SMART WORKING ACROSS ECONOMIC SECTORS IN EUROPE; THE MANIFOLD OF UBIQUITOUS BIG DATA

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Abstract:
The stream of the new society is driving us to smart working and the digital transformations is one of the most important engines. Using Big Data as an effect of the new digital tools such as Artificial Intelligence, Social media, the Internet of Things, etc., could indicate the potential smart working. Starting from the consideration that Big Data usage is ubiquitous and social and economic life depends on it more and more. We appreciate that this ubiquitous appearance is different at any time and everywhere. In our opinion, there are differences in the economic sector, size of the company, or geographic location. To appreciate these, it was supposed to find a way to measure the usage of the Big Date. The indicator and row data used was Big Bata analysis provided by EUROSTAT with a unit of Measure Percentage of enterprises where employed persons have internet access. The findings reconfirm that Big Data ubiquitous but highlight the manifolds of the usage depending on company size, location, and economic sector.

Keywords: *Big data, Digital transformation, Innovative behavior, new business models Smart working,* Sustainability

Introduction

Nowadays society, after facing the COVID-19 pandemic with a lot of restrictions has to adapt the working style and the business models accordingly. A big step was made by the digital transformation that was expected to be implemented for more than ten years but the process was slow.

Forced by necessity, the public organization and companies understood that sustainability stays in implementing the technology-driven models (Romanelli, 2022). Adopting combined hybrid working systems (digital and physical), and encouraging

innovative and collaborative work environments, the smart managers enforced smart innovative solutions and increased the organization's resilience (Romanelli, 2022). More than this Romanelli (2022) stated that the use of ICT, digital and interactive technology helps to drive sustainable public organizations, a remark that could be extended to the business as well.
The transformation to a hyper-connected society and economy, towards an "Industry 4.0" (W. Bauer et al., 2015) can be considered only if a critical mass is involved in digital transformation. Digitalization with all its components: infrastructure, application, and skilled human resources are the main tool for acceding to the next industrial level and changing many socio-economic behaviors.

Digitalization and data-intensive activities are the base of industry 4.0 and smart businesses or organizations. This technical update and tremendous upgrade could not be done without significantly changing human resources skills and organizational culture. The congruence of the technical aspects and the employees W. Bauer et al. (2015) examines the work architecture of qualification, leadership, and demography-resistant on the new framework.

Crowdsourcing is increasingly present in various areas, sometimes not expected, as a way of creating and sharing information and knowledge, offering services, and changing the world of work. Bauer & Gegenhuber (2015) identified four types of values for crowdsourcing actors: creative expertise, critical items, execution capacity, and bargaining power, due to its global dimension. The authors highlighted the tendency to twist and shift roles and attributes.

Cloud computing technology gives an example of the global dimension, a facile alternative to a classic database. The advantages of fewer investments and maintenance costs were highly appreciated by the financial institutions, but not only (Al-lawati et al., 2016). We have to be awarded by the accessibility and security of the storage data, and the fast cybernetic and digital crime evolution.

Under different labels Industry 4.0 (Europe), made in China 2025 (China), Smart Cities (Asia), Society 5.0 (Japan) or Industrial Internet (USA) is a global phenomenon with a strong impact on industrial policies. This transformed all the coordinates of the life-work framework Industry 4.0 claiming Quality 4.0., new skills being required as critical thinking, digital skills, Information and Communications Technology (ICT) knowledge, and big data usage (Santos et al, 2021). The changes in the professional's core knowledge and skills are now related to the challenges introduced by digital transformation, innovation, creativity, teamwork, mind flexibility, the know-how of new ITC applications and high wishful thinking to be in the stream. These are becoming reality only with the contribution of skilled human resources (Arora et al., 2021).

Our understanding is that the usage of big data gives a relevant hint of the potential for a fast and successful shift to smart working and business. The present study is mapping the usage of big data for several economic sectors in Europe for 2021.

Literature review

Smart working. The relationship between the employee and the organization is changing, more and more professionals are looking for flexible work and hybrid or full remote work, short-time contacts, or part-time jobs. The understanding of smart jobs involves an innovative, collaborative, motivational environment (Decastri, 2020). Smart working is related to talent hunting and expectation, more complex and changed from the regular, new component as ethics, personal valuation potential, and eco-friendly, green process being part of. The smart working organization culture includes cultural values, innovative behavior, collaborative work, and commitment (Romanelli, 2022). An image of a smart working based on big data is a retail store built on a complex interconnected database and interlinked big data systems from suppliers to distributors, banking system, and tax control (Evans & Kitchin, 2018). The smart working performance measurement proposed by Yuan et al. (2015) includes: 1) a smartphone-based APP to collect employee attendance, work, and location information; 2) a data warehouse to preprocess and store the data; and 3) a smart data analysis center to make a comprehensive and systematic evaluation of employee work performance.

