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FRIEDRICH EBERT STIFTUNG

THE FUTURE OF WORK AND INDUSTRY 4.0 IN THE FACE OF MULTIPLE DRIVERS OF CHANGE

A report by Syndex for Industriall Global Union

December 2021

Photos : AdobeStock

Dear all,

We are pleased to publish our report on Industry 4.0. We hope that it will help you to understand the main challenges and provide input to your collective debate.

This is not a report that encompass all issues related to digitalization. It focuses on some specific aspects that are more relevant to industrial activities. That's why many issues (privacy, management algorithm etc.) are not covered here.

We would like to thank all the interviewees whom we met throughout this work. The helpful interviews supplemented our desk research. We also used our knowledge from previous studies as well as our sectoral analysis.

We hope to soon have the opportunity to present this report.

For Syndex

Emmanuel Reich
Fabien Couderc

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SUMMARY

With the invention of the printing press, human memory was entrusted to books, while intelligence was entrusted to machines.

Our emerging human organisation is no longer based on the printing press but on code and algorithms. Digitalisation is nothing but the conversion of information into a sequence of characters and numbers.

Pervading the entire economy and human activities, digitalisation is transforming whole sectors of the economy, probably with no economic activity excluded.

More generally, the most striking phenomenon underlying, encompassing and overhanging the above trends is the rise of software: «software is eating the world», to quote Mr. Andreessen, one of the designers of the first Internet browser. We could even add that «code is law».

Digital technology is ambivalent, arousing fascination as much as rejection. Like all technologies, digital technology is neither good nor bad in essence: all depends on power relations and the use made of it.

Modernisation, automation and productivity gains are not a recent phenomenon. However, something new and major is now taking place, made possible by the acceleration and convergence of several technologies.

Technological advances at work often become merged, leading to product and service innovations. Dominant underlying trends include 5G and ultra-high-speed broadband, the Internet of Things (IoT), cloud computing, big data, augmented reality, artificial intelligence, robotics and additive manufacturing.

All sectors of the economy and society are affected by digitalisation. Some, such as music, the press and the media, have already been totally transformed. Others, such as financial services, are currently riding the wave.

While digitalisation is hitting many sectors hard, things are a bit more complicated in the case of industry. Digitalisation is already transforming industrial companies, with many non-industrial functions (sales, accounting, recruitment, etc.) impacted.

But in industry, digitalisation is taking a particular form through the emergence of what some call Industry 4.0, the industry of the future or the smart factory. And this revolution is set to transform the way goods are designed, produced and consumed.

This transformation is only now beginning. Based on data, interviews and analyses, some first comments can be made:

The pace differs greatly from one country to the next, with some countries are clearly in the lead. In many cases, this is due to a strong industrial base combined with a clear industrial policy. Many developed countries have launched political initiatives promoting Industry 4.0, including France, Germany, Japan, the Netherlands, Singapore, South Korea and the United States. China is not the only developing country to be mentioned in this list. In Latin America, Argentina, Bolivia, Brazil, Chile and Costa Rica are among those countries having endorsed ICT plans or digital transformation strategies.

In Asia, India has long been at the forefront on account of its Information Technology Act adopted in 2000. The “Making Indonesia 4.0” plan or Thailand 4.0 plans show that several countries are tackling the issue of Industry 4.0, while other Asian countries such as Malaysia or Sri Lanka have adopted digital plans/ digital strategies.

But such national approaches are not enough, especially as there are great differences between sectors. The ICT sector for example has long been totally globalised, with just few differences between factories in North America, Europe – or Asia, the continent where most hardware plants are now located. And the leaders in the semiconductor industry, electronics, telecoms, or IT hardware continue to invest in new, modern, and efficient plants.

The globalisation of the automotive industry is much more recent and not yet not completed. While Industry 4.0 is being slowly implemented, transformation is only beginning, mostly in plants in the most advanced countries.

The mechanical engineering sector is partially globalised, though there are still differences between countries and regions despite the existence of many multinational companies. In the case of the energy sector, changes are impacting both production and distribution.

In all three sectors, large transnational companies have invested heavily. In many cases, plants in India, Indonesia or Vietnam are just as modern as those in the US or Europe.

The textile industry is a further case of a seemingly globalised industry with a worldwide supply chain. However, manufacturing plants in South Asia churning out garments for Western companies are not always very automated, meaning that Industry 4.0 remains theoretical, with little immediate impact.

At this stage, the link between the digitalisation of industry and the destruction or creation of jobs is still difficult to predict. However, changes are profound, with digitalisation progressively pervading all aspects of a company, both through investments in processes, production, supply chains and maintenance, and in the content of jobs.

Moreover, digitalisation cannot be limited to production activities: the expected impacts potentially affect all company functions, from R&D to sales functions, and including support functions.

These are all questions that trade unions must address in order for them to be prepared for these changes and avoid having them imposed on them. Digitalisation, like technology in general, is not neutral. Everything depends on the use made of it.

Some of these topics have already been addressed by unions. Some interesting initiatives have already taken place regarding the right to disconnect, organising workers from the 'gig economy' of trying to set up a social dialogue framework to tackle changes generated by digitalisation.

Social dialogue is developed most in Europe. In other regions of the world, it is difficult to find countries practicing social dialogue in depth. This is the reason why, when searching for initiatives involving social partners, they are found mostly in Europe, with Japan, South Korea and Singapore as possible exceptions.

Interesting initiatives have been launched in France or Germany for instance. In Europe, many unions have at least launched studies or set up monitoring centres to assess the impact of digitalisation. In some cases, innovatory initiatives have been launched.

This also applies when looking for good social dialogue practices in the field of digitalisation and its impacts at company level. Apart from agreements related to Work from Home (WFH), it is not easy to find cases of company-level social dialogue tackling the issue of digitalisation. While the right to disconnect is one of the most frequent issues, it represents just one small aspect of the whole issue of digitalisation. Though other agreements can be found, they are rare.

Digitalisation, like technology in general, is ambivalent. It neither induces any kind of determinism nor constitutes a natural order of things.

The use of technology is the result of political decisions. At company level, it is the subject of strategic/business decisions. Trade unions must not be intimidated by the technical nature of these choices. They must get themselves invited to the negotiating table.

CHAPTER 1

THE RISE OF INDUSTRY 4.0

#1 4TH INDUSTRIAL REVOLUTION (4IR) IN THE WORLD

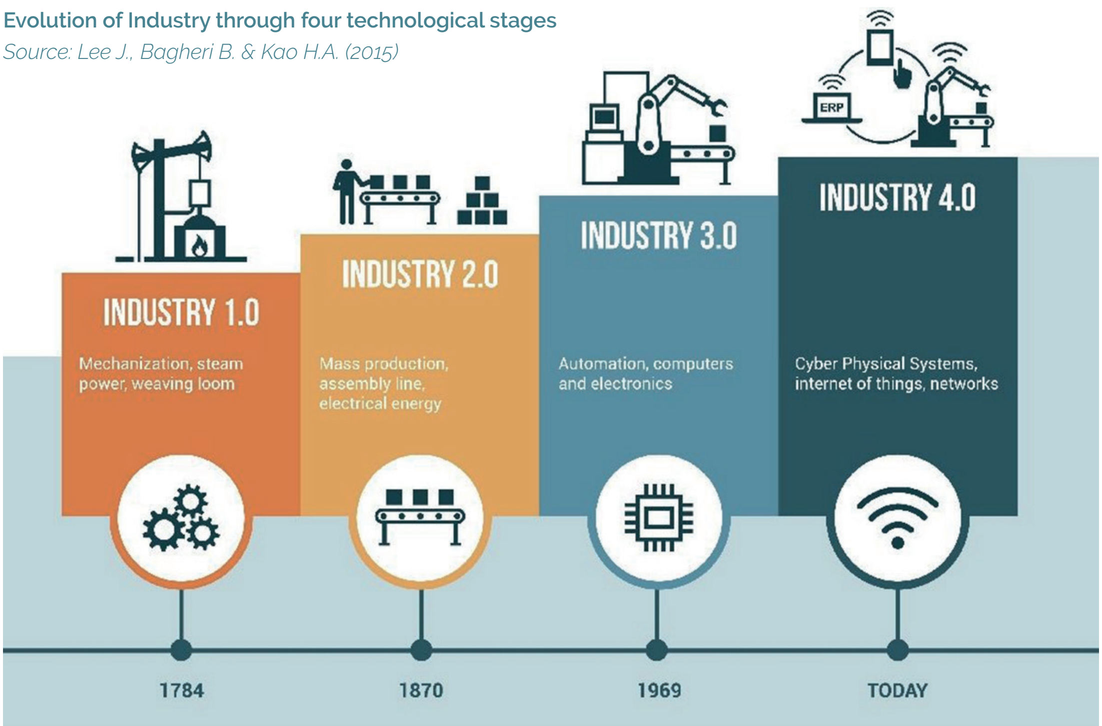
The term "industry 4.0" refers to the next developmental stage in the organisation of the entire value chain process in the manufacturing industry. It is also known as the "fourth industrial revolution" (4IR). The term of industry 4.0 was first introduced by the German government as a hightech strategy to promote the computerisation of its manufacturing industry. It is now widely used across Europe and Asia, especially in China. The terms "internet of things" (IoT) or the "industrial internet" are often used as equivalents in the United States and the English-speaking world. But the concepts stay the same: it is the recognition that traditional manufacturing and production methods are going through a digital transformation process. Industrial processes have increasingly embraced modern information technology (IT), but the most recent trends go beyond simply the automation of production that has, since the 1970s, been driven by developments in electronics and IT.

The widespread adoption by the manufacturing industry of information and communication technology (ICT) is increasingly blurring the boundaries between the real world and the virtual world, and is creating new production systems, namely cyberphysical physical systems[1].

Smart factories are at the heart of industry 4.0 and the 4th Industrial Revolution. They are factories that are connected, allowing a high level of reactivity and the ability to customise products:

- to customers (interconnection between order system/manufacturing order/production launch, collection of customer data, involvement of the consumer/customer/user/patient in the production process.)
- to suppliers, via shared logistics platforms for example: we now speak of an extended supply chain or collaborative supply chain, which refers

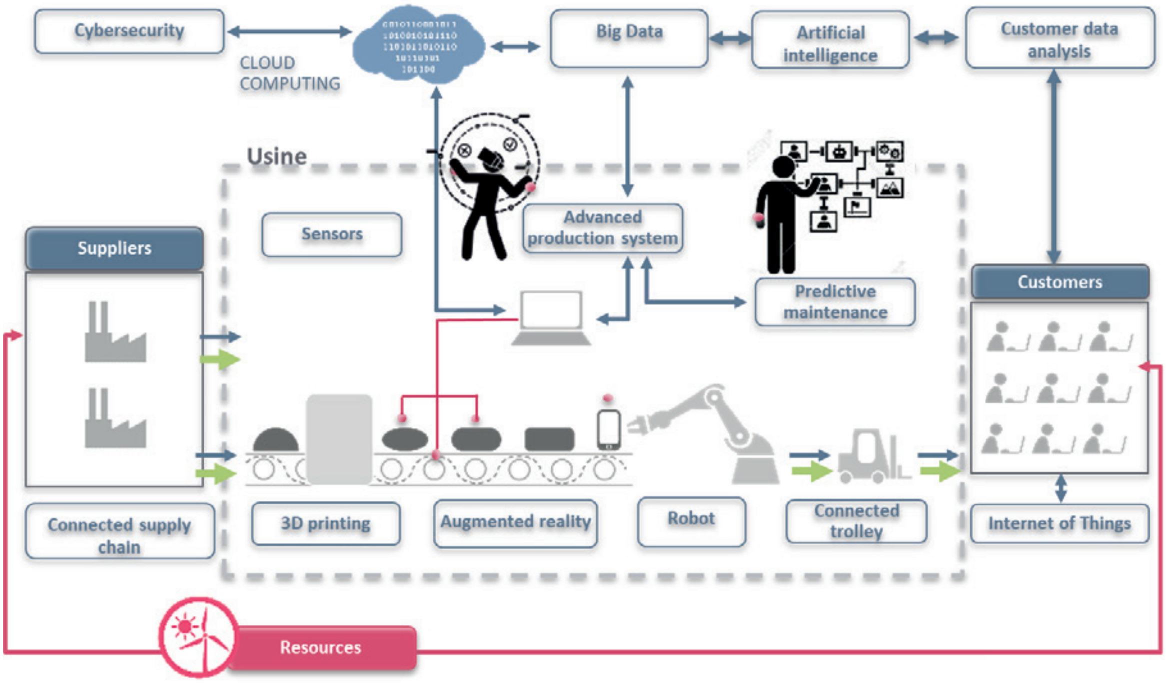
Evolution of Industry through four technological stages
Source: Lee J., Bagheri B. & Kao H.A. (2015)



1 Cyber physical systems (CPS): systems where computers drive physical elements.

The Smart Factory

Source: Syndex



to collaborative logistics strategies involving the company and its various partners.

- internally, via processes that enable an uninterrupted link to be established between all the stages of a product's production cycle, including design, commissioning of a production line, monitoring and optimisation of production, and data obtained in return from customers.

Those factories are characterised by :

- An infinite amount of data: big data + nano-electronics + sensors at all levels to connect the factory, for quality monitoring, for predictive maintenance... the challenge is to be able to collect, process, analyse, store, secure and use data on a large scale.
- Introduction of new technologies: 3D printing for prototype or production, automation of operations: robot, cobot, trolleys
- An awareness of the scarcity of resources and the concern to limit resources consumption and improve the ecological footprint

#1.1 A CONCENTRATION OF TECHNOLOGIES IN FEW FRONTRUNNER COUNTRIES

The 4th industrial revolution is not yet entirely global. One striking feature of the creation and spread of 4IR technologies is its extreme concentration in a handful of countries, especially with regard to patenting and exporting activity. Indeed, according to the United Nation Industrial Development Organisation (UNIDO), just four countries (the US, Japan, Germany and China) account for 77% of advanced digital production (ADP2) technology-related patents worldwide. If we add the following six countries, the share of patent reaches 91% of all global patent families. Ordered by their shares, these countries are Taiwan, France, Switzerland, the United Kingdom, the Republic of Korea and the Netherlands. Trade in capital goods related to ADP technologies, such as robots and 3D printers, shows a similarly concentration, with these ten countries accounting for almost

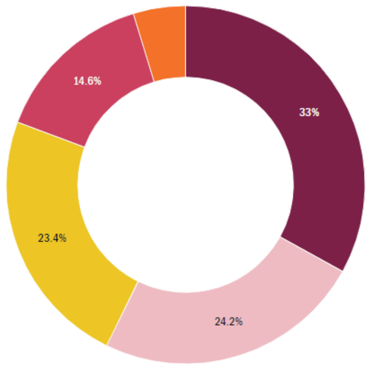
2 Technologies such as artificial intelligence, big data analytics, cloud computing, Internet of Things (IoT), advanced robotics and additive manufacturing.

70 percent of global exports and 46 percent of global imports in 2019[3].

Another group of countries are also engaging with these new technologies, albeit with lower shares. Some feature large shares of patents, including Israel, Italy and Sweden. Countries like Austria and Canada have high shares of exports. Conversely, Mexico, Thailand and Turkey have high shares of imports. The next 40 countries, after the ten aforementioned frontrunners, account for 8% of global patents and almost half of all imports of goods with embedded 4IR-related technologies.

Unfortunately, the rest of the world representing by far the majority of countries shows very little

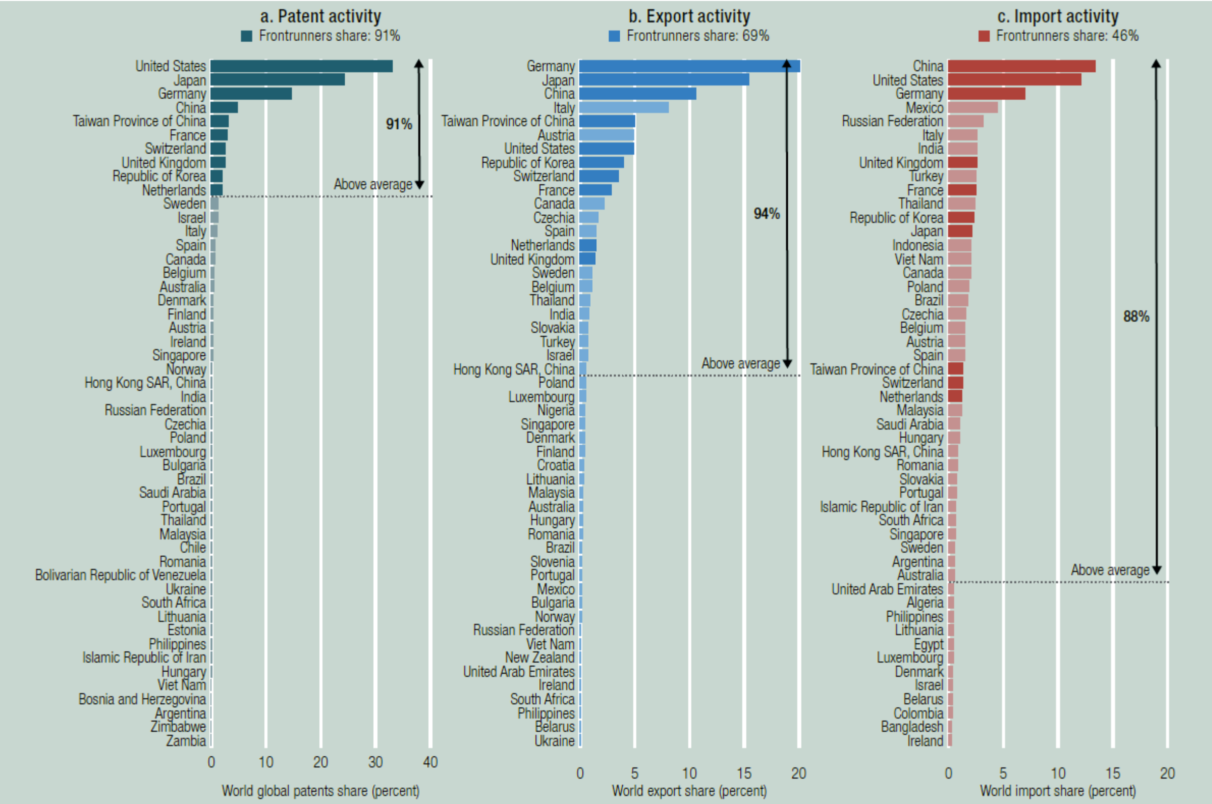
Share in global ADP-related patents



● United States ● Japan ● Germany ● China ● Rest of the World

Note: The shares are based on the cumulative number of global patent families in the last 20 years. Global patents are defined as those simultaneously applied for in at least two of the following patent offices: the European Patent Office, the United States Patent and Trademark Office, the Japan Patent Office and/or the China National Intellectual Property Administration Office.
Source: UNIDO Industrial Development Report 2020.

