all hubs on national and regional level is presented as follows:

Fully Operational Digital Innovation Hubs:

DIH Name	Smart Specialisation	Location	City	Website	Contact	NUTS2 Name
ATHENA Research and Innovation Centre	General innovation	Artemidos 6 & Epidavrou	Maroussi, Athens	http://www.athena-innovation.gr	https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/2094/view	Attiki
Attica Hub for the Economy of Data and Devices (AHEDD)	Big Data Management and Analytics, Internet of Things, Business Intelligence,	Patr. Gregoriou E & 27 Neapoleos Str, Agia Paraskevi	Athens	http://ahedd.demokritos.gr/	https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/2092/view	Attiki

DIH Name	Smart Specialisation	Location	City	Website	Contact	NUTS2 Name
	Assistive Technologies					
Center for Research and Technology Hellas	General Innovation	6th km Harilaou - Thermi Rd	Thermi - Thessaloniki	https://www.certh.gr/	https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/3085/view	Kentriki Makedonia
Embedded System Design & Application Laboratory	Embedded systems	Megalou Alexandrou 1	Patra	http://esda-lab.cied.teiwest.gr	https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/12382/view	Dytiki Ellada
Foundation for Research and Technology – Hellas (FORTH) / PRAXI Network	General innovation	Kolokotroni 8	Athens	https://www.praxinetwork.gr	https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/5967/view	Attiki
Internet of Things, Intelligent Systems, Data Engineering and Media DIH [National Technical University of Athens - Institute of Communication and Computer Systems]	IoT, data engineering and media	Heroon Polytechniou 9	Athens	https://www.dih-ntua.gr/services/	https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/1980/view	Attiki
Nanotechnology Lab LTFN (Lab for Thin Films - Nanobiomaterials - Nanosystems - Nanometrology)	Nanotechnology	University Campus	Thessaloniki	http://www.lfn.gr/	https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/1784/view	Kentriki Makedonia
National Documentation Centre / National Hellenic Research Foundation	General innovation	48, Vas. Constantinou Ave.	Athens	http://www.ekt.gr/en	https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/5806/view	Attiki
nZEB Smart House	Construction and ICT	CERTH/ITI , 6th km Charilaou-Thermi Road	Thessaloniki	https://smarthome.iti.gr	https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/1521/view	Kentriki Makedonia

Digital Innovation Hubs in Preparation:

DIH Name	Smart Specialisation	Location	City	Website	Contact	NUTS2 Name
Piraeus Blue Growth Digital Innovation Hub (BG-DIH)	General innovation	91, Iroon Polytechniou Ave	Piraeus	http://www.bluegrowth.gr/	https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/2491/view	Attiki

DIH Name	Smart Specialisation	Location	City	Website	Contact	NUTS2 Name
OK!Thess (Οικοσύστημα Καινοτομίας Θεσσαλονίκης)	General innovation	2 Komotinis Street	Thessaloniki	https://okthess.gr/en/	https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/2872/view	Kentriki Makedonia
ManuHub@WG	Manufacturing Systems & Automation	Archimidous 7	Patras	http://lms.mech.upatras.gr	https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/1559/view	Dytiki Ellada
Central Macedonia Digital Innovation Hub on Agrofood	Food and Agriculture	Dioikitirio	Thessaloniki	http://www.thessinnozone.gr/	https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/1361/view	Kentriki Makedonia
Institute of Entrepreneurship Development (iED)	General innovation	169 Iroon Politechniou str	Larissa	https://ied.eu/	https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/12716/view	Thessalia

Both the European Commission and the Greek Government actively support the innovation in the Greek Industry through the provision of targeted funding schemes

Currently the Government’s policies for the digitisation of the enterprises in the industrial sector are supported through two main funding streams, the Operational Program “Competitiveness, Entrepreneurship & Innovation” (EPAnEK) and the Hellenic Development Bank (former ETEAN).

The operational programme EPAnEK constitutes one of the seven sectoral Operational Programmes of the Partnership and Cooperation Agreement (former NSRF) for the period 2014-2020. The pivotal strategic objective of EPAnEK is to enhance the competitiveness and extroversion of enterprises, to facilitate transition to quality entrepreneurship with innovation and the growth of domestic added value as the cutting edge. The total public expenditure for EPAnEK is set at €4,66 billion.

EPAnEK funds the support measure " Research – Create – Innovate " (total of €542,5 million) and also provisions the use of financial instruments (loans, guarantees, microfinance and equity financing) that could support its purposes. The measure “Research – Create – Innovate”¹⁴⁶ is managed by the General Secretariat for Research and Technology and aims to support:

- research and innovation

¹⁴⁶ Source: http://www.antagonistikotita.gr/epanek_en/news.asp?id=7

- technological development and demonstration at operating enterprises for the development of new or improved products
- the development of synergies among enterprises
- research and development centres and higher education sector as well as to support
- the patentability of research results and industrial property.

EPAnEK has also published two actions that promote the digital transformation of enterprises and organisations, the “Digital Step” that aims at the digital upgrading of very small, small and medium sized enterprises with business plans from €5.000 to €50.000 and the “Digital Jump”, that aims at the digital transformation of very small, small and medium sized enterprises with business plans from €55.000 to €400.000. The funding scheme was co-financed by Greece and the European Union – European Regional Development Fund with a budget of €51,6 million.

The Hellenic Development Bank (HDB) is an integral part of the wider Greek financial sector, aiming to support the design, implementation and management of specialised financial actions, delivered by financial institutions to small and medium sized enterprises. The Hellenic Development Bank created two funding schemes that aim to support digital development of enterprises, the programme “Business Innovation Greece” and the programme “4th Industrial Revolution”.

- The programme “Business Innovation Greece”, aims to support the general objectives of European Economic Area and Norway Grants 2014-2021. The programme targets to increase value creation and sustainable growth in the Greek business sector and to allocate 75% of the funding to SMEs. The total budget of the programme for the ICT sector is €3 million and it is divided in two grant schemes, the “Individual Project Scheme” concerning SMEs and large enterprises with no more than 25% public ownership, and the “Small Grants Scheme 1” concerning SMEs.
- The Investment Scheme “4th Industrial Revolution”, aims to invest in new or existing SMEs that retain an establishment in the Greek territory at the time of the investment and are active in the field of the 4th Industrial Revolution. The budget of “4th Industrial Revolution” is set at €50 million from public funding and €15 million from private equity.

Besides the abovementioned funding sources and initiatives, there are additional funding sources that are used to support enterprises towards digital transformation:

- EquiFund¹⁴⁷: An initiative created by the Hellenic Republic in cooperation with the European Investment Fund (EIF) that supports research projects of SMEs and start-ups.
- COSME¹⁴⁸: The EU program for the Competitiveness of Enterprises and SMEs, running from 2014 to 2020, with a budget of €2.3 billion.
- InnovFin¹⁴⁹: With InnovFin – EU Finance for Innovators, the EIB Group (the European Investment Bank and the European Investment Fund) can provide financing starting at €25.000 for investments in research and innovation to companies and other entities of all sizes and age. InnovFin supports start-ups, SMEs, mid-caps, larger private companies, research institutes/ organisations and universities or R&I-driven entities.

¹⁴⁷ EquiFund Brochure (<https://equifund.gr/wp-content/uploads/2018/02/EquiFund-Brochure.pdf>)

¹⁴⁸ COSME – Leaflet (<https://ec.europa.eu/docsroom/documents/9783>)

¹⁴⁹ InnovFin (<https://www.eib.org/en/products/blending/innovfin/products/index.htm>)

- EIB¹⁵⁰: Offers loans, guarantees, equity investments and advisory services. The most suitable tool will depend on the objectives of the project and on various other factors.
- Tax incentives for investment¹⁵¹: General Secretariat of Research and Technology provides certifications of scientific and technological research expenditure and deduction of 30% surcharge.

7.3.4 Legal & Regulatory Strengths

The Greek Government has already undertaken a set of measures to transform Greece’s regulatory environment through the introduction of a set of directives on digital technologies and a set of laws (i.e. 4622/2019 and 4635/2019) for the simplification and reorganisation of Greece’s public administration and for boosting and assisting the Greek business environment

In the previous years the Greek authorities have undertaken a limited number of initiatives to transform Greece’s regulatory environment and facilitate the Greek digital economy. These initiatives included the Directive (EU) 2016/1148 for Cybersecurity¹⁵² and the national cloud policy.¹⁵³ In the latest months, two initiatives have been taken up by the Greek government in order to simplify and promote the regulatory environment of the country:

- Law 4622/2019: This new law practically seeks to re-organise the way the country’s public administration is conducted, by simplifying the process of decision making (which from now on will be operated centrally from the Government). This will allow for clarity and coordination of actions among all respective Ministries, resulting in turn in a more efficient and less time-consuming policy making procedure.
- Law 4635/2019 (new multibill) that seeks to address the growth of the economy and the country at multiple levels. With respect to the Greek Industry, the multibill seeks to simplify the issuing of licenses for businesses in the Industry sector as well as offer financial incentives to businesses that seek to operate in the context of business clusters. This latter provision can drastically create value chains among business, leading to greater synergies and better results.

Other than developing industry specific initiatives, there have been however during the recent years horizontal efforts to boost and assist the business environment of Greece in general. Since 2018 and more specifically laws L. 4442/2016 & 4512/2018, have pursued the simplification of the regulatory framework for economic activities. Furthermore, in 2019, law L.4442/2016 was supplemented and extended by law 4635/2019, introducing simplification of the standardisation, licensing and supervision processes as well as by Law 4512/2018, which establishes a new framework for the supervision of economic activities and the product markets.

Also, since early 2018, the “Better Regulation Delivery Directorate” of the General Secretariat for Industry has been established in order to act towards the successful implementation of the aforementioned laws. As stated in the OECD Economic Survey of Greece 2018-2020, “the digitisation of licensing and inspection procedures through an Integrated Licensing Information Management System (ILIMS)” is pursued. “The development of the ILIMS has been approved for funding under the structural funds programme and will be key to the implementation of reforms through the digitisation of processes that enhance the transparency and efficiency of public administration”. Further to that, since June 2017, the electronic

¹⁵⁰ EIB (<https://www.eib.org/en/products/index.htm>)

¹⁵¹ Source: General Secretariat for Research and Technology

¹⁵² <https://eur-lex.europa.eu/legal-content/EL/TXT/PDF/?uri=CELEX:32016L1148&from=EN>

¹⁵³ <https://www.gsis.gr/dimosia-dioikisi/G-Cloud>

licensing platform “Notify business – notifybusiness.gov.gr” was established. Lastly, in a significant effort to reduce the administrative burdens of enterprises, the new law for electronic one-stop shops (e-OSS) was developed (Law 4441/2016 and MD 63577/2018). As per OECD’s report “E-OSS has been extremely successful and user-friendly, making the minimum time for creating a company just 6 minutes. Since July 2018, 8.838¹⁵⁴ companies have been created with e-OSS.” The 2020 Doing Business Report ranked starting a business in Greece 1st in among EU countries and 11th worldwide¹⁵⁵.

7.3.5 Social & Environmental Strengths

Greece demonstrates a technically adept human capital, with an overall high number of tertiary graduates, an adequate number of ICT and STEM graduates & a high diaspora around the world

Greece has a significant number of people with tertiary education. In fact, for 2017, it contributed 4% of the overall tertiary education students across EU (see Figure 23).¹⁵⁶

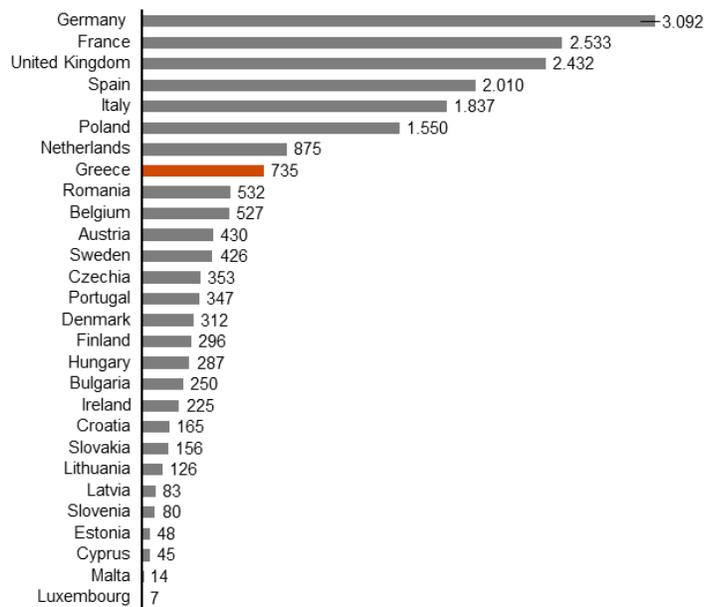


Figure 23: # of Tertiary Education Students, 2017 (Thousands #) – Source: Eurostat: : Students enrolled in tertiary education by education level, programme orientation, sex, type of institution and intensity of participation

¹⁵⁴ Data received from Greek Business Register dated 4th December 2019

¹⁵⁵ <https://www.doingbusiness.org/content/dam/doingBusiness/country/g/greece/GRC.pdf>

¹⁵⁶ Eurostat: Students enrolled in tertiary education by education level, programme orientation, sex, type of institution and intensity of participation, https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=educ_uoe_enrt01&lang=en

At the same time, Greece's share of ICT graduates is on par with the average EU country, with 3% ICT graduates, when compared to 4% reported on average in the continent (see Figure 24).¹⁵⁷

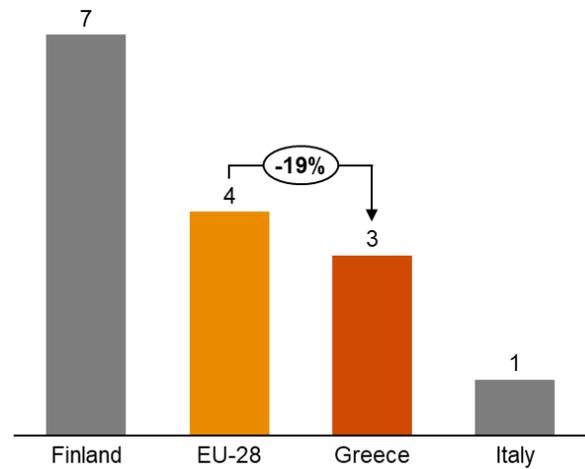


Figure 24: % of ICT graduates out of total graduates, EU, 2018 - Source: DESI 2019, Employed persons with ICT education by educational attainment level

With regards to the number of graduates in tertiary education in science, math, computing, engineering, manufacturing, and construction (STEM), Greece is also in sync with the EU average, with 18% of Greek graduates pursuing tertiary education in the abovementioned fields (see Figure 25).¹⁵⁸

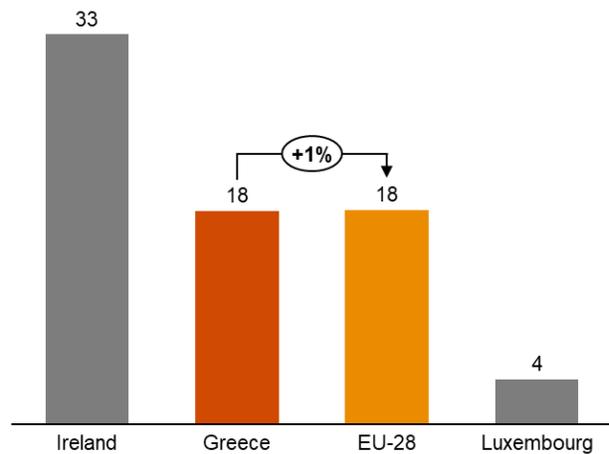


Figure 25: Graduates in tertiary education, in science, math., computing, engineering, manufacturing, construction, - per 1000 of population aged 20-29, EU 2017 - Source: Eurostat, Graduates in tertiary education, in science, math., computing, engineering, manufacturing, construction, by sex - per 1000 of population aged 20-29

Furthermore, according to government statistics and census reports from around the world it is estimated that the Greek diaspora, including 2nd, 3rd generations of Greek ancestry not born in Greece, is between

¹⁵⁷ Eurostat, Employed persons with ICT education by educational attainment level, https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_ski_itedu&lang=en

¹⁵⁸ Eurostat, Graduates in tertiary education, in science, math., computing, engineering, manufacturing, construction, by sex - per 1000 of population aged 20-29, https://ec.europa.eu/eurostat/web/products-datasets/product?code=educ_uoe_grad04

4 – 5 million.¹⁵⁹ If Greece succeeds in strengthening the involvement of its expatriates in the economic life of Greece, and if the country improves the connection between them as well as with the motherland, Greece shall gain in many ways including growth, expand its economic base and by extension its geopolitical strength.¹⁶⁰

The Greek Government has already undertaken some key initiatives for the digital upskilling and reskilling of the Greek human capital

Greek Government has undertaken some key initiatives for the digital upskilling and reskilling of the Greek human capital. In June 2018, the Greek National Coalition for Digital Skills and Jobs was launched.¹⁶¹ The Greek Coalition was led by the Ministry of Administrative Reconstruction and included Central Government agencies, Local Government agencies, businesses, social partners and NGOs as its members. In addition, in 2017 the “Alliance for Digital Employability (AFDEmp)” initiative¹⁶² provided a 12 or 24- week intensive training course to previously unemployed candidates with no ICT background, in order to reskill and certify them as full stack developers in Java or C#. Candidates. Until today, 97% are hired as entry-level, full-stack developers by top companies.

In addition, the new Ministry of Digital Governance aims to design a new digital skills initiative, the “Digital Academy”. Digital Academy will act as the platform that will interconnect all digital skills initiatives, will enable collaboration between the various bodies that provide ICT training and certification, will eliminate overlaps and replications, will provide global expertise and best practices and will enable international collaboration.¹⁶³

7.3.6 How can Greece leverage its Strengths for its Industry 4.0 strategy?

The aforementioned Industry 4.0 strengths that Greece demonstrates introduce a set of favourable conditions for Greece’s rotation to Industry 4.0 and highlights key levers that could be further exploited to accelerate the country’s digital transformation. Greece’s financial recovery (prior to the COVID-19 pandemic), the important role that the Greek Industry plays in the Greek economy and the reinvigorated interest of the Greek Government and Greek enterprises in digital indicates that this is the right time for Greece to design and implement a holistic Industry 4.0 strategy that will focus on the Greek Industry’s digital transformation.

The Industry 4.0 strategy shall incorporate initiatives that will further enhance the investments of Greek enterprises in the digitization of their production and product development functions and will accelerate the “smartification” of their products. At the same time, Industry 4.0 funding and financing initiatives shall enable the Greek Industry to experiment and deploy emerging Industry 4.0 technologies like IIoT, industrial robots and Artificial Intelligence.

Greek enterprises’ strength regarding their focus and investment on big data analytics capabilities shall also be leveraged through an appropriate set of measures and initiatives. Applied research on big data analytics shall be promoted, while potentially the setup of a relevant competence centre or digital hub on

¹⁵⁹ <https://greekcitytimes.com/2018/11/18/the-greek-diaspora-approaches-the-5-million-mark/?amp>

¹⁶⁰ <https://www.greeknewsagenda.gr/index.php/topics/opinion-analysis/6914-the-importance-of-the-greek-community-abroad-for-greece>

¹⁶¹ <http://www.nationalcoalition.gov.gr/>

¹⁶² <https://www.afdemp.org/>

¹⁶³ As per interview with the Ministry of Digital Governance held on Monday, 13 January 2020.

Artificial Intelligence and analytics can further stimulate the broad uptake of Artificial Intelligence and analytics in both industries (in particular SMEs and midcaps) and public sector organisations.

Finally, the burgeoning Greek start-up scene should further be supported through targeted measures (i.e. mentoring programmes, participation of startups in relevant innovation hubs, funding schemes targeted to startups, etc.), in order to ensure the creation of the right conditions for ambitious entrepreneurs of the Greek Industry.

7.4 Weaknesses¹⁶⁴

Below we present Greece’s key Industry 4.0 related weaknesses. These are areas where Greece underperforms and that should be improved in order to accelerate the Greek industry’s digitisation and Industry 4.0 rotation.

7.4.1 Political & Economic Weaknesses

The significant hit in fixed capital investments during the last years decelerated investments in Industry 4.0 technologies and applications

GDP grew by 1,93% in 2018 even though the, mainly Government controlled, investments in other construction and in transport equipment fell by- 22,9% and -43,5% respectively. In 2019 the recovery investment in transport equipment was notable (+30,5%) but the recovery of investment in other construction was much lower than expected (+3,1%). Also, investment in Fixed Capital (FC) excluding investment in other construction and transportation equipment were up by an expected +4,9% in 2019. The huge fall of investment in other construction in 2018 and their inadequate recovery in 2019 was obviously due to extended delays observed in the implementation of the General Government Investment Budget and of the privatisation programme (see Figure 26).¹⁶⁵ The overall hit in fixed capital investments indicates as well the decelerated investments that took place during the last years with regards to Industry 4.0 technologies and applications.

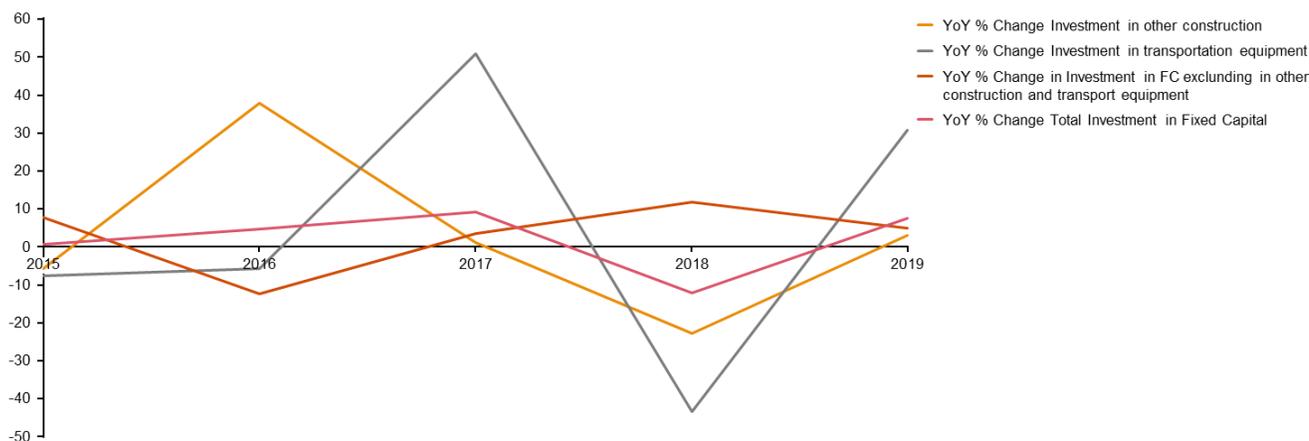


Figure 26: YoY % Change in different types of Investments of Fixed Capital, 2015 - 2019, (%) – Source: Eurostat, Stochasis Macroeconomic Trends -Sectoral Forecasts, December 2019. Forecasts have been provided by Stochasis

Money supply in the Greek economy has undergone major shocks, preventing enterprises from investing in Industry 4.0 technologies

During the years of recession, money supply has undergone severe shocks with the amount of all types of provided loans (i.e. consumer, residential and business) decreasing more than 50%. The money supply in the Greek economy entered an upward trend in 2013 and 2014 but fell abruptly during between 2014 - 2015 due to the economic policy debacle of January - July 2015 (see Figure 27).¹⁶⁶

¹⁶⁴ All graphs included in Chapter 6 are also presented in 8. Appendix in full resolution and in a reader-friendly way.

¹⁶⁵ Eurostat, Stochasis Macroeconomic Trends -SectoralForecasts, December 2019. Forecasts have been provided by Stochasis

¹⁶⁶ <https://www.bankofgreece.gr/en/statistics/evolution-of-loans-and-non-performing-loans>

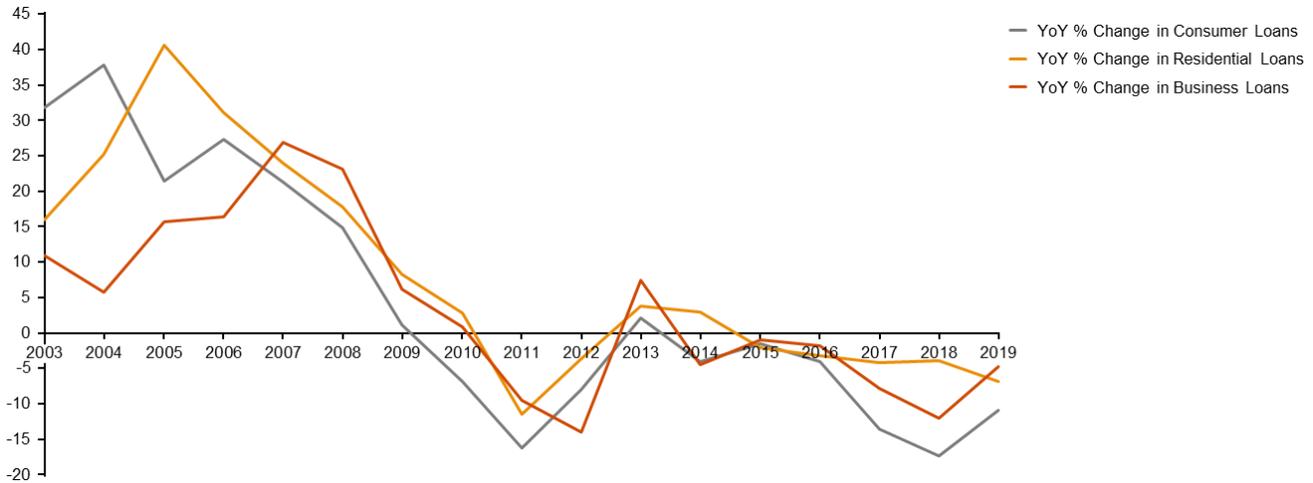


Figure 27: YoY % Change in value of different types of loans provided, 2003 - 2019, (%) - Source: Bank of Greece

At the same time the Non-Performing Loans ratio (NPL) for all types of loans skyrocketed, with the NPL ratio of the consumer loans reaching 63% in 2015 (see Figure 28). This economic turbulence, combined with the fact that investments in Industry 4.0 technologies require a higher cost of adoption and a longer payback period, have prevented a great number of Greek industrial enterprises from investing in Industry 4.0.

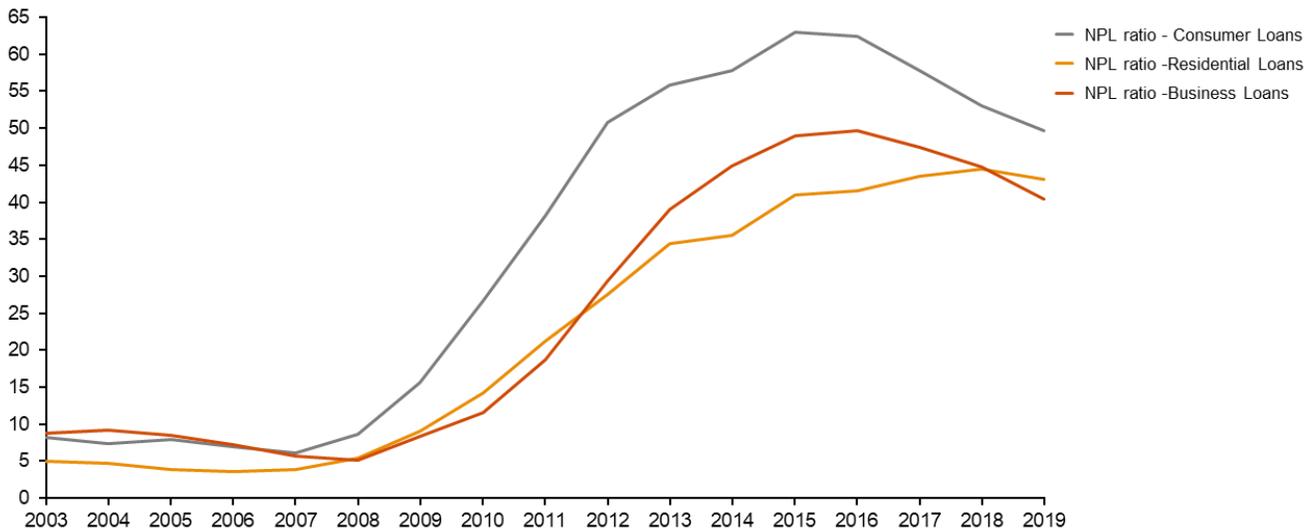


Figure 28: NPL ratio for all types of loans, 2003 - 2019 (%) - Source: Bank of Greece

The Greek Manufacturing is fragmented, with a very high number of enterprises (more than 90%) having a very small number of employees (less than 10)

According to Eurostat 92% of the total number of Greek Manufacturing enterprises have 0-9 employees. The biggest number of this type of enterprises sits within the food, beverage & tobacco and the Furniture, jewellery & toys sub-sectors (see Figure 29).¹⁶⁷

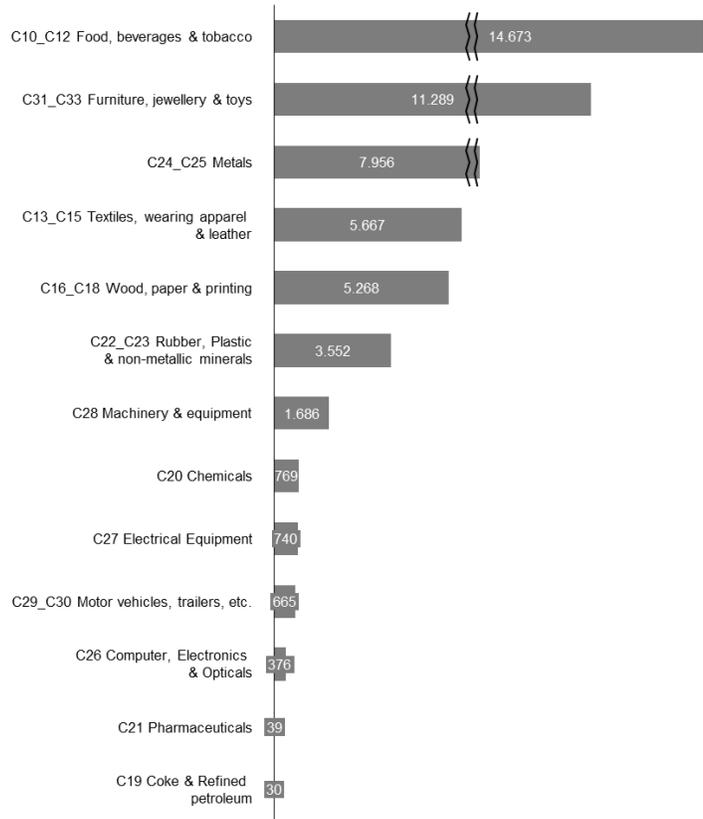


Figure 29: Number of enterprises with 0-9 employees, 2017, (#) – Source: Eurostat: Annual detailed enterprise statistics for industry (NACE Rev. 2, B-E)

¹⁶⁷Eurostat: Annual detailed enterprise statistics for industry (NACE Rev. 2, B-E), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=sbs_na_ind_r2&lang=en

7.4.2 Technological Weaknesses

Greece lacks a holistic national Industry 4.0 strategy and a structured mechanism to coordinate Industry 4.0 programmes and initiatives

Greece lacks a holistic national Industry 4.0 vision and strategy. The first structured approach for Greece's digital transformation was only introduced in 2016 by the Ministry for Digital Policy, Telecommunications, and Media through the design of the Greek National Digital Strategy (2016-2021). Although the establishment of this Ministry and the design of the National Digital Strategy was a first step towards the right direction, it did not provide the expected outcomes. This was mainly due to the fact that the National Digital Strategy 2016 – 2021 set, at a high level, a set of guiding principles that should govern Greece's digital transformation, instead of proposing a concrete strategy and a structured action plan that would engage all responsible stakeholders for the country's digital transformation.

Furthermore, in contrast to 16 of its EU counterparts, Greece has not designed yet an Industry 4.0 platform, through which the Greek Public Administration could monitor, manage and coordinate the different Industry 4.0 programmes. Although a set of initiatives have been undertaken towards the Industry's digitisation, governmental efforts thus far have remained fragmented, dispersed and are not structured around common objectives for the digitisation of the Greek industry.¹⁶⁸

The Greek enterprises lag across the adoption of Industry 4.0 and digital technologies and applications¹⁶⁹

Greece appears to lag behind across all Industry 4.0 and digital indicators. In more detail, according to EU's DESI Index, in 2019, Greece ranked 26th out of 28 EU member states with regards to its digital maturity and was positioned at the tail end of the index, with a score 28% lower than that of the European average. Greece's unfavourable rating in the DESI index is aligned with the country's low ranking across Accenture's Digital Economic Opportunity Index (DEOI), where Greece scored at the lowest end of the digital maturity curve in 2018 (22nd out of the 22 countries of the sample) and EU's Digital Transformation Scorecard.

Digital technologies and technological infrastructure in general constitute important factors that will support the digital transformation of enterprises¹⁷⁰. According to a study by the Federation of Enterprises (SEV)¹⁷¹, despite the fact that bigger enterprises have invested more in new/ digital technologic applications and technologies during the latest 3 years, enterprises with turnover of less than € 30m either did not invest or invested less than €100k on that field for the same period.

If we further examine the level of adoption of a set of digital technologies that underpin the Industry 4.0 rotation of an economy, it is evident that Greece is suboptimally positioned very low across all areas below:

- In terms of the adoption of cloud computing technologies, Greece's enterprises show low rates of adoption, with only 13% of enterprises making use of the technology, half the EU average of 26%.

¹⁶⁸ For more information on the existing initiatives that Greece has undertaken with regards to the country's digitisation, please refer to Deliverable 1

¹⁶⁹ A detailed analysis of how Greece performs across all Industry 4.0 and digital indicators is provided in Deliverable 1

¹⁷⁰ Digital and technological maturity of the economy and enterprises, Observatory of Digital Transformation, 1st Annual Report, July 2019, SEV

¹⁷¹ Digital and technological maturity of the economy and enterprises, Observatory of Digital Transformation, 1st Annual Report, July 2019, SEV

Greece ranks 25th in Europe, with a mere five percentage points above the lowest ranked country, Bulgaria (8%).¹⁷²

- With regards to RFID technologies, Greek enterprises also recorded the lowest levels of adoption in the EU along with Hungary and Romania, reporting 7% RFID adoption in 2017.¹⁷³
- In addition, just 2% of Greece’s enterprises used industrial robot technology in 2018, demonstrating the country’s slow rate of adoption in terms of industrial robotics.¹⁷⁴
- Greek enterprises have also been moderately too slow in their adoption of Customer Relationship Management (CRM) systems, with just 20% of Greek enterprises using the technology (EU average 33%).¹⁷⁵
- Greece has also been slow to bring nanotechnology into its industrial landscape, reporting just 52 nanotechnology job positions in 2016. At less than 1 basis point of the total workforce, the Greek economy has yet to make any measurable contributions to the nanotechnology sector.¹⁷⁶
- With regards to additive manufacturing, 924 job positions are currently classified as Additive Manufacturing related jobs. This is a small but not negligible part of the workforce, at 0,03%, which indicates that the Greek industry has made some initial steps, in terms of adopting this technology.¹⁷⁷
- On the cybersecurity front, Greece appears to also perform suboptimally. According to the Global Cybersecurity Index (GCI)¹⁷⁸ Greece scores on the 77th position against the overall, worldwide sample, that consisted of 193 countries.
- If we shift our focus on circular economy, Greece is Europe’s lowest ranking country, with regards to the average circular use of materials as a percentage of total material use, reporting only 1% circular material use. The average circular use of materials as a percentage of total material use was 12% in the EU in 2016.¹⁷⁹

Greece’s suboptimal position with regards to its digital infrastructure and the provision of digital public services, prevent the Greek enterprises from rapidly adopting new Industry 4.0 technologies and supporting their technology needs

With regards to the country’s digital infrastructure, the country is also suboptimally positioned. In more detail, in 2019 Greece ranked last among all EU countries (28 out of 28 member-states) according to EU’s DESI Index. In fact, Greece’s Connectivity score was 31% lower than the European average and 44% lower than Denmark, the EU leader, which recorded a score of 0,74 (out of 1) in 2019.¹⁸⁰

The deployment of new, modern and flexible digital infrastructure shall support and facilitate companies’ rapid adoption of new Industry 4.0 technologies. This in turn, will yield significant financial and non-financial benefits for them. The implementation of new Industry 4.0 tools is expected to modify companies’ production and sales processes, leading to increased cost efficiencies across these areas. At the same

¹⁷² Eurostat, Cloud computing services, https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_cicce_use&lang=en

¹⁷³ Eurostat, Enterprises using radio frequency identification (RFID) instrument, <https://ec.europa.eu/eurostat/web/products-datasets/-/tin00126>

¹⁷⁴ No data was available with regards to the use of industrial robots by Greek manufacturers

¹⁷⁵ Eurostat, Integration of internal processes, <https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do>

¹⁷⁶ https://ec.europa.eu/growth/tools-databases/kets-tools/sites/default/files/library/kets_observatory_second_report.pdf

¹⁷⁷ KETs observatory - https://ec.europa.eu/growth/tools-databases/kets-tools/sites/default/files/library/kets_observatory_second_report.pdf

¹⁷⁸ <https://www.itu.int/en/ITU-D/Cybersecurity/Pages/global-cybersecurity-index.aspx>

¹⁷⁹ <https://ec.europa.eu/environment/circular-economy/>

¹⁸⁰ Digital Economy and Society Index Indicators 2019, Connectivity, <https://digital-agenda-data.eu/datasets/desi/indicators>

time, the deployment of a digital IT architecture will also enforce businesses to increase their awareness on cybersecurity and adopt relevant practices that enhance the security of their internal systems.

The importance of the digital infrastructure for the Greek enterprises is also highlighted within the Industry 4.0 Survey. Namely, when the surveyed executives were asked about Government incentives that could

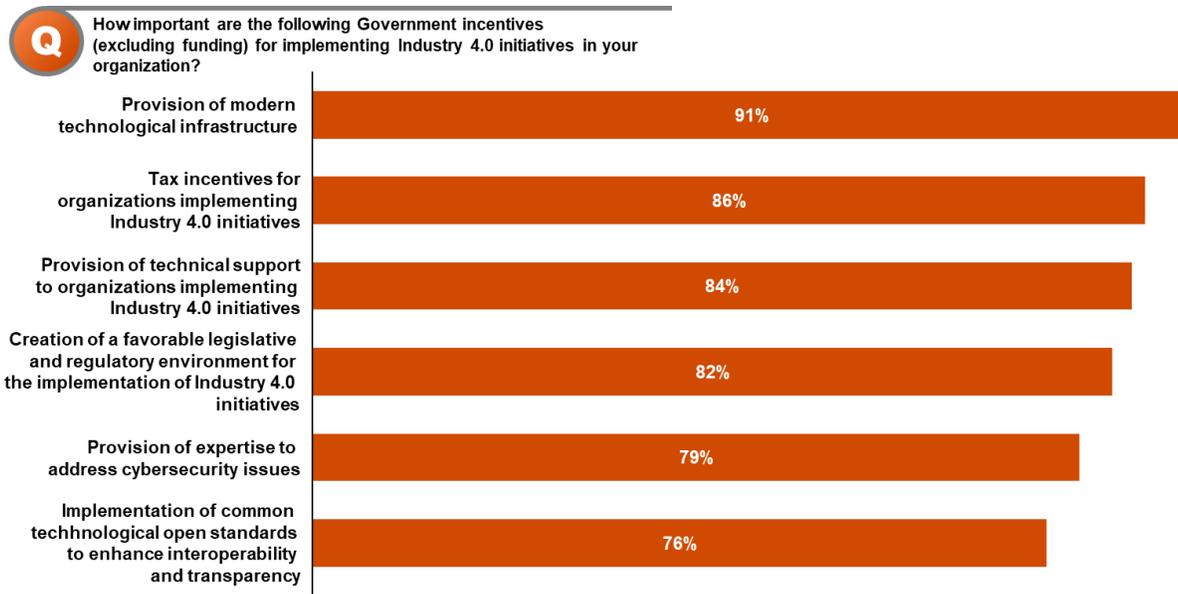


Figure 30: Important Government initiatives (excluding funding) that Greek executives wish to undertake in order to accelerate their organisations’ digital transformation, (%) - Source: Industry 4.0 survey

accelerate their organisations’ digitisation, 9 out of 10 of them cited the provision of modern technological infrastructure as the most important governmental incentive (see Figure 30).¹⁸¹

With regards to the state of e-government applications for Greece, according to EU’s DESI Index 5th pillar of Digital Public Services, Greece is among the lowest ranking EU countries, positioned at the 27th place among the EU 28.¹⁸²

- Focusing on the level of eGovernment use, Greece, performs poorly, scoring last among all 28 EU countries, with just 36% of Greek citizens submitting forms to public authorities over the internet during 2018.
- In terms of the digital public services for businesses, Greece also scores poorly, indicating that the country must significantly upgrade its current framework for accommodating the eGovernment needs. Greece’s score was 65 points in 2018, 20 points below the EU average.

New, redesigned, user-centric public services (i.e. start a new business, online submission of financial reports, etc.) are expected to digitally impact the Greek Industry. “Digital by default” public services will enforce compliance across the Greek companies and will infuse transparency both across businesses’ and within Public Administration’s services. In addition, the enforcement of digital public services will inevitably increase businesses’ level of digitalisation. In fact, the adherence and use of digital public services will necessitate the redesign and automation of organisations’ internal operations and the adoption of new digital tools to achieve seamless communication with the Greek Public Administration.

¹⁸¹ The performed analysis and the respective conclusions were based on data recorded through the “Industry 4.0” survey ran by the Ministry of Development, PwC and Accenture

¹⁸² The Digital Economy and Society Index 2019, Digital Public Services, https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=59975

The new automated internal processes are also expected to reduce the workload of repetitive, low value tasks and achieve important time/ cost efficiencies.

The surveyed Greek enterprises have initiated their Industry 4.0 rotation, albeit they are still at the beginning of their transformation journey. In fact, an alarmingly high percentage of them (especially across the very small enterprises¹⁸³, the national¹⁸⁴ enterprises and those with less than 10 years of operation) have not invested yet in any Industry 4.0 technology

The Industry 4.0 survey surfaced a quite alarming finding with regards to industrial organisations’ adoption of Industry 4.0 technologies. To our question of which Industry 4.0 technologies organisations currently use, 20% of them responded that they have not implemented any Industry 4.0 technology in their organisations thus far (see Figure 31).¹⁸⁵

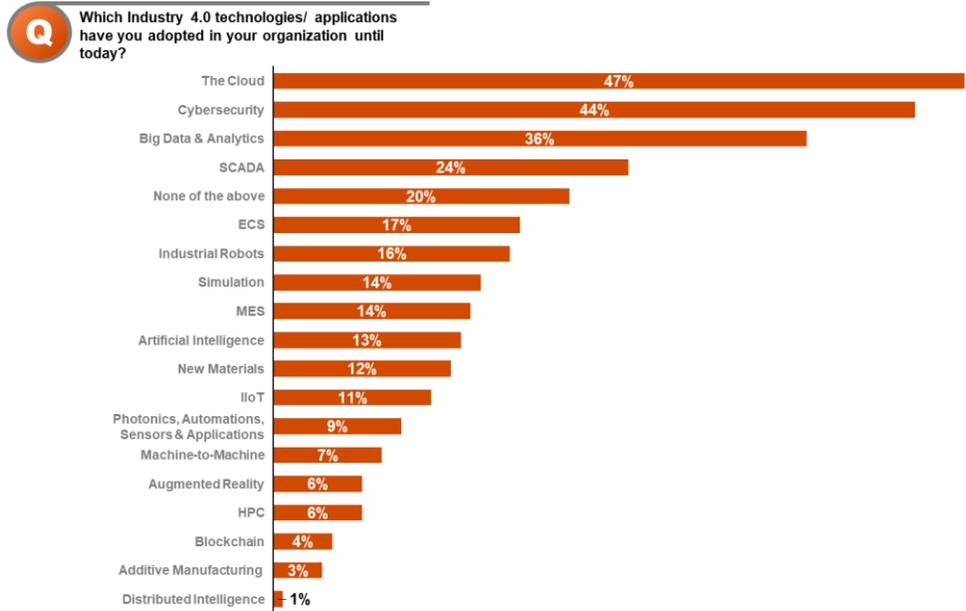


Figure 31: Key Industry 4.0 technologies/ applications that Greek executives have adopted in their organisations (%) – Source: Industry 4.0 Survey

This picture further deteriorates, when we focus on the very small enterprises of the survey’s sample. According to our findings, 4 out of 10 of them have not invested to any Industry 4.0 technology thus far (see Figure 32).

¹⁸³ Based on characterisation of company size by number of employees from Eurostat (Very Small – <10, Small – <50, Medium – <250, Large – >250)

¹⁸⁴ Greek: the company operates exclusively in Greece, Multinational: the company operates in at least one country other than its home country

¹⁸⁵ The performed analysis and the respective conclusions were based on data recorded through the “Industry 4.0” survey ran by the Ministry of Development, PwC and Accenture

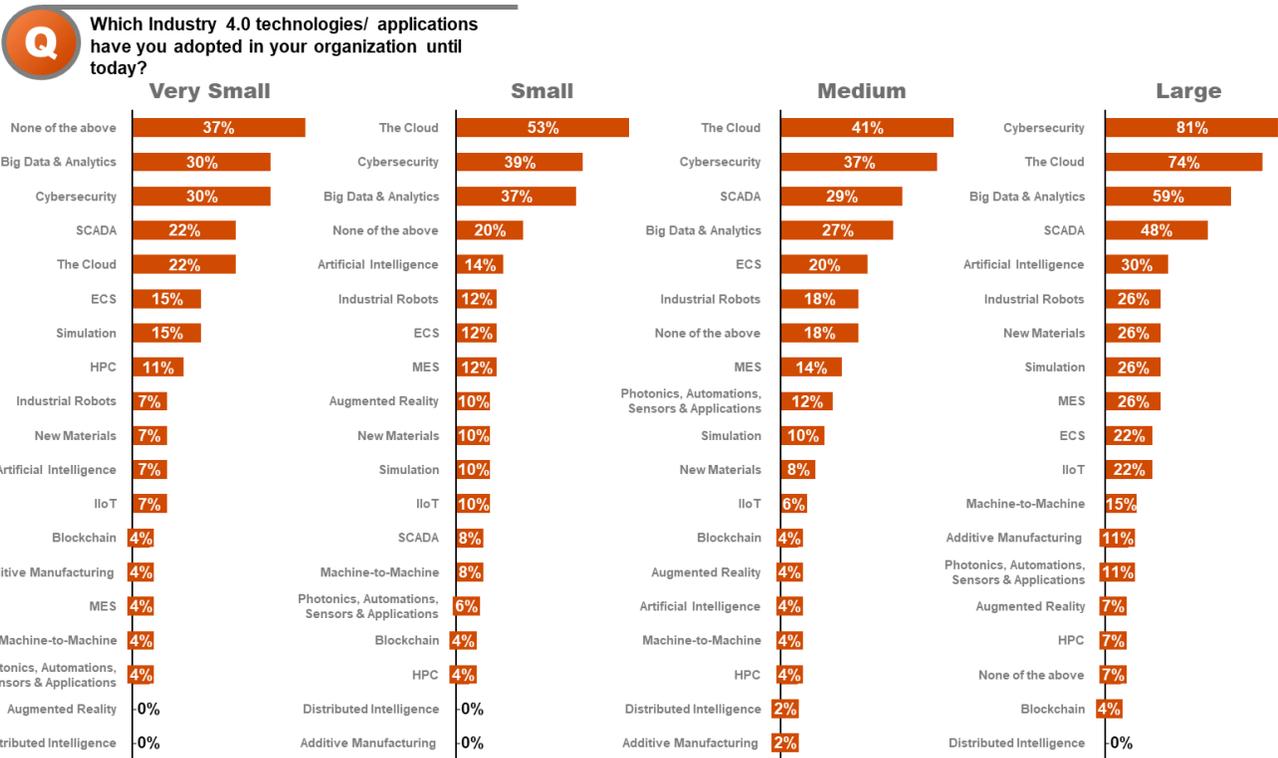


Figure 32: Key Industry 4.0 technologies/ applications that Greek executives have adopted in their organisations, by Size, (%) – Source: Industry 4.0 survey

At the same time, 25% of the surveyed national enterprises and 31% of enterprises with less than 10 years of operation claim to not have adopted any Industry 4.0 technology yet (see Figures 33, 34).

