Robotics and Artificial Intelligence Impact on Economies

Literature Review

April 2020

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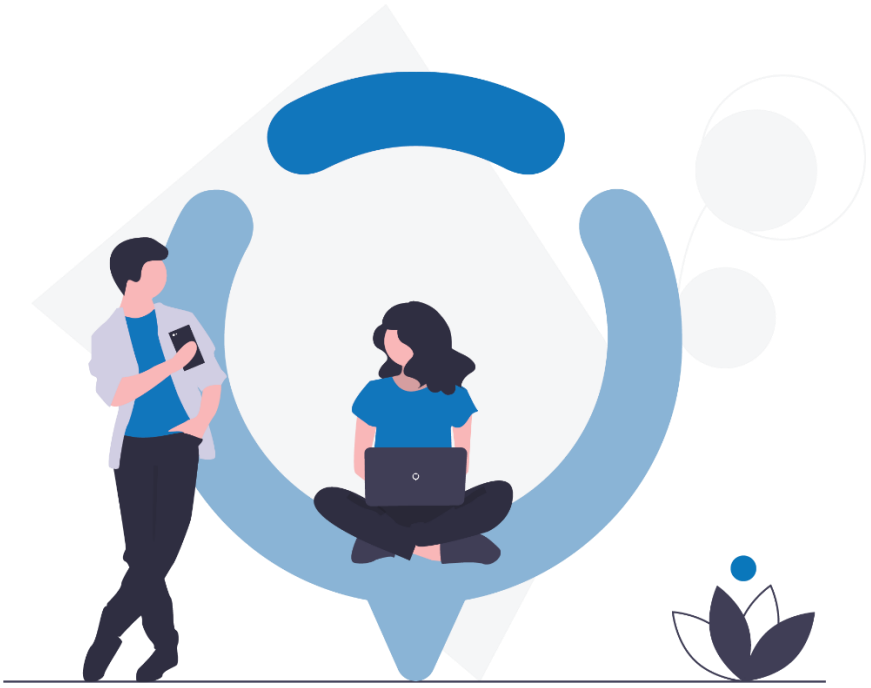

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Introduction

According to the European Union (EU) 2020 Robotics Strategy (Comission, 2010) , «robotics technology will become dominant in the next decade. It will influence all aspects of work and home. Robotics has the ability to transform lives and work practices, increase efficiency and safety levels, provide enhanced levels of service and create jobs. Its impact will increase over time, as will the interaction between robots and people».

The aforementioned article is the inspiration to bridge the path EU is taking regarding the implementation of industry 4.0 and the purpose of the Robots & SMEs project of developing a series of training and support tools for Small and medium-sized enterprises (SME) managers to enable them to assess the value of robots to their business development and sustainability and then effectively introduce them.

According to Servoz,M. (2019) since the genesis of industry 4.0 at the beginning of the decade of 2010, the various European governments and organisations have outlined a socioeconomic profile different from the previous, based on Artificial Intelligence (AI), Robotics, 3D Printing, Nanotechnology and the Internet of Things, which will have a major impact on companies and on how the economy affects people, societies and countries.

Although the outcomes of the ROB-SME project will be targeted at SME Managers in Europe this 'desk based analysis' document intends to present the current status of Robotics and Artificial Intelligence worldwide, as it is vital that activities in this field are viewed in the context of a worldwide setting.

Together with the European Perceptual Survey that has been undertaken by individual SME Managers throughout Europe this analysis will help inform and shape the outputs of the project.

The analysis looks at the sectors that have already adopted robots in their production processes and its impact; the existing training offers for the introduction of Robotics in companies; legislation and National (Policy at Manchester, 2018) initiatives to promote the adoption of Robots/AI in SMEs.

The answer to all these questions will underline the urgency of assessing the value of robots and AI in order to support the development of SMEs.

1. Definition of Robotics and Artificial Intelligence

Before analysing the impact of Robotics and Artificial Intelligence at world level, it is pertinent to define both concepts to avoid any ambiguity and to clarify the spectrum of this research. As stated by Policy@Manchester (2018), *although the challenges that companies and policymakers are facing with respect to AI and robotic systems are similar in many ways, these are two entirely separate technologies*.

Even though they can be merged in advanced systems, SME managers should be careful not to mix up them when developing policies for the future.

1.1. Robotics - definition

As maintained by MarketsandMarkets (2019), robots are programmable machines that perform physical processes and/or tasks and may be controlled by human action or by an Artificial Intelligence system (or by both). Robots are extensions to traditional machines with the capability to execute potentially complex processes, often equipped with sensing devices to identify aspects of their surroundings.

Robotic systems can be programmed to carry out several processes/tasks, such as:

- Performing repetitive industrial tasks such as moving materials, assembling parts, welding and painting, or loading other machines in factory environments.
- Collaborating with people in the workplace. Collaborative robots operate alongside humans in a shared workspace to jointly complete tasks (often by moving and handling heavy loads).
- Autonomously performing useful basic tasks for end-users, such as vacuum or pool cleaning.
- Carrying out difficult procedures with human control and supervision. Professional service robots that can be human-operated, semi-autonomous or fully autonomous with human supervision are used in complex applications, such as in surgery.
- Intelligent robots and autonomous devices are sometimes referred to as artificially intelligent robots. Combining advanced environmental sensing capabilities with AI analysis and decision-making, such systems can perform difficult processes for extended periods without human oversight. A prominent example in this category is an autonomous driving car.

1.2. Artificial Intelligence - definition

According to MarketsandMarkets (2019), AI could be perceived as the collection of programming and computing techniques carried out to simulate, and, in many cases, exceed, aspects of human-level perception, learning and analysis. It is often considered a part of computer science and implicates techniques that cover a range of different areas, such as:

- **Visual perception** – identification of specific objects or patterns from unprocessed image data (e.g. facial recognition systems).
- **Neural networks** – models of brain function, with applications in learning and analysis.
- **Speech and natural language processing (NLP)** – discerning meaning from written or spoken text (e.g. some translation *apps*).
- **Machine learning (ML) and deep learning** – training computer systems to improve their capacity to perform certain tasks based on examples. Learning systems are used in simple settings such as in recommendation algorithms that refine results based on user behaviour (e.g. Google and Netflix).
- **Expert systems** – tools that provide specialist information, in context, from existing databases and repositories for use by human operators (e.g. decision-support systems in healthcare).