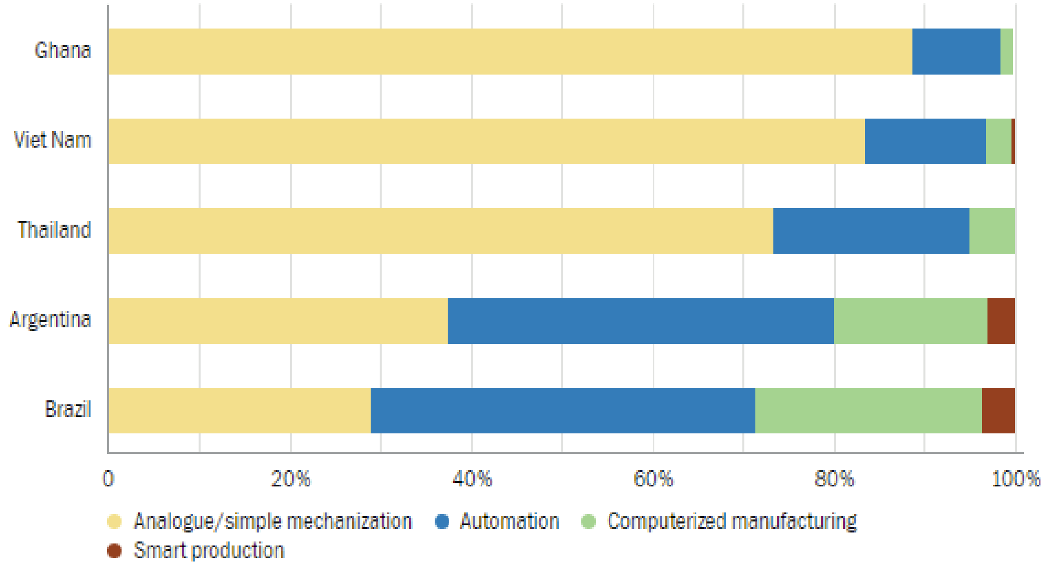
Patents and Trade Data, 2019



Note: Panel (a) refers to the cumulative number of global patent families in the last 20 years. Global patents are defined as those simultaneously applied for in at least two of the following patent offices: the EPO, the USPTO, the Japan Patent Office and/or the China National Intellectual Property Administration Office. Panels (b) and (c) refer to the average export and import values of capital goods associated with these technologies for 2014-16. The figure only shows the shares of the top 50 performers, but the averages are calculated considering all with non-zero values for each indicator. Source: UNIDO IDR 2020 Figure 1.12, page 48

3 United Nations Industrial Development Organization, 2019. *Industrial Development Report 2020. Industrializing in the digital age*. Overview. Vienna.

Adoption of production technologies in 5 selected countries



Note: Analogue/simple mechanization (or rigid production) refers to manual production and/or basic electronic stand-alone machinery with no or only specific use of basic digital technologies (e.g. internet for emails). Automation (or lean production) refers to automated production with the use of some isolated digital technologies (e.g. design software for product development and manufacturing). Computerized manufacturing (or integrated production) refers to the use of computerized process execution systems and internet based support for client and supplier relationships. Smart production entail the use of interconnected and internet-based digital production technologies associated with the 4IR.
Source: UNIDO Industrial Development Report 2020.

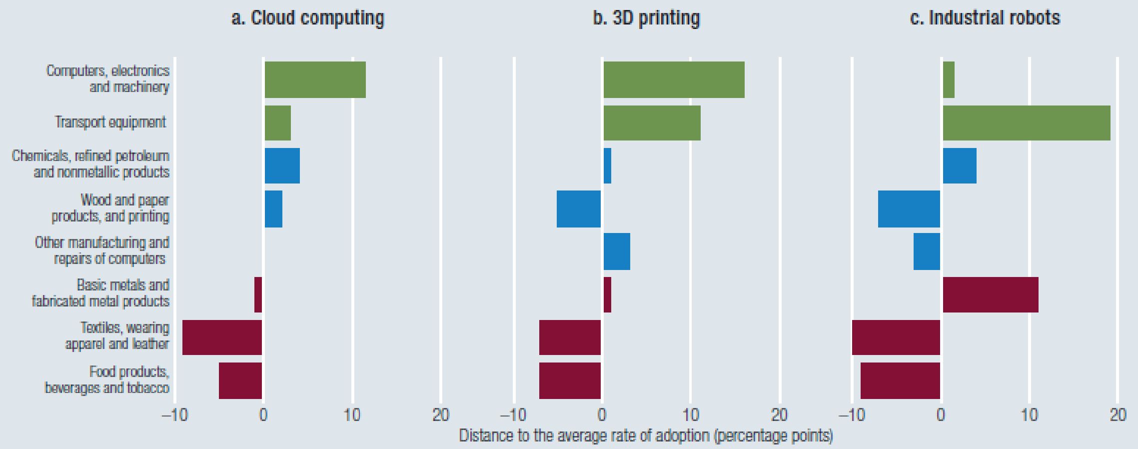
engagement with 4IR technologies. We can assume that there is a clear spillover effect explaining this concentration on the leading 50 countries: the more technology and digitally-intensive industries (such as computers and electronics) exist in an economy, the faster the spread of ADP technologies and the greater the build-up of experience and expertise will be, in turn accelerating further digitalisation.

The reverse logic is also worthy of being highlighted. Even where computerised manufacturing is adopted in a subset of industries in certain non-frontrunner countries, smart production technologies are relatively less developed. In Argentina and Brazil, for example, just 3% and 4% of companies, respectively, employ advanced digital technology, while in Ghana, Thailand and Vietnam, non-digital mechanisation accounts for most manufacturing processes. These economies are more likely to be characterised by less digitally-intensive industries, such as basic metalworking, food production and textiles.

In most countries, different generations of digital technology applied to manufacturing coexist, while those associated with 4IR have permeated only a small part of the sector. A lot of countries, especially in the developing world, have still not fully integrated basic automation and ICT, making the adoption of next-generation technologies more difficult. In least developed countries (LDCs) and low-income economies, the share of non-digital production remains significantly high.

Nevertheless, the globalised nature of value chains means that most parts of the world will be impacted by 4IR sooner or later, directly or indirectly, positively or negatively. But the ability to benefit from 4IR will be contingent on the availability (and affordability) of ADP technologies, together with the right level and combination of skills and industrial capabilities. Unless developing economies are able to fulfil these two requisites simultaneously, the accelerating frontrunner economies are likely to leave them further behind.

Trend of adoption of key ADP technologies in across industries in Europe, 2019



Note: All values are for 2018 and are aggregates for the 28 countries of the European Union. Rate of adoption is defined as the percentage of firms in an industry using a chosen technology. Due to data availability, chemicals is presented together with refined petroleum and non-metallic products (ISIC codes 19 to 23). The colours of the bars reflect the technology and digital intensity classification of industries. Green = TDI industries (industries that are simultaneously intensive on digitalization and technology). Blue = industries that are intensive on either digitalization or technology but not on both. Red = industries that are intensive on neither digitalization nor technology. The bars show the distance from the average rate of adoption in all manufacturing industries, in percentage points.
Source: UNIDO elaboration based on Eurostat (2019).

#1.2 THE SPREAD OF THESE TECHNOLOGIES IS ALSO CONCENTRATED AT COMPANY LEVEL

A wide gap can be seen in the adoption of ADP technologies between industries and sectors at a global level. Indeed, according to UNIDO, two sectors stand out in their uptake of 4IR technologies: computers and machinery, and, less intuitively, transport equipment. The computer and machinery industry features the highest use of cloud computing and 3D printing technologies, in front of the transport equipment industry. However, the latter tops the charts in its use of industrial robots in manufacturing. Looking at Europe (see chart below) the trend is obvious.

Size can also matter when looking at the uptake of ADP technologies. Indeed, large companies with higher investment resources tend to enjoy the technological and productive capabilities allowing them to adopt the new technologies. Even so, this is not always true: countries like Thailand are experiencing the adoption of advanced manufacturing technologies in a significant share of small companies[4].

4IR is set to greatly impact global value chains, even if the effect is as yet uncertain. On the one hand, 4IR-related innovations can improve trade logistics and lower transaction costs, making it cheaper and easier to offshore certain aspects of production. On the other hand, digitalised production technologies enable increased productivity and capacity utilisation at home, undermining the advantages of large-scale production formerly associated with fragmented global value chains. This is already leading to a small but increasing shift towards the backshoring[5] of production tasks. On the one hand, increases in productivity and capacity utilisation associated with 4IR technologies make labour arbitrage between high-income countries and offshoring locations less appealing, thus creating an incentive for backshoring. On the other hand, greater production flexibility and quality enable customised production in small batches at very low marginal cost, possibly opening up new markets to companies, particularly in developed countries.

4 Ibid.

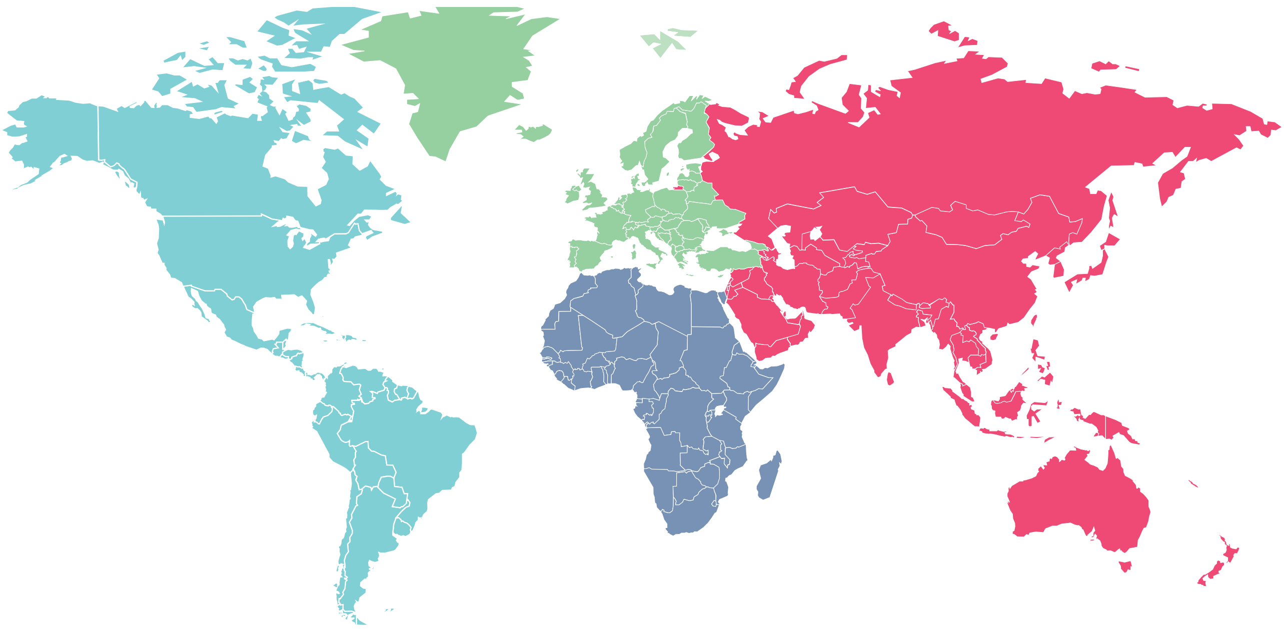
5 Dachs, B., & Seric, A. (2019). *Industry 4.0 and the changing topography of global value chains*. UNIDO.

#2 4IR DEVELOPMENT AND POLICIES IN DIFFERENT COUNTRIES

UNIDO's industrial Development report defines 4 broad types of strategy developed by countries with regard to the 4th industrial revolution:

- Managing the market (Most of the European Union, the USA, some ASEAN countries…): Articulate a "Digital Single Market" strategy (as the EU intends to do) and set a framework of rules within which technological change takes place while trying to ensure stability and a certain level of fairness for all.
- Taking control (China, in part Germany and the Republic of Korea…): Take ownership of new technologies and use them for national advantage, whether for economic and domestic political purposes or for more assertive ends.
- Open for Business (Singapore, most of ASEAN, some EU countries, in part the Republic of Korea, Ireland, the UK, Japan, Australia…): Governments, particularly (but not only) smaller ones, may not be able to control 4IR, but can choose to instead surf the wave, doing all they can to attract inward investment through attractive tax regimes, light-touch regulations, investment in infrastructure (such as 5G) and openness to trade with other parts of the world.
- Hands-off (none): governments radically downsizing by devolving more functions to regional and local levels, retaining only a few key functions, including defence and security, and foreign and trade relations.

Most of countries with a national strategy, or a dedicated 41R industrial policy combine a mix of some - if not all of - the first three strategies.



AMERICA
United States: Advanced Manufacturing Partnership; Institutes for Manufacturing Innovation
Canada: The Digital Charter
Brazil: National Strategy for Industry 4.0; Route 2030
Argentina: Digital Industrial Innovation 4.0
Mexico: Industry 4.0
Dominican Republic: Strategic Plan; Digital Agenda 2016-2020

AFRICA
EU-AU Digital Economy Task Force;The Smart Africa Alliance; One Network Area (ONA); A harmonised regional regulatory framework in ECOWAS; The regional programme for the Promotion of Digital Uses by the WAEMU; The Africa Skills initiative

EUROPA
France: Industrie du Futur
Spain: Industria Conectada 4.0
Germany: Industrie 4.0
Czechia: Strategy Industry 4.0

ASIA
China: Made in China 2025
Japan: Society 5.0
India: National Policy for Advanced Manufacturing ; National Strategy for Additive Manufacturing
Singapore: Singapore I4.0
Thailand: Thailand 4.0
Malaysia: National 4IR Policy
Indonesia: Making Indonesia 4.0

Australia: Industry 4.0 TF

#2.1 ASIA/PACIFIC

The Asia/Pacific region offers a very varied landscape with regard to the 4th Industrial Revolution, with the continent featuring a broad share of the frontrunners mentioned above (Japan, the Republic of Korea, China, Taiwan…). These economies are well on the way to combining digital technologies and advanced manufacturing processes.

Other countries like Singapore, and to a certain extent India, have been fast in reaping the benefits from these technologies and aim to accelerate their incorporation into their national industry. With his "Make in India" campaign, Indian Prime Minister Narendra Modi has laid the foundation for manufacturing lead growth. Indeed, while India's service sector has grown tremendously over the last few decades, most manufacturing sectors are still stuck with technology, equipment, and processes belonging to Industry 2.0. such as manual inputs, lack of ICT integration, and critical capability gaps[6].

At the other end of the spectrum, we see a very slow penetration of 4IR technologies in countries characterised by low productivity and labour-intensive industry, including a significant share of countries in the ASEAN region. Even though annual ASEAN exports increased 5.6% between 2010 and 2015 and the region is enjoying a strong influx of Japanese investment, its ambitions to progress towards advanced manufacturing could be hindered by low labour productivity. Labour costs in most ASEAN countries are lower than those in China — in many cases less than half of China's costs — but low labour productivity, except in Brunei and Singapore, erase this advantage completely.

Most new technologies in ASEAN countries is introduced through the value chains of big multinational players. To be attractive to multinational manufacturers and bolster its manufacturing economies, the region cannot compete solely on low wages. It must also focus on improving productivity, a move which will also support domestic improvements in wages and living standards. Viewed by some as a close rival to China, Vietnam for instance is 87% less productive than China with respect to output per daily wage7.