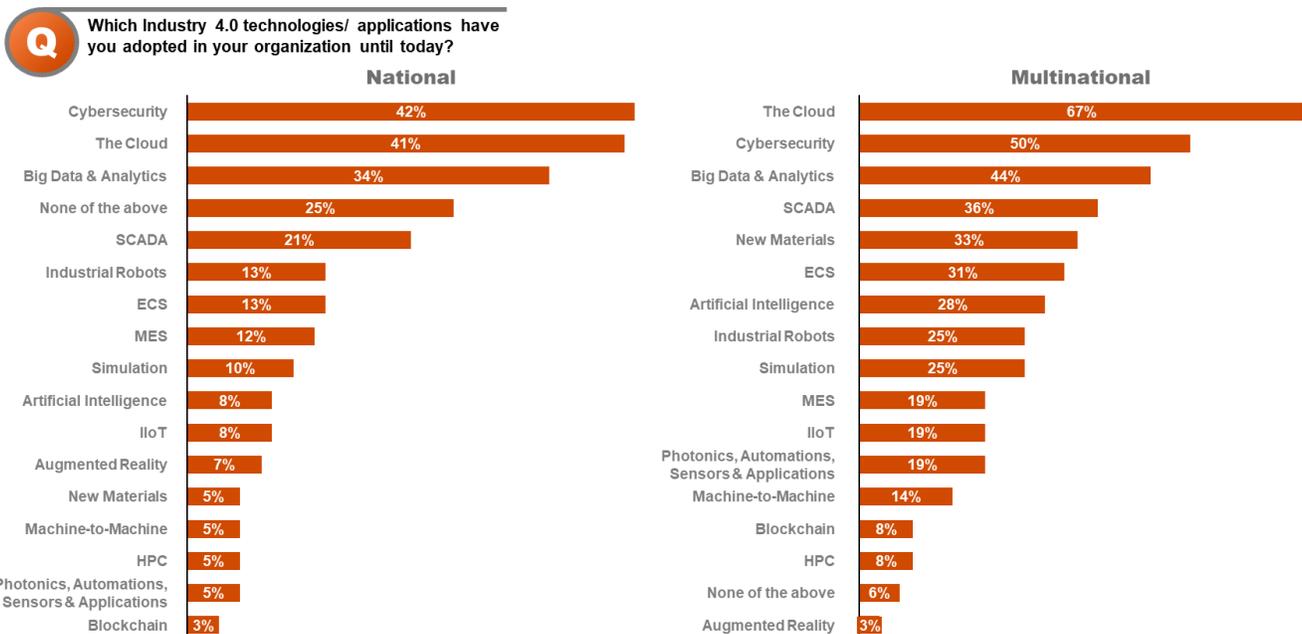


Figure 33: Key Industry 4.0 technologies/ applications that Greek executives have adopted in their organisations, by Origin, (%) – Source: Industry 4.0 survey

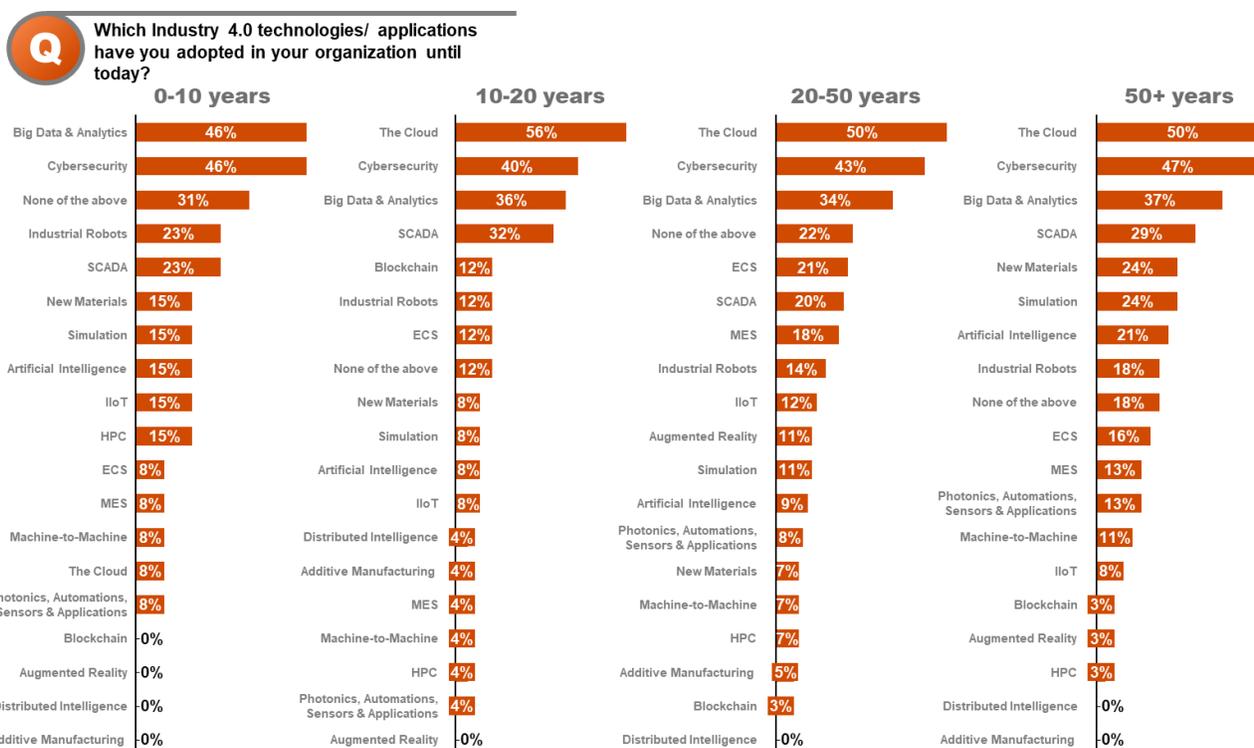


Figure 34: Key Industry 4.0 technologies/ applications that Greek executives have adopted in their organisations, by Years of Operation, (%) – Source: Industry 4.0 survey

Despite their recent revamping of their production IT landscape, the surveyed enterprises demonstrate a low level of digitisation across their production lines. Out of these, the very small and small enterprises¹⁸⁶, the national¹⁸⁷ ones and those with less than 20 years of operation appear to be the worst positioned.

With regards to the digitisation of the surveyed organisations’ production lines, an interesting finding also emerged. Almost 4 out of 10 of the participants indicated that their organisations’ production lines demonstrate a very low degree of digitisation. Nevertheless, at the same time 7 out of 10 of the same sample claimed that they have modernized their production lines within the last two years. According to results, it appears that the term “modernization” in this case may simply imply a mere replacement of the old production equipment with a new one (see Figure 35, 36).¹⁸⁸

¹⁸⁶ Based on characterisation of company size by number of employees from Eurostat (Very Small – <10, Small – <50, Medium – <250, Large – >250)

¹⁸⁷ Greek: the company operates exclusively in Greece, Multinational: the company operates in at least one country other than its home country

¹⁸⁸ The performed analysis and the respective conclusions were based on data recorded through the “Industry 4.0” survey ran by the Ministry of Development, PwC and Accenture

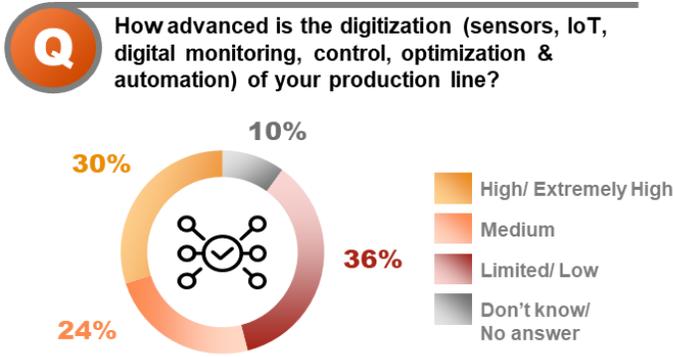


Figure 35: Level of digitisation of organisations' production lines (%) – Source: Industry 4.0 Survey

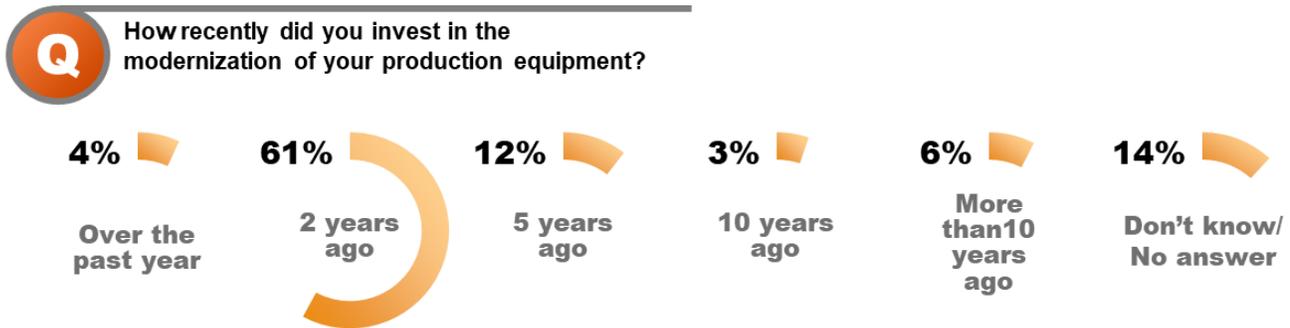


Figure 36: Last time organisations invested in the modernisation of their production equipment, (%) – Source: Industry 4.0 Survey

Very small and small enterprises, as well as national enterprises and enterprises with less than 20 years of operations appear in fact to be the worst positioned with regards to their production lines' level of digitisation (see Figures 37, 38, 39).

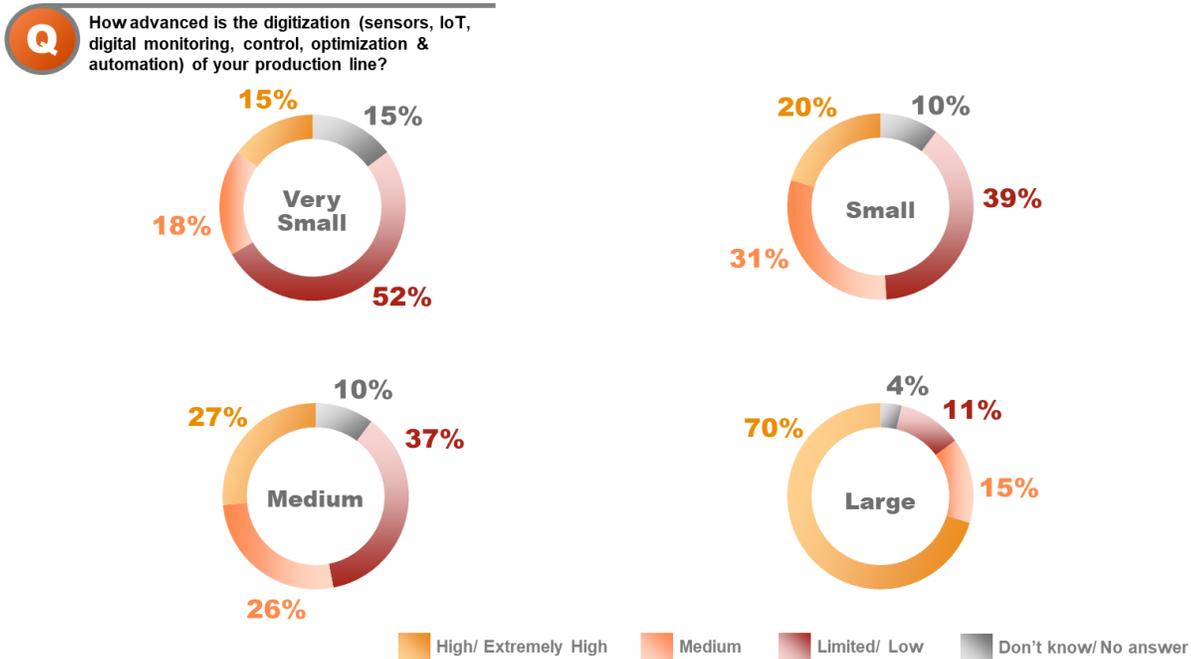


Figure 37: Degree of digitisation of the production line of organisations, by Size, (%) – Source: Industry 4.0 survey

Q How advanced is the digitization (sensors, IoT, digital monitoring, control, optimization & automation) of your production line?

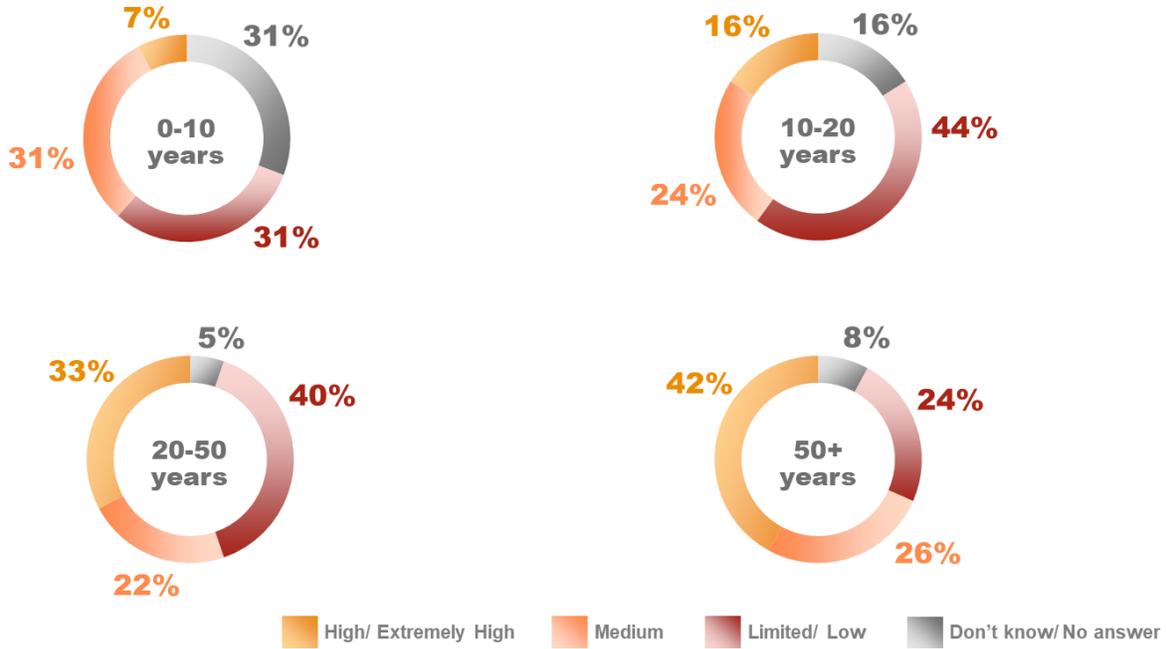


Figure 38: Degree of digitisation of the production line of organisations, by Years of Operation, (%) – Source: Industry 4.0 survey

Q How advanced is the digitization (sensors, IoT, digital monitoring, control, optimization & automation) of your production line?

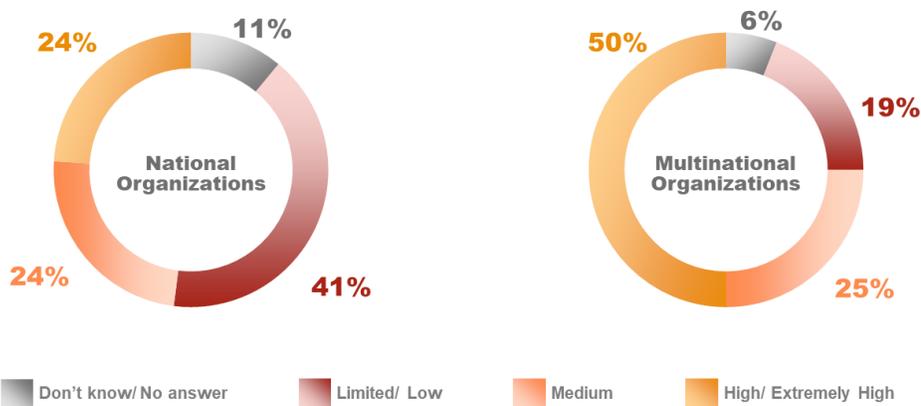


Figure 39: Degree of digitisation of the production line of organisations, by Origin, (%) – Source: Industry 4.0 survey

7.4.3 Innovation & R&D Weaknesses

Greece ranks low in terms of innovation and R&D, both with regards to their R&D intensity and with regards to the overall number of the issued Greek patents

Zooming into the Innovation and R&D areas, Greece also ranks significantly below its EU peers. In more detail, with regards to Research & Development (R&D) intensity, defined as the gross domestic spending on R&D as a percentage of GDP, Greece ranks significantly below its EU peers, at 1,18% in 2018, compared to an EU average of 2,12% in the same year (see Figure 40).¹⁸⁹

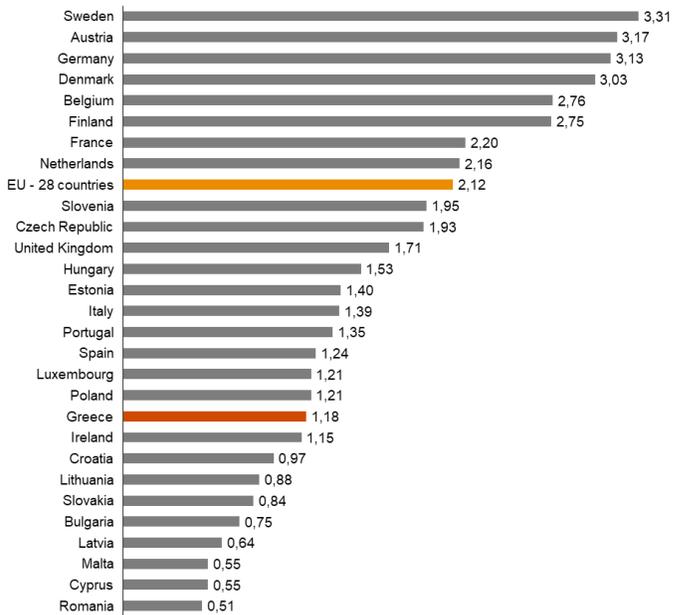


Figure 40: Gross Domestic Expenditure in R&D 2018, % of GDP – Source: OECD, Gross domestic spending on R&D

The overall technological development remains also low, as this is reflected in the very low number of Greek patents compared with other countries. While the EU-28 average was 107 patents per million inhabitants in 2017, Greece reported 8 patent applications, 97% less patents than Sweden, the European leader (283 patents) (see Figure 41).¹⁹⁰

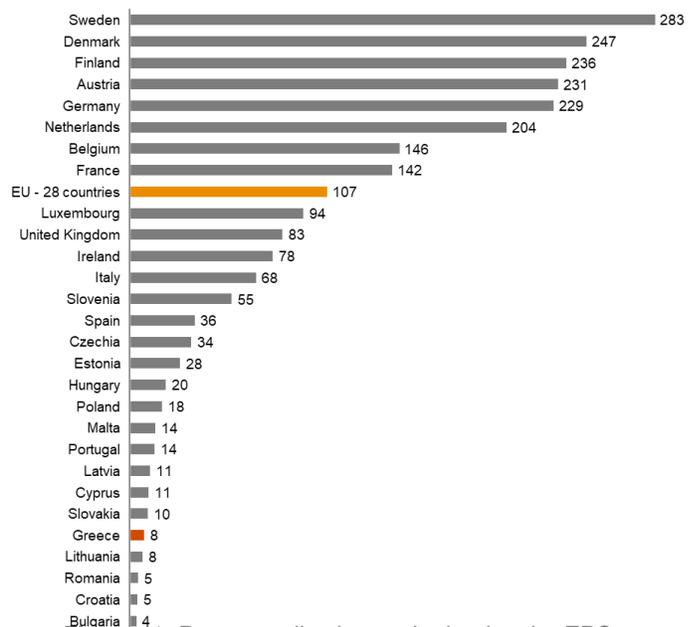


Figure 41: Patent applications submitted to the EPO per million inhabitants, EU, 2017 Source: Eurostat, Patent applications to the European Patent Office

¹⁸⁹ OECD, Gross domestic spending on R&D, <https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm>

¹⁹⁰ Eurostat, Patent applications to the European Patent Office, https://ec.europa.eu/eurostat/web/products-datasets/product?code=sdg_09_40

Greece’s industry, much like the overall economy, is far behind the European average when it comes to industrial R&D. Greece’s total business R&D expenditure in the manufacturing sector was €290 million in 2017, among the lowest in the EU. In comparison, Germany’s business R&D in the manufacturing sector in 2017 was €58 billion, while France and the UK’s business sectors spent approximately €16 and €11 billion in industrial R&D respectively (see Figure 42).¹⁹¹

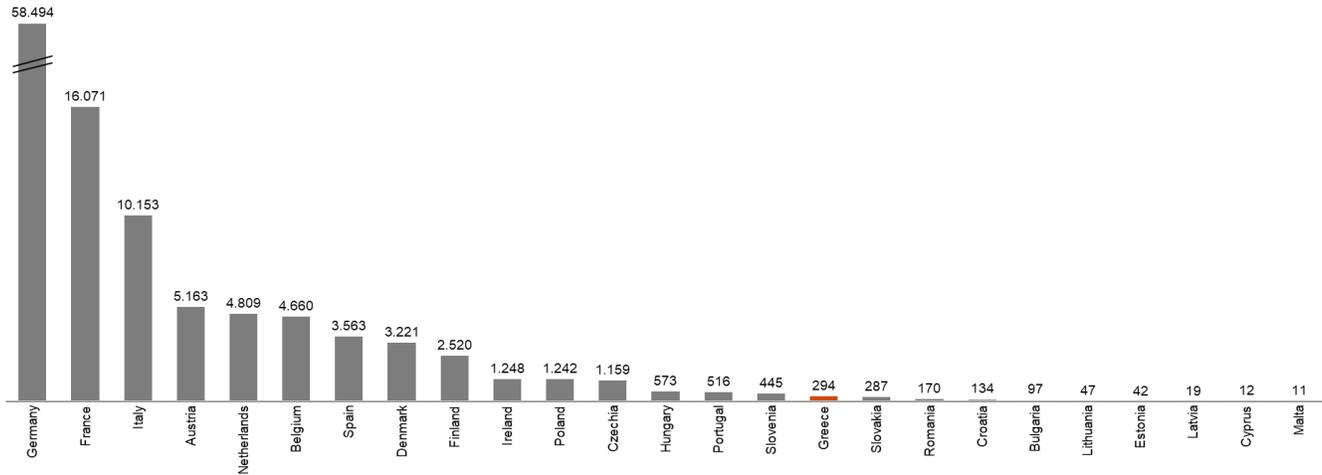


Figure 42: Business R&D Expenditure in the manufacturing sector, € Billion (2017) – Source: Eurostat, Business expenditure on R&D (BERD) by NACE Rev. 2 activity

R&D appears disassociated with applied research & industry implementation, as contrary to the EU average, where the business sector appears highly involved in R&D, the Greek R&D is mainly dominated by the higher education sector, while Greek organisations appear reluctant to invest in applied R&D

Nonetheless, the most alarming finding in the innovation field, is the fact that the current Greek R&D investments appear disassociated to applied research and industrial implementation. This is evident from the distribution of the Greek R&D personnel across the different sectors of the economy. Namely, contrary to the EU average, where the business sector appears highly involved in R&D (58% FTE), the Greek R&D is mainly dominated by the higher education sector (46% FTE). This highlights that Greek organisations appear hesitant to invest in research of new technologies, as well as in

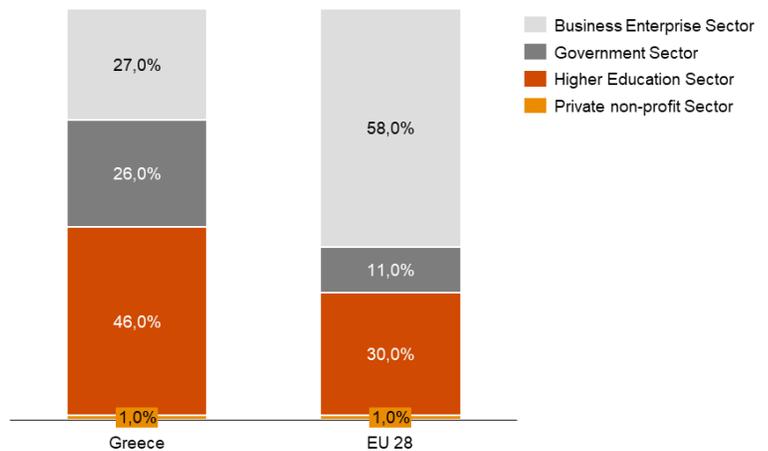


Figure 43: % of total R&D FTE per sector Greece and EU-28, 2018 – Source: Eurostat, Total researchers by sectors of performance - full time equivalent

¹⁹¹ Eurostat, Business expenditure on R&D (BERD) by NACE Rev. 2 activity, <https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do>

active experimentation of how these could be implemented to drive new sources of revenues (see Figure 43).¹⁹²

7.4.4 Legal & Regulatory Weaknesses

Greek enterprises face structural and regulatory obstacles during their setup and operations, with areas of “dealing with construction permits”, “registering property”, “getting credit” and “enforcing contracts” scoring particularly low across the annual report on the ease of “Doing Business” for 2020

According to the World Bank’s annual report on the ease of “Doing Business” per country for 2020¹⁹³, Greece has improved its index score slightly (from 67,4% to 68,4%). However, the country has still a lot of room for improvement, as it is ranked as 79th across 190 countries.

Greece scores best in the “Starting a Business” dimension where it takes a minimum of 4 days to start a limited liability private business of between 10 and 50 employees, that does not qualify for investment incentives or any special benefits, is 100% domestically owned, does not perform foreign trade activities, does not handle products subject to a special tax regime, for example, liquor or tobacco and is not using heavily polluting production processes.

However, Greece performs particularly poorly in the “Dealing with Construction Permits” (86th), “Registering Property” (156th), “Getting Credit” (119th), “Paying Taxes” (72nd), “Enforcing Contracts” (146th) and “Resolving Insolvency” (72nd) dimensions.

This indicates that although it may be relatively easy to start a standard business in Greece, there are many structural obstacles that may occur until the company becomes fully operational (Dealing with Construction Permits, Registering Property, Getting Credit), as well as during its operations (Paying Taxes, Enforcing Contracts, Resolving Insolvency).

The surveyed Greek executives place the provision of Industry 4.0 related tax incentives and the development of a flexible, digital-friendly regulatory framework as top incentives that could accelerate their organisations’ digital transformation

Greek organisations also cited that the Greek Government has an important role to play in abolishing the abovementioned structural inhibitors and accelerate Industry 4.0 adoption within the Greek industry, through the provision of relevant financial and non-financial incentives. To start with, 8 out of 10 of the respondents perceive the provision of relevant tax incentives as an important motive for organisations’ digital transformation. Next to tax incentives, the establishment of a favourable regulatory framework to encourage Industry 4.0 rotation feature high on the agenda of 8 out of 10 respondents. These results suggest that the breadth and depth of the digital interventions required to be implemented by the Greek

¹⁹² Eurostat, Total researchers by sectors of performance - full time equivalent, <https://ec.europa.eu/eurostat/web/products-datasets/product?code=tsc00004>

¹⁹³ <https://www.doingbusiness.org/>

Government shall be significantly deep and wide, to ensure the setup of a holistic support mechanism for the Industry’s rotation to Industry 4.0 (see Figure 44).¹⁹⁴



Figure 44: Important Government initiatives (excluding funding) that Greek executives wish to undertake in order to accelerate their organisations’ digital transformation, (%) – Source: Industry 4.0 Survey

¹⁹⁴ The performed analysis and the respective conclusions were based on data recorded through the “Industry 4.0” survey ran by the Ministry of Development, PwC and Accenture

7.4.5 Social & Environmental Weaknesses

Greece has performed limited investments in the digital upskilling and reskilling of its industrial workforce and does not have in place a structured mechanism to measure the effectiveness of the undertaken digital skills initiatives

Greece’s limited digital skills is also considered a structural inhibitor towards the country’s Industry 4.0 rotation. In particular, in 2019 Greece ranked 25th in DESI’s Human Capital dimension, with an overall score of 0,33 units, which is 32% lower than the European average. During the past 6 years, Greece’s score in the Human Capital dimension has remained stable. The relatively stagnant performance of the country combined with the evolution of digital skill capabilities within other EU member states is creating a widening gap between Greece and EU average in the Human Capital dimension.¹⁹⁵

Zooming into the human workforce, the Greek enterprises appear unwilling to further invest in their human capital’s digital upskilling. Only 14% of Greek enterprises offered ICT skills training to their employees in 2018, compared to the EU average of 23% (see Figures 45).¹⁹⁶

This evidence is directly linked with Greece’s and the Greek Industry’s overall low digital maturity, the limited awareness of Greek enterprises regarding Industry 4.0 and the thus far limited investments performed in digital technologies (please refer to paragraph 7.4.2).

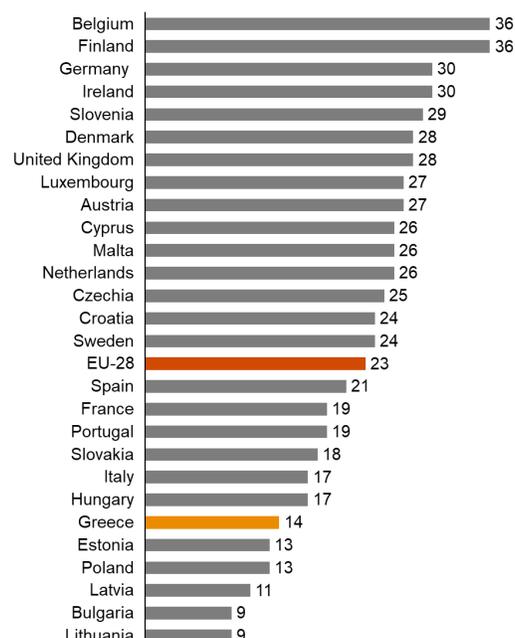


Figure 45: % of Enterprises that provide ICT skills training, 2018 - Source: Eurostat, Enterprises that provided training to develop/upgrade ICT skills of their personnel

¹⁹⁵ The Digital Economy and Society Index 2019, Human Capital, <https://ec.europa.eu/digital-single-market/en/desi>

¹⁹⁶ Eurostat, Enterprises that provided training to develop/upgrade ICT skills of their personnel, https://ec.europa.eu/eurostat/en/web/products-datasets/-/ISOC_SKE_ITTN2

If we turn our attention to the country’s industrial workforce, it appears that with only 13% of manufacturers providing ICT training to their personnel, Greece’s industry ranks low among its EU peers, nine points below the EU average (EU average 22%) (see Figure 46).¹⁹⁷

The latter consists a major weakness for the Greek manufacturing enterprises, since about half of Manufacturing workers (43%) are skilled craftsmen and practitioners while about 1 in 5 (19%) are industrial plant, machinery and equipment operators and assemblers, followed by 8% of those who were unskilled workers. manual laborers and small businessmen.¹⁹⁸

In addition, according to interviews we had with Government representatives, currently the initiatives currently undertaken by the Public Administration, academia, federations and private businesses have been fragmented, dispersed and are not underpinned by any common digital skills vision and strategic guidelines. In addition, it appears that there is no structured mechanism in place to measure the effectiveness of the undertaken digital skills initiatives. This leads to lack of and/or wrong information with regards to the real level of digital skills across the Greek society and workforce.¹⁹⁹

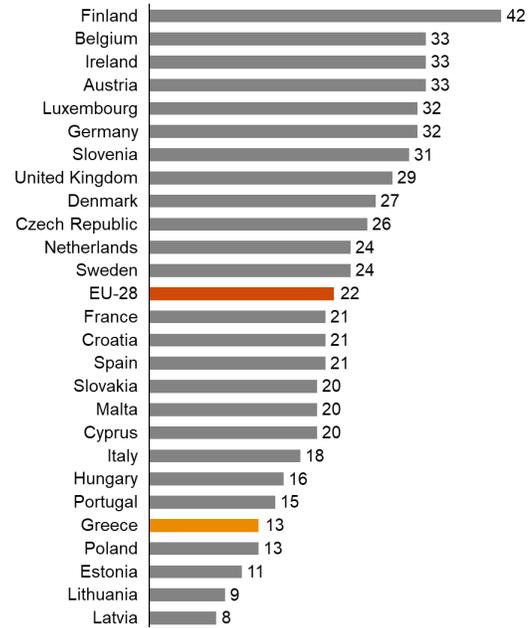


Figure 46: % of Manufacturers providing ICT training to their personnel, 2018 - Source: Eurostat, Enterprises that provided training to develop/upgrade ICT skills of their personnel

¹⁹⁷ Eurostat, Enterprises that provided training to develop/upgrade ICT skills of their personnel, https://ec.europa.eu/eurostat/en/web/products-datasets/-/ISOC_SKE_ITTN2

¹⁹⁸ IOBE Report, <https://hellenicproduction.org/meleti-iove-2018/>

¹⁹⁹ As per interview with the Ministry of Digital Governance held on Monday, 13 January 2020.

Greek surveyed executives verify the limited digital skills currently existing in the Greek market. This challenge appears even greater for the very small and small enterprises²⁰⁰ that we surveyed.

According to the Industry 4.0 survey, only 17% of the Greek executives believe that their workforce is currently digitally adept (see Figure 47). This challenge becomes even greater for the very small and small enterprises that we surveyed (see Figure 48).²⁰¹

Q How would you characterize the readiness of your workforce's digital skills to meet your Industry 4.0 needs over the next 5 years?

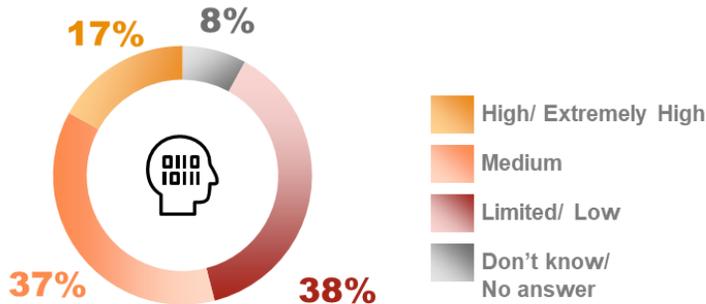


Figure 47: Degree of organisation's confidence in the current level of digital skills of their workforce, to meet Industry 4.0 challenges, by Size, (%) – Source: Industry 4.0 survey

Q How would you characterize the readiness of your workforce's digital skills to meet your Industry 4.0 needs over the next 5 years?

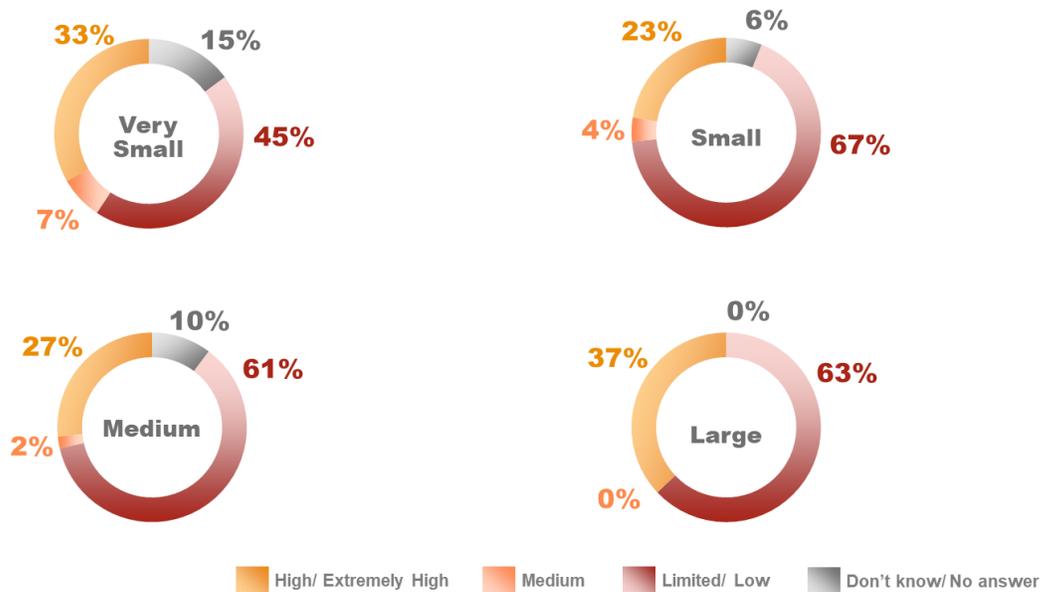


Figure 48: Degree of organisation's confidence in the current level of digital skills of their workforce, to meet Industry 4.0 challenges as per size of organisations – Source: Industry 4.0 survey

²⁰⁰ Based on characterisation of company size by number of employees from Eurostat (Very Small – <10, Small – <50, Medium – <250, Large – >250)

²⁰¹ The performed analysis and the respective conclusions were based on data recorded through the "Industry 4.0" survey ran by the Ministry of Development, PwC and Accenture

The most highly sourced digital skills in the future appear to be around Artificial Intelligence, Cloud, Big Data Analytics and Cybersecurity

Zooming into the expertise in new technologies, Artificial Intelligence, Cloud, Big Data analytics and Cybersecurity capabilities appear the hardest ones to find in the future, among the Industry 4.0 technologies and applications (see Figure 49).

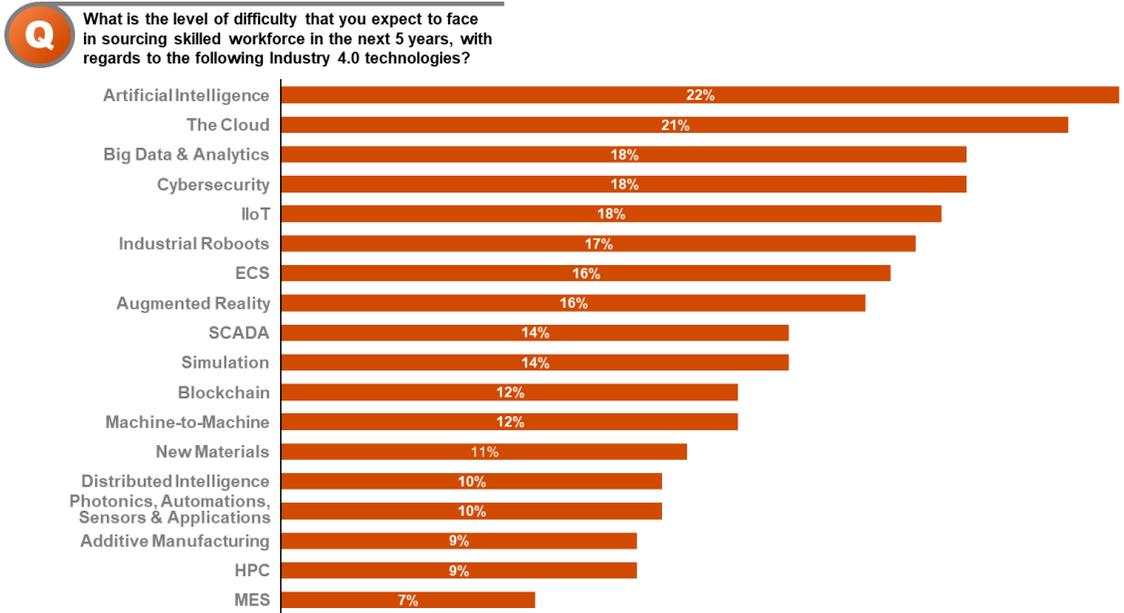


Figure 49: Level of difficulty that organisations expect to face in sourcing skilled workforce for adopting Industry 4.0 initiatives, in the next 5 years, (%) – Source: Industry 4.0 survey

An interesting fact is also surfaced at this point. Only a low percentage of respondents overall perceive that Industry 4.0 capabilities will be hard to find in the future (i.e. 22% of the respondents perceive AI capabilities to be hard to source, while IIoT or Industrial Robots capabilities were quoted by 17% and 16% of the respondents). This indicates that either the Greek executives believe that in the future the Greek workforce will become highly skilled and equipped with Industry 4.0 capabilities, or they simply underestimate the difficulty of sourcing capabilities in these areas, that still remain for a great percentage of them “uncharted waters”.

Greece is Europe’s lowest ranking country, with regards to the average circular use of materials

According to Eurostat data, the average circular use of materials as a percentage of total material use averaged 12% in the EU on 2016. On the country level, the circularity of national economies varies highly with the Netherlands leading the way at 29% circular material use while Greece, Europe’s lowest ranking country, reports only 1% circular material use (see Figure 50).²⁰²

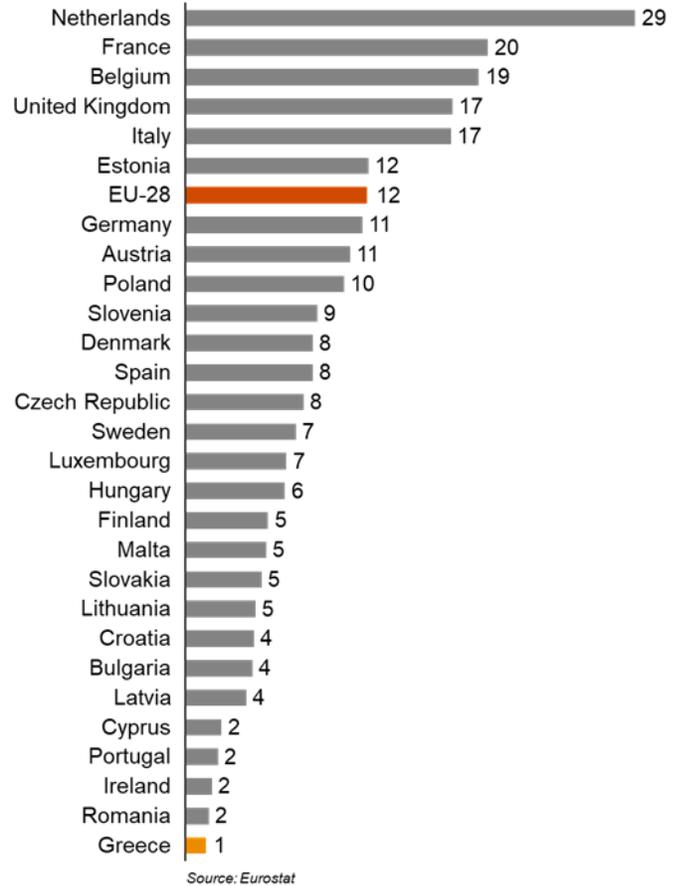


Figure 50: EU Circular material use rate, % of total material use, 2016 – Source: Eurostat, Circular material use rate

²⁰² Eurostat, Circular material use rate, https://ec.europa.eu/eurostat/databrowser/product/view/cei_srm030?lang=en

7.4.6 How can Greece address its weaknesses through the Industry 4.0 strategy?

The fragmented and dispersed Industry 4.0 and digital initiatives, that have taken thus far place regarding the Greek industry, shall become consolidated under the holistic Industry 4.0 strategy for Greece. In addition, their effective management and monitoring shall be addressed by the introduction of a structured monitoring mechanism and the introduction of the Industry 4.0 platform that will consolidate all related initiatives and will provide an oversight of their progress.

The thus far low adoption of digital technologies by the Greek enterprises, sets also as a prerequisite for the Industry 4.0 strategy to introduce and prescribe a set of measures and relevant funding mechanisms to ensure the increase of the Industry 4.0 awareness across the Greek industry, as well as to enhance the incentivization of the firms to actively invest in new technologies and technological equipment and improve their digital maturity. This mandate becomes even more pressing for the Greek SMEs that demonstrate limited awareness and that according to the Industry 4.0 survey results, approximately 40% of them have not invested yet in any Industry 4.0 technology.

At the same time, the limited investments in R&D, as well as its disassociation with the applied research and industry implementation asks for targeted strategic initiatives that shall aim to strengthen the collaboration between the Greek Government, Industry, Research & Academia and performance of targeted applied research to solve industry related problems.

Despite Greece's technically adept human capital, the Greek Government and enterprises have only performed limited investments regarding the digital upskilling and reskilling of their industrial workforce thus far. This consists a major inhibitor for the Greek industry's rotation to Industry 4.0. As such, a set of initiatives shall be introduced with the aim to ensure the digital upskilling and reskilling of existing and future Industry workforce. These initiatives undertaken by the Greek Government shall also be actively supported by the Greek enterprises and their respective federations. In addition, specific emphasis shall be given to the workforce's upskilling in specific capabilities around Artificial Intelligence, Cloud, Big Data analytics and Cybersecurity.

Another area of focus to be covered by the newly introduced Industry 4.0 strategy, according to the aforementioned national weaknesses, is the introduction of a flexible, digital-friendly regulatory environment, that shall abolish the existing regulatory hurdles, restrictions, and red tape and prevent the exit of capital, labor and entrepreneurship from Greece. This flexible regulatory environment shall be also accompanied and enhanced by the introduction of an ICT standardization framework to help ensure that the implemented Industry 4.0 technologies, systems and services retain the ability to connect and interoperate with each other, boosting innovation, and keeping the Greek ICT market open, competitive and interconnected with the rest of the Europe.

Greece's suboptimal position with regards to its digital infrastructure and the provision of digital public services indicates that the Industry 4.0 strategic plan shall also prescribe a set of foundational initiatives regarding the establishment of digital infrastructure and public digital services, that will act as the accelerators for Greek enterprises to rapidly adopt new Industry 4.0 technologies. These initiatives shall be only mentioned at a high level, since they will be presented in full detail in the "Bible of Digital Transformation", soon to be published by the Ministry of Digital Governance.

Last but not least, Greece's low ranking with regards to the average circular use of materials, indicates that the Industry 4.0 strategy shall also zoom into targeted actions that will enable the Greek industry to actively participate in the circular economy ecosystem and enhance their adoption of "greener" policies and technological solutions.

7.5 Opportunities²⁰³

Below we present the key Industry 4.0 related opportunities we identified for Greece that can positively affect the Greek Industry's digitisation.

7.5.1 Political & Economic Opportunities

Global changes in the distribution and nodes of power enable Greece to become part of wider global ecosystems

The near future will be different in terms of power distribution, but also in the nature of power itself. Power will not be determined solely by classic measures such as population size, GDP and military spending. Power will also be determined by countries' relational influence. In this context, countries will not act anymore as "poles" of power. Instead, they will form "nodes" of wider, multi-country ecosystems to tackle major global challenges as a union. Key determinant for the emergence of these ecosystems will be the number and quality of bi- and multilateral relationships formed between countries. Influence will be determined by trade and aid flows rather than economic power, and by arms and technology transfers rather than military spending. Alliances of international organisations will constitute capital, as will connectivity – especially in the form of new technologies.²⁰⁴

In this context, the EU has enabled accordingly the unification of Europe's biggest economies, which has allowed Europe to have a bigger influence in the global market and a leading position in the world trade. It has also enabled the free flow of goods, services, money and people, it allowed for equal competition and has provided political and diplomatic ways of resolving conflicts between member-states.

EU's competitive positioning within the global market and ecosystem, as well as the "open" and "free flow" market that has established amongst its member-states, enables Greece to become part of wider European ecosystems. Greece shall leverage the EU's policies and schemes that favour the country's digitisation and tap into a wealth of initiatives and support mechanism available on the EU level, in order to join forces with other member-states and jointly form new digital ecosystems that will further enhance innovation sharing and production growth.

The European Industrial Strategy can significantly benefit Greece's rotation towards Industry 4.0

As described earlier in this report, the European Industrial Strategy was introduced in March 2020 to facilitate the EU industry's transition to the Industry 4.0 paradigm. The EU Industrial Strategy stresses three key strategic priorities: maintaining the EU industry's competitiveness at home and globally, making Europe climate neutral by 2050, and shaping the continent's digital future. The policy initiatives and support mechanisms outlined in the Strategy shall be leveraged by the Greek Industry and economy to significantly benefit them over the years to come.

²⁰³ All graphs included in Chapter 6 are also presented in 8. Appendix in full resolution and in a reader-friendly way.