Setting the work-life balance is the challenge to be addressed by smart work, both organization and employee benefiting an open, network results-oriented organization (Butera, 2020). Digital transformation and remote work with access to resources and the possibility to provide results on-tine, and work in a collaborative way, no matter the location of the professionals, is the way to be considered for a smart organization. The cultural change to new business models could be done innovatively, components of smart work supporting and speeding the process, and a road map of the process implementation must be considered by the management (Torre & Sarti, 2018).

Smart data using Big Data collected by the organizations, reunited in huge volumes, processed, filtered, cleansed, and offered to the decision-makers to be analyzed for insights (Foote, 2018). Big Data is characterized by value, variety, volume, velocity, and veracity. The difference between Big Data and Smart Data is the volume detection and the relevance increase. Foote (2018) appreciates that "Variety may, or may not, be reduced, depending on the screening process used to filter the data. Value, velocity, and veracity (accuracy) should all increase with the decrease in volume."

Data analysis plays a very important role in transforming data into information; they are techniques meant to eliminate the noise and retain useful data as usable information. They are transforming Big Data into Smart data when they act on large amounts of information, contributing to smart decisions (ESA, 2021). Smart data are accurate for machine learning, they give the possibility for the machines to identify patterns and efficiently and effectively adapt to the new tasks (ESA, 2021).

Digital transformation is present in the academic environment from two perspectives: 1) adapting the academic working space to the new challenges of cyberculture and 2) reforming the teaching programs to the new skills needs. The digitalization of the universities will include all structural aspects: infrastructure, human resources, management, and relationships. All teaching, researching, evaluating, and monitoring processes will be digitalized (Hahanov et al., 2016). Cloud mobile management based on metric measurement improves the education quality, research results, global visibility, and performance of scientists (Kurth et al., 2016). Moreover, a highly integrated smart factory concept is appreciated as a potential business or society model (Kurth et al., 2016).

An important factor of the digital transformation is human resources, the appetence of the employees for new opportunities, tools, and novelty is increasing the potential for adaptability and development (Abukhait et al., 2020). The new models in business consider the importance of competitive advantage built on knowledge transfer, innovation, and the employees' skills playing a significant role in the transformation into a smart organization (Graczyk-Kucharska et al., 2017).

Data analytics transforms government and business people, processes, and policy. Using the data could be created added value and engage the stakeholders and incorporate data resources in their analytical initiatives as they tackle important questions. The managers who understand and implement collaborative, inclusive networks that leverage knowledge from previous experiences to orient current analytical endeavors will drive the organization to a smart level. For example, the study of Cronemberger & Gil-Garcia (2022) suggests "that data analytics practices in local governments that implement a smart city agenda are knowledge-driven and developed incrementally through inclusive networks that leverage stakeholder knowledge and data resources."

Industry 4.0 is one of the challenges we are facing for a few years one pillar of this transformation is Big Data. While using Big Data represents an opportunity to improve performance, Big Data does not necessarily mean good data, it can be uncertain, imprecise, ambiguous, etc. Uncertainty is one of the most important risks to be addressed and confidence in the data source has to be increased.(Souifi et al., 2022). The impact of Industry 4.0 was investigated for cargo logistic business in Bangladesh and Canada using big data, smart factories, cyber-physical systems, and the Internet of things, showing differences for various countries. (Rahman et al., 2022)

We identify a gap in quantitative methods of measuring smart working in the literature. Our original contribution is to measure the presence of smart working by using big data, regardless of their typology, in different sectors of activity in Europe.

Big data usage is the first step to the digital transformation of the socio-economic and environment in a ubiquitous manner. The cleaned Big Data is Smart Data functional and valuable input for Artificial Intelligence (AI). IA algorithms becomes more and more accessible and with extremely rich applications. The typologies of big data are differentiated by the big data creation process, the technology of analysis, and by the economic data market. But beyond all these developments, there is more and more of a trend to specialize these tools according to economic sectors' specific activities.

We sketch some patterns of Big Data usage by sector profile, relevant issues of the present study are:
a) mapping the smart working development in 2020 by NUTS0 and sector
b) new skills development of human capital for new occupations.

Methodology

The research objectives are identifying patterns of Big Data usage by sector profile and new skills development of human capital for new occupations.