Some companies in the region have already begun introducing elements of these new technologies into their business models. Here are some examples:

- Infineon Technologies, a semiconductor company with a large presence in Asian countries, plans to invest more than $84 million in a smart factory in Singapore to test these technologies. The company expects to cut cycle times in half, increase productivity by 10% and save $1 million a year in energy costs through the investment.
- Malaysian energy group Petronas and Indonesian mining equipment maker PT Trakindo Utama have launched efforts to digitalise their operations and customer offerings.
- OMRON, an automation solution provider, has opened a $10 million Automation Center (ATC) in Singapore to help its local clients deploy their automation solutions.

Singapore seems to be at the forefront of digital initiatives in South-East Asia, notably because it aims to establish an environment for small companies dedicated to Industry 4.0 (e.g. start-ups), supported by the creation of Innovation centres focused on research and development. For instance, the Advanced Remanufacturing and Technology Centre (ARTC), jointly created by companies, government agencies and academic institutions, works with industrial partners, including such global brands as Siemens and Rolls-Royce, and local SMEs in aerospace, machinery, oil and gas, land transport, consumer goods and other industries.

6 Iyer, A. (2018). Moving from Industry 2.0 to Industry 4.0: A case study from India on leapfrogging in smart manufacturing. Procedia Manufacturing, 21.

7 McKynsey&Company, 2018. *Industry 4.0: Reinvigorating ASEAN Manufacturing for the Future.*

4IR Policies in Asia

In the preceding chapter, we noted that a significant share of 4IR "frontrunners" are located in Asia. Indeed, countries like China, Japan and South Korea have rolled out structured policies to support the rise of new manufacturing technologies, mirroring Germany's "Industrie 4.0". These efforts generally aim to give individual companies an initial boost before they become self-sustaining.

Some South-East Asian countries, including Singapore and Thailand, have also drafted plans for encouraging manufacturers to adopt Industry 4.0; otherwise, there has been little progress in implementing these road maps.

Selected policies focusing on the 4th Industrial Revolution

Countries	Policies
China	**Made in China 2025** promotes key technical breakthroughs in the manufacturing industry and increases competition in the manufacturing sector by transforming the large-scale global manufacturing approach from a resource-dependent, capital- and labour-intensive model to a strong innovation-driven model.
Japan	**Society 5.0 (Super Smart Society)** is a concept developed and promoted by the Japanese government. It focuses not only on the industrial sector but also on the social economy. It is linked to the 'New Industrial Structure Vision' (16) covering IT-related policies, including BD, IoT for 4IR and the IVI (Industry Value Chain Initiative). The policy focuses on robotics, mechanics, control and instrumentation – areas of strengths for Japan.
India	**National Policy for Advanced Manufacturing** together with the **National Strategy for Additive Manufacturing** drafted in January 2021. Focusing on 3D printing, the strategy aims at promoting the creation of a conducive ecosystem for design, development and deployment, and at overcoming technical and economic barriers for local manufacturers to seamlessly adopt Additive Manufacturing. It also promotes the creation of a **National Additive Manufacturing Centre** to lead national initiatives.
Singapore	**Singapore I4.0** provides strong industry-research-academic network programmes with various multinationals in Singapore to promote designated technologies, especially for in-the-field application. Targeting mainly 3D printing and AI, the policy focuses on the aviation, electronics, chemicals, biomedical, marine-plant and water industries.
Thailand	**Thailand 4.0** represents a combination of promoting industrial transformation and establishing an economic corridor in eastern Thailand. Ten industries have been targeted to serve as growth engines. The government is supporting an Eastern Economic Corridor, with three provinces receiving infrastructure investments and incentives to attract foreign investment.
Malaysia	The **National 4IR Policy** launched in July 2021 is aimed at increasing the country's 4IR readiness. Still at an early stage, it paints a strategy set to be backed by roadmaps, technology-related policies and sectoral initiatives
Indonesia	With its **Making Indonesia 4.0** roadmap, the government is targeting the evolution of five key sectors – food and beverages, textiles, automotive, chemicals and electronics – with the aim to boost exports and become globally competitive.
Australia	Launched in April 2016, **Industry 4.0 TF** is closely related to the National Innovation Plan. It aims to proactively absorb 4IR capacity for food/beverages, medical, oil/gas, mining, AM industries

#2.2 AMERICAS

Overall, the American continent has shown divergent scenarios in adopting new technologies linked to the 4IR. Few countries have a traditionally strong innovation system. Canada and the United States America perform well, while emerging economies such as Argentina, Brazil or Mexico are struggling on the technological, entrepreneurial or innovation ecosystems, and others such as Haiti need further support to turn the country into a thriving digital innovation ecosystem.

Looking at the latest data from the European Patent agency, United Stated is by far the most innovative world country in 4IR technologies, with a strong presence in all technology sectors of 4IR. In the last decade the growth rate of patents issued from the US has outpaced Europe and Japan.

The 4IR transformation of supply chains in Latin America and the Caribbean (LAC) is still in an early stage, even though large companies are at a higher implementation level than other enterprises.

According to the Inter-America Development Bank[8], the situation also varies a lot across sectors and countries in LAC countries. the LAC automotive supply chain seems more advanced in its transformation than that of other sectors. Looking by countries in the sector, Mexico is ahead due to its close geographic integration with US original equipment manufacturers, followed by Brazil. Following behind are Argentina, with lagging implementation due to its difficult economic context and Colombia.

At the other end of the spectrum, the textile and the food industry are at a low stage of digital transformation. The appliances supply chain is progressing in terms of its 4IR transformation, driven by integration needs with Asian manufacturers. It is especially true for Brazil and Argentina.

The LAC sub-region face challenges and barriers to the adoption of 4IR technologies:

- low labour costs: technology costs are falling, such that emerging country and cheap labour is losing its competitive advantage.
- the limited availability of technology locally which compels to seek advanced solutions overseas, resulting in higher costs and lower returns on investment.
- A skills gap and shortage of qualified workers.
- A deficit in modernization of key infrastructures (road and railway infrastructure, congestion in the access to ports, uneven technology adoption among logistics service providers…)

8 Inter-American Development Bank (IDB) and World Economic Forum. (2019). *Supply Chain 4.0 Global Practices and Lessons Learned for Latin America and the Caribbean.*

4IR Policies in America

Selected policies focusing on the 4th Industrial Revolution

Countries	Policies
United States	United Stated policies is largely private-driven, large Enterprise based, with government support. The **Advanced Manufacturing Partnership** promote innovative manufacturing. The **Institutes for Manufacturing Innovation** (IMI), a national network of linked manufacturing institutes, is specifically designed to foster Industry 4.0 in the country.
Canada	**The Digital Charter**. Since 2016, the Government of Canada has been developing a plan for economic growth that aims to create jobs, helping citizens gain skills for the future workforce and building innovation ecosystems.
Brazil	**National Strategy for Industry 4.0**: Developed by the Ministry of Industry, Trade and Services; programme is managed by the Brazilian Agency of Industrial Development to provide support to test new products in technology companies; additionally, the entity is currently working to define robotics standards and precision agriculture strategy. **Route 2030**: Developed jointly by the Ministry of Finance and the Ministry of Industry, Trade and Services, this programme is focused on a specific industrial policy and incentives to bring innovation to the automotive supply chain, including suppliers of auto parts and car manufacturers.
Argentina	**Digital Industrial Innovation 4.0**: spearheaded by the Ministry of Modernization with the objective of fostering the digitization of SMEs.
Mexico	**Industry 4.0:** Programme organized around three axes: Deployment of R&D centres focused on Industry 4.0 technologies applied to key strategic sectors; creation of innovative ecosystems; and organization of competitiveness clusters.
Dominican Republic	**Strategic Plan** of Ministry of Industry, Commerce and SMEs: Among its action plans, the programme identifies improvement of production processes, support for technology innovation in enterprises and workforce training. **Digital Agenda 2016-2020:** The agenda focused on increasing broadband coverage, integrated e-government services, and promotion of ICT development industries.

#2.3 EUROPE

Europe is a world leader in terms of digitalisation. However, there are significand disparities between regions, even within the European Union. We observe the same disparities in terms of policies, even though the European Union has designed cross-industry initiatives to foster digitalisation and Industry 4.0 in the 27 Member States.

Europe is one of the world's most advanced regions in terms of digital transformation, with a wealth of evidence to prove it. The latest IMD digital competitiveness report ranks 6 European countries in the top 10, while half of the top 20 countries are European. OECD data shows that European countries are among the leaders in terms of Research & Development indicators. The concept of the Fourth Industrial Revolution, or Industry 4.0, appeared in the public debate for the first time in Europe. The expression itself was born in Germany.

Nevertheless, a wide gap exists between countries. Although some European countries rank high in terms of digital development and although European averages appear higher than other regions, the reality is that there are very significant differences within Europe in terms of digital development. For instance, gross domestic expenditure on R&D per capita is 12 times higher in Sweden or Austria than in Romania. There are three times more researchers per thousand employees in Belgium than in Latvia. Of course, such indicators are only indirect when it comes to assessing industry digitalisation.

Other more direct indicators confirm the general picture of the disparities. Data from the International Federation of Robotics shows that robot density in the manufacturing industry is 2.2 times higher in Germany than in Slovenia. Similarly, the Digital Economy and Society Index, a composite index calculated by the European Commission that tracks relevant indicators on Europe's digital performance, shows that Finland, the country with the highest rating, performs almost twice better than last-placed Bulgaria. In greater detail, the Integration of Digital Technology index which measures business digitalisation rates Ireland 4 times higher than Bulgaria, while the Human Capital Index is 2.4 times higher in Finland than in Italy.

The implications of these disparities for the European economy are significant, further widening the inequalities between countries. When it comes to assessing the impacts of digitalisation, these differences have to be taken into account. Any generalisation for Europe as a whole will inevitably be wrought with nuances and exceptions.

In 2020, Syndex and IndustriAll European Trade Union carried out a survey of trade union perceptions of the level of digitalisation in 11 European countries. The result highlighted the above-mentioned disparities. When asked to assess the level of robotisation of industrial processes, trade unions from North-West Europe (Germany, Belgium, the Netherlands, Sweden, Finland) and South-West Europe (France, Spain, Italy) assessed it to be much more advanced compared to the answers provided by their peers from Central and Eastern European countries (Poland, Czechia, Romania).

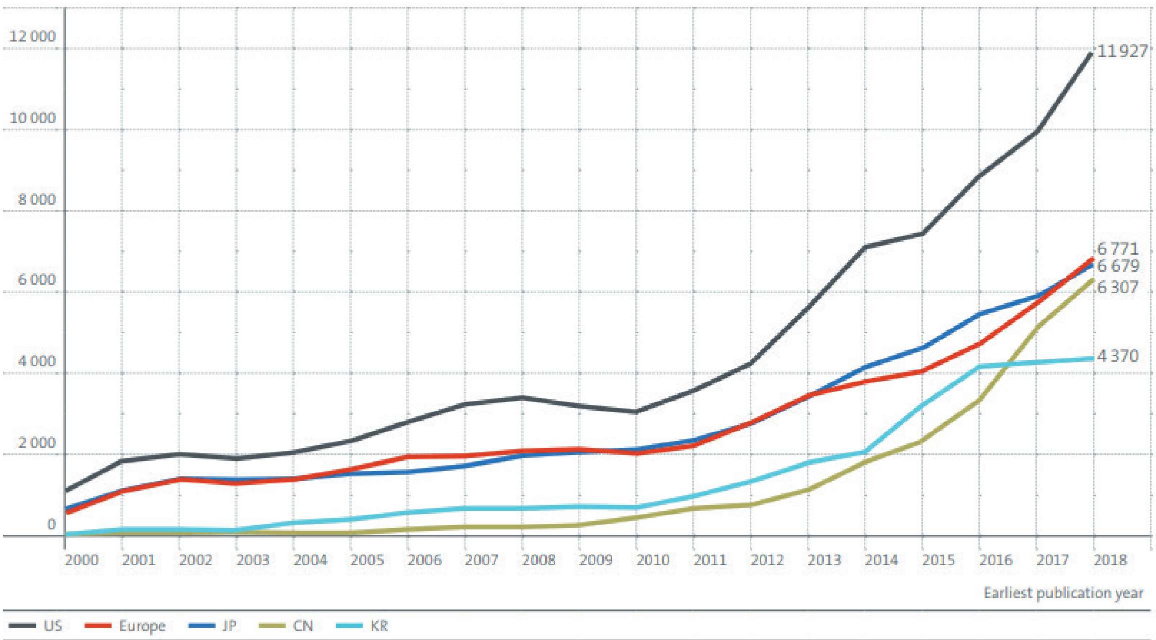
Even if the region is still at the forefront of the global race in advanced manufacturing, another feature of the 4th Industrial Revolution in Europe is that it is losing ground to the United States and some Asian countries like China, where growth of 4IR-related International Patent Families (IPF) is faster.

Compared to the United States, European companies show lower digital adoption rates. Most of the policies design at European level aim to correct this trend.

4IR policies in Europe

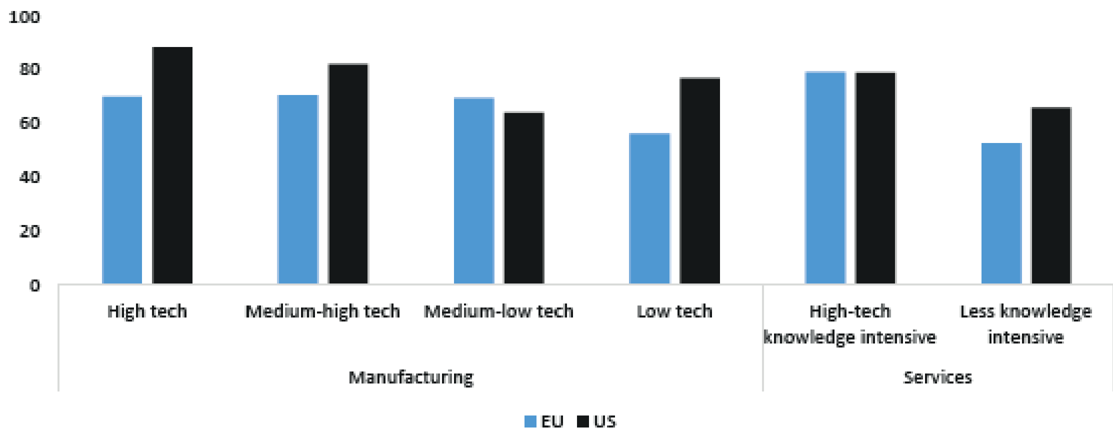
On 18 December 2020, the Council and the Parliament of the European Union reached provisional agreement on the €672.5-billion Recovery and Resilience Facility (RRF). The facility is at the heart of the EU's extraordinary recovery effort, NextGenerationEU

Growth of IPFs in 4IR technologies by global innovation centres, 2000-2018



Source: European Patent Office

Digital adoption (in % of all firms)**, by technology intensity of the sector**



Source: EIBIS 2019. *Note:* Eurostat aggregation of industry according to the technological intensity based on NACE industry classification at two-digit level. Firms are weighted with value added.

(NGEU), the €750-billion plan agreed by EU leaders in July 2020. With regard to digitalisation, the Recovery and Resilience Facility expressly states that National Recovery and Resilience Plans should earmark a minimum of 20% of the resources to foster the digital transition.

The European Commission also published its digital strategy aimed at to supporting national projects to achieve concrete target in 2030: for instance, at least 80% of the population with digital skills, double EU shares in the global production of high-tech semi-conductors, 75% of EU companies using cloud computing/AI/big data, more than 90% of SMEs with at least a basic level of digital intensity.

Selected policies in Europe

Countries	Policies
France	**Industrie du Futur.** Launched in 2015, the national plan Industrie du Futur (Industry of the Future) is a programme aiming to boost the modernisation of production tools and business models of industrial companies, via digital technologies. The plan has a strong sectoral dimension as the established framework allows for the conclusion of Sector Contracts promoting structural projects, especially on digital issues. In addition, the government wishes to set up platforms for accelerating towards the industry of the future, bringing together a sector's entire innovation ecosystem (large corporations, start-ups, research centres, universities) in a single physical location with a view to finding solutions in terms of innovation, training and support (financial, deployment, integration).
Spain	**Industria Conectada 4.0**. The national government's 'Industria Conectada 4.0' strategy was rolled out in 2014. Its main objectives are to increase added value and skilled employment in industry, to promote the industrial sectors of the 'future' by increasing their growth potential, to promote the local offer of digital solutions, and to develop a series of competitive levers to promote Spanish industry and its exports. It focuses on sectors with major spillovers and sectors presenting opportunities in the value chain. Priority is given to SMEs, especially medium-sized companies with international potential and a knock-on effect on Spanish companies, and medium-large companies with potential to be European and world leaders.
Germany	**Industrie 4.0.** Germany has been a pioneer in addressing industrial igitalisation . Plattform Industrie 4.0 offers a comprehensive framework for manufacturing innovation through Industry 4.0 with the aim of maintaining the competitiveness of German manufacturing (especially mechanical engineering) and building a factory that creates future factories around the world. The strategy is very much oriented towards medium-sized companies. The platform itself is steered and led by the Federal Ministry for Economic Affairs and Energy, the Federal Ministry of Education and Research and high-ranking representatives from industry, science and the trade unions. The Platform promotes the development of Industrie 4.0 by developing pre-competitive concepts and solutions and putting them into practice, supporting companies with recommendations, sharing good practices and feeding ideas into the international Industrie 4.0 discourse, and participating in international standardisation processes.
Czechia	**Strategy Industry 4.0**. The Action Plan for the Development of the Digital Market (2015) deals with the potential impacts of digitalisation on the Czech economy and society as whole. Since its launch, numerous initiatives have been developed on various topics: a national strategy "Industry 4.0" was published in 2016 outlining measures aimed at boosting the country's economy and industrial base. The strategy was based on an extensive report analysing the consequences of digitalisation on industry and labour.