²⁰⁴ ESPAS: European Strategy and Policy Analysis System – Global Trends to 2030, Challenges and Choices for Europe, https://ec.europa.eu/epsc/sites/epsc/files/espas_report2019.pdf

One of the Strategy's main priorities is the removal of entrenched barriers in the European single market, which will enable Greek organisations to tap into a more open, accessible market for their goods and services, while also broadening the scope of potential partnerships and synergies with enterprises in different EU member states. The Single Market Enforcement Action Plan, which falls under the EU Industrial Strategy umbrella of initiatives, represents a significant opportunity for Greek organisations to deepen their access to the single EU market by initiatives such as streamlining standards requirements, removing language, administrative and tax barriers, and curtailing uneven access to public procurement.²⁰⁵

Furthermore, the EU Industrial Strategy will create new opportunities for Greek SMEs, through the introduction of targeted policy initiatives to empower SMEs. The underlying EU SME Strategy is expected to bring about the overhaul of numerous regulatory and practical obstacles to SME growth, while introducing SME initial public offerings through the InvestEU SME window. With regards to increasing support for start-ups, the European Commission is introducing the EU Start-up Nations Standard, which will share and adopt best practices to accelerate growth of high-tech SMEs and start-ups. Greece's large number of SMEs and rising start-up community will benefit significantly the EU Industrial Strategy's SME initiatives.²⁰⁶

In addition to the above, the EU Industrial Strategy is expected to provide support and best practices guidelines across a number of specific areas from the implementation of an intellectual property strategy (through the Intellectual Property Action Plan), to decarbonisation support offered by the Clean Hydrogen Alliance and a number of sectoral strategic initiatives (i.e. the EU Pharmaceutical Strategy).

If leveraged appropriately, the EU Industrial Strategy could enable Greek enterprises of all sizes to grow their business and competitiveness by integrating further within the single market and utilizing the Commission's support to innovate in their field.

7.5.2 Technological Opportunities²⁰⁷

The “smartification” of products can enable Greek enterprises to produce products & services of higher added value and to become more competitive

Industry 4.0 will bring about radical shifts in industrial products' form and functionalities. Digital technologies create smart, connected products, what we also call “living” products. These products share four traits: They are constantly connected to other devices and to the cloud, they become “smart” through the incorporation of sensors and on-board processing capability, they learn and evolve through the use of Artificial Intelligence and they can be offered as a subscription service allowing the customer to pay for use rather than ownership.

The adoption of smart products represents an important growth opportunity for Greek enterprises. Greek enterprises can leverage digital technologies to produce “smart” products tailored to the individual needs of their customers. Global studies startlingly reveal the stakes for companies in driving tailored experiences for their customers. Namely, high performers that produce smart, personalised products, are able to achieve significant increase on their return of investment (up to 14%), cost savings (up to 6%) but also

²⁰⁵ https://ec.europa.eu/commission/presscorner/detail/en/fs_20_427

²⁰⁶ https://ec.europa.eu/commission/presscorner/detail/en/fs_20_426

²⁰⁷ These may include opportunities directly linked to technologies and/ or business opportunities that may derive from the introduction of Industry 4.0

differentiation (up to 22%) and customer satisfaction (up to 16%).²⁰⁸ A number of Greek enterprises have already shown signs of turning into the design and production of “smart” products and services, the most predominant of which being the smart home services currently offered by Greece’s major telecommunications and utility companies. In light of Greece’s strong reliance on tourism and hospitality as a source of income, innovating early in smart home offerings for the hospitality sector shall also become a significant point of competitive advantage for the sector’s enterprises. That being said, opportunities for smart product growth should not be limited to the B2C market. Smart products can produce innovation across the economy, as demonstrated by innovations observed in Greek shipping, exemplified by companies like METIS²⁰⁹, a smart ship management solution provider that facilitates wireless data acquisition from a ship’s onboard equipment for real time diagnosis and prediction on the cloud.

The emergence of new business models can support Greek enterprises in tapping new sources of value creation

As Industry 4.0 brings about new capabilities and ways of doing business, industrial manufacturers and equipment providers are introducing new business models to adjust to new needs and offerings. Two distinct business models are likely to play a key role in the development of Industry 4.0: “As-a-Service” models and Platform-based business models.

In the “As-a-Service” or “pay-as-you go” models, a provider’s industrial equipment is still located at the buyer’s premises, but the latter will pay for its uses on a use-based principle. So, instead of purchasing a piece of equipment, the manufacturer will purchase a subscription for its use over a time period of their preference, including any maintenance and support services that may be offered by the provider.

Moreover, in the Industry 4.0 era of smart, connected products, manufacturing and hardware-centric companies need to work out whether they also need a platform strategy. While platform-based business models offer tremendous value creation potential, not all traditional product companies need to, nor will be able to make this pivot. Several Internet and software companies have already created successful connected product platforms. As such, the traditional players will need to consider whether to plug into these platforms as partners or compete directly.

In Greece’s context, the emergence of new business models offers an unprecedented opportunity for the growth of domestic industrial enterprises and the setup of cross-sectoral platform plays. In the past, Greece’s limited industrial activity and scarcity of domestic end-to-end industry ecosystems created barriers to industrial innovation and growth, as geographical proximity to other manufacturers was vital to determining supply chain compatibility. However, the emergence of platform-based business models empowers Greek enterprises to access a more seamlessly connected industrial ecosystem, which will rely more on the ability of each partner to innovate within the platform rather than on their underlying geographical proximity.

Sunlight, a Greek specialist battery supplier for electrical industrial vehicles (eIVs), which is responsible for 10% of the global volume of lead battery sales for eIV, exemplifies already the case. Through continuous product innovation, the investment in “smart battery” products and the introduction of “battery

²⁰⁸ Forrester Consulting (2016) Expectation vs. Experience: the good, the bad, the opportunity, Accenture [online], <https://www.accenture.com/acnmedia/pdf-23/accenture-expectations-vs-experience-infographic-june-2016.pdf>

²⁰⁹ METIS Company Website <https://www.metis.tech/#oursolution>

as a service” business model, which enable real time data management in the Cloud, Sunlight has managed to compete successfully in the rapidly growing electrical industrial vehicle ecosystem.²¹⁰

The massive explosion of digital data at a global scale introduces a set of favourable conditions that can further boost Greece’s big data & analytics national strengths

In Industry 4.0, technological advances have made possible the collection, synthesis, and evaluation of data from every stage of the organisation’s value chain. Data from the industrial production, sales and distribution process and product use can all be used in tandem to achieve more optimal and efficient operations. The number of devices connected to IP networks will be more than three times the global population by 2023. There will be 3.6 networked devices per capita by 2023, up from 2.4 networked devices per capita in 2018.²¹¹ There will be 29.3 billion networked devices by 2023, up from 18.4 billion in 2018. In addition, the total amount of data created in the world is forecast to increase dramatically in the coming years, reaching 175 zettabytes²¹² in 2025. The rapid development of digitalisation contributes to the ever-growing global datasphere (see Figure 51).²¹³

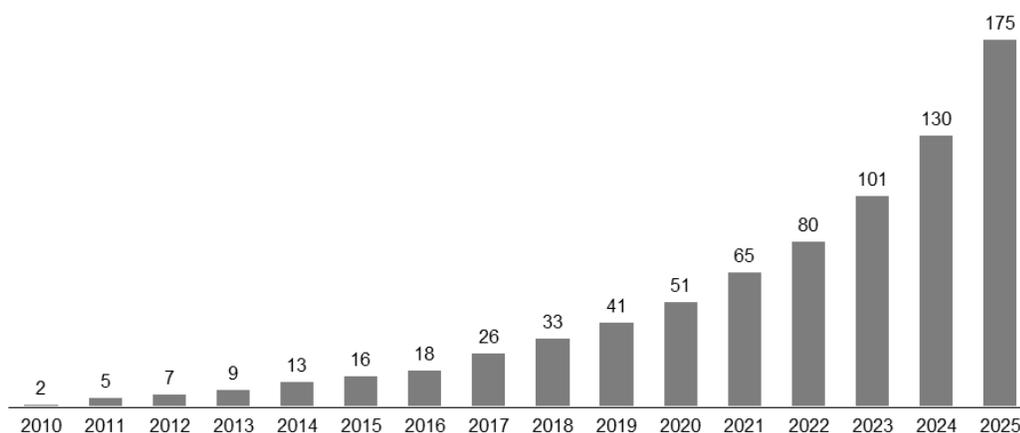


Figure 51: Volume of data/information created worldwide from 2010 to 2025 (in zettabytes) – Source: Cisco Annual Internet Report (2018–2023) White Paper

The growing global significance and ubiquity of digital data creates a wealth of opportunities for Greek enterprises which, as discussed in further detail in Section 7.3.2 of this report, have been quicker than the average EU country in their adoption of big data analytics.²¹⁴ Moreover, Greece’s highly educated and technically proficient workforce, explored further in Section 7.3.5 of this report, could play an important role in enabling Greek enterprises to properly leverage the opportunity created by the growing global demand for data analytics solutions. Finally, the increased global demand of data and their analysis can underpin Greece’s decision to further invest on big data analytics technology through the potential setup of dedicated digital analytics innovation hubs.

Artificial intelligence is changing the current status quo and can significantly benefit the Greek economy

²¹⁰ Sunlight Company Website <https://www.systems-sunlight.com/corporate-news/2019/04/3197/>

²¹¹ Cisco Annual Internet Report (2018–2023) White Paper, <https://www.cisco.com/c/en/us/solutions/collateral/executive-perspectives/annual-internet-report/white-paper-c11-741490.html>

²¹² 1 Zettabyte = 1000⁷ bytes

²¹³ <https://www.statista.com/statistics/871513/worldwide-data-created/>

²¹⁴ Eurostat, Big data analysis, https://ec.europa.eu/eurostat/web/products-datasets/product?code=isoc_eb_bd

Artificial Intelligence (AI) transforms our societies, the way we perceive the world, essentially altering our way of living. Today, we are already beyond the “science fiction” discussion. AI is broadly used in everyday applications. From navigating our cars to automatic translation, from intelligent chatbots to shopping recommendations. Smart homes, smart cars, smart cities. AI is everywhere, it is becoming embedded in our reality. Governments, academic institutions and companies around the world are already embracing AI as a powerful force for building value, aiming to become global frontrunners in their respective fields. For countries that adopt AI, a future of increased growth becomes a key target as AI’s transformative power can be compared to that of electricity or the internal combustion engine - leading to disruption both directly and indirectly, thus enabling a vast range of complementary innovations.²¹⁵

The global emergence of AI technologies poses a significant opportunity for the Greek economy. According to a report by Accenture Greece, AI has the potential to lead to a cumulative \$195 billion GDP uplift over a 15-year period (from 2020 to 2035) in Greece. Moreover, the study demonstrated that Greek organisations recognize the strategic importance of AI and acknowledge it as a critical centrepiece of their business strategy moving forward.²¹⁶ Some Greek organisations have already demonstrated a positive track record in the field of AI, as exemplified by companies like Innoetics²¹⁷, which innovates in text-to-speech applications, AI-powered agriculture solutions provider Augmenta²¹⁸, and Signal Maritime²¹⁹, a company that offers artificial intelligence solutions for commercial ship management.

5G and the “IoT-isation” economy can become game changers for “unlocking” innovation and growth for the Greek economy

5G will change the world even more profoundly than 3G and 4G. It will be as revolutionary as the automobile, benefitting the economy and society. Many developing nations have gained more than their industrialised counterparts from the deployment of mobile technology. It is estimated that the global economic impact of 5G in new goods and services will reach \$12 trillion by 2035, as 5G moves mobile technology from connecting people to people and information, towards connecting people to everything. In addition, the evolution of wireless communication to 5G is not only one of the greatest leaps in wireless technology, but also a forerunner for innovation. This innovation will not be limited to network technologies that support the service to end users, but also will prompt allied industries to leverage the Internet of Things to innovate and develop new technology services geared to those end users, revolutionizing the way humankind uses those technologies in its day-to-day activities.²²⁰

In fact, the Internet of Things can become a force of faster growth in an increasingly digital global economy. **Many Governments view the IoT as a means to stimulate national competitiveness and economic growth.** For example, the UK Government staked out a leading position in this “new industrial revolution,” directing nearly US\$125 million to IIoT research.²²¹ In China, the government has made the IIoT an “emerging strategic industry” and invested some US\$800 million in it by 2015.²²² And Germany plans to

²¹⁵ Accenture, „With an AI to the Future”, 2019, <https://www.accenture.com/gr-en/insights/digital/greece-an-ai-future>

²¹⁶ Accenture, „With an AI to the Future”, 2019, <https://www.accenture.com/gr-en/insights/digital/greece-an-ai-future>

²¹⁷ Innoetics Company Website <https://www.innoetics.com/>

²¹⁸ Aigmenta Company Website <http://www.augmenta.ag/>

²¹⁹ Signal Maritime Company Website <https://www.signalmaritime.com/>

²²⁰ Accenture, „5G | The Game Changer and Key to Innovation”, 2019, https://www.accenture.com/_acnmedia/pdf-106/accenture-5g-the-industry-game-changer.pdf

²²¹ Gov.uk, Prime Minister David Cameron’s speech to the CeBIT trade fair in Hanover, Germany, January 9, 2014

²²² Voigt, Kevin, China looks to lead the Internet of Things, CNN, December 3, 2012

use IIoT technology to increase the productivity of its manufacturing industry by 30 percent through its Industry 4.0 initiative.²²³

Moreover, Accenture in 2015 analysed 20 countries²²⁴ and estimated that these countries’ investment in IIoT products and technologies pointed to cumulative real GDP contributions of US\$10.6 trillion by 2030. With greater investment and the enactment of key measures to absorb IIoT technologies, that figure could rise to US\$14.2 trillion (see Figure 52).²²⁵

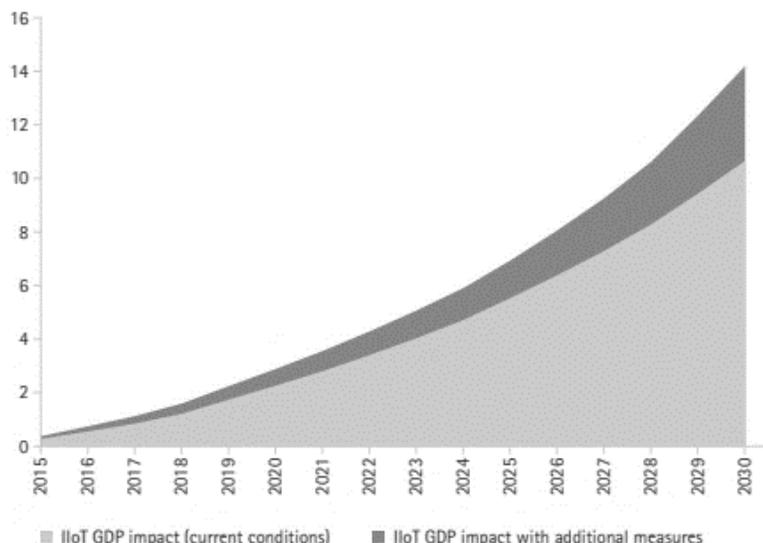


Figure 52: Cumulative GDP impact of IIoT for 20 countries (US\$ trillion) – Source: Accenture, „The Growth-Game changer: How the Industrial Internet of Things can drive progress and prosperity”, 2015

The rise of 5G and the IoT economy present a critical opportunity for Greece’s industrial and manufacturing enterprises. In fact, Greek enterprises can significantly benefit by the Internet of Things technology, by achieving cost efficiencies, by providing higher visibility across their production lines and by better managing their inventory and industrial equipment. Namely, some of the top benefits from adopting IoT are presented below:

- **Introduction of the Connected Factory:** IoT enabled machines are capable of communicating operational information to personnel both inside and peripheral to an organisation. That includes machine operators, managers, field service personnel and even partners like suppliers, subcontractors, etc. This connectivity delivers mission-critical data and information to operation managers and factory leadership on-site and out-of-office. The power to control operations and manage factory activity on a remote level increases opportunity for process optimisation and automation.
- **Enhanced Production Visibility:** The continuous monitoring of processes that IoT connectivity provides will enable improvements to be made on a rolling basis. Downtime in assembly and manufacturing operations gain particular benefit when bottlenecks are identified, and adjustments can be made in nearly real-time to realize better approaches to production management and the

²²³ Deutsche Bank Research, Industry 4.0: Huge potential for value creation waiting to be tapped, May 23, 2014.

²²⁴ These countries include: Australia, Brazil, Canada, China, Denmark, Finland, France, Germany, Netherlands, India, Italy, Japan, Korea, Norway, Russia, Spain, Sweden, Switzerland, United Kingdom and United States.

²²⁵ Accenture, „The Growth-Game changer: How the Industrial Internet of Things can drive progress and prosperity”, 2015,

https://www.accenture.com/acnmedia/accenture/conversion-assets/dotcom/documents/global/pdf/dualpub_18/accenture-industrial-internet-things-growth-game-changer.pdf

reduction of operational costs. Additionally, part waste can be reduced alongside fewer resources tied up in inventory and better overall product delivery.

- **Better inventory management:** With technologies like IoT, personnel tasked with managing inventory can leverage automated asset tracking and reporting through ERP to avoid the costly mistakes that come with working within antiquated inventory tracking systems. This connectivity allows items to be tracked and the data recorded to the ERP system automatically. These performance management capabilities made possible through IoT connectivity and ERP can help organisations reduce the number of working hours committed to inventory management each month and reduce the probability of human error.
- **Safer Working Environment:** IoT can also help create a safer working environment for employees. This can be in the form of vision and spatial awareness systems for human-machine interactions or wearable safety technologies that staff keep on them throughout the day. There are several safety concerns in any manufacturing facility. IoT connected devices can communicate to larger systems within the organisation of aberrations, such as too much vibration or heat being exhibited from a machine or pressure loss within piping segments, and even gas leaks that might be otherwise undetectable to human perception. Staff moving through dangerous parts of the facility can signal to connected machines that a human is in close proximity and appropriate action can be taken automatically. An employee that sustains an injury in a remote location of the facility or even off-site can receive faster care with the inclusion of IoT-connected safety equipment.
- **Introduction of Predictive Maintenance:** Predictive maintenance identifies the condition of equipment while it is in-service and determines the optimal service interval. It saves time and money by completing maintenance activity only when necessary. A special focus has been placed on predictive maintenance, as opposed to preventative maintenance, more recently. This is because it allows longer periods of operation between maintenance tasks, resulting in less downtime for essential machinery. When coupled with technologies like IoT for Manufacturers, everything from vibration, voltage, temperature, and other performance indicators feed into sensing tools attached to machines. This information is interpreted and visualised by intelligent software solutions, such as ERP platforms, into updates, warnings, and alerts. Organisation's teams can use this information to evaluate the situation and take the most appropriate action. Intelligent and connected devices assist in setting data points that indicate when a part is reaching end-of-life, too.

Industry 4.0 can significantly benefit Greece in increasing its economy's circularity

Industry 4.0 is tied to the circular economy in a number of ways. Firstly, the Internet of Things, which is at the centre of I4.0, provides businesses with an unprecedented level of data and insights when it comes to waste reduction in production process management and product design. Secondly, the innovation of new business models, particularly models of product serviceisation, aligns the incentive to manage a product's waste and use-life with an organisation's core profits, making circularity a central business dimension, as opposed to a matter of business ethics. Thirdly, Industry 4.0 technologies enable the disruption of more traditional and unsustainable business practices, from electric vehicles to materials science applications in construction and food processing, and data driven energy efficiency.²²⁶

As a country that derives a measurable portion of its income from the annual inflow of tourists driven to its natural landscape, it is vital for Greece to sustain its environment and develop a product lifecycle that will keep waste at an absolute minimum. As a result, the advent of Industry 4.0 technologies comes as a

²²⁶ <https://www.tandfonline.com/doi/full/10.1080/00207543.2019.1680896>

significant opportunity for Greece, providing new tools and approaches for the Greek enterprises to increase the economy’s circularity. Moreover, Greece’s levels of annual sunlight and wind conditions could be further exploited to increase the share of renewable energy in Greece’s energy system, further enabling the country’s potential for adopting a more circular economy.

7.5.3 Innovation and R&D Opportunities

Greece can significantly benefit from the European Commission’s active investment in the development of digital innovation capabilities across its EU member-states.

As part of the Digitising Europe Initiative (DEI Pillar 2), the European Commission actively promotes the development of digital innovation capabilities, through the setup of Digital Innovation Hubs (DIHs)²²⁷. Their role is to help ensure that every company, regardless of size or level of digital maturity, can grasp the emerging digital opportunities. A total investment of €100 million per year within the Horizon 2020²²⁸ program will continue supporting DIHs until 2020. Through this funding for the last five years (2016-2020) major accomplishments have been achieved. Namely:

- Support was provided to more than 2000 Start-ups, SMEs and mid-caps to test digital innovations in collaboration with more than 200 Digital Innovation Hubs networked across the European Union.
- 13 EU countries included Digital Innovation Hubs in their national digitalisation strategies. More are preparing to do so.
- Coaching was provided to more than 60 potential Digital Innovation Hubs in regions with slower adoption of digital technologies, with focus on Central and Eastern Europe

The Digital Innovation Hubs pillar is expected to continue having a pivotal role in the European Multiannual Financial Framework for 2021-2027²²⁹, in order to ensure the wide accessibility of Industry 4.0 technologies across all key stakeholders of the EU member states.

Greece, as already presented in paragraph 7.3.3, is home to a burgeoning start-up & Digital Innovation Hubs scene, that is actively supported by the European Commission’s investment initiatives in digital innovation capabilities and that can be further benefited by the additional financial support to be provided under the European Multiannual Financial Framework for 2021-2027.

The European Commission’s support for the setup of Industrial Platforms and Partnerships can encourage the development of Greek platforms and Public-Private Partnerships on areas of competitive advantage.

As part of the Digitising Europe Initiative (DEI Pillar 3), the European Commission supports the setup of Industrial Platforms and Public-Private Partnerships (PPPs) to strengthen leadership around the digitisation of industry and develop future digital technology building blocks. In more detail, these PPPs focus on developing strategic research and innovation agendas across a set of digital technologies, i.e. big data analytics, high performance computing, robotics, photonics, cybersecurity, 5G and electronic components & systems. These PPPs have proven extremely successful in developing the technology building blocks that underpin EU countries’ transition to digital. The EU has secured around €1 billion in

²²⁷ <https://ec.europa.eu/digital-single-market/en/digital-innovation-hubs>

²²⁸ <https://ec.europa.eu/programmes/horizon2020/en>

²²⁹ https://ec.europa.eu/info/strategy/eu-budget/documents/multiannual-financial-framework_en

funds over the past years for the establishment of strategic next-generation industrial platforms. Currently, EU is investing more than €3 billion in these areas, roughly 2/3 on the development of PPPs for digital building blocks and 1/3 on platform building, large-scale piloting, pilot lines and related actions.²³⁰

For the period 2018-20, the European Commission focuses on the development of next-generation platform building and piloting through large scale federating projects. The aim is to foster Member States' cooperation to achieve the following EU-wide digital strategies (see Figure 53).²³¹

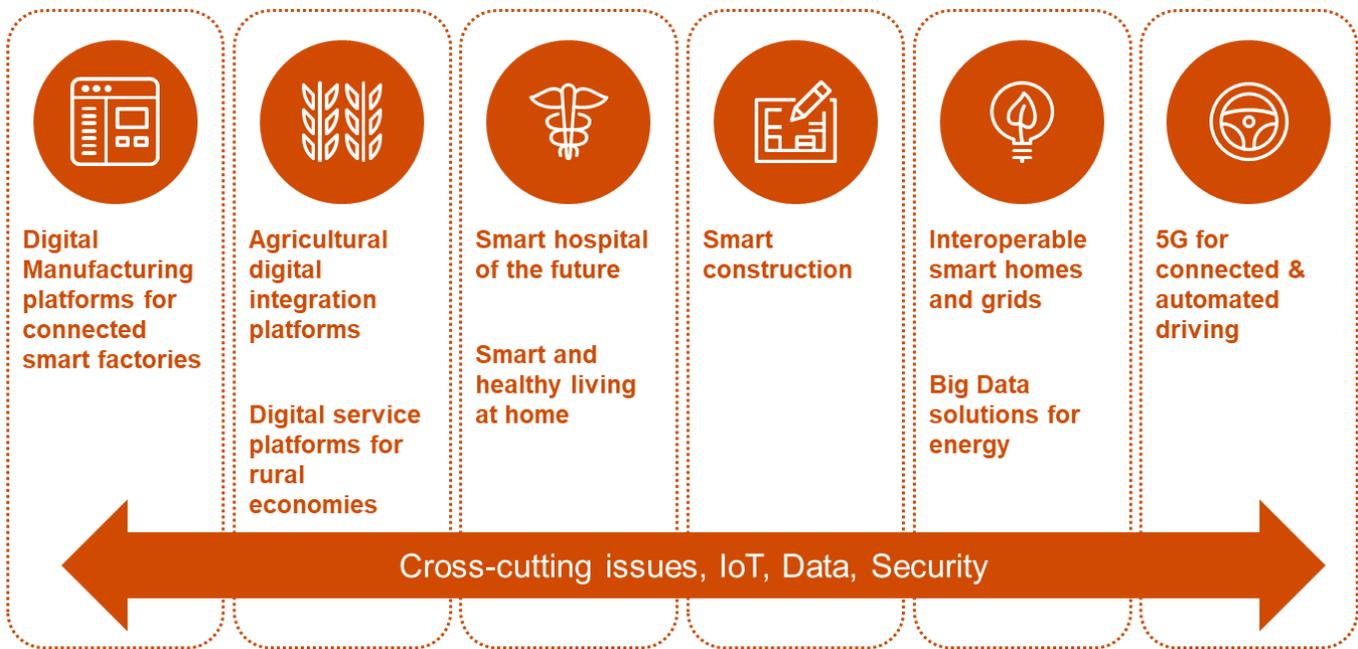


Figure 53: Cross-EU Strategic Themes for the development of next generation platforms – Source: Horizon Europe

In Greece, the development of industrial platforms and PPPs are still at a nascent level. As explored in Deliverable 1, Greek research networks are rare and cooperation between the public research, academia and industry has been initiated but remains weak.²³² For this reason, Greece can leverage EU's guidance and financial support to encourage the development of industrial platforms in areas of comparative advantage for Greece and promote the partnerships among the private and public stakeholders for the digitisation of the Greek industry.

The European Commission’s Horizon Europe Initiative & other EU funding schemes can financially support the Greek Industry’s innovation & digitisation

The EC’s Horizon Europe²³³ initiative is the Commission proposal for a €100 billion research and innovation funding program for seven years (2021-2027) to strengthen the EU's scientific and technological bases to boost Europe's innovation capacity, competitiveness and jobs to deliver on citizens'

²³⁰ <https://ec.europa.eu/digital-single-market/en/industrial-platforms-and-large-scale-pilots>
²³¹ <https://ec.europa.eu/digital-single-market/en/industrial-platforms-and-large-scale-pilots>
²³² For further information, please visit Deliverable 1, paragraph 7.5.3
²³³ https://ec.europa.eu/info/horizon-europe-next-research-and-innovation-framework-programme_en

priorities and sustain our socioeconomic model and values. The programme consists of three pillars (see Figure 54):

- **Pillar 1** is focused on Open Science & Research Infrastructure. The pillar supports researchers through fellowships and exchanges as well as funding to projects defined and driven by researchers themselves, through the European Research Council and the Marie-Sklodowska-Curie actions.
- **Pillar 2** is focused on Industrial Competitiveness and Global Challenges (Health / Inclusive & Secure Society/ Digital & Industry/ Climate, Energy & Mobility/ Food & Natural Resources). The pillar directly supports research relating to societal challenges, setting EU-wide missions with ambitious goals around issues that worry us daily such as such as the fight against cancer, clean mobility and plastic-free oceans. Industrial leadership will be prominent within this pillar and throughout the programme as a whole.
- **Pillar 3** is focused on open innovation (innovation ecosystems, etc.). The Open Innovation pillar aims to make Europe a front runner in market-creating innovation. A European Innovation Council will offer a one-stop shop for high potential and breakthrough technologies and innovative companies with potential for scaling up.



Figure 54: Horizon Europe 2021 structure – Source: Horizon Europe

In addition, the European Commission plans to support Research and Innovation through the following schemes & initiatives²³⁴:

- **InvestEU** provides an EU guarantee mobilise public and private financing in the form of loans, guarantees, equity or other market-based instruments, to strategic investments in the support of Research and Development through a dedicated investment window. With a contribution from the

²³⁴ https://ec.europa.eu/commission/sites/beta-political/files/budget-proposals-research-innovation-may2018_en.pdf

EU budget of €15.2 billion, InvestEU will mobilise more than €650 billion of additional investment across Europe.

- **EU Cohesion Policy** plays an important part of the EU funds for Research & Innovation through an increased focus on innovation and Smart Specialisation strategies. The “Seal of Excellence” allows projects successfully evaluated under Horizon Europe to be funded at regional level under the European Structural and Investment Funds.
- The new **European Defence Fund**, with an overall budget of €13 billion, will boost Europe’s ability to protect and defend its citizens. It will offer EU funded grants for collaborative projects which address emerging and future defence and security threats and bridge technological gaps.
- **ITER, the International Thermonuclear Experimental Reactor**, is a first-of-a-kind, long-term project to build and operate a reactor to test the feasibility of fusion as an energy source. €6 billion will be allocated to it.
- The **Euratom Research and Training Programme** funds research and training on the safety of nuclear energy production. The new Digital Europe Programme, with €9.2 billion aims to bring the benefits of the digital transformation to all European citizens and businesses. The programme will boost frontline investments in high-performance computing and data, artificial intelligence, cybersecurity and advanced digital skills. It will promote large-scale deployment of digital technologies across economic sectors and it will support the digital transformation of public services and businesses.
- Finally, the Commission has proposed the creation of the **Digital Europe Programme**²³⁵, with a dedicated budget of €9.2 billion. The programme will be focused on building the strategic digital capacities of the EU and on facilitating the wide deployment of digital technologies, to be used by Europe's citizens and businesses. The programme will boost investments in supercomputing, artificial intelligence, cybersecurity, advanced digital skills, and ensuring a wide use of digital technologies across the economy and society. Its goal is to improve Europe's competitiveness in the global digital economy and increase its technological autonomy.

The EU’s strong commitment to scaling up R&D activities poses significant opportunities for Greece’s own R&D capabilities, while facilitating the Greek industry’s access to the European innovation ecosystem. These funding schemes can support the Greek Industry’s research & innovation initiatives, as also presented in section 7.3.3.

7.5.4 Legal & Regulatory Opportunities

The digitisation of the Greek economy & society shall be further supported by the European Commission’s updates of the EU regulatory framework

The European Commission has introduced several measures for the update of regulatory frameworks in fields such as cybersecurity and the free flow of data, which are key for the development of Industry 4.0. The European Commission identifies four key areas of regulatory focus:

²³⁵ Proposal for a Regulation of the European Parliament and of the Council establishing the Digital Europe programme for the period 2021-2027, COM(2018) 434 final

- Cybersecurity - Key measures undertaken²³⁶: The NIS directive, the Cybersecurity Act, the blueprint for rapid emergency response, measures for free and fair European elections, including recommendations on election cooperation networks, online transparency, protection against cybersecurity incidents and fighting disinformation campaigns, a Network of Cybersecurity Competence Centres and a new European Cybersecurity Industrial, Technology and Research Competence Centre, a set of operational steps and measures to ensure a high level of cybersecurity of 5G networks across the EU has been recommended by the Commission, the framework for a joint EU diplomatic response to malicious cyber activities under the Common Foreign and Security Policy for Cyber-defence.
- The free flow of non-personal data²³⁷: The EU has proposed a regulation²³⁸ on free flow of non-personal to enable the abolishment of localisation restrictions. This combined with the General Data Protection Regulation (GDPR) will facilitate the creation of a common European data space.²³⁸
- AI-regulations²³⁹: The European Commission welcomed the final Ethics Guidelines for Trustworthy Artificial Intelligence prepared by the High-Level Group on Artificial. The European Commission also welcomed the Report on liability for Artificial Intelligence and other emerging technologies prepared by the Expert Group on Liability and New Technologies – New Technologies Formation.
- Business relations to online platforms²⁴⁰: The regulation on online platform-to-business relationships provides a framework for minimum transparency and redress rights. The regulation protects companies dependent on online platforms for marketing their products and safeguards the innovation capacity of platforms. The online platform economy Observatory, monitors and analyses the latest trends and issues regarding online platform economy.
- Measures addressing illegal content online²⁴¹, building on the Communication on tackling illegal content online and securing political commitment of the preceding Communication into a (non-binding) legal form.

As a member of the EU, Greece shall also implement the aforementioned regulations and legal frameworks, giving the country a leg up over the majority of its global peers outside the EU. Being quick to set forth a favourable and flexible legal framework is a significant opportunity for Greece to facilitate quick and sustainable innovation and growth within the Industry 4.0 framework.

²³⁶ <https://ec.europa.eu/digital-single-market/en/cyber-security>

²³⁷ <https://ec.europa.eu/digital-single-market/en/free-flow-non-personal-data>

²³⁸ <https://ec.europa.eu/digital-single-market/en/free-flow-non-personal-data>

²³⁹ <https://ec.europa.eu/digital-single-market/en/artificial-intelligence>

²⁴⁰ <https://ec.europa.eu/digital-single-market/en/business-business-trading-practices>

²⁴¹ <https://ec.europa.eu/digital-single-market/en/illegal-content-online-platforms>

7.5.5 Social & Environmental Opportunities

The European Commission actively supports the digital upskilling and reskilling of the European and the Greek Human Capital

The European Commission has already undertaken a number of emblematic initiatives for the acceleration of the digital upskilling and reskilling of the European human capital. Namely:

- The Digital Skills and Jobs Coalition²⁴² - The Digital Skills and Jobs Coalition brings together Member States, companies, social partners, non-profit organisations and education providers to act to improve digital skills of all types in Europe.
- The Digital Opportunity Scheme²⁴³ - The Digital Opportunity Scheme aims to boost EU digital skills through internship opportunities for students of all disciplines residing in the EU.
- The Digital Education Action Plan²⁴⁴ - The Action Plan focuses on initial education and training systems (including schools, vocational education and training (VET) and higher education), prioritizing digital technologies for teaching and learning, digital competences and skills, and the improvement of education through data analysis and foresight.

These initiatives shall be leveraged by the Greek Government to achieve the digital upskilling and reskilling of the Greek Human Capital. As indicated in paragraph 7.3.5, Greece’s limited digital skills is considered a structural inhibitor towards the country’s rotation towards Industry 4.0. In fact, although Greece has a significant number of people with a track record in tertiary education and an adequate percentage of ICT & STEM graduates that could be “infused” in the Greek industry to accelerate its digitisation, the Greek enterprises appear unwilling to further invest in their human capital’s digital upskilling. Therefore, these EU-driven initiatives could particularly support the Greek Government’s effort to upskill the Industry and manufacturing workforce and demonstrate its importance to the Greek organisations.

The European Commission supports Greece in increasing its economy’s circularity

The European Union has launched a number of initiatives to boost the circular economy and facilitate the sustainable growth of member states. A few of the most notable ones are the EU Green Deal, the Circular Economy Action Plan, and the EU Plastics Strategy.

- **The EU Green Deal:** In order to support sustainable growth and promote advances in the circular economy, the European Commission introduced the European Green Deal, a set of policy initiatives with the overarching aim of making the European Union climate neutral by 2050. The initiatives incorporated in the new European Green deal aim at decarbonising the energy sector, incentivizing building renovation to achieve greater energy efficiency, supporting industry to innovate and become leaders in the green economy globally, and rolling out cleaner, cheaper and healthier forms of public and private transportation.²⁴⁵
- **Circular Economy Action Plan:** In 2015, the European Commission adopted a Circular Economy Action Plan aiming at boosting economic growth and jobs within the circular economy, while concurrently reducing the amount of waste and goods disposed in the overall EU economy.

²⁴² <https://ec.europa.eu/digital-single-market/en/digital-skills-jobs-coalition>

²⁴³ <https://ec.europa.eu/digital-single-market/en/digital-opportunity-traineeships-boosting-digital-skills-job>

²⁴⁴ https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan_en

²⁴⁵ https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

Measures in the Circular Economy Action plan include all stages of a product, from production and consumption to waste management, and the market for secondary raw materials, as well as a revised legislative proposal on waste.²⁴⁶

- **EU Plastics Strategy:** In an effort to minimize the amount of plastics used in the European economy, the European Commission has devised a “European Strategy for Plastics in a Circular Economy”. The strategy consists of a set of measures aimed at improving the economics and quality of plastics recycling, curbing plastic waste and littering, driving investment and innovation towards circular solutions and harnessing global action through the cooperation with industries and governments outside European borders.²⁴⁷

In terms of the circular economy, the Greek industry partakes in the EU’s initiatives toward sustainable growth. In fact, leveraging these initiatives consists a unique opportunity for Greece to evolve its production capabilities in a way that will minimize negative externalities and will support the Greek circular economy.

7.5.6 How can Greece exploit the global opportunities around Industry 4.0 through the Industry 4.0 strategy?

Industry 4.0 brings radical shifts, redefines and blurs the boundaries between industries and nodes of power, leading to the emergence of new cross-country and cross-industry ecosystems. This opportunity shall not remain untapped by the Greek industry. The Industry 4.0 strategy shall incorporate initiatives targeted in increasing the collaboration and synergies between different Greek industries, but also between Greek enterprises and their EU counterparts. These initiatives are also expected to promote the internationalization of the Greek industry and position it as a valuable partner within the emerging EU ecosystems.

In addition, the global explosion in the use of emerging interconnected Industry 4.0 technologies such as the Internet of Things, Artificial Intelligence, 5G and big data analytics, introduces a set of optimal conditions that can further boost the Greek Industry’s investment in these technologies. As such, the Industry 4.0 strategy shall take this trend into consideration and introduce tailored initiatives towards this direction. These initiatives can favor the creation of innovation districts or innovation hubs focused on the applied research and knowledge diffusion on these technologies or could be translated into incentivization initiatives that will enable enterprises of all sizes to further experiment with these technologies.

All in all, the Greek Industry 4.0 strategy shall take into consideration and exploit the European Commission’s active investment both for the development of digital innovation capabilities across its EU member-states (through the setup and support of the digital innovation hubs), but also for the setup of Industrial Platforms and Partnerships to encourage the development of Greek platforms and Public-Private Partnerships on areas of competitive advantage. The existing and forthcoming EU funding schemes can potentially fund part of the Greek Industry’s innovation & digitization; therefore, they should be reviewed and carefully leveraged when designing the funding mechanisms for the implementation of the Greek Industry 4.0 strategy.

Additionally, the digitisation of the Greek economy & society shall be further supported by the European Commission’s updates of the EU regulatory framework. As such, initiatives prescribed with regards to the

²⁴⁶ <https://ec.europa.eu/environment/circular-economy/>

²⁴⁷ https://ec.europa.eu/environment/waste/plastic_waste.htm

revamping of the Greek regulatory environment shall leverage the respective EU regulation as a guidance and leading practice. Finally, EU's emphasis placed on the circular and green economy verifies the need mentioned also earlier for the Greek Industry 4.0 to focus on initiatives that will support the Greek circular economy.

7.6 Threats²⁴⁸

Below we present the key Industry 4.0 related threats we identified for Greece that can negatively affect Greece and the Greek Industry.

7.6.1 Political & Economic Threats

The rise of economic nationalism and the shaking up of Global Trade may prohibit Greece's cooperation with other countries in the Industry 4.0 field

Economic nationalism is rising globally, with Governments around the world favouring protectionism and domestic production and **imposing sanctions in trade of products and goods**. In the US, the Trump administration has made it harder for foreigners to obtain visas to work in, study in, or travel to the United States. In Europe, Brexit is another evidence of national protectionism and imposing barriers to globalisation.

The rise in economic nationalism undermines the tradition of economic liberalism (globalism), discourages the economic and political cooperation between countries and severely threatens global trade as well as **inflow of foreign investments**. In more detail the rising protectionism across several developed countries, including the United States, the uncertain impact of Brexit on both British and European markets, the escalation of US-China trade tensions and the higher or additional US tariffs on car imports, are only some of the causes that jeopardize the progressive integration of the global trade system and act as a structural inhibitor to Greece's cooperation with other countries within and outside Europe. Testament of this is the number of trade-restrictive measures adopted by G20 members since the global financial crisis and still in force almost quadrupled, from 324 in 2010 to 1,263 in 2016 (see Figure 55).²⁴⁹

²⁴⁸ All graphs included in Chapter 7 are also presented in 9. Appendix in full resolution and in a reader-friendly way.

²⁴⁹ Source: World Trade Organisation Secretariat, World Bank

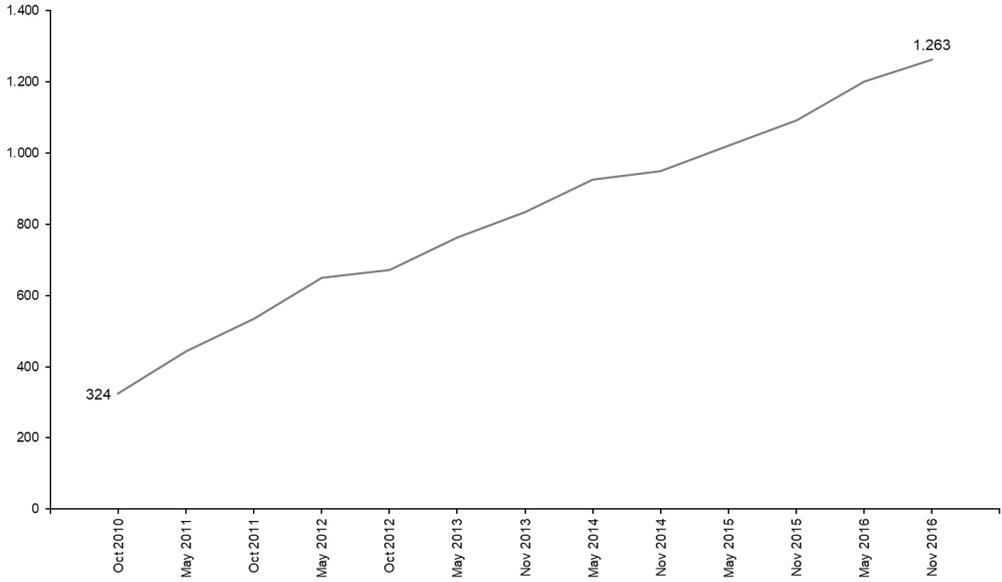


Figure 55: Number of trade-restrictive measures adopted by G20 members (#) - Source: World Trade Organisation Secretariat, World Bank

In addition, in 2018, global foreign direct investment inflows have hit a record low (see Figure 56).²⁵⁰

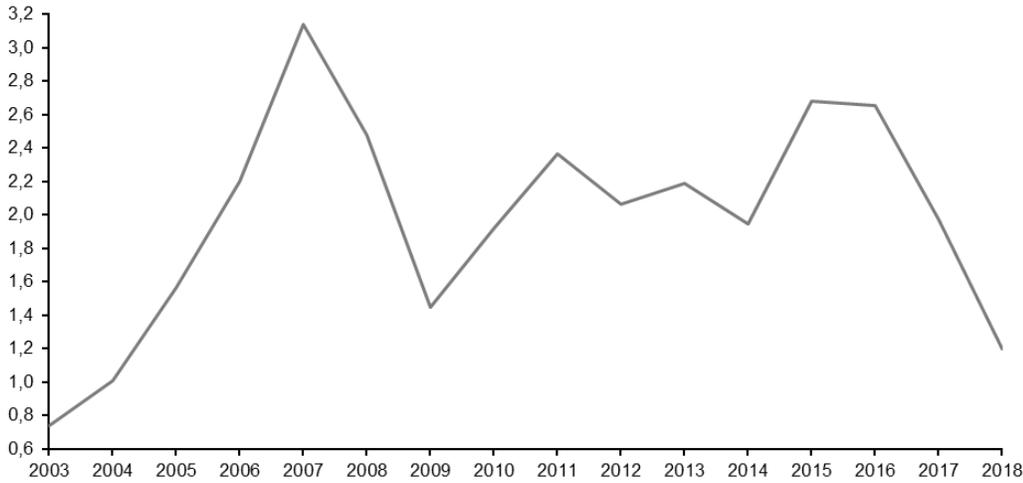


Figure 56: Global foreign direct investment inflows (trillions of dollars) – Source: Accenture, “Digital Fragmentation” Report

²⁵⁰ Accenture, „Digital Fragmentation” Report, <https://www.accenture.com/acnmedia/PDF-60/Accenture-Digital-Fragmentation-Interactive-POV.pdf>

The COVID-19 Pandemic may severely impact the global and the Greek economy

This report was finalised during the Covid-19 pandemic, whose adverse effects on the global economy may alter the course of the continued growth trend in Greece's economic growth, industrial output and employment figures. The economic aftermath of the COVID-19 pandemic cannot be forecasted with certainty due to a vast number of unknown factors. These include the duration of the ongoing outbreak and the measures that have been imposed for its containment, the time required for a vaccine to become available to the general population, and the reactions of household and firm spending to the pandemic. While an imminent economic shock is inevitable, its size and long-term structural effects on the economy remain uncertain.

Whereas financial crises like the Lehman Brothers collapse of 2008 affect an economy's financial system months before the effects are felt in the real economy, the COVID-19 pandemic uniquely produces a dual shock felt at once by the financial system and the real economy. As financial markets collapse, businesses are in a standstill, with social distancing measures halting a sizeable portion of the economy's productive capabilities. Both shocks are currently liquidity problems, but as the crisis deepens, they could develop into capital problems, leading to the shutdown of credit channels and widespread bankruptcy events in real economy. Moreover, the interrelated relationship between the real economy and the financial markets further complicates the situation, as issues in one could affect the other.²⁵¹

With Greece's financial institutions already facing a vast array of capital formation problems and considering possible recapitalisation measures pre-pandemic, the likelihood that Greece will experience a strong shock to its financial system is very high. Moreover, the low liquidity and highly indebted profile of the average Greek business points to a strong likelihood of significant shocks in the real economy, especially if one factors the criticality of tourism-related income to Greece's GDP.

Furthermore, the pandemic's economic impact on Greece's economy will be influenced by the success of policy responses on the EU and national level. On the EU level, the introduction of an EU-wide stimulus, could lessen the drop in Greece's GDP and employment levels. Moreover, the Greek government's response in terms of public health precautions and economic measures could affect the economic aftermath of the pandemic. While the effectiveness of Greece's economic measures is yet to be decided, the country's public health strategy has so far been successful in preventing the exponential growth of COVID-19 cases in the population. All in all, while the COVID-19 pandemic is certain to bring Greece back to a negative growth trajectory, its magnitude and duration is still uncertain.

A recent OECD report²⁵² on the evaluation of the initial impact of COVID-19 containment measures on the global economic activity, suggests that the initial direct impact of the business shutdowns could lead to a decline in the level of output of between one-fifth to one-quarter in many economies, with consumers' expenditure potentially dropping by around one-third. This broad estimate only covers the initial direct impact in specific sectors of the economy that are affected by the shutdowns (i.e. retail) and does not take into account any additional indirect impacts that may arise across the economies. The implications for annual GDP growth will depend on many factors, including the magnitude and duration of national

²⁵¹ <https://hbr.org/2020/03/understanding-the-economic-shock-of-coronavirus>

²⁵² OECD, „Evaluating the initial impact of COVID-19 containment measures on economic activity”, https://read.oecd-ilibrary.org/view/?ref=126_126448-

[kcrc0cs6ia&title=FFEVALUATING THE INITIAL IMPACT OF COVID CONTAINMENT MEASURES ON ECONOMIC ACTIVITY](https://read.oecd-ilibrary.org/view/?ref=126_126448-kcrc0cs6ia&title=FFEVALUATING%20THE%20INITIAL%20IMPACT%20OF%20COVID%20CONTAINMENT%20MEASURES%20ON%20ECONOMIC%20ACTIVITY)

shutdowns, the extent of reduced demand for goods and services in other parts of the economy, and the speed at which significant fiscal and monetary policy support takes effect. Nonetheless, it is clear that the impact of the shutdowns will weaken short-term growth prospects substantially. The scale of the estimated decline in the level of output is such that it is equivalent to a decline in annual GDP growth of up to 2 percentage points for each month that strict containment measures continue. If the shutdown continued for three months, with no offsetting factors, annual GDP growth could be between 4-6 percentage points lower than it otherwise might have been.

Rough estimates indicate that all major forces, like Germany, France, the United Kingdom, Italy and the USA may lose up to 30% of their annual GDP due to the potential impact of partial or complete shutdowns on activity, while Greece, a country that is heavily dependent on retail and tourist and leisure services this decrease may come up to 35% of its annual GDP.

