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Data Analytics in SMEs: Trends and Policies

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OECD SMEs and Entrepreneurship Papers

Data Analytics in SMEs: Trends and policies

By: Marco Bianchini and Veronika Michalkova[1]

The report contextualises the role of data analytics in the ongoing digital revolution and its potential for SME performance, including for enhancing SME productivity. It presents evidence on the use of data analytics in SMEs, discusses main internal and external barriers to the use of data analytics by SMEs, and illustrates policy approaches to foster data-driven decision-making in SMEs.

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Executive Summary

Digitalisation is one of the most important trends reshaping economies and societies. Digital technologies offer new opportunities to Small and Medium-sized Enterprises (SMEs) and entrepreneurs to participate in the global economy, innovate and grow.

An important aspect of this transition is the possibility to generate and gather huge volumes of data (i.e. Big Data) thanks to a number of technological developments (e.g. mobile broadband connections, cloud computing, geo-localisation). Data analytics techniques enable firms to use effectively such abundant data, giving SMEs a competitive edge and increasing their productivity, for example by reducing costs, enhancing marketing practices, and strengthening their ability to identify or foresee trends.

However, SMEs and entrepreneurs face important challenges in accessing and analysing relevant data. On the one hand, limited digital skills by management and employees may fuel misperceptions on the actual risks and benefits deriving from adoption of recent digital technologies. On the other hand, small businesses typically find it more difficult to identify, attract and retain the specialists needed to deploy effective data analytics. Lack of financing options and burdensome regulatory requirements (e.g. personal data protection) often represent additional barriers for SMEs.

Governments increasingly acknowledge the importance of data analytics for SMEs and are taking action to address key challenges. Measures include inter alia: offering training and skills development programmes to entrepreneurs and SMEs' employees; introducing regulatory reforms that contribute to enhance data management practices by SMEs; promoting data sharing and diffusion; supporting knowledge exchange among SMEs as well as between SMEs, public institutions, business associations and other stakeholders; and providing financial support for data analytics projects in SMEs.

This document describes the main technological drivers of data analytics and the increased relevance for SMEs, illustrating adoption trends in recent years. It discusses opportunities and challenges related to the adoption of data analytics techniques by SMEs, including impact on productivity, and presents selected policies adopted in OECD countries to support the use of data analytics by SMEs and entrepreneurs.

This report contributes to the OECD horizontal project on "Going Digital: Making the Transformation Work for Growth and Well-Being", which aims to help policy makers better understand the digital transformation and develop and implement a resilient policy framework that fosters a positive and inclusive digital economy and society.

Chapter 1. Background and rationale

Digital technologies open up new opportunities for Small and Medium-Sized Enterprises (SMEs). They can allow new and small businesses to improve market intelligence, reach scale without mass, and access global markets and knowledge networks at relatively low cost. The digital transition facilitates the emergence of "born global" small businesses and provides new opportunities for SMEs to enhance their competitiveness in local and global markets, through product or service innovation and through improved production processes. It also facilitates the emergence of "lean start-ups" which leverage the Internet to lower fixed costs and outsources many aspects of the business to stay agile and responsive to the market (OECD, 2017[1]).

In particular, the Big Data phenomenon can transform how businesses operate by enabling them to gather accurate information about customers, competitors, and suppliers, and use this information to make strategic decisions. The Internet of Things (IoT) and the ubiquity of mobile devices embedding sensors connected to the Internet and to GPS have sharply increased data generation and data collection. In this context, "data analytics", which refers to a series of techniques used to analyse effectively large amounts of data from structured and unstructured sources, can become a key driver of enterprise competitiveness.

However, small businesses find it more difficult to adopt new technologies and take advantage of Big Data than large companies. Evidence shows that a large number of small businesses across OECD and non-OECD countries lag behind in the digital transition. Some of the barriers relate to financial and human resource constraints typically associated with the small business size, as also discerned in early studies on the first wave of computerisation (Ein-Dor and Segev, 1978[2]). Other challenges, however, are more specifically linked to the latest wave of digital technologies, such as the unequal access to data and the limited capacity to manage privacy concerns and other forms of digital security stemming from the use of personal data (OECD, 2017[3]).

Furthermore, digitalisation may lead to market disruption for SMEs, including through reduced market contestability (due to winner-takes-all dynamics by which network effects allow first-comers to quickly seize large market shares), rapid obsolescence of knowledge, skills and business models, and increased complexity in the business environment (OECD, 2018[4]).

Governments increasingly recognise the importance of a policy environment that enables all businesses to prosper in the digital economy. In the 2018 *Ministerial Declaration on Strengthening SMEs and Entrepreneurship for Productivity and Inclusive Growth* (OECD, 2018[5]), Ministers and High-Level Representatives from 55 countries and the European Union indicated that they will continue efforts "to enable SMEs to make the most of the digital transition by fostering conditions for SME adoption and diffusion of innovative and digital technologies, investment in complementary knowledge-based assets and digital security".

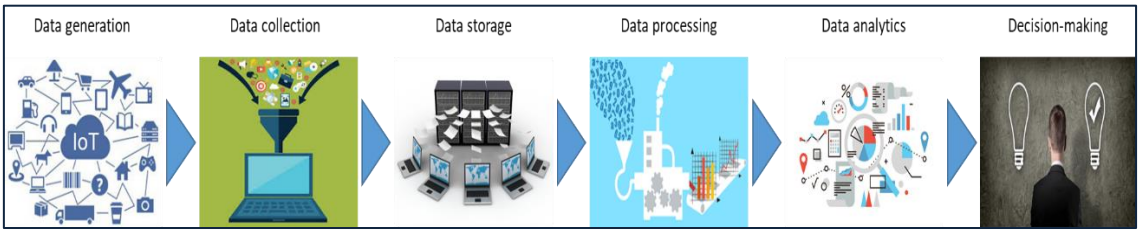
In 2017-18, the OECD has launched a horizontal project on "Going Digital: Making the Transformation Work for Growth and Well-Being", which aims to help policy makers better understand the digital transformation and develop and implement a resilient policy framework that fosters a positive and inclusive digital economy and society (OECD, 2018[4]). This report provides a contribution to the OECD Going Digital horizontal project. It offers a general overview of the opportunities and challenges related to the use of data analytics in SMEs, discusses the impact of data analytics on SME productivity, illustrates trends in data analytics use in SMEs, and comments on government policies in this area.

Chapter 2. SMEs competing in the age of Big Data: the role of data analytics

Drivers of data analytics

Data analytics includes a set of techniques and tools to extract and analyse information from data. Data generated by day-to-day business operations, sensors embedded in a vast array of physical objects (e.g. Internet of Things) or direct human activities (e.g. online searches) are potentially useful, but also highly unstructured and hard to interpret. Data analytics can help make sense of these data by identifying patterns, relationships and interactions. Indeed, raw data is not enough to generate value, and there is evidence that data collection in itself does not bring the anticipated results in terms of productivity growth (Bakshi, Bravo-Biosca and Mateos-Garcia, 2014[6]). Raw data need to be cleaned, standardised, consolidated and organised before statistical analysis can be performed on them (Figure 1).

Figure 1. The data value chain and life cycle



Source: OECD based on (OECD, 2013[7]).

Data analytics help gain insights from large data sources analysis and reporting (e.g. easily understandable dashboards and visualisations), thus allowing for better communication of the information and providing a basis for data-driven decision-making. The rest of this section presents the main concepts which underpin and make data analytics possible.

Big Data is the key input for all recent data analytics applications. Even though the literature offers no universally accepted definition of Big Data, most authors focus on "Volume", the vast amounts of data generated over time, "Velocity", the speed at which data are generated, become available and change over time, and "Variety", the different format of data and their various sources, ranging from business transactions, machines and sensors to social media and publicly available information. Some authors have also recently referred to the fourth "V" of "Veracity", pointing at the need for reliable and transparent data as a base for analysis (e.g. (Zikopoulos et al., 2015[8])).

A main driver of the Big Data transition is the Internet of Things (IoT). The IoT blurs the lines between day-to-day objects and computers, with sensors able to gather an increasing array of phenomena and send them to back-end IT infrastructures for storage and analysis. Examples are the accelerometer, gyroscope, compass, and GPS embedded in any smartphone that can automatically track movements and location of the person carrying the

device and continuously transmit these data over the internet. This growing amount of data offers the possibility of unprecedented analysis to inform the decision-making process and can have a large impact on future business models (OECD, 2016[9]; OECD, 2015[10]).

Enterprise information software programmes embed data analytics within their functions, to provide an end-to-end service to gather, store and perform a first analysis of the data. Empirical studies show a positive correlation between the use of these programmes and productivity growth in SMEs (Shin, 2006[11]). This is especially the case for the three following categories of software:

- Enterprise resource planning (ERP) - to manage and integrate their business activities, such as accounting, finance, procurement, inventory and human resources. ERP software enables data flows and data checks, thus ensuring data quality and integrity;
- Customer relationship management (CRM) - to facilitate the interaction of firms with customers by centralising and tracking all customer related information, such as contact data, purchase patterns and history of contacts;
- Supply Chain Management (SCM) – to help with executing and controlling transactions and managing supplier relationships, inventory and logistics.

Connected with the surge of Big Data is the recent leap in Artificial Intelligence (A.I). "Machine learning", the technology underlying A.I., can identify complex patterns in large databases (Chen, 2012[12]). The study of neural networks and the development of "Deep learning" algorithms over the past 6-7 years have led to A.I. systems which are able to perform human-like cognitive functions, with machines operating independently in complex, unpredictable environments (e.g. understanding human speech, competing in strategic games, driving vehicles, recognising facial expressions).

The large investments in technology, skills and data management that A.I. implies are outside the reach of most SMEs and new firms (OECD, 2018[13]). However, it is interesting to note that some commercial applications of this technology are starting to be available for SMEs through the cloud computing (CC) services offered by large corporations, allowing SMEs to access tailored A.I. services even when they lack the internal resources to develop them.

To make use of Big Data and harness the potential of data analytics, cloud computing services are particularly useful to SMEs, as, by providing supercomputing resources in a flexible manner, they allow companies to overcome barriers related to the high costs of building the ICT infrastructure (OECD, 2016[14]). In fact, for data analytics to be effective, a large amount of data must be collected, requiring storage space and processing power on a scale that is often out of reach for SMEs. The offer of cloud services is flexible, both in terms of pricing, quantity and of type of services, as many tailored solutions are available on the market.

Major cloud services providers (e.g. Amazon Web Services, Google, SAS, and Salesforce) are usually subscription-based and offer built-in analytical tools, so that clients have ready-to-go solutions for both storage and basic analysis of their data. Services can be deployed privately for exclusive use, made publicly available or offered under a mixed format. However, the dominance of a few large incumbents in the cloud computing services market comes with some challenges. For example, SMEs' data can be locked-in with databases optimised only within a specific ICT ecosystem.

Distributed Ledger Technologies (DLTs), blockchain in particular, exhibit a similar diffusion patterns among SMEs, as services of data storage, tracking of goods, "tokenisation" of digital and physical assets and other applications start to be offered on the market[2], enabling SMEs to seize some of the benefits of this technology without the need to develop applications in-house.

Why do data analytics matter for SMEs?

The use of data analytics provides a wide range of opportunities for SMEs, such as better understanding of the internal production process, of the needs of clients and partners, and of the overall characteristics of national and local markets through the tools of market analysis.

The impact of data analytics and data-driven decision making on enterprise performance mostly happens through five channels (OECD, 2013[7]): enhancing research and development (data-driven R&D); developing new goods and services by using data either as a product or as a major input (data products and data-intensive products); optimising production or delivery processes (data-driven processes); improving marketing through targeted advertisement (data-driven marketing); developing new organisational and management approaches or significantly improving existing practices (data-driven organisation).