Although these examples cover a diverse range of areas, state-of-the-art technology today is often referred to as *weak* or *narrow AI* as it is only tailored for small and specific tasks. A longer-term goal of some in the field is to create *strong AI*, also known as *artificial general intelligence (AGI)*, which would have much wider applicability and is the form of AI that appears most often in popular culture.

2. Robotics and Artificial Intelligence impact in the global economy

2.1. The impact of Robotics/Artificial Intelligence on the three economic sectors

2.1.1. Primary Sector

Agricultural Robotics is the logical proliferation of automation and cost-effective technology into biosystems such as agriculture, horticulture, and livestock. As stated by Mordor Intelligence (2019), the market is valued at USD 3.42 billion in 2017 and is expected to register a compound annual growth rate of 21.1%.

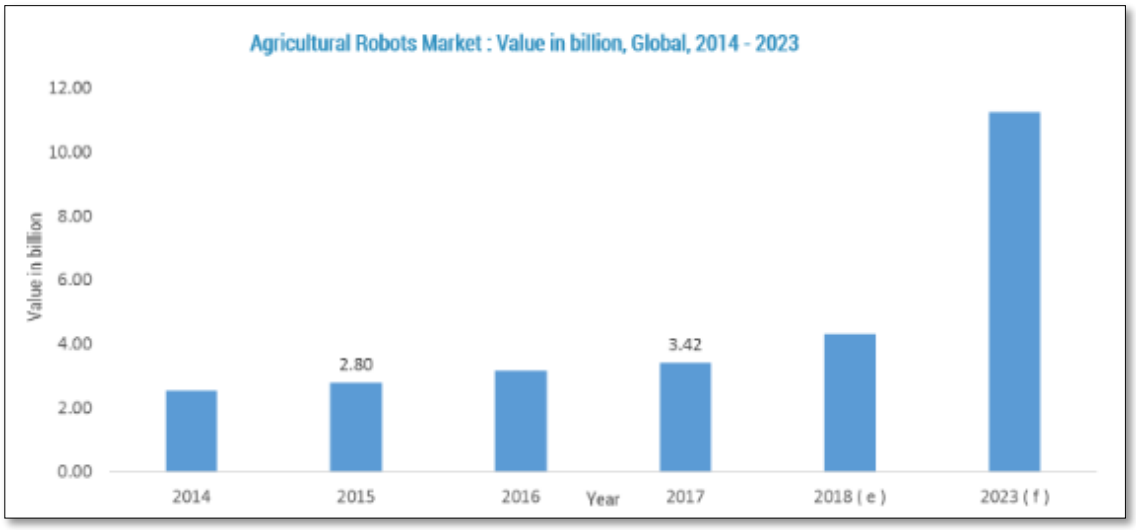

Image 1 - Agricultural Robots Market: Value in US$ billion, Global, 2014-2023. Source: Mordor

Robotics and automation are gradually becoming stronger in the agricultural industry. The most common applications of robots in agricultural fields include aerial data collection, filed mapping, seeding, and planting, fertilizing and irrigation, intercultural operations, picking, and harvesting, while others including dairy farming activities like milking, and shepherding. According to the International Federation of Robotics (2017), China, Republic of Korea, Japan, Western Europe and Germany, accounting for 74% of the total supply, mainly occupy most of the market.

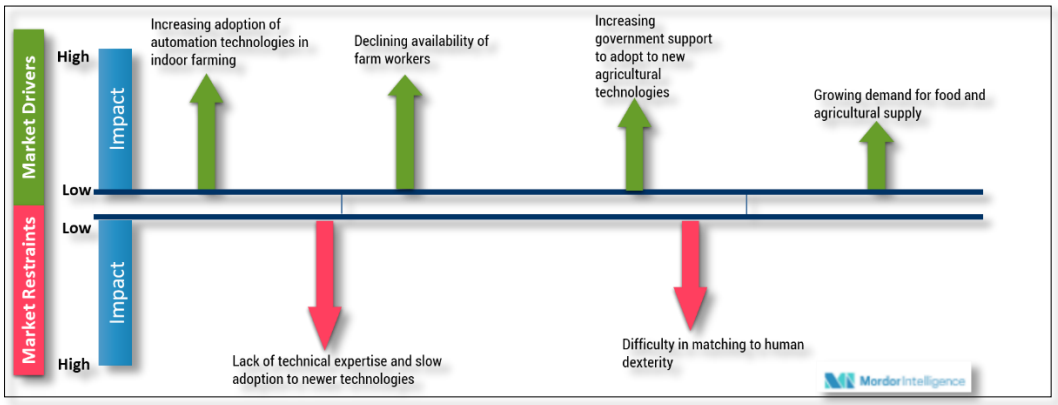

***Image 2** - Agricultural Robots Market Drivers and Restraints. Source: Mordor Intelligence*

Agricultural Robots Market Report Summary

Metrics	Details
Industry	Agricultural Robots Market
Study Period	(2014 – 2023)

Metrics	Details
Market revenue in 2017	USD 2.8 billion
Market revenue in 2023	USD 11.2 billion
Growth Rate	21.1%

Table 1 - *Agricultural Robots Market: Report Summary. Source: Mordor Intelligence*

Across the world, farmers are becoming older and older. According to the International Labor Organization (2014), agricultural workers as a percentage of the workforce went down from 81.0% to 48.2% in developing countries and 35.0% to 4.2% in developed ones by 2014. The shortage of people working on farms is growing globally. In the Asia Pacific region, especially in Japan, the number of people working in farms dropped from 2.2 million in 2004 to 1.7 million in 2014. Such a significant decline in the workforce of about 12.8% is also observed in the European agriculture sector, mainly due to lack of young farmers, due to the unattractiveness of such area. Thus, skill shortages are encouraging farming automation technologies.

2.1.2. Secondary Sector

Industrial environments are constantly changing as new business priorities and innovation opportunities arise. The current period is often called the fourth industrial revolution or Industry 4.0, referring to the potentially disruptive effects of several emerging and maturing technologies. As stated by Tarver (2018), the leading ones among such technologies are AI and robotic automation, which have the potential to revolutionise many aspects of industrial environments whether deployed separately or together. According to the International Federation of Robotics (2018), the global market for industrial robots has been estimated at over $40 billion in 2017, and is predicted to grow to over $70 billion by 2023.