On May 20th 2020, the Greek Prime Minister announced a reboot plan to the tune of 24 billion euros that will serve as a three-pillar bridge from “from today’s uncertainty to tomorrow’s security” aiming primarily to revive the Greek tourism and other Greek economic sectors hit by the coronavirus pandemic. These three pillars will focus on job support, targeted tax cuts and the boosting of entrepreneurship. In addition, all unemployment benefits shall be being extended and the government will also subsidize salaries and social security contributions for workers in the tourism sector. It will also pay unemployment benefits to seasonal employees, who will not be hired this year. Moreover, there will be a five-month reduction (from June 1 until October 31) of VAT from 24% to 13% for travel by ship, bus and airplanes, so that those who go on vacation in the summer “can do so at the lowest possible cost.”²⁵³

At the same time, it is worth mentioning, that the COVID-19 pandemic “forces” businesses around the world and within Greece to deploy digital technologies immediately and at a large-scale to deal with such an emergency. **Social distancing** has enforced the Greek Public Sector during the last days to accelerate the digitisation of the public services provided, schools have started providing remote learning capabilities, while the majority of the Greek enterprises have adopted digital technologies that enable their employees to work remotely from home. This shall potentially lead to an abrupt, nevertheless much needed digital upskilling of the Greek society and workforce. At the same time, the COVID-19 pandemic has led to an intensification of applied research in the health and pharmaceutical sectors to solve COVID-19 related problems, as well as to the development of the digital health sector. In fact, this pandemic —and its associated strain on the healthcare system— is happening at a time of technological optimism and promise. The digitalization of health data, together with the advent of advanced data mining techniques, has brought forward the possibility of automating and even improving the tasks that healthcare professionals have traditionally conducted in a qualitative or semi-quantitative way. In particular, Artificial Intelligence (AI) techniques are increasingly being used in a wide variety of applications involving cognitive tasks, from image-based pattern recognition and data integration models for disease prognosis to triaging chatbots. The hope is that this new family of tools will alleviate the burden on an overstretched healthcare workforce and also enable new ways for patients to receive care that contribute to the long-term sustainability of the system. In addition, the COVID-19 has made the flexible manufacturing a prerequisite for many enterprises’ survival. The pandemic is anticipated to have a severe impact on industrial

²⁵³ <https://www.ekathimerini.com/252882/article/ekathimerini/news/tax-cuts-labor-subsidies-to-revive-economy>

organizations' operations. In this context, many of them ramp up production and convert new production lines to produce products that are needed and in-demand (face masks and hand sanitizer for example).

7.6.2 Technological Threats

Industry 4.0 disrupts the traditional linear value chains & redefines the Greek industries

More than any technological revolution in history, Industry 4.0 and the digital revolution have already proven their capacity to reshuffle the fundamentals of industries and to blur their boundaries. The spread of Industry 4.0 and the declining cost of technology allowed companies to build products and services, which are simultaneously better, cheaper and customized. At the same time, it enabled new, disruptive, technology-driven companies to take over entire industries. This disruption often does not come from direct competitors in the same industry or even from companies with a remotely similar business model. Digital disruptors leveraged scale and divergent business models to write off incumbents' positions of strength. Users/ buyers often made the switch in a matter of weeks. And it isn't just the least profitable or "underserved" customers who were lured away. Consumers in every segment defected simultaneously and in droves.

Similarly to the global industries, Greek economic sectors are already heavily impacted by digital. For instance, the tourist and accommodation services in Greece have been heavily impacted by Airbnb, an online marketplace for arranging or offering lodging, primarily homestays, or tourism experiences. The Greek Financial Services are currently disrupted by OPAP's Tora Wallet, an online wallet and debit card that will enable customers to bypass banks, issue an online account and perform their everyday transactions through this channel. And Cosmote steps into the insurance market through the provision of an online platform that compares, contrasts and offers the most advantageous home, health and vehicle insurance to their customers.

Techno-centricity of industrial production may disrupt the Greek labour market

The transformation brought about by Industry 4.0 technologies in business and operating models will, in turn, bring about significant shifts in the workplace. As more areas of labour-intensive activity become automated, new roles will be introduced to ensure the proper deployment and function of automation, while more transactional and routine tasks will become defunct. Digital advances may indeed displace certain types of work. Typically, highly repetitive, predictable and transactional activities are the prime candidates. According to the latest projections by the U.S. Bureau of Labor Statistic (BLS), occupations like farmers, postal services officers and clerks, word processors and typists are expected to massively decline in number and percentage of workers between 2010 and 2020.²⁵⁴ At the same time, new types of work will be created, leveraging unique human capabilities like empathy, emotional intelligence, judgment, creativity and complex problem solving.

Moreover, as the manufacturing sector becomes more digitalised, skills and know-how relating to digital will be increasingly central to the workplace. For instance, the ability to comprehend and leverage data analytics for operational decision-making is likely to become a prerequisite for industrial operators at all

²⁵⁴ <https://www.forbes.com/pictures/lmj45iqhg/top-20-disappearing-jobs/#2c24d5994bc5>

levels. In addition, employees will be required to understand the basics of information systems to navigate the challenges and leverage the benefits of fully integrated industrial solutions.

The limited digital skills of the Greek industrial workforce make this threat especially perilous for the Greek Industry. In addition, the fact that about half of Manufacturing workers (43%) are skilled craftsmen and practitioners while about 1 in 5 (19%) are industrial plant, machinery and equipment operators and assemblers, followed by 8% of those who were unskilled workers, manual laborers and small businessmen, indicates that there is a high probability that Industry 4.0 may displace many of these manual labour job positions.²⁵⁵ Unless effective measures are taken toward navigating the upcoming displacement of manual labour, Greece's job market could experience a new crisis which may threaten the overall wellbeing of the economy.

Industry 4.0 poses new, wider and deeper cybersecurity threats for the Greek Industry

As the adoption of use of connected technologies increases, cyber risks are expected to grow and change. There is no simple fix or single product or patch that enterprises shall apply to address the cyber risks and threats presented by Industry 4.0. Connected technologies already support critical business processes today, and these processes will likely only grow more connected, integrated, and vulnerable in the future. Organisations may thus need to rethink their business continuity, disaster recovery, and response plans to accommodate the increasingly complex and ubiquitous cyber environment.

Regulation and industry standards are often reactive, and “compliance” often represents the minimum-security posture. This does not usually achieve full security across the breadth of technologies in use, since intruders have only to find the single weakest point to gain successful entry into an organisation's systems. This challenge may only continue to grow: Increasing connectivity and the need to gather and process real-time analytics may continue to introduce vast numbers of connected devices and huge amounts of data that require protection.²⁵⁶

Greek enterprises, performing their first steps towards their digital transformation, can be particularly cyber vulnerable. This can be translated in two ways. The first is that criminals, rogue state actors, unscrupulous competitors or inside threats can potentially manipulate organisations' fledgling IT programs; for example, a shady competitor could attack another company's pricing algorithm. The second is that attackers can potentially use Industry 4.0 technologies in a variety of ways to exploit vulnerabilities in their victims' defences; a cyber-thief targets a financial institution's AI-controlled customer recognition software.

EU counterparts' rapidly progress with regards to their digitisation both at a national and at an industry level, continuously increase their digital “rift” with Greece and makes Greece's digitisation a necessity rather than a wishful thinking

Divergent country performances are observed with regards to their digital maturity both at a national and industry level across the EU. As per the DESI & the DEOI indices, digital leaders such as Finland, Sweden, the Netherlands and Denmark have long started their digital transformation and have already advanced regarding their digital performance. This group of leaders also includes United Kingdom, Ireland,

²⁵⁵ IOBE Report, <https://hellenicproduction.org/meleti-iove-2018/>

²⁵⁶ Deloitte, “Industry 4.0 and cybersecurity: Managing risk in an age of connected production”, 2017, https://www2.deloitte.com/content/dam/insights/us/articles/3749_Industry4-0_cybersecurity/DUP_Industry4-0_cybersecurity.pdf

Luxembourg and Estonia, a European country that during the last years is pioneering in digital innovation.^{257,258} In addition, in the context of the Digitising European Industry (DEI) initiative, more than 16 EU countries (i.e. Austria, Germany, UK, etc.) have already adopted Industry 4.0 strategies to digitise their Industries.

As EU countries accelerate their digitalisation on a national and industrial level, the threat of being left behind becomes increasingly imminent for digital laggards like Greece. While the gap between digital laggards and the EU average is large today, the incremental nature of digitalisation could result in even larger gaps between in the digitalisation levels of different EU countries and industries, as frontrunners continue to grow at an accelerating pace.

7.6.3 Innovation and R&D Threats

EU counterparts' progress regarding targeted measures to support and enhance digital innovation and R&D, indicates that Greece's R&D capabilities are threatened to curbe, if the country does not timely undertake similar initiatives

In the context of the Digitising European Industry (DEI) initiative, several EU countries (i.e. Austria, Germany, UK, etc.) have already included Digital Innovation Hubs & clusters in their national digitalisation strategies, while more are preparing to do so.

Additionally, in order to foster investment in innovation and R&D across their economy, several EU countries have undertaken a number of measures, ranging from tax deduction for investment in R&D and over-depreciation for R&D investments to public funding and subsidizing, as well as reduced contributions of employees engaged in R&D work.

Deliverable 1 presents detailed lists of measures that EU countries have implemented to set up national Digital Innovation Hubs and to foster investment in Innovation and R&D.

While Greece's EU counterparts have already instituted the aforementioned targeted measures to boost their countries' R&D capabilities, Greece has been slow to introduce similar initiatives. Taking into account the competitive nature of R&D activities, further delays in the introduction of similar initiatives to support Greece's R&D community could threaten to curbe the country's R&D capabilities.

7.6.4 Social & Environmental Threats

EU countries progress with regards to the digital upskilling and reskilling of their human capital, leaves Greece behind in terms of its digital human capital

According to the DESI Index – Pillar 2: Human Capital²⁵⁹, countries like Finland, Sweden, and Estonia demonstrate the most digitally adept human capital, while Bulgaria, Romania, Italy and Greece rank last among all EU member states.

²⁵⁷ <https://ec.europa.eu/digital-single-market/en/desi>

²⁵⁸ Digital Greece: The Path to Growth". Accenture, 2017, <https://www.slideshare.net/accenture/digital-greece-the-path-to-growth>

²⁵⁹ The Digital Economy and Society Index 2019, Human Capital, <https://ec.europa.eu/digital-single-market/en/desi>;

Zooming into digital skills in the overall EU population, Luxembourg ranked first in 2018, with 85% of its total population holding at least basic digital skills. Luxembourg was closely followed by the Netherlands and Sweden at 79% and 77% of their population demonstrating digital skills respectively.²⁶⁰

With regards to the ICT graduates, Finland, Ireland and Malta lead the EU pack, with 7% of their total graduates from tertiary education having received ICT degrees in 2018. In terms of the number of graduates in science, math, computing, engineering, manufacturing, and construction, Ireland leads the European sample with 33 graduates per 1000 citizens in science and engineering-related fields, followed by France at 26 and Poland at 24.²⁶¹

Zooming into the digital skills of countries' workforce, Ireland once again is the country with the highest percentage of enterprises employing ICT specialists (32%), while Finland is the one with the highest percentage of enterprises providing ICT skills training (38%).²⁶²

Greece's low score in terms of digital human capital poses a significant threat for the country moving forward. Perhaps one of the most vital accelerators of a successful digital transformation and of comparative advantage is the level of digital skills among a country's population. As such, it is critical that Greece ramps up its efforts in order to catch up with its EU peers with regards to its population's digital skills.

Climate Change and Global Warming significantly affect the Greek environment and necessitates the use of Industry 4.0 technologies across the Greek Industry

Climate change has two aspects to it: the dire consequences of past mistakes, which are already tangible today and will increase towards 2030, and the far worse consequences of mistakes we must avoid now. This means two things for the coming decade: first, that the world will finally begin to feel the disruptive impact of rising temperatures and related weather events (the world is already 1 degree warmer than in the 1950s), and second, that we may reach a tipping-point where changes to the climate become uncontrollable. An increase of 1.5 degrees is the maximum the planet can tolerate; should temperatures increase further beyond 2030, we will face even more droughts, floods, extreme heat and poverty for hundreds of millions of people.²⁶³

Greece's large coastline and strong reliance on agricultural production and tourism make the country especially vulnerable to the threat of climate change. According recent estimates, rising sea levels may lead to a loss of 3,5% of the country's land, resulting in a loss of 2% of the country's GDP. Moreover, in terms of the effects on tourism, studies have estimated that an increase of 2,5 degrees Celsius could result in a 1% reduction of overnight stays in the country, leading to a €825 million revenue loss in annual income for the tourist industry, despite the likelihood that of an overall lengthening of the tourist season. Finally, the threat of climate change to Greece's agriculture is critical, with estimates proposing that soil conversion to dryland could occur in 60% of the country's arable land during the second and third quarters of the 21st century. The areas at highest risk of impact are Thessaly and Central Macedonia.²⁶⁴

²⁶⁰ The Digital Economy and Society Index 2019, Human Capital, <https://ec.europa.eu/digital-single-market/en/desi>

²⁶¹ The Digital Economy and Society Index 2019, Human Capital, <https://ec.europa.eu/digital-single-market/en/desi>

²⁶² The Digital Economy and Society Index 2019, Human Capital, <https://ec.europa.eu/digital-single-market/en/desi>

²⁶³ ESPAS: European Strategy and Policy Analysis System – Global Trends to 2030, Challenges and Choices for Europe, https://ec.europa.eu/epsc/sites/epsc/files/espas_report2019.pdf

²⁶⁴ <https://www.dianeosis.org/en/2017/08/impact-climate-change-greek-economy/>

In this direction, Greece, as well as its global counterparts, shall evaluate the use of Industry 4.0 technologies, like the IIOT to establish a circular economy and a greener industry. “Smart manufacturing” shall allow the gathering of data along the lifecycle of a material, understanding the material input, and considering the end-of-life of a material, instead of putting it to landfill. This can subsequently introduce production processes with zero per cent of extracted raw material, net-zero emissions, and 100 per cent recycling. In addition, certain industries, like the electronics industry, shall become forced to use Industry 4.0 technologies for circularity earlier than others. This is because, their need for rare earths and emission-heavy metals will not be manageable by additional extraction soon. This can potentially lead to the so-called urban mining, meaning, the recycling of electronic equipment in order to extract and recycle it as a secondary raw material.²⁶⁵

7.6.5 How can Greece mitigate the global Industry 4.0 related threats through the Industry 4.0 strategy?

The Greek Industry 4.0 strategy shall not only exploit the global Industry 4.0 related opportunities, but at the same time shall address and mitigate the global threats imposed by or related to digital. In fact, the EU counterparts’ rapidly progress with regards to their digitisation both at a national and at an industry level, continuously increase their digital “rift” with Greece and makes the introduction of a Greek Industry 4.0 strategy a necessity rather than a wishful thinking.

In more detail, the introduction of initiatives related to the internationalization of the Greek enterprises and their participation in EU value chains shall aim to prevent Greece’s exclusion from EU ecosystems due to the rise of the economic nationalism and will focus on supporting the Greek enterprises to turn the disruption of the traditional linear value chains from a threat into an advantage.

In addition, proactive skill-related initiatives shall be introduced in the Greek Industry 4.0 strategy. These will focus on identifying jobs in select professions, that will be affected by digitisation, and on introducing appropriate training initiatives that will focus on digitally upskilling and reskilling the workforce that currently performs labor-intensive activities. Circular economy and green Industry 4.0 initiatives also proposed above, shall contribute at decreasing the global Climate Change and Global Warming threat.

Finally, although COVID-19 may severely impact the global and the Greek economy, this pandemic shall be also seen as a global opportunity for the acceleration of countries’ and industries’ digitisation. It is evident that the COVID-19 pandemic has already “forced” the Greek businesses to immediately deploy digital technologies to deal with such an emergency. The Industry 4.0 strategy initiatives shall further contribute towards the digitization of the Greek enterprises, promote their workforce’s remote working and safety, while ensuring the organizations’ viability.

²⁶⁵ „Industry 4.0 could be a key player in mitigating climate change”, <https://www.construction21.org/articles/h/industry-4-0-could-be-a-key-player-in-mitigating-climate-change.html>

8 Greece’s Industry 4.0 Vision & Execution Strategy

8.1 Chapter’s summary

Up until now, Greece had demonstrated signs of economic recovery. This was depicted both in the country’s GDP and employment growth (1,9% and 2% in 2019).²⁶⁶ More specifically, the Greek industry significantly contributes to the national economy, generating more than 24% of the country’s Gross Value Added (for 2017) ²⁶⁷, employing 19% of Greek employees in 2017 (-6% from 2000) ²⁶⁸ and increasing its production by 3% by 2020 compared to 2015.

It should be mentioned that during the last decade, the investing activities of many Greek enterprises (including those of the Greek industry) have been put on hold due to the deep economic recession, thus creating a significant investing gap between their investment needs and their actual investments, hindering their ability to remain competitive and grow their market share. A crucial factor for the aforementioned was the high cost of capital and also the inability of enterprises to gain access to funding.²⁶⁹ Currently, Greek enterprises are significantly behind their EU counterparts as far technological or other investments are concerned, which are already implementing their strategic transition to Industry 4.0. The Greek Industry’s unfavorable position creates a burning platform for the country to act fast, perform in sync many equally important tasks, and within a tight timeframe.

The need to the Greek Industry to act fast and in a structured way is further accelerated by the COVID-19 pandemic, that has recently erupted on a global scale and is expected to be rather impactful and affect the “way things are traditionally done” for most of the economies around the world, including the Greek one.

This crisis will not only have a social and healthcare impact for countries worldwide but will also call for drastic action and measures as far as their economic activities are concerned, and the way value has so far been created. This will become imperative especially for countries, like Greece whose economies are mainly based on the tertiary sector and more specifically on tourism and the provision of services. According to OECD²⁷⁰, in the short and medium term, economies that are mainly based on tourism will be the most hard-hit ones since they will be adversely affected by the restrictions imposed across the world and are related to movement, travelling and social distancing.

However, as far as the current COVID-19 crisis (or other such crisis that might unfold in the near or not future) is concerned, it should be capitalised upon and turned into a unique opportunity for Greece to unlock new sources of growth and disprove the grim reality of future forecasts for the country. This does not mean that Greece should divest from economic activities such as its tourism and services sector, but rather triple down on its strengths and efforts as far as other sectors of economic activity are concerned, as suggested by the recent quarterly report published by IOBE²⁷¹. Such sectors (i.e. the manufacturing

²⁶⁶ Hellenic Statistical Authority, Stochasis Macroeconomic Trends -SectoralForecasts, December 2019. Forecasts have been provided by Stochasis

²⁶⁷ Eurostat, National accounts aggregates by industry (up to NACE A*64), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64&lang=en

²⁶⁸ Eurostat, National accounts employment data by industry (up to NACE A*64), http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64_e&lang=en

²⁶⁹ PwC Report: “Stars and Zombies: Greek corporates coming out of the crisis” <https://www.pwc.com/gr/en/publications/assets/stars-and-zombies-september-2015.pdf>

²⁷⁰ OECD, „Evaluating the initial impact of COVID-19 containment measures on economic activity”, https://read.oecd-ilibrary.org/view/?ref=126_126448-kcrc0cs6ia&title=FFEVALUATING_THE_INITIAL_IMPACT_OF_COVID_CONTAINMENT_MEASURES_ON_ECONOMIC_ACTIVITY

²⁷¹ Report for the Greek Economy, 01/2020 IOBE, http://iobe.gr/docs/pub/ECO_Q1_2020_PRE_SHORT_GR.pdf

sector) can play a catalytic role in this significant effort of the country to diversify the sources value is generated from and overall seek to increase the country's Gross Domestic Product.

One of the most prominent sectors is that of the Greek industry, which can be the main protagonist in the medium and long term for Greece, creating a strong and resilient production base for the country. Greece can take great advantage of the fact that Europe has entered an era (during the latest decade) where it seeks to reinforce its industrial sector as a whole, and at the same time the industry of each respective member state. On that note, there are many initiatives, such as the recently published European Industrial Strategy, the Digitising European Industry (DEI), the Agenda 2030 etc., that Greece can rely upon and take advantage of in order to significantly transform its Industrial sector and its contribution to the Greek economy. At the same time, the need for a strong and autonomous Greek industry, competent enough to act as one of the main drivers of the Greek economy has been acknowledged during the recent years by Greek government officials, federations across the country as well as key industrial stakeholders.

One of the fundamental links for all the aforementioned to materialise within the short and medium term is a holistic, concise and well-designed Industry 4.0 strategy for Greece. A strategy that, as presented also within the SWOT analysis, shall take advantage of the global Industry 4.0 opportunities (i.e. the emergence of new cross-country and cross-industry ecosystems and the global explosion in the use of emerging Industry 4.0 technologies such as the Internet of Things, Artificial Intelligence, 5G and big data analytics) to enhance the Greek Industry's digitization, while at the same time shall include initiatives that will aim at mitigating the Industry 4.0 related threats (i.e. the economic nationalism and the disruption of linear value chains and "traditional" industries at a global scale). The Greek Industry 4.0 strategy shall also take advantage of the momentum built thus far and streamline all the next steps that need to be carried out by the various stakeholders of the Greek political and Industrial landscape in order to set this plan into motion. A strategy that will introduce and enable the mass adoption of digital solutions and technologies across the Greek Industrial sector by leveraging the strengths of the Greek industry (such as the burgeoning start-up and Digital Innovation Hubs' scene, the high number of STEM graduates and the recent effort of Greek industrial enterprises to enter the digital era by investing on i4.0 technologies and systems, the high adoption and implementation of big data analytics), while at the same time addressing its weaknesses (i.e. the Greek Industry's overall low digital maturity, the limited investments in R&D, as well as its disassociation with the applied research and industry implementation, the insufficient investments in the Greek workforce's digital upskilling, as well as the existing regulatory hurdles, restrictions, and red tape , that decelerate Greece's rotation to Industry 4.0 etc.).

The strategy should place the Greek Industry as a "growth engine" for the Greek economy. At the same time, the Industry 4.0 strategy will aim to reinforce the Greek Industry's position in the European setting, as an integral part of current and emerging value chains.

To achieve all the above, Greece's Industry 4.0 strategy needs to address the following key questions:

- What actions shall the Government, supported by the Industry, undertake to ensure the digital upskilling and reskilling of existing and future Industry workforce?
- How can the Greek Government, Industry, Research & Academia strengthen their collaboration and make it more targeted to ensure the conduct of applied R&D, directly associate with industry implementation?
- Which are the appropriate measures and mechanisms that shall be put in place to further incentivize and support the Greek enterprises' innovation capabilities as well as the Greek start-up ecosystem?

- Which are the levers that can promote the collaboration between Greek and international enterprises to address specific needs of Greek value chains, foster the development of Greek enterprises and position them as part of international ecosystems?
- Which are the key ICT standardisation priorities that the Greek Government, Industry and academia shall address to the implementation of interoperable and interconnected Industry 4.0 technologies, products and services?
- How can the Greek Government improve the regulatory environment to decrease regulatory hurdles, restrictions, and red tape and enhance Industry’s digitisation and innovation?
- Which are the direct and indirect financial incentives that shall be provided to Greek enterprises to accelerate their investments in Industry 4.0 technologies, applications and relevant digital skills? Which are the tailored mechanisms that can address Greek SMEs digitisation needs?
- How can the Greek Industry become incentivized to leverage Industry 4.0 to enhance the organizations’ average circular use of materials and enable the Greek industry to actively participate in the circular economy ecosystem?
- Finally, what actions shall the Government undertake to ensure that the key digital foundations (including the deployment of nation-wide digital infrastructure (5G) and the provision of “digital by default” public services) are in place to horizontally enable the digitisation of the Greek Industry?

The national Industry 4.0 strategy aims to introduce a cohesive and comprehensive national agenda, under which all key stakeholders, i.e. the Greek Public Administration, the Greek Industry and the Greek research and academia will streamline their efforts to achieve the Greek Industry’s Industry 4.0 transformation and to successfully realise the Greek Industry 4.0 vision. The Greek Industry 4.0 vision is stated below:

Greece’s Industry 4.0 Vision

“An innovative, internationally competitive and extrovert Greek Industry with the leverage of digitisation and the continuous integration of new Industry 4.0 technologies & applications”

The operationalization of the Greek Industry 4.0 vision shall support the Greek Industry to accomplish a set of goals. These are listed below:

- Increase the Greek Industry’s overall digital maturity
- Digitally upskill and reskill the human workforce in the Greek industry
- Enhance the Greek Industry’s applied R&D, innovation and production capabilities
- Support the Greek Industry to transition into the zero-carbon and low environmental footprint economy
- Develop a collaborative industrial ecosystem to accelerate the digitization and scale up of the Greek SMEs and mid-caps
- Enhance the internationalization and extroversion of the Greek Industry and strengthen its active participation in global, European and regional value chains

- Increase the Greek Industry's potential to meet personalized needs and imminently respond to emergencies and crises (flexible processing)
- The enhancement of internationalization of the Greek Industry and its active participation in EU ecosystems
- Increase the overall contribution of Greek industry to the Greek economy

The implementation of the Greek Industry 4.0 vision shall be based upon six execution pillars. There are the following:

1. **Digital skills & human capital qualifications:** The provision of the current and future Greek industrial workforce with the appropriate digital knowledge and skills. The pillar focuses both on the digital upskilling and reskilling of the current workforce (with particular attention to be given to the reskilling and upskilling of lesser-skilled workers and SME's workforce), as well as on attracting and developing the future talent pipeline for the Greek Industry. In addition, the pillar includes targeted initiatives for the repatriation of Greek human capital and the attraction of international human capital.
2. **Innovation & start-up supporting mechanisms in the Digital Age:** The pillar's focus is threefold. First, it focuses on the enhancement and promotion of innovation across the Greek Industry, through the closer and targeted collaboration of the Greek Government, Industry and Research & Academia (triple helix innovation model) and the design of new or the enhancement of existing Digital Innovation Hubs (DIHs) and Innovation Districts. Second, the pillar focuses on the targeted mechanisms for the support of the booming start-up ecosystem in Greece. Third, the pillar targets on incentives to foster investment in innovation and applied R&D within the Greek enterprises to contribute to the solution of industrial and societal problems (i.e. circular economy).
3. **Collaboration & synergies:** The pillar focuses on the development of a collaborative industrial ecosystem, where Industry stakeholders shall cooperate and utilise each other's expertise in order to achieve greater goals. Collaborations shall be pursued across many different levels ranging from the provision of technical know-how and expertise from large, digitally-advanced enterprises to Greek SMEs and mid-caps, to increase their thus far limited awareness on digital and Industry 4.0, to the setup of industrial platforms on specific areas of economic activity that will enable the creation of ecosystems of market actors in a multi-sided marketplace. Moreover, this pillar shall promote the internationalization of the Greek enterprises and their participation in EU value chains and global emerging ecosystems.
4. **Standardisation & Norms:** The pillar aims at setting key ICT standardisation priorities, in accordance to the European Commission's ICT Standards plan and communication²⁷², to help ensure that the implemented Industry 4.0 technologies, systems and services retain the ability to connect and interoperate with each other, boosting innovation, and keeping the Greek ICT market open, competitive and interconnected with the rest of the Europe.
5. **Regulatory Environment:** The pillar focuses on improvements of the Greek regulatory environment, primarily in the areas of cybersecurity, data protection, free flow of data and Artificial Intelligence in order to provide a more flexible and digital-friendly environment within which the Greek Industry can accelerate its digitisation.

²⁷² <https://ec.europa.eu/digital-single-market/en/news/communication-ict-standardisation-priorities-digital-single-market>

6. **Acceleration of investment in digital technologies:** The last pillar focuses on the financial incentivisation of Greek enterprises in order to invest and leverage Industry 4.0 technologies and applications. In that context, tailored financial instruments will be developed, targeted at upgrading and modernising enterprises with regards to Industry 4.0 on multiple areas (i.e. both adoption of new technologies, the upskilling/reskilling of employees and the use of circular material). This effort will be pursued in the lines of a “holistic” upgrade of enterprises, and in total coordination with all other actions of the strategy.

Having concluded the analysis of the six execution pillars, it is finally important to mention that the Greek Industry 4.0 strategy shall also focus on the **enhancement of the key digital foundations** that consist prerequisite for the Greek Industry’s rotation to Industry 4.0. These foundations include:

- the deployment of nation-wide digital infrastructure (5G)
- the digitisation of the Greek Public Administration and the provision of “digital by default” public services

Although the identification of initiatives for digital infrastructure and digital public services consists part of the National Digital Strategy and will be included in the Bible of Digital Transformation, to be issued by the Greek Ministry of Digital Governance, the Industry 4.0 strategy shall describe at a high level key initiatives regarding the key digital foundations that shall be introduced to enable the Greek Industry’s digitisation. The implementation of these digital foundations shall be performed in parallel with the initiatives to be included in the six execution pillars to achieve the highest possible results from implementing the Industry 4.0 strategy.

8.2 The rationale for Greece's Industry 4.0 Strategy

Up until now, Greece had demonstrated signs of economic recovery. This was depicted both in the country's GDP and employment growth (1,9% and 2% in 2019).²⁷³ More specifically, the Greek industry significantly contributes to the national economy, generating more than 24% of the country's Gross Value Added (for 2017) ²⁷⁴, employing 19% of Greek employees in 2017 (-6% from 2000) ²⁷⁵ and increasing its production by 3% by 2020 compared to 2015.

It should be mentioned that during the last decade, the investing activities of many Greek enterprises (including those of the Greek industry) have been put on hold due to the deep economic recession, thus creating a significant investing gap between their investment needs and their actual investments, hindering their ability to remain competitive and grow their market share. A crucial factor for the aforementioned was the high cost of capital and also the inability of enterprises to gain access to funding.²⁷⁶ Currently, Greek enterprises are significantly behind their EU counterparts as far technological or other investments are concerned, which are already implementing their strategic transition to Industry 4.0. The Greek Industry's unfavorable position creates a burning platform for the country to act fast, perform in sync many equally important tasks, and within a tight timeframe.

The need to the Greek Industry to act fast and in a structured way is further accelerated by the COVID-19 pandemic, that has recently erupted on a global scale and is expected to be rather impactful and affect the "way things are traditionally done" for most of the economies around the world, including the Greek one.

This crisis will not only have a social and healthcare impact for countries worldwide but will also call for drastic action and measures as far as their economic activities are concerned, and the way value has so far been created. This will become imperative especially for countries, like Greece whose economies are mainly based on the tertiary sector and more specifically on tourism and the provision of services. According to OECD²⁷⁷, in the short and medium term, economies that are mainly based on tourism will be the most hard-hit ones since they will be adversely affected by the restrictions imposed across the world and are related to movement, travelling and social distancing.

However, as far as the current COVID-19 crisis (or other such crisis that might unfold in the near or not future) is concerned, it should be capitalised upon and turned into a unique opportunity for Greece to unlock new sources of growth and disprove the grim reality of future forecasts for the country. This does not mean that Greece should divest from economic activities such as its tourism and services sector, but rather triple down on its strengths and efforts as far as other sectors of economic activity are concerned, as suggested by the recent quarterly report published by IOBE²⁷⁸. Such sectors (i.e. the manufacturing

²⁷³ Hellenic Statistical Authority, Stochasis Macroeconomic Trends -SectoralForecasts, December 2019. Forecasts have been provided by Stochasis

²⁷⁴ Eurostat, National accounts aggregates by industry (up to NACE A*64), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64&lang=en

²⁷⁵ Eurostat, National accounts employment data by industry (up to NACE A*64), http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64_e&lang=en

²⁷⁶ PwC Report: "Stars and Zombies: Greek corporates coming out of the crisis" <https://www.pwc.com/gr/en/publications/assets/stars-and-zombies-september-2015.pdf>

²⁷⁷ OECD, „Evaluating the initial impact of COVID-19 containment measures on economic activity”, https://read.oecd-ilibrary.org/view/?ref=126_126448-kcrc0cs6ia&title=FFEVALUATING_THE_INITIAL_IMPACT_OF_COVID_CONTAINMENT_MEASURES_ON_ECONOMIC_ACTIVITY

²⁷⁸ Report for the Greek Economy, 01/2020 IOBE, http://iobe.gr/docs/pub/ECO_Q1_2020_PRE_SHORT_GR.pdf

sector) can play a catalytic role in this significant effort of the country to diversify the sources value is generated from and overall seek to increase the country's Gross Domestic Product.

In this context, the European Union thoroughly coordinates a common European response to the coronavirus outbreak and is currently examining measures to help the Member States respond to the apparent unprecedented crisis by taking actions to reinforce their public health sectors and mitigate the socio-economic impact of the pandemic. From supporting research on vaccines, diagnostics and treatment, to ensuring the flow of goods and workers' mobility in the EU single market, as well as putting in place flexible state rules to save jobs and companies, the European Commission does its best to tackle the crisis. Thus far EU has mobilized around 3,4 trillion euros with 2,5 trillion euros being national liquidity measures and the rest coming from multiple sources at an EU-level such as the European Investment bank group financing for businesses, the SURE-EU funding for short time work schemes, the European Stability Mechanism, direct EU budget support, etc.

In these lines, the European Commission published on 15 April 2020²⁷⁹ a document reflecting on the need for the EU to act swiftly on the COVID-19 pandemic in order to form “a comprehensive recovery plan and unprecedented investment to help the economies across the EU relaunch and transform”. The document places an emphasis on the need to “achieve strategic autonomy of the EU” by supporting to the utmost extent the European industrial sector, and more specifically the SMEs and startups within it, through a solid Industrial policy, investing in strategic value chains. In the lines of this, the IndustriAll Europe organisation, on April 28th 2020²⁸⁰ (representing employees in the manufacturing, mining and energy sectors) sparked a discussion that highlighted the need for a Recovery plan for Europe and more specifically the European Industry. Highly impacted by COVID-19, the European Industry, having its workforce at the epicentre, should be highly supported as one of the main pillars that will assist the EU overcome this crisis. For that reason, the key areas/ initiatives highlighted by IndustriAll Europe are the following:

- Assisting viable companies to cope with the crisis and remain competitive, at the same time assisting their human capital to grow and become more competent in this challenging environment.
- Map out the impact of COVID 19 across the Industrial sectors, designing tailored strategic initiatives for their recovery, investing in a sustainable Industry for the future and pursuing the simultaneous transition of the EU industry with regards to digitalisation and a low-carbon footprint.
- Enhance strategic industrial value chain across the EU, aiming at the autonomy of EU Industry.
- Introduce and utilise innovative instruments (i.e., as mentioned by IndustriAll EU, the “**Carbon Border Adjustment Mechanism** or the **Instrument on Foreign Subsidies**”) as well as dedicated funds in order to assist in this overall boost of the European Industry.

One of the most prominent sectors is that of the Greek industry, which can be the main protagonist in the medium and long term for Greece, creating a strong and resilient production base for the country. Greece can take great advantage of the fact that Europe has entered an era (during the latest decade) where it seeks to reinforce its industrial sector as a whole, especially at this time in order to come through the COVID-19 pandemic stronger as analysed above, and at the same time the industry of each respective member state. On that note, there are many initiatives, such as the recently published European Industrial

²⁷⁹ <https://www.consilium.europa.eu/media/43384/roadmap-for-recovery-final-21-04-2020.pdf>

²⁸⁰ https://news.industriall-europe.eu/content/documents/upload/2020/4/637238495414024176_Letter%20to%20Commissioner%20Breton.pdf

Strategy, the Digitising European Industry (DEI), the Agenda 2030 etc., that Greece can rely upon and take advantage of in order to significantly transform its Industrial sector and its contribution to the Greek economy. At the same time, the need for a strong and autonomous Greek industry, competent enough to act as one of the main drivers of the Greek economy has been acknowledged during the recent years by Greek government officials, federations across the country as well as key industrial stakeholders.

One of the fundamental links for all the aforementioned to materialise within the short and medium term is a holistic, concise and well-designed Industry 4.0 strategy for Greece. A strategy that, as presented also within the SWOT analysis, shall take advantage of the global Industry 4.0 opportunities (i.e. the emergence of new cross-country and cross-industry ecosystems and the global explosion in the use of emerging Industry 4.0 technologies such as the Internet of Things, Artificial Intelligence, 5G and big data analytics) to enhance the Greek Industry's digitization, while at the same time shall include initiatives that will aim at mitigated the Industry 4.0 related threats (i.e. the economic nationalism and the disruption of linear value chains and "traditional" industries at a global scale). The Greek Industry 4.0 strategy shall also take advantage of the momentum built thus far and streamline all the next steps that need to be carried out by the various stakeholders of the Greek political and Industrial landscape in order to set this plan into motion. A strategy that will introduce and enable the mass adoption of digital solutions and technologies across the Greek Industrial sector by leveraging the strengths of the Greek industry (such as the burgeoning start-up and Digital Innovation Hubs' scene, the high number of STEM graduates and the recent effort of Greek industrial enterprises to enter the digital era by investing on i4.0 technologies and systems, the high adoption and implementation of big data analytics), while at the same time addressing its weaknesses (i.e. the Greek Industry's overall low digital maturity, the limited investments in R&D, as well as its disassociation with the applied research and industry implementation, the insufficient investments in the Greek workforce's digital upskilling, as well as the existing regulatory hurdles, restrictions, and red tape , that decelerate Greece's rotation to Industry 4.0 etc.). A detailed analysis of the areas that the Industry 4.0 strategy for Greece should address is presented in paragraphs 7.3.6, 7.4.6, 7.5.6 and 7.6.5.

The overall ambition of the Industry 4.0 strategy shall be to place the Greek Industry as a "growth engine" for the Greek economy. At the same time, the Industry 4.0 strategy shall aim to reinforce the Greek Industry's position in the European setting, as an integral part of current and emerging value chains.

Summarizing all areas of focus, as these surfaced through the performed SWOT analysis, Greece's Industry 4.0 strategy needs to address the following key questions:

- What actions shall the Government, supported by the Industry, undertake to ensure the digital upskilling and reskilling of existing and future Industry workforce?
- How can the Greek Government, Industry, Research & Academia strengthen their collaboration and make it more targeted to ensure the conduct of applied R&D, directly associate with industry implementation?
- Which are the appropriate measures and mechanisms that shall be put in place to further incentivize and support the Greek enterprises' innovation capabilities as well as the Greek start-up ecosystem?
- Which are the levers that can promote the collaboration between Greek and international enterprises to address specific needs of Greek value chains, foster the development of Greek enterprises and position them as part of international ecosystems?

- Which are the key ICT standardisation priorities that the Greek Government, Industry and academia shall address to the implementation of interoperable and interconnected Industry 4.0 technologies, products and services?
- How can the Greek Government improve the regulatory environment to decrease regulatory hurdles, restrictions, and red tape and enhance Industry’s digitisation and innovation?
- Which are the direct and indirect financial incentives that shall be provided to Greek enterprises to accelerate their investments in Industry 4.0 technologies, applications and relevant digital skills? Which are the tailored mechanisms that can address Greek SMEs digitisation needs?
- How can the Greek Industry become incentivized to leverage Industry 4.0 to enhance the organizations’ average circular use of materials and enable the Greek industry to actively participate in the circular economy ecosystem?
- Finally, what actions shall the Government undertake to ensure that the key digital foundations (including the deployment of nation-wide digital infrastructure (5G) and the provision of “digital by default” public services) are in place to horizontally enable the digitisation of the Greek Industry?

The following chapters seek to analyse how the above challenges will be addressed by the proposed Industry 4.0 Strategy for Greece.

8.3 Greece's Industry 4.0 vision

The national Industry 4.0 strategy aims to introduce a cohesive and comprehensive national agenda, under which all key stakeholders, i.e. the Greek Public Administration, the Greek Industry and the Greek research and academia will streamline their efforts to achieve the Greek Industry's Industry 4.0 transformation and to successfully realise the Greek Industry 4.0 vision. The Greek Industry 4.0 vision is stated below:

Greece's Industry 4.0 Vision

“An innovative, internationally competitive and extrovert Greek Industry with the leverage of digitisation and the continuous integration of new Industry 4.0 technologies & applications”

The operationalization of the Greek Industry 4.0 vision shall support the Greek Industry to accomplish a set of goals. These are listed below:

- Increase the Greek Industry's overall digital maturity.
- Digitally upskill and reskill the human workforce in the Greek industry.
- Enhance the Greek Industry's applied R&D and the innovation capabilities.
- Support the Greek Industry to transition into the zero-carbon and low environmental footprint economy.
- Develop a collaborative industrial ecosystem to accelerate the digitization and scale up of the Greek SMEs and mid-caps.
- Increase the Greek Industry's potential to meet personalized needs and imminently respond to emergencies and crises (flexible processing).
- Enhance the internationalization and extroversion of the Greek Industry and strengthen its active participation in global, European and regional value chains and ecosystems.
- Increase the overall contribution of Greek industry to the Greek economy.

The abovementioned set incorporates on purpose a number of goals that range from strategic ones (i.e. Increase the overall contribution of Greek industry to the Greek economy) to operational ones (i.e. Digitally upskill and reskill the human workforce in the Greek industry), in order to effectively cover the micro, meso and macro effects of the Greek Industry's rotation to digital.

According to our analysis, other EU member states that have designed and implemented national Industry 4.0 strategies over the last decade have seen their digital maturity to become significantly enhanced and to accelerate their Industries' digitisation. To verify this, we examined two valuable and reliable proxies for the monitoring of Industry's rotation to Industry 4.0 technologies that are also recommended to be included as part of our national agenda. Namely, we reviewed:

- **The annual growth rate (CAGR) of their DESI Index:** This indicates the annual growth of countries' digital maturities at a national level

- **The annual growth rate (CAGR) of DESI's 4th pillar - Integration of Technology:** This focuses on the annual growth of the countries' enterprises' digital maturity (industry level)

The results are presented in the table below:

Dimension	Minimum Value – (Country)	Median Value – (Country)	Maximum Value – (Country)
DESI CAGR	4% (Denmark)	5% (Belgium)	10% (Italy)
Integration of Technology CAGR	6% (Austria)	11% (Germany)	29% (Hungary)

Based on the other countries' progress, and with the assumption that all other macropolitical and macroeconomic conditions for Greece are held equal, a modest estimate indicates that the Greek Industry 4.0 strategy could also improve Greece's DESI index between 4%-5% annually, while the digital maturity of the Greek Industry could improve by 6% to 11%.²⁸¹

²⁸¹ The measurement of Industry 4.0's contribution to the Greek Industry and economy sets as a precondition the initiation of strategy execution, the definition of an appropriate time horizon and the conduct of an econometric analysis that will rest on mutually agreed assumptions between Government, Industry and academia.

8.4 Industry 4.0 strategic initiatives within the EU

As it was already presented in Deliverable 1, and as agreed during the technical meeting with the Ministry’s team and DG Reform on the 4th of February 2020, special emphasis has been put on studying the current mechanisms, the initiatives and measures supporting the industrial digital transformation and the adoption of industry 4.0 technologies in three European countries, namely Germany, France and Portugal. However, in the context of Deliverable 1, the status of the rest of the EU countries currently implementing Industry 4.0 initiatives/ strategies was presented at a higher level. In the lines of the above, a more extensive mapping and analysis of all European Industry 4.0 initiatives and measures was conducted, per EU country, in order to lay the foundations for the execution pillars of the proposed Industry 4.0 Strategy for Greece. This analysis surfaced that based on a set of specific characteristics (state of digitisation at a state and enterprise level, contribution of the Industry to the country’s economy etc.) each country would choose to put special emphasis on different dimensions, tailoring its Industry 4.0 strategy/ initiatives to its specific needs. As a result of this analysis, nine (9) areas were pinpointed as the different “execution pillars” each country chose to focus on (or not) with regards to measures, initiatives and actions taken towards the digitisation of its Industry. An overall picture for the countries implementing i4.0 initiatives and their strategy’s execution pillars is briefly presented below:

Country																
Execution Pillars																
Human Capital & Skills	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Technologies' Adoption	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Business Connectivity/ Synergies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Regional focus		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	*		✓	
Start-ups	✓	✓	✓	✓	✓				✓	✓	✓		✓	✓	✓	✓
Financial & Investment Incentives	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Regulatory Environment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Cybersecurity	✓	✓	✓	✓		✓	✓	✓	✓	✓				✓		✓
Standardisation & Norms	✓	✓		✓	✓		✓	✓	✓		✓				✓	

* recently the UK has started developing a regional focus on its i4.0 policy

Based on the above, the nine (9) execution pillars that act as the core parts of the individual Industry 4.0 initiatives of EU countries are:

1. Human Capital & Skills
2. Industry 4.0 technologies’ adoption
3. Business connectivity and synergies
4. Measures at a regional focus
5. Start-ups in the Industrial digital age
6. Financial and investment incentives
7. Regulatory environment
8. Cybersecurity
9. Standardisation and norms

As shown in the above table, all countries have chosen to put a special emphasis on upskilling and reskilling their human capital in the face of the Digital age, identifying it as one of the crucial drivers for the transition of their industry to Industry 4.0. As stated by each of the countries that are already implementing i4.0 initiatives, the human capital factor is the single most important differentiator that can have an immediate impact on the strategy's success. This should be no different for the case of Greece, taking into account that, as surfaced earlier, the lack of digital skills in the human capital of the country in general but also in the manufacturing sector is evident. For that reason, a heavy emphasis has to be given through the strategy to the proper upskilling and reskilling of the Greek human capital.

Along these lines, the adoption of industry 4.0 technologies across the industrial ecosystem as well as the “triple-helix” model and the synergies and collaborations that we have analysed in the selected best practices (Germany, France, Portugal) have also been pursued across all countries. In some cases, initiatives have been targeted at start-ups and the rise of new industrial enterprises in the digital age. For the case of Greece and as stated in our SWOT analysis, the connection between enterprises and academic research centres has been quite poor, not building interdependencies and connections between applied research and developing the relevant business solutions needed by the industry sector. Research institutions, enterprises and academia in general have been for the most part detached within the Greek business environment, hindering the potential synergies that, if promoted and utilised to their fullest, could lead to tremendous results in the near future.

Furthermore, some countries have sought to assist enterprises at a regional level with specific measures and initiatives based on their present needs (such as France, being the most characteristic example in that area). Other EU countries have chosen to address the area of cybersecurity with regards to Industry 4.0. A certain group of the countries above, have acted towards creating a standardised Industry 4.0 framework for all enterprises, in order to promote a “common language” and “way of doing business” between enterprises and with regards to data exchange and the adoption of Industry 4.0 technologies (the highlight being the collaboration between Germany, France, Italy²⁸²).

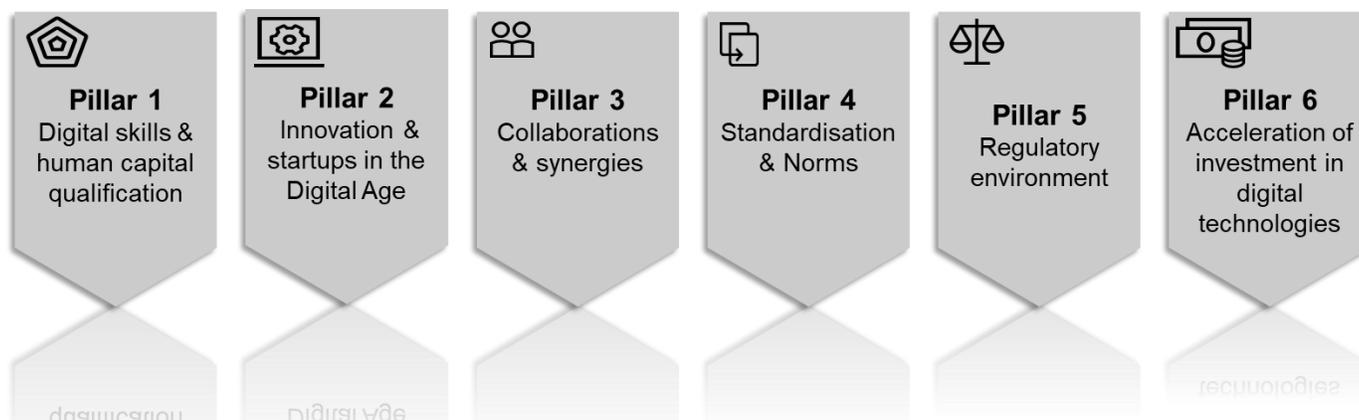
A significant focus has been given by all countries to design and offer to Industrial enterprises the right financial tools and incentives in order to adopt Industry 4.0 solutions and invest in new technologies or the training of their employees. With regards to the financial incentives and as analysed in the current Deliverable as well as Deliverable 1, Greece has in recent years offered financial incentives and programmes to Greek enterprises with regards to their digitisation. However, a more tailored and targeted approach has to be pursued in order to offer Industry 4.0 specific financing to enterprises of the Greek industry.