It should be noted that not all sectors are equally impacted. Data analytics has evolved into an essential driver of business competitiveness in some sectors, while it is quite marginal in others. According to the McKinsey Global Institute (MGI, 2011[15]), data intensity, measured as the average amount of data per organisation, is highest in financial services (including securities and investment services and banking), communication and media, utilities and discrete manufacturing.

A recent OECD study, which offers a more comprehensive taxonomy of digital intensive sectors, broadly confirms the centrality of data access and analytics in sectors such as telecom and IT services and consistent low levels of digital intensity in other sectors, including agriculture, mining and real estate. Other sectors are engaged in the transformation at different rates, depending on the dimension considered, e.g. intensity in ICT tangible and intangible (i.e. software) investment; intensity in purchases of ICT intermediate goods and services; stock of robots per employee; number of ICT specialists over total employment; and the proportion of turnover from online sales (Calvino et al., 2018[16])[3].

In manufacturing for example, operations managers can use advanced techniques to analyse historical production data, identify patterns and relationships among discrete process steps and inputs, and then optimise the factors that prove to have the greatest effect on yield. The

[2] Applications of this technology for SMEs are starting to be tested and offered in the market, especially in the areas of supply chain management (e.g. for enforcement of Corporate Social Responsibility standards), access to finance (e.g. ICOs, trade finance) and corporate governance (e.g. DAO). Given the relatively recent development of the technology, these applications are in most cases Proof of Concepts or anyway at early stages of development.

[3] Further analysis based on this taxonomy shows that firm mark-ups across countries are positively correlated with the digital intensity of the sector and that the difference between digitally-intensive and non-digitally intensive sectors has increased over time (Calligaris, Criscuolo and Marcolin, 2018[65]).

use of data analytics in quality control in manufacturing process can also improve efficiency (Auschitzky, Hammer and Rajagopaul, 2014[17]).

Data analytics also contributes to lean production, helping companies to optimise their processes and minimise deficiencies in manufacturing (e.g. lower number of defect products and reduced waiting times). Quality control is an important area of application of data analytics, as the identification of recurring patterns and the monitoring of process expertise can allow for continuous improvement of products. Moreover, when firms in many industries offer similar products and use comparable technologies, differentiation in business processes can bring competitive advantages (Davenport, 2006[18]).

Data-driven decision making and SMEs productivity

The impact of ICT on firm productivity has been researched extensively, with numerous studies highlighting a "productivity paradox", i.e. a lack of a clear correlation between ICT adoption and productivity trends, which has led to question also conventional measures of productivity and output (Brynjolfsson, 1993[19]; Harris, 1994[20]).

Data analytics serves as a basis for data-driven decision making, whose impact on firm-level productivity has been studied by several authors. Focusing on 179 publicly traded firms in the US, (Brynjolfsson, Hitt and Kim, 2011[21]), estimate that the output and productivity in firms which adopt data-driven decision-making are 5-6% higher than what would be expected from their other investments in, and use of, information technology. The study confirms a positive impact on other performance measures, namely output, asset utilisation, return on equity and market value. The authors also identify a negative correlation between data-driven decision-making and firm age, suggesting that younger firms are more likely to adopt innovative solutions. At the same time, extending this type of analysis to SMEs is stymied by a general lack of granular firm-level data capturing their information technology investments and usage.

A study of 500 UK firms, mostly privately held medium companies, which are commercially active online, finds that firms in the top quartile of online data use are 13% more productive than those in the bottom quartile (Bakshi, Bravo-Biosca and Mateos-Garcia, 2014[6]). The study considers several aspects of data activity (e.g. data collection, analysis and reporting, deployment), and finds data analysis and reporting have the strongest effect on performance. In particular, enterprises which are one standard-deviation above the mean in levels of data analysis and reporting are almost 11% more productive, controlling for firm-level characteristics such as firm age, IT employment share, and level of product and process evaluation. The study also finds a statistically significant and positive correlation between data analysis and reporting and other profitability measures such as the EBITDA (Earnings Before Interests, Taxes, Depreciation and Amortisation) per employee and ROE (Return On Equity), although the lack of longitudinal data does not allow to test causal relationship.

Determining if the introduction of ICT practices and decision-making in business processes is not only correlated, but *causes* increases in firm productivity and performance is challenging, due also to data gaps. By controlling for the timing of installation and use of ERP, SCM and CRM software in large, public U.S. firms (differentiated from the moment of acquisition of the software), (Aral, Brynjolfsson and Wu, 2006[22]) find a causal relation with performance gains.

Overall, firm-level studies suggest that using data and data analytics raises labour productivity faster than in non-users firms by approximately 5-10% (OECD, 2015[10]).

Linking indicators of IT use, workplace organisation, and the demand for skilled labour, (Bresnahan, Brynjolfsson and Hitt, 2002[23]) find that to have a stronger positive impact on firm-level productivity, the investment in ICT infrastructure has to be complemented with investment in other organisational capabilities and human capital. The same is true about investment in data infrastructure. Data collection and storage has little value without subsequent expert evaluation.

Furthermore, the business organisational model has an impact on the benefits accrued from big data. In particular, the degree of decentralisation of analytics might be a decisive factor in the success or failure of the transition to the data-driven business model. (Grossman and Siegel, 2014[24]) identify three main types of organisational models: a single unit with all data scientists; a few data scientists allocated in every business unit; or a hybrid solution called "centre of excellence", where data scientists in all different business units can obtain information and expertise from a central team.

The type of business model that is most effective for a specific firm will depend on the business complexity, the interactions of units and the final goal of data management (i.e. building a new business line vs optimising an existing one; (Coleman et al., 2016[25])). Some studies provide evidence about the key techniques and research practices that maximise the impact of analytics at enterprise level, as a mean for an organisation to become more competitive and link analysis with organisational performance (Davenport, 2013[26]).

Chapter 3. Trends in SMEs' use of data analytics

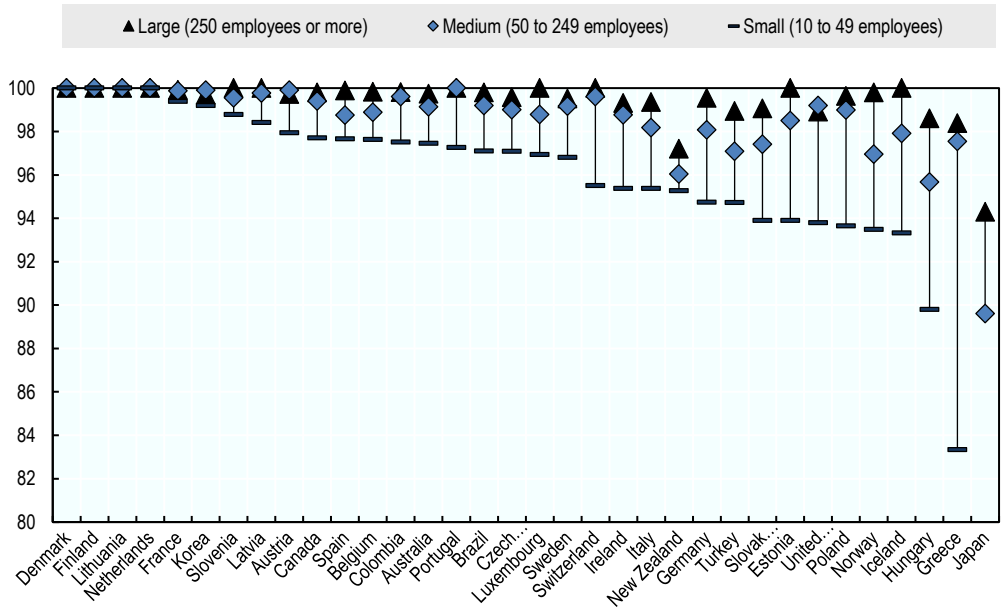
Infrastructures and framework conditions

Access to reliable and fast internet connection is key to unlock the benefits of data analytics. Over the last decade, fixed and mobile broadband subscriptions have continued to increase in the OECD area, with the two trends going hand-in-hand as often mobile services are accessed through mobile devices (e.g. smartphones, tablet) connected to fix Wi-Fi networks. Digital Subscriber Lines (DSL) still represent the majority of connections, but they are gradually being replaced by optical fibre networks that offer higher speed (OECD, 2017[3]).

The widespread broadband connections in OECD countries constitute a crucial infrastructure for businesses of all size. In most European countries, almost 100% of large businesses (250+ employees) have access to broadband connection. Medium sized-companies (50-249 employees) are normally close to those figures (or in any case above 95%), while smaller companies (10-49 employees) still lag behind in many countries (Figure 2).

Figure 2. Businesses with a broadband connection (fixed and/or mobile)

2017 or latest available year, as percentage of enterprises in each employment size class

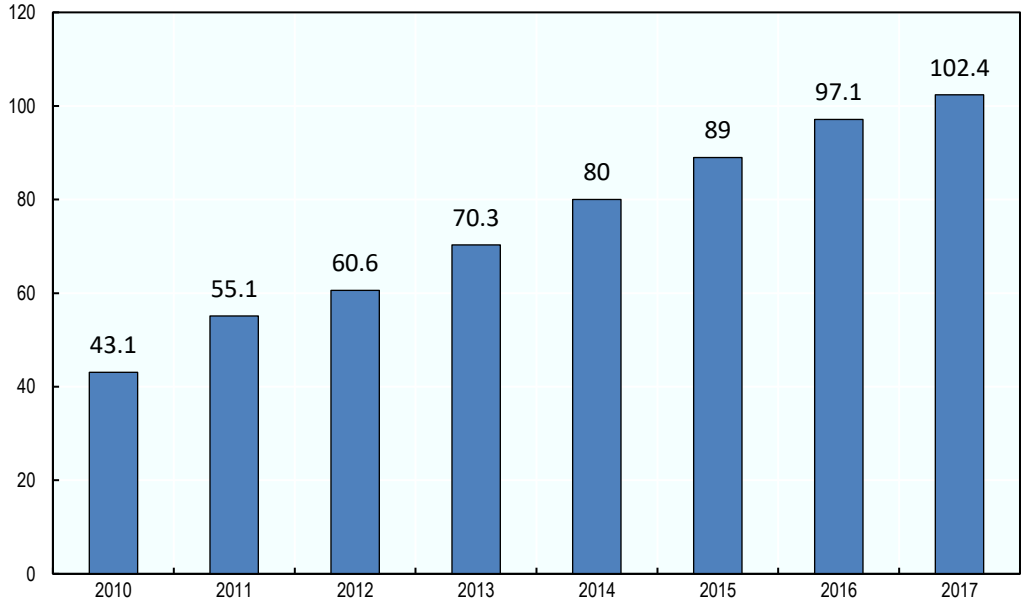


Notes: Data for Australia, Colombia, Japan, New Zealand and Korea refer to 2016; Data for Switzerland refer to 2015; Data for Iceland refer to 2014; Data for Canada refer to 2013. Data for Japan and Switzerland were collected with a different methodology.
Source: OECD (2018), ICT Access and Usage by Businesses (database), https://stats.oecd.org/Index.aspx?DataSetCode=ICT_BUS (accessed February 2019).

Wireless mobile broadband subscription rates have increased quickly in the past few years. In the OECD area, the rate of mobile subscriptions with data speeds of 256 Kbit/s or higher grew rapidly in the 2010-2017 period, passing from 43 to 102 per 100 inhabitants on average (Figure 3).