Butera (2020) appreciates that Big Data is ubiquitous regardless of economic sector, country, or company dimension. We appreciate that Big Data, although ubiquitous, has ways of measuring usage and differences based on the economic sector, country, and company size. The hypothesis is that Big Data usage is the same regardless of economic sector, place, or company size.

The research methods used by the authors for the present study are: statistical comparative analysis, Pareto graphs, and profiling of the sectors but Big Data usage. While its common to refer to Pareto as the "80/20" rule, under the assumption that, in all situations, 20% of causes determine 80% of results, this ratio is merely a convenient rule of thumb and is not, nor should it be considered, an immutable law of nature.

The indicator and the row data used was Big data analysis [ISOC_EB_BD] provided by EUROSTAT with a unit of Measure Percentage of enterprises where employed persons have internet access [PC_ENT_IUSE]. The economic sectors are considered at NACE rev 2(see Table 1) and the reference area covers EU-Member States, Iceland and Norway, Candidate countries, and potential Candidate countries (Eurostat, 2021). The considered indicator was measured by EUROSTAT using a sample of about 135000 companies of 1.4 million EU enterprises, covering all sizes (SE - small 10-49 employees, ME – medium 50-249 employees, SME - – small and medium 10-249 employees, LE – large > 250).

Table 1. Economic sectors covered: Enterprise size (10 or more employees and self-employed persons) and NACE Rev. 2

2 digits	1 digit	NACE Rev 2 sector
10_C10_33	C	Manufacturing
10_D35_E39	D-E	Electricity, gas, steam, air conditioning and water supply
10_F41_43	F	Construction
10_G45_47	G	Wholesale and retail trade; repair of motor vehicles and motorcycles
10_H49_53	H	Transportation and storage
10_I55	I	Accommodation
10_J58_63	J	Information and communication
10_L68	L	Real estate activities
10_M69_74	M	Professional, scientific and technical activities
10_N77_82	N	Rental and leasing activities, Employment, travel agency, security and investigation, service and landscape, office administrative and support activities

Source: authors selection, data Eurostat, 2021

The indicator and the raw data offered by EUROSTAT were grouped and selected the components that are giving a dimension of the smart working (see Table 2)

Table 2. Indicators of information society relevant for big data employees use

Code var	Variable
E_BDA	Analyse big data internally from any data source or externally
E_BDAINT	Analyse big data internally from any data source
E_BDAEXT	Have another enterprise or organisation perform big data analysis for the enterprise (externally)

E_BDBUY	Enterprises purchased (access to) any big data
E_BDSELL	Enterprises sold (access to) its own big data
E_BDAAM	Analyse big data internally using any method (of E_BDAML, E_BDANL, E_BDAOM)
E_BDAOM	Analyse big data internally using other methods (than E_BDAML, E_BDANL)
E_BDAML	Analyse big data internally using machine learning
E_BDANL	Analyse big data internally using natural language processing, natural language generation or speech recognition
E_BDAOS	Analyse big data from other sources (than E_BDASDS, E_BDALOC, E_BDASM)
E_BDASDS	Analyse big data from smart devices or sensors
E_BDALOC	Analyse big data from geolocation of portable devices
E_BDASM	Analyse big data generated from social media

Source: authors selection and synthesis, data Eurostat, 2021

We used the data of Eurostat Information and Communications Technologies (ICT) usage in enterprises (isoc_e). The collected raw data is very complex; Big Data is a component of the e-business, part of a vast area of digital transformation measures. There are collected data about: General information about ICT systems; Access to and use of the internet including mobile use of the internet, e-commerce, e-business including Cloud computing, Internet of Things, Big data analytics, 3D printing, Robotics, Artificial Intelligence, etc.; ICT specialists, training on ICT and e-skills; ICT security; Covid-19 impact (Eurostat, 2021). This study uses data for the 2020 year. Data was gathered on the basis of the National Statistical Institutes.

We used IBM SPSS Statistics 23 for the statistical analysis and the Pareto graphs to measure de manifolds of Big Data usage.

Results and discussion

We used relative data, and indirect measures for the smart working. The main conclusion is that the process of producing, exploiting, and usage of Big data is becoming more and more converted by the sector profile, dependent by location in two ways:

a) by the source of innovation
b) by the sectoral space dependence profile, if it is the case.

The research objectives and measure in a quantitative way the smart working by the proxy “Percentage of enterprises where persons employed have access to the internet and analyze big data internally from any data source or externally in 2020 in EU 27 and Romania any type of Big data analysis and source.