Last but not least, almost all countries have taken action in order to modernise their regulatory frameworks, as a “supportive net” that will facilitate confidence to businesses, employees and society as a whole, for the transition towards Industry 4.0. As surfaced in the SWOT analysis, Greece's regulatory framework contains many inhibitors that do not simplify the business environment so that it is allowed to grow with the fast pace dictated by the digital age.

²⁸² <https://www.plattform-i40.de/PI40/Redaktion/EN/News/Actual/2018/2018-01-18-trilaterale-kooperation.html>

8.5 The six execution pillars for Industry 4.0 vision’s operationalisation

Combining the analysis of the abovementioned EU countries i4.0 initiatives with the needs and special conditions that have been surfaced by Deliverable 1 as well as with the SWOT analysis for Greece, we have developed six (6) discrete **execution pillars for the operationalisation of the Greek Industry 4.0 vision**. These execution pillars are presented below:



As it has been identified by reviewing all other Industry 4.0 strategies and initiatives across Europe, the active participation as well as the strong involvement of the various stakeholders present in the Greek Industry ecosystem (i.e. Government, Industry stakeholders such as federations, enterprises, academia and research centres) for the implementation of the strategy is crucial. For that reason, under each pillar we outline the most significant stakeholders (indicatively but non exhaustively) that will assist in achieving its discrete goals and implement their selected measures. Moving to Deliverable 3, each of these execution pillars will become enriched with discrete initiatives that will consist the Operational Plan of the Greek Industry 4.0 strategy.

The strategic purpose/ goal that each pillar will seek to serve is presented as follows:

Digital skills & human capital qualifications

Pillar 1 Providing the current and future Greek industrial workforce with the appropriate knowledge and skills that are required by the Digital era is a prerequisite for the strategy’s success. Pillar 1 will seek to, first and foremost, digitally upskill and reskill all the current workforce of the Greek industry. By developing special training programmes based on the technologies to be adopted and already utilised by the Greek industry, employees will have the chance to learn new skills and better position themselves in their field of work, enabling them to perform better in the new setting of their current or future job. On this front, particular attention shall be given to the reskilling and upskilling of lesser-skilled workers and SME’s workforce.

At the same time, Pillar 1 shall include dedicated initiatives for attracting and developing the future talent pipeline for the Greek Industry. This could be achieved (indicatively but non exhaustively) by better equipping ICT and STEM students with the necessary skillsets to work in the Industry 4.0 environment, by enhancing the collaboration between the Greek academia and the Greek Industry, by enriching the

education syllabus for STEM-related subjects to better match with industry needs and by increasing the attractiveness of the Greek Industry as a career destination for top talent. These initiatives shall provide to the future workforce a set of basic digital skills that they could further build upon throughout their career and also help them respond more effectively to increased work-related burden and upskilling/ reskilling needs.

Finally, this pillar shall include targeted initiatives for the repatriation of Greek human capital and the attraction of international human capital. This could be achieved through the design of targeted fellowship programmes for international PhD students/ researchers and Greek PhD students/ researchers working on Industry 4.0 technologies or RIS3 Strategy areas of focus, or through the provision special benefits (i.e. tax benefits) for the incentivization of expatriates to return home.

It is important to state at this point that horizontal digital skills and human capital initiatives regarding the accelerating reskilling of the Greek society and the transformation of the transformation of the Greek education system to embed the principles of the Digital age shall not be covered in this execution pillar. Although of great importance for Greece’s digitisation and with incipient benefits for the Greek Industry, these horizontal initiatives consist part of Greece’s national digital strategy and shall be included in the respective Bible of Digital Transformation, expected to be published soon by the Greek Ministry of Digital Governance.

The key stakeholders (indicatively but non-exhaustively) that will participate in the implementation of the first Pillar’s proposed measures and initiatives are presented below:

 **Key stakeholders involved**

- | | |
|--|------------------------------------|
| 1. General Secretariat for Industry | 2. Ministry of Education |
| 3. General Secretariat for Research and Technology | 4. Federation of Enterprises |
| 5. Ministry of Digital Governance | 6. Academia/ Industry stakeholders |

For additional details on how this pillar addresses the SWOT analysis observations, please refer to Appendix I, paragraph 9.1.

Innovation & start-up supporting mechanisms in the Digital Age



The second Pillar has a threefold focus. Firstly, the pillar focuses on the enhancement and promotion of innovation across the Greek Industry, through the closer and targeted collaboration of the Greek Government, Industry and Research & Academia (triple helix innovation model) and the design of new or the enhancement of existing Digital Innovation Hubs (DIHs) and Innovation Districts. In this way, all Greek enterprises, especially SMEs, start-ups and mid-caps, will be able to actively experiment, produce applied research and innovation and improve their business, production processes, products and services through digital innovations.

In fact, as it has been identified by the technical meetings conducted between the project working team and the Ministry’s team as well as various General secretaries during the 2nd Workshop of the project, there exists today a big gap between the country’s research institutes and the Greek industry. The research produced is left unutilised and rarely does it serve the actual needs of industrial enterprises. Digital Hubs will enable the Greek enterprises to come in contact with research institutes and collaborate over the industry’s burning needs to be answered by targeted research projects. At the same time, innovation Districts, will enable industrial start-ups and enterprises along with business incubators and other public and private actors to come together, in order to work on collaborative projects and achieve synergies at all levels. This close collaboration amongst the hub participants is expected to instigate higher innovation demand, which in turn will enable greater innovation supply and diffusion.

Secondly, the pillar shall focus on the targeted initiatives and mechanisms to support the booming start-up ecosystem in Greece. Apart from the DIHs and Innovation Districts, into which Greek start-ups can participate to access necessary resources, capabilities and networking, Greek start-ups could benefit from targeted funding or tax schemes, networking and mentoring programs tailored to their needs, etc.

Finally, this pillar shall also incorporate a set of initiatives for the enhancement of the applied R&D and dissemination of innovation across the Greek Industry. Relevant initiatives may include the establishment of Industry 4.0 test labs or testbeds and the introduction of funds to support the applied research for addressing big industrial and societal challenges (i.e. the circular and green economy) that the Industry faces today.

The key stakeholders (indicatively but nonexclusively) that will participate in the implementation of the second Pillar’s proposed measures and initiatives are presented in the table below:

 **Key stakeholders involved**

- | | |
|-------------------------------------|--|
| 1. General Secretariat for Industry | 2. General Secretariat for Research and Technology |
| 3. Ministry of Digital Governance | 4. Federation of Enterprises |
| 5. Research Institutions/ Academia | |

For additional details on how this pillar addresses the SWOT analysis observations, please refer to Appendix I, paragraph 9.2.

Collaborations & synergies



The third Pillar will seek to develop a collaborative industrial ecosystem where Industry stakeholders shall cooperate and utilise each other’s expertise in order to achieve greater goals. This is expected to accelerate the digitisation of the Greek SMEs and mid-caps, as well as to increase their thus far limited awareness on digital and Industry 4.0. Ultimately assist the Greek industry to advance “as one” to the Industry 4.0 era and cumulatively reap the benefits that it has to offer, instead of having a few i4.0-advanced groups of firms and many i4.0-laggards operating in two different speeds.

Collaborations should be pursued across many different levels ranging from the provision of technical know-how and expertise from large, digitally-advanced enterprises to Greek SMEs and mid-caps to the setup of industrial platforms on specific areas of economic activity that will enable the creation of ecosystems of market actors in a multi-sided marketplace. These ecosystems will enable the creation of new innovative products and services and accelerate the development of worldwide standards. Moreover, tailored measures shall also be included in the remits of this pillar in order to promote the internationalization of the Greek enterprises and their participation in EU value chains and global emerging ecosystems.

Adding to the above and as it happens for all other Industry 4.0 strategies across Europe, Greece has to establish its own Industry 4.0 platform. This platform will not only act as communication tool for the dissemination of the strategy to the various stakeholders, but also as a forum that will invite all involved actors in order to participate and take action throughout the various initiatives pursued. It is important to mention here that a first positive step has been made towards this direction, through the sign off of the relevant memorandum of cooperation between the General Secretariat for Industry and the Ministry of Digital Governance.

The key stakeholders (indicatively but nonexclusively) that will participate in the implementation of the third Pillar’s proposed measures and initiatives are presented in the table below:

 **Key stakeholders involved**

1. General Secretariat for Industry	2. Ministry of Digital Governance
3. Ministry of Infrastructure	4. General Secretariat for Research and Technology
5. Federation of Enterprises	6. Research Institutions/ Academia

For additional details on how this pillar addresses the SWOT analysis observations, please refer to Appendix I, paragraph 9.3.

Standardisation & Norms



The fourth execution Pillar aims at setting key ICT standardisation priorities, in accordance to the European Commission’s ICT Standards plan and communication²⁸³, to help ensure that the implemented Industry 4.0 technologies, systems and services retain the ability to connect and interoperate with each other, boosting innovation, and keeping the Greek ICT market open, competitive and interconnected with the rest of the Europe.

By doing so, the implementation of Industry 4.0 solutions will be performed in a consistent and uniform way for all industry players, allowing for better results and smoother cooperation for business partners (suppliers, vendors etc.). The European Commission has identified five priority areas as the building blocks of ICT standard setting: 5G communications, cloud computing, the internet of things (IoT), big data technologies and cybersecurity. Nevertheless, as technologies converge, stronger leadership in standard

²⁸³ <https://ec.europa.eu/digital-single-market/en/news/communication-ict-standardisation-priorities-digital-single-market>

setting in these priority areas will also significantly impact many other technology areas. Therefore, the ICT standardisation actions are not restricted to a single area or a specific application. Areas such as eHealth, smart energy, intelligent transport systems and connected and automated vehicles, including trains, advanced manufacturing, smart homes and cities and smart farming will significantly benefit from the proposed prioritisation of standards, as they rely on the essential building blocks identified.

It is important to mention here that the aim of our current project is not to design in detail new Greek standards for Industry 4.0 technologies, systems and services or to investigate the alignment of Greek and international standards, however, this will be the ultimate goal of Pillar 4. For this to be achieved, a discrete working group should be established (comprised of public and private sector stakeholders), responsible for identifying the current and designing the future state of Greek standards, based on international and European best practices. Our current project seeks to define the key actions that need to be undertaken by the respective authorities and stakeholders, (i.e. the setup of a task force from the private and public sector to identify needs for ICT standards for big data analytics applications, etc.) to ensure the introduction and implementation of ICT standards across the Greek industry.

The key stakeholders (indicatively but non-exhaustively) that will participate in the implementation of the fourth Pillar’s proposed measures and initiatives are presented below:

 **Key stakeholders involved**

- | | |
|-------------------------------------|--|
| 1. General Secretariat for Industry | 2. Ministry of Digital Governance |
| 3. Research Institutions/ Academia | 4. General Secretariat for Research and Technology |

For additional details on how this pillar addresses the SWOT analysis observations, please refer to Appendix I, paragraph 9.4.

Regulatory Environment



As it has been surfaced in Deliverable 1, the Greek regulatory environment is a rather complex and non-business-friendly one, ranking 79th amongst 190 economies. This means that companies in Greece face an adverse regulatory system, which can be considered as a critical reason for continuous exodus of capital, labour and entrepreneurship from Greece. Greek businesses, both start-ups and larger ones, face a multitude of regulatory hurdles, restrictions, and red tape.

For that reason, the regulatory environment has to be revamped in order to simplify current complicated regulations in different areas as well as improve or even eliminate time- and cost-intensive procedures that create uncertainty and hinder business activity, and in particular innovation and entrepreneurship.

Overall, changes to the regulatory environment have to include improvements in the areas, product liability and safety, intellectual property, cybersecurity and data protection, free flow of data as Industry 4.0 disrupts the various facets of the current status quo.

The key stakeholders (indicatively but nonexclusively) that will participate in the implementation of the fifth Pillar’s proposed measures and initiatives are presented below:

 **Key stakeholders involved**

- | | |
|-------------------------------------|--|
| 1. Ministry of Justice | 2. Ministry of Digital Governance |
| 3. General Secretariat for Industry | 4. General Secretariat for Research and Technology |
| 5. Industrial Property Organisation | |

For additional details on how this pillar addresses the SWOT analysis observations, please refer to Appendix I, paragraph 9.5.

Acceleration of investment in digital technologies



Pillar 6

The sixth and final Pillar of the Industry 4.0 strategy will focus on the financial incentivisation of Greek enterprises in order to invest and leverage Industry 4.0 technologies and applications.

In that context, tailored financial instruments will be developed, targeted at upgrading and modernising enterprises with regards to Industry 4.0 on multiple areas (i.e. both adoption of new technologies and the upskilling/reskilling of employees). This effort will be pursued in the lines of a “holistic” upgrade of enterprises, and in total coordination with all other actions of the strategy. In addition to horizontal financial incentives for all Greek enterprises, targeted initiatives shall be provided for the Greek SMEs to ensure their rapid digitisation. In addition, select initiatives shall be targeted to specific Industry 4.0 technologies, as per the Greek organisations’ identified needs (i.e. big data analytics, cybersecurity, etc.)

For instance, a set of financial instruments could be developed aimed at specifically helping enterprises adopt new technologies in their business model and processes (i.e. in the form of Grants or “Coupons” as done currently in Portugal, or through low rate loans as it has been implemented across other EU countries). In addition, the pillar shall target on measures and incentives to foster investment in Innovation and applied R&D within the Greek enterprises. These measures could span from R&D tax deductions (as discussed during Workshop 2, the Government is considering increasing tax deductions on ICT investments from 30% to 100% in the near future) to over-depreciation and subsidisation of enterprises that actively invest in R&D. Finally, the pillar could also include funding and incentivization mechanisms to enable enterprises to turn to the circular use of materials and enhance the green economy.

The key stakeholders (indicatively but nonexclusively) that will participate in the implementation of the sixth Pillar’s proposed measures and initiatives are presented below:

 **Key stakeholders involved**

- | | |
|--|------------------------|
| 1. Ministry of Development and Investments | 2. Ministry of Finance |
| 3. Hellenic Development Bank (HDB) | |

For additional details on how this pillar addresses the SWOT analysis observations, please refer to Appendix I, paragraph 9.6.

To summarize, the six execution pillars will address the following areas of focus. Each area of focus shall then be analysed into a set of initiatives within Deliverable 3.

 Greek Industry 4.0: Strategic pillars & high level areas of attention		 Key stakeholders involved
Pillar 1: Digital skills & human capital qualifications		
 <p>Pillar 1</p> <ul style="list-style-type: none"> Upskill and reskill the Industrial workforce Attract and develop the future talent pipeline for the Greek Industry Repatriate Greek human capital and attract international workforce 	<ul style="list-style-type: none"> 1. General Secretariat for Industry 2. Ministry of Education 3. Ministry of Digital Governance 4. General Secretariat for Research and Technology 5. Federation of Enterprises 6. Academia/ Industry stakeholders 	
Pillar 2: Innovation & start-up supporting mechanisms in the Digital Age		
 <p>Pillar 2</p> <ul style="list-style-type: none"> Design of new and/or enhance existing Digital Innovation Hubs (DIHs) and Innovation Districts to ensure the diffusion of expertise and best practices between all the players of the Industrial ecosystem Support the Greek start-up ecosystem and create the right conditions for ambitious entrepreneurs of the Greek Industry through targeted support (funding or tax schemes, networking and mentoring programs, etc.) Enhance the applied R&D and Innovation within the Greek Industry 	<ul style="list-style-type: none"> 1. General Secretariat for Industry 2. General Secretariat for Research and Technology 3. Ministry of Digital Governance 4. Federation of Enterprises 5. Research Institutions/ Academia 	
Pillar 3: Collaborations & synergies		
 <p>Pillar 3</p> <ul style="list-style-type: none"> Enhance the collaboration between large, digitally-advanced enterprises and Greek SMEs and mid-caps to enhance the latter's digital awareness Set up industrial platforms on specific areas of economic activity to enable the creation of ecosystems and achieve the scaleup of the Greek SMEs and mid-caps Promote the internationalization of the Greek enterprises and their participation in EU value chains 	<ul style="list-style-type: none"> 1. General Secretariat for Industry 2. Ministry of Digital Governance 3. Ministry of Infrastructure 4. General Secretariat for Research and Technology 5. Federation of Enterprises 6. Research Institutions/ Academia 	

Pillar 4: Standardisation & Norms



- Set key ICT standardisation priorities, in accordance to the European Commission's ICT Standards plan and communication
- Set up of a task force from the private and public sector to identify needs for ICT standards
- Promote a set of standardised technological applications by the government, incentivising enterprises to adopt and implement a set of technologies to create a uniform Industrial network of companies

1. General Secretariat for Industry
2. Ministry of Digital Governance
3. General Secretariat for Research and Technology
4. Research Institutions/ Academia

Pillar 5: Regulatory Environment



- Update of the regulatory environment towards being more "Industry-friendly" with regards to product liability laws, data protection and free flow of data
- Prioritise the issue of cybersecurity
- Address the subject of intellectual property

1. Ministry of Justice
2. General Secretariat for Industry
3. General Secretariat for Research and Technology
4. Ministry of Digital Governance
5. Industrial Property Organisation

Pillar 6: Acceleration of investment in digital technologies



- Design financial tools targeted at upgrading enterprises on multiple areas (i.e. both adoption of new technologies and the upskilling/reskilling of employees) towards a "holistic" upgrade of enterprises
- Introduce tax adjustments to allow for a more "investment friendly" environment

1. Ministry of Development and Investments
2. Ministry of Finance
3. Hellenic Development Bank (HDB)

Having concluded the analysis of the six execution pillars, it is important to mention that emphasis shall be also given on the enhancement of the key digital foundations that consist prerequisite for the Greek Industry's rotation to Industry 4.0. These foundations include:

- the deployment of nation-wide digital infrastructure (5G)
- the digitisation of the Greek Public Administration and the provision of "digital by default" public services

Although the identification of initiatives for digital infrastructure and digital public services consists part of the National Digital Strategy and will be included in the Bible of Digital Transformation, to be issued by the Greek Ministry of Digital Governance, the Industry 4.0 strategy shall describe at a high level key initiatives regarding the key digital foundations that shall be introduced to enable the Greek Industry's digitisation. The implementation of these digital foundations shall be performed in parallel with the initiatives to be included in the six execution pillars to achieve the highest possible results from implementing the Industry 4.0 strategy.

8.6 Next Steps

Having analysed the strategy's execution pillars, the next step will be to develop and propose initiatives for each one of them, by also addressing the prerequisite key digital foundations for Greek Industry' a task that will be conducted throughout the development of the strategy's operational plan (Deliverable 3), as it can be seen in the graph below:

 **Greek Industry 4.0 Vision**

Execution Pillars

Pillar 1: Digital skills & human capital qualification	<i>Initiatives</i>						
Pillar 2 : Innovation & startups supporting mechanisms in the Digital Age	<i>Initiatives</i>						
Pillar 3: Collaborations & synergies	<i>Initiatives</i>						
Pillar 4: Standardisation & Norms	<i>Initiatives</i>						
Pillar 5: Regulatory environment	<i>Initiatives</i>						
Pillar 6: Acceleration of investment in digital technologies	<i>Initiatives</i>						

Emphasis will be also given to the key digital foundations that consist prerequisite for the Greek Industry’s rotation to Industry 4.0. These foundations include:

- the deployment of nation-wide digital infrastructure (5G)
- the digitisation of the Greek Public Administration and the provision of “digital by default” public services

9 Appendix I – How the Six Execution Pillars address the SWOT analysis

In this Appendix, we have mapped the six execution pillars with the relevant SWOT analysis observations that each pillar leverages for its implementation (mainly this refers to identified strengths and opportunities) or aims at addressing and mitigating (this mainly refers to weaknesses and threats). The SWOT analysis observations can be mapped to more than one execution pillars.

9.1 Pillar 1: Digital skills & human capital qualifications

Actions and initiatives in this execution pillar aim to:

- Upskill and reskill the Industrial workforce
- Attract and develop the future talent pipeline for the Greek Industry
- Repatriate Greek human capital & attract international workforce

SWOT related points	
Strengths	S1. The Greek economy demonstrated signs of recovery until recently; nevertheless, moving forward the coronavirus may severely affect the Greek economy
	S2. The Greek industry plays an important role in the Greek economy, generating more than 24% of its Gross Value Added (for 2018)
	S3. Increased interest and focus are placed on digital and Industry 4.0 from the higher levels of the Greek Government and industry federations, as well as from the European Commission
	S4. Greek surveyed executives recognize the significance of Industry 4.0 for their enterprises and primarily aim to implement Industry 4.0 technologies to increase their internal efficiencies and productivity
	S12. Greece demonstrates a technically adept human capital, with an overall high number of tertiary graduates, an adequate number of ICT and STEM graduates & a high diaspora around the world
	S13. The Greek Government has already undertaken some key initiatives for the digital upskilling and reskilling of the Greek human capital
Weaknesses	W3. The Greek Manufacturing is fragmented, with a very high number of enterprises (more than 90%) having a very small number of employees (less than 10)
	W5. The Greek enterprises lag across the adoption of Industry 4.0 and digital technologies and applications

SWOT related points	
	W13. Greece has performed limited investments in the digital upskilling and reskilling of its industrial workforce and does not have in place a structured mechanism to measure the effectiveness of the undertaken digital skills initiatives
	W14. Greek surveyed executives verify the limited digital skills currently existing in the Greek market. This challenge appears even greater for the very small and small enterprises that we surveyed.
	W15. The most highly sourced digital skills in the future appear to be around Artificial Intelligence, Cloud, Big Data Analytics and Cybersecurity
Opportunities	O2. The European Industrial Strategy can significantly benefit Greece’s rotation towards Industry 4.0
	O5. The massive explosion of digital data at a global scale introduces a set of favourable conditions that can further boost Greece’s big data & analytics national strengths
	O6. Artificial intelligence is changing the current status quo and can significantly benefit the Greek economy
	O7. 5G and the “IoT-isation” economy can become game changers for “unlocking” innovation and growth for the Greek economy
Threats	T2. The COVID-19 Pandemic may severely impact the global and the Greek economy
	T4. Techno-centricity of industrial production may disrupt the Greek labour market
	T5. Industry 4.0 poses new, wider and deeper cybersecurity threats for the Greek Industry
	T6. EU counterparts’ rapidly progress with regards to their digitisation both at a national and at an industry level, continuously increase their digital “rift” with Greece and makes Greece’s digitisation a necessity rather than a wishful thinking
	T8. EU countries progress with regards to the digital upskilling and reskilling of their human capital, leaves Greece behind in terms of its digital human capital

9.2 Pillar 2: Innovation & start-ups in the Digital Age

Actions and initiatives in this execution pillar aim to:

- Design of new and/or enhance existing Digital Innovation Hubs (DIHs) and Innovation Districts to ensure the diffusion of expertise and best practices between all the players of the Industrial ecosystem
- Support the Greek start-up ecosystem and create the right conditions for ambitious entrepreneurs of the Greek Industry through targeted support (funding or tax schemes, networking and mentoring programs, etc.)
- Enhance the applied R&D and Innovation within the Greek Industry

SWOT related points	
Strengths	S1. The Greek economy demonstrated signs of recovery until recently; nevertheless, moving forward the coronavirus may severely affect the Greek economy
	S2. The Greek industry plays an important role in the Greek economy, generating more than 24% of its Gross Value Added (for 2018)
	S3. Increased interest and focus are placed on digital and Industry 4.0 from the higher levels of the Greek Government and industry federations, as well as from the European Commission
	S5. Greek executives appear to have initiated their Industry 4.0 transformation, starting mainly from the digitisation of their organisations’ support functions, their Marketing & Sales and their production divisions. Moving forward, the majority of them plan to dedicate additional funding on the digitisation of their production and product development divisions
	S6. Greek enterprises claim to have initiated a close collaboration with their clients and suppliers to co-create customized products & services. Small and very small enterprises appear to lead the way in product co-creation
	S7. Greek enterprises appear to already invest in specific Industry 4.0 technologies, i.e. cloud, cybersecurity, big data analytics, SCADA and MES systems. In the future, they aim to continue investing in Cloud, Cybersecurity and big data analytics, while they also aim at actively experimenting with IIoT, industrial robots and AI
	S8. Greek enterprises place specific emphasis on big data analytics and actively exploit its potential
	S9. Greece is home to a burgeoning start-up & Digital Innovation Hubs scene
	S10. Both the European Commission and the Greek Government actively support the innovation in the Greek Industry through the provision of targeted funding schemes

SWOT related points	
	S11. The Greek Government has already undertaken a set of measures to transform Greece’s regulatory environment through the introduction of a set of directives on digital technologies and a set of laws (i.e. 4622/2019 and 4635/2019) for the simplification and reorganisation of Greece’s public administration and for boosting and assisting the Greek business environment
Weaknesses	W4. Greece lacks a holistic national Industry 4.0 strategy and a structured mechanism to coordinate Industry 4.0 programmes and initiatives
	W5. The Greek enterprises lag across the adoption of Industry 4.0 and digital technologies and applications
	W9. Greece ranks low in terms of innovation and R&D, both with regards to their R&D intensity and with regards to the overall number of the issued Greek patents
	W10. R&D appears disassociated with applied research & industry implementation, as contrary to the EU average, where the business sector appears highly involved in R&D, the Greek R&D is mainly dominated by the higher education sector, while Greek organisations appear reluctant to invest in applied R&D
	W16. Greece is Europe’s lowest ranking country, with regards to the average circular use of materials
Opportunities	O1. Global changes in the distribution and nodes of power enable Greece to become part of wider global ecosystems
	O2. The European Industrial Strategy can significantly benefit Greece’s rotation towards Industry 4.0
	O3. The “smartification” of products can enable Greek enterprises to produce products & services of higher added value and to become more competitive
	O4. The emergence of new business models can support Greek enterprises in tapping new sources of value creation
	O5. The massive explosion of digital data at a global scale introduces a set of favourable conditions that can further boost Greece’s big data & analytics national strengths
	O6. Artificial intelligence is changing the current status quo and can significantly benefit the Greek economy
	O7. 5G and the “IoT-isation” economy can become game changers for “unlocking” innovation and growth for the Greek economy
	O8. Industry 4.0 can significantly benefit Greece in increasing its economy’s circularity
Threats	T2. The COVID-19 Pandemic may severely impact the global and the Greek economy
	T3. Industry 4.0 disrupts the traditional linear value chains & redefine the Greek industries
	T5. Industry 4.0 poses new, wider and deeper cybersecurity threats for the Greek Industry

SWOT related points

T7. EU counterparts' progress regarding targeted measures to support and enhance digital innovation and R&D, indicates that Greece's R&D capabilities are threatened to curbe, if the country does not timely undertake similar initiatives

T9. Climate Change and Global Warming significantly affects the Greek environment and necessitates the use of Industry 4.0 technologies across the Greek Industry

9.3 Pillar 3: Collaborations & synergies

Actions and initiatives in this execution pillar aim to:

- Enhance the collaboration between large, digitally advanced enterprises and Greek SMEs and mid-caps to enhance the latter’s digital awareness
- Set up industrial platforms on specific areas of economic activity to enable the creation of ecosystems and achieve the scaleup of the Greek SMEs and mid-caps
- Promote the internationalization of the Greek enterprises and their participation in EU value chains

SWOT related points	
Strengths	S1. The Greek economy demonstrated signs of recovery until recently; nevertheless, moving forward the coronavirus may severely affect the Greek economy
	S2. The Greek industry plays an important role in the Greek economy, generating more than 24% of its Gross Value Added (for 2018)
	S3. Increased interest and focus are placed on digital and Industry 4.0 from the higher levels of the Greek Government and industry federations, as well as from the European Commission
	S4. Greek surveyed executives recognize the significance of Industry 4.0 for their enterprises and primarily aim to implement Industry 4.0 technologies to increase their internal efficiencies and productivity
	S6. Greek enterprises claim to have initiated a close collaboration with their clients and suppliers to co-create customized products & services. Small and very small enterprises appear to lead the way in product co-creation
	S8. Greek enterprises place specific emphasis on big data analytics and actively exploit its potential
Weaknesses	W3. The Greek Manufacturing is fragmented, with a very high number of enterprises (more than 90%) having a very small number of employees (less than 10)
	W7. The surveyed Greek enterprises have initiated their Industry 4.0 rotation, albeit they are still at the beginning of their transformation journey. In fact, an alarmingly high percentage of them (especially across the very small enterprises, the national enterprises and those with less than 10 years of operation) have not invested yet in any Industry 4.0 technology
	W8. Despite their recent revamping of their production IT landscape, the surveyed enterprises demonstrate a low level of digitisation across their production lines. Out of these, the very small and small enterprises, the national ones and those with less than 20 years of operation appear to be the worst positioned.

SWOT related points	
	W14. Greek surveyed executives verify the limited digital skills currently existing in the Greek market. This challenge appears even greater for the very small and small enterprises that we surveyed.
	W15. The most highly sourced digital skills in the future appear to be around Artificial Intelligence, Cloud, Big Data Analytics and Cybersecurity
Opportunities	O1. Global changes in the distribution and nodes of power enable Greece to become part of wider global ecosystems
	O2. The European Industrial Strategy can significantly benefit Greece’s rotation towards Industry 4.0
	O3. The “smartification” of products can enable Greek enterprises to produce products & services of higher added value and to become more competitive
	O4. The emergence of new business models can support Greek enterprises in tapping new sources of value creation
	O5. The massive explosion of digital data at a global scale introduces a set of favourable conditions that can further boost Greece’s big data & analytics national strengths
	O6. Artificial intelligence is changing the current status quo and can significantly benefit the Greek economy
	O7. 5G and the “IoT-isation” economy can become game changers for “unlocking” innovation and growth for the Greek economy
	O8. Industry 4.0 can significantly benefit Greece in increasing its economy’s circularity
Threats	T1. The rise of economic nationalism and the shaking up of Global Trade may prohibit Greece’s cooperation with other countries in the Industry 4.0 field
	T2. The COVID-19 Pandemic may severely impact the global and the Greek economy
	T3. Industry 4.0 disrupts the traditional linear value chains & redefine the Greek industries
	T6. EU counterparts’ rapidly progress with regards to their digitisation both at a national and at an industry level, continuously increase their digital “rift” with Greece and makes Greece’s digitisation a necessity rather than a wishful thinking
	T8. EU countries progress with regards to the digital upskilling and reskilling of their human capital, leaves Greece behind in terms of its digital human capital

9.4 Pillar 4: Standardisation & Norms

Actions and initiatives in this execution pillar aim to:

- Set key ICT standardisation priorities, in accordance to the European Commission’s ICT Standards plan and communication
- Set up of a task force from the private and public sector to identify needs for ICT standards
- Promote a set of standardised technological applications by the government, incentivising enterprises to adopt and implement a set of technologies to create a uniform Industrial network of companies

SWOT related points	
Strengths	S2. The Greek industry plays an important role in the Greek economy, generating more than 24% of its Gross Value Added (for 2018)
	S3. Increased interest and focus are placed on digital and Industry 4.0 from the higher levels of the Greek Government and industry federations, as well as from the European Commission
	S4. Greek surveyed executives recognize the significance of Industry 4.0 for their enterprises and primarily aim to implement Industry 4.0 technologies to increase their internal efficiencies and productivity
	S8. Greek enterprises place specific emphasis on big data analytics and actively exploit its potential
	S10. Both the European Commission and the Greek Government actively support the innovation in the Greek Industry through the provision of targeted funding schemes
	S11. The Greek Government has already undertaken a set of measures to transform Greece’s regulatory environment through the introduction of a set of directives on digital technologies and a set of laws (i.e. 4622/2019 and 4635/2019) for the simplification and reorganisation of Greece’s public administration and for boosting and assisting the Greek business environment
Weaknesses	W7. The surveyed Greek enterprises have initiated their Industry 4.0 rotation, albeit they are still at the beginning of their transformation journey. In fact, an alarmingly high percentage of them (especially across the very small enterprises, the national enterprises and those with less than 10 years of operation) have not invested yet in any Industry 4.0 technology
	W8. Despite their recent revamping of their production IT landscape, the surveyed enterprises demonstrate a low level of digitisation across their production lines. Out of these, the very small and small enterprises, the national ones and those with less than 20 years of operation appear to be the worst positioned.
	W11. Greek enterprises face structural and regulatory obstacles during their setup and operations, with areas of “dealing with construction permits”, “registering property”, “getting credit” and “enforcing contracts” scoring particularly low across the annual report on the ease of “Doing Business” for 2020
Opportunities	O1. Global changes in the distribution and nodes of power enable Greece to become part of wider global ecosystems

SWOT related points	
	O2. The European Industrial Strategy can significantly benefit Greece’s rotation towards Industry 4.0
	O3. The “smartification” of products can enable Greek enterprises to produce products & services of higher added value and to become more competitive
	O5. The massive explosion of digital data at a global scale introduces a set of favourable conditions that can further boost Greece’s big data & analytics national strengths
	O6. Artificial intelligence is changing the current status quo and can significantly benefit the Greek economy
	O7. 5G and the “IoT-isation” economy can become game changers for “unlocking” innovation and growth for the Greek economy
Threats	T3. Industry 4.0 disrupts the traditional linear value chains & redefine the Greek industries
	T7. EU counterparts’ progress regarding targeted measures to support and enhance digital innovation and R&D, indicates that Greece’s R&D capabilities are threatened to curb, if the country does not timely undertake similar initiatives

9.5 Pillar 5: Regulatory Environment

Actions and initiatives in this execution pillar aim to:

- Update of the regulatory environment towards being more “Industry-friendly” with regards to product liability laws, data protection and free flow of data
- Prioritise the issue of cybersecurity
- Address the subject of intellectual property

SWOT related points	
Strengths	S2. The Greek industry plays an important role in the Greek economy, generating more than 24% of its Gross Value Added (for 2018)
	S3. Increased interest and focus are placed on digital and Industry 4.0 from the higher levels of the Greek Government and industry federations, as well as from the European Commission
	S4. Greek surveyed executives recognize the significance of Industry 4.0 for their enterprises and primarily aim to implement Industry 4.0 technologies to increase their internal efficiencies and productivity
	S7. Greek enterprises appear to already invest in specific Industry 4.0 technologies, i.e. cloud, cybersecurity, big data analytics, SCADA and MES systems. In the future, they aim to continue investing in Cloud, Cybersecurity and big data analytics, while they also aim at actively experimenting with IIoT, industrial robots and AI
	S8. Greek enterprises place specific emphasis on big data analytics and actively exploit its potential
	S11. The Greek Government has already undertaken a set of measures to transform Greece’s regulatory environment through the introduction of a set of directives on digital technologies and a set of laws (i.e. 4622/2019 and 4635/2019) for the simplification and reorganisation of Greece’s public administration and for boosting and assisting the Greek business environment
Weaknesses	W4. Greece lacks a holistic national Industry 4.0 strategy and a structured mechanism to coordinate Industry 4.0 programmes and initiatives
	W6. Greece’s suboptimal position with regards to its digital infrastructure and the provision of digital public services, prevent the Greek enterprises from rapidly adopting new Industry 4.0 technologies and supporting their technology needs
	W11. Greek enterprises face structural and regulatory obstacles during their setup and operations, with areas of “dealing with construction permits”, “registering property”, “getting credit” and “enforcing contracts” scoring particularly low across the annual report on the ease of “Doing Business” for 2020
	W12. The surveyed Greek executives place the provision of Industry 4.0 related tax incentives and the development of a flexible, digital-friendly regulatory framework as top incentives that could accelerate their organisations’ digital transformation

SWOT related points	
Opportunities	O1. Global changes in the distribution and nodes of power enable Greece to become part of wider global ecosystems
	O2. The European Industrial Strategy can significantly benefit Greece’s rotation towards Industry 4.0
	O4. The emergence of new business models can support Greek enterprises in tapping new sources of value creation
	O5. The massive explosion of digital data at a global scale introduces a set of favourable conditions that can further boost Greece’s big data & analytics national strengths
Threats	T1. The rise of economic nationalism and the shaking up of Global Trade may prohibit Greece’s cooperation with other countries in the Industry 4.0 field
	T2. The COVID-19 Pandemic may severely impact the global and the Greek economy
	T3. Industry 4.0 disrupts the traditional linear value chains & redefine the Greek industries
	T4. Techno-centricity of industrial production may disrupt the Greek labour market
	T5. Industry 4.0 poses new, wider and deeper cybersecurity threats for the Greek Industry
	T6. EU counterparts’ rapidly progress with regards to their digitisation both at a national and at an industry level, continuously increase their digital “rift” with Greece and makes Greece’s digitisation a necessity rather than a wishful thinking

9.6 Pillar 6: Acceleration of investment in digital technologies

Actions and initiatives in this execution pillar aim to:

- Design financial tools targeted at upgrading enterprises on multiple areas (i.e. both adoption of new technologies and the upskilling/reskilling of employees) towards a “holistic” upgrade of enterprises
- Introduce tax adjustments to allow for a more “investment friendly” environment

SWOT related points	
Strengths	S1. The Greek economy demonstrated signs of recovery until recently; nevertheless, moving forward the coronavirus may severely affect the Greek economy
	S2. The Greek industry plays an important role in the Greek economy, generating more than 24% of its Gross Value Added (for 2018)
	S3. Increased interest and focus are placed on digital and Industry 4.0 from the higher levels of the Greek Government and industry federations, as well as from the European Commission
	S4. Greek surveyed executives recognize the significance of Industry 4.0 for their enterprises and primarily aim to implement Industry 4.0 technologies to increase their internal efficiencies and productivity
	S5. Greek executives appear to have initiated their Industry 4.0 transformation, starting mainly from the digitisation of their organisations’ support functions, their Marketing & Sales and their production divisions. Moving forward, the majority of them plan to dedicate additional funding on the digitisation of their production and product development divisions
	S7. Greek enterprises appear to already invest in specific Industry 4.0 technologies, i.e. cloud, cybersecurity, big data analytics, SCADA and MES systems. In the future, they aim to continue investing in Cloud, Cybersecurity and big data analytics, while they also aim at actively experimenting with IIoT, industrial robots and AI
	S8. Greek enterprises place specific emphasis on big data analytics and actively exploit its potential
	S10. Both the European Commission and the Greek Government actively support the innovation in the Greek Industry through the provision of targeted funding schemes
	S11. The Greek Government has already undertaken a set of measures to transform Greece’s regulatory environment through the introduction of a set of directives on digital technologies and a set of laws (i.e. 4622/2019 and 4635/2019) for the simplification and reorganisation of Greece’s public administration and for boosting and assisting the Greek business environment
	S13. The Greek Government has already undertaken some key initiatives for the digital upskilling and reskilling of the Greek human capital

SWOT related points	
Weaknesses	W1. The significant hit in fixed capital investments during the last years decelerated investments in Industry 4.0 technologies and applications
	W2. Money supply in the Greek economy has undergone major shocks, preventing enterprises from investing in Industry 4.0 technologies
	W3. The Greek Manufacturing is fragmented, with a very high number of enterprises (more than 90%) having a very small number of employees (less than 10)
	W5. The Greek enterprises lag across the adoption of Industry 4.0 and digital technologies and applications
	W7. The surveyed Greek enterprises have initiated their Industry 4.0 rotation, albeit they are still at the beginning of their transformation journey. In fact, an alarmingly high percentage of them (especially across the very small enterprises, the national enterprises and those with less than 10 years of operation) have not invested yet in any Industry 4.0 technology
	W12. The surveyed Greek executives place the provision of Industry 4.0 related tax incentives and the development of a flexible, digital-friendly regulatory framework as top incentives that could accelerate their organisations’ digital transformation
	W13. Greece has performed limited investments in the digital upskilling and reskilling of its industrial workforce and does not have in place a structured mechanism to measure the effectiveness of the undertaken digital skills initiatives
	W14. Greek surveyed executives verify the limited digital skills currently existing in the Greek market. This challenge appears even greater for the very small and small enterprises that we surveyed.
Opportunities	O1. Global changes in the distribution and nodes of power enable Greece to become part of wider global ecosystems
	O2. The European Industrial Strategy can significantly benefit Greece’s rotation towards Industry 4.0
	O4. The emergence of new business models can support Greek enterprises in tapping new sources of value creation
	O6. Artificial intelligence is changing the current status quo and can significantly benefit the Greek economy
	O7. 5G and the “IoT-isation” economy can become game changers for “unlocking” innovation and growth for the Greek economy
Threats	T1. The rise of economic nationalism and the shaking up of Global Trade may prohibit Greece’s cooperation with other countries in the Industry 4.0 field
	T2. The COVID-19 Pandemic may severely impact the global and the Greek economy
	T4. Techno-centricity of industrial production may disrupt the Greek labour market

SWOT related points	
	T6. EU counterparts' rapidly progress with regards to their digitisation both at a national and at an industry level, continuously increase their digital "rift" with Greece and makes Greece's digitisation a necessity rather than a wishful thinking
	T7. EU counterparts' progress regarding targeted measures to support and enhance digital innovation and R&D, indicates that Greece's R&D capabilities are threatened to curb, if the country does not timely undertake similar initiatives
	T8. EU countries progress with regards to the digital upskilling and reskilling of their human capital, leaves Greece behind in terms of its digital human capital
	T9. Climate Change and Global Warming significantly affects the Greek environment and necessitates the use of Industry 4.0 technologies across the Greek Industry

10 Appendix I – Reader Friendly Graphs

10.1 Strengths

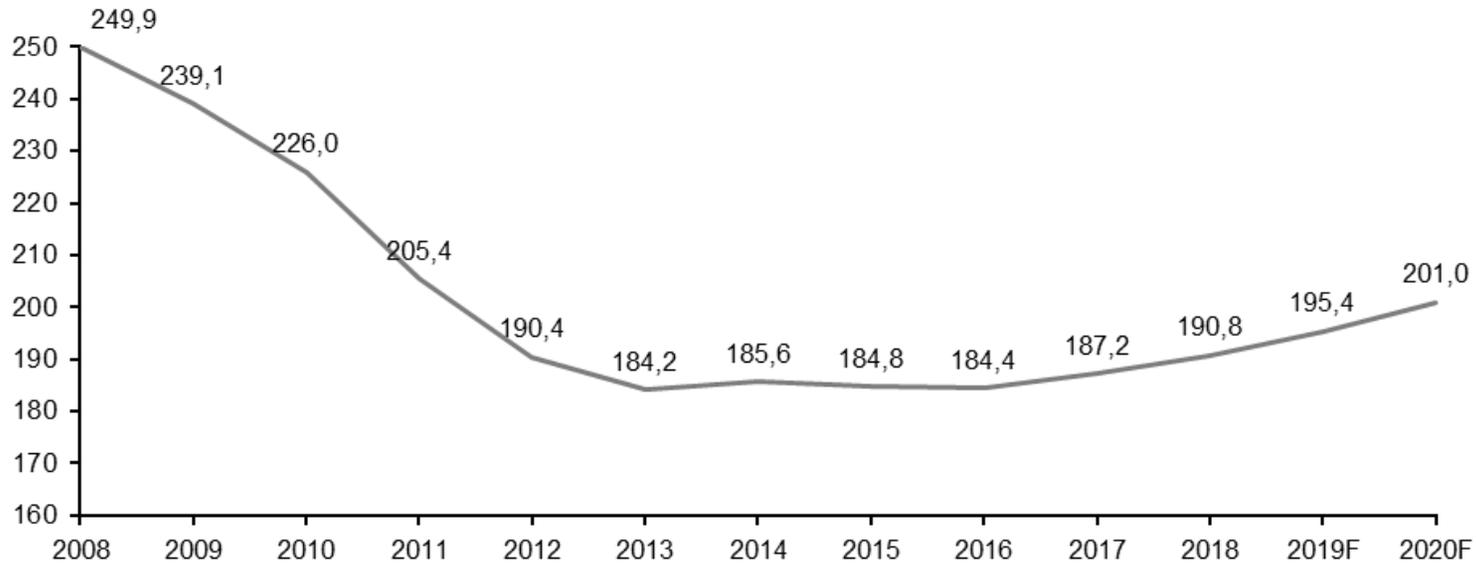


Figure 57: Greek GDP at Fixed 2010 prices (in billion €) - Source: Eurostat, Stochasis Macroeconomic Trends -Sectoral Forecasts, December 2019. Forecasts have been provided by Stochasis

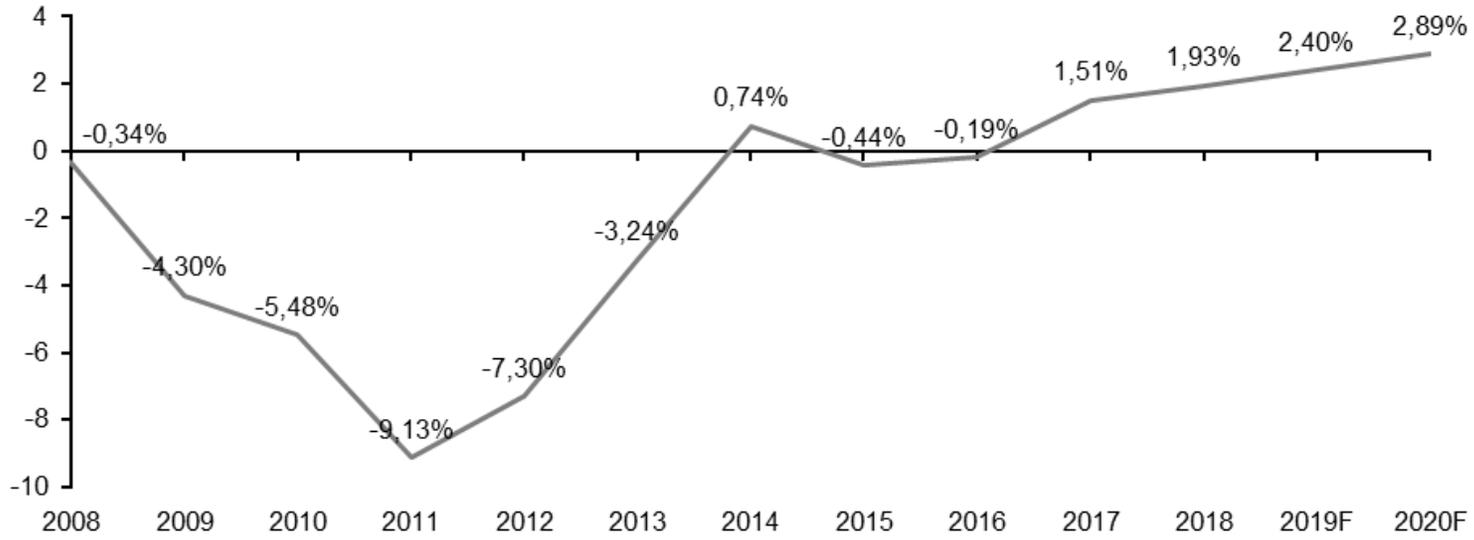


Figure 58: YoY % GDP Change, 2008 - 2020F (%) - Source: Eurostat, Stochasis Macroeconomic Trends -Sectoral Forecasts, December 2019. Forecasts have been provided by Stochasis