Industrial robots play a key role in manufacturing industrial automation, with many core operations in several industries being performed by robots. With economic growth across regions, the growth of e-commerce, electronics, and the automotive industry, among others has been on the rise. Increased demand across economies, product manufacturers are adopting robots to automate some of the repetitive processes. According to the US National Institute of Standards and Technology (2016), more than 250,000 industrial robots had been installed in the United States alone, which gives an estimate of the penetration of industrial robots. The same source refers that the industrial robots market has been witnessing an impacting demand over the past decade, owing to the rising adoption of smart factory systems, of which these robots play a vital part.

Due to industrial robots becoming smaller and cheaper without compromising on the quality, the market is becoming more attractive for key players in the end-user industry. Therefore, and according to Image 3 and 4 below, the worldwide supply of industrial robots is rising. European countries, as Image 4 shows, are above the world average, while the Australia/Asia region is the fastest-growing market (Image 5).

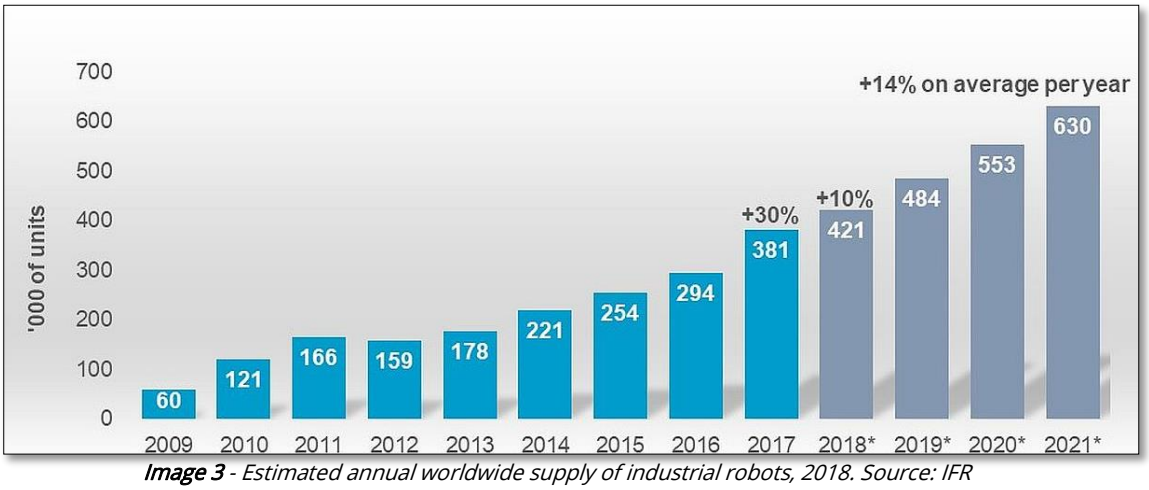

Image 3 *- Estimated annual worldwide supply of industrial robots, 2018. Source: IFR*

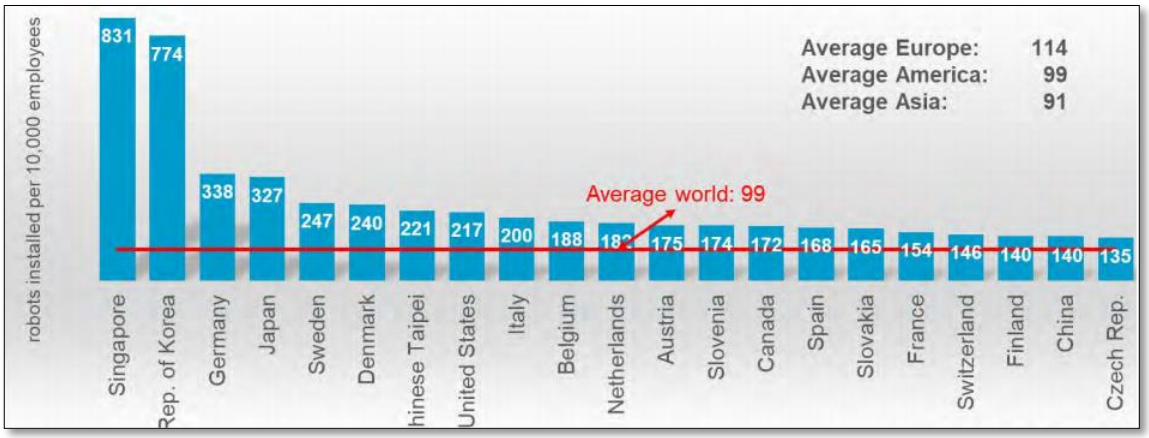

Image 4 *– Robot density in the manufacturing industry by country, 2018. Source: IFR*