First, we select the data and organize them by company size. Table 3 presents the synthesis for EU-27 and Romania. It could be seen that the usage of Big Data belongs to the LE and significantly less to SMEs. Romania has a similar behavior as the European countries. The analyses of big data internally from any data source or externally, (E_BDA) present this activity as specific to LE. In the EU, the share of employees in LE using Big Data is 34% and for SE it is 13%. In Romania, the gap compared to the EU 27 average values is represented by levels of big data use with values 2 times lower. (Table 3)

The first result is NO validation of the hypothesis. Big Data usage is ubiquitous but is NOT the same by company size.

***Table 3.Big data usage by employees in firms by dimension* in 2020**

Code var	**European Union - 27 countries (from 2020)**					**Romania**				
	Total	**SE 10-49**	**ME 50-249**	**SME 10-249**	**LE >250**	**Total**	**SE 10-49**	**ME 50-249**	**SME 10-249**	**LE >250**
E_BDA	**15**	**13**	**21**	**14**	**34**	**6**	**6**	**8**	**6**	**14**
E_BDAINT	*13*	*11*	*19*	*12*	*31*	*5*	*5*	*6*	*5*	*13*
E_BDAEXT	*3*	*3*	*5*	*3*	*11*	*2*	*1*	*2*	*2*	*3*
E_BDBUY	***1***	***1***	***2***	***1***	***4***	***1***	***1***	***2***	***1***	***4***
E_BDSELL	***0***	***0***	***1***	***0***	***2***	***0***	***0***	***0***	***0***	***0***
E_BDAAM	**7**	**6**	**11**	**6**	**24**	**5**	**5**	**6**	**5**	**13**
E_BDAOM	*5*	*4*	*8*	*4*	*17*	*3*	*3*	*4*	*3*	*9*
E_BDAML	*3*	*2*	*4*	*2*	*11*	*2*	*1*	*2*	*1*	*5*
E_BDANL	*1*	*1*	*2*	*1*	*5*	*1*	*1*	*1*	*1*	*3*
E_BDAOS	**3**	**2**	**5**	**3**	**12**	**1**	**1**	**2**	**1**	**4**
E_BDASDS	*3*	*2*	*6*	*3*	*17*	*2*	*1*	*2*	*2*	*6*
E_BDALOC	*7*	*6*	*9*	*7*	*14*	*3*	*2*	*4*	*3*	*8*
E_BDASM	*7*	*6*	*9*	*6*	*15*	*2*	*2*	*3*	*2*	*5*

(Source: Big data analysis [ISOC_EB_BD], Eurostat)

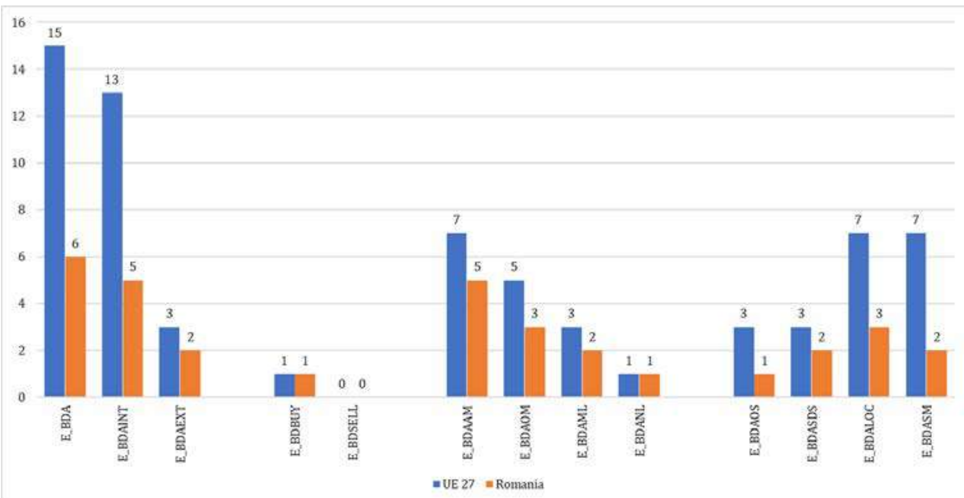
Smart market data (buy and sell) is reaching the average of UE only by the ME. In Romania, the market for data is not identified, neither for sales nor for buying, no matter the company size. We can underline that there are records for the LE, most probably the multinational, where the activity of buying data is about 4% in Romania and the EU.

The usage of Big Data can be done in various ways and they are contributing with different shares. Usage of Machine Learning or Artificial Intelligence (AI) is 3% for the EU and 2% for Romania, with the LE contributing with the larger share, in this case, 6 times more than the SE. The pattern is similar in Romania LE having 5 times the rate of SE. we can appreciate that there is a large gap between the LE and SE in using AI in EU countries. The usage of natural language processing or speech recognition is 3 times less in the EU and 2 times in Romania compared to Machine learning. but find the same gap between the LE and SE.