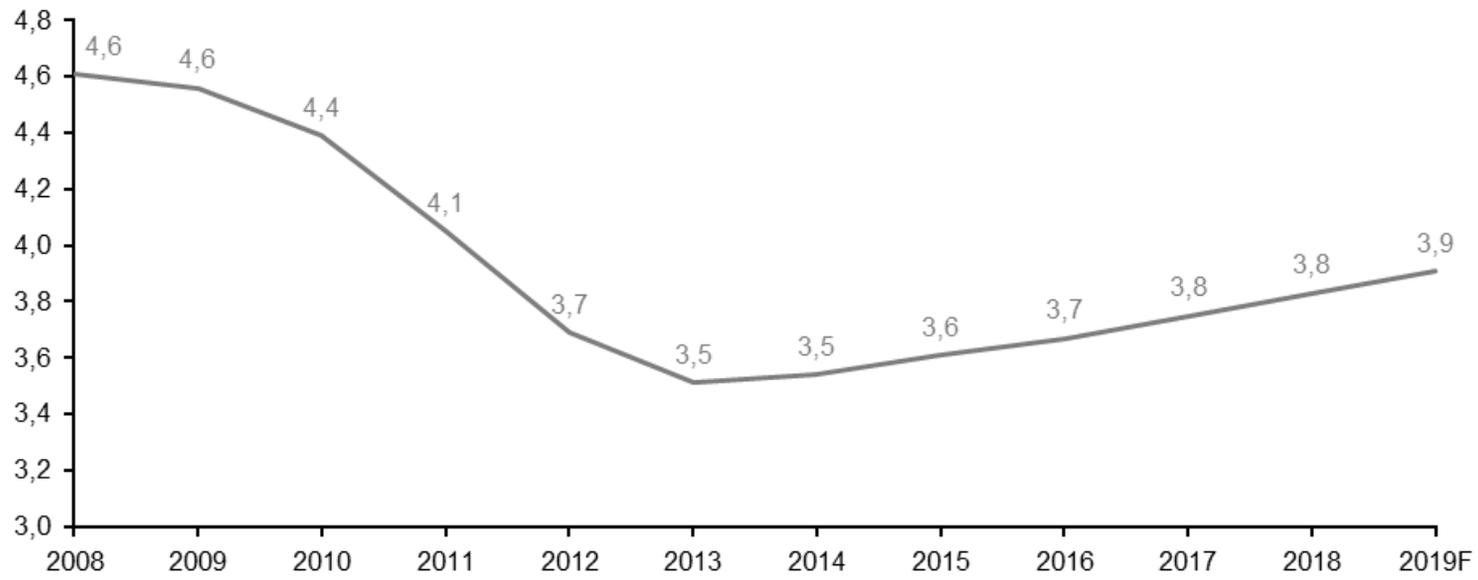


Figure 59: Greek employment 2008 - 2019F (in millions) – Source: Eurostat/ Hellenic Statistical Authority. Until 2018, Forecast from Stochasis report: Stochasis Macroeconomic Trends - Sectoral Forecasts, December 2019

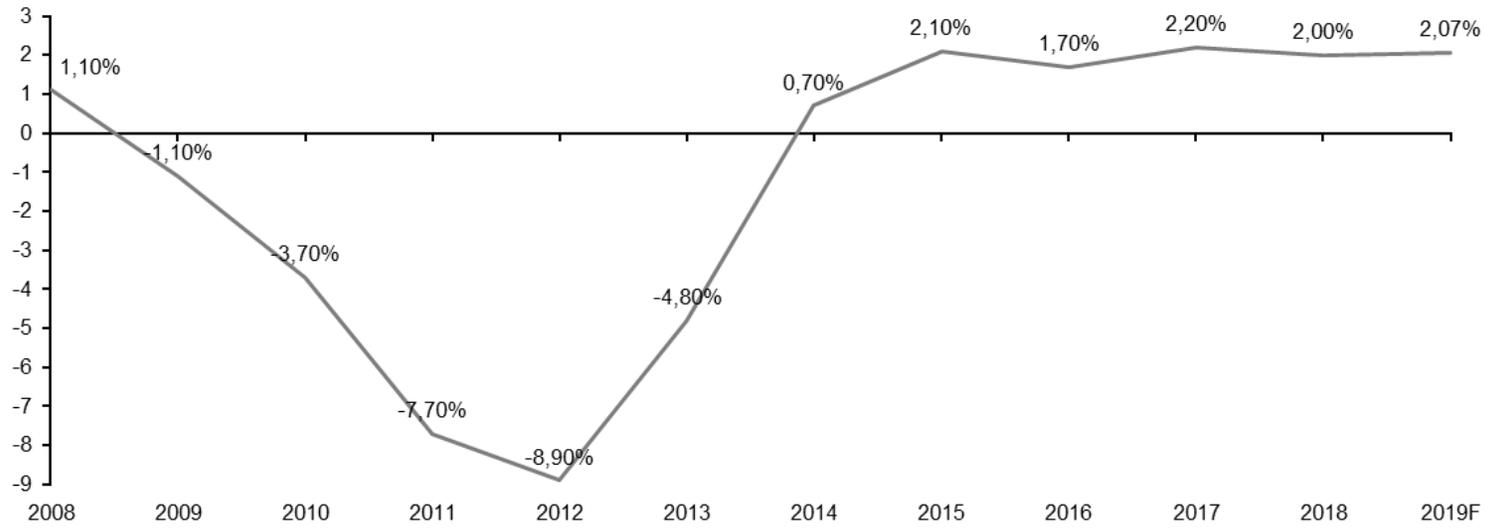


Figure 60: YoY % Employment Change, 2008 - 2019F (%) – Source: Eurostat/ Hellenic Statistical Authority. Until 2018, Forecast from Stochasis report: Stochasis Macroeconomic Trends - Sectoral Forecasts, December 2019

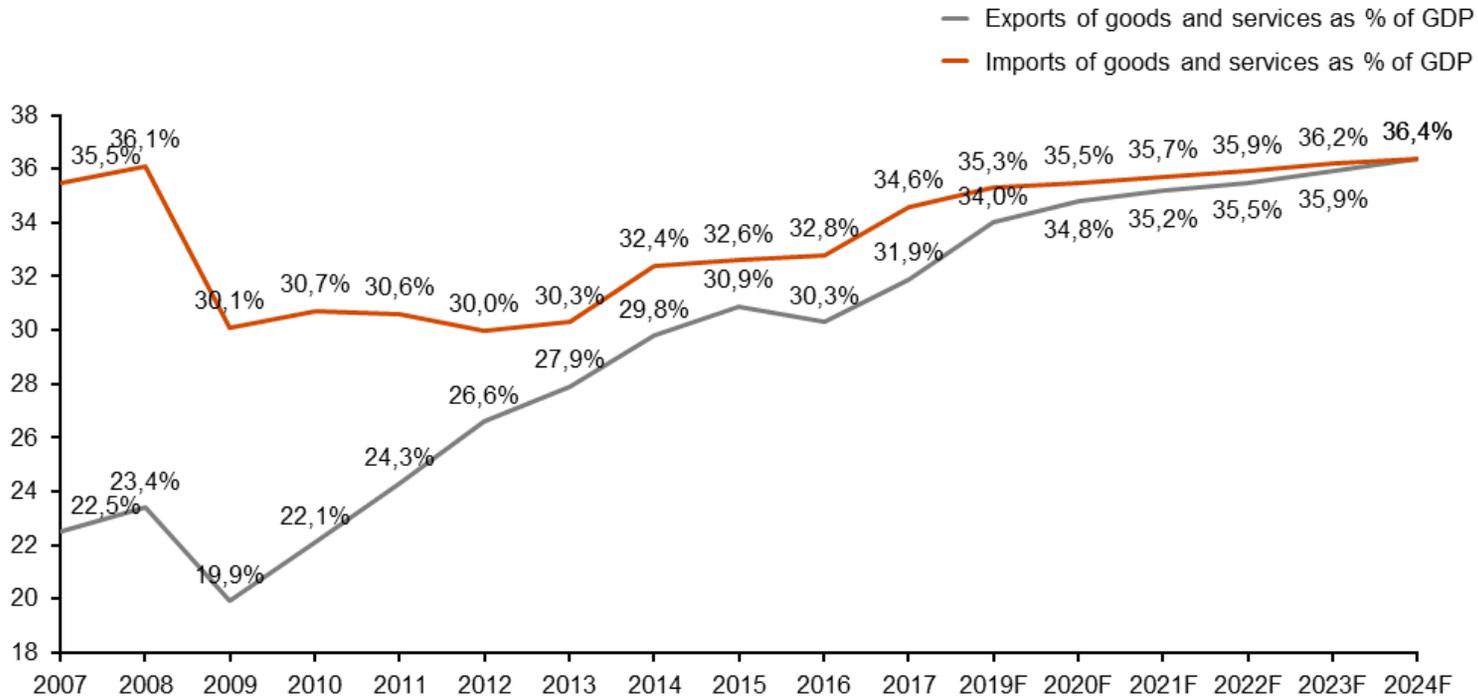


Figure 61: Imports and exports of goods and services as a percentage of GDP (in fixed 2010 prices) – Source: Eurostat/ Hellenic Statistical Authority. Until 2018, Forecast from Stochasis report: Stochasis Macroeconomic Trends - Sectoral Forecasts, December 2019

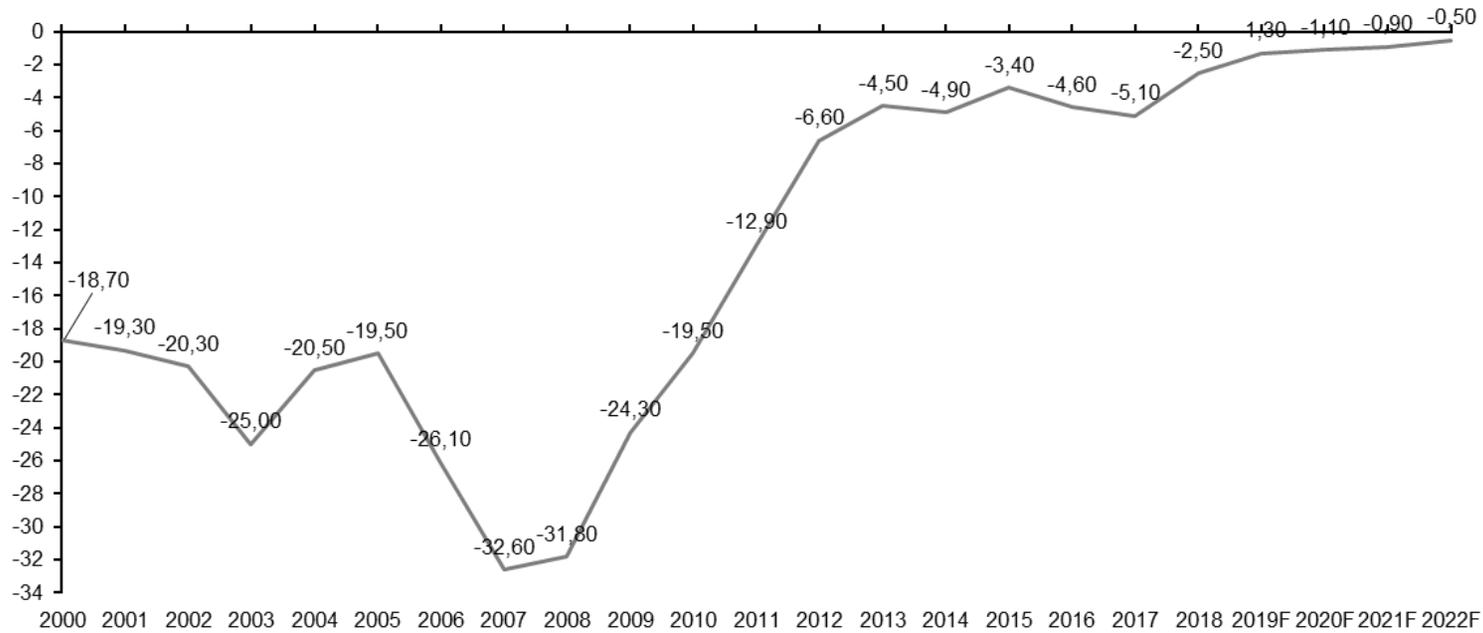


Figure 62: External Balance of Goods and Services in fixed 2010 prices (in billion Euros) – Source: Eurostat/ Hellenic Statistical Authority, Until 2018, Forecast from Stochasis report: Stochasis Macroeconomic Trends - Sectoral Forecasts, December 2019

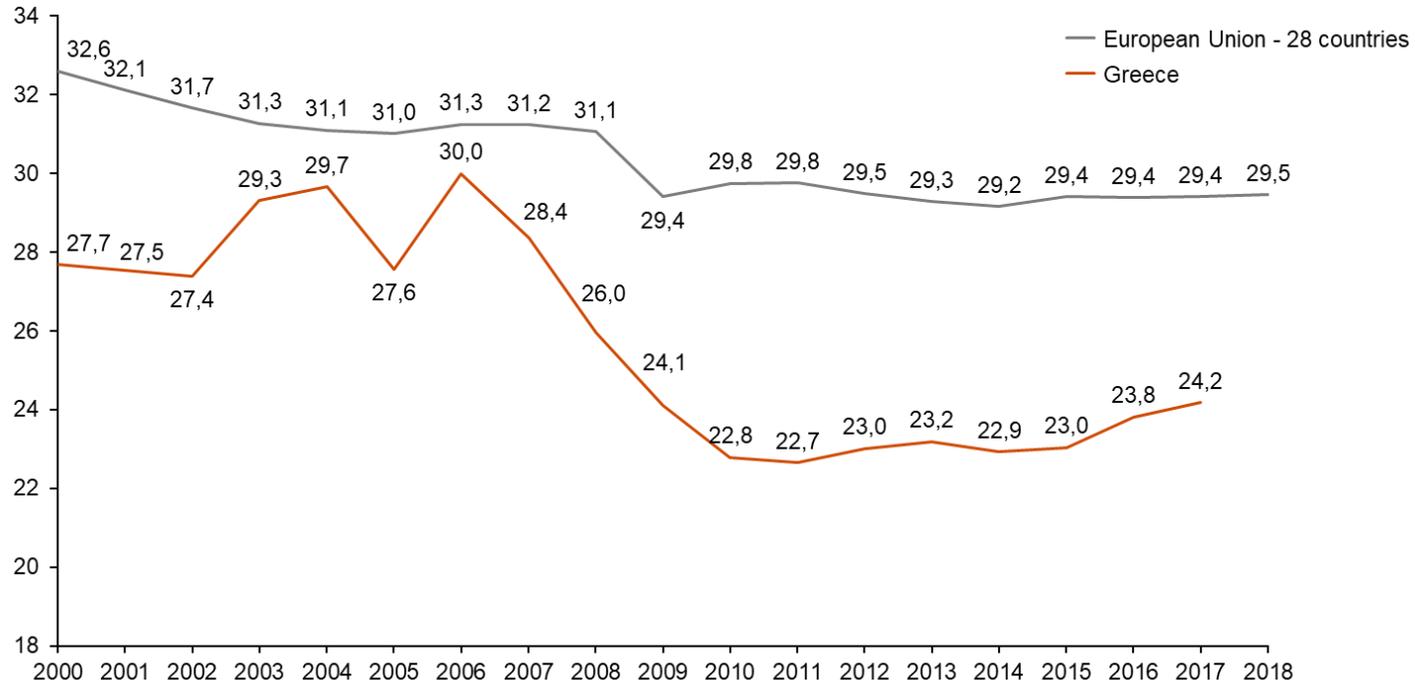


Figure 63: EU & Greek Industry Gross Value Added as % of total EU & Greece's Gross Value Added (%) – Source: Eurostat, National accounts aggregates by industry (up to NACE A*64)

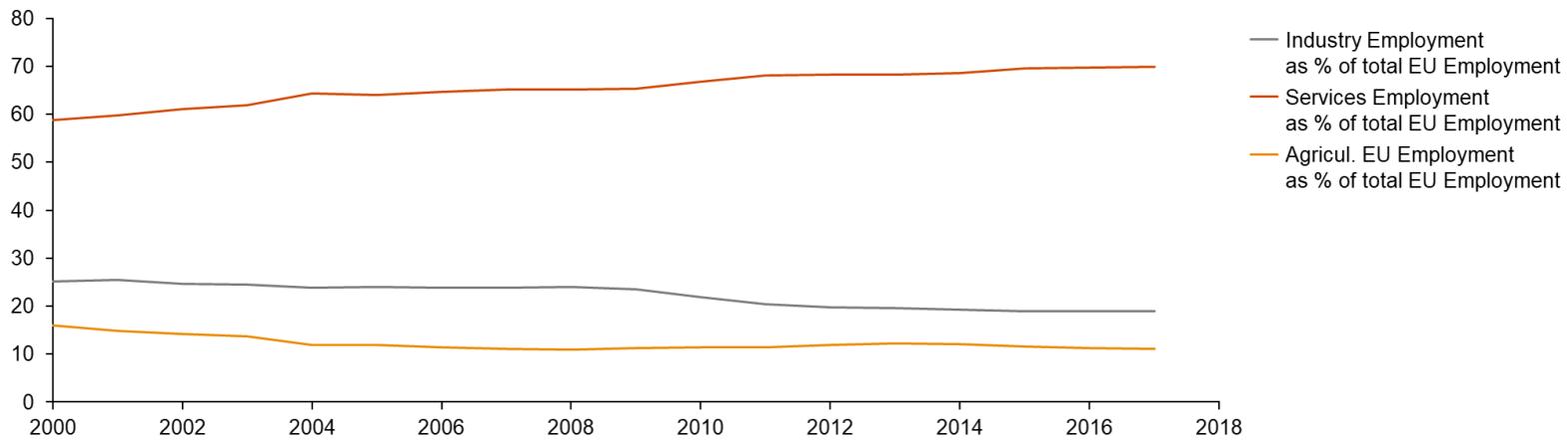


Figure 64: Greece's Industry, Services & Agriculture Employment as % of total Greece's Employment (%) – Source: Eurostat, National accounts employment data by industry (up to NACE A*64)

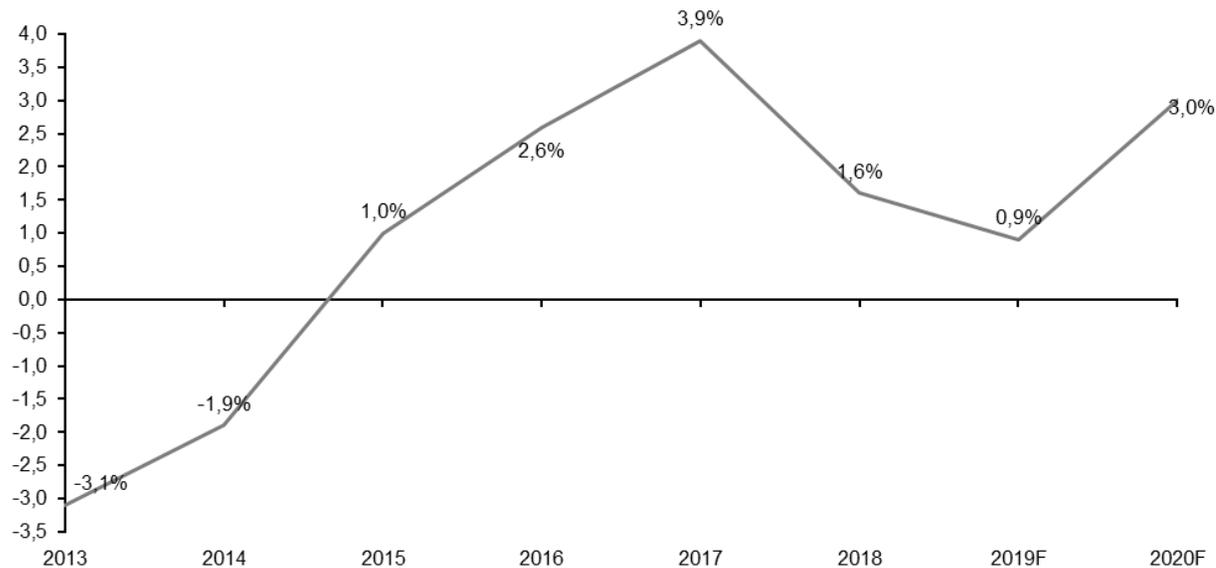


Figure 65: YoY change (%) of Greece's industrial production index, 2013 – 2020F (2015=100) - Source: Eurostat, Production in industry - annual data / Stochasis Macroeconomic Trends -Sectoral Forecasts, December 2019. Forecasts have been provided by Stochasis

Q Industry 4.0 will disrupt your industry over the next 5 years

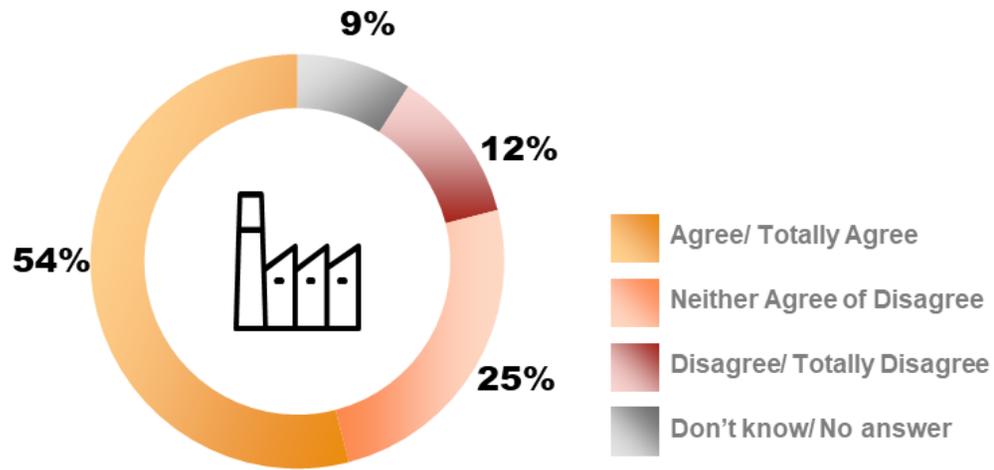


Figure 66: Greek executives' level of agreement regarding the disruption of their industry due to Industry 4.0, (%) - Source: Industry 4.0 Survey

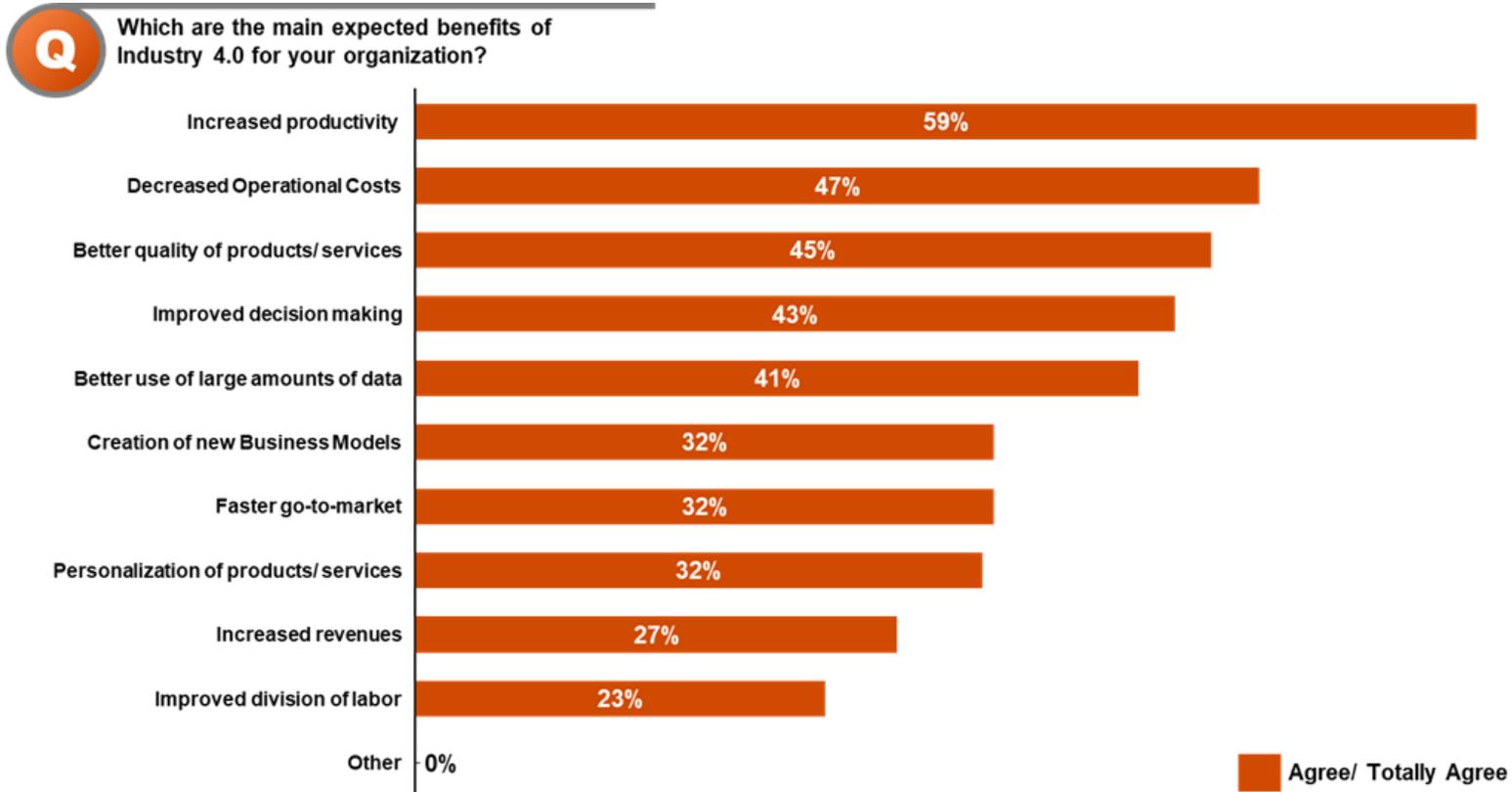


Figure 67: Greek executives' level of agreement regarding the benefits that Industry 4.0 will bring to their organisations, (%) – Source: Industry 4.0 survey

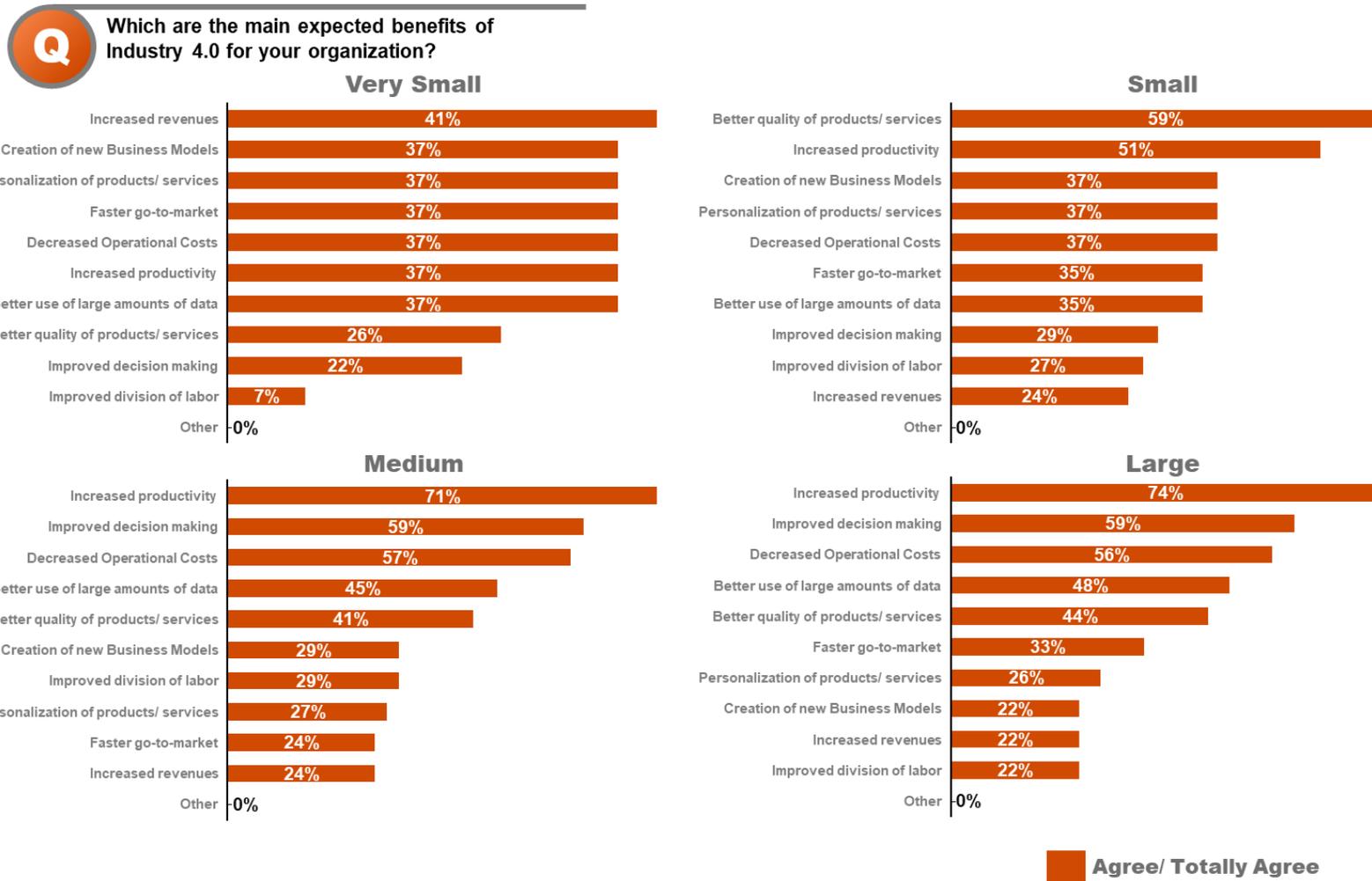
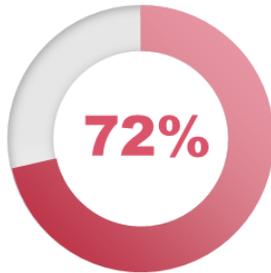


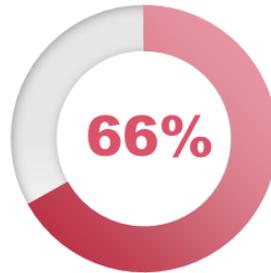
Figure 68: Greek executives' level of agreement regarding the benefits that Industry 4.0 will bring to their organisations, by Size, (%) – Source: Industry 4.0 survey

Q Which is the level of digitization for the following functions in your organization?

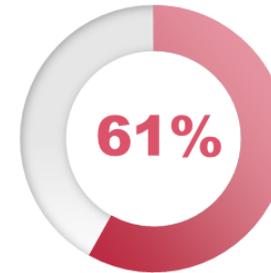
Support Functions
(e.g. Finance, HR, IT, etc.)



Marketing & Sales



Production



Warehouse & Logistics



After Sales Support



Product Development



■ High/ Very High/ Extremely High

Figure 69: Greek executives' perception with regards to the level of digitisation of their organisation's functions, (%) - Source: Industry 4.0 Survey

Q Which business functions require a greater percentage of funding, in order to become further digitized in your organization?

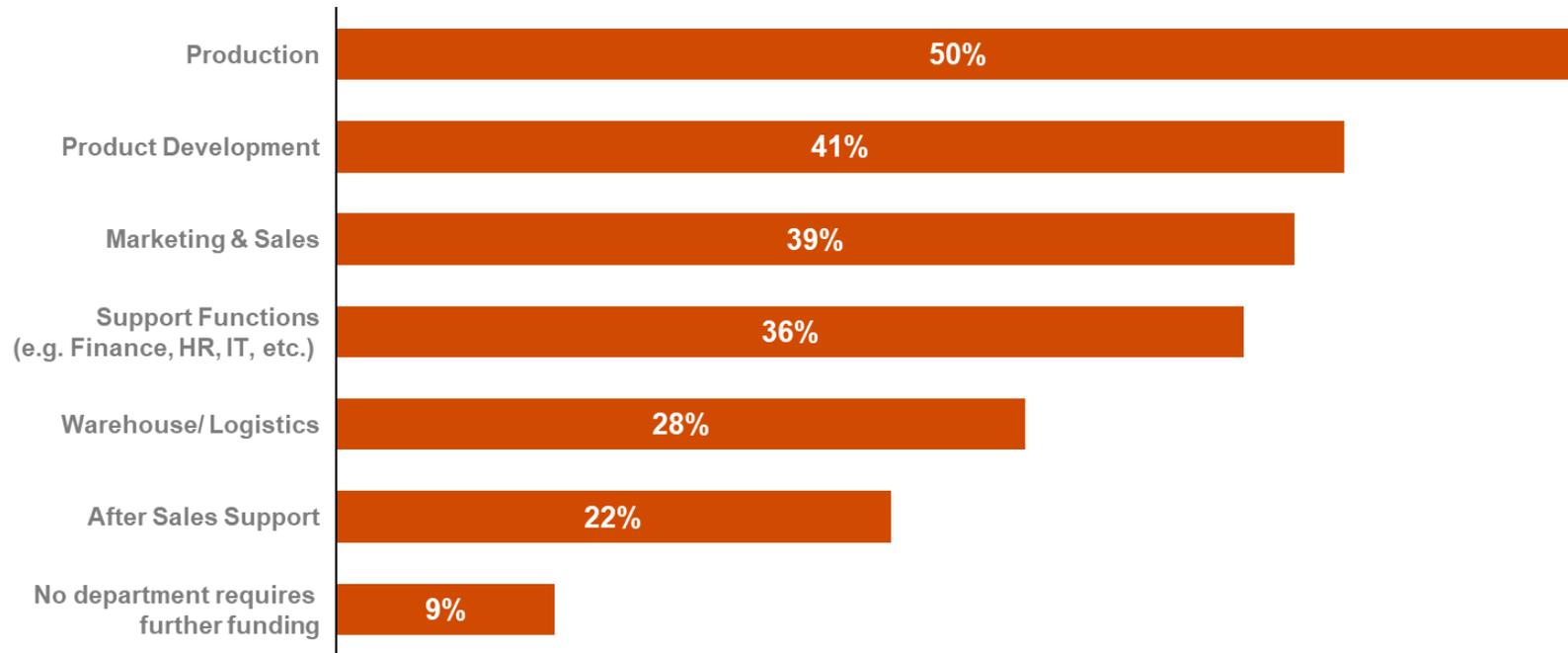


Figure 70: Funding required for further digitisation across different business functions of organisations, (%) – Source: Industry 4.0 survey

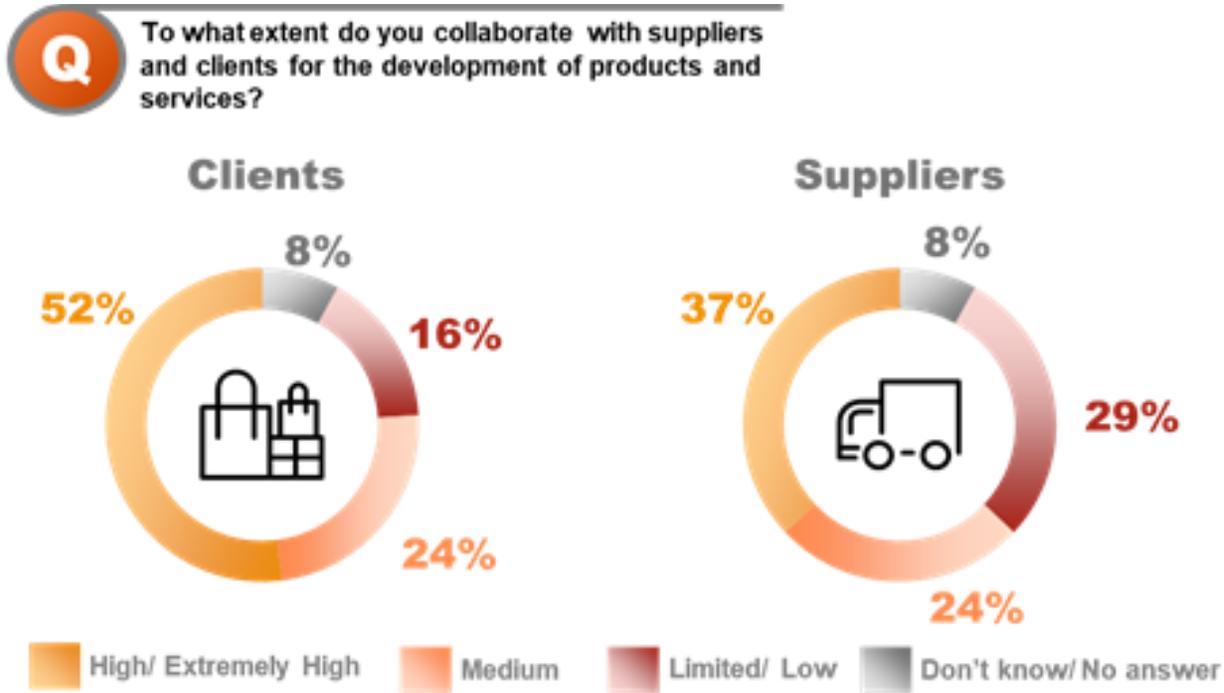


Figure 71: Degree of collaboration with partners/ suppliers for product/service development, (%) - Source: Industry 4.0 Survey

Q To what extent do you collaborate with suppliers and clients for the development of products and services?

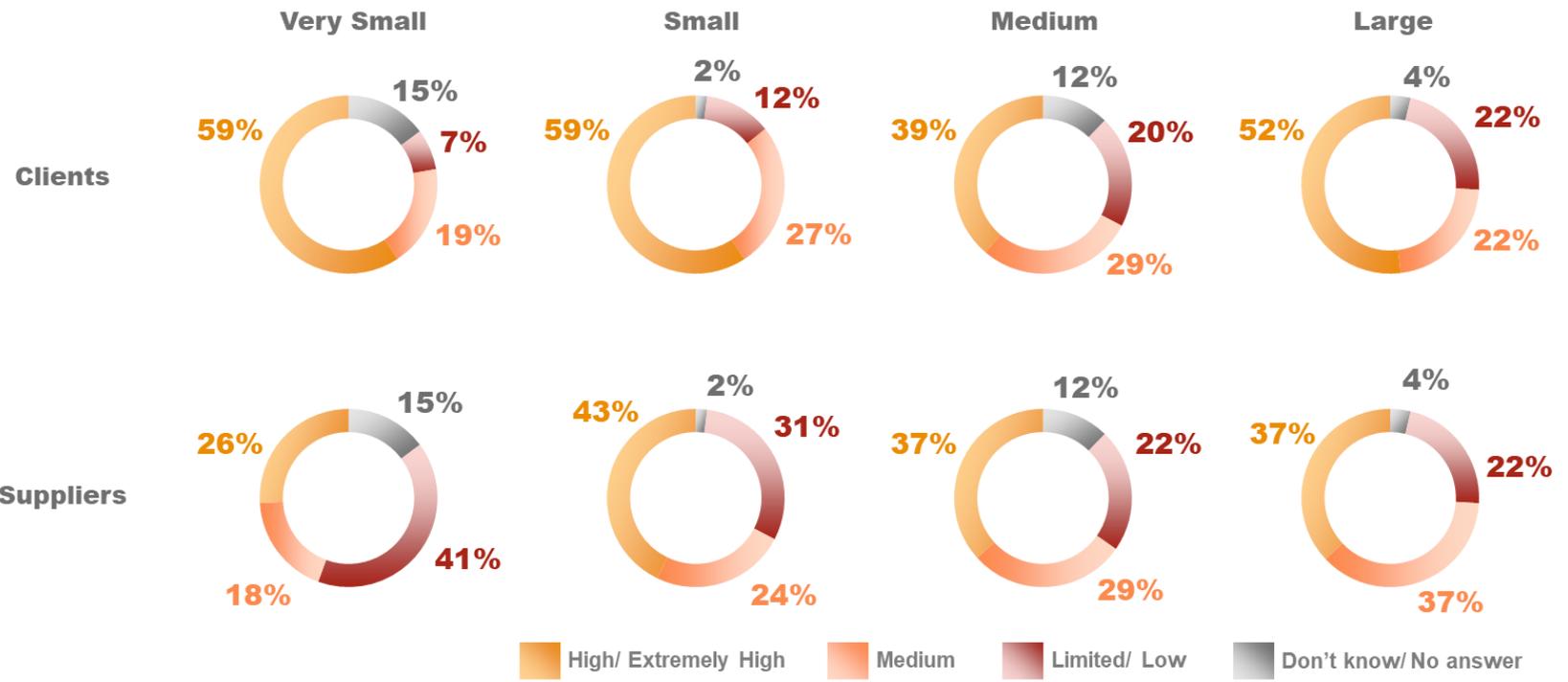


Figure 72: Degree of collaboration with partners/ suppliers for product/service development, by Size, (%) – Source: Industry 4.0 survey

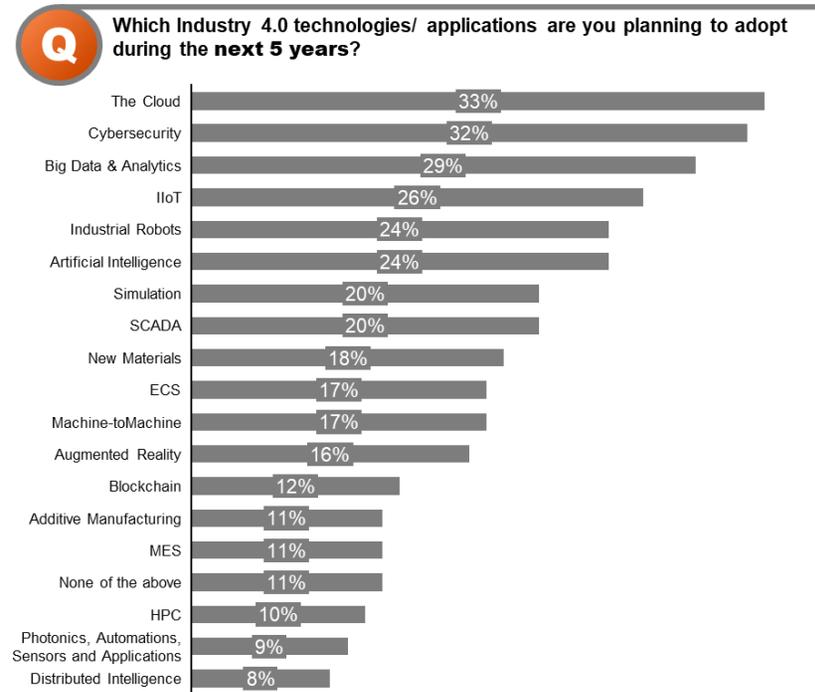
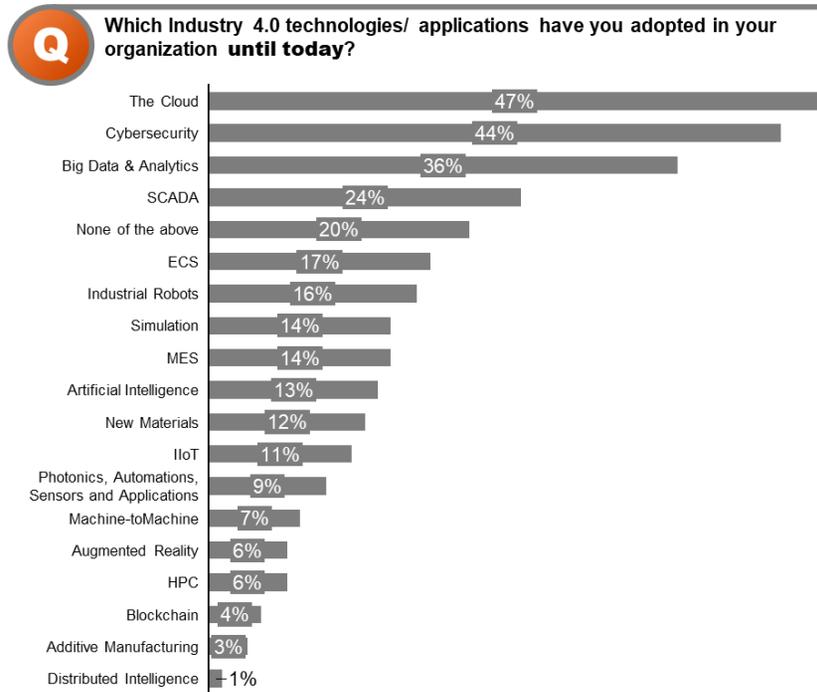


Figure 73: Key Industry 4.0 technologies/ applications that Greek executives have adopted in their organisations or plan to adopt within the next five years, (%) - Source: Industry 4.0 Survey

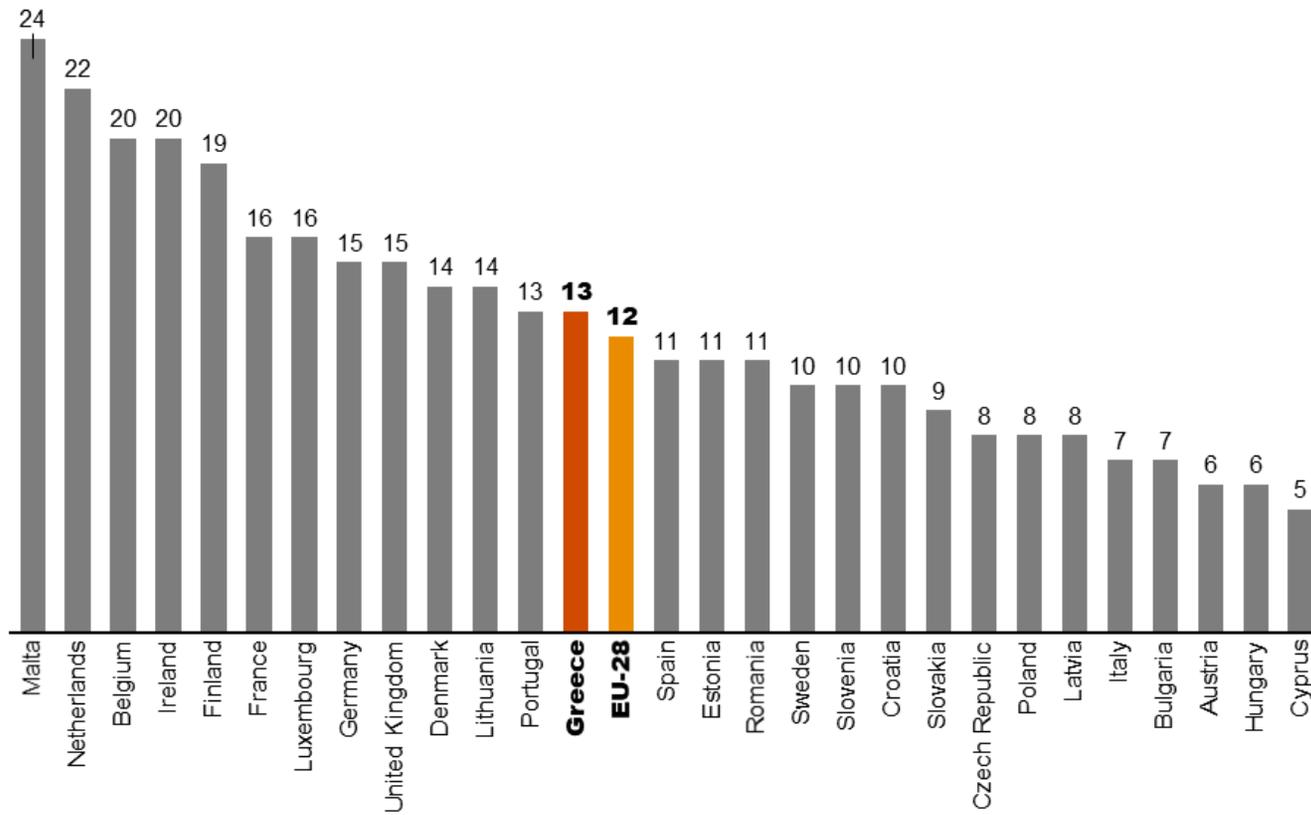


Figure 74: % of Enterprises analysing big data from any data source, EU, 2018 (%) – Eurostat, Big data analysis

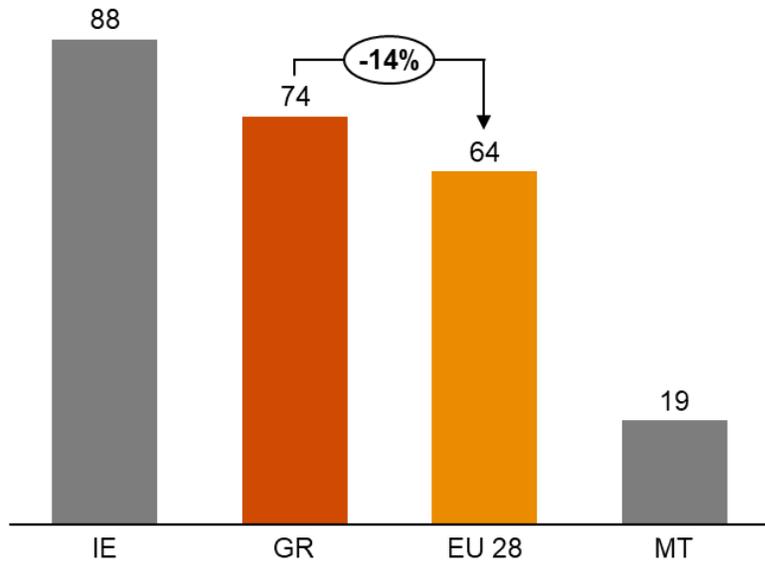


Figure 75: Open Data, 2018 (% of the maximum open data score) – Source: Digital Economy and Society Index Indicators 2019, Digital Public Services