Figure 3. Mobile broadband subscriptions in OECD countries

OECD average, subscriptions per 100 inhabitants

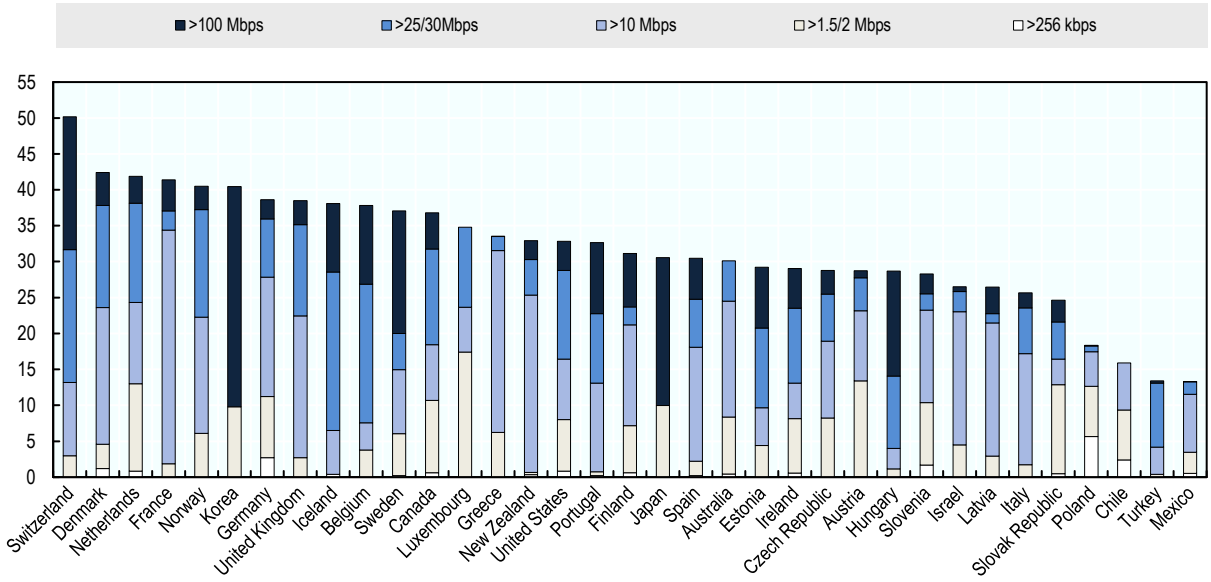


Note: The subscription must allow access to the Internet via HTTP and must have been used to make a data connection via Internet Protocol (IP) in the previous three months.
Source: OECD (2018), "Broadband database", OECD Telecommunications and Internet Statistics, database, http://dx.doi.org/10.1787/1277ddc6-en (accessed February 2019).

However, not all connections have the same speed. When considering fixed broadband subscriptions in OECD countries, the different level of services can be represented through speed tiers, and evidence shows that differences across countries can be sizeable. (Figure 4). For businesses, the access to "High Speed Internet" (>30 Mbit/s) has been shown to be an important factor influencing the uptake of digital technology, with a positive effect on the use of ERP and CRM software and of cloud computing (CC) solutions. This holds both for basic CC services as e-mails or data storing as well as for advanced CC services as financial, accounting and HR management or the provision of computing power to run firm-specific software applications (Andrews, Nicoletti and Timiliotis, 2018[27]).

Figure 4. Speed of broadband subscriptions

Subscriptions per 100 inhabitants, per speed tiers, 2016



Note: Mbps = megabits per second; kbps = kilobits per second. In Korea, 96.2% of subscriptions have a speed above 50 Mbps.
Source: OECD (2018), "Broadband database", OECD Telecommunications and Internet Statistics, database, www.oecd.org/sti/broadband/oecdbroadbandportal.htm (accessed February 2019).

Uptake of data analytics by SMEs

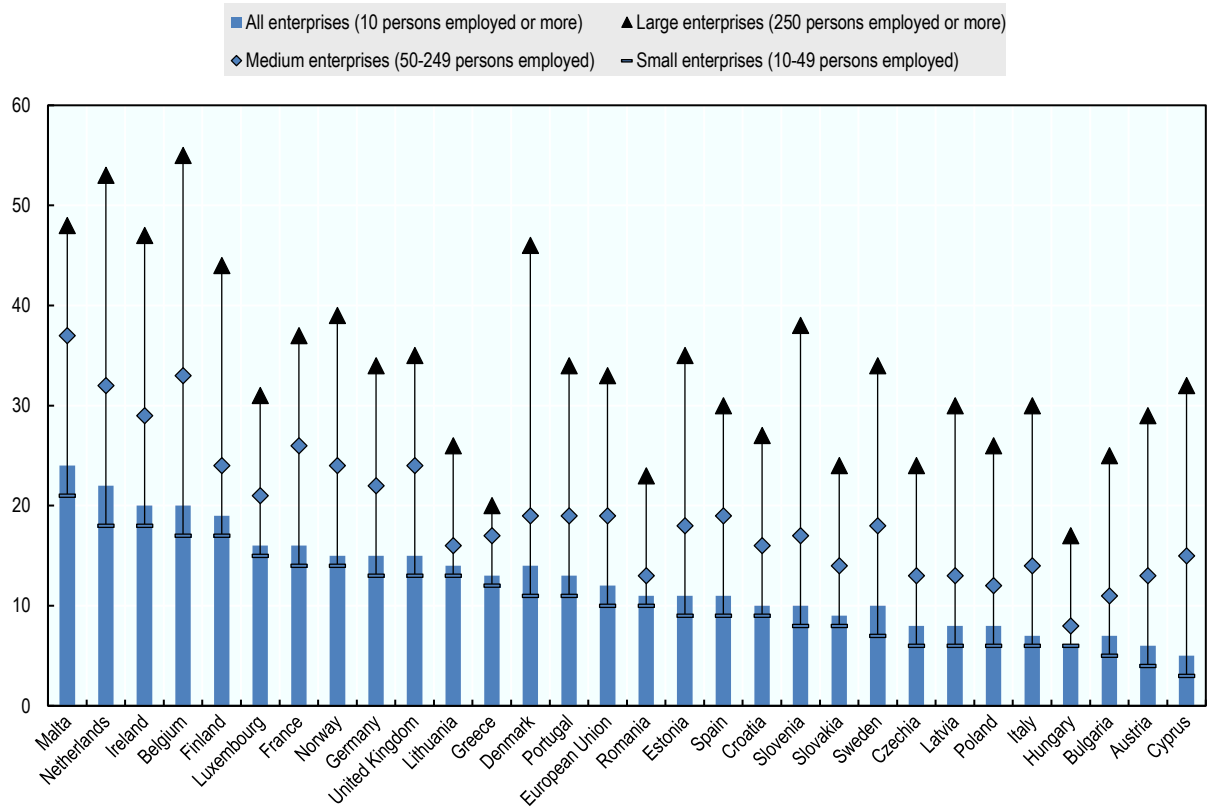
Efforts to map the use of data analytics practices by businesses have increased in recent years. For European countries, Eurostat provides evidence on the use of Big Data analysis, most common data sources and the approaches adopted. As highlighted in Figure 5, firm size largely matters. On average, across the EU Big Data analysis is adopted by 33% of large firms, 19% of medium-size enterprises and 10% of small firms (Eurostat, 2019[28])).

Differences across countries in the adoption gaps between large and small firms mainly relate to differences in the practices of large firms, while some convergence is observed in the adoption rates by SMEs. For example, the largest gaps between large and small companies are observed in Belgium (55% vs 17%), Denmark (46% vs 11%) and the Netherlands (53% vs 18%). While the smallest divides are observed in countries where less than one fourth of large firms adopt data analytics, such as Greece (20% vs 12%), Hungary (17% vs 6%) and Romania (23% vs 10%).

With regard to micro enterprises (1-9 employees), the evidence, available only for a handful of countries, points to rather limited uptake of data analytics techniques (7% of micro-firms in Portugal, 6% in the UK and 3% in Spain and the Slovak Republic in 2016).

Figure 5. Big Data analysis by SMEs in the EU

2018, as percentage of enterprises in each employment size class

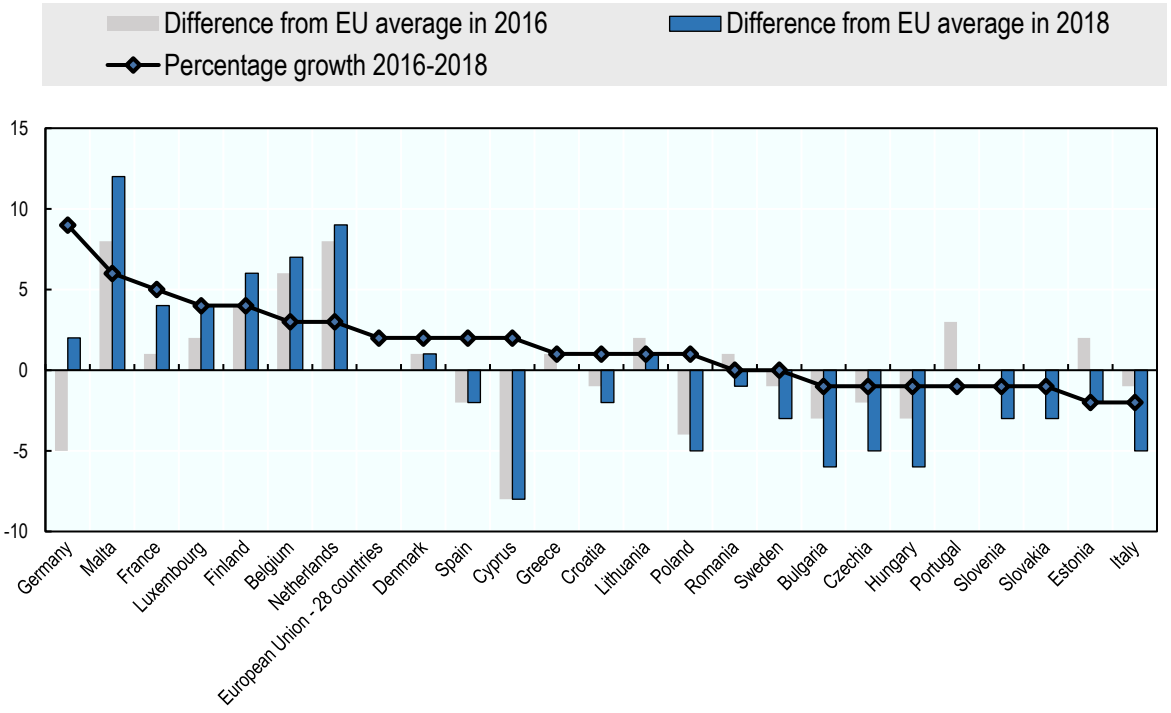


Note: Without financial sector. Data for the United Kingdom refer to 2016.
Source: Eurostat (2019), database, http://ec.europa.eu/eurostat/data/database?node_code=isoc_eb_bd (accessed February 2019).

On average, one in ten SMEs (10-249 employees) in the European Union analyses big data, with a slight upward trend from 10% in 2016 to 12% in 2018 (against 33% of large firms in 2018, up from 25% in 2016). However, the adoption trends by SMEs have varied substantially across countries, advancing rapidly in some cases while decreasing in others. As shown in Figure 6, over 2016-18, adoption rate by SMEs increased in 15 EU countries, with the strongest growth observed in Germany (+9%), which moved from a below EU average performance to an above average adoption rate. The German strong growth was followed by Malta (+6%) and France (+5%). On the other hand, a downward trend was observed in eight EU countries, with largest contractions in Italy (-5%) and Estonia (-2%), which fell below the EU average.

Figure 6. Trend in use of data analysis by European SMEs 2016-2018

Share of total SMEs (10-249 employees)



Note: Including only the 24 European countries for which both 2016 and 2018 values were available
Source: Eurostat (2019), database, http://ec.europa.eu/eurostat/data/database?node_code=isoc_eb_bd (accessed February 2019).