Considering the Big Data analysis on the type of the tool we should look at Smart devices and sensors that provide Big Data for 3% of the companies in the EU and 2% in Romania. Again the LE has 6 times more than SE, and the gap for Romania is only 3 times. Geo-location of portable devices smart devices or sensors provides 7% of Big Data for companies in the EU and 3% for Romanian companies. In this case, the gap between the LE and SE remains present (3-4 times more). Social media provides 7% of Big Data in the EU and 2% in Romania, with LE being the favorite.

The conclusion is that Big Data usage is present in all most companies but it significantly differs based on the company size, in accordance with our analysis of market share, analysis methods, and tools for collecting and reproducing data. It is obvious that the LE has a higher probability of Big Data usage than the SE and confirms the potential and the orientation to smart work.

Figure 1 Employees accessing the internet and analyses Big Data internally or externally in 2020 in EU 27 and Romania.



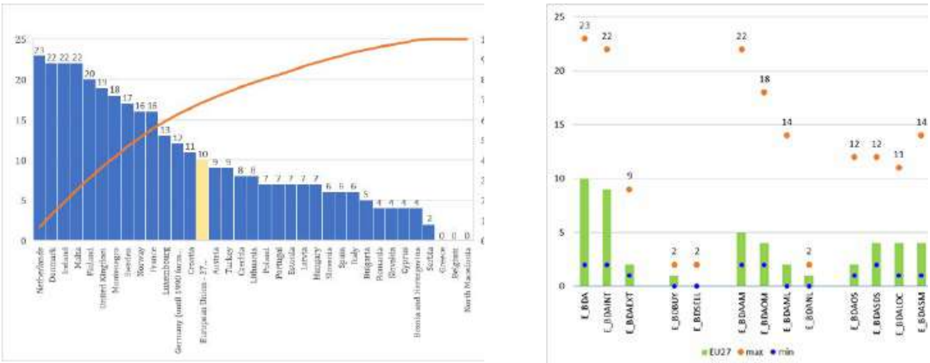
(Source: Big data analysis [ISOC_EB_BD], Eurostat)

It can be seen in figure 1 the Big Data analyses highlight the contribution of the Geo-location of portable devices smart devices or sensors and Social media, with shares of 7% for UE and 3% for Ro.

The usage of Big Data is at the 'start us' stage, the current activities indicate the production of Big Data and less the exploitation of them and the contribution of AI or the Internet of Things (IoT).

The second step of our analysis is the sectoral patterns by the percentage of enterprises where persons employed have access to the internet and analyze big data internally from any data source or externally in 2020 in EU 27 countries and other 6 European Countries by any type of Big data analysis and source (Source: Big data analysis [ISOC_EB_BD], Eurostat) and Pareto graphs.

Figure 2. Sector C - Manufacturing

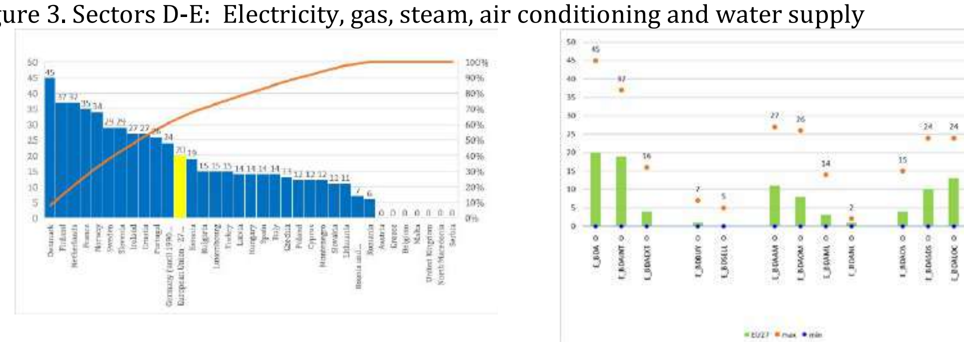


EBDA Pareto **BIG data usage**

Source: authors' representation (Big data analysis [ISOC_EB_BD], Eurostat

Figure 2 is presenting for the sector of manufacturing the specialized locations in using Big Data: Netherlands, Malta, Ireland, and Denmark. The main usage is internal (22% for EU), the market, both sales, and buying are low (about 2%), analyses methods – the most frequent is AI with 14% machine learning and tools are social media with a 14% maximum, geo-location with maxim 11% and sensors with 12% maximum.