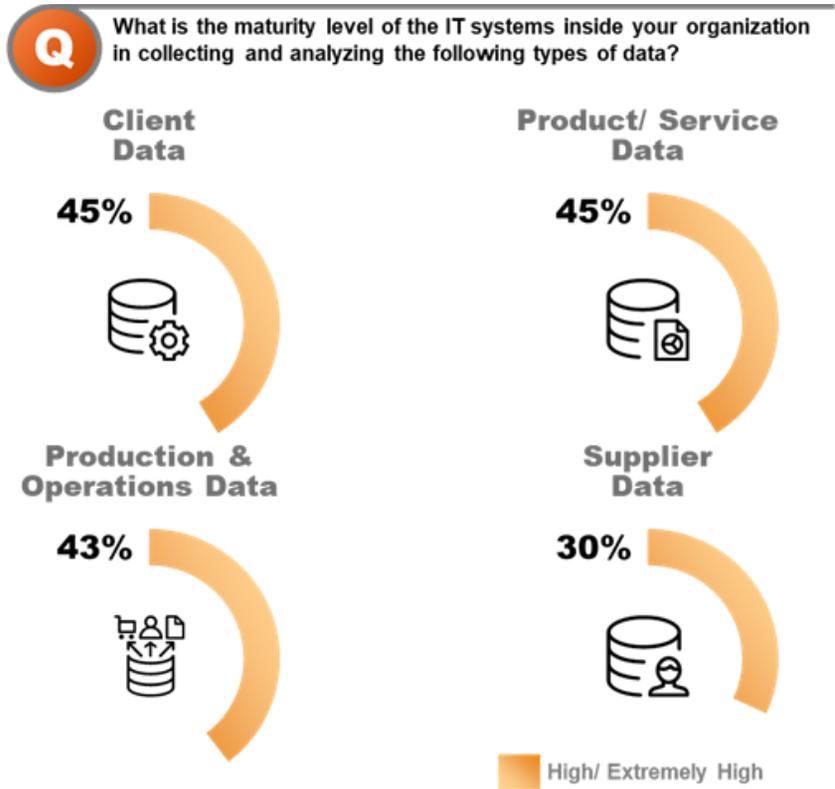


Figure 76: Level of IT systems maturity with regards to their capacity to collect and analyse data generated from different sources, (%) - Source: Industry 4.0 Survey

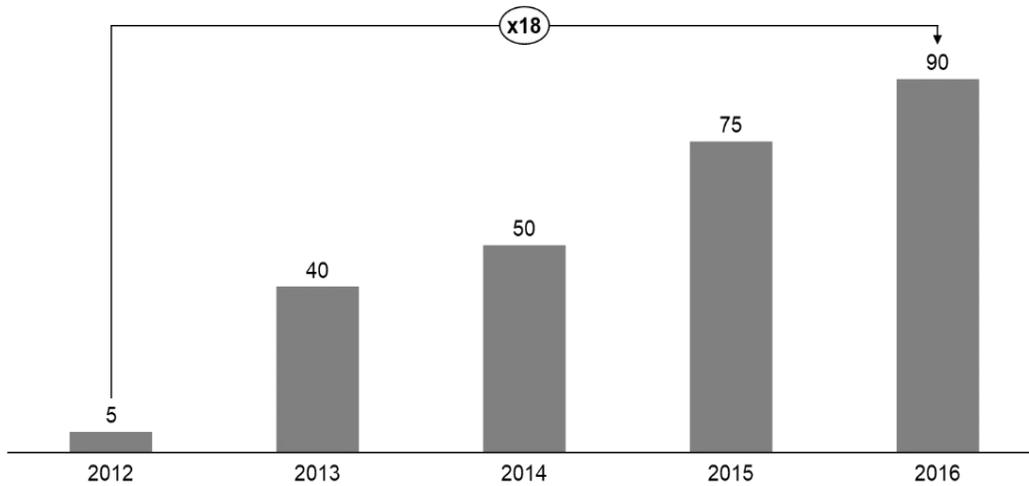


Figure 77: Annual start-up funding in Greece, € Millions, 2012-2016 – Source: BCG, The Greek start-up Ecosystem

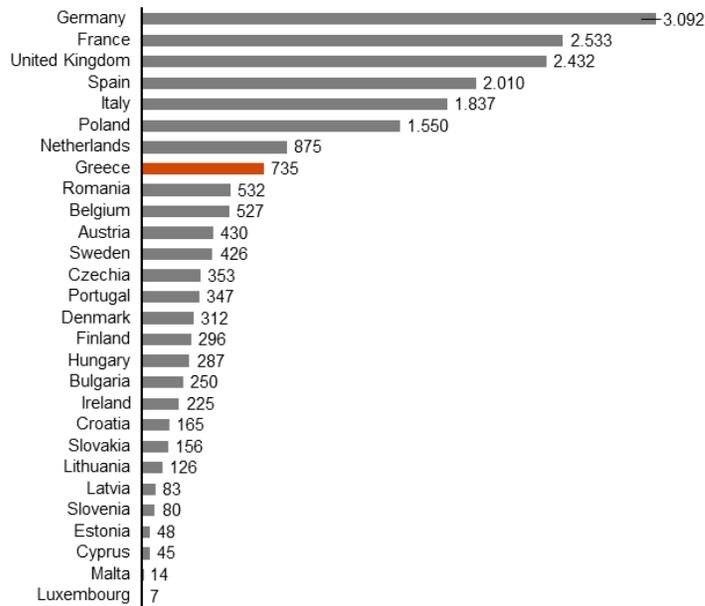


Figure 78: # of Tertiary Education Students, 2017 (Thousands #) – Source: Eurostat : Students enrolled in tertiary education by education level, programme orientation, sex, type of institution and intensity of participation

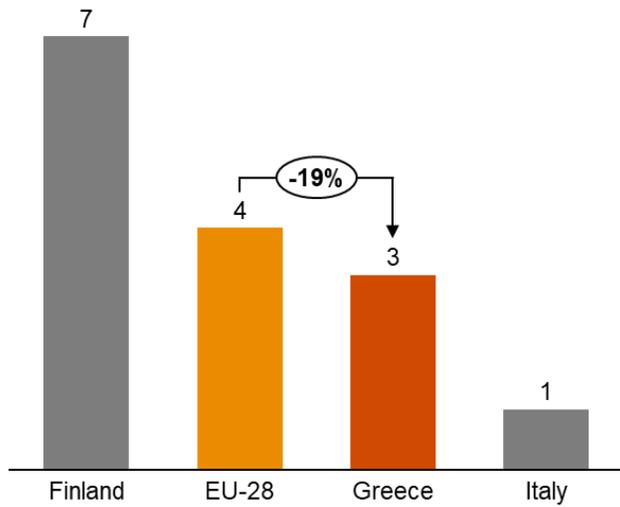


Figure 80: % of ICT graduates out of total graduates, EU, 2018 - Source: DESI 2019, Employed persons with ICT education by educational attainment level

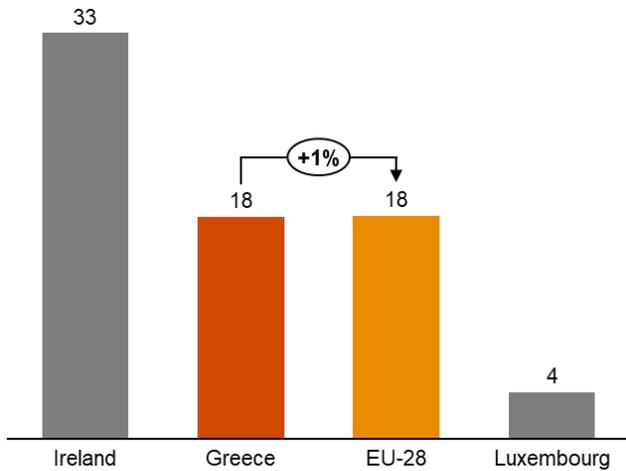


Figure 79: Graduates in tertiary education, in science, math., computing, engineering, manufacturing, construction, - per 1000 of population aged 20-29, EU 2017 - Source: Eurostat, Graduates in tertiary education, in science, math., computing, engineering, manufacturing, construction, by sex - per 1000 of population aged 20-29

10.2 Weaknesses

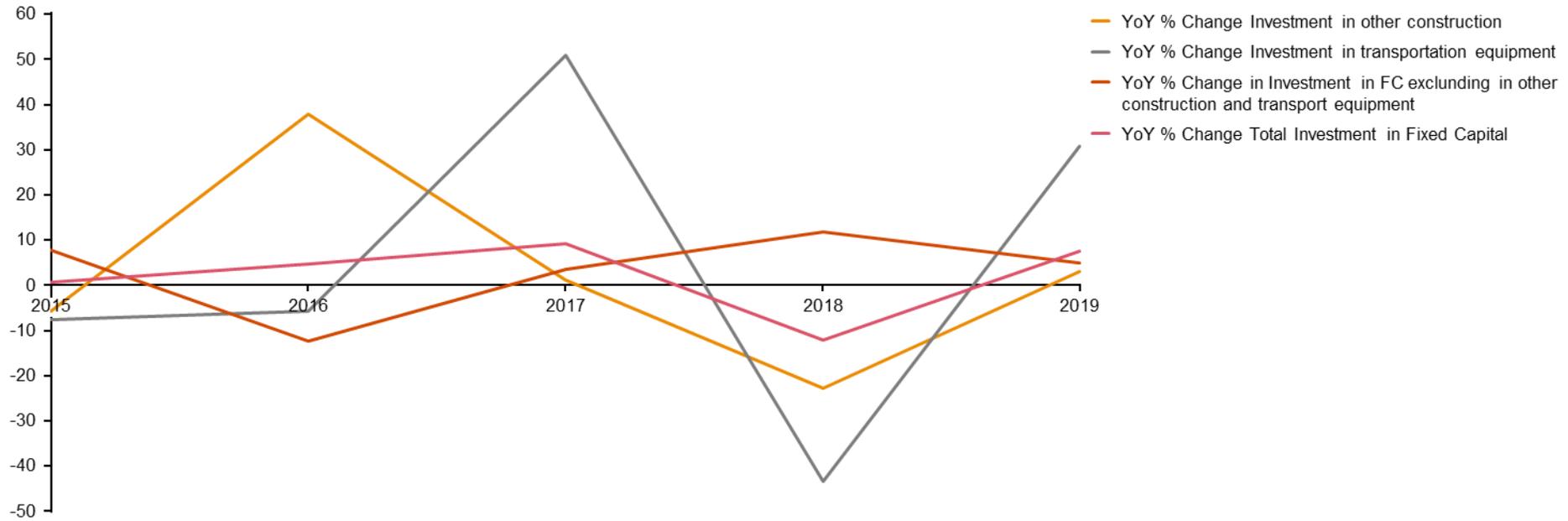


Figure 81: YoY % Change in different types of Investments of Fixed Capital, 2015 - 2019, (%) – Source: Eurostat, Stochasis Macroeconomic Trends - Sectoral Forecasts, December 2019. Forecasts have been provided by Stochasis

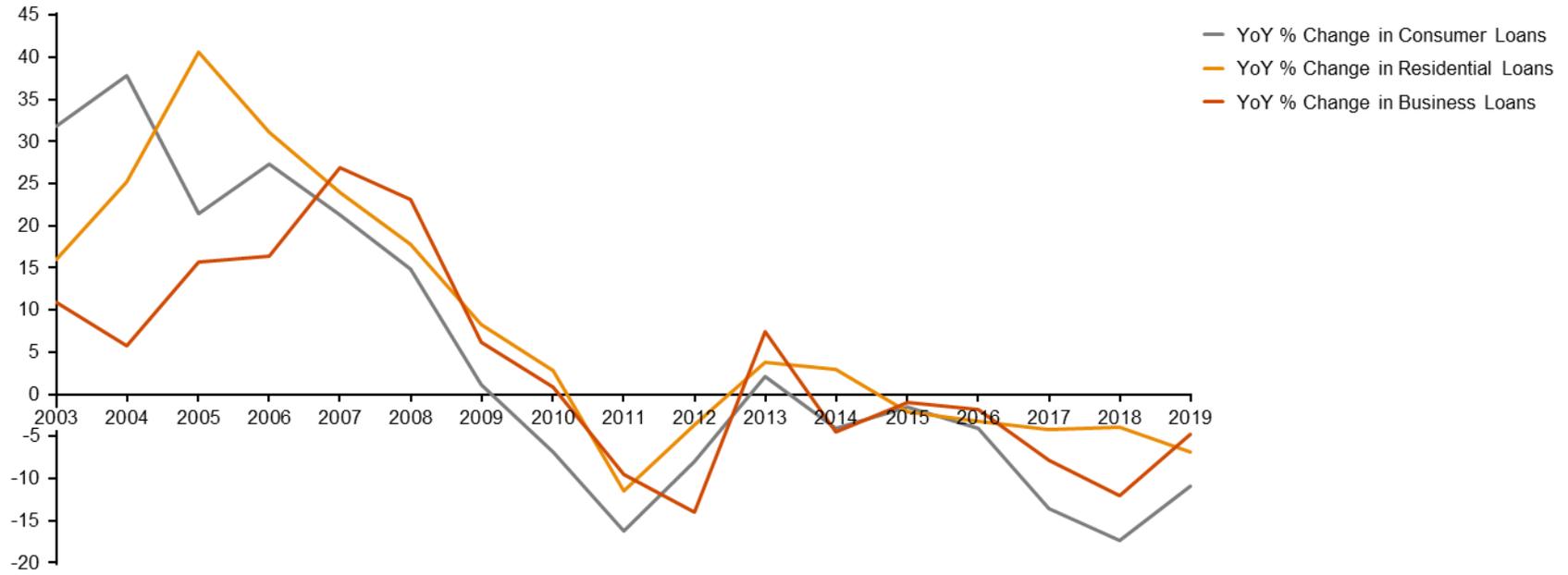


Figure 82: YoY % Change in value of different types of loans provided, 2003 - 2019, (%) – Source: Bank of Greece

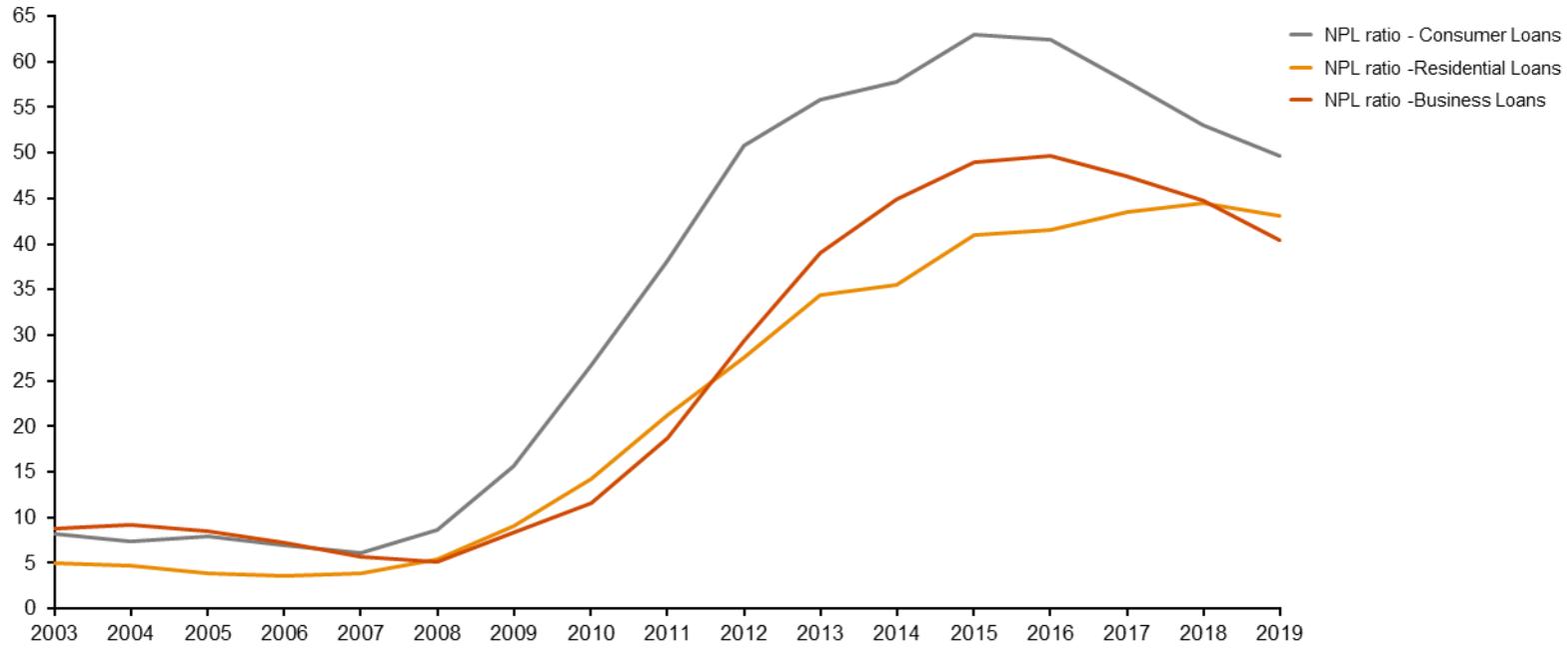


Figure 83: NPL ratio for all types of loans, 2003 - 2019 (%) – Source: Bank of Greece

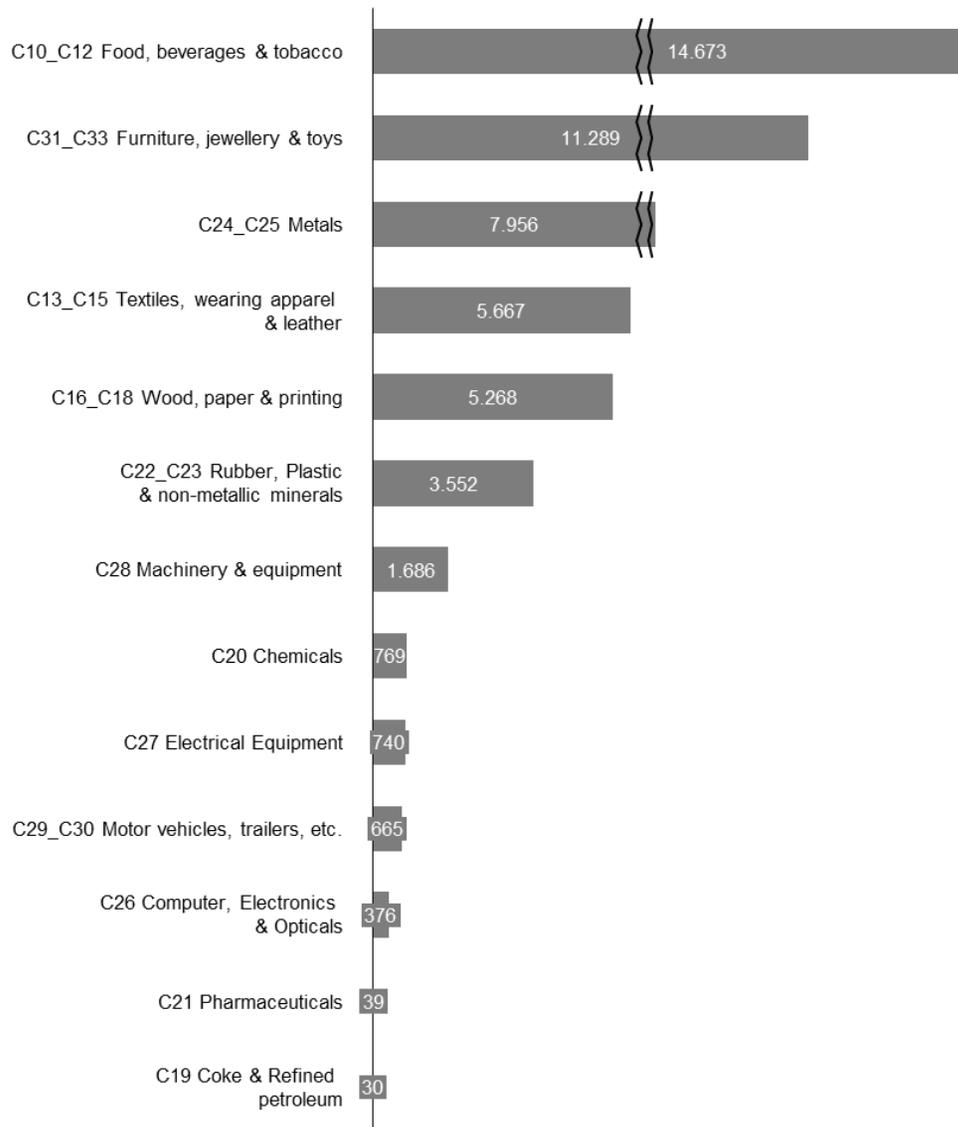


Figure 84: Number of enterprises with 0-9 employees, 2017, (#) – Source: Eurostat

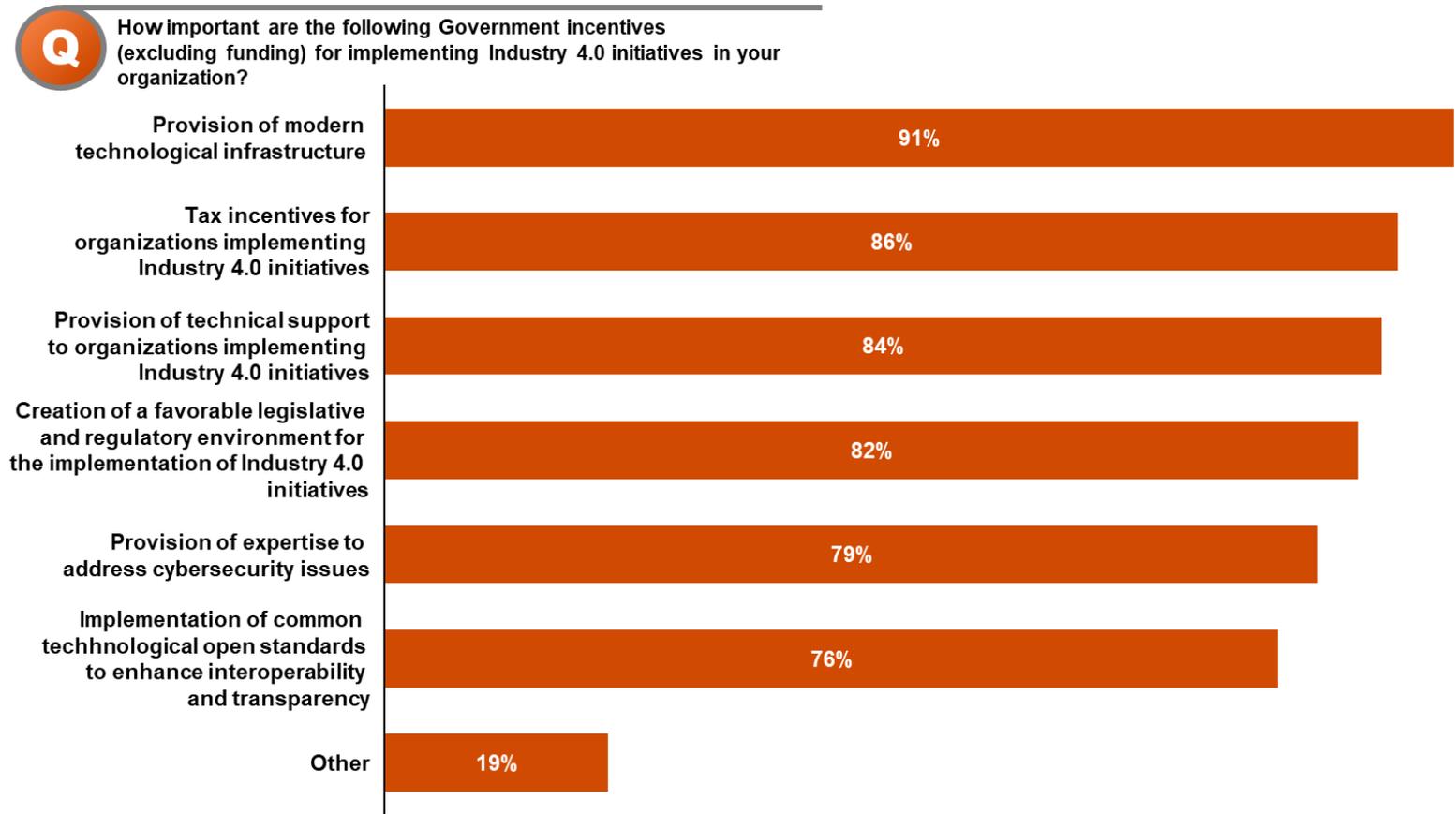


Figure 85: Important Government initiatives (excluding funding) that Greek executives wish to undertake in order to accelerate their organisations' digital transformation, (%) - Source: Industry 4.0 survey



Which Industry 4.0 technologies/ applications have you adopted in your organization until today?

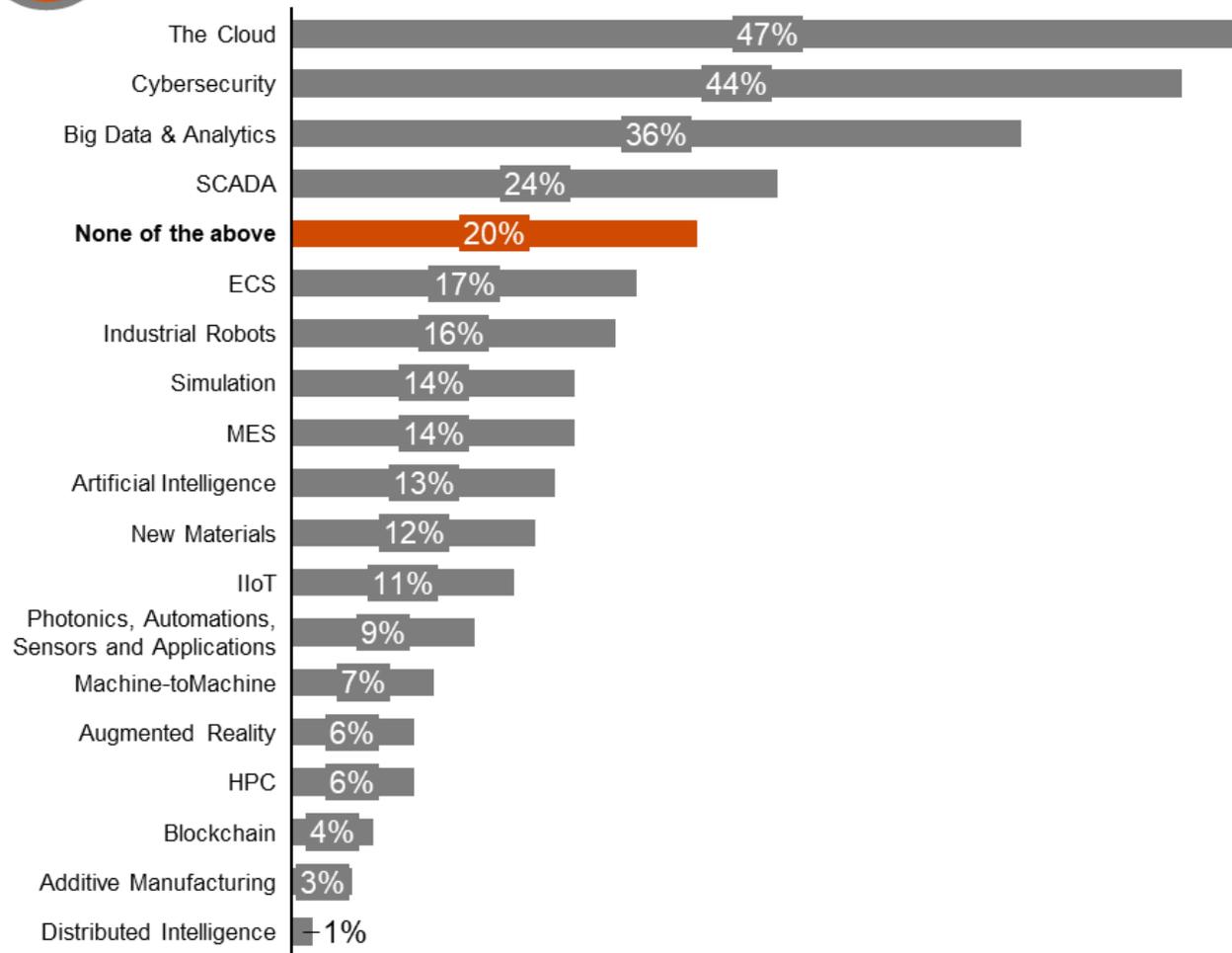


Figure 86: Key Industry 4.0 technologies/ applications that Greek executives have adopted in their organisations (%)
 – Source: “Industry 4.0” survey



Which Industry 4.0 technologies/ applications have you adopted in your organization until today?

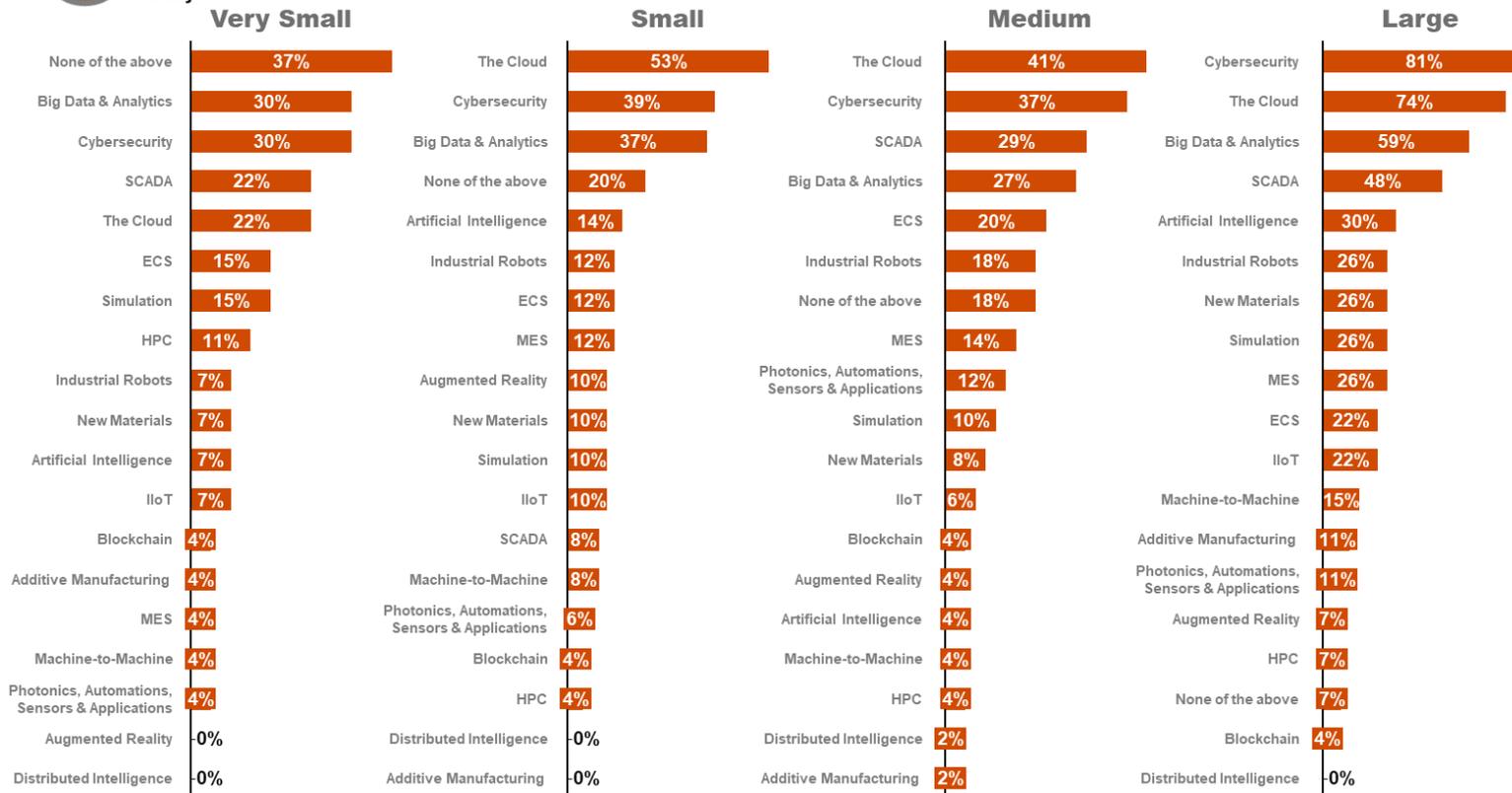


Figure 87: Key Industry 4.0 technologies/ applications that Greek executives have adopted in their organisations, by Size, (%) – Source: Industry 4.0 survey

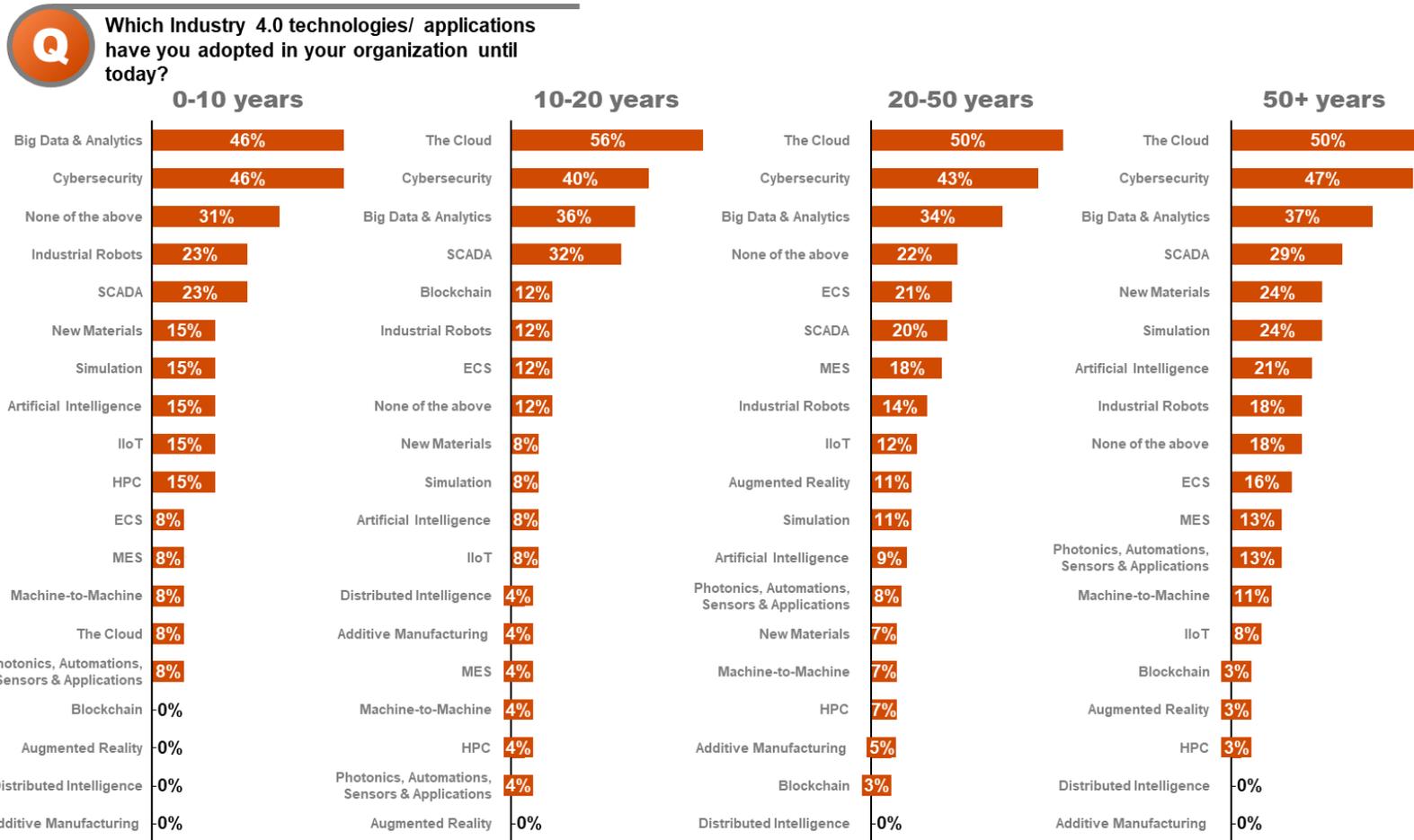


Figure 88: Key Industry 4.0 technologies/ applications that Greek executives have adopted in their organisations, by Years of Operation, (%) – Source: Industry 4.0 survey



Which Industry 4.0 technologies/ applications have you adopted in your organization until today?

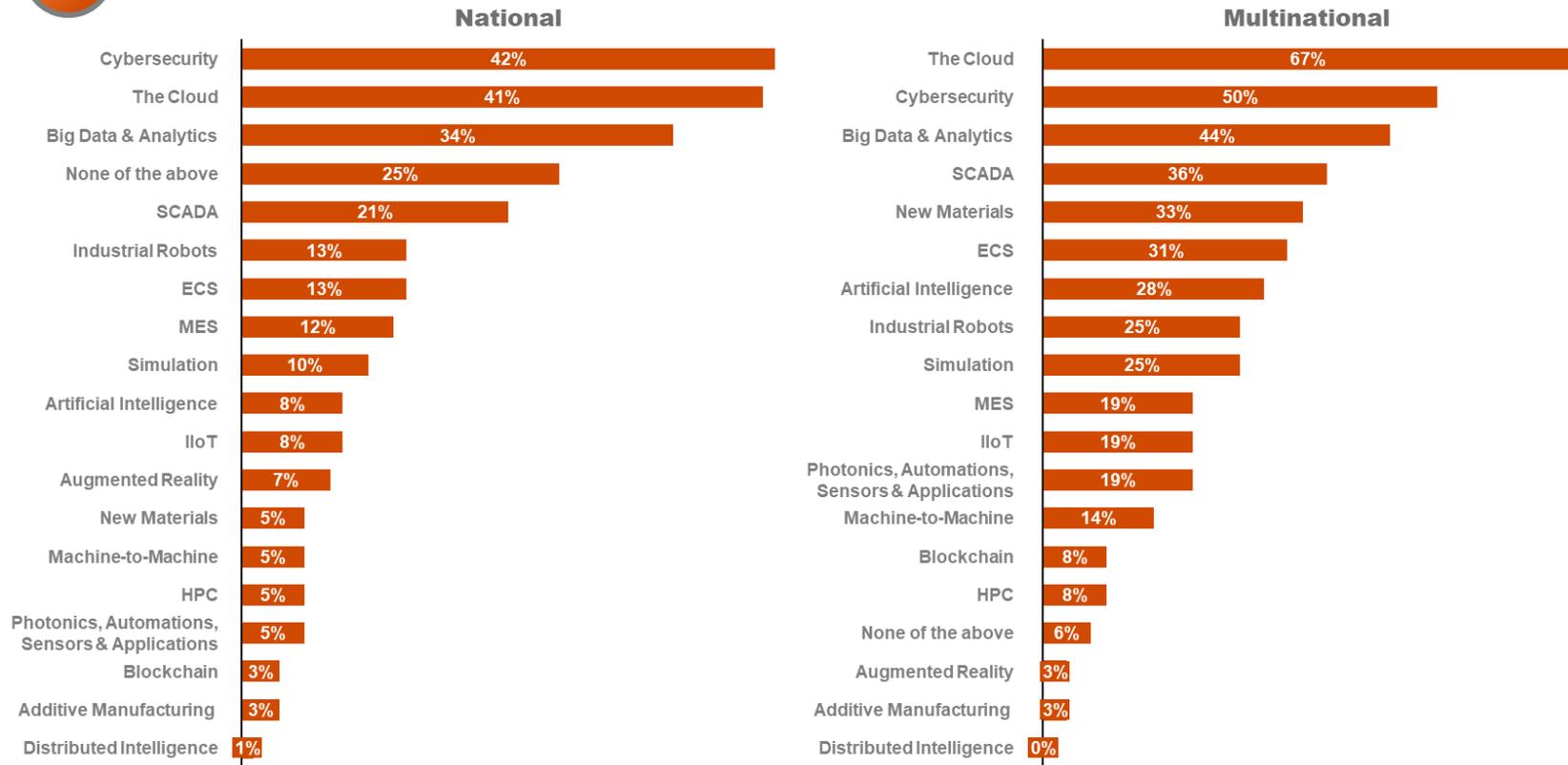


Figure 89: Key Industry 4.0 technologies/ applications that Greek executives have adopted in their organisations, by Origin, by Origin, (%) – Source: Industry 4.0 survey

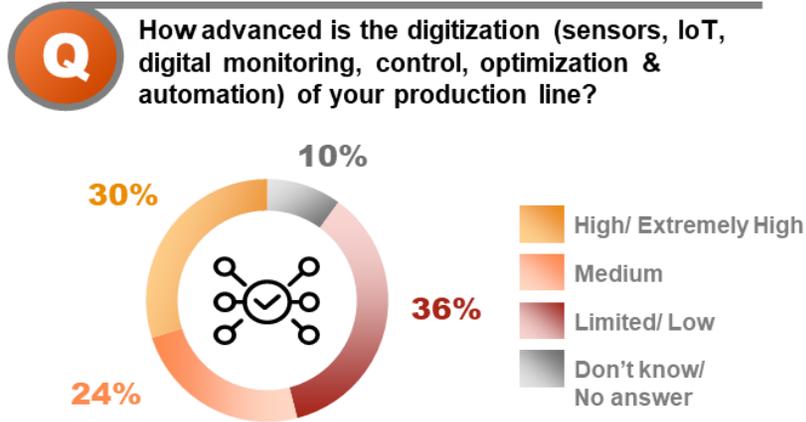


Figure 90: Level of digitisation of organisations' production lines (%) – Source: “Industry 4.0” survey

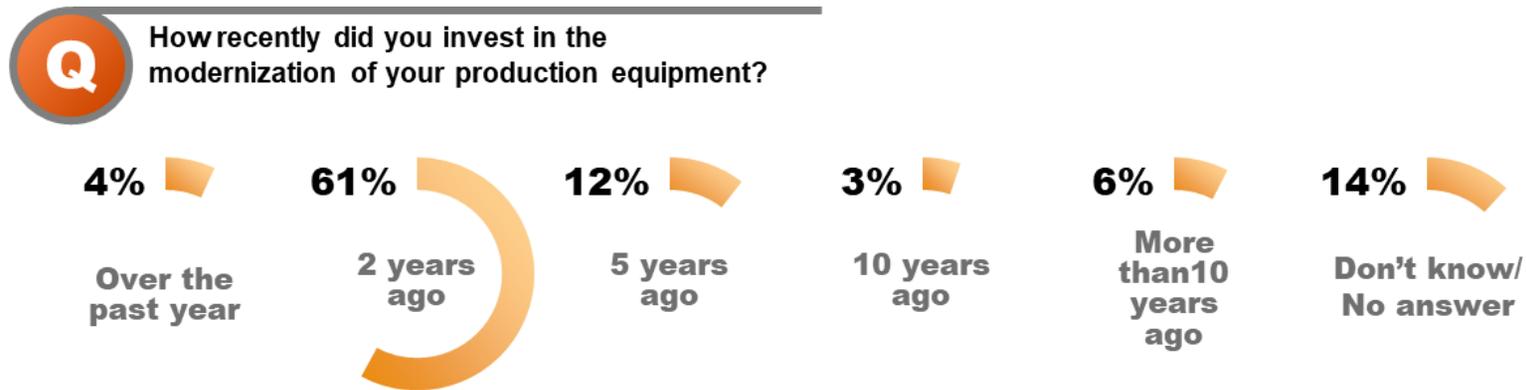


Figure 91: Last time organisations invested in the modernisation of their production equipment, (%) – Source: “Industry 4.0” survey

Q How advanced is the digitization (sensors, IoT, digital monitoring, control, optimization & automation) of your production line?

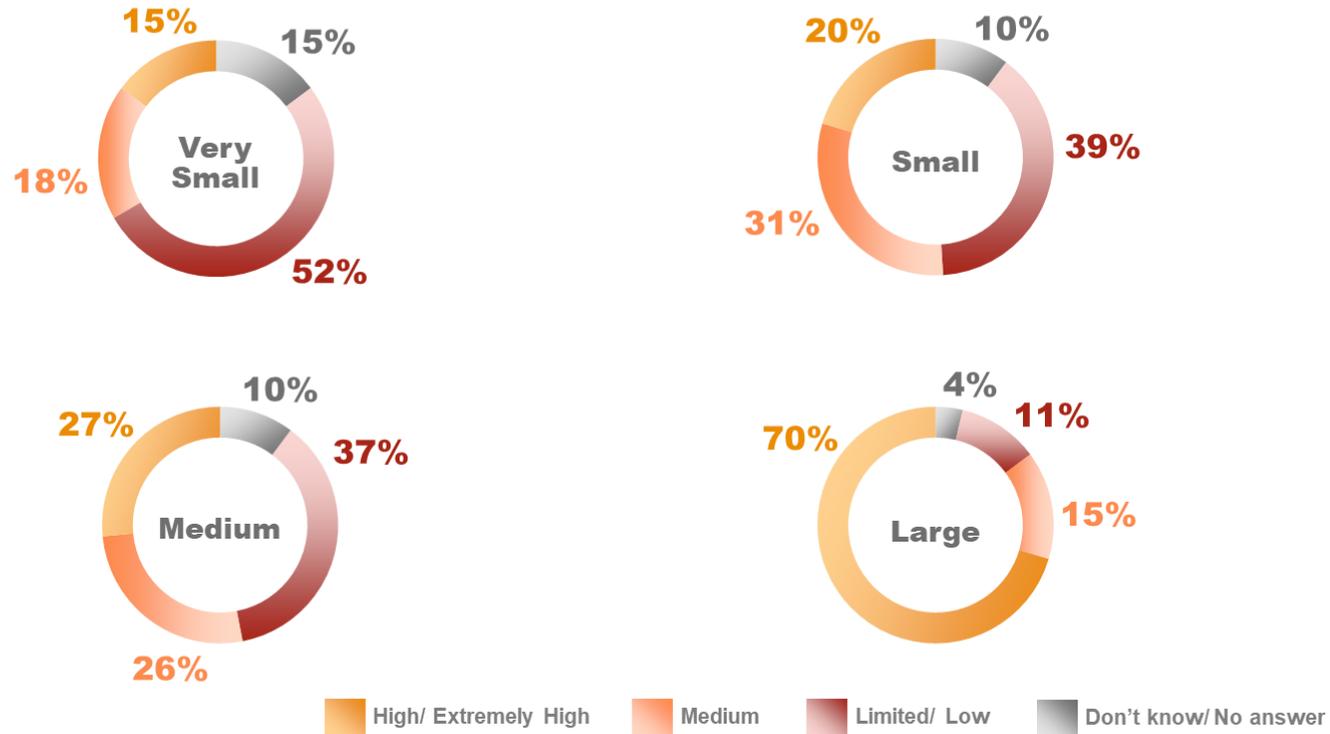


Figure 92: Degree of digitisation of the production line of organisations, by Size, (%) – Source: Industry 4.0 survey

Q How advanced is the digitization (sensors, IoT, digital monitoring, control, optimization & automation) of your production line?

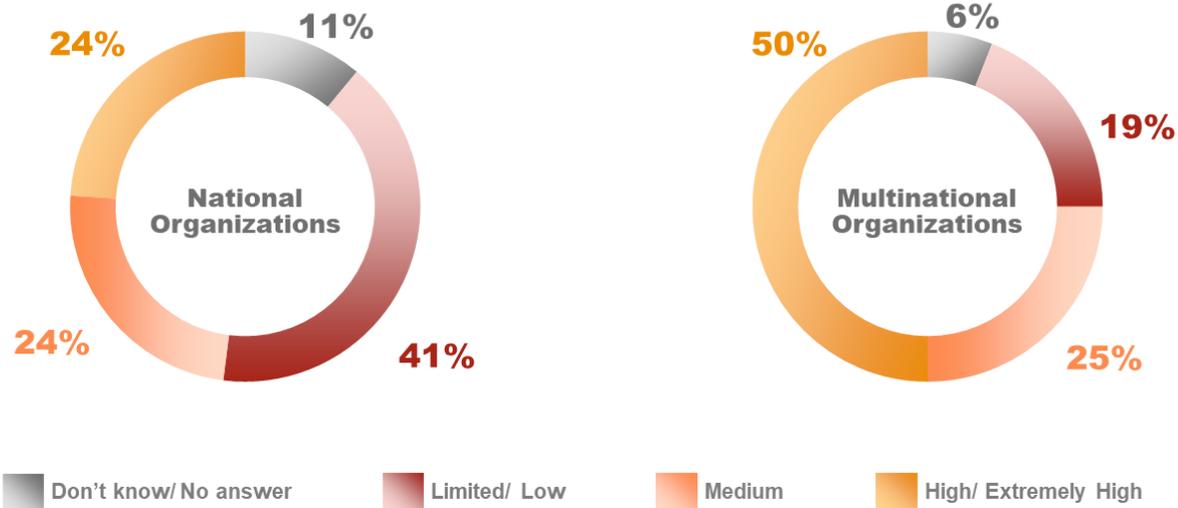


Figure 93: Degree of digitisation of the production line of organisations, by Origin, (%) – Source: Industry 4.0 survey

Q How advanced is the digitization (sensors, IoT, digital monitoring, control, optimization & automation) of your production line?