SMEs that use data analytics techniques can gather data from multiple sources, in relation with the specific information they are interested in. In 2018, the most common practice was to source data from geolocation of portable devices, with half of European SMEs (50%) doing so. This source was followed by data generated from social media (46%), data from enterprise's smart devices or sensors (27%) and data from other sources (24%). As Figure 7 illustrates, the sources of data for analysis vary widely across countries, with Slovenian and Cypriot[4] SMEs leveraging mostly own smart devices and sensors, SMEs in Romania and Poland focusing on geolocation of portable devices, SMEs in the UK and Ireland particularly keen on using data from social media and Swedish and Cypriot[4] SMEs utilising other sources the most. On the other hand, in 2018 the most common source of data in large

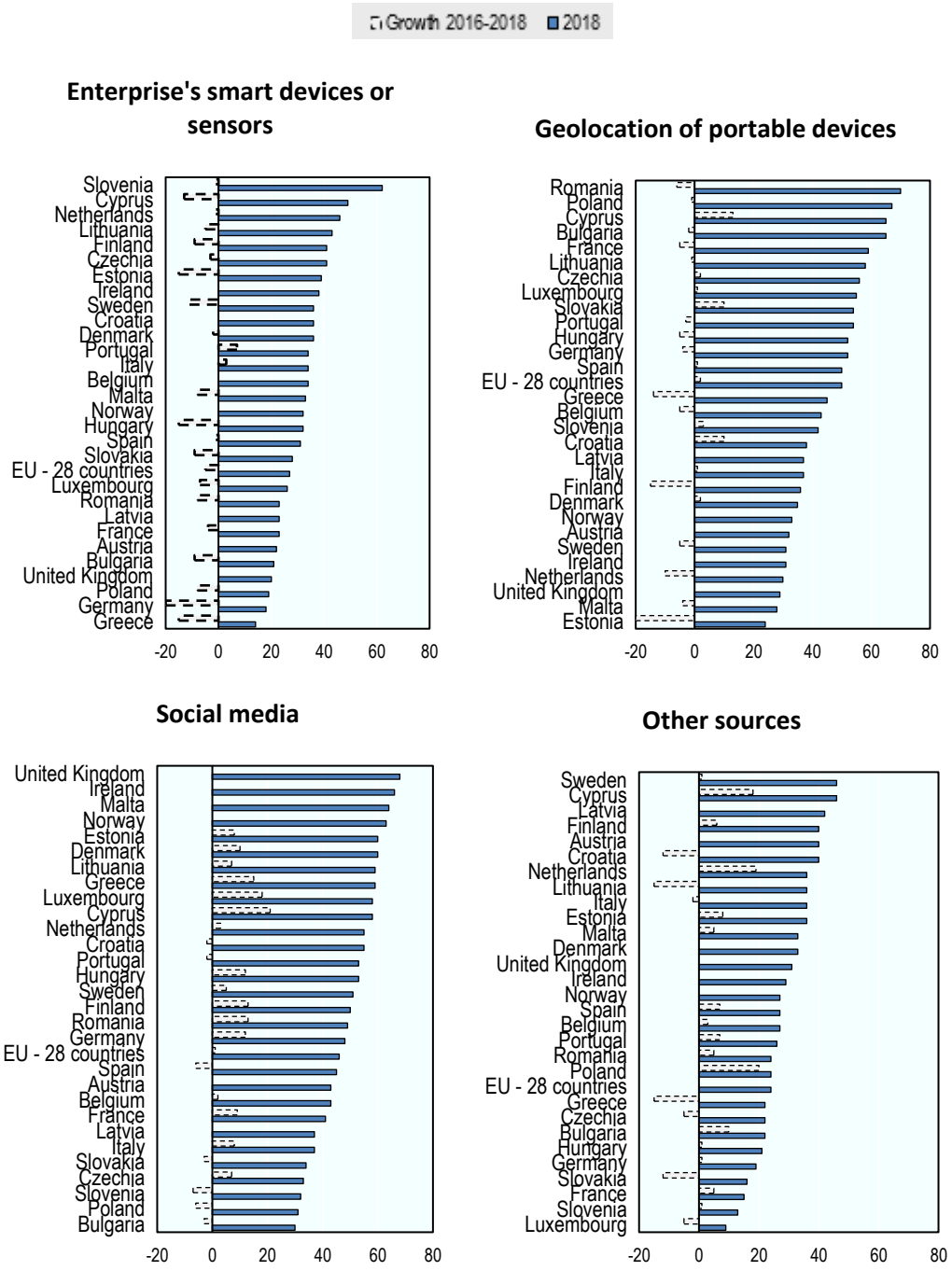
[4] Note by Turkey: The information in this document with reference to 'Cyprus' relates to the southern part of the island. There is no single authority representing both Turkish and Greek Cypriot people on the island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the 'Cyprus issue'.

Note by all the European Union Member States of the OECD and the European Commission: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

enterprises using data analytics are the enterprises' smart devices or sensors (54%), followed by the geolocation of portable devices, other sources and social media (respectively 41%, 40% and 39%).

Figure 7. Sources of data for analysis by SMEs in the EU

2018, share of SMEs (10-249 employees) performing data analysis



Note: Financial sector not included.
Source: Eurostat (2019), database, http://ec.europa.eu/eurostat/data/database?node_code=isoc_eb_bd (accessed February 2019).

Analysis of Big Data is increasingly outsourced by SMEs, as the offer of cloud-based services and specialised companies grows in the market. In 2018, among the SMEs that analyse Big Data in the European Union, 42% contracted an external service provider (up from 36% in 2016); at the same time, the percentage of firms that had internal staff performing the function decreased from 79% in 2016 to 75% in 2018. . A large share of large enterprises performed the analysis internally (90% in 2018, +1% on 2016) rather than externally (40%, -1% on 2016).

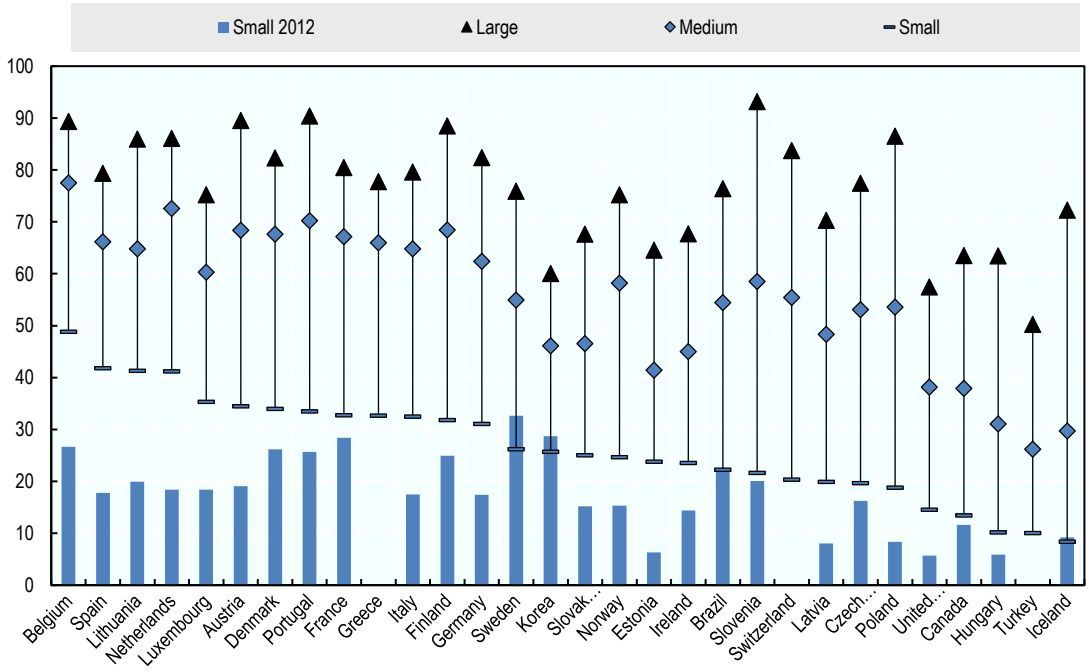
Big Data Analysis in the European Union varies broadly across sectors. In 2018, across all sizes of enterprises, analytical activities were more common in the ICT (25% of total firms), electricity, gas and water supply (20%) and transportation and storage sector (19%). On the other hand, about one in ten enterprises in manufacturing and real estate activities (9%) construction (11%) and retail and wholesale (12%) analysed big data (Eurostat, 2019[28]).

Enterprise Information software

Information on the use of ERP, CRM and SCM systems in the OECD can serve as a proxy for data-driven decision making in business. Data on businesses using ERP software shows that SMEs are less likely to invest in ERP compared to large companies, in some countries more significantly so than in others (Figure 8). The largest disparities between large and small enterprises (more than 60%) are observed in Slovenia, Poland, Iceland and Switzerland.

Figure 8. Businesses using ERP software

2017, as percentage of enterprises in each employment size class



Note: Data for Korea refer to 2016; data for Switzerland refer to 2015; data for Canada refer to 2013, while Canada uses different methodology.
Source: OECD ICT Access and Usage by Businesses database http://dotstat.oecd.org/Index.aspx?DataSetCode=ICT_BUS (accessed February 2019)

The difference is in part driven by the smaller scale of operations, that is, by the limited value generated from integrating business activities in many SMEs. Large enterprises with more complex structures and business models obviously enjoy higher returns on investment from the use of ERP software. Economies of scale can help to offset the high costs of deploying the ICT infrastructure and of the investment in human capital.

Nevertheless, as illustrated in Figure 8, in most OECD countries the use of ERP software by small firms has increased consistently over 2012-17. On average, 11% more small firms use some type of ERP software, similarly to what observed for medium-sized and large businesses. Some likely explanations include the pervasiveness of digital solutions in the market and their lower aggregate cost thanks to cloud computing services.

Similarly, a significant gap between SMEs and large enterprises is observed in the use of CRM and SCM software, as they bring greater value to companies that have more customers and business partners and more frequent interactions with them. CRM technology is used by more than half of medium sized enterprises only in Finland, Belgium, Netherlands, Denmark, Germany, Austria, Sweden, Norway and Spain.

While the adoption of ERP, CRM and SCM suggests to what extent large enterprises and SMEs engage in data analytics, the extent to which companies analyse the data and base their operational and strategic decisions on the outcomes is uncertain, as well as difficult to measure. Nonetheless, business intelligence software is essential to have accurate, integrated operational data, which are a key component of any further data utilisation.

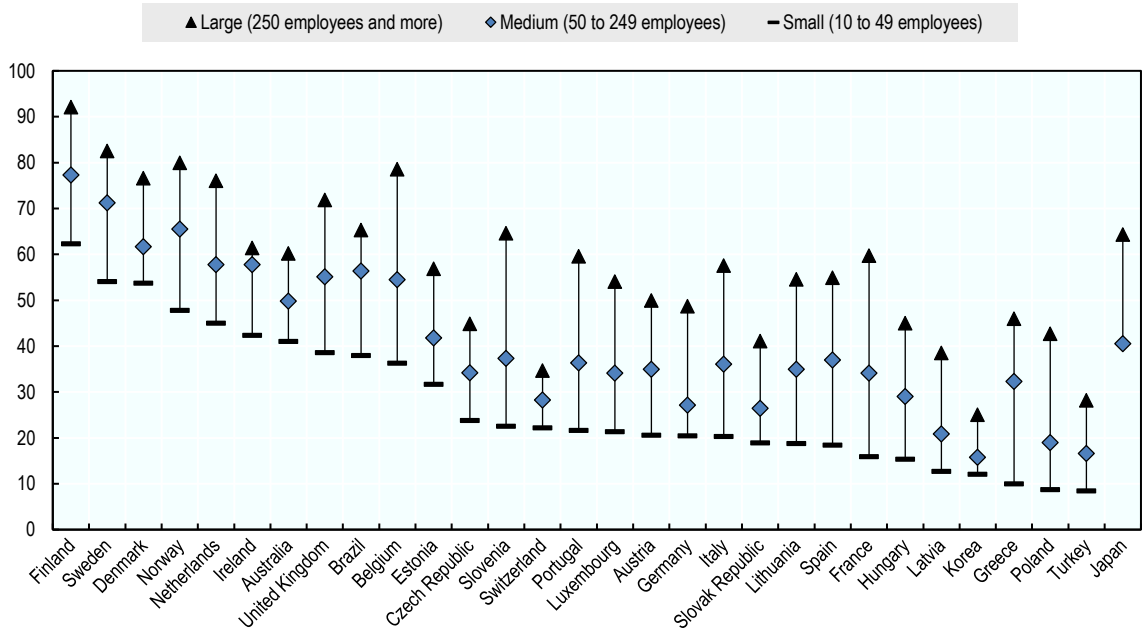
Cloud computing facilities

The level of use of cloud computing facilities by companies is a core indicator of data-related activities, especially for SMEs. Cloud services are very relevant for SMEs, as they can be easily scaled up or down, be used on-demand by customers, and are paid for either per use or by capacity used (OECD, 2017[29]). Figure 9 shows that Finland and Sweden more than 70% of medium-sized businesses used CC services in 2018, while in Poland, Turkey and Korea[5] less than 20% did so. However, the percentage of businesses that purchase cloud-computing services is directly proportional with size. In 2018 the largest difference between large and small businesses was observed in France, Belgium and Slovenia (>40%) and the lowest in Switzerland, Korea, Ireland and Australia (<20%).