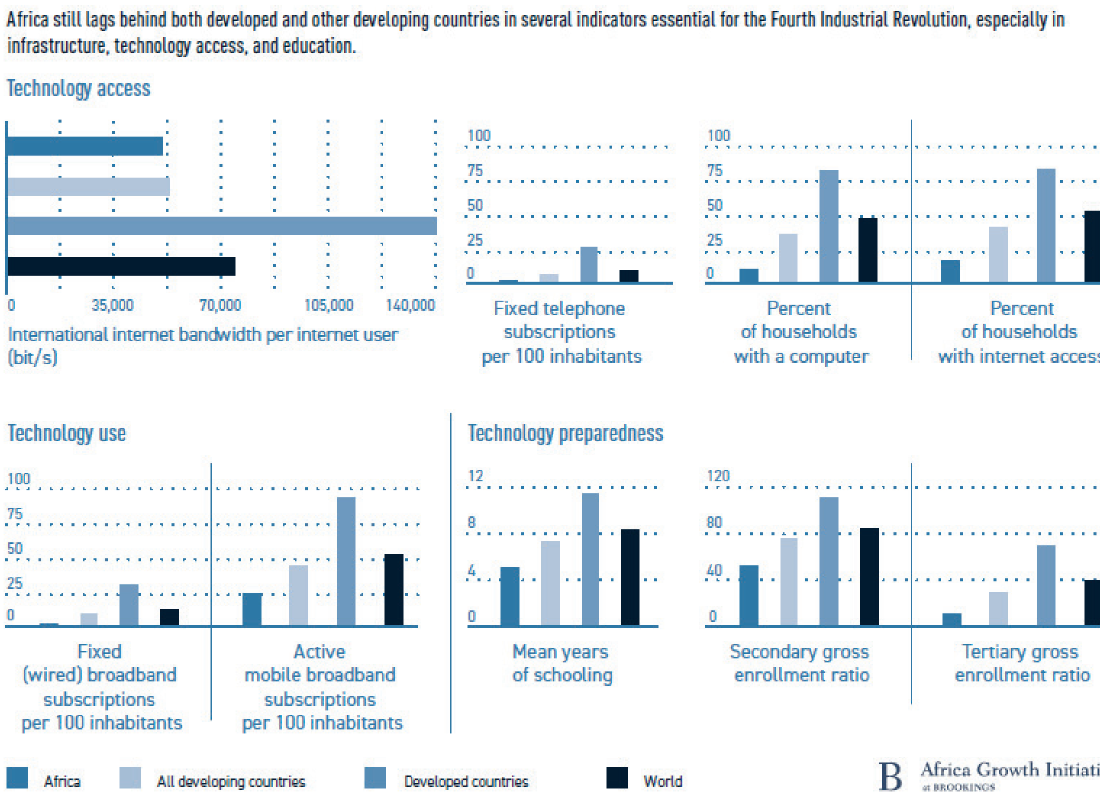
#2.4 AFRICA

The African continent benefits from substantial advantages helping to make the 4th Industrial Revolution a success. 4IR is a real opportunity to address some of the structural issues faced by the continent. By 2030, Africa's potential workforce is set to be among the world's largest. Paired with the necessary infrastructure and skills for innovation and technology use, 4IR represents a massive opportunity for growth. Nevertheless, several threats and hurdles have to be tackled to harness this opportunity and improve employment and working conditions.

Digitalisation is expanding fast in Africa, especially through mobile devices. Improvements in Africa's ICT sector have been largely driven by expanding mobile digital financial services. The region featured nearly half of the world's mobile money accounts in 2018 and is set to enjoy the fastest growth in mobile money through 2025. Mobile technologies and services have already generated 1.7 million direct jobs (both formal and informal) and contributed to $144 billion of economic value9 (8.5 percent of the GDP of sub-Saharan Africa).

Looking at the health sector, mobile technology has become a platform for improving medical data and service delivery. For instance, some 27,000 public health workers in Uganda use a mobile system called mTrac to report stocks of medicines. A public-private partnership, the SMS for Life programme reduces medicine shortages in primary health care facilities by using mobile phones to track and manage stock levels of malaria and other essential drugs. Rwanda has become the first country to incorporate drones in its health care system, using autonomous air vehicles to deliver blood transfusions to remote regions. IBM

Africa ICT's indicators



Sources: Hebatallah Adam, "The Digital Revolution in Africa: Opportunities and Hurdles," Proceedings of the 10th International Conference on Digital Strategies for Organizational Success (2019) and International Telecommunication Union, Measuring the Information Society Report: Volume 1 (Geneva: International Telecommunication Union, 2018).

9 Ndung'u, N., & Signé, L. (2021). *Capturing the fourth industrial revolution.*

Research Africa is also using AI to determine the optimal methods for eradicating malaria in specific locations and using game theory and deep learning data analytics to diagnose pathological diseases and birth asphyxia.

But artificial intelligence (AI) and blockchain are also attracting interest in Africa, as they have the potential to successfully address social and economic challenges there. The spread of digital technologies can empower the poor through access to information, job opportunities and services that improve their standard of living. AI, the Internet of Things (IoT), and blockchain can enhance opportunities for data gathering and analysis for more targeted and effective poverty reduction strategies. For example, in West Africa and Kenya, blockchain has enabled the efficient verification of property records and transactions, and expanded access to credit in some previously informal sectors of the economy.

Turning to fintech, digitalisation has gone beyond the financial sector to affect the real economy and households, transforming product design and business models across market segments. Businesses are able to design products and trade online, and individuals are able to operate financial services and payments for shopping and investments.

Africa has yet to harness the full potential of 4IR technologies in the agricultural sector. With farming accounting for 60 percent of total employment in sub-Saharan Africa, information on competitive pricing and crop monitoring, disease prevention tips and disaster mitigation support have the potential to support the agricultural sector and improve incomes, production and demand throughout the continent.

Nevertheless, such potential is accompanied by risks, especially regarding the replacement of low-skilled workers — who account for a high share of workers in Africa — with higher-skilled workers, a circumstance restricting 4IR participation to economies with relevant skills.

Infrastructure is also a significant issue. Access to advanced technology in Africa is constrained by infrastructure parameters such as a lack of electricity and low rates of teledensity, internet density and broadband penetration. Similarly, the lack of adequate investment in research and development is an important obstacle.

Policy initiatives in Africa

4IR technologies are still at an embryonic stage in most parts of Africa (apart from a few targeted areas). Nevertheless, the continent features a range of policy initiatives aimed at preparing the ground for adopting such technologies.

Looking at policies for the continent or specific regions, many of them do not specifically target Industry 4.0 but focus on regulating the ICT sector for better mobile and internet access, an important enabling factor for the adoption and use of 4IR technologies.

At national level, few countries have targeted initiatives. **South Africa** is an outlier here, featuring an initiative dedicated to 4IR technologies. It has established a Presidential Commission on the Fourth Industrial Revolution to develop an integrated national response strategy. Made up of representatives from various stakeholders (tech start-ups, academia, cybersecurity specialists, researchers, social scientists, trade unionists…), the commission works on issues such as infrastructure and resources, research, technology and innovation, human capital, industrialisation, and policy and legislation. Moreover, the South African Department of Trade and Industry established a Chief Directorate for Future Industrial Production and Technologies as early as 2017 to examine the impacts of emerging digital technologies (Internet of Things, Big Data, AI, robotics and new materials). Set up in 2018, the Intsimbi programme focuses on the development of skills and SME competitiveness. In addition, a Digital Industrial Revolution National Coordination Committee has been set up. South Africa is also a member of a BRICS (Brazil, Russia, India, China, South Africa) working group on the future of work, focusing on the development of skills.

We can find few other examples of initiatives. In 2017, **Rwanda**, in partnership with Inmarsat, the provider of global mobile satellite communications, set up a centre for the Internet of Things (IoT). The programme aims to accelerate the deployment of IoT and smart city solutions. In March 2019, **Morocco** and UNIDO signed the Programme for Country Partnership for Morocco (PCP Morocco), focusing on several priority industrial sectors and areas, namely industrial zones, agro-industry, energy, the circular economy, Industry 4.0 and e-commerce.

Continental and regional initiatives in Africa

Name	Description
EU-AU Digital Economy Task Force	The European Commission and the African Union (AU) Commission launched this Task Force in 2018. Made up of 20 African and European decision-makers and representatives from the private sector, the international financial sector and civil society, the task force produces policy recommendations for improving digital integration in the continent.
The Smart Africa Alliance	The overall objective of the alliance is to significantly increase socio-economic and business exchanges whilst bringing down the cost of communication within and between the participating countries. A pan-African organisation, it covers 24 African countries and is supported by the African Union (AU), the ITU, the World Bank, AfDB, ECA, the GSMA, ICANN and the private sector. It aims at enabling regulators to work more closely, to support the digital transformation agenda, to stimulate the technological revolution on the continent and to create a single common digital market in Africa. Furthermore, Smart Africa members develop flagship projects on various themes related to 4IR (High-tech parks, smart cities, smart energy, digital literacy..to name a few)
One Network Area (ONA)	Initiated in Eastern Africa under the Northern Corridor Agreement, this is a roaming initiative aiming to promote regional integration by bringing down the high cost of mobile roaming. More precisely, the initiative wants to eliminate charges for receiving voice calls while roaming in Kenya, Rwanda, South Sudan and Uganda by getting regulators to cooperate.
A harmonised regional regulatory framework in ECOWAS[1]	This regulatory framework lays the foundation for the development of 4IR technologies, namely those related to cybersecurity, data protection and e-commerce. The plan is to review and revise it in the future to take account of the latest technology advances.
The regional programme for the Promotion of Digital Uses by the WAEMU[2]	This programme is structured around three pillars: - Increasing the digital service offering. - Improving user access to digital services - Strengthening the governance of the digital economy sector. WAEMU is also working on the regulatory framework for the development of emerging technologies, including blockchain, cloud computing and AI.
The Africa Skills initiative	Set up by the World Economic Forum's Africa Regional Business Council, the initiative supports public-private dialogue for reforming education systems and labour policies with a view to preparing African workforces for 4IR.

1 Economic Community of West Africa States
2 West African Economic and Monetary Union

CHAPTER 2

INDUSTRY 4.0 AND ITS IMPACT ON JOBS AND WORK

In industry, digitalisation refers to everything that contributes to the modernisation of production tools in the age of digital technology and connected objects ("industry of the future" or "Industry 4.0"). It concerns all areas: the design and development of production and maintenance processes and tools, as well as a production unit's upstream and downstream relations.

Tomorrow's factory is expected to use fewer resources, to be more intelligent, more responsive and more adapted to production runs of all kinds. It should be better interconnected with suppliers and customers. This all requires technologies that already exist but still have a huge growth potential:

- eco design and energy-saving technologies;
- digital simulation upstream of industrial processes;
- sensors and integration of RFID chips in products to facilitate quality follow-up;
- Internet, Extranet, cloud computing;
- Big data analytics;
- 3D printing or additive manufacturing;
- connected devices;
- robotics.

#1 IMPACT ON JOBS

The many studies looking at the link between digitalisation and jobs oscillate between techno-pessimism and techno-optimism. A 2013 study by Frey and Osborne[10] suggested that up to 47% of jobs in the United States are set to be transformed or are threatened with extinction. Other studies[11] suggest that as many as 10% of jobs could be at risk.

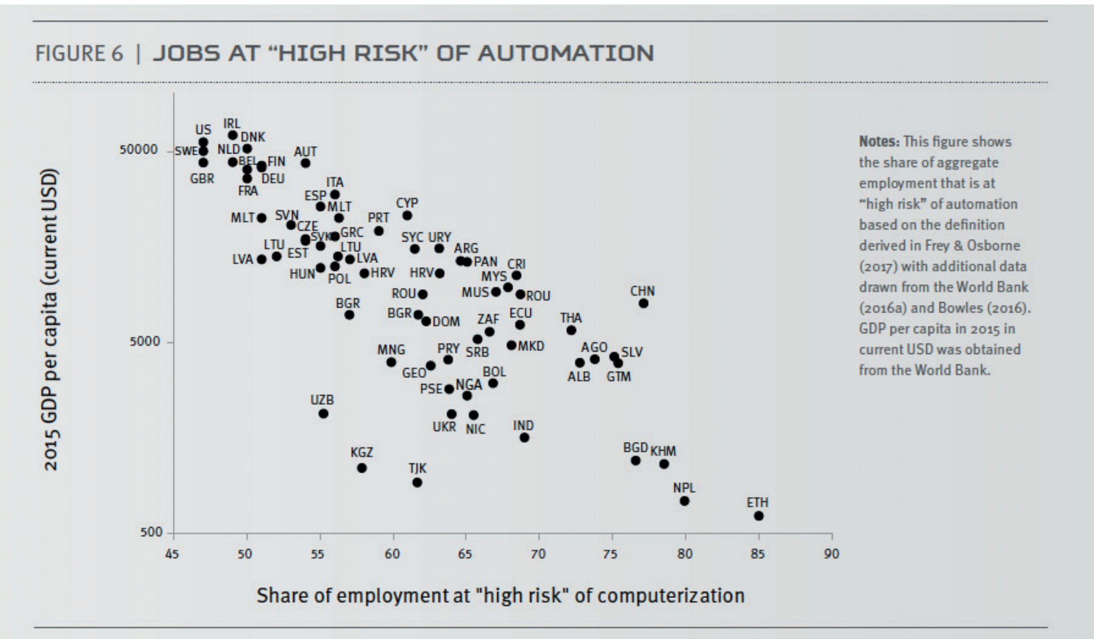
Much recent research has been done on this topic.

The use of digital technology leads to increases in productivity and rationalisation, and in turn to potential layoffs. In manufacturing and production-related occupations, for example, the technologically possible substitutability potential could exceed 70%[12] . This does not imply that 70% of employment will be replaced by machines and computers, but

10 Carl Benedikt Frey et Michael A. Osborne, *The Future of employment: how susceptible are jobs to computerisation?* Oxford Martin School. September 17, 2013.
11 The risk of automation for jobs in OECD countries, June 2016, Mélanie Arntz, Terry Gregory, Ulrich Zierahn
12 The impacts of digital transformation on the labour market: substitution potentials of occupations in Germany. Katharina Dengler. Britta Mattes. *Technological Forecasting and Social Change,* 2018, vol. 137, issue C, 304-316

Jobs at high risk of automation

Source: Accelerating clean energy through Industry 4.0. Manufacturing the next revolution. UNIDO. 2017.



that 70% of occupations could theoretically be substituted.

On the other hand, digitalisation can be a way of safeguarding employment and good working conditions. For example, the introduction of remote services can help to launch new business areas. For worker representatives, it is important to influence the introduction and implementation of digital techniques – with the aim of averting the potential disadvantages of digitalisation and of taking employee interests into account in the sense of "good quality work".

It remains difficult to decide between these two approaches.

What is certain is that many jobs are threatened while others are set to disappear. But the final balance remains uncertain. Total employment in recent years tended to increase, at least up till the 2020 pandemic.

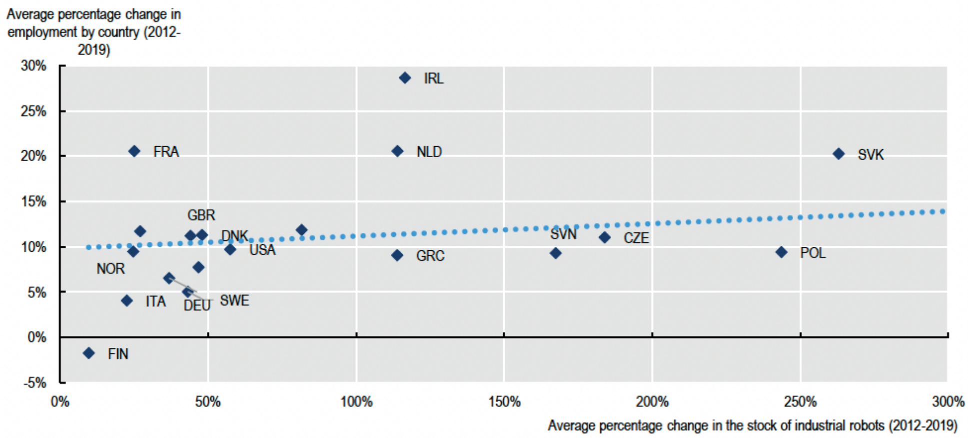
In 2021, the OECD published a short paper[13] stating that an estimated 14% of jobs were at risk. By contrast, It noted that employment had increased in all OECD countries over the period 2012-2019. However, these estimates varied hugely across countries as well as across occupations.

The OECD also highlighted that employment had grown in nearly all occupations since 2012. At country level, its paper showed that there was no indication that higher automation was associated with lower employment growth.