IFR

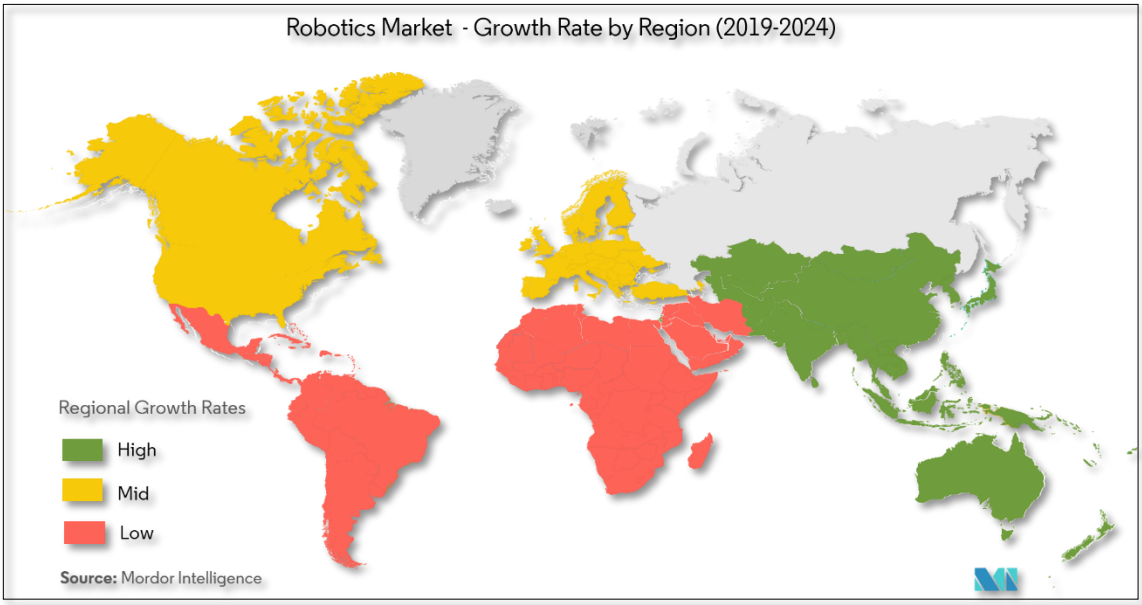

***Image 5** – Robotics Market – Growth Rate by Region (2019-2024). Source: Mordor Intelligence*

2.1.3. Tertiary Sector

International Federation of Robotics (2018) forecasts that sales of service robots will grow between 20 and 25 per cent by 2020. Having already significantly impacted the agriculture, surgery and logistics sectors, service robots are expected to offer greater assistive capability and value in the future.

By sales value, however, medical robots take second place after logistics robots, accounting for 30% of the value of total new sales of professional robots in 2018. Given ageing populations in developed economies, strong sales growth of 47% in units sold and 45% in sales value annually on average between 2019 and 2022 is forecasted for this category of robot (International Federation of Robotics, 2019).

Another fast-growing category of professional service robots with a promising future is public relations robots, which are used to provide information in shops and public spaces. The sales value of public relations robots increased by 28% in 2018 to just over US$ 158 million, with 40% growth forecast for 2019. The category personal / domestic robots covers robots used in the home for domestic tasks, entertainment and assistance. Sales of cleaning robots reached over US$ 2.4 billion, accounting for 67% of personal / domestic service robot sales value – a growth of 24% over 2017 (International Federation of Robotics, 2016).

The market for robots for elderly and handicap assistance is currently small, accounting for only 1.3% of sales value of personal / domestic service robots in 2018. However, this market is expected to increase by an average of 29% per year from 2019 to a value of around US$ 126 million in 2022. As in the professional service robot sectors, technology advancements in robot mobility, end effectors and vision technologies are driving adoption of robots in this sector

Different from the industrial robot sector, which is dominated by Japanese, Korean and German manufacturers, the US and Europe drive service robot development . In 2018, 44% of all service robot manufacturers are European companies, 35% are American firms, and 21% are Asian manufacturers. Around half of all logistic

system manufacturers are European companies, while US manufacturers have a strong presence in medical and defence robots. Asian manufacturers are the dominant producers of robots for domestic tasks and entertainment.

The dynamism of the service robot sector, illustrated by strong growth in 2018, is set to continue. The sales value of professional service robots is estimated to increase by 45% on average per year between 2019 and 2022, reaching a total of about US$ 38 billion in 2022. Meanwhile, the sales value of personal /domestic robots will increase by an annual average of 35% in the same period to just over US$ 11.5 billion in 2022 (International Federation of Robotics, 2019).

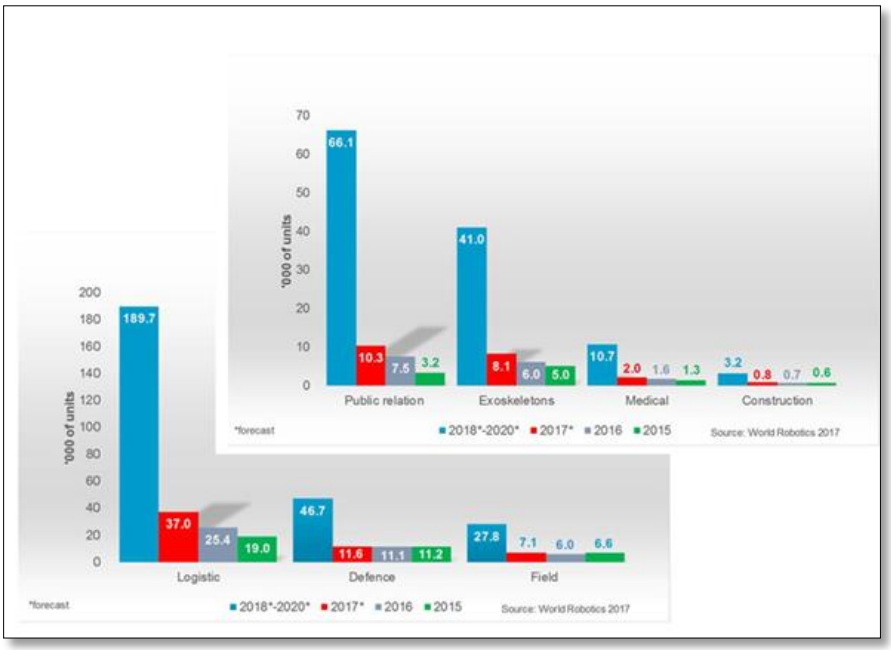

Image 6 *– Professional service robots main applications unit sales 2015-2017 and forecast for 2018-2020; Source: World Robotics Report 2017*

3. Global legislation, initiative and training policy regarding Robotics/Artificial Intelligence

3.1. A global overview

The role of governments, policymakers and regulators in dealing with the changes that AI and automation will bring is many-sided. Existing laws, standards and regulations for these emerging technologies will differ significantly across countries and territories, and approaches to supporting innovation while protecting workers and consumers will require the insights of experts from several fields (Policy at Manchester, 2018).

The wide-ranging applications of the technologies demand comprehensive sets of policies that cover, amongst other things:

- Industrial strategies and productivity;
- Human safety, legal liability and risk;
- Data use, privacy and security;
- Intellectual property development and protection.

Countries may have separate policy programmes for Robotics and Artificial Intelligence, or may combine them in large-scale industrial and research strategies, and existing laws will be challenged as new problems and opportunities come.

To provide context in this area, this section gives an overview of some of the prominent international approaches to developing effective policies for AI and automation:

United States of America (USA)

The USA was the first country to develop a genuinely comprehensive AI strategy.