[5] As in the note to Figure 8, data for Korea refer to 2015

Figure 9. Businesses purchasing cloud computing services by size

2018 or latest available year, as percentage of enterprises in each employment size class

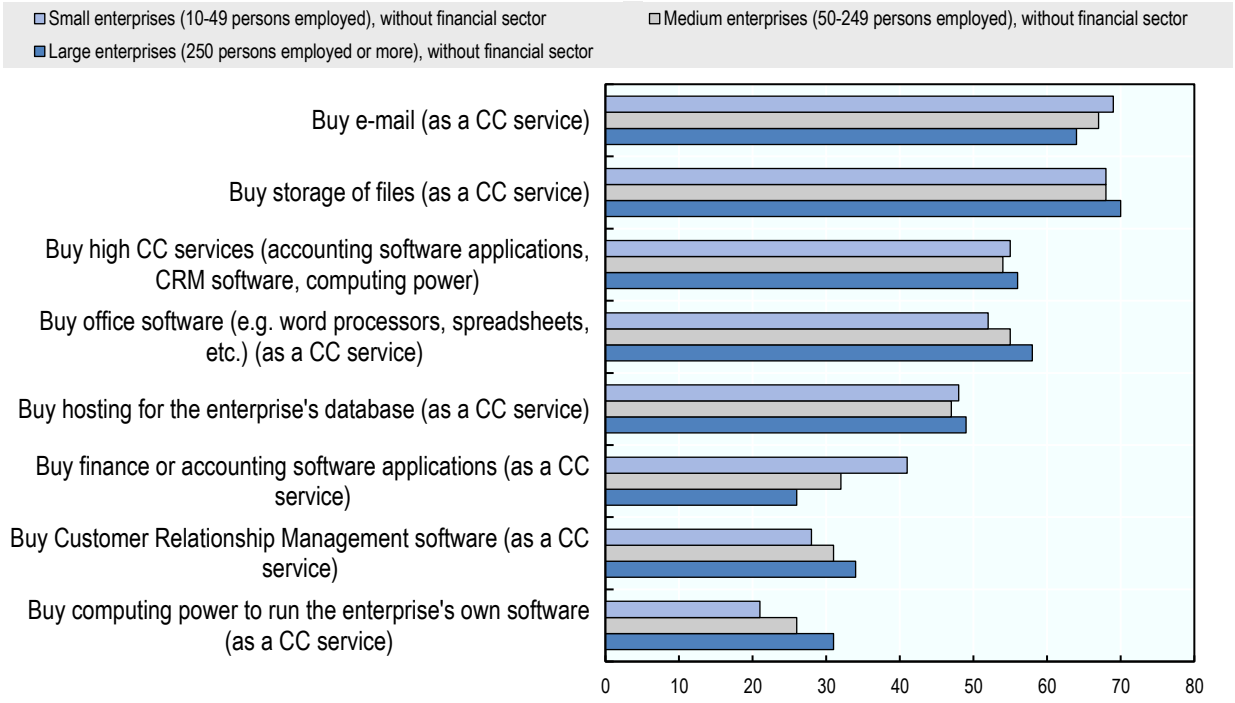


Note: Data for Korea and Switzerland refer to 2015; data for Australia and Japan refer to 2016; data for Brazil refer to 2017
Source: OECD based on OECD ICT Access and Usage by Businesses database (accessed December 2018), http://dotstat.oecd.org/Index.aspx?DataSetCode=ICT_BUS (accessed February 2019)

The aggregate data need to be qualified though, as the type of cloud computing services purchased by large and small firms differ substantially, according to their different needs. As Figure 10 illustrates, small, medium and large firms are relatively in line on buying storage of files, high CC services and hosting for enterprises' databases. However, small business are 15% more likely than large businesses to buy finance or accounting software applications (which can lead to significant saving, reducing the need for specialised personnel) and 5% more likely to buy e-mail services (basic functions that are immediate to outsource). On the other hand, large businesses are 10% more likely to buy computing power to run the enterprise's own software and 6% more likely to buy CRM software, which is expected considering their different IT capacity in terms of data and skills in the organisation (e.g. programmers to develop proprietary software).

Figure 10. SMEs and large firms differ in the types of cloud computing services they purchase

2018, average of the European Union, Percentage of businesses purchasing cloud computing services

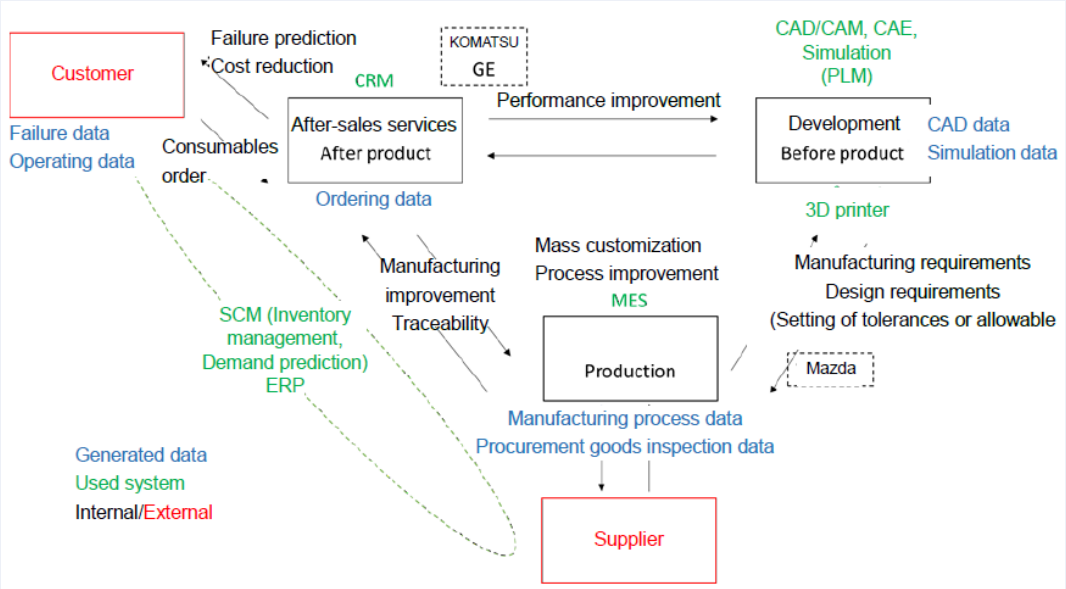


Note: Without financial sector.
Source: Eurostat (2019), database, http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_cicce_use&lang=en (Accessed February 2019)

Box 1. The use of big data in Japan's manufacturing industry

A 2015 survey-based study conducted in Japan on 592 manufacturing firms (of which 414 SMEs[6]) offers some insights about the use of data analytics in manufacturing. To analyse the use of big data, researchers divided the process in three stages: development, mass production and after-sale services. For each stage, the survey investigated the following aspects: status of data generation and data use in each process, mutual use of data between processes, collaboration for data use with external stakeholders such as suppliers or customers. Figure 11 provides an example of how data is generated and used in a manufacturing firm, including through the application of enterprise information software.

Figure 11. Example of data generated and used in a manufacturing company



Source: (Motohashi, 2017[30])

Results point at large differences by firm size in the approach to big data use, both in absolute terms and when considering individual departments. While 80% of firms with more than 300 employees use data analytics, the share lowers to 70% for firms with 20-300 employees and to 50% for firms with less than 20 employees... Across all companies, the main purposes of data usage are, in this order: cost reduction, customer development and improvement of manufacturing process. Interestingly, more than half of the SMEs in the sample are aware of recent trends as the IoT, but do not have a strategy to cope with it. The study also indicates organisational differences in relation to the breadth of data used. For example, more than 20% of companies engaging in company-level data use set up a specialised department for data analysis, while less than 10% of companies that have only section-level data use did so (Motohashi, 2017[30]).

[6] In the definition used in the study, SMEs are companies with less than 300 employees

Chapter 4. Key challenges for the adoption of data analytics by SMEs

Recent OECD work identifies the main determinants of business adoption of digital technologies as cloud computing and back or front office integration in terms of capabilities and incentives. The study finds strong evidence that availability of enabling infrastructures (such as high-speed broadband internet), managerial quality and workers skills, as well as product, labour and financial market setting have a strong effect on the rate of diffusion (Andrews, Nicoletti and Timiliotis, 2018[27]).

While not focused exclusively on SMEs, the study provides useful insights about the main forces at play in the diffusion of advanced techniques such as data analytics, whose uptake outside of the ICT sector is still limited among SMEs, which are held back by a number of internal and external barriers. Internal barriers include lack of knowledge and awareness, mistrust in digital solutions, inability to address digital security challenges and lack of skilled human capital. External barriers include limited access to finance and digital networks, limitations in the availability of data and regulatory constraints.

Internal barriers

Lack of managerial awareness and skills. Entrepreneurs and managers might not understand the need to change traditional business practices, which have worked well in the past. For example, based on a survey of 3,000 business executive worldwide, (LaValle et al., 2010[31]) identify as main barriers to the uptake of data analytics the "lack of understanding of how to use analytics to improve the business" and the "lack of management bandwidth". Similarly, according to a 2014 survey among 1 000 German SMEs, 70% of enterprises with annual revenue below 500 million EUR do not attach relevance to the digitalisation of processes (OECD, 2017[3]). Having little knowledge about possible benefits, managers perceive low expected returns when compared to the costs of building a data infrastructure.

SME managers interested in data analytics need to prioritise their efforts, while securing enough resources for projects that typically bring results only in the long-term. Indeed, it has been found that if an organisation does not fully trust the information coming from Big Data sources, the use of data analytics is unlikely to bring change at the firm level (Ross, Beath and Quaadgras, 2013[32]), thus suggesting an incremental approach to the use of data analytics in SMEs. The shift from an "intuition-driven" to a "data-driven" decision making culture is not immediate for senior executives and typically requires a strong commitment (McAfee and Brynjolfsson, 2012[33]).

Studies also show that organisational readiness plays an important role in making ICT projects successful at the firm level (Khazanchi, 2005[34]). In this respect, the perceived strategic value of ICT innovations by small business managers is key to its subsequent adoption and use as a support to decision-making (Love and Irani, 2004[35]; Grandon and Pearson, 2004[36]; OECD, forthcoming[37]).

In addition, the possibility to try out the new model and to put in place smaller-scale pilot projects is an interesting feature for SMEs with limited resources. Evidence shows that SMEs with a positive track record in trying out new technologies are keener on future technology adoption (Dholakia and Kshetri, 2004[38]).