Another interesting point is that those countries which have invested the most in robots are those that have benefited the most from employment growth. But this does not close the discussion on the effects of robots on employment. The countries investing the most are those with the strongest industrial base. There may be a connection. But it is not clear that there is a correlation [14].

Countries that invested more heavily in robots experienced greater employment growth

Average percentage change in employment level by country and percentage change in the stock of industrial robots (2012-2019)



Note: The International Federation of Robots calculates the operational stock of robots by accumulating annual deployments and assuming that robots operate 12 years and are immediately withdrawn after 12 years. The variable here reflects the average change in the stock of industrial robots between 2012 and 2019 per country. Lithuania and Estonia have been excluded for readability reasons, but the results are qualitatively the same when these countries are included.
Source: (Nedelkoska and Quintini, 2018[1]) and the International Federation of Robots.

13 What happened to jobs at high risk of automation? OECD. January 2021.

14 How robots change the world. What automation really means for jobs and productivity. Oxford Economics. June 2019. This report has a different opinion on the impact on employment.

Looking at the jobs most at risk, it would seem that these are:

- Routine jobs (tasks and procedures)
- Jobs based on the sole use of knowledge (databases)

Jobs are better protected when linked to:

- Creativity, interaction and social intelligence
- Reasoning beyond the mere mobilisation of knowledge or the application of a procedure.

Creativity might be inversely correlated to automation.

#2 THE GIG ECONOMY

Over the last few decades, many new employment forms have emerged, with fixed-term contracts, zero-hour contracts, temporary work and self-employment rising steadily. More recently, the gig economy has developed in connection with digitalisation.

The online gig economy is a term used in reference to the online labour market, online freelancing or platform work.

Self-employment, freelancing and zero-hour contracts are all employment modalities that go beyond the classical employee framework and that are on the rise. Micro-enterprises and sole proprietorships are exploding, as are crowdsourced microwork models and online outsourcing.

Online outsourcing is defined as contracting out tasks and services to third parties - workers or service providers - via platforms or marketplaces (internet). These channels allow companies to outsource tasks to a huge pool of remote resources and obtain quality, control, coordination, and payment for these tasks.

These tasks can be divided into two categories:

- microwork or micro-tasks: tasks that can be done in seconds or minutes and require little skill (data entry, reading, commenting, etc.). They are low-paid and accessible to many people.
- online freelancing: these are contracts for third parties that often require specific skills. Tasks tend to last for hours or weeks, or even months, and include services such as graphic design, web development or technical reporting. Advertising, communications, translation and journalism are sectors particularly susceptible to this form of work.

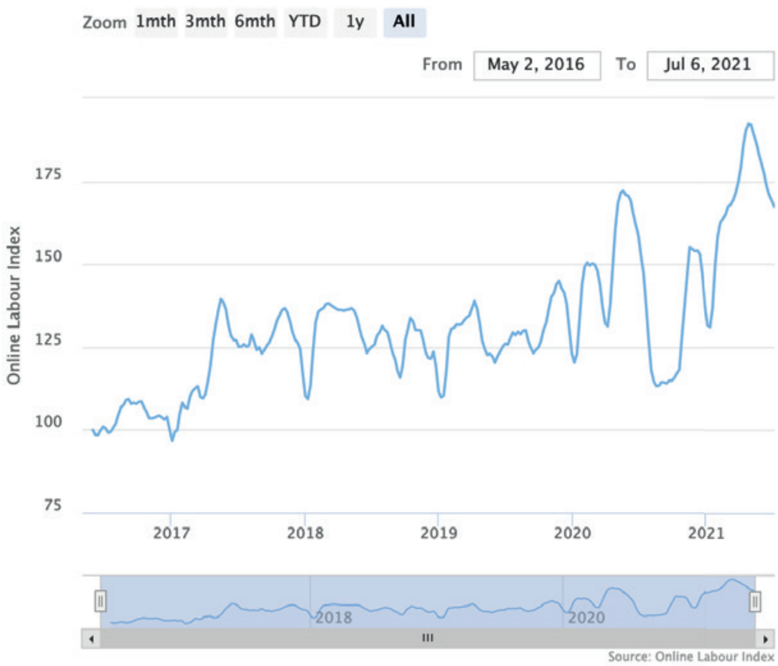
To these first two categories, we must add the precarious tasks of the digital world, performed by a real proletariat of geeks, such as the click-farmers in Bangladesh who are paid a pittance to post «likes».

A typology of platforms

Source: The McKinsey Global Institute 2015.

	Digital tools that enable users to...	Example platforms, 2015
Matching individuals with traditional jobs	• Post full-time or part-time jobs • Create online resumes of individuals • Search for talent or work opportunities based on extended matching attributes • Provide transparency into company or worker reputations, skills, and other traits	Careerbuilder Glassdoor Indeed LinkedIn Monster Vault Viadeo Xing
Online marketplaces for contingent work	• Connect individuals with contingent or freelance projects or tasks • Facilitate transactions by providing transparency on reputation and ratings	Amazon Home Services Angie's List TaskRabbit Uber Upwork
Talent management	• Assess candidates' attributes, skills, or fit • Personalize onboarding, training, and talent management • Optimize team formation and internal matching • Determine the best options for training and skill development	Good.co PayScale Pymetrics beta ReviewSnap

The rise of online labour workers



Or the practice of farming by Chinese gamers or prisoners who, on multiplayer online video games such as World of Warcraft or Starcraft, earn points that they then sell to «real» players.

A more recent study develops another typology[15] :

- on-location platform-determined work: low-skilled work assigned by a platform and delivered in person;
- on-location worker-initiated work: low- to moderately-skilled work where tasks are selected and delivered in person;
- online contest work: high-skilled online work, where the worker is selected by the client by means of a contest.

Some of the tasks need skills. The gig economy is not only a matter of low-skilled, poorly paid workers. High-skilled workers are also needed, though less frequently.

Whatever the way this rising phenomenon is described and tasks classified, data shows that the gig economy has been growing fast in recent years, as revealed by the iLabour project[16]

According to researchers, there might be as many as 163 million freelancers registered on online labour platforms[17].

Antonio Casilli has highlighted another interesting feature of these online workers[18]: artificial intelligence and automation are not … automatic. Indeed, they need "click workers" to filter pornographic pictures, moderate content, copy text fragments and educate artificial intelligence. There is no such thing as smart automation. There's a back story inhabited by precarious micro-workers. The rise of the gig economy has led to many political discussions over hot topics: working conditions, social protection, platform responsibility, algorithmic management, etc. Many countries have adopted new legislation to tackle some of these issues. Legal recourse and court decisions are also contributing to the new policies progressively being implemented.

15 Eurofound. Employment and working conditions of selected types of platform work. Willem Pieter de Groen, Zachary Kilhoffer and Karolien Lenaerts (CEPS); Irene Mandl (Eurofound). 2018

16 https://ilabour.oii.ox.ac.uk/online-labour-index/

17 How many online workers are there in the world? A data-driven assessment. Otto Kässi, Vili Lehdonvirta. Fabian Stephany. October 15, 2021.

18 En attendant les robots. Enquête sur le travail du clic. Antonio Casilli. Seuil. 2019.

#3 WOMEN AND EQUAL OPPORTUNITY IN THE FUTURE OF WORK

Men and women need to be skilled and tech-savvy in the automation age, but women face pervasive barriers. Nevertheless, the automation brings new challenges for women overlaid on long-established ones.

Adoption of new technologies could displace millions from their jobs; many others will need to change the way they work, often into higher-skilled roles. It can be both an opportunity and a threat for women: they could find more productive, better paid work. But if the transition is not successful, they could face a growing wage gap or leaving the labor market.

Men and women tend to cluster in different occupations in both mature and emerging economies. For instance, in many countries, women account for more than 70 percent of workers in healthcare and social assistance, but less than 25 percent of machine operators and craft workers.

A study from McKynsey[19] found that women and men could face job displacement and potential job gains of a broadly similar magnitude. In the ten countries studied, an average of 20 percent of working women (107 million) could lose their jobs to automation versus 21 percent of men (163 million) by 2030. Rising demand for labor could imply 20 percent more jobs for women, compared with 19 percent for men, assuming their shares of sectors and occupations hold. Those results must be taken with caution, as the effect of automation on the number jobs are still uncertain. But it gives interesting hints on the composition of potential job losses and gains for women, as it could be different from the one for men. We can expect that entirely new occupations will be created, but for instance about 60 percent of new US occupations linked to new technologies have been in male-dominated fields.

On one hand, Automation of Service-oriented and clerical support occupations, where women are well represented, will account to a significant share of job losses. On the other hand, women are well represented in fast-growing healthcare, which could account for potential jobs gained for women

Transition across occupation might be significant in the future, only will it be an opportunity for women if they gain new skills. In mature economies, only jobs requiring an advanced degree may experience net growth in demand. Women remaining in their current jobs will need to improve their skills. In emerging economies, many women are working in subsistence agriculture, often with little education. They may have difficulty securing work in other sectors. If women cannot take advantage of transition opportunities, gender inequality in work could worsen.

Moreover, more women work in lower-paid and precarious occupations than men. In mature economies, demand for high-wage labor is expected to grow, while demand for low-wage labor could shrink. Many emerging economies could experience stronger growth in demand for higher-wage jobs. Enabling women to move up the skills ladder could prepare them for higher-paying jobs and more economic opportunity.

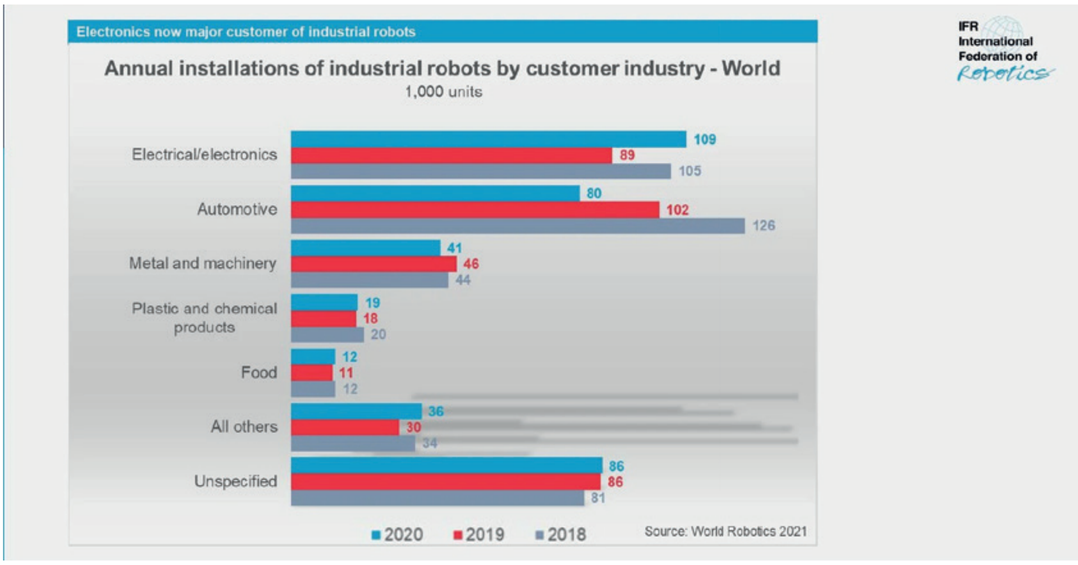
Finally, women face long established barriers. Indeed, women tend to have less time to reskill or search for employment. On average, they spend much more time than men on unpaid care work; are less mobile due to physical safety, infrastructure, and legal challenges; and have lower access to digital technology.

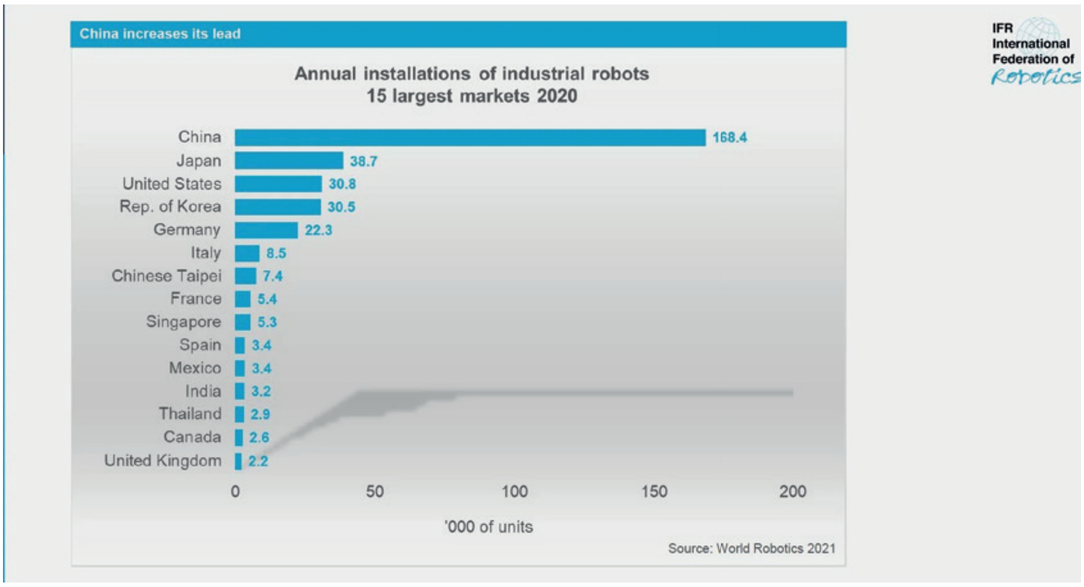
In November 2018, IndustriAll European Trade Union issued a statement highlighting those challenges: “For a fair digitalisation – close the gender gap!”. The document stresses the need to use collective bargaining and legislation to make sure that Digitalisation is a gender-neutral process.

19 McKinsey Global Institute. (2019). The future of women at work: Transitions in the age of automation.

CHAPTER 3

INDUSTRY 4.0 THROUGH THE LENSE OF 3 SECTORS


Electronics now major customer of industrial robots
Annual installations of industrial robots by customer industry - World
1,000 units
Electrical/electronics
109
89
105
Automotive
80
102
126
Metal and machinery
41
46
44
Plastic and chemical products
19
18
20
Food
12
11
12
All others
36
30
34
Unspecified
86
86
81
2020
2019
2018
Source: World Robotics 2021
IFR
International
Federation of
Robotics


China increases its lead
Annual installations of industrial robots
15 largest markets 2020
China 168.4
Japan 38.7
United States 30.8
Rep. of Korea 30.5
Germany 22.3
Italy 8.5
Chinese Taipei 7.4
France 5.4
Singapore 5.3
Spain 3.4
Mexico 3.4
India 3.2
Thailand 2.9
Canada 2.6
United Kingdom 2.2
0
50
100
150
200
'000 of units
Source: World Robotics 2021
IFR
International
Federation of
Robotics

Industry 4.0 transformation has only just begun. And it will take years to totally transform industry. It will take much longer than the transformations experienced by sectors such as media or music.

Looking at Industry, we see that the road to Industry 4.0 varies not only from one country to another but also from one industry to another. European data reveals real differences. This same study also shows differences between countries: the use of IoT in companies with more than 10 employees varies between 7% in Romania and 44% in the Czech Republic.

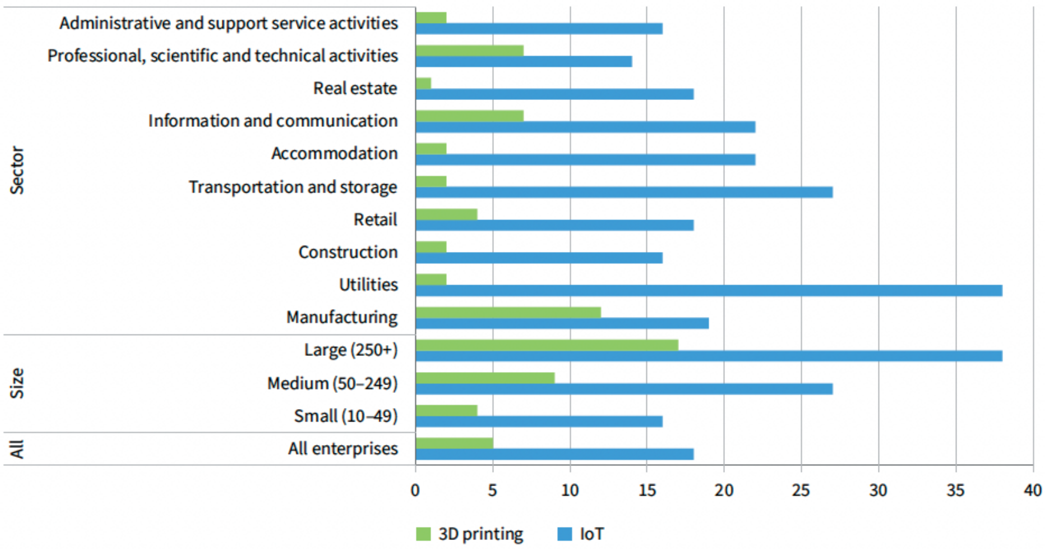
Looking at the data on robots, there are also interesting differences, both between countries and between different sectors.

Asian countries are well represented among the top countries with regard to the installation of industrial robots.