Launched in 2016, the **National Artificial Intelligence Research and Development Strategic Plan** envelops AI, Robotics and related technologies, and was designed as a high-level framework to direct effort and investment in research and development.

Germany

Industrial manufacturing plays a major role in the German economy, and this has been reflected in government strategies for exploiting AI and robotics.

In 2013 an initiative to boost participation and capabilities in Industry 4.0 applications was launched, known as **German Plattform Industrie 4.0**.

In 2017 the German government built on this with a strategy specifically for the autonomous vehicle sector, advancing the country's position as a global leader in car manufacturing.

The United Arab Emirates (UAE)

In 2017 the UAE Government launched the **UAE Strategy for Artificial Intelligence**.

This strategic plan is a pioneering initiative in the Middle East region and includes a major focus on public sector services.

China

The Chinese economy has been boosted by manufacturing and exports for many years.

In order to follow this trend and ensure that country's infrastructure and businesses are on track to be competitive in the future, the **Made in China 2025** strategy was launched in 2015.

This is a comprehensive plan to upgrade Chinese industry, involving the development of new standards, capabilities and capacity for autonomous manufacturing processes.

Following this, in 2017 China released its **New Generation AI Development Plan** that detailed an approach to become the world leader in the field by 2030.

Japan

The Japanese government enacted the **5th Science and Technology Basic Plan** in 2016.

This wide-ranging strategy covered aspects of innovation and internationalisation critical to the Japanese economy.

Part of the plan included approaches for developing a smart, technologically advanced and highly connected society known as **Society 5.0**, involving emerging innovation such as the Internet of Things (IoT), AI and robotics.

This plan was followed in 2017 with an **Industrialization Roadmap** that detailed Japan's approaches to developing and commercialising AI (Ministry of Internal Affairs and Communications (MIC), Japan, 2017).

The European Union (EU)

The European Commission (EC) is leading a number of research, funding and regulatory programmes that aim to position the EU as a global leader in robotics and AI.

The EC has developed a public-private partnership for robotics in Europe known as **SPARC**.

SPARC has €700M in funding for 2014–2020 from the EC, and three times as much from European industry, making it the largest civilian-funded robotics innovation programme in the world.

United Kingdom (UK)

The UK Government has been developing a modern industrial strategy, involving investments in robotics and other Industry 4.0 technologies, suitable for a post-Brexit country. Industry 4.0 is expected to shape the UK supply chain and force firms to adjust to a new operating environment. Suppliers will have to employ systems and machines compatible with next-generation systems required by their clients.

In 2017 the UK also revised its existing **Industrial Strategy** in order to boost the AI sector and capitalise on its existing competitive advantages.

To grow the AI industry, four priorities were identified:

1. *Improve access to data by leading the world in the safe and ethical use of data and AI,*
2. *Maximise AI research to make the UK a global centre for AI and data-driven innovation,*
3. *Improve the supply of skills needed for jobs of the future*
4. *Support the uptake of AI to boost productivity.*

In 2017, UK R&D expenditure as a percentage of GDP stood at 1.66%, lagging behind both the EU 28 and G7 averages, and government funding is set to remain important. With the UK government aiming for this figure to reach 2.4% of GDP by 2027, the manufacturing sector will play a highly important role. Specially designed automated processes have been available to manufacturers for decades.

According to Allinson (2019), artificial intelligence and automation are the fastest growing components of Industry 4.0. Automation can be found in nearly every UK sector from manufacturing to logistics, with machines required to undertake repetitive tasks and control processes. The next stage of these processes will involve interconnected machines able to communicate and make decisions to optimise processes. According to the Made Smarter Review by BEIS, the adoption of Industry 4.0 will require a balance between productivity and job creation. For example, a 30% adoption rate between 2015 and 2025 is expected to create 475,000 jobs. However, a 50% adoption rate would be expected to generate 380,000 jobs over the same period. Approximately one-third of new jobs created are expected to be in IT, analytics and R&D.

UK businesses can benefit from a number of sources of government funding, including the Industrial Strategy Challenge Fund, and the National Productivity Investment Fund. Moreover, through Innovate UK, the Department for Business, Energy and Industrial Strategy provides funding and support for SMEs in particular, after identifying that smaller companies are key to realising the I4.0. This is important as SMEs often lack funding, and many are uncertain where to begin the process of upgrading to Industry 4.0. The uptake among SMEs has been slow because it has been difficult for innovators to demonstrate value to small businesses with limited budgets. SMEs are challenged to disrupt and bring innovative ideas to the forefront of manufacturing, aided by funding provided by Innovate UK.

As a result, more efforts have been focused on making digitalisation more accessible to SMEs without excessive cost and risk. In addition, Industry 4.0 could lead to opportunities relating to R&D tax credits aimed at encouraging more SMEs. Robotics is the fastest growing technology for Industry 4.0 in the United Kingdom, which is currently home to the strongest artificial intelligence and machine learning in Europe, involving over 200 SMEs. UK manufacturers are already actively adapting mechanical and electrical designs to ensure they are capable of future industry standards. Although Industry 4.0 is slow to gain traction among UK sectors, full implementation in the coming years is expected to lead to sustainable economic growth.

Slovakia

As stated by (Berger, 2014), who has mapped the extent of progress with implementing Industry 4.0 in different EU Member States in terms of "*industrial excellence*" (production/ process sophistication, degree of automation, workforce readiness and innovation) and "*value networks*" (high value added, industry openness, innovation networks and internet sophistication) Slovakia is part of *The Traditionalists*, countries judged to have a sound industrial base but few have launched initiatives to take them into the new industrial era.

In 2015, Slovakian companies installed 79 robots per 10,000 workers. However, these figures have doubled in two years, since 151 robots per 10,000 workers were registered in 2017, according to the data produced by the International Federation of Robotics (IFR).According to Jesný (2017), robots are mostly implemented in production, as in painting or welding, even though the IFR data stated that the metal industry marked the highest increase in setting up robots in 2016.A rapid growth in robotic automation has furthermore been observed in logistics and in the sector of service robots.