Figure 3. Sectors D-E: Electricity, gas, steam, air conditioning and water supply

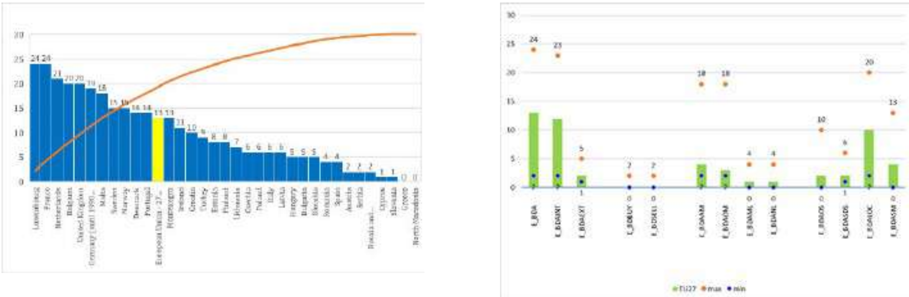


EBDA Pareto **BIG data usage**

Source: authors' representation (Big data analysis [ISOC_EB_BD], Eurostat

The Electricity, gas, steam, air conditioning and water supply sector (Figure 3) has the specialized locations on Denmark, Finland, Netherlands, France, and Norway. The predominant usage is internal (maximum 45% and average 20% in EU). The presence of the data market is modest with a maxim of 7% and an average of 5% in the EU, the most frequent method of analysis is AI and the tools are geo-location and sensors.

Figure 4. Sector F: Construction

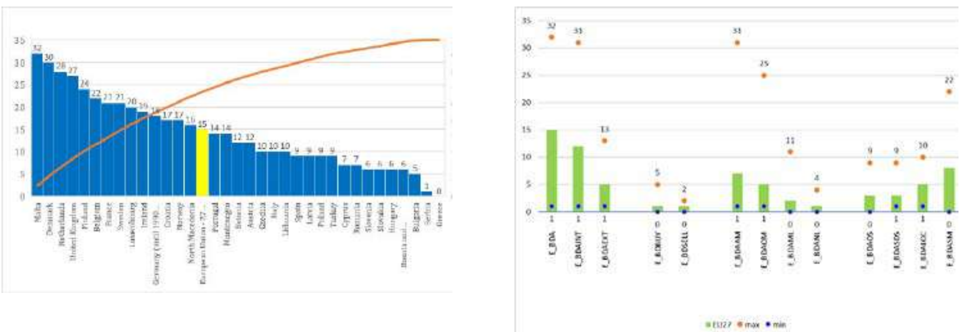


EBDA Pareto **BIG data usage**

Source: authors' representation (Big data analysis [ISOC_EB_BD], Eurostat

For constructions (Figure 4) the main locations are: Luxemburg, France, Netherlands, Belgium, UK, Germany, and Malta. The usage a mainly internal, but significantly higher (maximum 23%, average 12% for EU), the data market is very low, and the frequent method of analyses is AI and Natural Language Processing (NLP). The geolocation and social media are the most used tools.

Figure 5. Sector G: Wholesale and retail trade; repair of motor vehicles and motorcycles

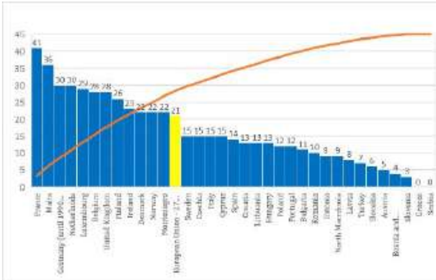


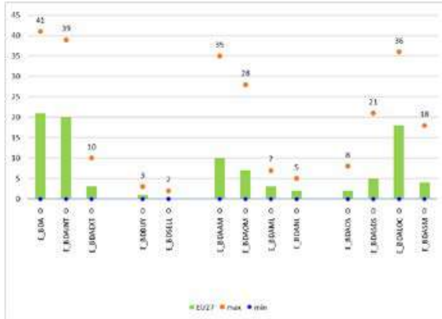
EBDA Pareto **BIG data usage**

Source: authors' representation (Big data analysis [ISOC_EB_BD], Eurostat

Wholesale and retail trade; repair of motor vehicles and motorcycles sector (Figure 5) has the specialized locations of Big Data usage in: Malta, Denmark, Netherlands, UK, Finland, Belgium, France, Sweden over 50% of the frequencies, usage is mainly internal (maximum 31% and average 12% for EU), market presence is low, analyses methods are AI and NLP and the tool is social media with a maximum of 22%.