Electronics/ICT and automotive are the top sectors regarding the installation of robots.

Because of these different effects, it seems appropriate not to limit ourselves to a global look at digitalisation in industry but rather to spotlight certain sectors. For this reason, we will examine its effects on 3 specific sectors: automotive, telecom (a subsection of ICT) and energy (a subsection of mechanical engineering).

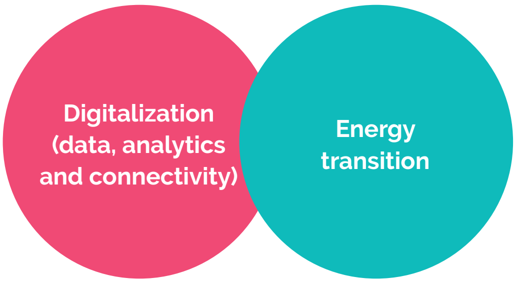
Figure 2: Adoption by enterprises of IoT and 3D printing by size and sector, EU27, 2020 (%)



Source: *ICT usage in enterprises survey (isoc_e), Eurostat, 2020*

#1 DIGITALISATION IN THE MECHANICAL ENGINEERING SECTOR WITH A SNAPSHOP ON ENERGY GENERATION SYSTEMS

#1.1 MECHANICAL ENGINEERING AND DIGITALISATION FEED EACH OTHER



Mechanical Engineering is one of the most affected sectors by the digitalisation of manufacturing in two ways:

- The sector provides the technologies for manufacturing sectors to introduce advance digitalization in their production process (hardware, software, biga data) with new business model.
- The sector itself is transforming due to digitalization: new form of designing, new producing tools, machinery and engines (e.g., 3D printing), new operating model.

The policy and regulatory framework is central to the development of new markets related to the energy and digital transition.

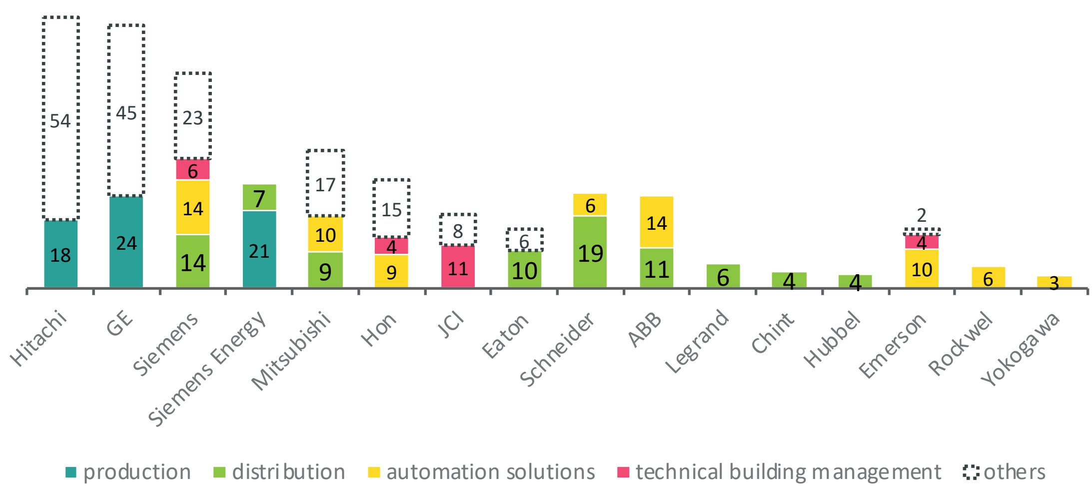
New production will steer the demand for high-tech mechanical engineering. Additionally, green tech will be an important driver for the sector. On the other hand, digital tools are useful levers in the context of an ecological transition.

The energy and digital transition movement combined with the pressure of the financial markets is leading to important changes in the business portfolio management strategy of companies.

The electrical construction industry which includes power generation, electrical distribution, industrial automation and building management is clearly impacted by this trend.

Digitalization is completely blurring the boundaries of the industrial automation and low and medium voltage electricity distribution markets: an equipment

Turnover by activity by the main players of electrical construction (€bn)



manufacturer like Schneider Electric is developing software in order to protect itself from the attempts of digital giants to enter its markets. Legrand, for its part, is investing heavily in connected objects but is counting on partnerships with Google or Microsoft to manage the integration of its products.

In the electrical construction and putting aside players working on production (Hitachi, General Electric and Siemens Energy), the other players are dedicated to distribution, automation solution and technical building management.

Some players have a diversified portfolio (Toshiba, UTC, Mitsubishi, Eaton..).others are more dedicated to energy management and automation solutions (ABB, Schneider Electric, Emerson).

There are also specialized players (low and high voltage distribution): Legrand, Hager, Chint, Powel, Hitron etc.

As a result of the energy and digital transition, new players are positioning themselves in the historical markets of electrical construction equipment manufacturers.

- On the software side, with new competitors such as Dassault Systèmes, Apen Tech, Autodesk or PCT.
- Via property management with John Long Lassale.
- Oil & Gas players looking for new stream of revenue regarding the consequences of energy transition on their business model.
- Digital giants and digital start-ups, who are developing software and platform in order to offer solution for digital and energy transition
- Engineering companies positioning themselves as the solutions provider to help the market to enhance digital and low carbon operating model
- Players from the automotive (Tesla) or telecoms (Huawei) sectors are also shaking up the game.

The case of technical building management is particularly emblematic of the transformations underway with the arrival of numerous competitors from different worlds seeking to compete with the existing players:

- Companies from the IT world.
- Telecom operators.
- Digital giants.
- Telecom equipment manufacturers.

Given the evolution of the markets and the prospects offered by digitalization, several significant have partially (Siemens) or totally (Hitachi) withdrawn from the energy production activity (via a joint-venture with Mitsubishi for the former and via the spin-off of Siemens Energy for the latter) to refocus on industrial automation activities and Industry 4.0 in particular.

The development of renewable energies is also reshuffling and redistributing the cards. Moreover, the intermittent nature of renewable energies leads to constraints on the management of the electricity network, which requires the development of smart grids and intelligent consumption management tools.

Many companies such as Hitachi, Siemens, ABB are both investing heavily in digital activities and GreenTech[20] and more specifically, renewable energies.

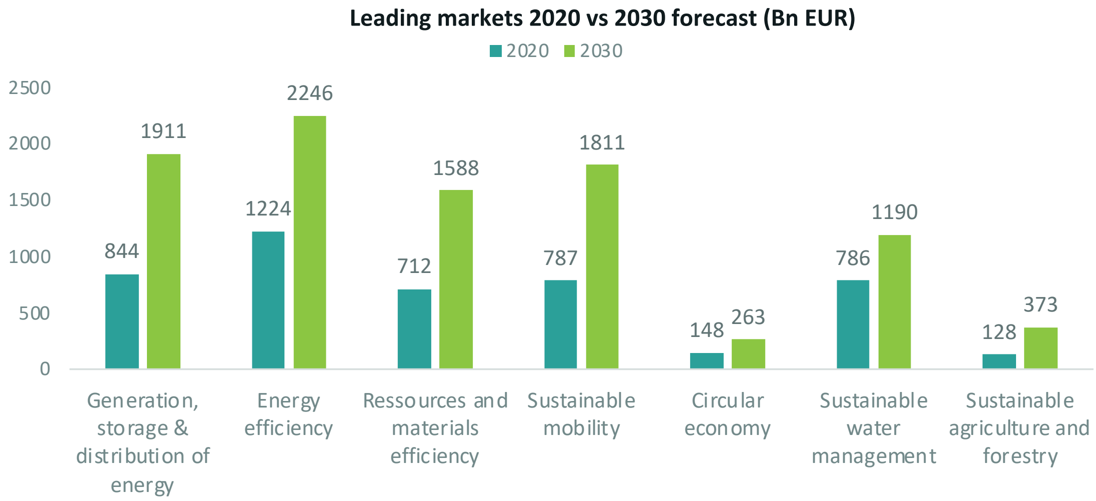
The four main markets of mechanical engineering are:

- Energy efficiency.
- Raw material and material efficiency.
- Sustainable mobility.
- Environmentally friendly generation, storage and distributed energy.

These 4 markets are growing and will continue to grow fast in the forthcoming years.

In all these markets, the use of digital technology is key.

20 GreenTech are technologies who enables to produce, work, serve and live with a significant lower environmental impact.



Source: Roland Berger (2020)

To increase energy efficiency, energy management systems are required. These systems themselves need a lot of sensors to gather information, IT communication tools to transfer the information and data management system to analyze it. Energy management is becoming and more interesting due to digitalization. The same logic applies to all or almost all markets of mechanical engineering:

- Ecodesign and 3D printing to increase raw material efficiency.
- Digitalized service to increase offshore wind reliability for instance
- Digitalized energy distribution.
- Asset cycle performance management with sensors and cognitive capabilities.

Green technology might combine economy and ecology as the transport sector shows. Taking into account the entire life cycle of an electric vehicle could, however, lead to a much less beneficial estimate than initially envisaged

Electrification of the powertrain, hydrogen and fuel cells are examples of new important key technologies. Green hydrogen can be an alternative in areas where electrification is not possible like aviation, shipping transport and industry.

#1.2 DIGITALIZATION AND THE ENERGY GENERATING SYSTEMS

The world of energy is being turned upside down by new uses, new technologies, and the optimization and monitoring possibilities offered by digital technology

The energy transition is and will continue to be accompanied by multiple transformations:

Changes in the energy mix in pursuit of the objective of reducing greenhouse gas emissions are evidenced by the reduced share of fossil fuels and the increased share of renewables, while the share of nuclear power is expected to remain stable; the objective of improving energy efficiency is leading to an increase in the range of services offered in this area. The mechanical engineering sector is providing many the technologies that are needed.

Turning to technical and technological innovations, the potential of renewables has certainly not yet been fully identified, in particular for marine energies, hydrogen and recovered energies. Energy storage is also set to develop, while the potential of digital technologies (network management, delicate maintenance operations, etc.) is still partially unknown.

Digitalisation pervades all sectors of the economy, and the energy sector, whether on the supply or demand side, is no exception. Digitalisation can improve energy efficiency and help save energy. The combination of sensors, networks and data analysis enables more effective management. Digital tools are interesting levers in the context of an ecological transition.

In transport, the development of connected vehicles is expected to radically transform the sector, both for passenger traffic and freight. However, there are no obvious results regarding the effects of digitalisation on the sector in terms of energy consumption.

The use of intelligent sensors and control systems for heating and lighting are expected to lead to substantial energy savings.

In industry, the gradual switch to the Factory of the Future (or Industry 4.0) should make it possible to combine productivity, raw material savings and energy savings.

On the energy demand side, digitalisation provides opportunities to optimise demand management through the use of smart electricity and gas meters.

On the supply side, though no new phenomenon, the use of digital technologies is set to increase, allowing oil and gas producers to improve efficiency (productivity gains) and reduce costs. Turning to electricity, digital technologies could facilitate better management of transmission and distribution networks, as well as the integration of renewables, energy sources which are by nature intermittent and decentralised.

Digitalisation, like nanotechnology, will be a key factor in the development of new electricity storage technologies as an alternative to hydroelectric pumped hydroelectric energy storage (PHES). Energy storage systems, most of which are still in the R&D phase, represent one of the key technologies for the energy transition as they are essential for the integration of renewable energies: new battery production technologies, hydrogen, fuel cells and power-to-gas.

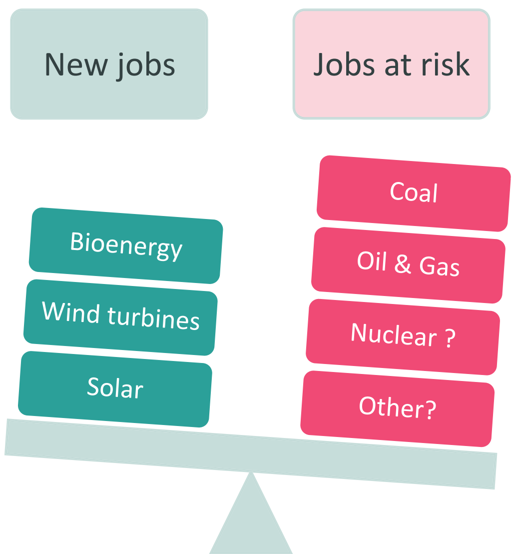
Digitalisation could have even more far-reaching effects, in particular transforming the way in which electricity networks operate. The connection of millions of small producers selling their surplus could considerably disrupt the grid and the energy landscape, historically dominated by state monopolies in Europe. The widespread use of sensors and data analysis would make the grid much more flexible and adaptable to needs.

At the same time, the growing electrification of passenger transport, in addition to its contribution to a de-carbonised economy, goes hand in hand with the development of renewables, here again amplified by the use of digital tools. Indeed, the interweaving of energy and digitalisation is undoubtedly strongest in the field of renewables.

Beyond the networks, business models linked to the exploitation of data generated by communicating products are developing and are expected to eventually transform energy markets.

The transformations already underway are therefore gigantic, driven by a wave of innovation that seems

Consequences on employment and work are usually poorly documented



to have accelerated in recent years. While arousing admiration, they also bring profound changes, particularly for the world of work.

It is commonly accepted that there will be winners and losers from these transitions in terms of jobs.

From 12 million jobs in renewable energy in 2020 to 20 million up to 38 million in 2030 according to IRENA[21].

In the many studies published on these issues, employment is always the poor relative. Yet, whether for the public authorities or a fortiori for the trade unions, the question of employment and its evolution is obviously crucial.

To be more precise, it is necessary to look at the evolution of employment, particularly in quantitative terms – how many jobs could disappear/how many could be created? But we also need to look at the evolution of jobs, skills and even tasks.

Automation may cause jobs to disappear. But in some cases, only certain tasks may be threatened, allowing jobs to simply be adapted or transformed. While some jobs may disappear in power stations, others may appear or develop (data analysis, for example).

Automation and artificial intelligence can lead to changes in the maintenance of an energy or telecom distribution network by promoting upstream fault detection and developing predictive maintenance. While the job of a maintenance technician will not necessarily disappear, his or her tasks will change significantly: less on-site work, an increased software dimension and more remote monitoring and control.

The question of the evolution of the required skills is a subject of attention, even if in some cases automation can lead to a reduction in qualification requirements.

But digitalisation raises new questions about information overload and the reconfiguration of work control methods. There is a risk of work intensification and increased complexity. In short, work and its organisation are set to be turned upside down.

More broadly, the questions of the polarisation of the labour market, growing inequalities and challenges in terms of skills are all issues directly linked to these problems.

21 IRENA Renewable energy and Jobs 2021

#2 DIGITALISATION IN THE AUTOMOTIVE SECTOR

The automotive industry is not spared from digitalisation and Industry 4.0. The technologies available (4G/5G, automation, robotisation, data analytics, artificial intelligence, augmented reality, etc.) are encouraging multiple developments.

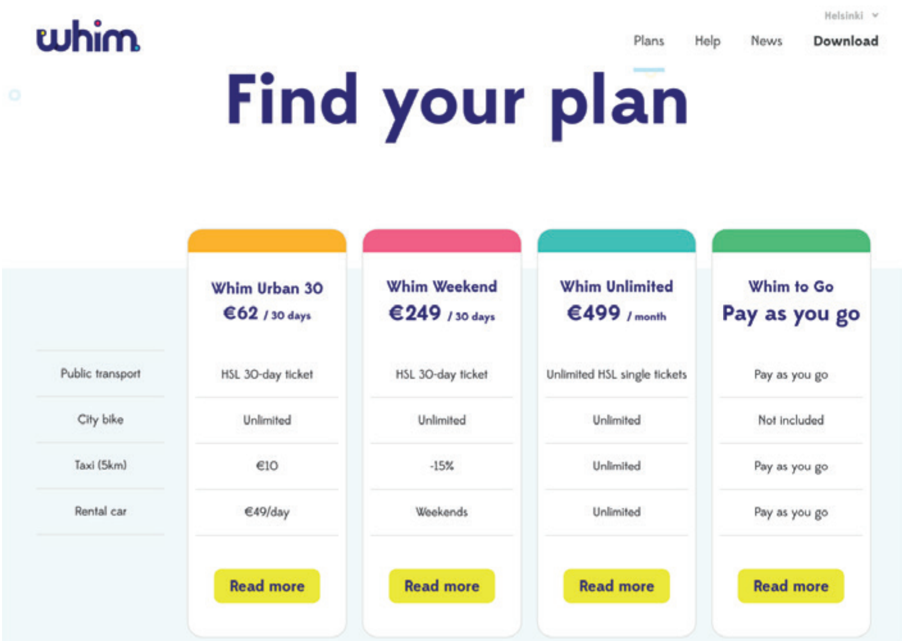
- (1) Digitalisation is driving the emergence of new mobility offerings. The industry's value chain is expected to be largely transformed within a few years.
- (2) The development of autonomous/connected vehicles is transforming vehicle design and opening the door to new players.
- (3) Vehicles contain an increasing amount of electronics and software.
- (4) Design and production processes are gradually becoming more digital and automated.
- (5) Digital technology is reshaping the automotive industry's ecosystem.
- (6) Digital technology is driving the development of the «extended enterprise».
- (7) These transformations have an impact on jobs, employment conditions, skills, work, work organisation and working conditions.