In many respects, Slovakia, as an industrial country, easily adapts to the Industry 4.0 concept. According to the (The Slovak Spectator, 2019) in an interview with Boris Duľa, CEO of the CEIT technology company, many Slovak-based branches are leaders in introducing technological innovations within their concerns, which focuses on Industry 4.0. He added that some of them even resemble pioneers in the implementation of innovative solutions, gaining the trust of the parent company in pilot projects.

The need for new technologies is reflected in the direction the country has embarked on. After the concept and action plan for smart industry was approved in previous years, the Economy Ministry now promotes and financially supports the area.

Bulgaria

According to Berger (2014), Bulgaria was considered "*A Hesitator*", in other words, a country considered not to have a reliable industrial base and suffer from severe fiscal problems that inhibit it from a future-orientation. The country has been at one of the last places in terms of introduction of digital technologies in economy and society according to the 2019 DESI (European Commission, 2019). In accordance with Jovanovski, Seykova, Boshnyaku & Fischer (2019), in order to promote the growth in Bulgarian SMEs, a national strategy "*The transformation of Bulgarian Industry – Industry 4.0*" is being introduced. Although the good ICT structure with high speed access; the grounded tradition in the ICT sector; the access to EU-funded programmes and the wide usage of Internet are considered as an advantage of the country and a sufficient basis for the implementation of I.4.0, Bulgaria still has a long way to go. One of the biggest obstacles before the country are the non-working ecosystem of innovations (science – education – innovations) and the lack of impact of R&D on the competitiveness of SMEs. A great opportunity is recognized in the ICT sector as it is defined to be the most powerful driver for growth in the industry as well as creating ICT clusters for industrial application in the country could accelerate the adoption of Industry 4.0 elements in SMEs. Another opportunity lies in the expansion of the networks for access of next generation (NGA) and the adoption of future internet applications based on e-services of high quality.

Portugal

According to the Portuguese Society of Robotics (2011), robotics has been present in Portuguese universities and R&D centres since the beginning of the 2000's, with excellent results, leading to the development of prototypes operating mainly as piloting projects in the agricultural sector and in the services sector. These two sectors have a plan to adopt them in the short term, although this entails some costs and scepticism from some leaders. As for the presence of robots in the industrial sector, Portugal is 24th in the world with 58 robots per 10,000 workers. However, considering the use of robots in the automotive industry (the leading industry in the country), Portugal reaches 767 robots per 10,000 workers in the sector, placing in the 7th place in the European Union. The country has more robots dealers than producers, which shows that Portugal is still in a phase of take-off and piloting. However, there is a large number of R&D centres, which shows that there is a lot of work in the area of Robotics research, with more and more projects in the pilot phases.

On the authority of the Innovation Finance Advisory within EIB Advisory Services (2019), historically, Portuguese companies have experienced lower levels of productivity, lower levels of investment (namely in innovation), and higher levels of indebtedness than other European countries. As in other markets, Portuguese SMEs largely depend on bank debt given their limited access to capital markets and limited alternatives (e.g. well-developed venture/angel investors, peer-to-peer lenders), as well as the historical preference of Portuguese SMEs for debt financing. Portugal has emerged from a crisis period with severe credit contraction that particularly hit SMEs, where total lending volumes shrunk, NPL (non-performing loan) volumes peaked, and funding costs increased. This likely postponed many investment projects, including digitalisation. While difficulties from the economic crisis persist (e.g. some SMEs still restructuring and with high or non-performing debt), recent economic growth has enabled these trends to reverse. In the past two years, investment levels and overall bank lending to the economy have started to recover. However, these new trends have not yet translated into improvements in productivity, which is a historical challenge for Portuguese companies' competitiveness, particularly in traditional sectors – and one where digitalisation can have a significant impact. Effectively, digitalisation and innovation are high on the Portuguese government's agenda. This is fuelled by recent public actions and

incentives, and economic growth. Numerous and diverse business associations and clusters play an important role in SME collaboration and integration, amongst others, to promote digitalisation (for instance, by disseminating best practices and use cases, promoting networking and the matching of buyers and sellers, offering training and advice). A small, but growing start-up ecosystem is also promoted via flagship events such as WebSummit, incubators and associations, and some venture capital finance (albeit with significant public support). Despite this, the overall level of digital adoption by the economy seems lower than the EU average as measured by aggregate rankings such as Digital Economy and Society Index (DESI), internet adoption and COTEC's recent I4.0 scoreboard. Demand for digital solutions from traditional SMEs seems more focused on digital technologies which improve sales channels (e-commerce being a growing area in the country) and efficiency gains (in production and administrative processes). The appetite of small businesses for bigger innovation programmes or R&D investments that are transformative for business models or geared towards new products and new markets is still limited compared to larger firms.

Ireland

McKinsey (2017) estimates that new digitally-enabled automation and artificial intelligence have the potential to bring a boost in GDP of €550 billion from 2016 to 2030 in nine European "digital front runner" economies, in which Ireland is included. According to a rigorous analysis of the digitalisation of the Irish economy (Innovation Finance Advisory at EIB Advisory, 2019) a two-speed digital economy was unveiled. While Ireland is already in a strong position, being among the most digitalised countries in the world (6th in the EU digital index DESI) for many years, the digital economy appears to run at two different speeds, with a small number of foreign-owned multinationals with high digitalisation levels and productivity, and traditional local SMEs, which are slower in supporting digital solutions to reduce costs, drive innovation and expand market presence. The DESI reveals the relatively high relevance of Ireland to Europe's digital performance and its high level of digital competitiveness.

The Irish government has unveiled a five-year Industry 4.0 strategy to help manufacturing firms to respond to technological change, available on the recently produced Ireland's Industry 4.0 Strategy 2020-2025, prepared by the Irish Government Department of Business, Enterprise and Innovation (December 2019). The plan includes €23.5 million of funding for the Irish Manufacturing Research (IMR) Centre, a joint initiative between Enterprise Ireland and the IDA, the government departments responsible, respectively, for economic development and inward investment in the country. According to the Irish government, strategy is geared towards the development of new digital skills and technologies in the country's manufacturing sector, and to drive collaboration between small, medium and large-sized enterprises.