Figure 6. Sector H: Transportation and storage



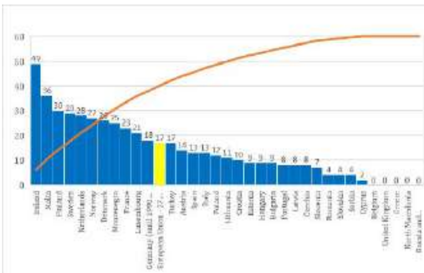


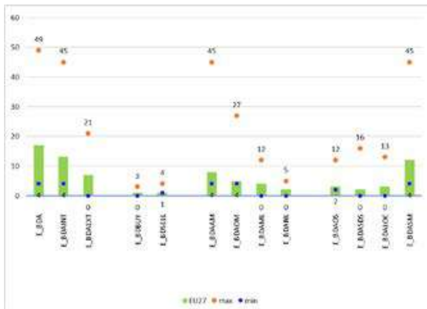
EBDA Pareto **BIG data usage**

Source: authors' representation (Big data analysis [ISOC_EB_BD], Eurostat

Transportation and storage (Figure 6) shows the most important locations for Big Data usage: France, Malta, Germany, Netherlands, Luxemburg, Belgium, UK, Finland, Ireland, and Denmark. The internal usage is Consistent, but low market share. The same methods of analysis are used and geo-location is the main tool.

Figure 7. I: Accommodation



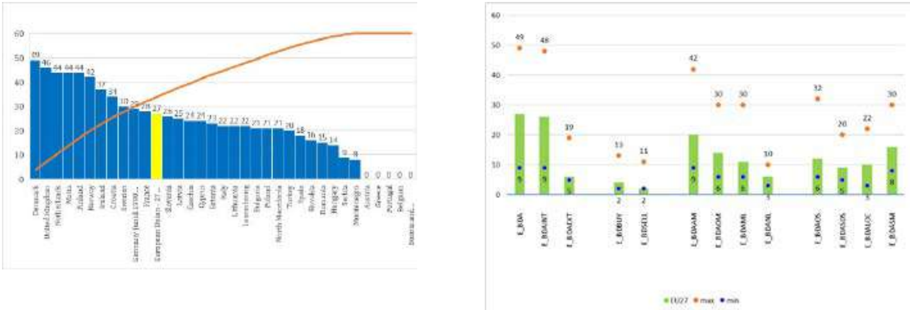


EBDA Pareto **BIG data usage**

Source: authors' representation (Big data analysis [ISOC_EB_BD], Eurostat

For the accommodation sector (Figure7) the specialized locations are: Ireland, Malta, Finland, Sweden, Netherlands, and Norway. We can appreciate that there is a prerequisite of a cluster. There is an internal high usage (maximum 45% and average of 13% for EU) and a low presence on the market, social media 12% media with a maximum of 45% is the main tool.

Figure 8. Sector J: Information and communication

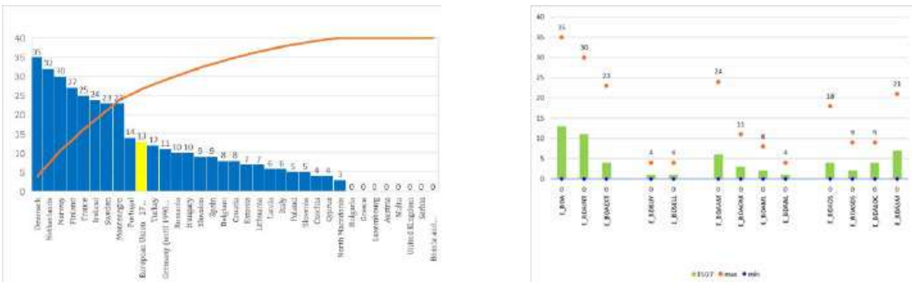


EBDA Pareto **BIG data usage**

Source: authors' representation (Big data analysis [ISOC_EB_BD], Eurostat

The Information and communication Sector (Figure 8) is very concentrated: Denmark, UK, Netherlands, Malta, Finland, Norway**,** and Ireland. The internal usage is very high (maximum 48% and average 26% for EU). Compared with the other sector, the market presence is high with a maximum of 13% and an average of 11% for the EU. The most present analysis method is Ai and the most used tool is social media.