#2.1 MOBILITY AS A SERVICE (MAAS)

This idea of Mobility as a Service (MaaS) comes from the Finnish start-up Whim. It is based on the idea of a mobility service enabling people to go from one point to another using all modes of transport (public transport, bicycles, taxis, rental cars, etc.).

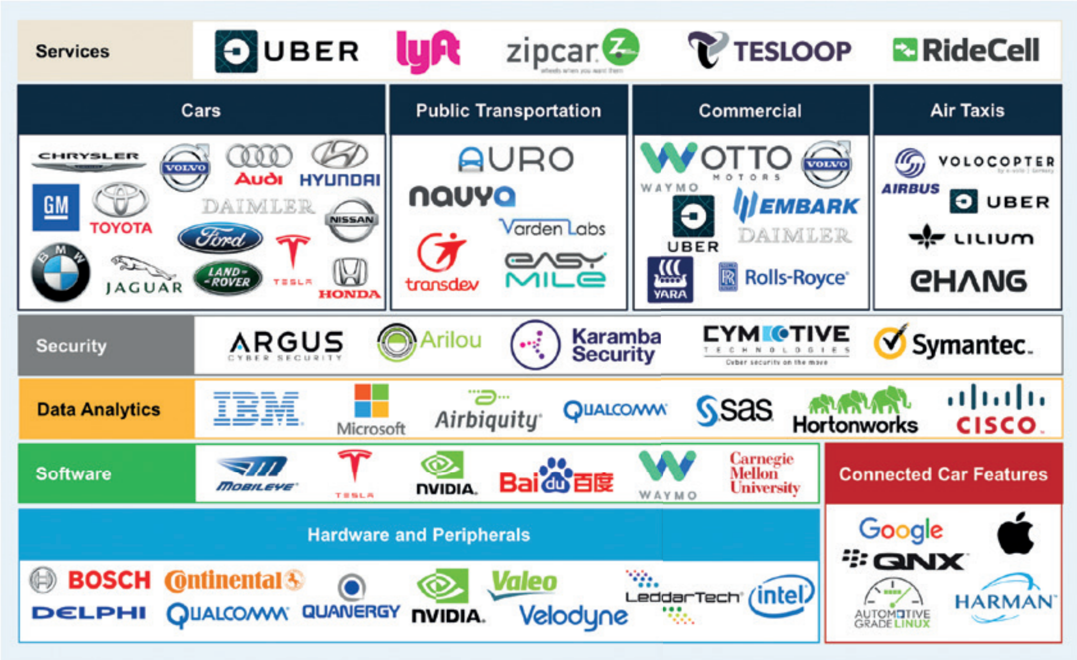
Such a unification of mobility services is made possible by a single application which, via a subscription, brings together all the ticketing and information needed to use and combine these different modes of transport. This approach can evolve according to needs and territories. But above all, it shows that a platform/aggregator can potentially (and we are not there yet) disrupt an entire sector, or even several sectors, as the automotive industry is not the only one concerned.

An example of a MaaS offer by Whim, a start-up



	Whim Urban 30 €62 / 30 days	Whim Weekend €249 / 30 days	Whim Unlimited €499 / month	Whim to Go Pay as you go
Public transport	HSL 30-day ticket	HSL 30-day ticket	Unlimited HSL single tickets	Pay as you go
City bike	Unlimited	Unlimited	Unlimited	Not included
Taxi (5km)	€10	-15%	Unlimited	Pay as you go
Rental car	€49/day	Weekends	Unlimited	Pay as you go
	Read more	Read more	Read more	Read more

The automotive landscape is crowded with new players



This example illustrates how digitalisation can enable new entrants to disrupt a market and in particular the balance of power between players, in short the value chain.

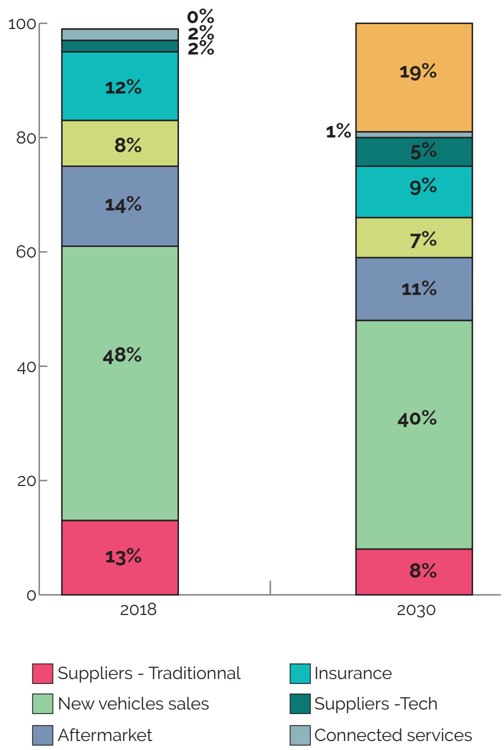
#2.2 CAR MANUFACTURERS ARE NO LONGER THE ONLY ONES IN CHARGE AND MUST EVOLVE WITHIN A RENEWED ECOSYSTEM

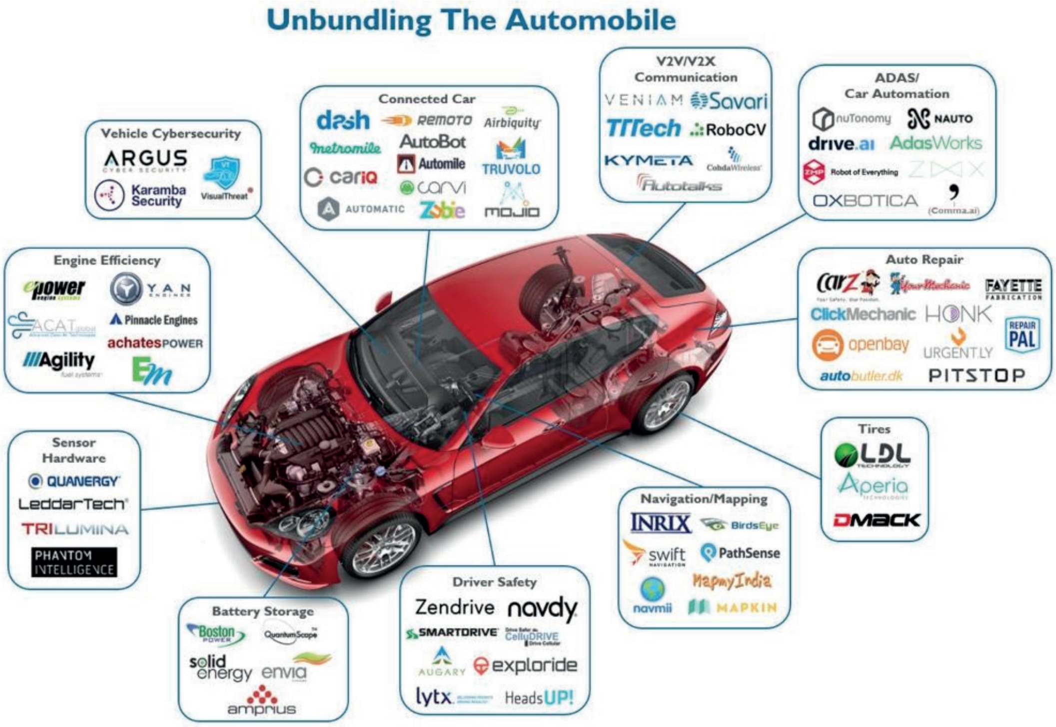
The landscape has been overturned by the emergence of new players. Automotive companies have to choose between what is done internally or externally and increase cooperation and partnerships.

The value of car manufacturers' activities is expected to increase in the medium term. However, the share of these activities in the overall value of the sector is expected to decrease (from 48% to 40% in 12 years according to PwC) to the benefit of service activities.

The margins generated by these activities would be even more strongly affected. But what is striking is the rise of MaaS, set to represent 20% of overall value.

Distribution of revenue in $bn
5400-5600 bn$ in 2018
9200-9500 bn$ in 2030





Source: https://babeltechreviews.com/autonomous-cars-require-more-than-just-technology/

#2.3 TOWARDS THE SELF-DRIVING CAR

VEHICLES HAVE INCREASINGLY IMPORTANT DRIVER ASSISTANCE SYSTEMS

More and more vehicles have partially autonomous systems (L2): emergency braking systems, lane keeping assistance, lane departure warning, adaptive cruise control, automatic driving at low speeds, reversing assistance, parking assistance.

The complexity of the systems is increasing for the conditional (L3) and full (L4/L5) autonomy levels. This increasing complexity applies to design, but in production it involves highly automated processes with a relatively low employment content (often less than 10% of turnover).

Although self-driving vehicles are not for tomorrow (very low volumes of L4 autonomous vehicles will be sold before 2030), driver assistance systems are developing widely.

THE DEVELOPMENT OF VEHICLE CONNECTIVITY

Vehicle connectivity, made possible by the integration of a telematics module (geolocation + telecommunication) within the vehicle – within the framework of the new regulations (eCall, ERA Glonass) –, is undoubtedly the top structuring trend for the vehicle of the future.

Vehicle connectivity not only makes it possible to meet the challenges of autonomy (fewer accidents, less traffic congestion and reduced consumption = less CO2) but also opens up new opportunities for all players.

The vehicle of the future will therefore be traversed by multiple data flows (enabled by 5G) used for driving (accident prevention, artificial horizon, intelligent navigation, etc.), vehicle maintenance (predictive maintenance), comfort (connectivity inside the vehicle, dedicated applications) and marketing (knowledge of the driver and passengers allows better targeting). These are flows that need to be monetised.

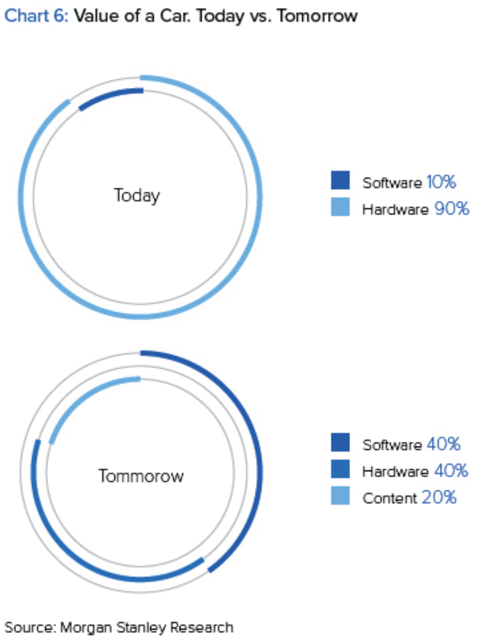
#2.4 CAR SOFTWARISATION

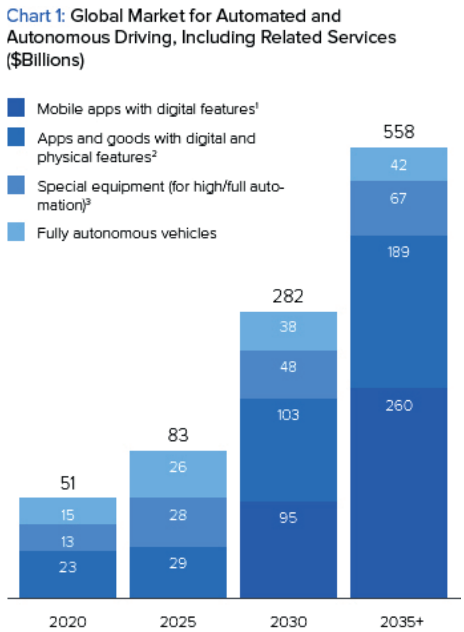
Software is increasingly found in all activities and sectors (just like semiconductors which themselves contain a lot of code). Many of the companies that have disrupted entire sectors of the economy are essentially just companies that have developed a software product (or suite) or a (software) platform. But this is how companies, as new entrants to a market, have been able to challenge established positions and entire sectors: Google & advertising; Amazon & retail; Uber & transport etc.

The share of software in industrial activities (aeronautics, defence, security, energy, etc.) is growing. This is also the case in the automotive industry. As in other sectors, the distribution of value between hardware and software is changing, with the share of software in total value expected to quadruple over the next few years.

In addition to the growing amount of software in vehicles, vehicle-related services (in the form of applications) are set to develop rapidly over the coming decades, contributing to the 'softwarisation' of the industry.

Software represents a growing part of the value
Source: AT Kearney





#3 DIGITALISATION IN THE TELECOM INDUSTRY

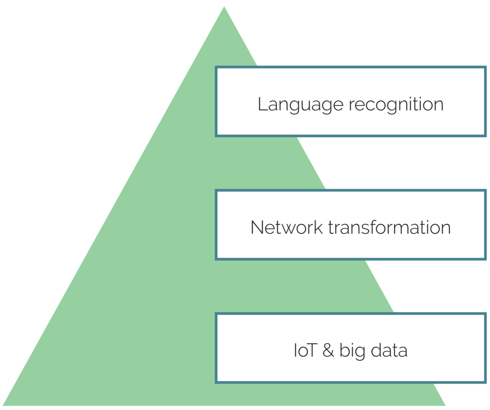
Digitalisation in the telecom industry is special: on the one hand the telecom industry provides tools allowing digitalisation, while on the other hand it is a sector transformed by digitalisation.

#3.1 ARTIFICIAL INTELLIGENCE, AUTOMATION AND TELECOM NETWORKS

Artificial intelligence (AI) is increasingly present in mobile phones:

- In the phone's camera which recognises the object (animal, landscape, etc.) and adapts the settings accordingly.
- At the heart of the phones via machine learning in the chips (ARM, Huawei, Qualcomm, Samsung) to make the phones even easier to use.
- For smartphone users to suggest the right content and applications (predictive AI).

AI is progressively found in 3 areas of the network:



A major trend is the use of voice rather than keyboard. AI can now analyse voice and tone but also facial emotions.

Moreover, IoT and AI are very much linked. IoT allows the monitoring and control of the physical world, especially via multiple sensors, while AI can be used to analyse data and make processes intelligent and automatic.

LANGUAGE RECOGNITION

Voice recognition has made enormous progress in recent years. For telecom operators, this means at least two opportunities: the not entirely new development of chatbots in call centres; and the rise of virtual assistants.

Virtual assistants were launched by Internet giants (Amazon and Google).

The challenges are very different: in the one case (chatbots), it is a question of offering/adapting to the increasing digitalisation of interactions between customers and their operator. In the other case (that of virtual assistants), it is a battle between many players for the control of user data (profiles, type of consumption, habits, etc.).

In the first case, social issues (risks to employment) are at stake. In the other case, there are more commercial and privacy protection issues at stake.

NETWORK TRANSFORMATION

Telecom networks are being transformed, notably with the gradual arrival of Software-Defined Networks (SDN) and Network Functions Virtualisation (NFV). AI is at the heart of telecom networks:

- machine learning for network management and traffic flow prediction;
- better control of the network;
- radio resource optimisation;
- predictive maintenance in networks.

Overall, the use of AI to monitor network performance, perform predictive maintenance and continuously adapt the network will be unavoidable, given the thousands of parameters to be integrated and adjusted.

Tupl's Customer Care used by T-Mobile: Automated Customer Care Resolution (ACCR). T-Mobile employees receive reports and technical solutions very quickly.

- 100 times faster and 4 times more accurate.
- Customer support responds very quickly (10 times faster according to Tupl). The workload of engineers is said to be reduced by 25%.

Vodafone uses AI through SON (Self-organising network) technology. This approach to the network was chosen to configure 450 radio sites to enable them to do VoLTE. It would have taken an engineer 2.5 months to do this by hand. With SON technology, it took 4 hours!

IOT AND ANALYTICS

When it comes to network analysis and performance, AI can provide many tools for improvement:

- AI in analytics. Analysis of network data enables network optimisation
- high degree of automation in the OSS (Operating Support System): improved network planning
- AI is proving to be a powerful tool for network planning and optimisation
- Solutions are being developed by players such as Nokia, Amdocs or Aria Networks

In addition, AI offers tools contributing to the development of sales and marketing functions:

- analysis of customer behaviour
- customer segment
- prediction of customer behaviour
- customer experience analysis
- recommendations
- Churn (attrition) predictions.

The use of AI and automation has effects on employment, both in terms of quantity and quality. But also on work. Some jobs will partially or totally disappear while others will be transformed (network maintenance). But technological change is also creating new jobs (network optimisation, analytics, etc.).

CHAPTER 4

SOCIAL DIALOGUE AT SECTORAL/ REGIONAL AND NATIONAL LEVEL

#1 SOCIAL DIALOGUE AT GLOBAL LEVEL

Over the past few decades a handful of multinational companies signed International Framework Agreements with trade unions. The 321 agreements identified in the database shared by the International Labour Organisation (ILO) and the European Commission[22] represent just a tiny proportion of the 70 000 multinational companies. With many of these agreements already few decades old, it is not surprising that digitalisation is generally not mentioned in them. Instead, they tend to address fundamental rights, health & safety, training etc.

It should be noted that some of the agreements recorded in the database are about European Works Councils or only have a European scope.

Apart from these agreements, a handful of multinational companies (Renault, Volkswagen etc.) have established Global Works Councils. This could be in a position to tackle the issue of digitalisation.