For management, caution about changing business models that have worked well in the past is coupled with concerns about entering in a long-term unfavourable contract or locking-in by a particular vendor, particularly when lacking any previous experience and technical knowledge. SMEs might be also deterred by increasing legal risks, especially when collecting, storing and processing personal data. In the absence of legal and compliance teams, executives in SMEs often lack information on current regulatory aspects of digital economy.

Lack of specialists. Data analytics deployment requires highly specific skills, especially if data analysis is conducted at an advanced level. SMEs rarely employ specialised data analysts and statisticians and face difficulties to hire ICT specialists, who are in short supply and are typically attracted by better working conditions and opportunities for professional growth in large companies. In the Europe Union for example, a shortage of 900 000 ICT workers is expected by 2020 (Ansip, 2015[39]). Open source tools and Massive Open Online Courses (MOOCs) provide opportunities to train SMEs' IT staff in inexpensive ways (Rising, Kristensen and Tjerrid-Hansen, 2014[40])). However, the lack of time to be dedicated to such type of training is a clear challenge that remain to be addressed (Coleman et al., 2016[25]).

According to a 2015 survey of the manufacturing sector in Japan (see Box 1), the main obstacles to data use are related to *lack of human resources and planning.* In particular the shortage of human resources represents a main obstacle to greater use of data, which is also constrained by failure to include data in growth strategy (Motohashi, 2017[30]).

Inability to assess and address digital risks. The scope of possible digital threats is widening. The media frequently report Cyberattacks, in the form of hacking, phishing or ransomware, triggering mistrust of individuals and enterprises in new technologies. SMEs might indeed lack the ability to address growing digital threats. As this is a very novel area of expertise, the capacity of most SMEs to understand and prevent or react to cyberattacks is limited. Even if strategies on how to mitigate risks do exist, SMEs might still be unaware of the necessary precaution and responses. For instance, in 2015, only 30% of SMEs in Europe had a formal security policy, against almost 70% among large enterprises, with the share ranging from almost 50% in Sweden and Portugal to close to 10% in Poland and Hungary[7].

Only 14% of European SMEs handle digital security and data protection with internal staff, against 64% of large enterprises (Eurostat, 2019[28]). The costly service by external providers is not seen as a priority in most cases, and this can constitute a problem in particular when SMEs are working either with larger companies in Global Value Chains (GVCs) or with public entities through public procurement contracts. When integrated in larger networks, SMEs can represent the weak link, particularly prone to be the objective of cyber-attacks directed at the wider network.

Limited collection and/or storage of data. A variety of data sources is available to SMEs, ranging from their internal operations and customer relations to open data and information online. However, despite an increasing number of activities being digitalised, the data is often not collected and/or stored in the necessary quantity and quality (e.g. inconsistent spreadsheets, incorrect mechanical inputs, gaps in data collection etc.). In a better scenario,

[7] The definition used in this context for ICT security measure is broad, including "measures, controls and procedures applied to ICT systems to ensure integrity, authenticity, availability and confidentiality of data and systems" (OECD, 2017[38]).

companies use business intelligence software, which makes the data collection automatised and therefore more precise. Challenges are typically compounded for young companies, which, even if interested in adopting innovative solution, might not have enough data to perform statistically significant analysis and might lack the resources to outsource the process. External private sources can be helpful but are usually rather expensive for small firms, while freely available public sources often lack the level of detail or methodological soundness to provide a real competitive advantage.

Box 2. Barriers to the use and uptake of cloud solutions by SMEs

In 2014, Eurostat performed a survey on factors limiting and preventing the use of cloud services among SMEs and large enterprises in the EU. Among enterprises *already using cloud services*, the risk of a security breach was identified as the main limiting factor for both large enterprises and SMEs (57% and 38% respectively). Mistrust of service providers' liability and accountability procedures, as well as the risk of merely technical issues impeding SMEs to access vital data to their business, constitute important barriers to more advanced uses of the technology. Larger companies were more concerned about the uncertainty on applicable law, jurisdiction, dispute resolution mechanism and data location (46%), than SMEs (about 30%). However, one in three SMEs (32%) identified insufficient knowledge or expertise as a limiting factor, against less than one in five large enterprises (17%).

The survey showed that factors *preventing firms from using cloud-computing services* altogether included insufficient knowledge and expertise, followed by contractual and legal aspects and the complex details of technical implementation. Moreover, also for this set of firms, the risk of a security breach was a key barrier.

Source: (Eurostat, 2014[41])

External barriers

Access to finance. Building a data infrastructure in the company (including physical and human capital) may require significant upfront investments, which typically represent a challenge for resource-constrained SMEs. Financing constraints are often more severe for innovative and new firms whose business model relies on intangibles, including data, which are highly firm specific and difficult to use as collateral in traditional debt relations (OECD, 2015[42]). For most enterprises, there are few alternatives to traditional debt, although, in recent years, a range of alternative financing instruments has been expanding at sustained rate (OECD, Forthcoming[43]).

Availability of data. Internal data generated and collected within a SME has more value if complemented with other available information, such as sectorial overviews, traces of individuals' digital activity (consumer preferences, purchase patterns), data on other enterprises (pricing policies, products and services offered) or data provided by public institutions. Resources are available online for free (open data) or for purchase (APIs), but their identification and processing demand expertise which SMEs may lack.

Complex regulatory environment in the domain of personal data. The definition of personal data is broad, covering any information relating to an identified or identifiable individual. Seeking to address privacy concerns, governments are imposing 'border controls' through

restrictions on cross-border data transfers and/or local storage requirements. Regulating on privacy protection cross-border data flows, governments ought to address issues such as collection limitation, data quality, purpose specification, security safeguards, openness, individual participation, accountability, national restrictions as well as international cooperation, as described in the OECD Guidelines on the Protection of Privacy and Transborder Flows of Personal Data (OECD, 2013[44]). The resulting complex regulation might deter SMEs from activities characterised by high compliance risks.

Lack of SME-tailored solutions. In the past, collection, storage and processing of data were expensive and therefore available only to large enterprises. Even though the solutions are becoming more affordable, many of the currently available ICT products do not necessarily take the specific needs of SMEs into account, whether in terms of design or pricing (even if some providers offer a 'light" version of their products and services to meet the needs of small business users).

Chapter 5. Policy approaches to foster use of data analytics by SMEs

Governments around the world are experimenting with a range of policy approaches to sustain the digital transition of SMEs and guide them towards more databased business models and decision-making procedures. Enabling framework conditions and targeted policies can play an important role in overcoming internal and external barriers to the use of advanced data analytics. The present sections discuss key areas of policy and provide illustrative examples of policy approaches and programmes.

Regulatory environment

Regulatory policies in this area increasingly consider the growing concern by citizens about the misuse of personal data and violations of privacy. In fact, data analytics can be conducted without using personal data, drawing instead on information from manufacturing processes, logistics or supply chain management. At the same time, data on consumers and their behavioural patterns can be very valuable, allowing enterprises to better target their offerings, or improve products' quality based on the demand.

Special regimes are in place across jurisdictions to ease compliance by SMEs with data protection rules and reduce burden. For example, exemptions may be applied to activity reports. In addition, small businesses may be granted easier access to dispute. On the other hand, standards of personal data protection have to be upheld irrespective of the size of an enterprise, namely knowledge or consent of the data subject, specific purpose or security safeguards.

In this domain, the General Data Protection Regulation (GDPR) that came into force in the European Union in May 2018 provides for governments to create a special regime for handling personal data by SMEs. The GDPR includes derogation for organisations with fewer than 250 employees with regard to data record keeping. In addition, EU Member States are encouraged to take account of the specific needs of SMEs in the application of the Regulation, as the GDPR contains more than 50 so-called opening clauses allowing EU Member States to put national data protection laws in place to supplement the GDPR. For example, in Portugal the fines for breaches for SMEs are between 500 and 2 000 EUR while for large enterprises are between 1 000 and 4 000 EUR. The European Commission developed a user-friendly portal for Small Businesses with information required to understand the GDPR and comply with its rulings (European Commission, 2018[45]), and is investing in support and advice for small businesses. Private initiatives, such as from associations, are also in place to support SMEs in the application of the new regulation, as the "GDPR for SMEs training course" proposed by the European Digital SME Alliance (European Digital SME Alliance, 2018[46])

The application of the new regulation may also constitute a positive impulse for SMEs, in terms of increased cybersecurity and digital awareness. For example, SMEs will need to undertake data audits and clean up, to determine exactly which information they hold about their customers and where the data are collected and stored. Monitoring data more regularly

and carefully and gathering them only with the explicit consent of the customer can: reduce marketing costs and make marketing campaigns more effective (knowing exactly which clients are active, willing to receive commercial information, etc.), reduce IT costs (by removing duplicates, obsolete and trivial files) and increase security (having to structure a security strategy, solutions and safeguard).

Guidelines or codes of conduct are also adopted to increase certainty in SMEs about the data protection laws and support compliance. For example, the "Guidelines for SMEs on the security of personal data processing" published by the European Union Agency for Network and Information Security (ENISA) aims at facilitating the understanding of the context of the personal data processing operation and the risks entailed (ENISA, 2016[47]).

Awareness-raising activities, especially shortly before and after the entry into force of new regulation, can contribute to the correct application of new or modified rules. Notions such as anonymisation and pseudonymisation (introducing artificial "identifiers") are especially relevant to the uptake of data analytics, as these represent powerful tools for analysing and making use of personal data without breaching data protection rules.

Addressing digital threats

In line with the modern privacy laws, enterprises controlling and processing personal data are obliged to inform security authorities and data subject after a personal data breach. Warning mechanisms can help SMEs prevent and address these threats. In some countries, national awareness systems are in place to ensure timely information about possible cyber threats and related security concerns. These can also include recommendations on how to protect an enterprise from hacking, ransomware and other digital threats, as well as training for its staff and management and links to relevant government resources.

The Department of Homeland Security (DHS) of the United States, for instance, has launched the "Stop. Think. Connect." awareness campaign (see Box 3) and the National Cyber Security Awareness Month, an annual campaign with events and initiatives to raise awareness on the importance of cybersecurity. Also, the website of the United States Computer Emergency Readiness Team (US-CERT), under the Department of Homeland Security (DHS), offers a regularly updated summary of the most frequent, high-impact types of cyber-security incidents currently ongoing (US-CERT, 2018[48]).

Box 3. The "Stop. Think. Connect." national awareness campaign in the United States

The "Stop. Think. Connect." national public awareness campaign promoted by the Department of Homeland Security (DHS) in the United States aims at increasing the understanding of cyber threats and enhancing safety standards among citizens and companies, focusing on the shared responsibility of keeping the internet safe. All type of organisations can join the campaign, which offers promotional material, videos, booklets and an up to date blog. The campaign offers also a broad range of downloadable toolkits, either by topic (e.g. Social Media Guide, Internet of Things Tip Card, Cybersecurity While Traveling) or tailored to different audiences, such as students, local governments, professionals and small businesses.

The toolkit for small businesses includes the "C^3 Voluntary Program", which is a public private partnership led by the DHS aiming at supporting start-ups and SMEs in establishing cyber resilience, increasing awareness and helping recognise and address their cybersecurity risks. The resources offered include talking points for CEOs, steps to start evaluating SMEs' cybersecurity programs, a list of hands-on documents for SMEs and entrepreneurs and a self-assessment package.