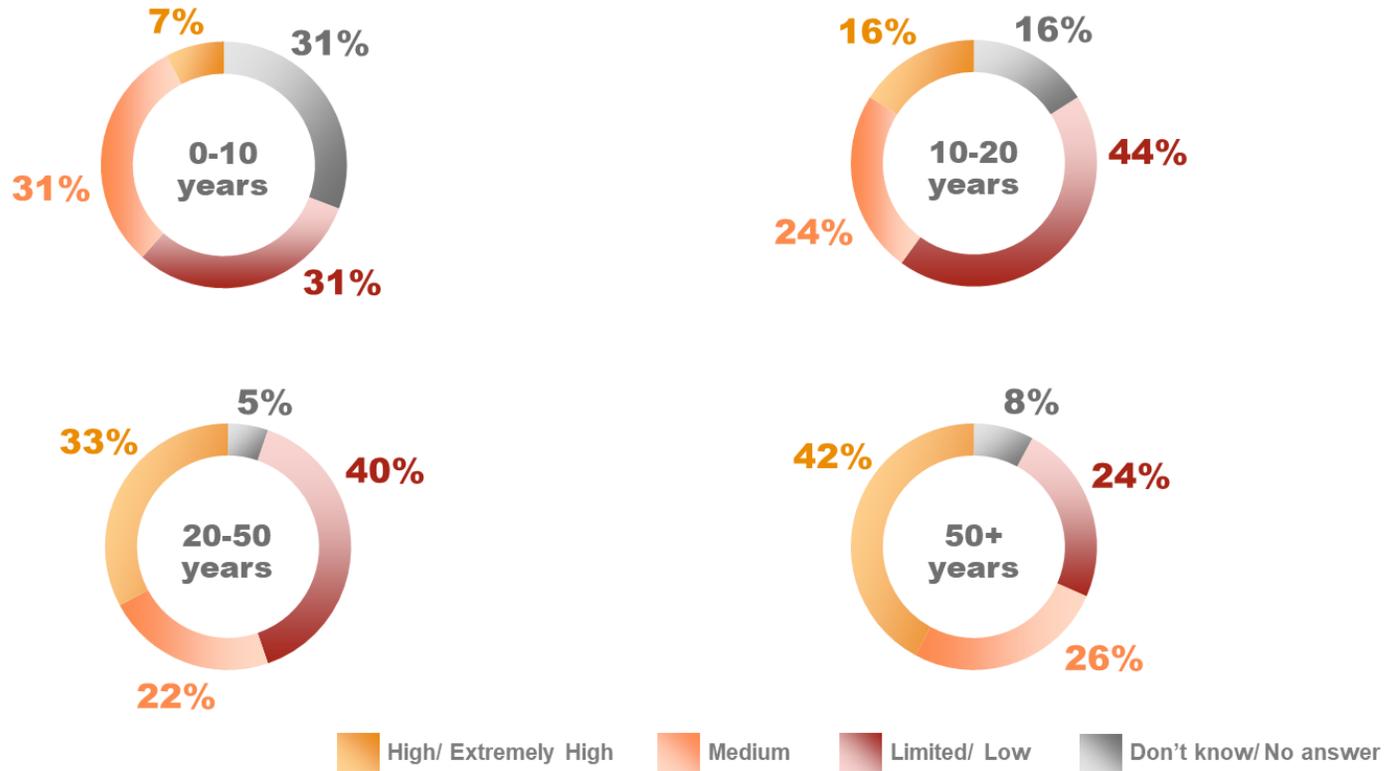


Figure 94: Degree of digitisation of the production line of organisations, by Years of Operation, (%) – Source: Industry 4.0 survey

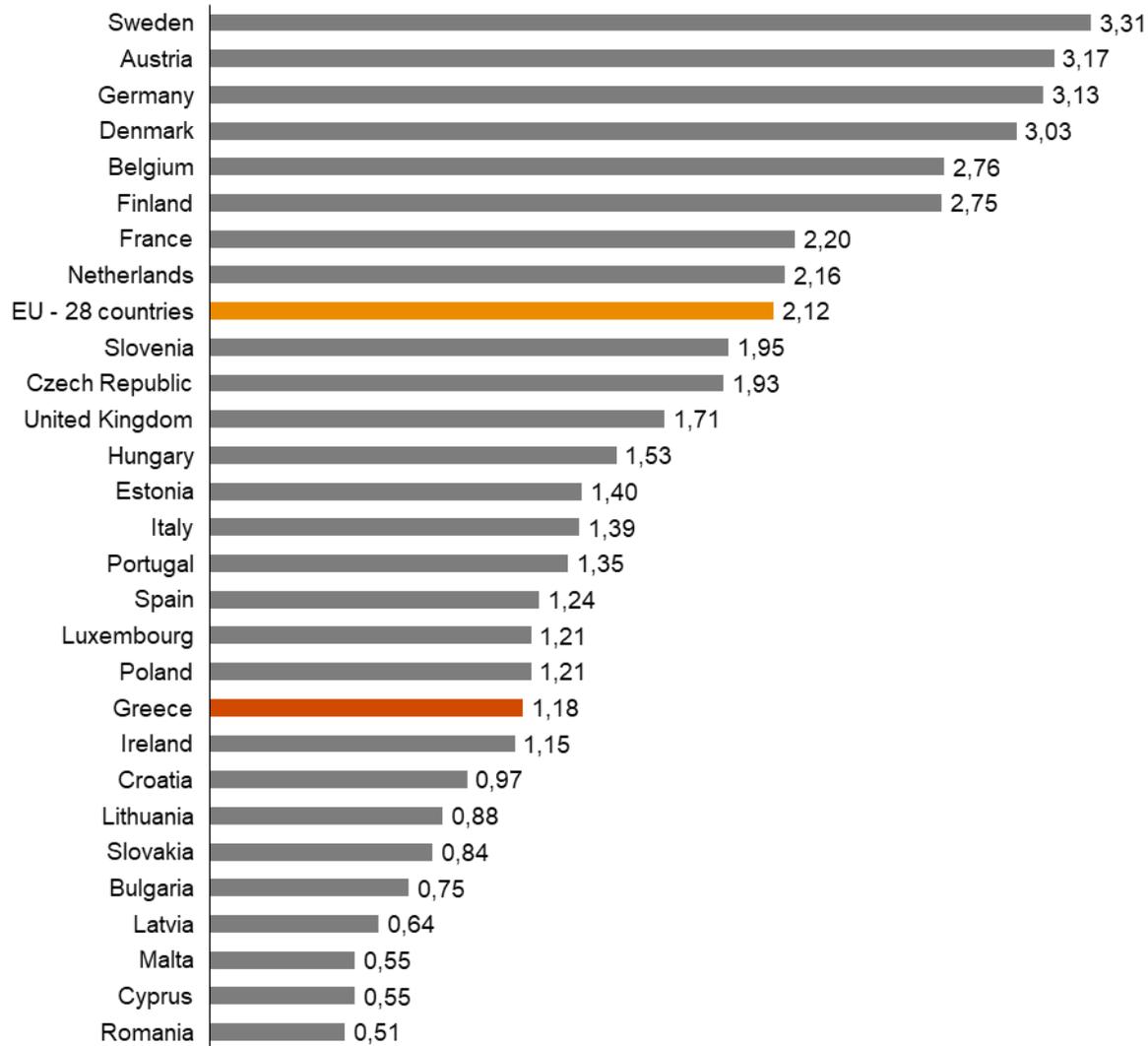


Figure 95: Gross Domestic Expenditure in R&D 2018, % of GDP – Source: OECD, Gross domestic spending on R&D

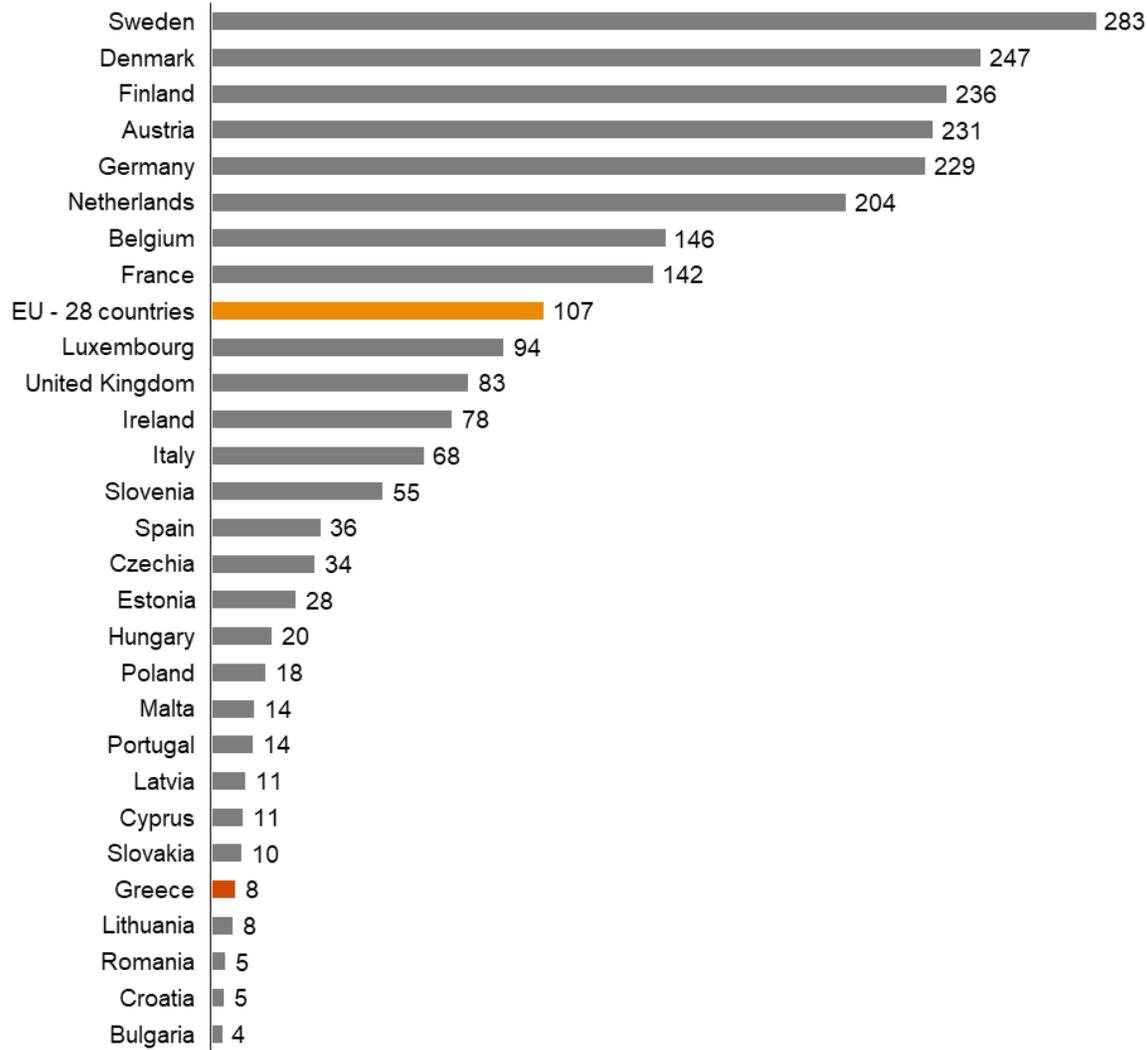


Figure 96: Patent applications submitted to the EPO per million inhabitants, EU, 2017 Source: Eurostat, Patent applications to the European Patent Office

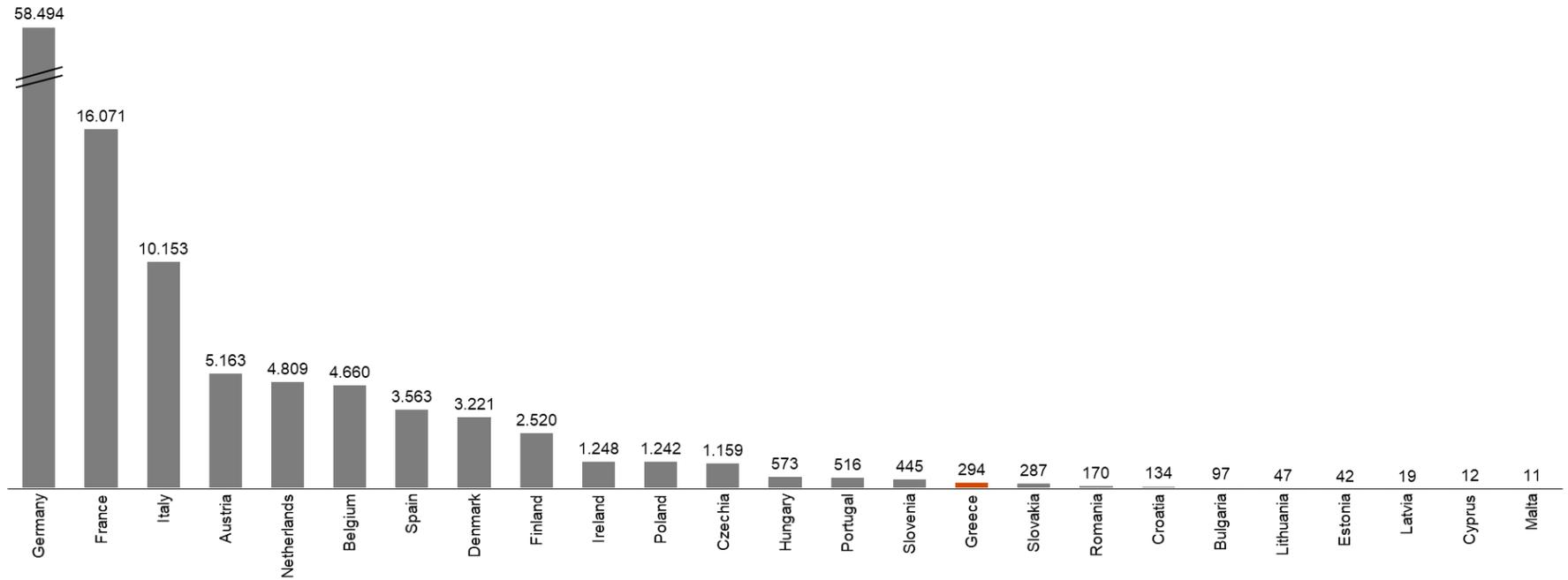


Figure 97: Business R&D Expenditure in the manufacturing sector, € Billion (2017) – Source: Eurostat, Business expenditure on R&D (BERD) by NACE Rev. 2 activity

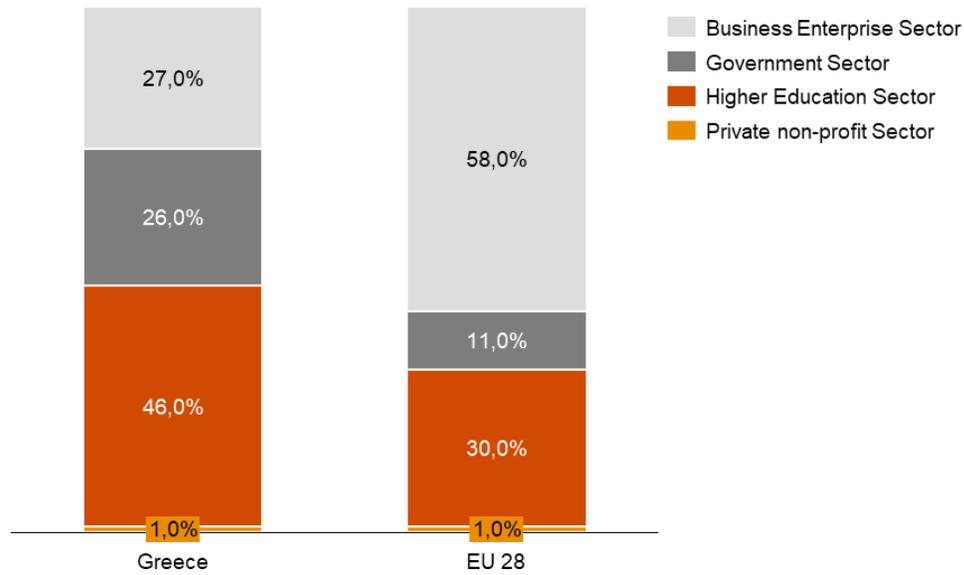


Figure 98: % of total R&D FTE per sector Greece and EU-28, 2018 – Source: Eurostat, Total researchers by sectors of performance - full time equivalent

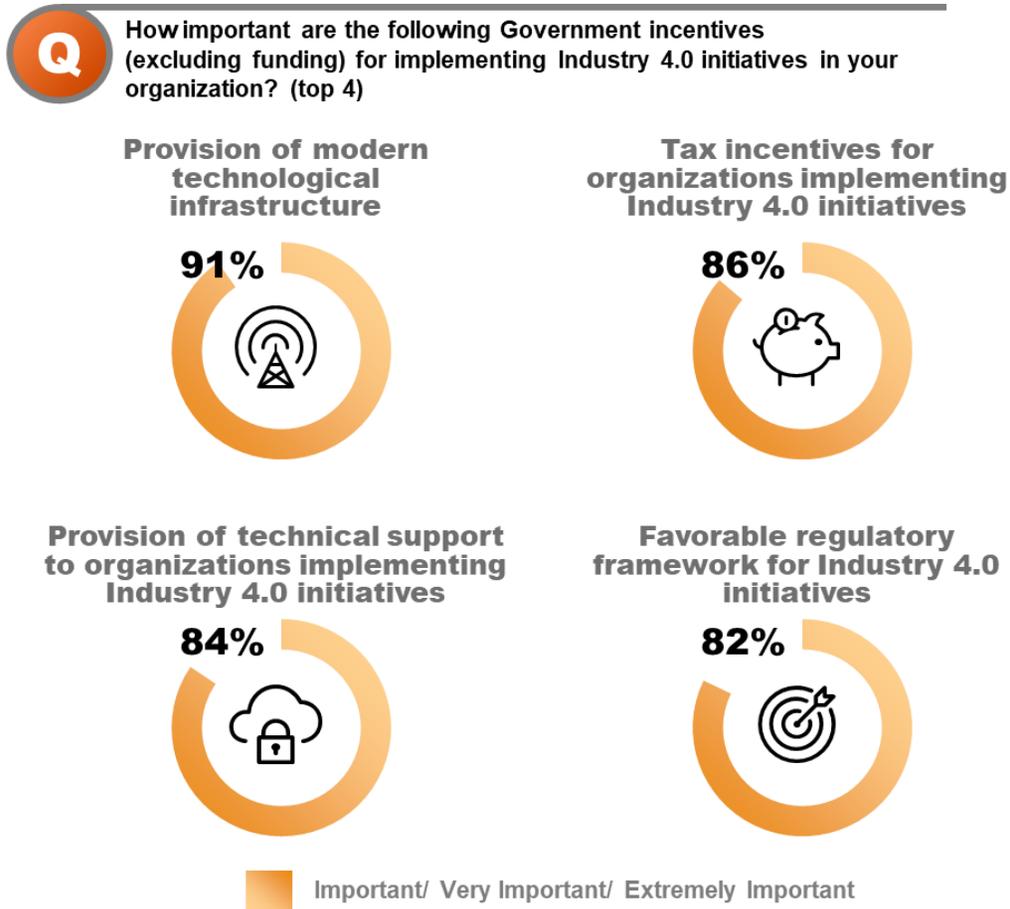


Figure 99: Important Government initiatives (excluding funding) that Greek executives wish to undertake in order to accelerate their organisations' digital transformation, (%) – Source: Industry 4.0 Survey

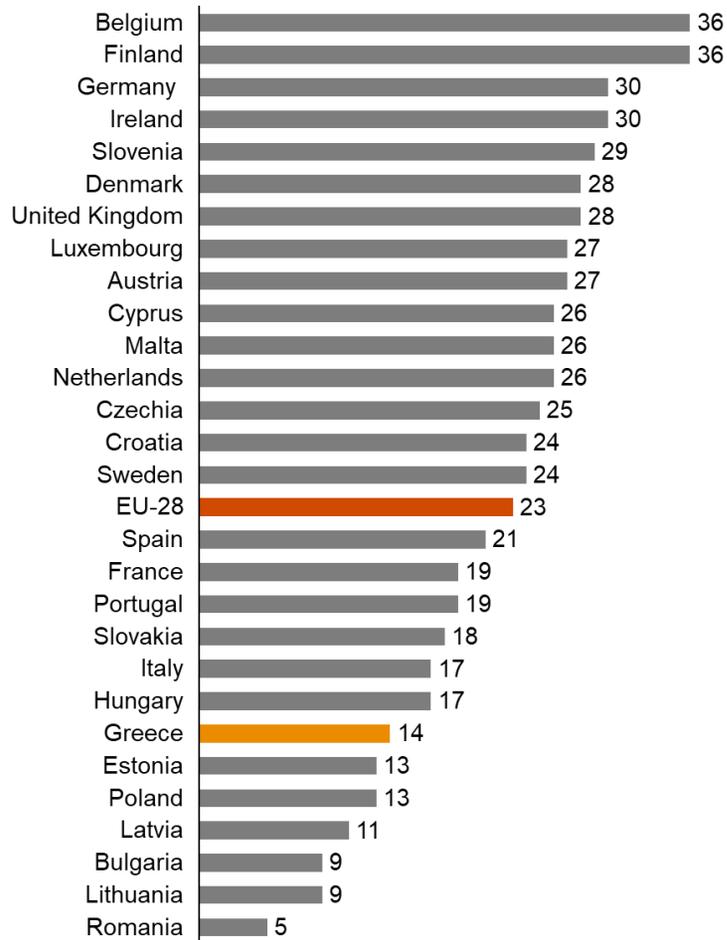


Figure 100: % of Enterprises that provide ICT skills training, 2018 - Source: Eurostat, Enterprises that provided training to develop/upgrade ICT skills of their personnel

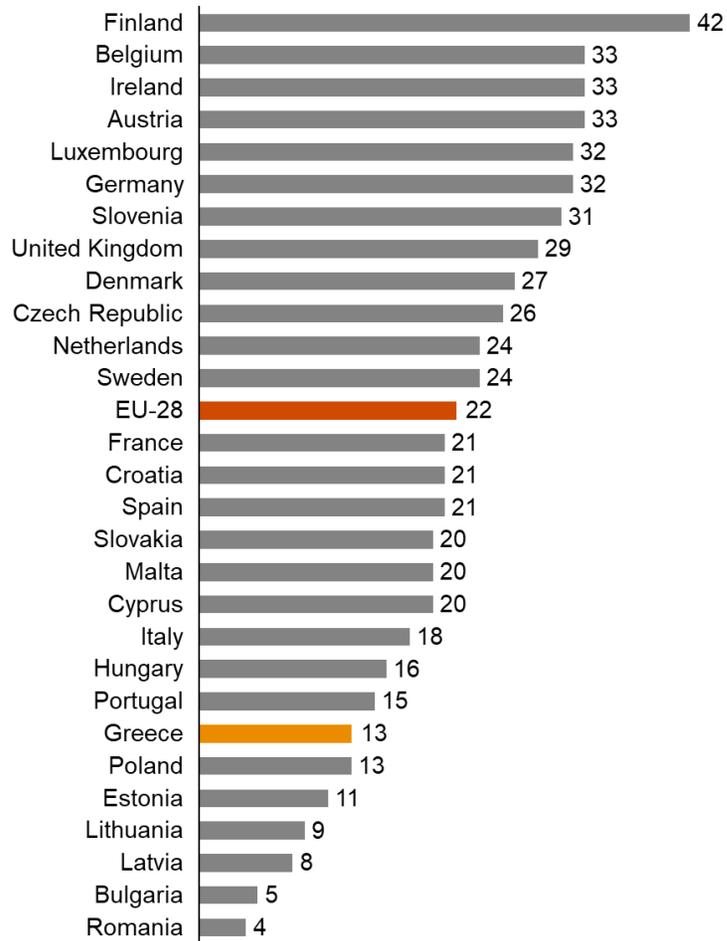


Figure 101: % of Manufacturers providing ICT training to their personnel, 2018 - Source: Eurostat, Enterprises that provided training to develop/upgrade ICT skills of their personnel

Q How would you characterize the readiness of your workforce's digital skills to meet your Industry 4.0 needs over the next 5 years?

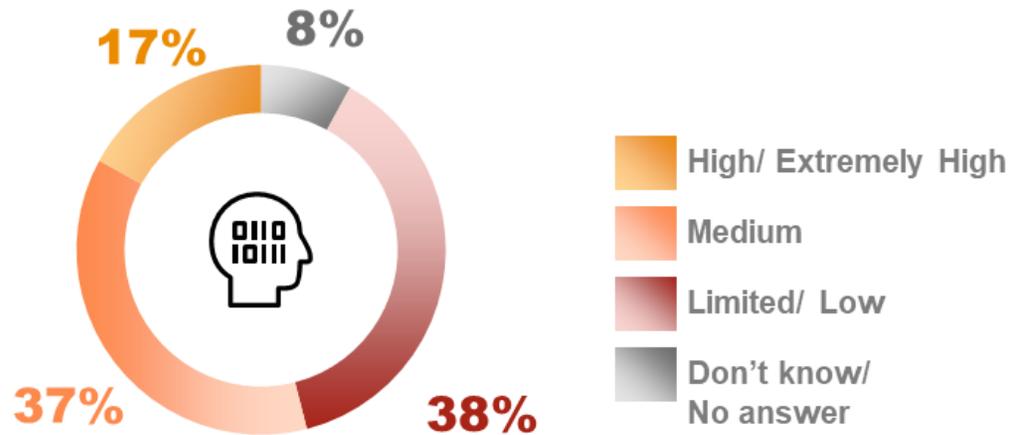


Figure 102: Degree of organisation's confidence in the current level of digital skills of their workforce, to meet Industry 4.0 challenges, by Size, (%) – Source: Industry 4.0 survey

Q How would you characterize the readiness of your workforce's digital skills to meet your Industry 4.0 needs over the next 5 years?

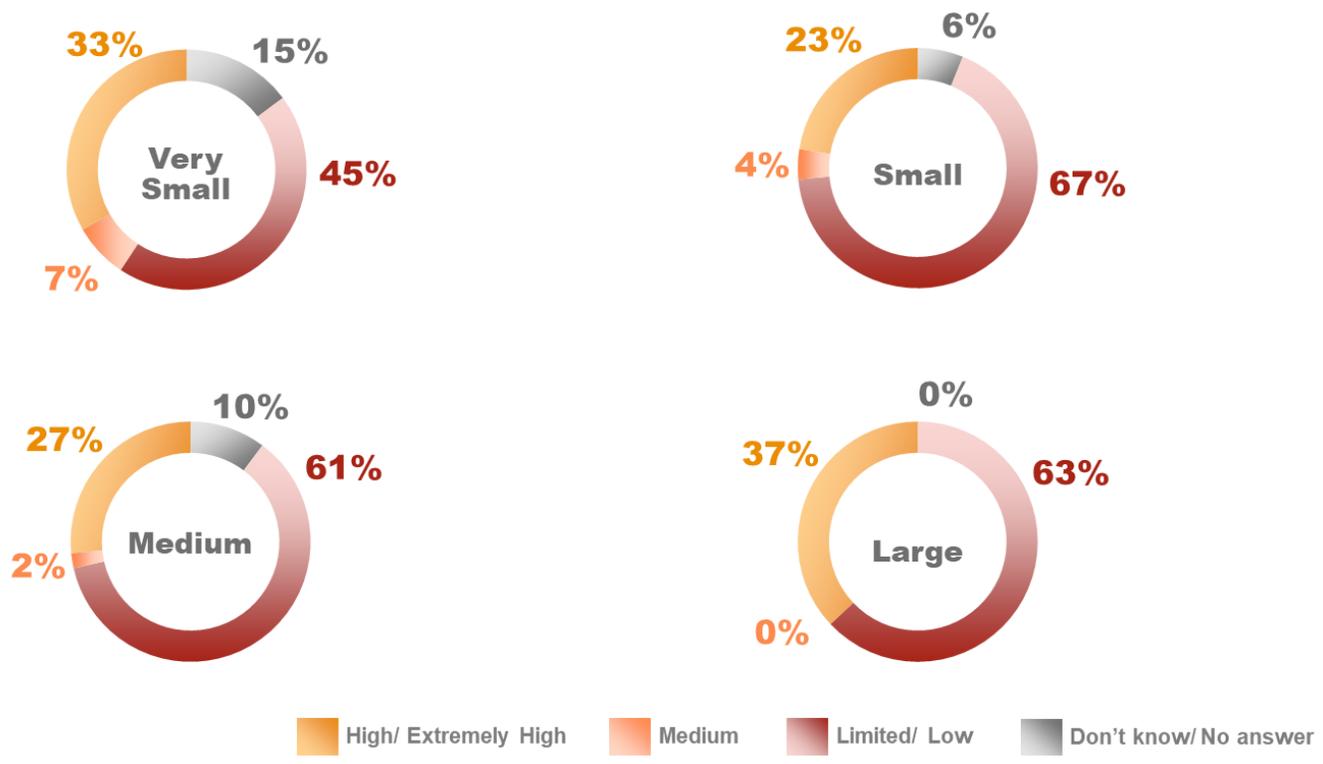


Figure 103: Degree of organisation's confidence in the current level of digital skills of their workforce, to meet Industry 4.0 challenges as per size of organisations – Source: Industry 4.0 survey

Q What is the level of difficulty that you expect to face in sourcing skilled workforce in the next 5 years, with regards to the following Industry 4.0 technologies?

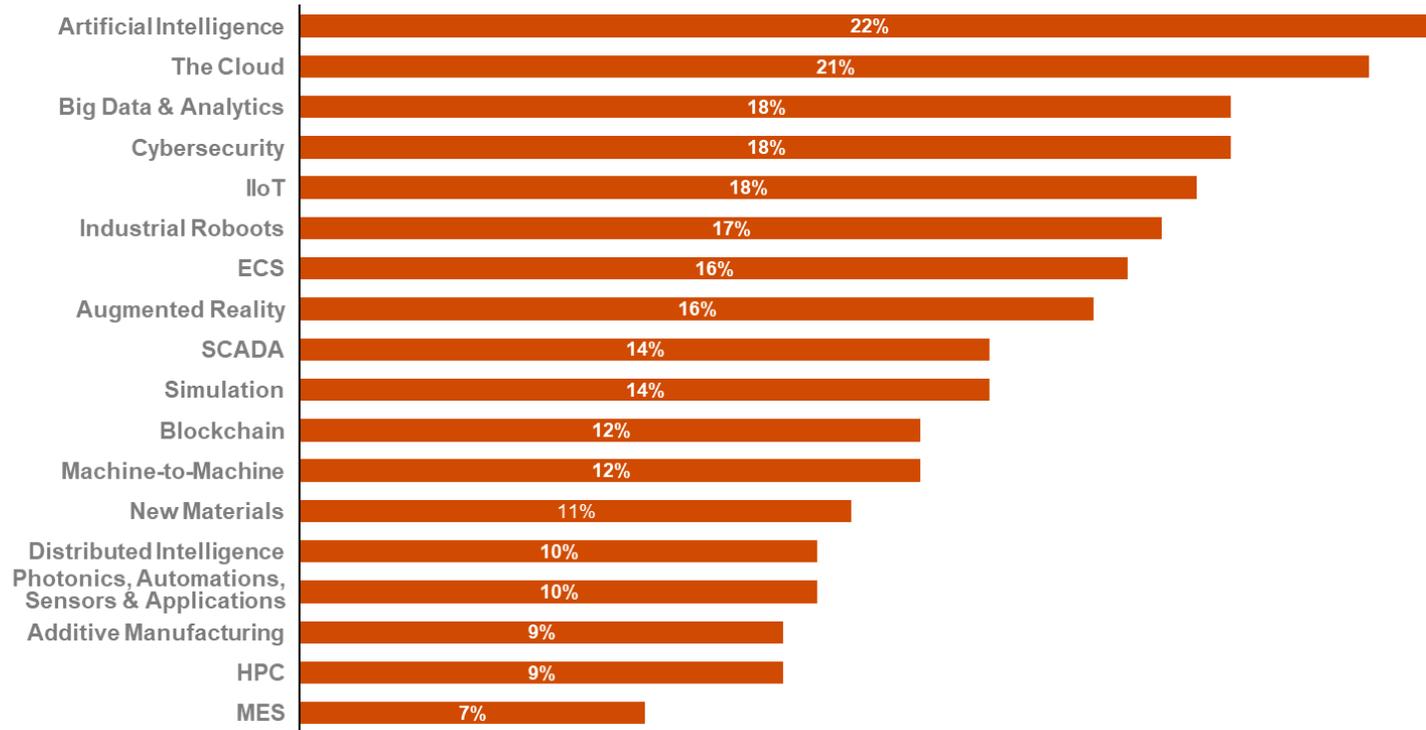


Figure 104: Level of difficulty that organisations expect to face in sourcing skilled workforce for adopting Industry 4.0 initiatives, in the next 5 years, (%) – Source: Industry 4.0 survey

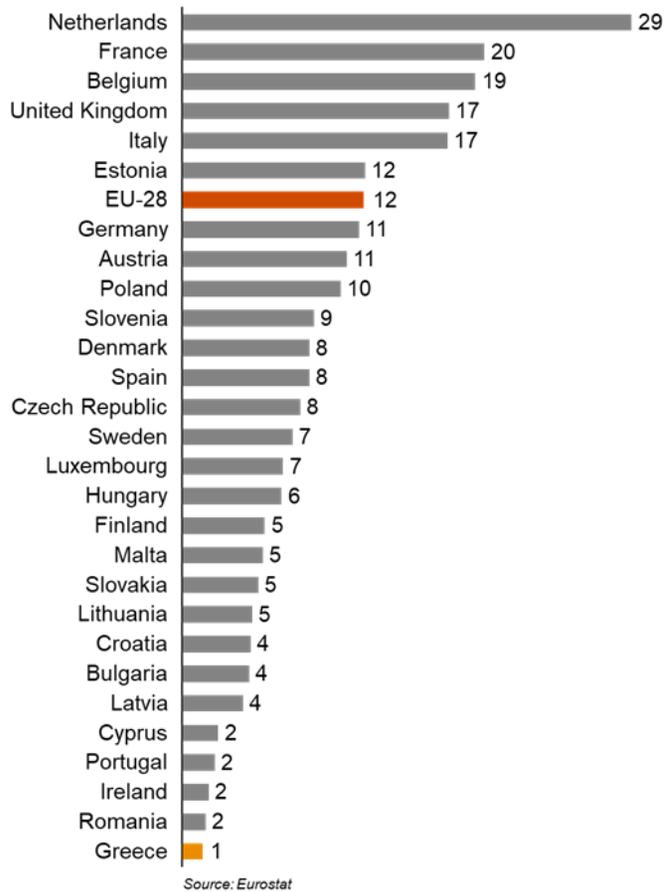


Figure 105: EU Circular material use rate, % of total material use, 2016 – Source: Eurostat, Circular material use rate

10.3 Opportunities

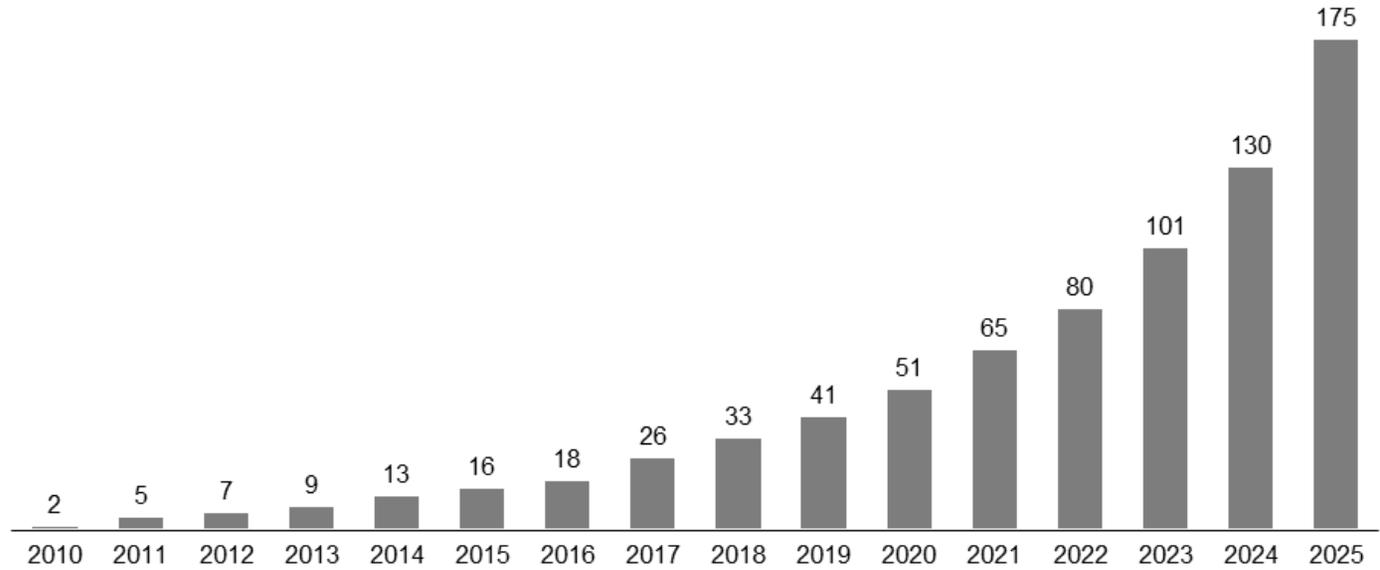


Figure 106: Volume of data/information created worldwide from 2010 to 2025 (in zettabytes) – Source: Statista, <https://www.statista.com/statistics/871513/worldwide-data-created/>

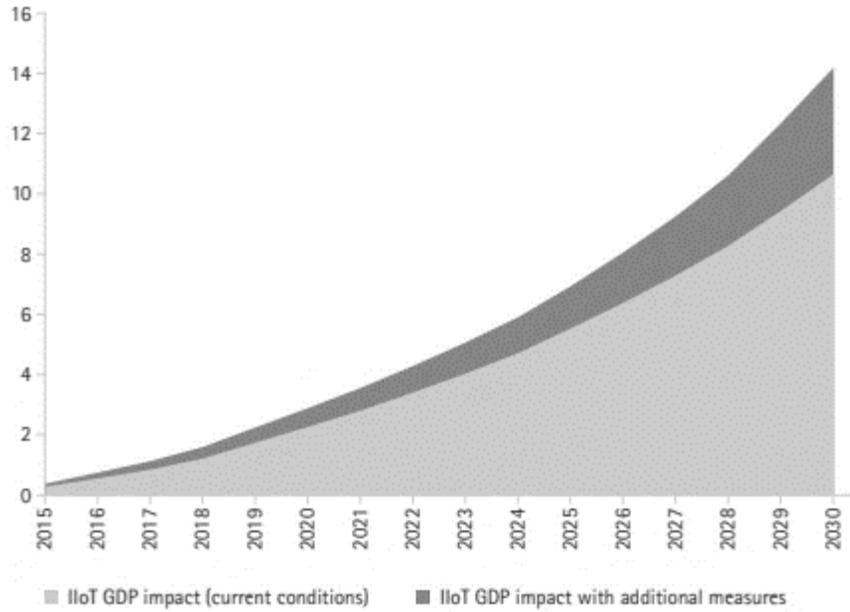


Figure 107: Cumulative GDP impact of IIoT for 20 countries (US\$ trillion) – Source: Accenture, „The Growth-Game changer: How the Industrial Internet of Things can drive progress and prosperity”, 2015

10.4 Threats

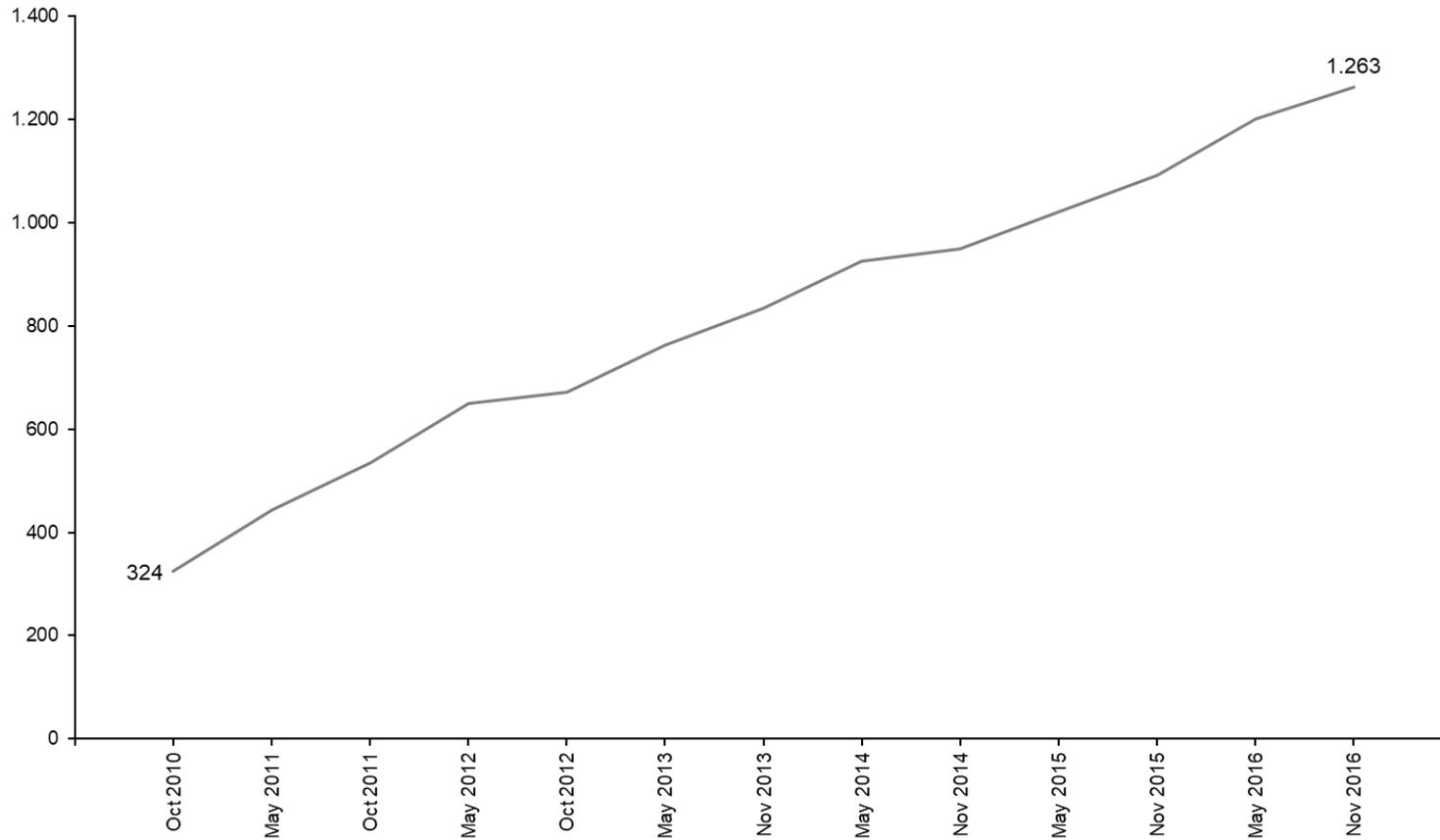


Figure 108: Number of trade-restrictive measures adopted by G20 members (#) - Source: World Trade Organisation Secretariat, World Bank

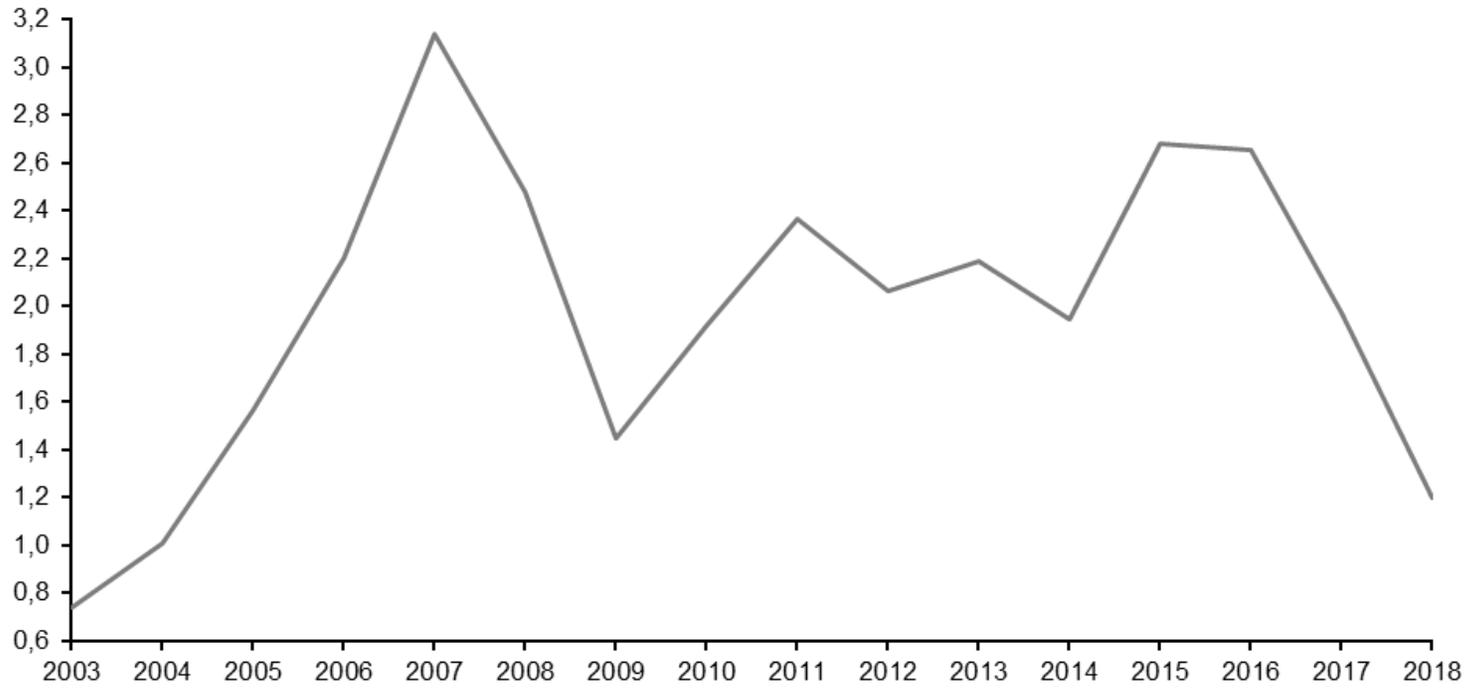


Figure 109: Global foreign direct investment inflows (trillions of dollars) – Source: Eurostat, Industrial production statistics, https://ec.europa.eu/eurostat/statistics-explained/index.php/Industrial_production_statistics#Overview

The current version of the document represents the 3rd Draft of Deliverable 2. This has been prepared in the context of the project “Digital transformation of the Greek Industry”, for the purposes of the Deliverable 2 in accordance with the signed contract.

© 2021 PricewaterhouseCoopers Business Solutions SA. All rights reserved. PwC refers to the Greece member firm and may sometimes refer to the PwC network. Each member firm is a separate legal entity. Please see www.pwc.com/structure for further details.

At PwC, our purpose is to build trust in society and solve important problems. We’re a network of firms in 158 countries with more than 250,000 people who are committed to delivering quality in assurance, tax and advisory services. Find out more and tell us what matters to you by visiting us at www.pwc.com.