All in all, global-level social dialogue can be considered poor or even non-existent.

#2 SOCIAL DIALOGUE AT EUROPEAN LEVEL

The European Union (EU-27) has a special position regarding social dialogue.

#2.1 SOCIAL DIALOGUE AT EUROPEAN UNION LEVEL

In the European Union, social partners have the prerogative to negotiate and conclude binding agreements for the whole EU. These must then be transposed into a legislative act.

22 https://ec.europa.eu/social/main.jsp?catId=978&langId=en

Framework agreements can also be signed. Though with less impact, they commit the signatories to promote and implement tool and measures, where necessary at national, sectoral and/or enterprise level.

In 2020, an agreement on digitalisation was signed by the European Social Partners[23]. Its aim is to "optimise the benefits and deals with the challenges of digitalisation in the world of work".

The agreement sets up a "dynamic circular process" involving five stages:

1. "Exploring, raising awareness and creating the right support base and climate of trust to (...) openly discuss the opportunities and challenges/risks of digitalisation".
2. Joint mapping of such opportunities and challenges and the identification of avenues of action.
3. Adoption of common strategies for digital transformation.
4. Implementation of appropriate measures.
5. Regular joint monitoring of their effectiveness.

The agreement lists the 4 following matters to tackle:

- Digital skills and securing employment
- Modalities of connecting and disconnecting
- Artificial Intelligence and guaranteeing the human in control principle
- Respect of human dignity and surveillance

For every of these 4 topics, certain measures to be considered are mentioned. It will be interesting to see how this framework agreement translates into concrete measures.

The European Trade Union Confederation (ETUC) has raised concerns about the impact of digitalisation on job quality and labour rights (2016). It has also pushed for legislation to protect privacy and combat invasive technologies.

It is worth mentioning here that a framework agree-

23 https://www.etuc.org/fr/node/19184

ment was signed by the social partners on telework/work from home back in 2002.

Considered as soft law, other initiatives include:

- In November 2019, the chemical social partners signed recommendations on digital transformation.
- In November 2020, IndustriAll European Trade Union and Ceemet (European Tech & Industry Employers) signed a joint statement in which they identify four areas in which social dialogue can shape the ongoing technological change to the benefit of both, employers and workers:
  - work organisation
  - skills
  - occupational health & safety
  - data protection.

#2.2 EUROPEAN WORKS COUNCILS SHOULD BE A PLACE TO DISCUSS DIGITALISATION ACCORDING TO INDUSTRIALL EUROPE

In 2020, IndustriAll European Trade Union published a mini-guide addressing all its European Works Council members.

Because digitalisation has multiple aspects, it recommends making this subject a regular agenda item. And many questions should be raised when certain topics are discussed (strategy, investment policy, employment policy, etc.):

- With regard to strategy: does digitalisation impact the company's business model? Is outsourcing via a platform planned? How can new technologies improve the company's situation? etc.).
- With regard to investment policy: In which areas? Which efficiency gains are expected? Which pay-back? Etc.).
- With regard to employment policy: What will be the impact of the new HR tool to hire or assess employees? What will be the impacts of new technologies on headcount? on working conditions? or on performance … training … data protection?

In many cases, the proposed changes will trigger an information consultation process.

#3 UNION INITIATIVES: A FEW EXAMPLES OF SUCCESSFUL PRACTICE IN A DIGITAL WORLD OF WORK

While impossible to record all union actions around the world concerning the digitalisation of our economies and its impact on the world of work, several initiatives provide a good insight into specific union activities or strategies covering the challenges caused by new technologies and give some hints of successful ways of addressing them.

The Fredrich Ebert Stiftung project "Trade Unions in Transformation 4.0" is one of these initiatives aimed at "*better understanding the representation of workers' interests in digital capitalism*". It provides case studies[24] on how different organisation are facing this new world of work and developing strategies to organise workers and represent their interests. All these studies show how digitalisation, included its application in manufacturing sectors, disrupt the power balance between employers and workers. Many organisations see opportunities to forge new alliances, unionise in new sectors where they as yet have no foothold, and develop new form of unionisation.

24 Friedrich Ebert Stiftung. (2021). *Trade Unions in transformation 4.0: Stories of Unions confronting the new world of work.*

#3.1 IN THE MANUFACTURING SECTOR

Looking at the rise of Industry 4.0, the two cases below, the initiative led by IG Metall and the union actions organised by the Brazilian SMABC, provide good examples of how union power, the quality of social dialogue and the institutionalisation of policy on industry 4.0 are important factors shaping union actions. Initiated by two strong unions, two different strategies are evolving in two very different institutional and political environments. While the IG Metall's Work+Innnovation project aims at engaging workers, and management, in shaping the changes confronting them, the SMABC stance uses defensive action to save jobs, achieve better working conditions and adapt to change in the automotive sector. The third example, in France, shows an ongoing project attempting to combine social dialogue and change management with the aim of creating a toolbox adaptable to the whole industry.

GERMANY: IG METALL AND THE WORK + INNOVATION (W+I) PROJECT

Initiated by IG Metall in 2016, this project aimed to engage workers in over a hundred plants and companies in Germany in a process to actively shape their workplaces and improve their qualifications in the context of Industry 4.0. This project was a way to concretely allow works councils to play an active role in shaping the world of work and to be involved in the introduction of new technologies.

The project revolved around worker training courses linked to innovation projects specifically designed by a company. The objective of those courses was to prepare workers and management for digitalisation in German industry by developing a common understanding of policies shaping working conditions as early as possible and reaching agreement on a common vision on how to integrate new technologies at company level.

The works councils of the companies taking part were heavily involved in defining the content of these courses. The main themes concerned technological changes in the company in question, employee participation and innovation policy. Each project was accompanied by a three-day module in a "learning factory" at the Ruhr University Bochum.[25]

In the meantime, the W+I project has developed a specific transformation project at company level accompanying workers and management in implementing new production line technologies in conjunction with the workforce, addressing issues such as working time and organisation, and establishing education and training programmes.

The report Shaping industry 4.0 on workers' terms[26] highlights the very concrete and positive results of such an approach:

- For instance, the W+I project was instrumental in maintaining the activity in the Siemens plant of Thüringen. To accommodate a structural decrease of production, management announced in 2017 the relocation of the assembly line to the Czech Republic, leaving 500 employees behind. Organised workers and the works council, in their will to save the plant, collected ideas on how costs could be reduced by using digital technology. They came up with more than 80 solutions with a saving potential of several million euros, convincing the employer to participate in W+I. A company group was set up and started extensive negotiations, with the support of IG Metall. Employees were selected for training provided under the W+I project. Ultimately, a number of digital applications were agreed upon and implemented in the production process. The plant continues to exist to this day, a flagship of digitally supported production within Siemens.

25 Friedrich Ebert Stiftung. (2021). *Trade Unions in transformation 4.0: Stories of Unions confronting the new world of work.*
26 Schäfers, K., & Schroth, J. (2020). *Shaping industry 4.0 on workers' Terms/IG Metall's « work+Innovation » Project.* Friedrich Ebert Stiftung.

- As part of the W+I project, Airbus employees developed a voluntary and self-organised system of scheduling weekend shifts to cope with the time difference between their engineering centres and those in the United States and India.

Concluded in 2019, this project is being followed up by an initiative to create tools and seminars to support works councils in the German co-determination process characterising a wide share of large German companies.

For instance, IG Metall recently created a "**compass for digitalisation**". It not only assesses digitalisation in companies, but also evaluates whether a company's strategy is adequate and assesses the quality of the change process. Designed as a tool for works councils and management alike, it supports company-level collective bargaining over digitalisation by providing a joint evaluation of the situation and measuring achievement of jointly-agreed targets.

It was used in a Miele factory near Hannover which produces laundry dryers. An assistance system was to be introduced, to help workers assemble different versions of the product. The works council used the compass to assess and document the work process and then analyse the new system, making sure that the new system could not be used to control workers' behaviour or performance. By using the compass, management and the works council were able to ensure that productivity targets were fulfilled, training schemes adjusted, and worker surveillance avoided.

BRAZIL: SMABC[27] AND THE AUTOMOTIVE INDUSTRY

In June 2019, Mercedes Benz Brasil announced the closure of four units affected by the introduction of a new concept in the context of Industry 4.0 (press shop; tool and dye shop; mechanical shop; and the outsourcing of the production of axles and aggregates).

27 Sindicato dos Metalúrgicos do ABC

SMABC approved a one-day work stoppage to demand negotiations on maintaining jobs. It very soon involved the World Works Council in Germany to gather relevant information, while organising debates and meetings with the shop workers potentially impacted by the move. They negotiated an agreement to have new components of Euro 6 trucks manufactured in the plant, along with new products and investments in those areas threatened by job cuts. At the end of the day, 300 jobs at risk were maintained and 200 new jobs created.

Here, the clear SMABC objectives were to tackle the effects on jobs of the arrival of new products and to gain a strong say in the design of new occupations.

Another successful agreement was concluded at VW Brasil. There, Industry 4.0 was not intensely introduced on the assembly line. Instead, it was the pre-production stage which was highly impacted by digitalisation, with a new digital process dramatically reducing the time needed to design a new vehicle and to set up an assembly line. The changes were negotiated, ensuring greater autonomy and regionalisation in the design of models with export potential. This created 100 new jobs in engineering and design, in addition to the 850 existing ones, and 400 on the assembly lines.

Capitalising on these successes, SMABC started to develop a vision on the implications of technological unemployment, opening up new opportunity structures for revamping SMABC's trade union action and organisation. They worked within a set of proposals to reinvent the union, oriented towards becoming a "Union 4.0". For instance, they promoted Training 4.0 aimed at enabling union leaders to work in this setting of ongoing transformation. The intention is for workers' representatives, equipped with more technical qualifications, to be able to identify even minimal technological interventions, assess their impact on jobs and propose alternatives to safeguard jobs, based on a factory's future investment decisions. A series of courses and lectures were held over the period 2017-19 on issues relating to Industry 4.0.

FRANCE: AN FGMM CFDT PROJECT BASED ON EXPERIMENTATION: SOCIAL DESIGN TO TACKLE DIGITALISATION (*DESIGN SOCIAL POUR LA TRANSFORMATION NUMÉRIQUE*)

Launched in 2018, the project is financed by the European Social Fund. It was supposed to last 2 years but because of the pandemic it is still ongoing as of December 2021.

The project was initiated by the French union FGMM CGDT (metal industry) and includes the employer federation UIMM (metal industry) and the Alliance du Futur (Industry 4.0 employer organisation).

With digitalisation beginning to impact industry and set to lead to huge changes, the project aims to:

- Develop an innovative approach to tackling digital transformation
- Elaborate a new social dialogue method
- Innovate a new method of dialogue to anticipate and accompany change
- Test the method in the field and make the necessary adjustments
- Disseminate the method

This innovative method has been tested in a major car company. The project is ongoing.

#3.2 INTERNATIONAL EXAMPLES OUTSIDE THE MANUFACTURING INDUSTRY

Workers in every sector are impacted by digitalisation. The examples below refer not to manufacturing, but to ICT, transport, or to workers in the gig economy. They highlight the different strategies and objectives adopted to cope with digitalisation.

The example of **Histadrut in Israel**[28] highlights an attempt to unionise workers in sectors traditionally distant from unions. The ICT sector is one of the most important sectors in Israel, employing some 300 000 workers. In 2014, Histadrut set up the Cellular, Internet and High-Tech Workers Union (CIHT) with a view to unionising tech workers, most of whom are white collars with little trade union affinity. Moving from its traditional member base in the public sector, Histadrut built up institutional power in order to promote a successful legislative campaign to allow workers to organise in the ICT sector. The result of the CIHT unionisation drive was mixed: despite just a few thousand ICT workers joining the union, the campaign discredited industry warnings that unionising efforts would lead to job losses (due to relocation elsewhere). This didn't happen. Moreover, the unionisation drive was positive, in that it attracted new members from other sectors.

Another example of a unionisation drive can be found in **Indonesia**[29], though this time unions concentrated their efforts on organising app-based transport workers in support of their demands. As in many other countries, these workers are not covered by labour laws as they are considered to be self-employed. In addition, the app-based system of payment leaves them without any control over their remuneration or working conditions. The Aerospace and Transportation Workers division of the Federation of Metal Workers' Union (SPDT-FSPMI) developed strategies to unionise those workers by fighting for the recognition of drivers as workers entitled to labour rights and trying to create a negotiation space with the app-based transport companies. Several protests and strikes have been called, but have been subject to severe repression and intimidation. So far, the struggle has failed to deliver a specific status for these workers, highlighting the difficulty to organise app-based workers without associational and institutional power.

28 Fischer, B. (2020). *Unlikely Unionist: Organised labour in the Israeli ICT sector.* Friedrich Ebert Stiftung.
29 Panimbang, F., Arifin, S., Riyadi, S., & Septi Utami, D. (2020). *Resisting exploitation by algorythms: Drivers' Contestation of App-based Transport in Indonesia.* Friedrich Ebert Stiftung.

In Argentina, the Platform Delivery Workers Union, **the Asociacion de Personal de Plataformas** (APP) is another example representative of the issues faced in organising platform workers[30]. The first of its kind in the region, it aims to organise delivery workers. The struggle faced by this young organisation illustrates the unionisation challenges to the sector. The APP is currently involved in a legal struggle to gain recognition as a union. However, proof of its members' employment relationships are required. Naturally, the companies concerned are refusing to recognise app workers, designating them as "partners" or "collaborators".

The case of **KAMBE (Kampala Metropolitan Boda Boda[31] Entrepreneurs) in Uganda[32]** is also an interesting experiment showing how new form of organisation and innovation can help workers shape digitalisation to their benefit. A cooperative established to organise *boda boda* drivers, Kambe has designed its own app to support its members. KAMBE is a member of the AGTWU (Amalgamated Transport and General Workers' Union) which supported the development of this innovative idea. *Boda boda* drivers work largely in the informal sector, earning their money on a daily basis, without any social protection in case of accidents or sickness. Hence the need to organise them. With their own ride-hailing app, drivers can handle passenger and courier demands. It also operates as a bank account for drivers, offering them the possibility to save money, withdraw funds and keep tracks of their transactions, and pay membership fees. The initiative is not without challenges, as developing and operating the app needs financial resources that AGTWU does not necessarily have, while not every driver has a smartphone. But this example shows innovative way of combining the organisation of workers and the challenge of facing the digital transformation on its own terms.

30 Perelman, L., Mangini, M., Perrot, B., Belén Fierro, M., & Sol Garbarz, M. (2020). *Proudly delivered by app: The struggle of Latin America's first union for platform workers.* Friedrich Ebert Stiftung.
31 Motorcycle taxis
32 Manga, E., Hamilton, P., & Stephenson, K. (2020). *Riding on a union app: Uganda's Public Transport Workers' Digital Response to Platforms.* Friedrich Ebert Stiftung.

CHAPTER 5

WHAT'S GOING ON AT COMPANY LEVEL?

It seems that company-level social dialogue is not yet really fruitful with regard to digitalisation. While many companies make many announcements related to digitisation, it is rarely a topic that is negotiated or even discussed.

#1 WHAT ARE WE TALKING ABOUT?

The pandemic has generated many company-level agreements, but these are mostly related to Working from Home or Telework.

There are also a number of agreements that have been signed these last years related to the right to disconnect. Though this is an issue, it is not the only one.

Agreements tackling other aspects of digitisation exist but are not commonplace.

#2 LEGAL ASPECTS

In the European Union, large companies are supposed to establish European works councils, an elected body to be informed and consulted on major issues.

A major project related to digitalisation and giving rise to deep-going changes to working conditions or work organisation is supposed to trigger an information and consultation procedure. We can suppose that many such procedures have taken place in major companies.

In France, a specific information and consultation process must be launched when any (digital) project has an impact of working conditions and/or workers' health & safety. For instance, if a new tool is launched, an information and consultation procedure must be followed.

The use of artificial intelligence, robots, a new ERP, new digital tools, new mission-planning tools are all projects triggering an information and consultation procedure.

It is already something but quite different from a negotiation.

#3 NEGOTIATION

As of 15 March 2020 (prior to the Covid-19 pandemic), the French government's open database listed :

- 6 070 Work from Home agreements
- 12 187 agreements on the right to disconnect
- Dozens of agreements on changes of skills and employment linked to digitalisation.

In France, companies must negotiate agreements on the evolution of skills and employment. Mainly concluded in large industrial companies (Engie, PSA, Renault, Schneider, Shell etc.), Just a few dozen of these agreements refer to digitalisation as a key change factor.

Outside France, some multinational companies have negotiated and signed agreements on the right to disconnect. Among others, one can mention BMW (Germany), Enel (Italy), Evonik (Germany), E.ON (Germany), Solvay (Belgium) and Volkswagen (Germany). Some of these agreements also address other topics (remote work, smartphone use, etc.). Other companies outside manufacturing (UniCredit, Banco Santander etc.) have similar agreements. Yet only a handful of these agreements tackle the changes in the work organisation and the content of the work itself.

If a growing number of companies in the industry are facing the transition to Industry 4.0, it's safe to assume that more and more of them will put this topic on the agenda. But those that will spontaneously do so are likely to remain a very small minority. It is likely that trade unions will need to assert themselves in order to be part of the discussions and even the decisions.

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