The IMR funding, a 57 % increase on its previous round of funding, covers the period to the start of 2025. It will see the centre leverage further funding in the region of €43 million from industry and competitive sources by 2024. The centre will split funding across some research tracks, including digitisation of manufacturing, automation and advanced control, design for manufacturing, and sustainable manufacturing. Its goal is to "triple the number of training days and to increase the number of intellectual property commercialisations by 467%". The IMR Centre has several specialist production capabilities, including in additive manufacturing equipment, augmented and virtual reality (AR/VR), cobotics and "Industry 4.0 demonstration lines".

The manufacturing sector supports 227,000 jobs in Ireland, with 80% of those based outside of Dublin.

The government has also established a new group, Future Manufacturing Ireland, to coordinate with government-funded research centres in this space, and make it easier for companies to access expertise. A new Industry 4.0 stakeholder forum, with representatives from the manufacturing sector as well as Industry 4.0 expert has als (IE Department of Business, Enterprise and Innovation, 2019) (Allinson, 2019)o been convened to oversee implementation of the strategy.

The new strategy is part of Future Jobs Ireland, a cross-sector government framework launched in 2019 to address the skills gap in the country, and notably the increasing demand for science, technology, engineering and maths (STEM) related skills.

3.2. Training policies for the use of robotics in business in European countries

The true digital transformation requires companies and their leaders to be sufficiently open to innovation and entrepreneurship, challenging the established rules, retaining talent and anticipating trends. Therefore, companies must start by rethinking processes from the business model to the relationship with the customer (passing, of course, through internal processes). In addition to these challenges, there are others to consider, namely the investment in the qualification of human resources for new technologies and processes and, of course, in the capitalization of the business - to implement the necessary changes. To leverage this process of change and ensure a harmonious assimilation of Industry 4.0 equipment and practices, managers must be guided in this direction. In this way, bad investment of funds, inadequate resources and ineffective processes will be avoided. When purchasing, for example, a robot to be included in an assembly line, the manager will have to know how to deal with the technical part of its installation, repair and maintenance; with the purchase process of the machine, often of high cost and associated with credit requests and with all aspects related to the human resources that the arrival of a robot entails (changing schedules, possible dismissals, changing functions, changing procedures and routines, etc.). This whole process, to be successful, will have to be well implemented and sustained.

Several EU countries have already taken steps to leverage their companies through training for the new era of Industry 4.0, which could serve as inspiration in the design of the Robots & SMEs project manual. The two following approaches are considered two good examples of practical and simple approaches to inspire *Robots & SMEs* materials (SME United, 2018):

MKB: Dutch SME Employer Organisation

For the majority of entrepreneurs, innovation takes place by modifying certain processes on a step by step basis. MKB put in place services for its members especially in the areas of digitalisation that are most confusing for entrepreneurs and perceived as disruptive technologies: data economy, platform economy, robotisation and cybersecurity.

Data Economy

The first step in digitalisation is organising your own data. Every entrepreneur has access to information but it is often not usable, or it is unknown what it can be used for. This is why MKB-Nederland is cooperating with JADS (Jheronimus Academy of Data Science), which gives entrepreneurs knowhow in the area of big data. Students and entrepreneurs can find common ground in the creation of value with data science and business analytics. The collaboration focusses on an SME Datahub (a data platform at branch level, which is focussed on

competitiveness supported by data and the insights extracted from it) and an SME Datalab, a so-called 'data carwash' for SMEs, with which entrepreneurs can undertake business based on internal and external data in smarter and more efficient ways.

Platform Economy

Entrepreneurs respond through branch or regional association to the opportunities platforms offer. For example, the Dutch association of real estate agents (NVM) has built the platform Funda on which all houses for sale in the Netherlands can be found. Another example comes from the Dutch association of automobile repair shops (BOVAG), which developed its own platform for garage companies that is called Viabovag.

Robotisation

The Dutch metal producer association (Koninklijke Metaalunie) developed the programme Teqnow. The acceleration of production processes through the use of robots is important in this sector. In order to test how this would work out in practice, SMEs can borrow a robot from a pool, hence giving the opportunity to test advantages of working with a robot, and easing the step to invest in one.

Cybersecurity

In 2016 MKB-Nederland started a campaign in cooperation with the Ministries for Security and Justice as well as Economic Affairs, to support individual entrepreneurs as well as branch associations in combating cybercrime. With the project 'Safely doing business on the internet' (Veilig Zakelijk Internetten) entrepreneurs are able to test, among other things, the security of their digital environment. On top of that, it offers branch organisations the ability to inform their constituency about all aspects related to cybersecurity.

Confartigianato Imprese: Italian association representing SMEs and crafts

Following the decision of the Italian government to launch the programme "Industry 4.0" to invest in digital development, Confartigianato Imprese also decided to develop a programme of information, education and service for their members. The programme could take advantage of the right momentum as the incentives scheme set out in "Enterprise 4.0" has convinced even those SMEs that were more reluctant to start the process of digitalisation. A newly appointed delegate of the President for Digital Affairs and a newly created Steering Committee composed by artisans and Confartigianato staff members oversee the whole programme. Within the framework of this new programme, Confartigianato created an online portal aimed at regrouping all the information and initiatives. One of the initiatives within this programme is the setting up of a nationwide network of Digital Innovation Hubs (DIH) that act as a first contact point for SMEs that want to acquire new skills, information, and advice on how to digitalise their business and that need to obtain evidence on the incentives offered by "Enterprise 4.0". DIHs are run at local level by experts able to give advice on where to find the most suited competences and solutions. The most noteworthy example is Confartigianato Varese - ASARVA, that three years ago opened "Faberlab" within the premises of the association. Faberlab has performed a crucial role in providing education to schools and companies in all the aspects of digital transformation, with a particular focus on digital fabrication. In addition to local and regional hubs, local offices of Confartigianato also give direct assistance on e-commerce, organise tailor-made courses on digital transformation, provide specific services and develop educational material. Moreover, Confartigianato has contributed to the production of ad hoc guides to be distributed to local associations and members, for example the two editions of the "Practical guide to Industry 4.0 for artisans and SMEs" in collaboration with the University of Brescia and a "Practical guide for Industry 4.0 compliance" in collaboration with Conforma (The Italian Association of Certification Bodies). In addition, a national road show with more than 50 public events at local level with the aim to discuss the benefits of Enterprise 4.0 and of digital transformation is still in place since last year. Finally, Confartigianato Imprese

continues to collaborate with institutional actors and bodies to ensure that the needs of SMEs are correctly met in shaping digitalisation policies and in addressing public resources.