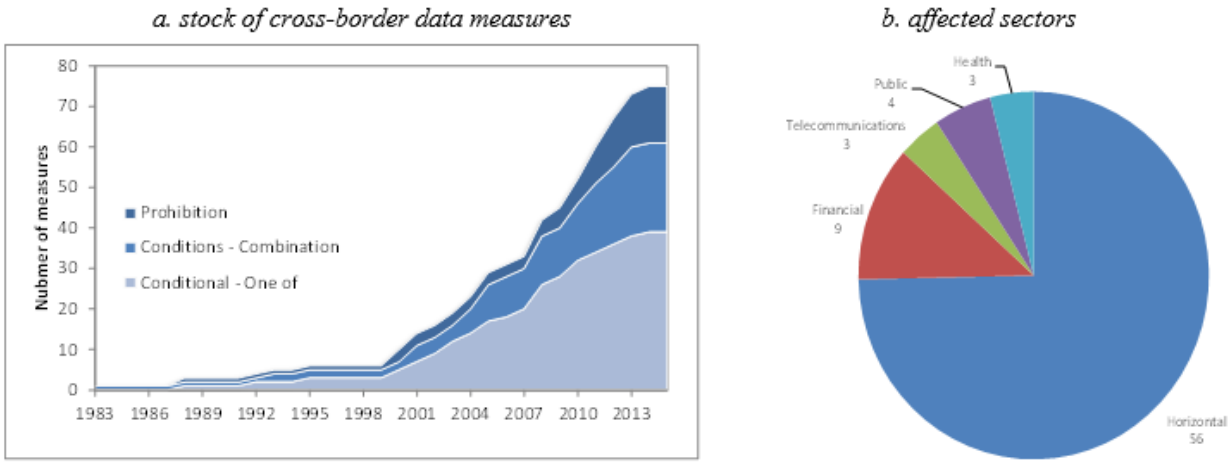
The website links as well to all the cyber security-related resources for SMEs offered by other government agencies and association (e.g. the Small Business Administration, the US Chamber of Commerce), enabling interested businesses to access a comprehensive overview of services and solutions available.

Source: (US-DHS, 2018[49])

Data localisation

As data flows across borders have started to become more relevant, "data localisation" measures have been put in place by governments to address concerns ranging from security and protection of individual privacy, to regulatory and audit reach. The main measures relate to the restriction of data transfer across borders and/or to local storage requirement, in particular for sensible data (e.g. personal information of citizens). Digital ‘border controls’ are growing in number and complexity (Figure 12) and may condition SMEs’ engagement in digital trade. It will be key for policy makers to find a balance to meet public policy objectives while preserving the benefits of an open internet (OECD, 2018[50]).

Figure 12. Cross-border data transfer restrictions are rising in number and complexity



Source: (OECD, 2018[50])

Open data initiatives

Open data is publicly available data that can be universally and readily accessed, used and redistributed free of charge. SMEs are particularly well placed to gain from Open Data innovation as it allows them to experiment new products and services at virtually no cost on large databases. This is of course conditional on their resources and on the willingness of the management to invest in the skills and talents needed to harness such opportunity (Wainwright, 2018[51]).

Openly available data can be a commercially valuable asset in many sectors. For example, a 2015 study on 354 SMEs in the United States identified particular use of open data in technology, finance and investment, business and legal services and healthcare sectors. Three main categories of data used by SMEs can be identified: government data (see OECD framework for Open Government and related survey[8]), science data (e.g. clinical, research and health-related) and shared corporate data (e.g. APIs – Application Programming Interfaces).

In particular, governments and public agencies produce vast quantities of data. Making the datasets available increases transparency and accountability, and Open Governments' Data can represent an important source of economic growth, new forms of entrepreneurships and social innovation. Published datasets can include business information (official registry), patent and trademark information, public tender databases, geographic information, including aerial photos and cadastral information, legal information, meteorological information and social data (statistics on economics, employment, health, population, public administration etc.) and transport information (traffic congestion, public transport or vehicle registrations (Ubaldi, 2013[52]).

An example of open government's data relevant for SMEs is provided by the Small Business Administration (SBA) in the United States. The SBA offers to the public a wide range of data resources and APIs for multiple purposes, as for example (SBA, 2018[53]):

[8] The information in the OECD Dataset on Open Government Data were collected using an online questionnaire, and are available online (link in references, (OECD, 2018[65])).

- to enhance transparency (e.g. the "SBA E-mails RSS", which includes all e-mails sent from SBA to the public);
- to facilitate networking and business opportunities (e.g. "SubNet", a subcontracting network system that bridges the gap between businesses seeking SMEs subcontractors and SMEs looking for subcontracting opportunities);
- to publish specific data on SBA programmes (e.g. the "SBA Loan Programme Performance" database);
- to provide businesses with core information (e.g. the "State Licences & Permits", to identify the specific licence and permits a business may need).

Interesting examples can also be found in the area of publicly funded satellite data. The Copernicus fleet of satellites developed by the European Space Agency and funded by the European Union, or Landsat in the United States, provide a "deluge" of satellite data to private companies and SMEs to build innovative products and services. In the private sector, large tech companies provide curated database, codes and training in the public domain as a way to diffuse AI (OECD, 2018[13]).

Skills and training

With data-management software becoming increasingly user friendly, SME employees can be trained to conduct specific data analytics relative to the business. SMEs thus do not necessarily need to outsource or employ data miners or statisticians. In fact, among SMEs that analyse Big Data in the European Union, 79% have their own employees conducting data analysis.

The use SME own employees for these tasks in part reflects the shortage of ICT specialists in the labour market, as well as competition by large enterprises and other organisations in this labour pool. However, the in-house activity also presents some advantages. Compared with external providers, employees may better understand the sources of data, such as production process, interaction with customers or supply chain information. In addition, employees can access information more easily, which allows them to make decisions based on all the necessary information. In this sense, data analytics undertaken within an enterprise can be less costly and more reliable. However, it also increases training needs in SMEs.

Employee training programs focused on data analytics

Across OECD countries, governments are taking initiatives to support skills development for big data use, such as through capacity building, training and other educational activities to support human capital development. For instance, in Germany training centres offer programs for employees of SMEs that express their interest in implementing data analytic solutions (see Box 4).

Box 4. Germany's *Mittelstand 4.0* – Competence Centres and *Plattform Industrie 4.0*

The concept of *Industrie 4.0* (I40) was first introduced in Germany in 2011. I40 refers to the intelligent networking of machines and processes for industry with the help of information and communication technology. Several strategic initiative have started since to help I40 spread widely within the German manufacturing sector. Besides local, regional and private initiatives, several projects are supported by the German Government (Ministry of Education and Research and Ministry of Economic Affairs and Energy), which aims at driving digital manufacturing forward. The two Ministries have initiated a "Transfer Network Industry 4.0". In this context, transfer institutions such as chambers of commerce, business associations, regional players, public and private support initiatives/centres exchange ideas and opinions, identifying synergies and combining resources in appropriate measures. Several public programmes target specifically Germany's Mittelstand (SMEs).

The goal of the "***Mittelstand 4.0* – Competence Centres**" funding initiative is to advance digitalisation of procurement, production and distribution processes, as well as the introduction of I40 applications, in SMEs across all sectors of activity. In total, there are twenty-five *Mittelstand 4.0* Competence Centres, each assisting SMEs in different areas such as cloud computing, communication, trade, and processes. Eighteen of these Competence Centres offer information, training, and the opportunity for companies to view and test new solutions out in practice across different regions. In addition, there are also dedicated centres for Digital Crafts, Planning and Construction, eStandards, Usability, Textiles Network, IT Industry, and Communication. These specialised centres are supported by regional contact points and offer their support to companies all over Germany. A Competence Centre for Trade is currently being set up and will open in 2019.

With over 350 actors from around 160 organisations, the German "***Plattform Industrie 4.0*"** (initiate by various German stakeholders in 2015) is the central network to advance digital transformation towards *Industrie 4.0* in Germany. In close cooperation with politics, industry, science, associations and trade unions, it develops and coordinates information and networking services in order to make *Industrie 4.0* solutions better known among companies and to deploy them on site. One of the largest international and national *Industrie 4.0* networks, it supports companies – particularly medium-sized companies – in implementing *Industrie 4.0*. It provides companies with decisive impulses through examples of company practices from across Germany and other countries as well as concrete recommendations for action and test environments. An online map displays over 350 examples of I40 solutions in practice, helping SMEs to find applications that may be used in their own company. Furthermore, the *I40 Compass* provides an intuitive way of finding the right support service for companies, such as gaining information, realisation of projects, finding partners, demonstrations and testing, etc. The platform's numerous international co-operations underscore its leading role in international discussions on *Industrie 4.0* (dedicated website: www.plattform-i40.de).

Germany is a global leader in providing and applying *Industrie 4.0* solutions. If properly informed and integrated in the transformation, SMEs can benefit from open standards, secure IT solutions, moving from proprietary systems to more integrated ICT, automation and production technologies in the value chain. This can enable them to reduce production costs, react faster to market conditions and develop new digital business models.

Source: (BMWi, 2018[54]; BMWi, 2019[55])

Awareness raising through management training

Entrepreneurs and SME management often exhibit a lack of direct knowledge of emerging technology that might enhance the productivity of their business, while SMEs rarely have digital experts within their organisations. It may be difficult for SMEs that lack expertise in ICT to keep abreast with new technological developments. Combined with complex regulatory frameworks and security concerns, data collection and analytics represents a challenge for business owners and executives. (OECD, 2016[14]).

Management training, introducing key notions of data analytics and their positive impact on business performance, can be a helpful tool for raising awareness among SMEs. Training is often organised by public agencies, in the form of coaching, workshops or seminars, focusing on identifying digital needs and advantages of data-driven enterprises. Information can also be provided online to ensure easier access and wider reach. Educational programs are offered either by skilled personnel of the public agencies or by private sector intermediaries hired for that purpose, as in the examples of Mexico and Uruguay (Box 5).

Box 5. Productivity growth through management upgrading in Mexico and Uruguay

OECD work shows that enhancing management skills can produce sizeable improvements in the productivity of small traditional enterprises. Integrated approaches that combine the provision of management training and advisory services with ICT solutions at the firm level, can be a means to jump-start productivity growth in these firms.

The policy experiences suggests that subsidising programme activities, at least at the beginning of the intervention, can help attract cash-constrained small firms, which are often unfamiliar with government support measures. Programmes with low per-enterprise costs and simple activities can reach a large number of participants, and the policy maker can target groups of firms rather than individual firms to help magnify the impact of the intervention and foster knowledge spill-overs among participants. Drawing on experienced private-sector business advisory service providers can help achieve stronger impacts in programme implementation.

An interesting example in this regards is the programme launched in Mexico in 2015 by INADEM (Instituto Nacional del Emprendedor) to cater existing micro enterprises in low-value added sectors of the economy. The programme aims to reach a vast number of enterprises (more than 70,000 over two years) by offering low-cost services (e.g. 6 hours of basic management training) to enhance management practices of the business owner and favouring the adoption of Information and Communication Technology (ICT).

The ISFR programme in Uruguay, financed by the Inter-American Development Bank and implemented over 1998-2004 by CAMBADU, the national chamber of commerce of small food retailers, provides another example of scheme for managerial upgrading in small traditional enterprise. The project aimed at repositioning small food retailers facing a tough competitive environment, though Business Development Services (BDS) that targeted managerial capacities and practices. The BDS project spurred a second project with a particular focus on the adoption of ICT in SMEs. The findings of the first project had in fact shown that most businesses used ICT at most to accept electronic payments but rarely to organise back-office activities or managerial tasks.

Source: (OECD, 2016[57])

Disseminating knowledge among SMEs about digital adoption and data analytics

Raising awareness among SMEs on the benefits of digitalisation and data analytics is a priority for many governments in the OECD area. For example, the Canadian government launched the Digital Technology Adoption Pilot Program (DTAPP) between 2011 and 2014 through the National Research Council of Canada Industrial Research Assistance Program. The project supported thousands of SMEs in the digital transition and gathered interesting data on successful and unsuccessful initiatives. The project had three main components: supporting the adoption of digital technology by SMEs by providing advisory services and funding; assessing the relation between digital adoption and productivity; and raising awareness of the benefits and importance of digital adoption.