Figure 9. L: Real estate activities

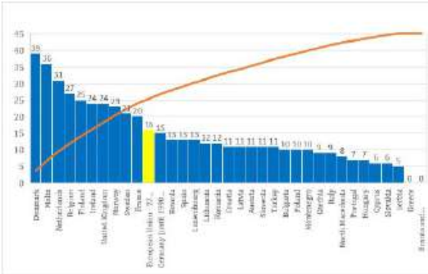


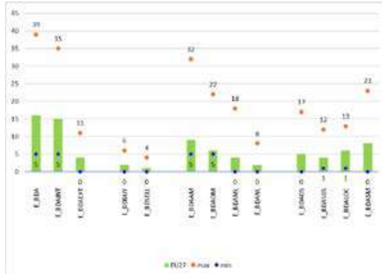
EBDA Pareto **BIG data usage**

Source: authors' representation (Big data analysis [ISOC_EB_BD], Eurostat

Another sector that has a very concentrate spatial usage is Real estate activities (Figure 9), the main locations are: Denmark, Netherlands, Norway, UK, Finland, France, Ireland, and Montenegro. A high internal usage with a maximum of 30% and an average of 11%, but a low market presence is recorded. Methods of analyses and tools are the same.

Figure 10. M: Professional, scientific, and technical activities



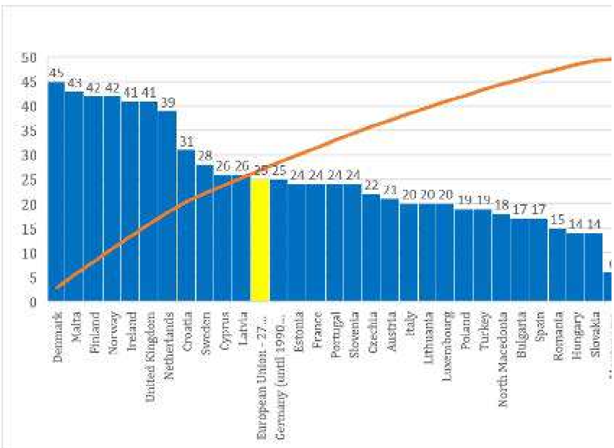


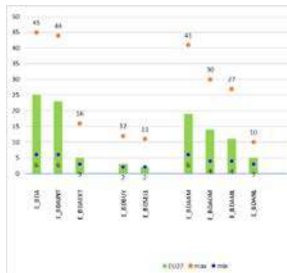
EBDA Pareto **BIG data usage**

Source: authors' representation (Big data analysis [ISOC_EB_BD], Eurostat

Professional, scientific and technical activities (Figure 10) is also very concentrated in terms of space usage of Big Data, the main location are: Denmark, Malta, Netherlands, Belgium, Finland, Ireland, UK, Norway, Sweden, France. The internal usage is high and the market presence is medium. Ai and Social media are the main methods and tools used.

Figure 11. N: Rental and leasing activities, Employment, travel agency, security and investigation, service and landscape, office administrative and support activities





EBDA Pareto **BIG data usage**

Source: authors' representation (Big data analysis [ISOC_EB_BD], Eurostat

For Rental and leasing activities, Employment, travel agency, security and investigation, service and landscape, office administrative and support activities the main locations are Denmark, Malta, Finland, Northway, Ireland, UK, Netherlands, Croatia, Sweden, Cyprus, Latvia.

Conclusions

Our Hypothesis: Big data usage is the same regardless of the economic sector and space is informed. The huge development of Big data usage is more specialized than we expected and more localized. The process of innovation contamination is still in development. While is still new Big data usage offers a monopole advantage for the pioneers.

It could be seen from the analysis that the LE are the main beneficiary and contributors of the Big Data usage compared with SE or ME, or even SMEs, their presence being several times higher. In terms of sector, it is obvious that Big Data usage is ubiquitous, but it takes manifolds pending the activity characteristics. The geographic spread of the Big Data usage analysis shows that the Pareto distribution (we do not apply the strictly 80/20 rule) is located in several, usually 6-7 countries. On the other hand, we identify a regional concentration that is the initial stage of cauterization.

In conclusion, the process of producing, exploiting, and using Big data is becoming increasingly transformed by the sector profile, dependent by location in two ways>

a) By the source of innovation
b) BY the sectoral space dependence profile, if it is the case.

Major limitations of the current research are related to using relative data and indirect measures for smart working. Smart working is ubiquitous in the new content of work, but, according to sectoral Big Data usage specificities, the potential occupational mobility could be infringed. Further developments of the study are a deep analyze of the localization of the Big Data usage, the potential of cauterization, and the overlay effect of the sectors. A new dimension could be exploring Big Data usage in education and research and the overlay effect on the economic sector.
Nevertheless, the present paper is the first attempt to measure the potential of smart working through Big Data usage.

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