4. The 2018 International Federation of Robotics Report main conclusions regarding the Impact of Robots on Productivity, Employment and Jobs around the world

The International Federation of Robotics connects the world of robotics around the globe. Their statistical department is the primary global resource for data on robotics, as members come from the robotics industry, national or international industry associations and research & development institutes. Therefore, it would be unthinkable not to consult the most recent report developed by IFR in 2018, so to conduct part of this research, as it is quite enlightening as to the impact of robots on productivity, employment and jobs around the world. The following are the main findings from the report:

Robots increase productivity and competitiveness.

Robots enable companies to become or remain competitive. This is particularly important for SMEs, the backbone of both developed and developing country economies.

- Investment in robots contributed 10% of growth in GDP per capita in OECD countries from 1993 to 2016.
- A one-unit increase in robotics density (which the study defines as the number of robots per million hours worked) is associated with a 0.04% increase in labour productivity.
- The McKinsey Global Institute predicts that up to half of the total productivity growth needed to ensure a 2.8% growth in GDP over the next 50 years will be driven by automation.

Overall, the greatest threat to employment is not automation but an inability to remain competitive.

- Companies that employ technology innovations effectively are between 2 and 10 times more productive than those that do not, according to research by the OECD.

Automation has created jobs and increased wages

- Automation has driven a net increase of over 10 million jobs in the EU 27 between 1999 and 2010.
- Robots have increased wages without reducing hours worked.
- Jobs have grown faster in occupations using automation.
- Countries that invested more in robots lost fewer manufacturing jobs than those that did not.
- Countries with the highest robot density, mainly Germany and South Korea, have among the lowest unemployment rates.

Robots complement and increase labour: The future will be robots and humans working together

Robots replace labour but not jobs:

- Less than 10% of jobs are fully automatable;
- Automation of tasks within a job do not lead to a decrease in workers with that job: e.g. the introduction of ATM machines in the US did not lead to a decrease in bank tellers.

Governments and companies must focus on providing the right skills to current and future workers to continue positive impact of robots on employment, job quality and wages.

- Governments must invest in robotics research and development to gather the employment benefits of this rapidly growing sector. They must also provide the policy incentives and education systems to support the acquirement of skills needed to secure and thrive in jobs that are created or changed by the operationalisation of robots and automation.
- Companies must engage actively in appropriate retraining programmes for employees to equip them with appropriate skills.

These goals will not be easy to achieve and require **coordinated public-private sector collaboration**.

Conclusion

The growing expansion of industry 4.0, a concept that emerged in Germany in the early 2010s, was a key factor in increasing the density of robotic and AI instruments in various economic sectors around the world. In the primary sector, it is an industry that has moved from a valuation of $ 2.8 billion in 2014 to a forecast of more than $ 10 billion by 2023 and is mostly present in countries such as South Korea, Japan and Western Europe; In regard of the secondary sector, the global market for industrial robots has been estimated at over $ 40 billion in 2017, and is predicted to grow to over $ 70 billion by 2023, as industrial robots play a key role in manufacturing industrial automation, with many core operations in several industries being performed by them; the tertiary sector will also grow, as IFR forecasts that sales of service robots will grow between 20 and 25 per cent by 2020, having already influencing the, surgery and logistics sectors, service robots are expected to offer greater assistive capability and value in the future.

The role of governments, policymakers and regulators in dealing with the changes that AI and automation will bring is many-sided. Existing laws, standards and regulations for these emerging technologies will differ significantly across countries and territories, and approaches to supporting innovation while protecting workers and consumers will require the insights of experts from several fields. Countries may have separate policy programmes for Robotics and Artificial Intelligence, or may combine them in large-scale industrial and research strategies, and existing laws will be challenged as new problems and opportunities come.

The 2018 International Federation of Robotics Report main conclusions regarding the Impact of Robots on Productivity, Employment and Jobs around the world were that robots enable companies to become or remain competitive (this is particularly important for SMEs, the backbone of both developed and developing country economies); since the last decade of the 20th century until now, automation has created jobs and increased wages; robots complement and increase labour, as the future will be robots and humans working together and

governments and companies must focus on providing the right skills to current and future workers to continue the positive impact of robots on employment, job quality and wages.

Regarding training for business, this investigation has retrieved useful good practices which may be an inspiration for the product we will work on for the next two years. Since many EU countries are striving to take the train of Industry 4.0 due to SMEs lack of investment and know-how, many programs were created from public and private initiatives around EU countries, giving the feeling that leverage for industry 4.0 is a common will. In this way, the initiatives carried out by Dutch SME Employer Organization MKB are particularly noteworthy, since it puts in place services for its members, especially in areas that may raise more doubts in the process of modernizing a company (data economy, robotization, cybersecurity). With the support of think tanks like JADS, SME managers created SME Datahub and SME Datalab, to accomplish these challenges through the exchange of good practices and retrieving knowledge from well-known universities and research centres. However, it is in robotization that greater emphasis should be given, as the practice of SMEs borrowing a robot from a pool, hence allowing testing advantages of working with a robot and easing the step to invest in one is something that the ROB-SME partnership should think about. Another case study to consider is Italy. Within the framework of the "Enterprise 4.0" governmental new program, Confartigianato (the most representative Italian organization of micro and small businesses) created an online portal aimed at regrouping all the information and initiatives. One of the initiatives within this program is the setting up of a nationwide network of Digital Innovation Hubs (IHL) that act as a first contact point for SMEs that want to acquire new skills, information, and advice on how to digitize their business and that need to obtain evidence on the incentives offered by "Enterprise 4.0". In addition to this joint effort, the research and review work carried out by the partnership between Confartigianato and the University of Brescia is added, underlining, again, the idea that having an academic / research centre working together with businessmen is important to successfully implement an SME modernization process.

All other initiatives described in the Best Practices in Assisting SMEs with the Digital Transformation (SME United, 2018) report should be given special attention by the project team, all of which include good practices that can be inspiring when designing the best possible plan so that SME managers from across Europe can count on an organized, effective and reliable plan to catapult your business into this new era of modernity, the era of Industry 4.0.

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