In accordance with its third component, to raise awareness the Canadian government undertook various initiatives to disseminate lessons learned and best practices to SMEs. The program evaluation of DTAPP found it to be an effective tool for engaging SMEs (Goss Gilroy Inc., 2013[58]).

Business membership organisations can represent an important information channel on digitalisation and use of data analytics for businesses. Chambers and associations can provide information on technology and innovation, appropriate data-related standards, adoption strategies, legal aspects, as well as available financing mechanisms and support schemes, including for internationalisation purposes. For example, the British Chamber of Commerce promotes a “Digital” page providing news, surveys and studies on the uptake of digital technologies by UK’s businesses, the main challenges they find and the opportunities opening up in the market (BCC, 2018[59]),

Big data Sherpa

The establishment of a national "Big Data Sherpa", as in the case of Korea (Box 6) aims to help businesses, NGOs and local authorities analyse the strength and weaknesses of their business models in leveraging data analytics, and find public and private finance sources for relevant investments. The national data centres are also a point of storage and access for public data gathered by central and local governments, public agencies and research institutes, offering equipment and skills to support businesses and citizens to leverage the data.

Box 6. Korea's National Big Data Centre (NBDC)

In Korea, the government has established in 2017 the National Big Data Centre, under the National Information Society Agency.

The objective of the Centre is to provide the shared service of big data to SMEs, start-ups, IT venture companies and Academia in order to foster the usage of big data analytics in the economy. The rationale is to have public data (from public agencies and institutions, central and local government) and private data (from businesses, universities, research institution) gathered in the centre. The centre is equipped with the necessary software and hardware infrastructure to support new ventures and manpower formation, to offer consulting on big data adoption and to devise future strategy, as well as to construct a central Data Bank, accessible to stakeholders.

The flagship data projects span from the optimisation of the late-night bus routes in Seoul (with sizeable saving for the municipality), to the distribution of market analysis services (in partnership with the Chamber of Commerce and Industry of Korea), to the data-driven enhancement of the manufacturing process of automotive components (jointly with Kodak and the Korean Automotive Technology Institute). Interesting results were also achieved in the field of animal and human disease control, with predictive model based on big data (e.g. movement log of livestock vehicles collected via GPS, mobile phone usage by customers in countries with infectious diseases, lists of airplanes passengers from contaminated areas). These were analysed with deep learning techniques offering extremely accurate results, which allow for effective prevention.

Key to the success of these projects is the gathering in a single database of public (i.e. government's agencies and Ministries) and private (i.e. mobile operators, airlines) data. The use of data analytics and deep learning algorithms enables to identify relevant patterns and offer accurate predictions and important market information to business partners (from SMEs and start-ups to big firms). Another important factor is the setting up of standards and rules for data exchange and the development of market policy for data, all taking into account the data access security.

The Centre offers a concrete example of how public-private cooperation can create opportunities for SMEs. Start-up and established businesses that want to leverage data analytics techniques to achieve commercial advantages can opt to cooperate with the Centre, finding experts and potential industry partners to develop operations in this innovative area.

Source: (Kwon Yeong-il, 2017[60])

Financial support

Despite decreasing costs of data storage, processing and analytics, as well as improving conditions to access to finance for SMEs in most OECD countries, lack of financial resources can represent a key constraint for SMEs to make the necessary investments in building data infrastructure or entering into a service contract to implement data analytics solutions.

Vouchers for data analytics project

In some countries, governments have launched Vouchers for Proof of Concept (POC) schemes, to address financing constraints by SMEs that are interested in testing and implementing small-scale innovations, including data analytics techniques. For example, in the Slovak Republic, vouchers are being introduced which can be used to demonstrate feasibility of a data analytics solution and verify whether it has potential in a given organisation (see Box 7).

In the UK, the Business and Local Government Data Research Centre (BLGDRC) established by the Economic and Social Research Council[9] offers "Data Analytics Innovation Vouchers" (DAIVs) The 2 000 GBP vouchers are granted to micro, small or medium-sized business, local authority, charity, or not-for-profit-organisation that want to deepen their understanding of data analytics and their possible use for their businesses. The voucher can then be used to access consultancy services from experts or to upskill staff with data analytics training. The researchers offering the services and trainings are usually from Universities, as the BLGDRC is based in the University of Essex, but also has advisors at University of East Anglia, University of Kent and London School of Economics. SMEs in the programme do not need to have pre-existing databases or data sources, as the consultancy services can include the identification of the most relevant data and how to gather and analyse them. Every business can apply for two vouchers a year, for a maximum of three years.

[9] One of the seven Research Councils in the UK, receiving most of its funding from the Department for Business, Energy and Industrial Strategy.

Box 7. Innovation vouchers supporting data analytics in The Slovak Republic

Rationale and Objectives of the programme

This program (inspired by the OECD Innovation Policy Platform, (OECD, 2018[61])) aims at providing small financial grants to SMEs to purchase services from public knowledge institutions to support the creation of long term partnerships and boosting innovation in SMEs business operations. The lack exposure to universities and research organisations can affect SMEs' ability to identify relevant providers and make them hesitant about positive outcomes of costly innovative solutions. On the other hand, public knowledge providers may see little incentives in working with SMEs, which might have lower absorptive capacity and guarantee lower returns as compared to large enterprises.

Programme activities

The Slovak government tailored the OECD Innovation Policy to the needs of local SMEs and knowledge providers. The program was launched in 2013 through the Slovak Innovation and Energy Agency (SIEA), which is a public agency established by the Ministry of Economy of the Slovak Republic focused on implementation of the national innovation policies. This agency acts as an administrator of the program, which prevents any conflict of interest and allows for a focused approach.

Programme delivery methods

Firstly, knowledge providers are invited to express their interest in participating in the program. These can be Universities, public research entities such as Academy of Sciences as well as private organisations. The competences and expertise of knowledge providers are verified, as these are required to present relevant documentation (final report of an R&D project, a copy of the patent application, industrial design etc.). The official list of eligible knowledge providers is then updated on a yearly basis and published on the website of the SIEA and Ministry of Economy.

This allows SMEs to choose from the knowledge providers and contact them with a proposal for collaboration. A second call is subsequently published, inviting SMEs to submit project proposals. In the project description, applicants explain the innovative aspects of their projects, also in comparison with their peers and competitors. As a part of the application, enterprises must submit a contract on the future contract (binding Memorandum of Understanding) with a listed knowledge partner. A Commission of experts evaluates the applications, taking into account the history of an enterprise, the aims and the benefits of a proposed project. In 2018, the value of a voucher for enterprises amounted to 5000 EUR with no co-financing required. The voucher must be used within one year from the award.

Results achieved

The calls for applications are published on a yearly basis since 2013 with the exception of the year 2017 (preparation of a new scheme). In 2014, the maximum

value of a voucher increased from 3500 to 5000 EUR. The budget has increased as well (see Table 1). In the 2013-16 period, over 200 projects were supported.

Table 1. Vouchers programme in The Slovak Republic

	2013	2014	2015	2016	2017*	2018	2019	2020
Budget (EUR)	235 000	235 000	300 000	350 000		300 000	470 000 (planned)	470 000 (planned)
# of projects supported	45	45	60	65		60	94	94

Note: In 2017 the programme was suspended for the preparation of a new scheme
Source: Ministry of Economic Development of the Republic of Slovakia

Projects can focus on three areas – innovation of products, services and technologies. In the 2013-16 period, most projects focused on innovation of products (incl. new materials, changes of design, development of new products).

In the domain of data analytics, projects supported include: implementation of CRM software, tailor-made data analytics platforms, production optimisation using localisation technologies and the use of cloud and big data in diagnosis and intervention (special pedagogics). A preliminary analysis of the project applications received in 2018 shows that SMEs tend to focus increasingly on automatisation and digitisation of processes, including data analytics as a key component.

Success factors and problems encountered

This policy was considered a success by the government. During the first funding scheme in the period of 2013-2016, the innovation vouchers became well known to the expert public. The availability of vouchers was also advertised through the internet. The listed knowledge providers include the most respected R&D entities, such as the Slovak Academy of Sciences and Technical Universities, among others. The number of knowledge providers increased every year, and in June 2018 a total of 74 knowledge partners were listed.

The application process and management of the program is kept simple. Only a few steps are required to obtain the voucher, with low costs for SMEs. All forms are published online (e.g. project description, budget proposal) which allows SMEs to apply autonomously. Guidelines and consultations with the program administrator are available. Complete applications and the contracts are published in the Central Register of Contracts, ensuring transparency and public control.

The main challenge relates to the assessment of the long-term impact of the innovation vouchers. Without a precise ex-post survey, neither the Ministry of Economy nor the SIEA are able to monitor and/or evaluate the subsequent cooperation of an SME with the knowledge provider.

Conditions for transferability to other countries

Given their simplicity and relatively low cost for the administration, innovation vouchers can be easily adopted by other countries willing to support the uptake of data analytics by SMEs.

Source: Information provided by the Ministry of Economy of the Slovak Republic, 2018

Chapter 6. Conclusions

Data analytics techniques are becoming an increasingly important tool for the competitiveness of SMEs and entrepreneurs. The advent of Big Data and other key trends in recent technological developments (e.g. IoT, A.I., cloud computing, blockchain) open up new ways for businesses to innovate, compete and increase their productivity.

However, seizing such opportunities requires transformative actions, such as changing internal operations, marketing, delivery systems and reshaping the decision-making process to improve performance.

SMEs that aim to adopt data-driven strategies often face unequal access to data and limited capacity to manage privacy concerns in the gathering, storage and analysis of personal data. In addition, building a data management infrastructure can be challenging for resource-constrained SMEs. For example, innovative firms relying on intangible assets find it difficult to use them as collateral to receive loans from traditional financial institutions.

Nevertheless, the market for new digital financing instruments, while still limited in size, is expanding rapidly and may provide viable alternative sources of capital for start-ups and SMEs in the future. It is however essential for firms to master the digital skills that are needed to identify, understand and manage these opportunities.

Government policies can play a role in easing the digital transition for SMEs. Training programmes for upscaling digital skills (e.g. cybersecurity), regulations related to data protection, compliance guidelines, codes of conduct and open data initiatives can all contribute to raise awareness and promote healthy data management practices. Financial support can also help to advance the digitalisation of SMEs. In the data analytics space, for instance, a number of countries have been experimenting voucher programmes to support projects in SMEs.

This study offers an overview of the main trends, opportunities and challenges in the use of data analytics techniques by SMEs and provides policy examples across OECD countries. More efforts are needed to monitor the rapid evolution in the field, identify good practices and assess policy implications, such as the impact of data privacy regulation on SMEs, both as "consumers" of data services and as "data-handlers" themselves. The recent adoption of the GDPR in the European Union[10] may indeed provide a good case for assessing the higher costs induced by stricter standards as well as the potential benefits from enhanced data management in SMEs.

In the framework of the 2019-20 PWB, the WPSMEE will conduct work on “Enabling SMEs to benefit from digitalisation”. This work could build on and expand the present analysis, further investigating the opportunities deriving from data analytics for different types of SMEs and explore the most effective policies in the field. For example, additional work could focus on the impact of cheap and flexible cloud computing capabilities on SME productivity and the role of policies, at different levels of government, to ensure that SMEs reap the benefits of these expanding digital infrastructures and services. In addition, in the framework of the 2019-20 Going Digital Phase II project of the OECD, the WPSMEE could contribute to the analysis of the evolution of Artificial Intelligence and blockchain technologies and their foreseeable impacts on the business models of traditional and innovative SMEs.

[10] For example, in 2018 the Spanish parliament passed a new bill on personal data protection and digital rights to adapt the Spanish regulation to the GDPR.

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